ADDENDUM #1
DESIGN SERVICES FOR KENNEBEC WATER DISTRICT'S WATER TREATMENT PLANT PFAS MITIGATION UPGRADES PROJECT

July 18, 2025

To All Bidders:
This addendum is issued to clarify and/or modify the RFP for the above titled project. Any and all changes to the RFP are valid only if they are included by written addendum and distributed to all potential respondents, which will be emailed prior to the RFP Deadline to all who are known to have received the RFP. Each Bidder must acknowledge receipt of any addenda by responding to the email for the respective addenda. Each Bidder, by acknowledging receipt of addenda, is responsible for the contents of the addenda and any changes to the project's scope or requirements therein. Failure to acknowledge receipt of addenda may cause the Bid to be rejected. If any language or figures contained in this addendum are in conflict with the original RFP, this addendum shall prevail.

Questions:

1) Can we get a copy of the Pre-Submission Meeting Notes?
   Answer: A copy of the Pre-Submission Meeting Notes are included with this addendum.

2) Can you provide a copy of the most recent wetlands survey for the area behind the treatment plant?
   Answer: A copy of the most recent wetlands survey are included with this addendum.

3) Can you provide a copy of the most recent design files for the lagoon discharge project?
   Answer: A copy of the design drawings and basis of design equipment cut sheets for the lagoon discharge project are included with this addendum. This also includes electrical drawings and specifications provided by Automatrix.

DESIGN SERVICES FOR KENNEBEC WATER DISTRICT'S WATER TREATMENT PLANT PFAS MITIGATION UPGRADES PROJECT
PRE-BID MEETING NOTES
JULY 1, 2025

1) Introductions

a. Roger Crouse – General Manager
b. Robbie Bickford – Water Quality Manager
c. Max Kenney – Senior Project Manager
d. Kendra Nash –Maine Drinking Water Program
e. Matt Zetterman – Engineering Manager

2) **Project Background**

a. CDM Smith completed a Basis of Design Memorandum in 2023, explored PFAS treatment options.
b. Evaluated options included alternative carbon types in existing filter beds and pressure vessels with carbon, resin, and novel sorbents.
c. Bench-scale of the above media alternatives and full-scale testing of GAC media was conducted.
d. Preliminary design for a new building with pressure vessels was developed.
e. Final decision: Proceed with more frequent carbon changes using a new carbon specification rather than constructing a new facility with pressure vessels.
f. Operating costs were similar, but capital funding for a new facility was unlikely.
g. Full-scale pilot testing of the new carbon spec was successful.
h. Avoided de-rating the treatment plant from 12 MGD to 6 MGD with this option.
i. $8 million in funding secured for PFAS treatment but not specific to carbon changeouts.
j. Current project scope expected to cost multiple millions of dollars but less than the original $8 million.
k. The technical memorandum from this project will guide discussions with the Maine DWP regarding the revised approach.

3) Project Overview

a. Develop a technical memorandum evaluating multiple projects to support more frequent carbon changeouts. Include cost estimates for each option. No design work expected at this stage, but a thorough evaluation is required.
b. Key Projects Under Consideration (including but not limited to):
    i. New piping for carbon addition/removal in each filter.
    ii. Outdoor hose connection for water supply during carbon transfer.
    iii. Pavement improvements for truck access to filter bays.
    iv. Replacement of 30+ year-old surface scour and backwash pumps.
    v. Discharge of lagoon water to nearby outlet stream (project already underway).
    vi. One full round of: carbon replacement, filter upgrades, HVAC improvements.

vii. Open to additional project ideas; proposals should include time for exploring alternatives.

4) RFP Schedule

a. Questions Due: July 16, 2025 (via email)
b. Proposals Due: July 24, 2025 (via email)
c. Anticipated Award Date: August 7, 2025 (Board of Trustees Meeting)
d. Draft Memorandum Due: September 15, 2025
e. Final Memorandum Due: October 15, 2025

5) Tour

a. Led by Robbie Bickford following the meeting discussion.

Questions

b. Can you provide wetlands survey for behind treatment plant?
c. Can you provide design for lagoon discharge portion of project?

KWD
Kennebec Water District

DESIGN SERVICES FOR KENNEBEC WATER DISTRICT'S WATER TREATMENT PLANT PFAS MITIGATION UPGRADES PROJECT
PRE-SUBMISSION MEETING ATTENDANCE SHEET
JULY 1, 2025
1:00 PM

Company	Name	Email	Phone
Wright-Pierce	Darrin D. Lary	darrin.lary@wright-pierce.com	207-798-3761
Tighe & Bond	Heidi Baird	hrbaird@tighebond.com	207-603-2917
Tighe & Bond	Meghan Trahan	mtrahan@wpi.edu	603-320-5879
CDM Smith	A LEBLANC	LEBLANCAG@cdmsmith.com	603 222 8380
CDMSmith	Anne Malenfant	malenfantae@cdmsmith.com	(617) 452-6638
CDM Smith	Victoria Hawkes	hawkesvg@cdmsmith.com	603-222-8315
CDC-DWP	Kendra Nash	kendra.nash@maine.gov	207-441-4022
Haley Ward	Joshua Saucier	jsaucier@haleyward.com	207-735-5117

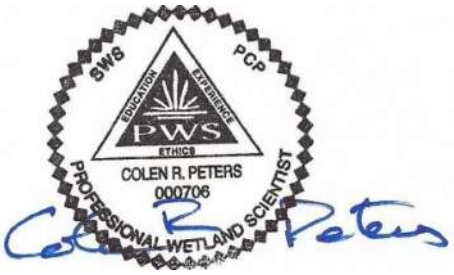
Wetland Review

To: **Owens McCullough, P.E., Project Manager**

From: **Cole Peters, PWS**

Date: **January 13, 2025**

Project: **240551 – Kennebec Water Treatment Plant, Vassalboro, ME**



On December 3, 2024, wetland boundaries previously delineated by FB Environmental on the west side of Main Street (Route 32) in Vassalboro (Site) were reviewed and specific segments immediately adjacent to the Kennebec Water District Treatment Plant to the south, were located with a handheld GPS (global position system) unit capable of submeter accuracy (Figure 1). The Site ranges between approximately 188 to 200 ft in elevation and generally slopes to the northeast and, also to the south. Two intermittent drainage courses (one draining to the northeast and the other draining southwest) are depicted at the Site on the USGS 2024 China Lake ME 7.5-minute Quadrangle Map. The Federal Emergency Management Agency (FEMA) has prepared a Flood Insurance Rate Map (FIRM) for this part of Vassalboro (Community Panel Number 23011C0380D effective date 6/16/2011) and no part of the Site occurs in a FEMA designated 100-year floodplain (Zone A). The Town's February 10, 2011, Shoreland Zoning Map indicates no part of the Site is subject to the Shoreland Zoning Ordinance.

Wetland Delineation:
The wetland boundary at the Site is described by FB Environmental to have been delineated in accordance with the 1987 *US Army Corps of Engineers Wetland Delineation Manual*, and the subsequent *Regional Supplement to the US Army Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region* (January 2012). Evidence indicative of wetland from three parameters – vegetation, soils and hydrology – is used to identify and delineate the wetlands and except for unusual or atypical situations, evidence of wetland must be exhibited by all three parameters for an area or position to be designated as wetland. FB Environmental has identified locations of USACE plots to document evidence used to delineate the wetland boundary with pink flagging (Photo 1).

The deciduous forested freshwater wetland (PFO1) at the Site is chiefly dominated by red maple (*Acer rubrum*) which is identified as an indicator of wetland or hydrophyte in the 2022 *National Wetland Plant List*[1] prepared by the US Army Corps of Engineers (USACE). The medium intensity soil survey prepared by the USDA Natural Resource Conservation Service (NRCS) indicates the Scantic silt loam (ScA) occurs in areas of the Site delineated as wetland. The Scantic Series is classified as poorly drained" (PD), and designated as being "hydric", or indicative of wetlands by NRCS. Hydrology is the "*driving force*" of wetlands (Mitch and Gosselink, 1986)[2] and is inherently responsible for the adaptation by certain vegetation (hydrophytes) and development of specific soil characteristics (hydric) indicative of wetlands.

[1] USACOE NWPL, 2022. https://wetland-plants.sec.usace.army.mil/mapper/NCNE
[2] Mitch, W.J., and Gosselink, J.G., 2000. *Wetlands* (3rd ed.), Van Nostrand Reinhold Company, NY, 920 pgs.

Evidence indicative of wetland hydrology observed at the Site includes soils saturated within 12-inches of the surface, small, localized areas of surface water, and water-stained leaves.

Watercourses:

"Rivers, streams or brooks" (**RSB**) are a designated resource of the Natural Resources Protection Act (NRPA- 38 M.R.S.A. §480-B (9)) regulated by the Maine Department of Environmental Protection (MDEP). To be regulated as an RSB under the NRPA, two of five characteristics must be present in *a channel between defined banks created by the action of surface water*. Appearance as a blue line on a USGS 7.5-minute quadrangle map is one of five potential diagnostic criteria and the four other definitive characteristics indicative of regulated RSB include- flow duration of at least 6 months of the year in most years, substrate character, presence of aquatic flora, and presence aquatic fauna. The NRPA states: "RSB" does not mean a ditch or other drainage way constructed, or constructed and maintained, solely for the purpose of draining stormwater or a grassy swale." Mapping by FB Environmental identified ditches and as noted above, two intermittent drainage courses appear on the USGS map, however no channels between defined banks created by the action of surface water were observed in the area reviewed on December 3, 2024.

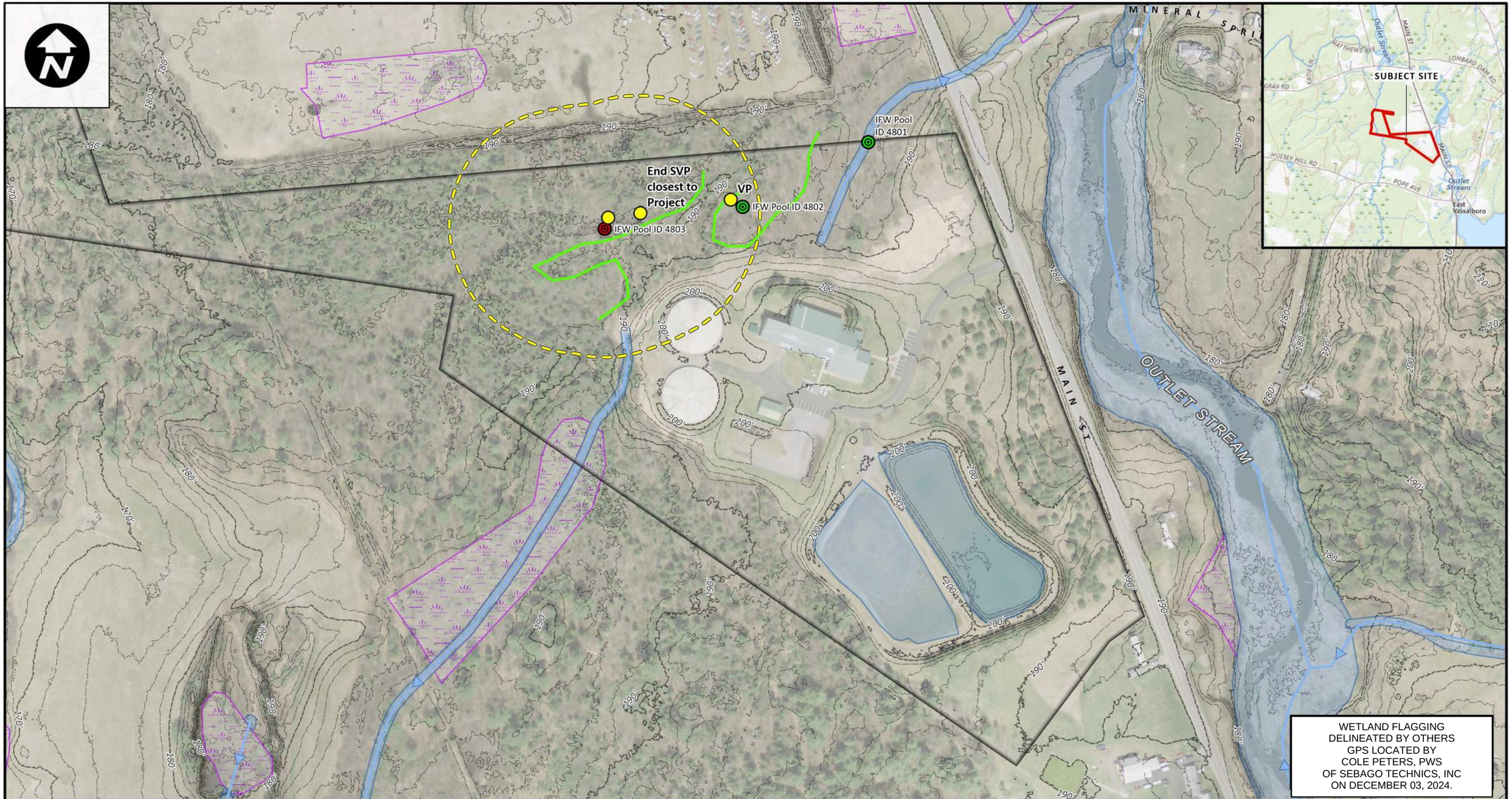
Vernal Pools:

Three vernal pools (**VP**s) have been identified in the wetland at the Site by FB Environmental. The west-most VP (Photos 2, 3) has been designated as a significant vernal pool (**SVP**) #4803 by the Maine Department of Inland Fisheries and Wildlife (MDIFW) but the two other VPs to the east (#4801, #4802) are not significant (Figure 1). Critical terrestrial habitat within the 250 feet around an SVP is referred to as "significant vernal pool habitat" (**SVPH**- Ch 335 §9A (7)), a form of "significant wildlife habitat" (**SWH**) - 38 M.R.S.A. §480-B (10)) regulated under the provisions of the NRPA, and wetlands containing SWH are regulated as a "wetland of special significance" (**WOSS**- (Ch 310 §4A (2)). Provided specific standards are adhered to, specific activities in, on or over SVPH can be authorized under Permit by Rule Standards (Ch 305 §19) of the NRPA.

Photo 1: A handheld GPS unit was used to locate the boundary of the deciduous forested wetland (PFO1) previously delineated by FB Environmental with pink flagging.

Photo 2: GPS also used to locate blue flagging corresponding to the Significant Vernal Pool #4803.

Photo 3: Regularly mown lawn occurs between the Kennebec Water District Treatment Plant and the 250 ft of Significant Wildlife Habitat surrounding Significant Vernal Pool #4803 (Figure 1).



SEBAGO TECHNICS

WWW.SEBAGOTECHNICS.COM

75 John Roberts Rd. - Suite 4A
South Portland, ME 04106
Tel. 207-200-2100

0 200 400 600

Feet

1" = 200' when printed at 11 x 17

FIGURE 1: NATURAL RESOURCES MAP

KENNEBEC WATER DISTRICT TREATMENT PLANT

INFORMATION: MAINE GEOLIBRARY
2022 USGS LIDAR CONTOURS
2013 ORTHOREGIONAL IMAGERY

THIS IS NOT A BOUNDARY SURVEY.
WETLAND AND VERNAL POOL FEATURES WERE DELINEATED USING GPS TECHNOLOGY CAPABLE OF SUB-METER ACCURACY.

LOCATION:
462 MAIN STREET
VASSALBORO, MAINE

DATE: 12/16/2024

PROJECT NUMBER: 240551

240551.aprx

SUBJECT SITE

SEBAGO TECHNICS, INC.
GPS DATA COLLECTED 2024-12-03

DELINEATED WETLAND BOUNDARY

STATE REGISTERED VP CENTERPOINT
SIGNIFICANT
NOT SIGNIFICANT, DOES NOT MEET THE BIOLOGICAL CRITERIA

STATE REGISTERED SIGNIFICANT VERNAL POOL HABITAT - 250' SETBACK

NHD STREAM

NATIONAL WETLAND INVENTORY
LAKE, FRESHWATER POND, & RIVERINE WETLANDS
WETLANDS

Map Projection : NAD 1983 StatePlane Maine West FIPS 1802 (INT Feet)

Kennebec Water District

SINCE 1899

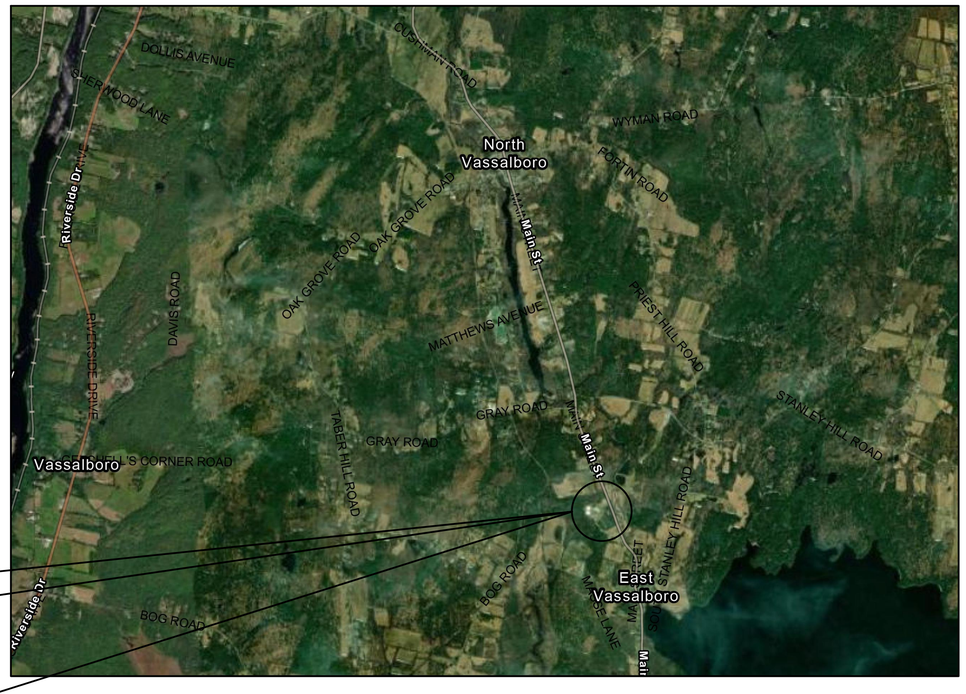
131 DRUMMOND AVE.
WATERVILLE, MAINE 04901
(207) 872-2763

SHT. NO.	DESCRIPTION
1	INTERIOR WATER TREATMENT PLANT AND RECYCLE PUMP STATION DEMOLITION PLAN
2	INTERIOR WATER TREATMENT PLANT PROPOSED PIPING PLAN
3	RECYCLE PUMP STATION MODIFICATIONS PLAN
4	EXTERNAL LAGOON DISCHARGE PIPING PROFILE AND SITE PLAN
5	DISCHARGE DETAILS

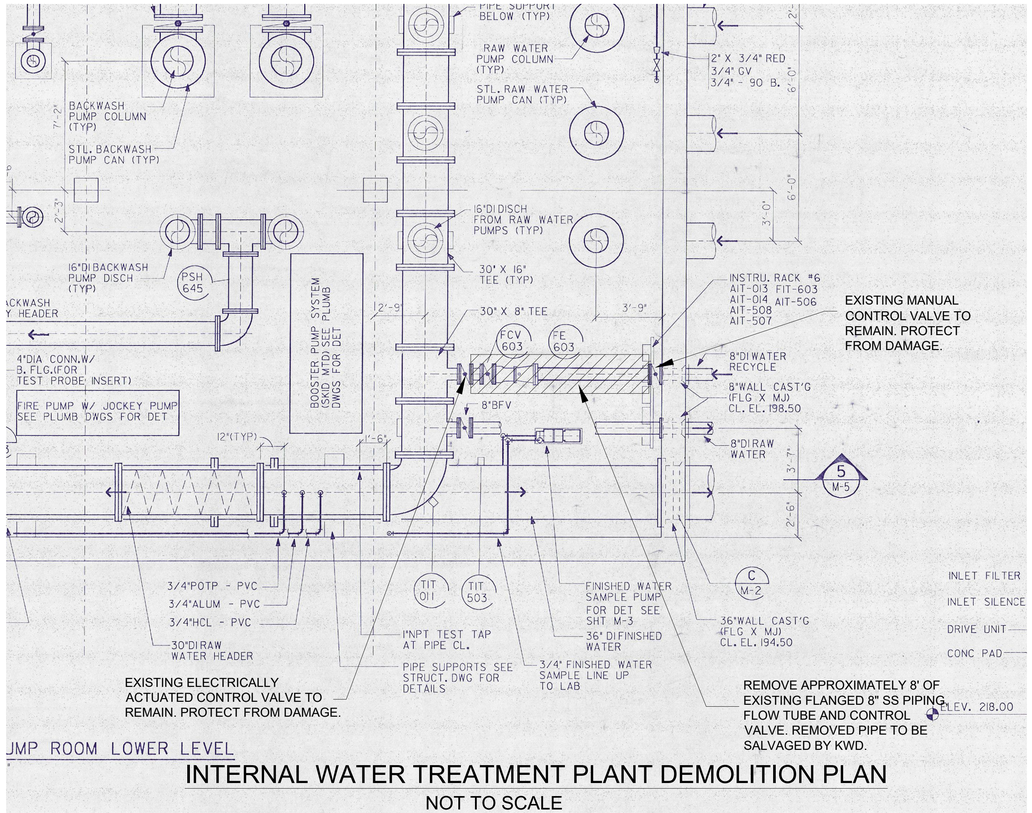
WATER TREATMENT PLANT LAGOON EFFLUENT SYSTEM UPGRADES

ISSUED FOR CONSTRUCTION: _____ 2024

KWD JOB # 28207

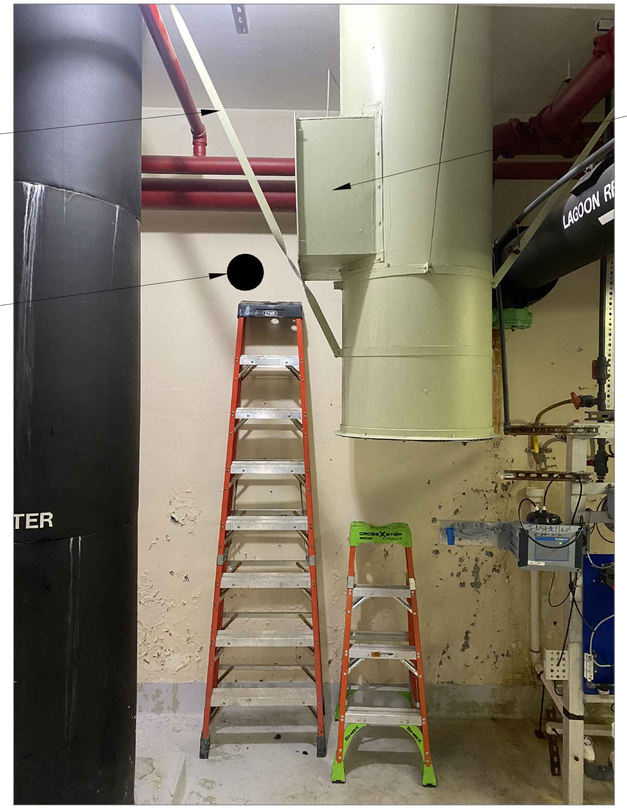


PROJECT LOCATION:
462 MAIN STREET
VASSALBORO, MAINE



INTERNAL WATER TREATMENT PLANT DEMOLITION PLAN

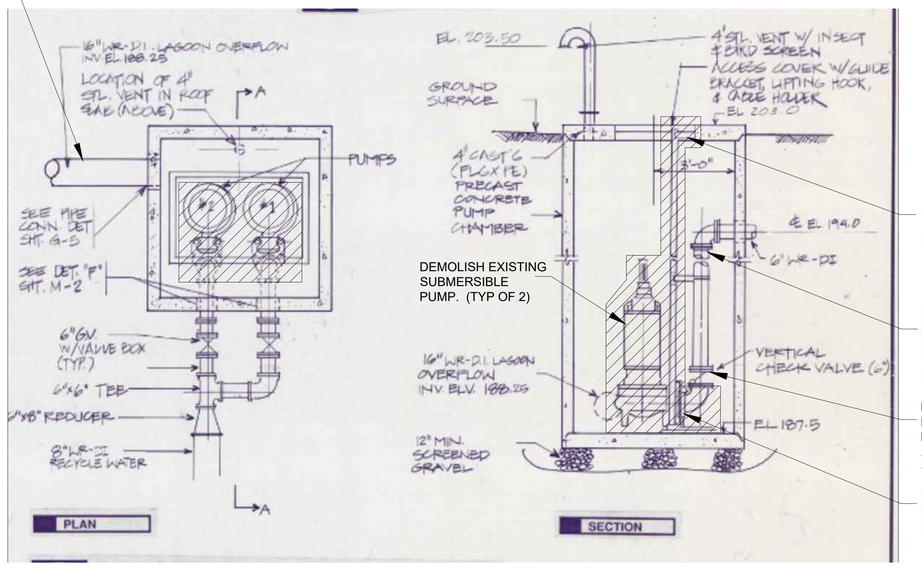
NOT TO SCALE



SOME LEAK-BY IS ANTICIPATED UPON SHUTDOWN OF THE LAGOON DECANT SYSTEM. CONTRACTOR SHALL PROVIDE INFLATABLE PIPE PLUG OR OTHER MEANS OF CONTROLLING FLOW..

NOTES:

1. 1993 RECORD DRAWINGS INDICATED A SQUARE BASIN T FOR THE PUMP STATION. PUMP STATION IS CIRCULAR AS SHOWN ON SHEET 3.
2. EXISTING PUMPS AND BASE ELBOWS SHALL BE REMOVED UNDAMAGED AND PROVIDED TO KWD IN WORKING CONDITION.
3. KWD CAN SHUT DOWN THE RECYCLE SYSTEM FOR A MAXIMUM OF 4 DAYS AT A TIME WITH 7 DAYS BETWEEN SHUTDOWNS. CONTRACTOR SHALL PLAN FOR COMPLETION OF THE WORK WITHIN THIS ALLOTTED TIME. PROVIDE KWD WITH 7 DAYS NOTICE PRIOR TO BEGINNING WORK THAT REQUIRES A SHUTDOWN OF THE RECYCLE PUMP STATION. CONTRACTOR SHALL DEMOLISH ONE PUMP PER SHUTDOWN CYCLE.
4. ALL ANCHOR BOLTS TO BE ABANDONED AS A RESULT OF DEMOLISHED ITEMS SHALL BE CUT OFF AND GROUND FLUSH WITH THE ADJACENT WALL OR SLAB SURFACES.
5. ANY HOLES LEFT FROM REMOVAL OF EQUIPMENT OR ANCHOR BOLTS SHALL BE IN FILLED WITH NON-SHRINK GROUT.
6. ELEVATIONS AND DIMENSIONS FROM 1993 RECORD DRAWINGS SHOULD NOT BE COMPARED TO THOSE FROM THIS PLANSET.



RECYCLE PUMP STATION DEMOLITION PLAN

NOT TO SCALE

No.	Revision	Date
1	_____	_____

INTERIOR WATER TREATMENT PLANT AND RECYCLE PUMP STATION DEMOLITION PLAN

PROJECT: WATER TREATMENT PLANT LAGOON EFFLUENT SYSTEM UPGRADES

DATE: _____

KWD
Kennebec Water District
131 DRUMMOND AVE.
WATERVILLE, MAINE 04901
(207) 872-2763

SURVEY BY: BB (KWD)

DRAWN BY: BB

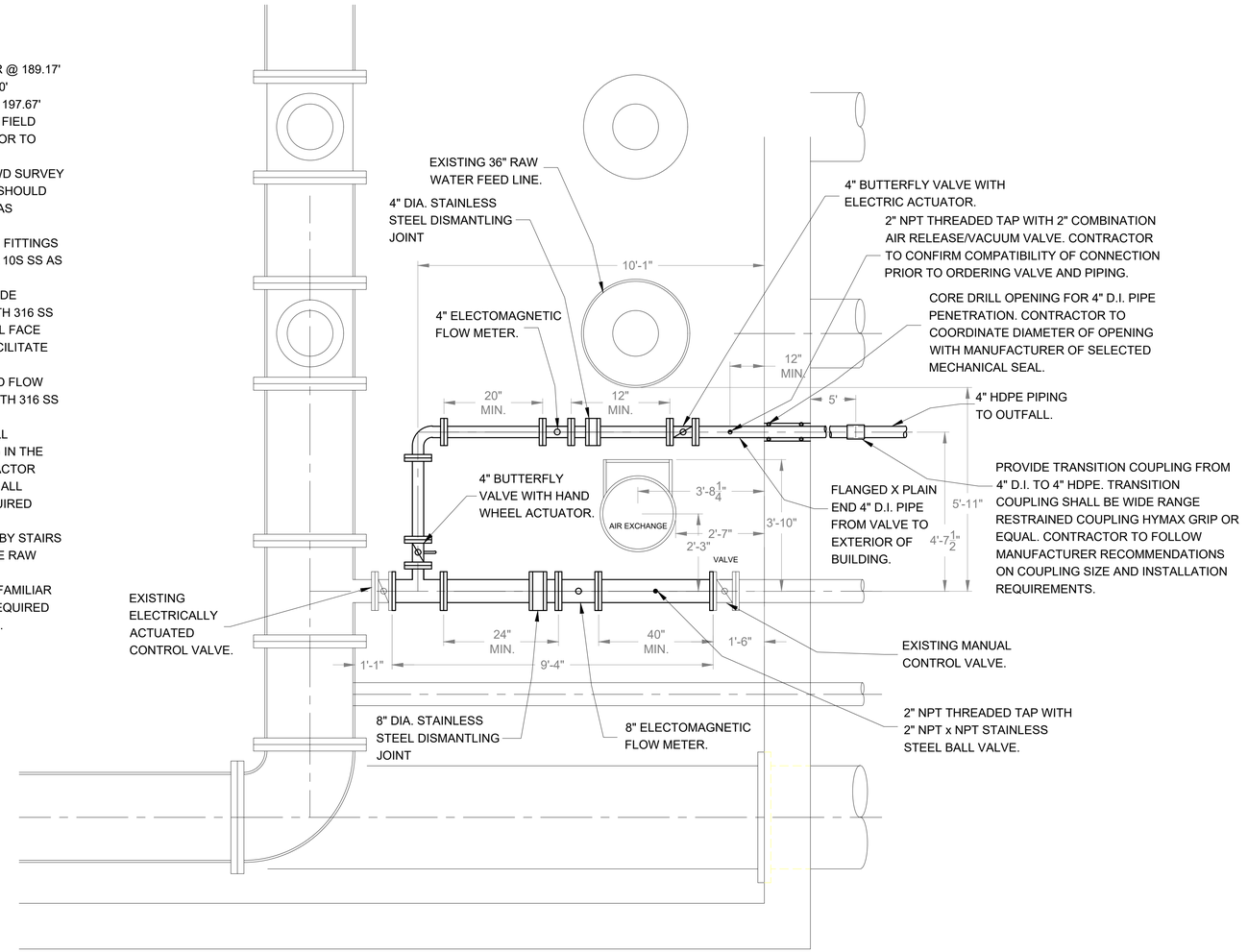
FILE: WTP-DISCHARGE.dwg

WORK ORDER 21-WII

SHEET NO. 1 OF 5

NOTES:

1. ELEVATION OF FINISHED FLOOR @ 189.17'
2. ELEVATION OF CEILING @ 201.00'
3. CENTERLINE OF NEW PIPING @ 197.67'
4. ALL PIPING LENGTHS SHALL BE FIELD VERIFIED BY CONTRACTOR PRIOR TO MANUFACTURING.
5. ELEVATIONS ARE BASED ON KWD SURVEY DONE FOR THIS PROJECT AND SHOULD BE VERIFIED BY CONTRACTOR AS REQUIRED.
6. ALL INTERNAL NEW PIPING AND FITTINGS INSIDE THE WTP SHALL BE 304L 10S SS AS SPECIFIED.
7. FOR PIPE PENETRATION, PROVIDE DOUBLE MECHANICAL SEAL WITH 316 SS HARDWARE. BOLT HEADS SHALL FACE THE INSIDE OF THE WTP TO FACILITATE FUTURE TIGHTENING.
8. ALL NEW VALVES, FITTINGS AND FLOW METERS SHALL BE FLANGED WITH 316 SS BOLTS AND HARDWARE.
9. PLAN IS NOT REFLECTIVE OF ALL EXISTING SYSTEMS AND PIPING IN THE WTP BASEMENT AREA. CONTRACTOR SHALL BECOME FAMILIAR WITH ALL EXISTING CONDITIONS AS REQUIRED PRIOR TO BEGINNING WORK.
10. ACCESS TO WTP BASEMENT IS BY STAIRS AND 4'x4' ACCESS HATCH IN THE RAW WATER PUMP ROOM ABOVE. CONTRACTOR SHALL BECOME FAMILIAR WITH AVAILABLE ACCESS AS REQUIRED PRIOR TO THE START OF WORK.



LAGOON WATER RECYCLE AND DISCHARGE PIPING MODIFICATIONS PLAN

NOT TO SCALE

No.	Revision	Date
1	_____	_____

INTERIOR WATER TREATMENT PLANT PROPOSED PIPING PLAN

PROJECT: WATER TREATMENT PLANT LAGOON EFFLUENT SYSTEM UPGRADES

DATE: _____

131 DRUMMOND AVE.
WATERVILLE, MAINE 04901
(207) 872-2763
KWD Kennebec Water District

SURVEY BY: BB (KWD)

DRAWN BY: BB

FILE: WTP-DISCHARGE.dwg

WORK ORDER 21-WII

SHEET NO. 2 OF 5

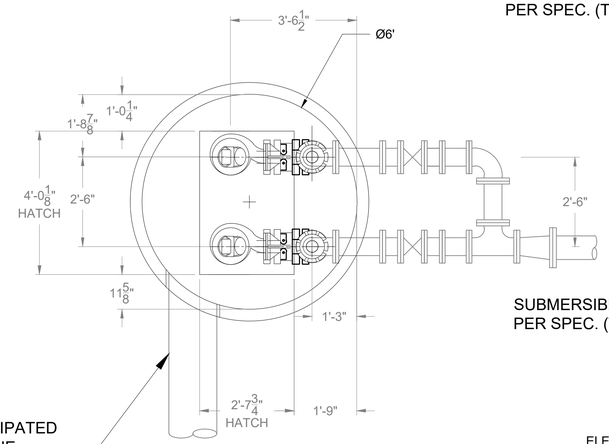
NOTES:

1. KWD CAN SHUT DOWN THE RECYCLE SYSTEM FOR A MAXIMUM OF 4 DAYS AT A TIME WITH 7 DAYS BETWEEN SHUTDOWNS. CONTRACTOR SHALL PLAN FOR COMPLETION OF THE WORK WITHIN THIS ALLOTTED TIME. PROVIDE KWD WITH 7 DAYS NOTICE PRIOR TO BEGINNING WORK THAT REQUIRES A SHUTDOWN OF THE RECYCLE PUMP STATION. CONTRACTOR SHALL INSTALL ONE PUMP PER SHUTDOWN CYCLE.

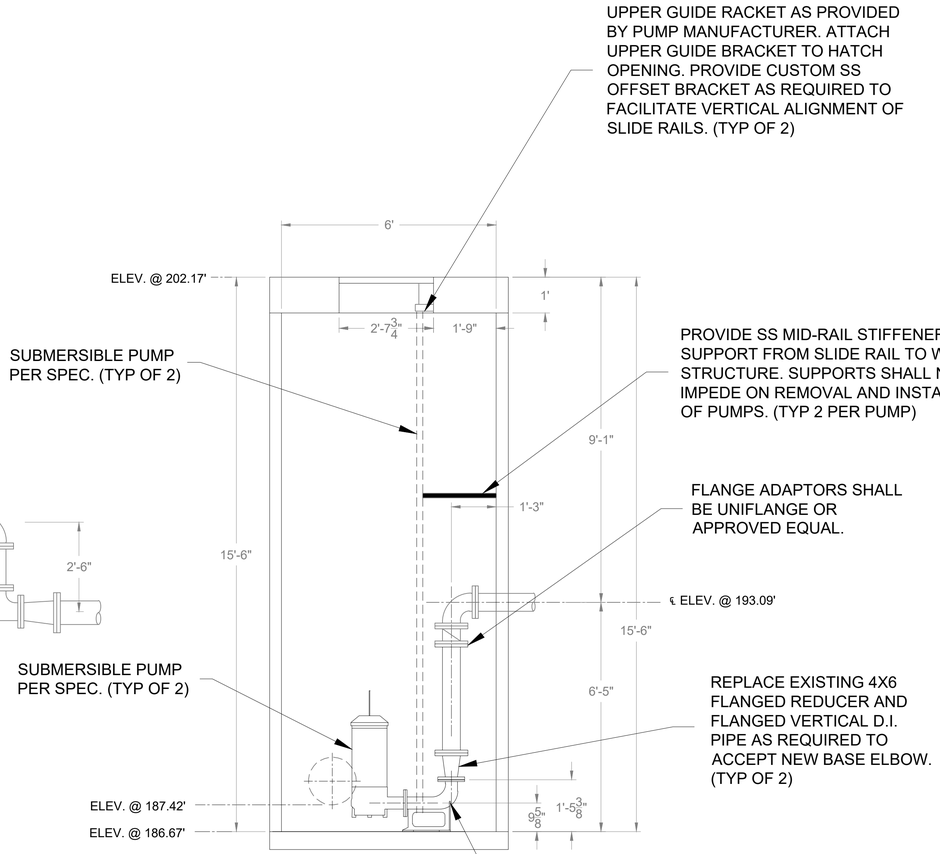
2. CONTRACTOR SHALL COORDINATE PUMP DIMENSIONS WITH THE AVAILABLE CLEAR OPENING AREA OF THE HATCH. PUMP REMOVAL SHALL NOT BE IMPEDED BY THE EXISTING HATCH.

3. STRUCTURE COVER INCLUDES VENT PIPE, CRANE BASE AND OTHER COMPONENTS NOT SHOWN ON THE PLANS. CONTRACTOR SHALL BECOME FAMILIAR WITH THE EXISTING SYSTEMS AND CONSTRAINTS.

4. CONTRACTOR TO PROVIDE 20' OF 316 SS LIFTING CABLE ATTACHED TO LIFTING BAIL OF PUMP. LIFTING CABLE SHALL INCLUDE LOPPED ENDS FREE OF SHARP PROTRUDING CABLE STRANDS. CABLE WEIGHT RATING SHALL BE PER THE PUMP MANUFACTURER RECOMMENDATIONS.



SOME LEAK-BY IS ANTICIPATED UPON SHUTDOWN OF THE LAGOON DECANT SYSTEM. CONTRACTOR SHALL PROVIDE INFLATABLE PIPE PLUG OF OTHER MEANS OF CONTROLLING FLOW.



RECYLCE PUMP STATION MODIFICATIONS PLAN

SCALE: 1/2" = 1'-0"

No.	Revision	Date
1	_____	_____

RECYCLE PUMP STATION MODIFICATIONS PLAN

PROJECT: WATER TREATMENT PLANT LAGOON EFFLUENT SYSTEM UPGRADES

DATE: _____

131 DRUMMOND AVE.
WATERVILLE, MAINE 04901
(207) 872-2763
KWD Kennebec Water District

SURVEY BY: BB (KWD)

DRAWN BY: BB

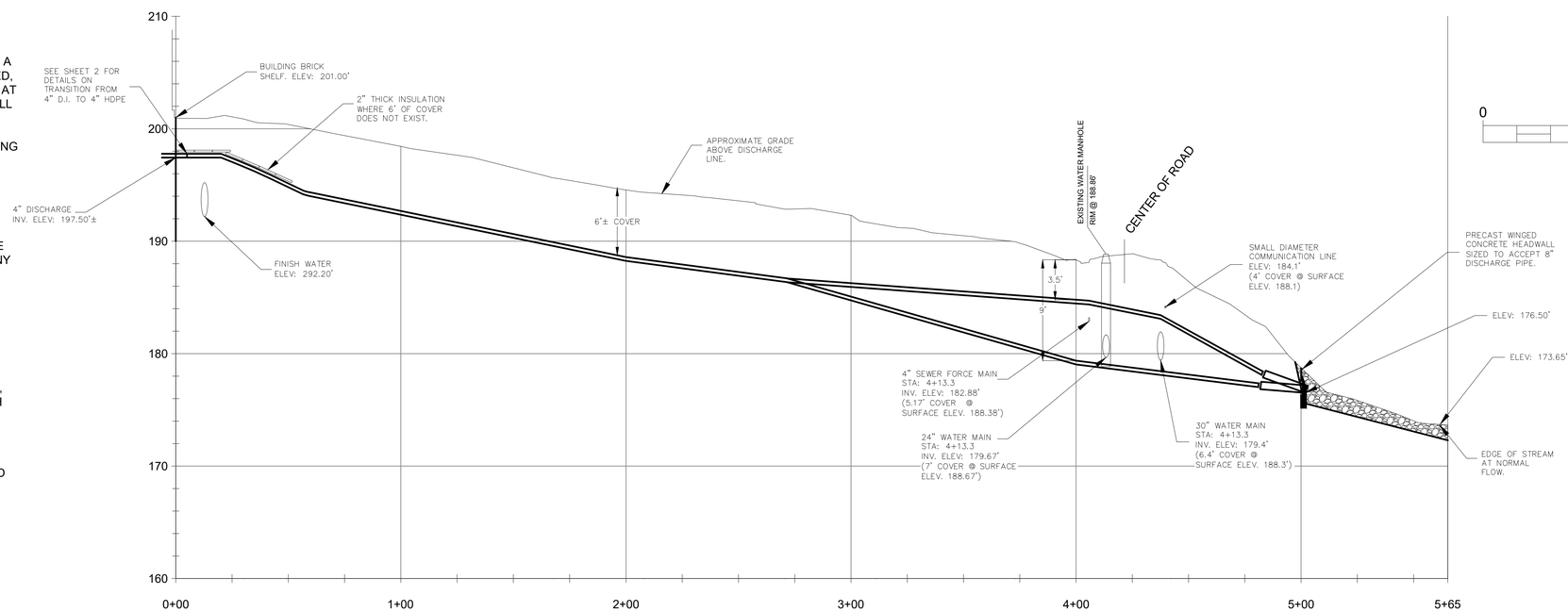
FILE: WTP-DISCHARGE.dwg

WORK ORDER 21-WII

SHEET NO. 3 OF 5

NOTES:

1. AT THE CONTRACTOR'S OPTION, THE 4" HDPE DISCHARGE PIPING BETWEEN THE WTP AND MAIN STREET MAY BE INSTALLED VIA OPEN CUT METHODS, DIRECTIONAL DRILL OR A COMBINATION OF BOTH. IF OPEN CUT METHODS ARE UTILIZED, PRECAST CONCRETE THRUST BLOCKS SHALL BE INSTALLED AT ALL BENDS AND THE WTP DRIVEWAY WHERE IMPACTED SHALL BE REPAVED TO MATCH THE EXISTING CONDITIONS.
2. CONTRACTOR MUST DIRECTIONALLY DRILL THE 4" HDPE PIPING UNDER MAIN STREET AND TO THE POINT OF SIZE INCREASE PRIOR TO DISCHARGE.
3. BETWEEN MAIN STREET AND THE OUTLET STREAM REMOVE TREES, BRUSH AND DEBRIS AS REQUIRED TO PROVIDE ACCESS. TREES GREATER THAN 4" IN DIAMETER SHALL BE LIMBED, CUT INTO 4' LENGTHS AND STACKED NEATLY TO THE NORTH OF THE WORK AREA FOR PROPERTY OWNER USE. ANY VEGETATION CUT AND NOT SALVAGED BY THE PROPERTY OWNER SHALL BE DISPOSED OF BY THE CONTRACTOR.
4. FOR AREAS TO THE WEST OF MAIN STREET; WHEN CONSTRUCTION IS COMPLETE, RESTORE IMPACTED AREAS DISTURBED WITH A MINIMUM OF 4" COMPACTED LOAM TO EXISTING GRADES AND SEED WITH A GRASS MIXTURE FORMULATED FOR QUICK GROWTH EROSION CONTROL. CONTRACTOR TO PROVIDE HAY MULCH, FERTILIZER, WATER, MOVING AND WEED CONTROL AS NECESSARY TO ESTABLISH GRASS GROWTH.
5. FOR LAWN AREAS AT THE WTP; WHEN CONSTRUCTION IS COMPLETE, RESTORE IMPACTED AREAS DISTURBED WITH A MINIMUM OF 4" COMPACTED LOAM TO EXISTING GRADES AND SEED WITH COTTAGE GRASS MIXTURE FORMULATED FOR QUICK GROWTH. CONTRACTOR TO PROVIDE HAY MULCH, FERTILIZER, WATER, MOVING AND WEED CONTROL AS NECESSARY TO ESTABLISH GRASS GROWTH.
6. CONTRACTOR SHALL AVOID DAMAGE TO THE EXISTING CONCRETE WALKWAYS AT THE WTP. IF THE WALKWAYS ARE DAMAGED AS A RESULT OF CONSTRUCTION ACTIVITIES THE CONTRACTOR SHALL REPAIR THE DAMAGED TO MATCH THE EXISTING CONDITIONS.



PROFILE SCALE: VERT. 1" = 6' HORZ. 1" = 30'

No.	Revision	Date
1	_____	_____

EXTERNAL LAGOON DISCHARGE PIPING PROFILE AND SITE PLAN

PROJECT: WATER TREATMENT PLANT LAGOON EFFLUENT SYSTEM UPGRADES

DATE: _____

131 DRUMMOND AVE.
WATERVILLE, MAINE 04901
(207) 872-2763
KWD Kennebec Water District

SURVEY BY: BB (KWD)

DRAWN BY: BB

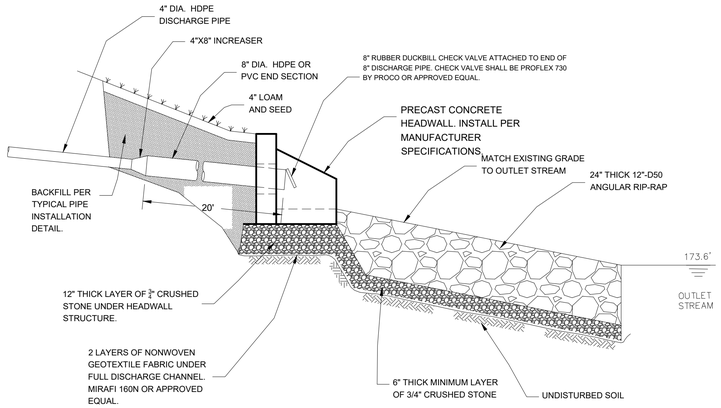
FILE: WTP-DISCHARGE.dwg

WORK ORDER 21-W11

SHEET NO. 4 OF 5

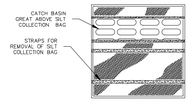
C:\Users\BillBoucher\Kennebec Water District\KWD Engineering Team - General\CAD Files\2023 PROJECTS\Water Treatment Plant - Discharge\WTP-Discharge.dwg, 3/29/2024 12:12:18 PM

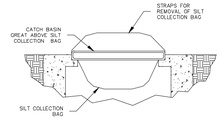
EROSION CONTROL DETAILS



DISCHARGE OUTFALL DETAIL
NOT TO SCALE

EROSION CONTROL DETAILS

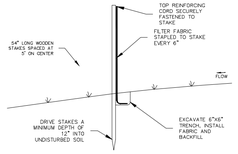




NOTES:

1. CATCH BASIN SILT COLLECTION BAG SHALL BE DANDY BAG OR APPROVED EQUAL.
2. SILT COLLECTION BAGS SHALL BE CLEANED ON A WEEKLY BASIS OR AS NEEDED TO LIMIT THE ACCUMULATION OF SILT AND DEBRIS.

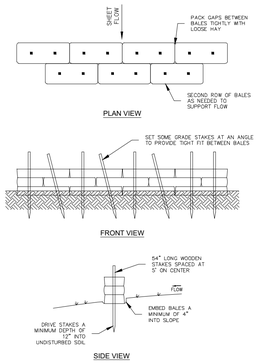
SILT COLLECTION BAG FOR CATCH BASIN



NOTES:

1. ACCUMULATED SILT SHALL BE REMOVED ON A WEEKLY BASIS OR AS NEEDED TO LIMIT THE ACCUMULATION OF SILT AND DEBRIS.

SILT FENCE

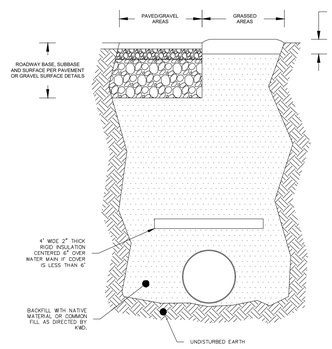


NOTES:

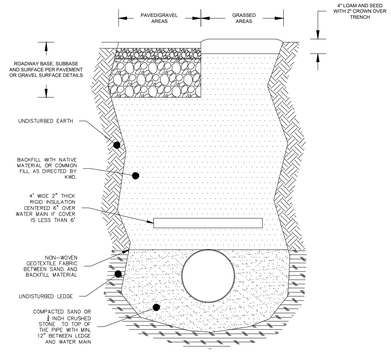
1. BALES SHALL BE PLACED ON THE SLOPED CONTOUR AS TO INTERCEPT RUNOFF.
2. BALES SHALL BE PLACED IN A ROW WITH THE END TIGHTLY ABUTTING.
3. DO NOT USE BALES IN STREAMS.
4. SILT AND DEBRIS COLLECTED BY THE HAY BALE BARRIER SHALL BE CLEANED ON A WEEKLY BASIS OR AS DIRECTED.

HAY BALE SILT BARRIER

TYPICAL WATER MAIN TRENCH SECTION



PIPE TRENCH IN EARTH

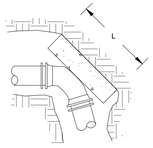


PIPE TRENCH IN LEDGE

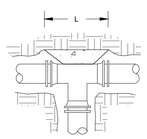
NOTES:

1. MINIMUM DEPTH OF COVER SHALL BE 6' UNLESS OTHERWISE DIRECTED BY KWD.
2. CLAY DAMS SHALL BE INSTALLED EVERY 150' IN AREAS WITH GREATER THAN 3% SLOPE.
3. EXISTING PAVEMENT SHALL BE SAW CUT PRIOR TO EXCAVATION.
4. BACKFILL SHALL BE PLACED IN 12" LIFTS AND COMPACTED TO 95% PROCTOR.
5. BACKFILL SHALL BE FREE FROM FROZEN MATERIAL, WOOD, VEGETATION, DEBRIS, AND STONES LARGER THAN 8" IN DIAMETER.
6. DETECTABLE MARKING TAPE SHALL BE PLACED 2' ABOVE ALL WATER MAINS AND SERVICES.

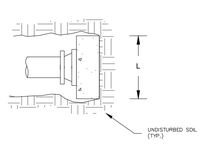
TYPICAL THRUST BLOCK



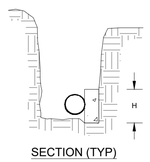
PLAN - ELBOW



PLAN - TEE



PLAN - CAP



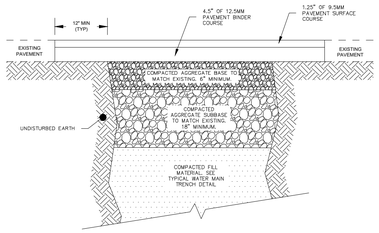
SECTION (TYP)

THRUST BLOCK SCHEDULE MINIMUM BEARING AREA LxH (SQUARE FEET)						
Fitting	NOMINAL PIPE DIA. (IN)					
	4	6	8	10	12	16
Tees, Caps, Plugs, & Tapping Sleeves	1.05	2.32	4.15	6.37	9.15	16.23
90 Degree Bends	1.48	3.29	5.86	9.01	12.93	22.96
45 Degree Bends	0.80	1.78	3.17	4.88	7.00	12.42
22-1/2 Degree Bends	0.41	0.91	1.62	2.49	3.57	6.33
11-1/4 Degree Bends	0.21	0.46	0.81	1.25	1.79	3.18
System Pressure: 100 psi Safety Factor: 1.5 Soil Bearing Capacity: 2,000 psf						

NOTES:

1. ALL THRUST BLOCKS SHALL BE AUGUSTA STYLE PRE-CAST CONCRETE UNLESS APPROVED BY KWD.
2. THE MINIMUM BEARING AREAS SHOWN IN THE THRUST BLOCK SCHEDULE ARE BASED ON A SYSTEM PRESSURE OF 100 PSI. IF THE SYSTEM PRESSURE IS ABOVE 100 PSI, INCREASE THE NOTED AREAS PROPORTIONALLY TO THE ACTUAL SYSTEM PRESSURE.
3. SELECT THRUST BLOCKS SUCH THAT THE LENGTH (L) OF THE BLOCK IS APPROXIMATELY TWICE AS LONG AS THE HEIGHT (H).
4. WHERE POSSIBLE, CONSTRUCT THRUST BLOCKS AGAINST UNDISTURBED SOIL. WHERE NOT POSSIBLE, PLACE COMPACTED COMMON FILL BETWEEN THE THRUST BLOCK AND UNDISTURBED SOIL.
5. PLACE THRUST BLOCK ALONG MAXIMUM LENGTH OF THE FITTING TO MAXIMIZE BEARING AREA.
6. PLACE TWO LAYERS OF POLYETHYLENE OR ROOFING PAPER AROUND FITTING AS PROTECTION FROM DAMAGE BY THE CONCRETE BLOCK.
7. CONCRETE COMPRESSIVE STRENGTH: 3,000 PSI MINIMUM.
8. USE OF THRUST BLOCKS DOES NOT ELIMINATE THE REQUIREMENT OF OTHER RESTRAINTS.

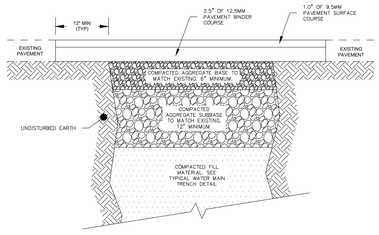
TYPICAL BITUMINOUS PAVEMENT REPAIR



TYPICAL STATE ROAD
PAVEMENT REPAIR

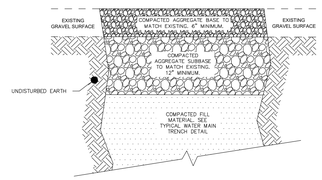
NOTES:

1. AGGREGATE BASE SHALL COMPLY WITH MAINE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATION SECTION 703.06A TYPE A AGGREGATE.
2. AGGREGATE SUBBASE SHALL COMPLY WITH MAINE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATION SECTION 703.06C TYPE D AGGREGATE.
3. SAW CUT EXISTING PAVEMENT TO PROVIDE A STRAIGHT EDGE. APPLY TACK COAT ON EXISTING PAVEMENT SURFACE PRIOR TO PAVING.
4. STRUCTURE COVERS SHALL BE SET PRIOR TO SURFACE PAVING. CUTTING INTO SURFACE COURSE PAVEMENT FOR SETTING STRUCTURE COVERS SHALL NOT BE ALLOWED.
5. PAVEMENT MARKING IN PLACE PRIOR TO EXCAVATION SHALL BE RESTORED ONCE PAVING IS COMPLETED.



TYPICAL TOWN ROAD & DRIVEWAY
PAVEMENT REPAIR

GRAVEL SURFACE REPAIR



TYPICAL GRAVEL ROAD, DRIVEWAY
AND SHOULDER REPAIR

NOTES:

1. AGGREGATE BASE SHALL COMPLY WITH MAINE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATION SECTION 703.06A TYPE A AGGREGATE.
2. AGGREGATE SUBBASE SHALL COMPLY WITH MAINE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATION SECTION 703.06C TYPE D AGGREGATE.

No.	Revision	Date
1	_____	_____

DISCHARGE DETAILS

PROJECT: WATER TREATMENT PLANT LAGOON EFFLUENT SYSTEM UPGRADES

DATE: _____

131 DRUMMOND AVE.
WATERVILLE,
MAINE 04901
(207) 872-2763

KWD
Kennebec Water District

SURVEY BY: BB (KWD)

DRAWN BY: BB

FILE: WTP-DISCHARGE.dwg

WORK ORDER: 21-WII

SHEET NO. 5 OF 5

EMERALD COAST™ MANUFACTURING

Advanced Wastewater Sampling Made Easy

Made in the U.S.A.

Standard Features:

- Programmable sample size (20-500 mL, 1 mL increments)
- 7" color touchscreen
- High impact, acrylic/ABS enclosure
- Heavy duty, piston vacuum pump
- Line velocity >3.75 FPS @ 20'
- Modular refrigeration w/ 1/3 HP compressor
- Time / Flow
- Random Time Sampling
- Constant sampling interval (1 – 9999 min.)
- Start / Stop programming
- Delay start (1 – 9999 min.)
- Scheduled Programming
- Auto shut-off
- Pre-sample / post-sample purge (0 – 140 sec.)
- Inputs – Pulses / 4-20mA
- Alarm output option
- Data logging
- Pass code protection on programming
- 2.5 gal, & 5.0 gal sample container options
- 115 operation
- App enabled *coming soon*

Patent # 11598696

Wastewater Vacuum Sampler

Details & Specifications

The WAVE™ by Emerald Coast Manufacturing is an electronically controlled, heavy duty vacuum wastewater sampler. This refrigerated sampler allows for composite sampling with a high level of accuracy. The WAVE™ features a high impact and weatherable acrylic/ABS body, making this all-climate unit perfect for even the harshest of outdoor and indoor environments.

The integrated touchscreen controls give you the ability to specify the sample size and program times or flow intervals to collect samples. Controls also allow you to digitally control temperature within the sample compartment.

The WAVE™'s powerful vacuum system generates stronger purges that remove contamination and can draw samples from greater distances, up to 200 Feet. The WAVE™ can pull samples with vertical lifts of nearly 30 feet and provide consistent accurate sampling with no need to worry about replacing costly internal tubes. With that, the WAVE™'s vacuum system exceeds EPA transport velocity.

The Wave's modular refrigeration unit is supplied with a 1/3 HP compressor. This strong module will handle all climates up to 125 degrees without any problems. It has the ability to cool down to 4 degrees Celsius very quickly on initial start-up.

EMERALD COAST MANUFACTURING

www.emeraldcoastmfg.com

Specifications

Size:	51.5" H x 28.25" W x 27" D
Weight (Dry):	220 lbs. approximate
Refrigeration Body:	Fully insulated cabinet
Intake Tubing:	PVC 3/8" ID x 5/8" OD Length: 3 - 200'
Containers:	2.5 gal., 5.0 gal.
Operational Temperatures:	-20°F to 125°F
Power Required:	115 VAC, 60 Hz
Maximum Lift:	Vertical lift 29', Horizontal 200'
Sample Transport Velocity:	Greater than 3.75 FPS @ 20' with 3/8" tubing
Repeatability:	+/- 1%
Accuracy:	+/- 3%
Programmable Functions:	Pre/Post-purge, Sample size, Auto shut-off, Delay start, Flow inputs, Sampling interval, Weekly programming
Sampling Modes:	Constant Time/Constant Volume; Random Time/ Constant Volume; Flow/Constant Volume
Controller:	Microprocessor control
Controller Protection:	Nema 4X, IP65
Warranty:	Two years from shipment

*Specifications subject to change.

7" color touchscreen provides custom control for:

- Sample Volume
- Program Times
- Flow Intervals
- Sample Temperature
- Sample History
- Manual Operation

Our Location
4117 Warehouse Lane
Pensacola, FL 32505

Contact Us
Phone: (850) 469-1142
Fax: (850) 469-1188
WAVE@emeraldcoastmfg.com

Represented By

RUSSELL RESOURCES, INC.
P.O. BOX 3276
BREWER, ME 04412
PH. 207-989-0591
OFFICE1@R-R-INC.COM

Quote

Date	Quote #
9/24/2024	221456

Name / Address
Kennebec Water District

Unless otherwise noted, shipping is not shown and will be added to the invoice. Terms are prepaid and add.

FOB
BREWER

Item	Description	Qty	Cost	Total
WAVE-AS	WAVE VACUUM SAMPLER -ALL SEASON, • 120 VAC • 29 FT SUCTION LIFT @ > 2 FT/SEC • ACRYLIC/ABS/FIBERGLASS ENCLOSURE, SUITABLE FOR CORROSIVE ENVIRONMENTS AND SEVERE OUTDOOR CONDITIONS W/ HEATER OPTION (EXTRA) • THE WAVE USES PATENT PENDING TECHNOLOGY THAT WILL ALLOW THE USER TO PRE-SELECT THEIR SAMPLE SIZE USING A KEYPAD WITH HIGHLY ACCURATE REPEATABILITY. • 7" LCD COLOR TOUCH SCREEN • 4-20 MA INPUT • PULSE INPUT • RANDOM TIME BASED, CONSTANT SIZE SAMPLING PROGRAMING • TIME OR FLOW-BASED SAMPLING PROGRAMMING • DATA LOGGING * 6' CABLE W/6 PIN CONNECTOR (mA, PULSE & ALARM	1	8,295.00	8,295.00
AC6005	NALGENE 5.0 GALLON CARBOY BOTTLE, HDPE	1	187.00	187.00
AC6016	OPTIONAL CONTROLS (START, START-STOP, MANUAL REMOTE CONTACT, RUN STATUS CONTACT), INC: 12 PIN CONNECTOR WITH 6 FT CABLE	1	86.00	86.00
AC6012	PRESSURE SAMPLE CELL	1	475.00	475.00
38 TUBE -25	25' -3/8" ID X 5/8" OD HEAVY WALL SAMPLE INTAKE TUBING	1	55.00	55.00
SHIP -WAVE	FREIGHT	1	450.00	450.00

Total

RUSSELL RESOURCES, INC.
P.O. BOX 3276
BREWER, ME 04412
PH. 207-989-0591
OFFICE1@R-R-INC.COM

Quote

Date	Quote #
9/24/2024	221456

Name / Address
Kennebec Water District

Unless otherwise noted, shipping is not shown and will be added to the invoice. Terms are prepaid and add.

FOB
BREWER

Item	Description	Qty	Cost	Total
	DELIVERY: 8-10 WEEKS ARO ***WE DO HAVE ONE UNIT IN STOCK IN BREWER CURRENTLY THAT IS AVAILABLE			

Total $9,548.00

RESILIENT SEATED BUTTERFLY VALVES

TECHNICAL SALES MANUAL

Bray®

Contents

Torques

INTRODUCTION TO TORQUES

There are a number of torques which butterfly valves may experience such as:

- **T_{su} - Seating and Unseating Torque**
- **T_d - Dynamic Torque Resulting from fluid flow**
- **T_{bf} – Bearing Friction Torque**
- **T_{ss} – Stem Seal Friction Torque**
- **T_e – Eccentricity Torque resulting from disc offset from centerline of stem (either single, double or triple offset)**
- **T_h – Hydrostatic Torque**

Factors which influence the butterfly valve torque values shown above are:

- Type of Seat and Seat Material
- Interference of Seat I.D. and Disc O.D.
- Shaft Diameter
- Valve Diameter
- Bearing Coefficient of Friction
- Angle of Opening
- Shut-off Pressure
- Fluid Velocity
- Disc Shape and Configuration
- Piping System and Location/Orientation of Valve in Pipe Line
- System Head Characteristics
- Physical Size of Disc/Shaft Obstructing Flow
- Disc Edge Finish

With respect to Butterfly Valves, the two major conditions for determining total valve operating torque (T_T) exists as follows:

CASE I (Angle = 0° , Disc in Closed Position)

$$T_T = T_h + T_{bf} + T_{ss} + T_{su}$$

Analyzed

Total Torque for Case I using a symmetrical disc butterfly valve is the sum of hydrostatic torque, bearing friction torque, stem seal, friction torque, and seating/unseating torque.

A. Hydrostatic Torque (T_h)

We will ignore discussion of the hydrostatic torque values as they are generally insignificant compared to the seating/unseating, bearing friction and stem seal torque values (the safety factor applied to seating/unseating, stem seal friction and bearing friction torque values more than compensates for the hydrostatic torque which is usually less than 2% of these total torques).

B. Bearing Friction Torque (T_{bf})

Bearing friction torque occurs because pressure forces against the disc are transmitted to the stem. As the stem is forced against the bearing supports, bearing friction torque is created between the stem material and the support material as the stem is turned. Bearing friction torques are normally included in the seating/unseating torque values.

Bearing friction torques can be determined by using the following equation:

$$T_{bf} = .785\ C_f\ D_v^2\ (d/2)\ \Delta P$$

Where:

- T_{bf} = Bearing Friction Torque
- C_f = Coefficient of Friction (approximately .25 for non-corroded stem to cast iron body) (dimensionless).
- D_v = Valve Diameter (Inches)
- d = Diameter of Shaft (Inches)
- ΔP = Pressure Differential (psi)

C. Stem Seal Friction Torque (T_{ss})

For all practical purposes stem seal friction torque values are insignificant when compared to seating/unseating and bearing friction torques. Stem seal friction torques are normally included in the seating/unseating torque values.

D. Seating/Unseating Torques (T_{su})

The seating/unseating torque value (T_{su}) is a function of the pressure differential, the seat material's coefficient of friction, the finished surface of the disc edge, the amount of interference between the seat I.D. and disc O.D. when flanged in piping, the seat thickness, and the type of service (media) for which the valve is being used. In determining the T_{su} values for Bray resilient seated butterfly valves, Bray has developed Seating/Unseating Torque Charts incorporating all bearing friction and stem seal friction torques for three classes of services for both the valves with standard discs (rated to full pressure) and for valves with reduced diameter discs (rated for 50 psi [3.5 bar]). The three service classes are:

Class A – Non-Corrosive, Lubricating Service

Class B – General Service

Class C – Severe Service

Please review the guidelines for each class in the technical manual when determining which Seating/Unseating Torque Class should be used. Most butterfly valves are used in Class II, General Service applications.

E. Total Torque (T_T)

The total torque values for Bray symmetrical disc valves for Case I applications are shown in the Seating/Unseating Torque Charts within this manual.

CASE II (Disc in Partial To Full Opening Position)

$$T_T = T_{bf} + T_{ss} + T_d$$

The total Torque for Case II using a symmetrical disc butterfly valve is the summation of bearing friction torque, stem seal friction torque and dynamic torque.

A. Bearing Friction Torque (T_{bf})

See Case I discussion. This torque value is normally included in the Dynamic Torque Value.

B. Stem Seal Friction Torque (T_{ss})

See Case I discussion. This torque value is normally included in the Dynamic torque value.

C. Dynamic Torque (T_d)

In a symmetrical disc design, dynamic torque occurs between the closed position, 0° and the full open position, 90°. With the disc in the partially open position, velocity of the fluid passing the leading disc edge is less than the velocity passing the trailing edge. This variance in velocity past the leading disc edge and trailing disc edge results in an unbalanced distribution of pressure forces on the upstream side of the face of the disc. The total pressure forces acting perpendicular to the disc face on the leading edge half of the disc are greater than the total pressure acting perpendicular on the trailing half of the disc. This uneven distribution of pressure on the disc face (exists on both sides of the disc) results in a torsional force which tries to turn the disc to the closed position **(Figure 1)**. This torsional closing force can become greater than the seating/unseating torque value depending on the valve angle of opening and differential pressure.

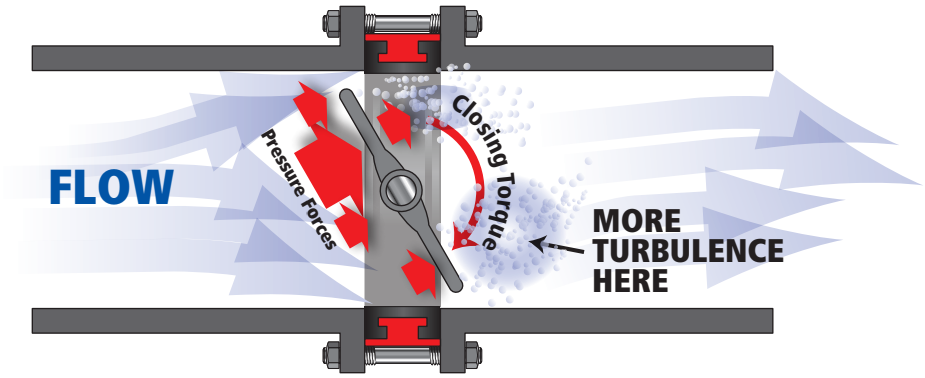
To determine dynamic torque, the following equation is applied:

$$T_d = C_{dt}\, d^3\, \Delta P$$

Where:

- T_d = Dynamic Torque (lbs- in).
- C_{dt} = Coefficient of Dynamic Torque (based on disc shape and angle of opening) (dimensionless)
- d = Diameter of Disc (Inches)
- ΔP = Pressure Differential Across Valve (psi)

Figure 1 - Pressure Distribution



As shown in **Figure 2**, coefficient of dynamic torque for Bray's symmetrical disc valves is at 0° angle of opening and increases until the angle of opening reaches 75°-80°, where it then decreases to a zero value at full open (90°) (no internal friction factors considered, just dynamic torque only).

One final comment about dynamic torque is that one may minimize the dynamic torque by the orientation of the valve (stem horizontal or vertical) in the pipeline as well as by the location (distance) in the pipeline from elbows, other valves, etc. (See Bray Resilient Seated BFV Operations and Maintenance Manual).

D. Total Torque (T_T)

The total torque required for operating a Bray symmetrical disc butterfly valve at an angle opening between 0° and 90° is shown in the Dynamic Torque section of this manual. Note that the dynamic torque includes all internal friction torque values.

CONCLUSION

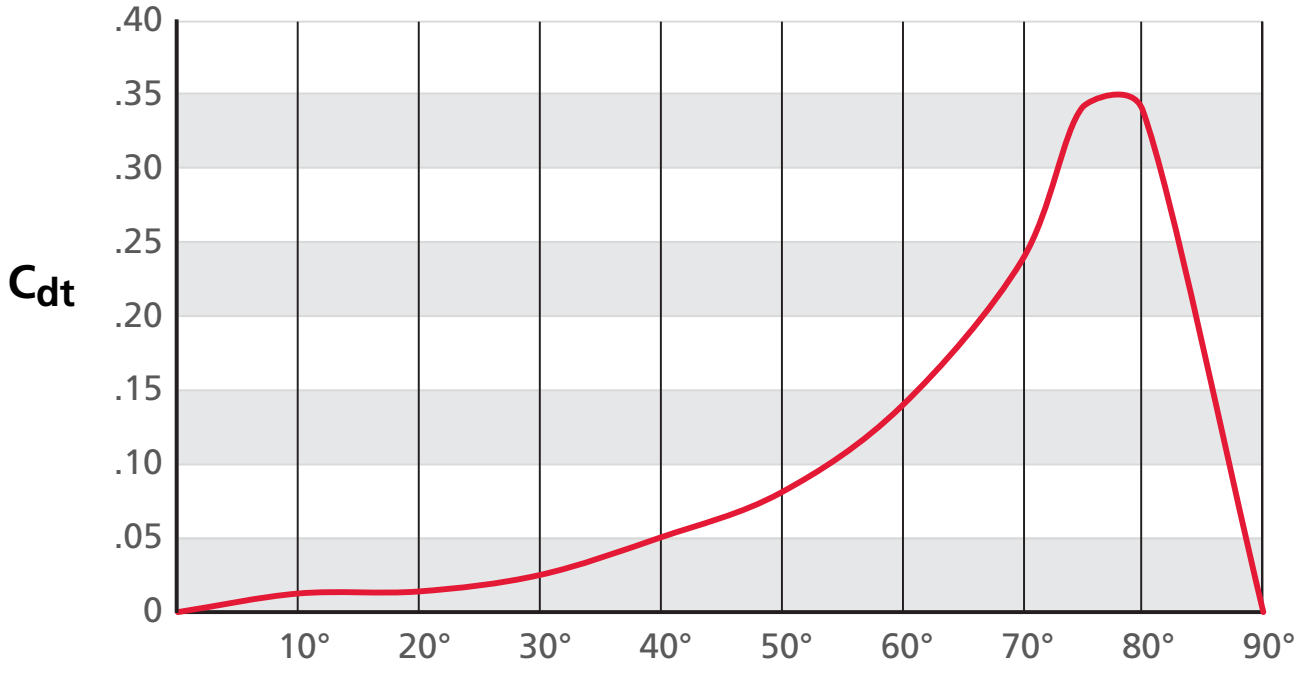
In most applications for butterfly valves, especially 20˝ (DN 500) or smaller, the maximum torque required to operate the valve will be seating/unseating torque. However, dynamic torque should be considered particularly in:

- Control applications using larger valves (24˝ [DN600] and above) where the disc is maintained in the open position
- Applications using larger valves (24˝ [DN 600] and above) where the velocity is high (16 ft./sec [4.9m/sec]).

Figure 2 - Angle of Opening

The C_{dt} value for Bray symmetrical disc valves are approximately:

Angle of Opening	0°	10°	20°	30°	40°	50°	60°	70°	75°	80°	90°
C_{dt}	0	0.0126	0.0140	0.0251	0.0505	0.0809	0.1394	0.2384	0.3419	0.3400	0



REDUCED DISC DIAMETER BRAY SERIES 30/31/3A VALVES

Bray offers a reduced disc diameter for 4"-20" for Series 30, 31 and 3A valves. The purpose of reducing the disc diameter is to decrease the seating/unseating torques and extend the seat life on low pressure applications.

By reducing the disc diameter, the interference between the disc O.D. and seat I.D. is decreased and the valve pressure rating, which is a function of this interference, is reduced to 50 PSI. Less interference between the disc and seat results in reduced seating/unseating torques. Lower seating/unseating torque may allow for the use of a smaller actuator on the valve. In other applications where abrasive dry bulk materials such as cement, sugar, plastic, pellets, flour, etc., are generally pneumatically conveyed at 50 PSI or less, the reduced disc diameter not only reduces the seating/unseating torque but, very importantly, usually significantly increases the service life of the seat.

Bray does the following to differentiate reduced diameter discs from full diameter discs:

Metal Discs: An " R " is stamped above the part number

Nylon 11 Coated Discs: Discs are differentiated by the color of the Nylon 11:

Grey – Full Disc Diameter

White – Reduced Disc Diameter

SEATING & UNSEATING TORQUES

Bray has developed Seating/Unseating Torque Charts for three Classes of Service for its valves with standard discs (rated for full pressure) and for valves with reduced diameter discs (rated for 50 PSI / 3.5 bar.).

The guidelines for selecting a Class to be used for determining a valve's seating/unseating torque are given below. Each valve application should comply with all five Class characteristics in order to be qualified for that Class.

Characteristics of Application	**Class A** Non-Corrosive, Lubricating Service	**Class B** General Service	**Class C** Severe Service
Media Type	Lubricating hydrocarbons; Aqueous processes and Water (See Note 1)	Water; aqueous processes; all other aqueous liquids including salt water; Lubricating gases	Dry, non-lubricating such as air, dry gas, cement, pneumatic conveying mediums
Corrosion by Media	Insignificant if any	No major corrosion or deposits from media	Can incur significant corrosion such as Ductile Iron disc in water
Chemical Reactions of Media with Seat	Insignificant if any	Only minor or insignificant in nature	Reactions causing swelling and hardness occur
Media Temperature	45º to 160ºF (7º to 71ºC)	Within seat temperature limits, not near limits	Near or at seat temperature limits
Frequency of Valve Cycling	Once weekly or more frequently	Minimum once every 3-6 weeks, or more frequently	Infrequently, sometimes not cycled for long periods

NOTE:

1. For aqueous processes and water, Class A torques may be used only if a Nylon 11 coated disc is selected and all other Class A characteristics apply. Otherwise, Class B torques should be used.
2. All the material trims may be classified into Class A, B, or C except Series 20/21 valves with a PTFE Lined Elastomer seat, PTFE molded disc/stem, or rubber molded disc/stem. These trims must always use Class C Seating/Unseating Torque Values unless they are used only in a throttling application. Valves with bonded seats must always be classified as Class C.
3. If a valve is used strictly in a throttling application, that is, it is never put in the closed position but throttled between 20° and 80°, then Class A torques may be used provided you have checked to see that dynamic torques do not exceed the Class A torque values.
4. With the exception of dry, non-lubricating medias, one is usually safe electing to use Class B torques for sizing actuators for all other valve service applications. Seating/Unseating Torque values shown include friction bearing torques for stated differential pressure.
5. Dynamic Torque values are not considered. See the Dynamic Torque chart in this manual for determination of Dynamic Torque.
6. Do not apply a safety factor to torque values when determining actuator output torque requirement.
7. **For 3-way assemblies where one valve is opening and another is closing, multiply torque by a 1.5 factor.**

Series 20/21 and 30/31/3A Torques Imperial (Lb-Ins)

	Valve Size Inches	Valve Differential Pressure (PSIG)						
		Full Disc					Reduced Disc	
		0 psi	50 psi	100 psi	150 psi	175 psi	0 psi	50 psi
Class A Non-Corrosive, Lubricating Service	1	54	59	65	70	73	54	59
	1.5	81	86	91	97	100	81	86
	2	109	114	119	123	128	109	114
	2.5	169	178	187	196	200	169	178
	3	220	236	250	264	273	220	236
	4	341	364	387	410	423	225	248
	5	510	560	610	660	687	324	374
	6	632	712	792	872	912	344	488
	8	1,182	1,341	1,500	1,660	1,741	735	894
	10	1,764	2,018	2,272	2,526	2,653	1,204	1,358
	12	2,701	3,110	3,519	3,928	4,132	1,665	2,074
	14	3,818	4,500	5,182	5,864	—	2,318	3,000
	16	4,638	5,819	7,000	8,182	—	2,699	3,880
	18	5,265	7,065	8,865	10,665	—	2,970	4,788
	20	7,000	9,364	11,728	14,091	—	3,356	6,243
Class B General Service	1	59	65	71	77	80	59	65
	1.5	89	95	100	106	110	89	95
	2	120	125	130	135	140	120	125
	2.5	185	195	205	215	220	185	195
	3	245	260	275	290	297	245	260
	4	375	400	425	450	462	252	267
	5	560	615	670	725	755	355	410
	6	695	783	871	953	1,003	427	537
	8	1,300	1,475	1,650	1,825	1,915	808	983
	10	1,960	2,240	2,520	2,800	2,940	1,213	1,493
	12	2,970	3,420	3,870	4,320	4,545	1,830	2,280
	14	4,200	4,950	5,700	6,450	—	2,550	3,300
	16	5,100	6,400	7,700	9,000	—	2,967	4,267
	18	5,850	7,850	9,850	11,850	—	3,267	5,267
	20	7,700	10,300	12,900	15,500	—	4,267	6,867
Class C Severe Service	1	74	82	89	97	100	74	82
	1.5	111	119	125	133	137	111	119
	2	151	157	163	169	175	151	157
	2.5	231	244	257	269	275	231	244
	3	306	325	344	363	375	306	325
	4	468	500	532	563	582	316	348
	5	700	769	838	907	944	444	513
	6	870	980	1,090	1,200	1,255	525	672
	8	1,625	1,844	2,063	2,282	2,394	1,011	1,230
	10	2,450	2,800	3,150	3,500	3,675	1,517	1,867
	12	3,712	4,275	4,838	5,400	5,682	2,287	2,850
	14	5,251	6,188	7,125	8,063	—	3,189	4,126
	16	6,375	8,000	9,625	11,250	—	3,709	5,334
	18	7,315	9,815	12,315	14,815	—	4,084	6,584
	20	9,625	12,875	16,125	19,375	—	5,334	8,584

Series 20/21 and 30/31/3A Torques Metric (Nm)

	Valve Size mm	Valve Differential Pressure (bar)						
		Full Disc					Reduced Disc	
		0 bar	3.4 bar	7 bar	10.3 bar	12 bar	0 bar	3.4 bar
Class A Non-Corrosive, Lubricating Service	25	6	7	7	8	8	6	7
	40	9	10	10	11	11	9	10
	50	12	13	13	14	14	12	13
	65	19	20	21	22	23	19	20
	80	25	27	28	30	31	25	27
	100	39	41	44	46	48	25	28
	125	58	63	69	75	78	37	42
	150	71	80	89	99	103	39	55
	200	134	152	169	188	197	83	101
	250	199	228	257	285	300	136	153
	300	305	351	398	444	467	188	234
	350	431	508	585	663	—	262	339
	400	524	657	791	924	—	305	438
	450	595	798	1,002	1,205	—	336	541
	500	791	1,058	1,325	1,592	—	379	705
Class B General Service	25	7	7	8	9	9	7	7
	40	10	11	11	12	12	10	11
	50	14	14	15	15	16	14	14
	65	21	22	23	24	25	21	22
	80	28	29	31	33	34	28	29
	100	42	45	48	51	52	28	30
	125	63	69	76	82	85	40	46
	150	79	88	98	108	113	48	61
	200	147	167	186	206	216	91	111
	250	221	253	285	316	332	137	169
	300	336	386	437	488	514	207	258
	350	475	559	644	729	—	288	373
	400	576	723	870	1,017	—	335	482
	450	661	887	1,113	1,339	—	369	595
	500	870	1,164	1,458	1,751	—	482	776
Class C Severe Service	25	8	9	10	11	11	8	9
	40	13	13	14	15	15	13	13
	50	17	18	18	19	20	17	18
	65	26	28	29	30	31	26	28
	80	35	37	39	41	42	35	37
	100	53	56	60	64	66	36	39
	125	79	87	95	102	107	50	58
	150	98	111	123	136	142	59	76
	200	184	208	233	258	270	114	139
	250	277	316	356	395	415	171	211
	300	419	483	547	610	642	258	322
	350	593	699	805	911	—	360	466
	400	720	904	1,087	1,271	—	419	603
	450	826	1,109	1,391	1,674	—	461	744
	500	1,087	1,455	1,822	2,189	—	603	970

Series 32/33, 35/36 Torques Imperial (Lb-Ins)[1]

	Valve Size inches	32, 35 - Max △P = 75 psi				33, 36 - Max △P = 150 psi			
		0 psi	25 psi	50 psi	75 psi	0 psi	50 psi	100 psi	150 psi
Class B General Service (Imperial)	22	5,450	6,350	7,250	8,150	8,100	11,700	14,700	17,700
	24	6,700	8,100	9,500	10,900	10,500	15,000	19,500	24,000
	26	7,900	9,800	11,700	13,600	12,400	18,400	24,400	30,400
	28	9,200	11,600	14,000	16,400	14,200	21,700	29,200	36,700
	30	10,400	13,300	16,200	19,100	16,100	25,100	34,100	43,100
	32	11,700	15,600	19,400	23,300	18,400	29,700	41,100	52,400
	34	13,500	18,500	23,500	28,500	20,950	34,750	48,600	62,400
	36	14,300	20,100	25,900	31,700	23,000	39,000	55,000	71,000
	40	18,200	26,200	34,100	42,000	24,300	46,300	68,300	90,300
	42	20,200	29,200	38,200	47,200	25,000	50,000	75,000	100,000
	44	20,800	32,500	44,200	55,800	26,700	56,700	86,700	118,300
	48	22,000	39,000	56,000	73,000	30,000	70,000	110,000	150,000
Class C	54	41,500	73,500	105,500	138,000	56,300	131,000	173,000	282,000
	60	55,500	98,200	141,000	184,800	75,100	174,500	208,000	376,000
	66	115,700	159,400	203,200	247,000	161,500	277,500	393,400	509,400
	72	Consult Factory							
	78	Consult Factory							
	84	Consult Factory							
	90	Consult Factory							
	96	Consult Factory							

Series 32/33, 35/36 Torques Metric (Nm)[1]

	Valve Size mm	32, 35, - Max △P = 5 bar				33, 36 - Max △P = 10.3 bar			
		0 bar	1.7 bar	3.4 bar	5.2 bar	0 bar	3.4 bar	7 bar	10.3 bar
Class B General Service (Metric)	550	616	718	819	921	915	1,322	1,661	2,000
	600	757	915	1,074	1,232	1,187	1,695	2,204	2,712
	650	893	1,107	1,322	1,537	1,401	2,079	2,757	3,435
	700	1,040	1,311	1,582	1,853	1,605	2,452	3,300	4,147
	750	1,175	1,503	1,831	2,158	1,819	2,836	3,853	4,870
	800	1,322	1,763	2,192	2,633	2,079	3,356	4,644	5,921
	850	1,526	2,091	2,656	3,221	2,367	3,927	5,492	7,051
	900	1,616	2,271	2,927	3,582	2,599	4,407	6,215	8,023
	1,000	2,057	2,961	3,853	4,746	2,746	5,232	7,718	10,204
	1,050	2,283	3,300	4,317	5,334	2,825	5,650	8,475	11,300
	1,100	2,350	3,673	4,995	6,305	3,017	6,407	9,797	13,368
	1,200	2,486	4,407	6,328	8,249	3,390	7,910	12,430	16,950
Class C	1,400	4,689	8,304	11,920	15,592	6,361	14,801	19,546	31,862
	1,500	6,271	11,095	15,931	20,880	8,485	19,716	23,501	42,482
	1,650	13,072	18,010	22,959	27,907	18,247	31,353	44,448	57,555
	1,800	Consult Factory							
	2,000	Consult Factory							
	2,200	Consult Factory							
	2,250	Consult Factory							
	2,400	Consult Factory							

[1]Dynamic Torque values are not considered. See the Dynamic Torque chart in this manual for determination of Dynamic Torque.

Series 22/23 Torques Imperial (Lb-In) and Metric (Nm)

	In.	mm	ΔP = 0-150 psi	ΔP = 0-10.3 bar
			Lb-In	Nm
Valve Size	2	50	288	33
	2.5	65	350	40
	3	80	560	63
	4	100	720	81
	5	125	960	108
	6	150	1,300	147
	8	200	2,402	271
	10	250	3,840	434
	12	300	5,812	657
	14	350	8,000	904
	16	400	11,000	1,243
	18	450	15,500	1,751
	20	500	19,300	2,181
	24	600	30,500	3,446

1) Torques listed are for PTFE, PFA and UHMWPE trims.
2) All information based on full rated pressure differential.

DYNAMIC TORQUE FACTORS (IMPERIAL)

To Use the Torque Chart, note the following:

1. Dynamic Torque values include all bearing friction and stem-seal friction torques.
2. Dynamic Torque values are per 1 PSI ΔP. To determine dynamic torque (lb-in) at a desired angle of opening, multiply the pressure drop ΔP at this angle by the appropriate dynamic torque factor in the charts below.
3. Bray recommends sizing control valves between 20° and 70°, with 60° the preferred angle.
4. Dynamic Torque will tend to close all Bray valves whose disc are symmetrical to the stem.

Series 20/21 and 30/31/3A (Dynamic Torque Factor - lb-in./psi)

Valve Size in.	Angle of Opening									
	10°	20°	30°	40°	50°	60°	70°	75°	80°	90°
2″	0.11	0.13	0.23	0.45	0.73	1.25	2.14	3.07	3.05	0.00
2.5″	0.22	0.24	0.43	0.87	1.39	2.39	4.09	5.86	5.83	0.00
3″	0.37	0.41	0.73	1.47	2.36	4.07	6.95	9.97	9.92	0.00
4″	0.86	0.95	1.70	3.43	5.49	9.45	16.17	23.19	23.07	0.00
5″	1.65	1.83	3.29	6.61	10.59	18.25	31.22	44.77	44.53	0.00
6″	2.49	2.77	4.97	10.00	16.01	27.59	47.19	67.68	67.32	0.00
8″	6.60	6.74	12.08	24.30	38.93	67.07	114.71	164.51	163.64	0.00
10″	11.99	13.32	23.89	48.06	76.99	132.65	226.86	325.35	323.64	0.00
12″	20.89	23.21	41.62	83.74	134.14	231.14	395.30	566.91	563.93	0.00
14″	30.04	33.38	59.84	120.40	192.87	332.34	568.37	815.12	810.83	0.00
16″	45.65	50.72	90.94	182.97	293.12	505.07	863.76	1238.76	1232.24	0.00
18″	65.91	73.23	131.30	264.16	423.18	729.18	1247.04	1788.44	1779.02	0.00
20″	91.42	101.57	182.11	366.39	586.95	1011.37	1729.64	2480.55	2467.50	0.00

Example: 4″ Valve; 60° Open with a 10 PSI pressure drop: [Td = (9.454)(10) = 94.54 lb-in]

Series 32/33, 35/36 (Dynamic Torque Factor - lb-in./psi)

Valve Size in.	Angle of Opening									
	10°	20°	30°	40°	50°	60°	70°	75°	80°	90°
24″	158.36	175.95	315.46	634.69	1016.76	1751.99	2996.23	4297.03	4274.40	0.00
30″	315.32	350.35	628.13	1263.77	2024.54	3488.51	5966.01	8556.12	8511.07	0.00
36″	551.88	613.21	1099.39	2211.92	3543.45	6105.77	10442.00	14975.33	14896.49	0.00
Larger Size Valves - Consult Factory										

Example: 24″ Valve; 60° Open with a 10 PSI pressure drop: [Td = (1,751.990)(10) = 17,519.90 lb-in]

DYNAMIC TORQUE FACTORS (METRIC)

To Use the Torque Chart, note the following:

1. Dynamic Torque values include all bearing friction and stem-seal friction torques.
2. Dynamic Torque values are per 1 bar ΔP. To determine dynamic torque (Nm) at a desired angle of opening, multiply the pressure drop ΔP at this angle by the appropriate dynamic torque factor in the charts below.
3. Bray recommends sizing control valves between 20° and 70°, with 60° the preferred angle.
4. Dynamic Torque will tend to close all Bray valves whose disc are symmetrical to the stem.

Series 20/21 and 30/31/3A (Dynamic Torque Factor - Nm/bar)

Valve Size mm.	Angle of Opening									
	10°	20°	30°	40°	50°	60°	70°	75°	80°	90°
50	0.19	0.21	0.37	0.74	1.19	2.05	3.51	5.03	5.00	0.00
65	0.35	0.39	0.70	1.42	2.27	3.91	6.69	9.60	9.55	0.00
80	0.60	0.67	1.20	2.41	3.87	6.66	11.39	16.34	16.25	0.00
100	1.40	1.56	2.79	5.61	8.99	15.49	26.49	38.00	37.80	0.00
125	2.70	3.00	5.39	10.84	17.36	29.91	51.16	73.36	72.98	0.00
150	4.09	4.54	8.14	16.38	26.24	45.22	77.33	110.91	110.32	0.00
200	10.82	11.04	19.79	39.82	63.79	109.91	187.97	269.58	268.16	0.00
250	19.65	21.83	39.14	78.75	126.16	217.38	371.76	533.16	530.35	0.00
300	34.24	38.04	68.20	137.22	219.82	378.77	647.77	929.00	924.11	0.00
350	49.23	54.70	98.06	197.29	316.06	544.61	931.38	1335.74	1328.71	0.00
400	74.81	83.12	149.03	299.83	480.33	827.66	1415.46	2029.97	2019.28	0.00
450	108.01	120.01	215.15	432.88	693.46	1194.92	2043.53	2930.72	2915.29	0.00
500	149.80	166.45	298.42	600.40	961.83	1657.34	2834.37	4064.89	4043.50	0.00

Example: 100 mm Valve; 60° Open with a .75 bar pressure drop: [Td = (15.49)(.75) = 11.62 Nm]

Series 32/33, 35/36 (Dynamic Torque Factor - Nm/bar)

Valve Size mm	Angle of Opening									
	10°	20°	30°	40°	50°	60°	70°	75°	80°	90°
600	259.50	288.34	516.94	1040.07	1666.17	2871.00	4909.94	7041.56	7004.49	0.00
750	516.71	574.13	1029.33	2070.95	3317.62	5716.65	9776.53	14020.96	13947.15	0.00
900	904.38	1004.86	1801.57	3624.68	5806.67	10005.56	17111.37	24540.17	24410.97	0.00
Larger Size Valves - Consult Factory										

Example: 600 mm Valve; 60° Open with a .75 bar pressure drop: [Td = (2871)(.75) = 2153.25 Nm]

VALVE SIZING COEFFICIENTS

Series 20/21 - Valve Sizing Coefficient (Cv)

Valve Size inches	Disc Position (Degrees)								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
1	0.1	1	3	6	11	21	36	56	61
1.5	0.2	2	6	11	26	50	87	129	147
2	0.9	7	16	27	45	73	123	172	244
2.5	1	11	25	43	71	115	201	310	439
3	2	16	35	62	102	165	290	488	691
4	4	28	63	110	182	294	515	906	1,282
5	6	44	98	172	284	459	805	1,416	2,070
6	7	59	130	227	376	607	1,065	1,873	2,786
8	13	106	244	427	714	1,147	1,935	3,402	5,191
10	21	168	387	675	1,130	1,815	3,062	5,385	8,238
12	31	245	562	981	1,642	2,636	4,448	7,820	12,102
14	40	307	706	1,234	2,064	3,313	5,590	9,829	15,210
16	52	403	925	1,617	2,706	4,343	7,328	12,885	19,940
18	68	528	1,213	2,121	3,549	5,695	9,610	16,898	26,150
20	85	660	1,517	2,651	4,436	7,120	12,014	21,124	32,690

Series 22/23 - Valve Sizing Coefficient (Cv)

Valve Size inches	Disc Position (Degrees)								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
2	1	7	16	27	44	62	85	115	146
2.5	1	11	24	43	69	110	176	235	300
3	2	15	35	61	98	158	286	413	586
4	3	27	62	109	177	285	503	812	1,051
5	5	43	98	171	276	440	798	1,297	1,814
6	6	57	129	226	364	580	1,048	1,737	2,576
8	12	104	242	424	698	1,111	1,908	3,142	4,354
10	20	165	385	672	1,105	1,761	3,004	4,976	6,834
12	29	241	559	975	1,604	2,591	4,420	7,392	10,090
14	35	300	720	1,280	2,100	3,300	5,700	9,350	12,880
16	45	350	850	1,650	2,750	4,400	7,500	12,320	16,900
18	55	510	1,200	2,100	3,600	5,700	9,830	15,600	21,600
20	80	650	1,550	2,700	4,480	7,100	12,200	19,900	27,500
24	180	1,000	2,450	4,600	7,000	11,300	18,900	28,500	34,800

Series 30/31/31H/3A/3AH/31U - Valve Sizing Coefficient (Cv)

Valve Size Inches	Disc Position (Degrees)								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
2	0.8	7	16	27	43	61	84	114	144
2.5	1	11	24	43	67	107	163	223	282
3	2	15	35	61	96	154	267	364	461
4	3	27	62	109	171	274	496	701	841
5	5	43	98	170	268	428	775	1,146	1,376
6	6	56	129	225	354	567	1,025	1,542	1,850
8	12	102	241	421	680	1,081	1,862	2,842	3,316
10	19	162	382	667	1,076	1,710	2,948	4,525	5,430
12	27	235	555	1,005	1,594	2,563	4,393	6,731	8,077
14	34	299	756	1,320	2,149	3,384	5,939	8,874	10,538
16	45	397	1,001	1,749	2,847	4,483	7,867	11,761	13,966
18	58	507	1,281	2,237	3,643	5,736	10,065	14,496	17,214
20	72	632	1,595	2,786	4,536	7,144	12,535	18,812	22,339

Series 32/33/35/36/35F/36H - Valve Sizing Coefficient (Cv)

Valve Size Inches	Disc Position (Degrees)								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
22	103	916	2,070	3,510	5,640	9,036	14,562	22,028	27,168
24	259	1,028	2,387	4,244	6,962	11,040	18,235	27,186	33,154
26	289	1,141	2,752	4,890	7,824	12,496	19,921	29,700	36,220
28	295	1,324	3,133	5,399	8,636	13,838	22,578	34,683	41,619
30	420	1,652	3,986	7,080	11,328	18,090	28,844	43,003	52,443
32	550	2,026	4,636	7,983	12,743	20,410	32,591	48,558	60,658
34	533	2,304	5,210	8,834	14,179	22,741	36,648	55,438	68,374
36	740	2,775	5,936	9,790	15,572	25,053	40,086	59,667	77,089
40	757	2,971	6,925	11,862	19,307	30,636	50,406	73,990	90,175
42	783	3,502	7,879	12,997	21,010	35,016	54,584	83,421	102,989
44	904	4,066	8,698	14,346	22,818	36,712	58,740	87,430	112,960
48	1,023	4,651	10,365	17,010	27,242	43,853	70,431	108,968	132,888
52	Consult Factory								
54	1,299	5,904	13,158	21,594	34,583	55,671	89,411	138,334	168,700
60	1,480	6,400	14,500	24,500	39,400	63,200	102,000	154,000	190,000
66	1,650	7,110	16,100	27,300	43,800	70,200	113,000	171,000	211,000
72	1,900	8,220	18,600	31,500	50,700	81,200	131,000	198,000	244,000
78	2,290	9,910	22,400	38,000	61,000	97,800	158,000	238,000	294,000
84	2,290	11,390	25,800	43,700	70,200	112,400	181,000	274,000	338,000
90	Consult Factory								
96	Consult Factory								

Series 20/21 - Valve Sizing Coefficient (Kv)

Valve Size mm	Disc Position (Degrees)								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
25	0.087	0.865	2.595	5.190	9.515	18.165	31.140	48.440	52.765
40	0.173	1.730	5.190	9.515	22.490	43.250	75.255	111.585	127.155
50	0.779	6.055	13.840	23.355	38.925	63.145	106.395	148.780	211.060
65	0.865	9.515	21.625	37.195	61.415	99.475	173.865	268.150	379.735
80	1.730	13.840	30.275	53.630	88.230	142.725	250.850	422.120	597.715
100	3.460	24.220	54.495	95.150	157.430	254.310	445.475	783.690	1,108.930
125	5.190	38.060	84.770	148.780	245.660	397.035	696.325	1,224.840	1,790.550
150	6.055	51.035	112.450	196.355	325.240	525.055	921.225	1,620.145	2,409.890
200	11.245	91.690	211.060	369.355	617.610	992.155	1,673.775	2,942.730	4,490.215
250	18.165	145.320	334.755	583.875	977.450	1,569.975	2,648.630	4,658.025	7,125.870
300	26.815	211.925	486.130	848.565	1,420.330	2,280.140	3,847.520	6,764.300	10,468.230
350	34.600	265.555	610.690	1,067.410	1,785.360	2,865.745	4,835.350	8,502.085	13,156.650
400	44.980	348.595	800.125	1,398.705	2,340.690	3,756.695	6,338.720	11,145.525	17,248.100
450	58.820	456.720	1,049.245	1,834.665	3,069.885	4,926.175	8,312.650	14,616.770	22,619.750
500	73.525	570.900	1,312.205	2,293.115	3,837.140	6,158.800	10,392.110	18,272.260	28,276.850

Series 22/23 - Valve Sizing Coefficient (Kv)

Valve Size mm	Disc Position (Degrees)								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
50	0.865	6.055	13.840	23.355	38.060	53.630	73.525	99.475	126.290
65	0.865	9.515	20.760	37.195	59.685	95.150	152.240	203.275	259.500
80	1.730	12.975	30.275	52.765	84.770	136.670	247.390	357.245	506.890
100	2.595	23.355	53.630	94.285	153.105	246.525	435.095	702.380	909.115
125	4.325	37.195	84.770	147.915	238.740	380.600	690.270	1,121.905	1,569.110
150	5.190	49.305	111.585	195.490	314.860	501.700	906.520	1,502.505	2,228.240
200	10.380	89.960	209.330	366.760	603.770	961.015	1,650.420	2,717.830	3,766.210
250	17.300	142.725	333.025	581.280	955.825	1,523.265	2,598.460	4,304.240	5,911.410
300	25.085	208.465	483.535	843.375	1,387.460	2,241.215	3,823.300	6,394.080	8,727.850
350	30.275	259.500	622.800	1,107.200	1,816.500	2,854.500	4,930.500	8,087.750	11,141.200
400	38.925	302.750	735.250	1,427.250	2,378.750	3,806.000	6,487.500	10,656.800	14,618.500
450	47.575	441.150	1,038.000	1,816.500	3,114.000	4,930.500	8,502.950	13,494.000	18,684.000
500	69.200	562.250	1,340.750	2,335.500	3,875.200	6,141.500	10,553.000	17,213.500	23,787.500
600	155.700	865.000	2,119.250	3,979.000	6,055.000	9,774.500	16,348.500	24,652.500	30,102.000

Series 30/31/31H/3A/3AH/31U - Valve Sizing Coefficient (Kv)

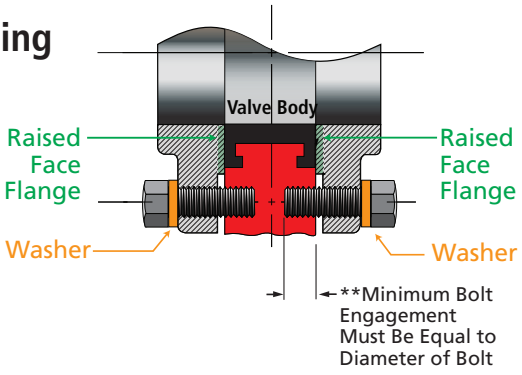
Valve Size mm	Disc Position (Degrees)								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
50	0.692	6.055	13.840	23.355	37.195	52.765	72.660	98.610	124.560
65	0.865	9.515	20.760	37.195	57.955	92.555	140.995	192.895	243.930
80	1.730	12.975	30.275	52.765	83.040	133.210	230.955	314.860	398.765
100	2.595	23.355	53.630	94.285	147.915	237.010	429.040	606.365	727.465
125	4.325	37.195	84.770	147.050	231.820	370.220	670.375	991.290	1,190.240
150	5.190	48.440	111.585	194.625	306.210	490.455	886.625	1,333.830	1,600.250
200	10.380	88.230	208.465	364.165	588.200	935.065	1,610.630	2,458.330	2,868.340
250	16.435	140.130	330.430	576.955	930.740	1,479.150	2,550.020	3,914.125	4,696.950
300	23.355	203.275	480.075	869.325	1,378.810	2,216.995	3,799.945	5,822.315	6,986.605
350	29.410	258.635	653.940	1,141.800	1,858.885	2,927.160	5,137.235	7,676.010	9,115.370
400	38.925	343.405	865.865	1,512.885	2,462.655	3,877.795	6,804.955	10,173.265	12,080.590
450	50.170	438.555	1,108.065	1,935.005	3,151.195	4,961.640	8,706.225	12,539.040	14,890.110
500	62.280	546.680	1,379.675	2,409.890	3,923.640	6,179.560	10,842.775	16,272.380	19,323.235

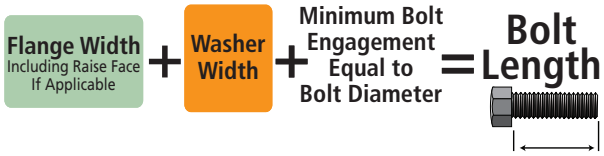
Series 32/33/35/36/35F/36H - Valve Sizing Coefficient (Kv)

Valve Size mm	Disc Position (Degrees)								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
550	89.095	792.340	1,790.550	3,036.150	4,878.600	7,816.140	12,596.130	19,054.220	23,500.320
600	224.035	889.220	2,064.755	3,671.060	6,022.130	9,549.600	15,773.275	23,515.890	28,678.210
650	249.985	986.965	2,380.480	4,229.850	6,767.760	10,809.040	17,231.665	25,690.500	31,330.300
700	255.175	1,145.260	2,710.045	4,670.135	7,470.140	11,969.870	19,529.970	30,000.795	36,000.435
750	363.300	1,428.980	3,447.890	6,124.200	9,798.720	15,647.850	24,950.060	37,197.595	45,363.195
800	475.750	1,752.490	4,010.140	6,905.295	11,022.695	17,654.650	28,191.215	42,002.670	52,469.170
850	461.045	1,992.960	4,506.650	7,641.410	12,264.835	19,670.965	31,700.520	47,953.870	59,143.510
900	640.100	2,400.375	5,134.640	8,468.350	13,469.780	21,670.845	34,674.390	51,611.955	66,681.985
1,000	654.805	2,569.915	5,990.125	10,260.630	16,700.555	26,500.140	43,601.190	64,001.350	78,001.375
1,050	677.295	3,029.230	6,815.335	11,242.405	18,173.650	30,288.840	47,215.160	72,159.165	89,085.485
1,100	781.960	3,517.090	7,523.770	12,409.290	19,737.570	31,755.880	50,810.100	75,626.950	97,710.400
1,200	884.895	4,023.115	8,965.725	14,713.650	23,564.330	37,932.845	60,922.815	94,257.320	114,948.120
1,300	Consult Factory								
1,400	1,123.635	5,106.960	11,381.670	18,678.810	29,914.295	48,155.415	77,340.515	119,658.910	145,925.500
1,500	1,280.200	5,536.000	12,542.500	21,192.500	34,081.000	54,668.000	88,230.000	133,210.000	164,350.000
1,650	1,427.250	6,150.150	13,926.500	23,614.500	37,887.000	60,723.000	97,745.000	147,915.000	182,515.000
1,800	1,643.500	7,110.300	16,089.000	27,247.500	43,855.500	70,238.000	113,315.000	171,270.000	211,060.000
2,000	1,980.850	8,572.150	19,376.000	32,870.000	52,765.000	84,597.000	136,670.000	205,870.000	254,310.000
2,200	1,980.850	9,852.350	22,317.000	37,800.500	60,723.000	97,226.000	156,565.000	237,010.000	292,370.000
2,250	Consult Factory								
2,400	Consult Factory								

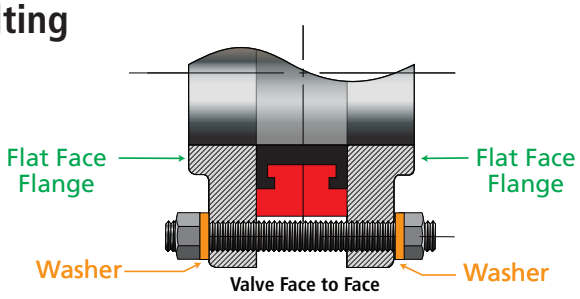
EXAMPLES OF TYPICAL FLANGE TO VALVE BOLTING*

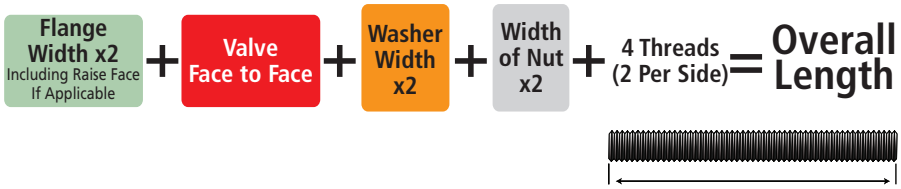
** Lug Style Bolting

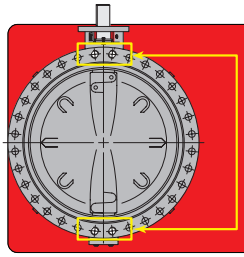




Wafer Style Bolting







**** Note: Please refer to Appropriate Bray Dimensional Drawings for specific valve drilling information on Wafer and Lug Valves 20" and larger.**

Please refer to ASME B-16.5 or B-16.47 for Flange and Bolt Dimension Information

* Double flange style bolting not shown.
** Lug threads may be tapped from both sides and therefore tap may not be continuous.

FLANGE BOLT TENSIONING
Bray Butterfly Valves with Metal Mating Flanges

A question frequently asked at Bray is "What torque do I apply to the flange bolts to insure the valve is properly installed?". Initially this seems to be a simple request until all of the factors are analyzed. The installation of a valve requires several components: the valve, mating flanges, nuts, bolts and studs. Each is supplied by different manufacturers and each has different characteristics. The proper torque for one combination may be too much or too little for a second combination. The following is a list of information which needs to be known in order to start calculating the torque requirements.

Valve
- Type
- Size
- Materials of construction (Body)
- Surface finishes / Surface conditions

Flange
- Type
- Size
- Finish / both sides
- Condition of flange / surface contamination

Bolt (or Stud)
- Type
- Materials of Construction
- Surface Conditions

Nut
- Type
- Materials of Construction
- Surface Conditions

Lubrication
- Type
- Coverage

General Factors
- Temperature and relative humidity at the time of installation
- Speed at which bolts are turned

Note: The elastomer valve seat manufactured by Bray also acts as the flange gasket. No additional gaskets are required or recommended. Other valve styles which do not have integral gaskets will need to have this component supplied. The characteristics of this component will also need to be considered.

Complete knowledge of all relevant conditions is almost impossible to obtain. As a result, the computation of the exact torque requirement is not practical. No reputable manufacturer can provide accurate information when so many outside factors are present.

The International Fasteners Institute covers some of the details required to "compute" a torque value. Even with this information the use of a torque wrench is only considered to be 25% accurate. Based on the difficulty and inaccuracy of using this method, Bray recommends the use of the "Turn of the nut" method.

"Turn of the Nut" Tightening
(For ANSI Standard Iron and Steel Flanges)
**For Non-Metallic or non-standard flanges, follow the manufacturers installation procedures.

1. The valve and flange faces must be aligned parallel to each other.

   Note: For rubber seated butterfly valves manufactured by Bray, it is required that the valve be fully opened prior to the tightening of the flange bolts.

2. After aligning the holes in a joint, sufficient bolts shall be placed and brought to a 'snug-tight' condition to ensure that the parts of the joint are *brought into full contact* with each other. 'Snug-Tight' is the tightness attained by the full effort of a man using a spud wrench.

3. Following the initial snugging operation, bolts shall be placed in any remaining holes and brought to snug-tightness. Re-snugging may be necessary in large joints.

4. Tighten opposite bolts in sequence to insure even pressure around the entire flange.

5. When all bolts are snug-tight, each bolt in the joint then shall be tightened additionally by the applicable amount of nut rotation given in Note 1. During tightening there shall be no rotation of the valve or flange.

Note 1

For bolt lengths **not exceeding** 8 diameters or 8 inches (203.2 mm) = **1/4 turn**
For bolt lengths **exceeding** 8 diameters or 8 inches (203.2 mm) = **1/2 turn**

Disclaimer:
Bray Controls is issuing these recommendations only as a guide to installation. This recommendation is based on the full compliance of all materials supplied to their appropriate specifications. Since many of the components are not manufactured by Bray we can take no responsibility for any damage caused during installation.

Series 20/21 and 30/31 - Flange Bolt Torque Chart

Valve Size		Normal Torque Range	Normal Torque Range
In	mm	Ft-lbs	Nm
2	50	30	40
2.5	65	30	40
3	80	35	50
4	100	35 - 40	50 - 55
5	125	35 - 45	50 - 60
6	150	35 - 50	50 - 65
8	200	45 - 55	60 - 75
10	250	55 - 75	75 - 100
12	300	65 - 110	90 - 150
14	350	75 - 120	100 - 165
16	400	75 - 120	100 - 165
18	450	85 - 130	115 - 175
20	500	85 - 130	115 - 175

Please note that the Nm and Ft-lbs values are based on bolt size in respective metric and ANSI flanges, i.e. these values are not a direct conversion between Nm and Ft-lbs.

The values represent average torques needed to ensure full compression of the resilient valves' seats into the valves' bodies when installed in pipeline flanges. The face of both flanges must come into full contact with the valves' metal bodies.

No additional torque is required for proper functioning of the Bray resilient seated valves.

The torque values are based on using new, coarse-threaded, lubricated fasteners. Up to 25% may be added to the Normal Torque Range values when using non-lubricated fasteners.

Torque Values specified by flange manufacturers ***must not be exceeded.***

Series 22/23 Installation - Flange Bolt Torque Chart, 150 lb Flanges

Valve Size		Normal Torque Range		Max Torque Range	
In	mm	Ft-lbs	Nm	Ft-lbs	Nm
2	50	30	40	35	50
2.5	65	30	40	35	50
3	80	35	50	40	55
4	100	35 - 40	50 - 55	40	55
5	125	35 - 45	50 - 60	50	65
6	150	35 - 50	50 - 65	65	90
8	200	45 - 55	60 - 75	80	110
10	250	55 - 75	75 - 100	100	135
12	300	65 - 110	90 - 150	120	165
14	350	75 - 120	100 - 165	140	190
16	400	75 - 120	100 - 165	140	190
18	450	85 - 130	115 - 175	170	230
20	500	85 - 130	115 - 175	180	245
24	600	100 - 150	135 - 205	220	300

The torque values are based on using new, coarse-threaded, lubricated fasteners. Up to 15% may be added to the Normal Torque Range values when using non-lubricated fasteners. However, the maximum torque should not be exceeded.

Flange gaskets are normally not used for installation of S22/23 valves. Flange leakage may be caused by combination of out-of-parallel and/or misaligned flanges, and surface damage on the flange face and/or the face of the valve seat. In such cases, suitable flange gaskets may be used to control flange leakage.

Torque values specified by manufacturers of certain flanges, for example plastic flanges, could be lower than the values specified above. In such cases, the flange manufacturers' torque values must not be exceeded. Use flange gaskets if necessary to secure flange seal.

Series 20/21 - Standard Metal Specifications

Part		Material	ASTM No.	UNS No.
Body		Cast Iron	A126 Class B	
		Ductile Iron	A395 Gr. 60-40-18	F32800
		316 Stainless Steel	A351 CF8M	J92900
		Aluminum	B26 Class B	
Disc/Stem 1-12"(25-300mm) One Piece		316 Stainless Steel	A351 CF8M	J92900
		Hastelloy® C22 *	B494 CX2MW	N26022
		17-4 ph Stainless Steel	A747 CB7Cu1 Heat Treated	J92180
Disc/Stem 14-20" (350-500mm) Fabricated	**Disc**	316 Stainless Steel	A240	S31600
		Hastelloy® C276 *	B575	N10276
		17-4 ph Stainless Steel	A564 630 Heat Treated	S17400
	Stem	316 Stainless Steel	A276	S31600
		Hastelloy® C276 *	B575	N10276
		17-4 ph Stainless Steel	A564 630 Heat Treated	S17400

Series 22/23 - Standard Metal Specifications

Part	Material	ASTM No.	UNS No.
Body	Ductile Iron	A395 Gr. 60-40-18	F32800
	316 Stainless Steel	A351 CF8M	J92900
	Carbon Steel	A216 WCB	J030002
Disc	316 Stainless Steel	A351 CF8M	J92900
	PTFE/316 SS (2"-12")	A351 CF8M	J92900
	PTFE/17-4 ph SS (14"-24")	A547 CB7Cu1	J92180
	PFA/316 SS (2"-12")	A351 CF8M	J92900
	PFA/17-4 ph SS (14"-24")	A547 CB7Cu1	J92180
	UHMWPE/316 SS (2"-6")	A351 CF8M	J92900
	UHMWPE/DI (8"-12")	A536 Gr 65-45-12	F33100
	Hastelloy® C22 *	B494 CX2MW	N26022
	Titanium		
Stem	17-4 ph Stainless Steel	A564 630 Heat Treated	S17400

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Series 30/31, 31H, 3A/3AH, 31U - Standard Metal Specifications

Part	Material	ASTM No.	UNS No.	30/31	31H	3A/3AH	31U
Body	Cast Iron	A126 Class B		●	●	●	
	Ductile Iron	A536 Gr. 65-45-12	F33100	●	●	●	
	Ductile Iron	A395	F32800				●
	Carbon Steel	A216 WCB	J030002	●		●	●
	Nickel Aluminum Bronze	B148	C95800				●
	Aluminum	B26 Class B		●			
Disc	Aluminum Bronze	B148	C95400	●	●	●	
	Nickel Aluminum Bronze	B148	C95800				●
	Nylon Coated Ductile Iron	A536 Gr. 65-45-12	F33100	●	●	●	
	316 Stainless Steel	A351 CF8M	J92900	●	●	●	●
	304 Stainless Steel	A351 CF8	J92600	●		●	
	Duplex Stainless Steel	A995 Gr 4A	J92205	●		●	
	Super Duplex Stainless Steel	A995 Gr 5A	J93404	●		●	
	Super Austenitic Stainless Steel (254 SMO™)*	A351 Grade CK3MCuN	S31254	●		●	
	Hastelloy® C-276 *	B575	N10276	●		●	
Stem	304 Stainless Steel	A276	S30400	●		●	
	316 Stainless Steel	A276	S31600	●		●	
	416 Stainless Steel	A582	S41600	●	●	●	●
	17-4 ph Stainless Steel	A564 630 Heat Treated	S17400				●
	Monel® *	B865	N05500	●		●	●

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Series 32/33, 35/36, 35F, 36H - Standard Metal Specifications

Part	Material	ASTM No.	UNS No.	32-36	36H	35F
Body	Cast Iron	A126 Class B		●		●
	Ductile Iron	A536 Gr. 65-45-12	F33100	●	●	●
	Carbon Steel	A216 Gr. WCB	J030002	●		
	316 Stainless Steel	A351 CF8M	J92900	●		
Disc	Nickel Aluminum Bronze	B148	C95800	●	●	
	Nylon Coated Ductile Iron	A536 Gr. 65-45-12	F33100	●	●	
	316 Stainless Steel	A351 CF8M	J92900	●		
	304 Stainless Steel	A351 CF8	J92600	●		
	Hastelloy® C-276 *	B575	N10276	CF		●
	Hastelloy® C-22 *	B494 CX2MW	N26022	CF		
	Duplex Stainless Steel	A995 Gr 5A	J93404	●	●	●
	Super Austenitic Stainless Steel (254 SMO ™) *	A351 Grade CK3MCuN	S31254	●	●	●
	Monel® *	A494 Grade M-35-1	N24135	●		
Stem	304 Stainless Steel	A276	S30400	●		●
	316 Stainless Steel	A276	S31600	●		●
	416 Stainless Steel	A582	S41600	●		
	17-4 ph Stainless Steel	A564 630 Heat Treated	S17400	●	●	
	Austenitic Stainless Steel	A479	S31651	●		
	Super Austenitic Stainless Steel (AL-6XN®) *	A276	N08367	●	●	
	Monel® *	B865	N05500	●		

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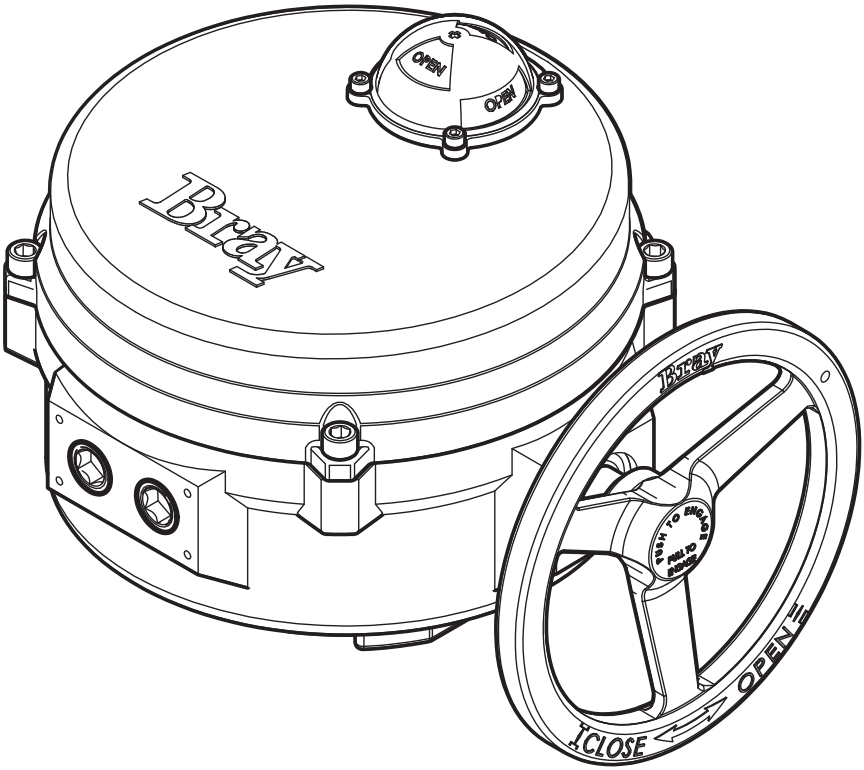
SERIES 70

ELECTRIC ACTUATORS

Installation, Operation, and Maintenance Manual



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READ AND FOLLOW THESE INSTRUCTIONS CAREFULLY.
SAVE THIS MANUAL FOR FUTURE USE.

1.0 DEFINITION OF TERMS

All information within this manual is relevant to the safe operation and proper care of your Bray valve. Please understand the following examples of information used throughout this manual.

SAFETY STATEMENTS: To prevent unwanted consequences. Standard symbols and classifications are:

DANGER
Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury.

WARNING
Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE
Used without the safety alert symbol, indicates a potential situation which, if not avoided, may result in an undesirable result or state, including property damage.

2.0 INTRODUCTION

The Bray Series 70 is a quarter turn electric actuator with manual override for use on any quarter turn valve requiring up to 18,000 lb-in [2,034 N m] of torque. Operating speeds vary between 30 to 110 seconds.

2.1 Principle of Operation

The Series 70 actuator is divided into two internal sections, the power center below the switch plate, and the control center above the switch plate. Below the switch plate, the gear motor, with its spur gear train, drives a non-backdriveable worm gear output. The override mechanism for manual operation is also housed here. Above the switch plate is where user required readily accessible components are placed. The indicator shaft assembly, limit switches, terminal strips, torque switches, heater, and electronic controllers are all placed here for easy access.

External to the unit are adjustable mechanical travel stops, a large and easy to read indicator, the unique manual override handwheel, and dual conduit entry ports. The external coating is a high-quality polyester powder coat which has exceptional UV protection and chemical resistance.

2.2 Electrical Operation

The gear motors used in the Bray Series 70 are of either permanent split capacitor (PSC) design (single phase AC power) or permanent magnet (PM) design (DC power). Travel limit switches are mechanical form (SPDT) with contacts rated at 10 Amp (0.8 PF), 1/2 HP 125/250 VAC.

In cases where the torque capacity of the unit is exceeded to the point where the motor stalls, a thermal protector switch, built into the PSC motor windings, will automatically disconnect the motor power and prevent overheating. Once the motor cools sufficiently, the thermal protector switch will reset automatically.

Optional torque switches are available in all units to prevent the possibility of stalling the motor, thus reducing the possibility of an inoperable thermal cool down period. Torque switches, installed by Bray, are factory adjusted to the output torque rating of the unit using electronic torque testing equipment.

2.3 Mechanical Operation

Mechanically, the ratio of the gear motor determines the speed of the unit. The gear motor utilizes high efficiency spur gears with various ratios for the different speeds. Initial gear reduction through the spur gears is then transferred to the worm shaft. The final gear reduction and output is through a non-backdriveable worm gear set. Positioning is determined by an indicator/cam shaft, which is linked to the output shaft. In the declutchable condition, the manual override drives the worm shaft when engaged.

3.0 PARTS INDENTIFICATION

3.1 Part Numbering System Reference Chart

Series
70

Torque	
E03	300 lb-in
E06	600 lb-in
E08	800 lb-in
E12	1200 lb-in
E20	2000 lb-in
E30	3000 lb-in
050	5000 lb-in
065	6500 lb-in
13W	13000 lb-in
18W	18000 lb-in

X - Speed	
0	60 sec
1	30 sec
6	110 sec

Product	
113	Actuator

Y - Style	
G	Imperial, Servo Nxt
R	Metric, Servo Nxt
D	Imperial, IRB
N	Metric, IRB

Z - Voltage	
A	120VAC
B	220VAC
C	24VAC/VDC
D	24VDC
0	120VAC
3	24VAC/VDC
4	220VAC

TTT - Trim	
536	Standard Bray Red
5F5	Bray Seacorr Coating

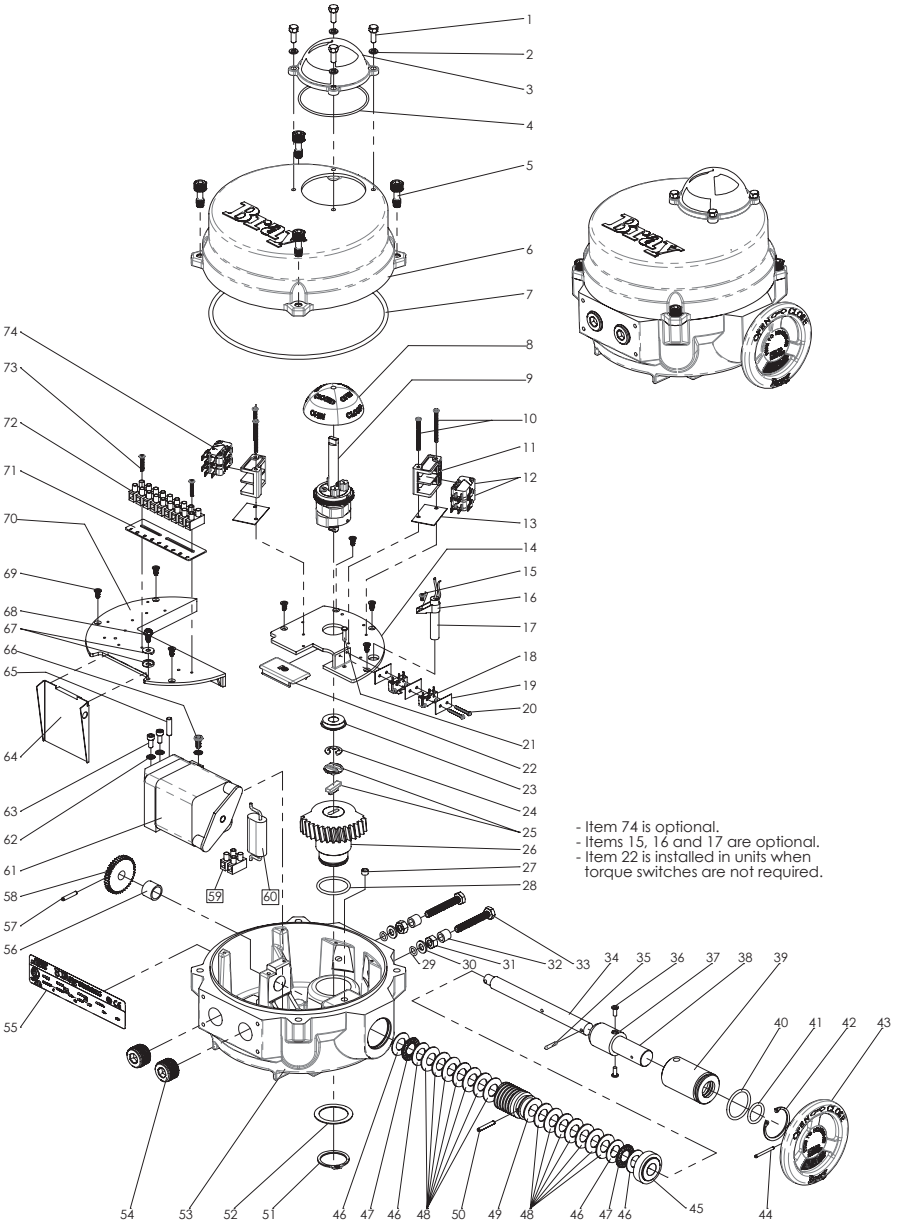
W - Designates The Output Bore Diameter	
0	2.5 Inches (63.5mm)
1	1.97 Inches (50 mm)

Actuator Size	Part Number	Torque	
		lb-in	N m
S70-E03	70-E03X-113YZ-TTT	300	34
S70-E06	70-E06X-113YZ-TTT	600	68
S70-E08	70-E08X-113YZ-TTT	800	90
S70-E12	70-E12X-113YZ-TTT	1,200	136
S70-E20	70-E20X-113YZ-TTT	2,000	226
S70-E30	70-E30X-113YZ-TTT	3,000	339
S70-050	70-050X-113YZ-TTT	5,000	565
S70-065	70-065X-113YZ-TTT	6,500	734
S70-130	70-13WX-113YZ-TTT	13,000	1469
S70-180	70-18WX-113YZ-TTT	18,000	2034

Style / Voltage		Voltage	Speed 1/4 Turn Seconds (60 Hz)	Controller
Imperial	Metric			
DA	NA	120VAC	30*	Interposing Relay Board (IRB)
DB	NB	220VAC	30*	Interposing Relay Board (IRB)
DC	NC	24VAC/VDC[1]	60	On/Off with Controller
DD	ND	24VDC	60	No Controller
G0	R0	120VAC	30*	Modulating with Servo NXT
G3	R3	24VAC/VDC	60	Modulating with Servo NXT
G4	R4	220VAC	30*	Modulating with Servo NXT
F3	Q3	24VAC/VDC	60	On/Off NXT Controller

[1]S70-050 is only 24VAC
*S70-130, 131 and 180, 181 are 110 seconds
Note: 220VAC units are 230VAC compatable

3.2 Series 70 – Size E03, E06, E08 – Electric Actuator Exploded View

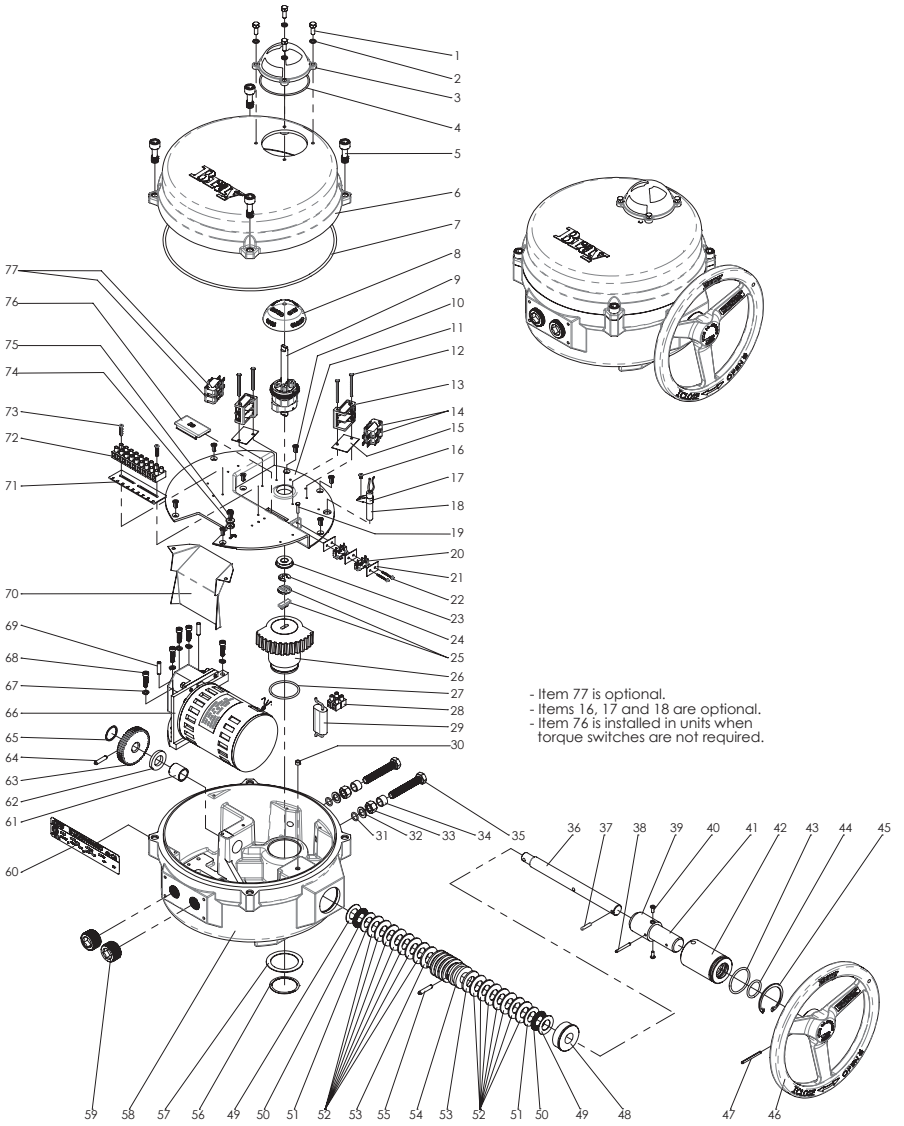


3.2.1 Series 70 – Size E03, E06, E08 – Parts

Item No.	Description
1	Indicator Cover Screws
2	Lockwasher
3	Position Indicator Cover
4	O-Ring
5	Cover Fastening Screws
6	Cover
7	O-Ring
8	Position Indicator
9	Cam Assembly
10	Limit Switch Screw
11	Limit Switch Bracket
12	Main Open/Closed Limit Switches
13	Limit Switch Insulator
14	Switch Plate, Fixed
15	Heater Bracket Screw
16	Heater Mounting Bracket
17	Heater
18	Override Switch
19	Override Switch Insulator
20	Override Switch Screw
21	Override Switch Trigger Pin
22	Torque Switch Cover
23	Switch Plate Ball Bearing
24	Retaining Ring
25	Coupler
26	Worm Wheel
27	Spring Pin
28	O-Ring
29	O-Ring
30	Nylon Flat Washer
31	Travel Stop Nut
32	Travel Stop Spacer
33	Travel Stop Bolt
34	Worm Shaft
35	Override Drive Pin
36	Spring Plunger
37	Manual Override Shaft Hub
38	Manual Override Shaft Stub

Item No.	Description
39	Manual Override Sleeve
40	O-Ring
41	O-Ring
42	Retaining Ring
43	Handwheel
44	Spring Pin
45	Manual Override Bushing
46	Thrust Washer
47	Thrust Roller Bearing
48	Disc Spring
49	Worm
50	Spring Pin
51	Retaining Ring
52	Thrust Washer
53	Base
54	Conduit Plug
55	Name Tag
56	Bushing
57	Drive Gear Pin
58	Drive Gear
59	Terminal Strip
60	Capacitor
61	Gearmotor
62	Lock Washer
63	Motor Cap Screw
64	Wire Entry Guard
65	Dowel Pin
66	Motor Screw
67	Ground Terminal Washer
68	Ground Terminal Screw
69	Switch Plate Mounting Screw
70	Removable Switch Plate
71	Terminal Strip Marker
72	Terminal Strip
73	Terminal Block Screw
74	Aux Open/Closed Limit Switches

3.3 Series 70 – Size E12, E20, E30 – Electric Actuator Exploded View

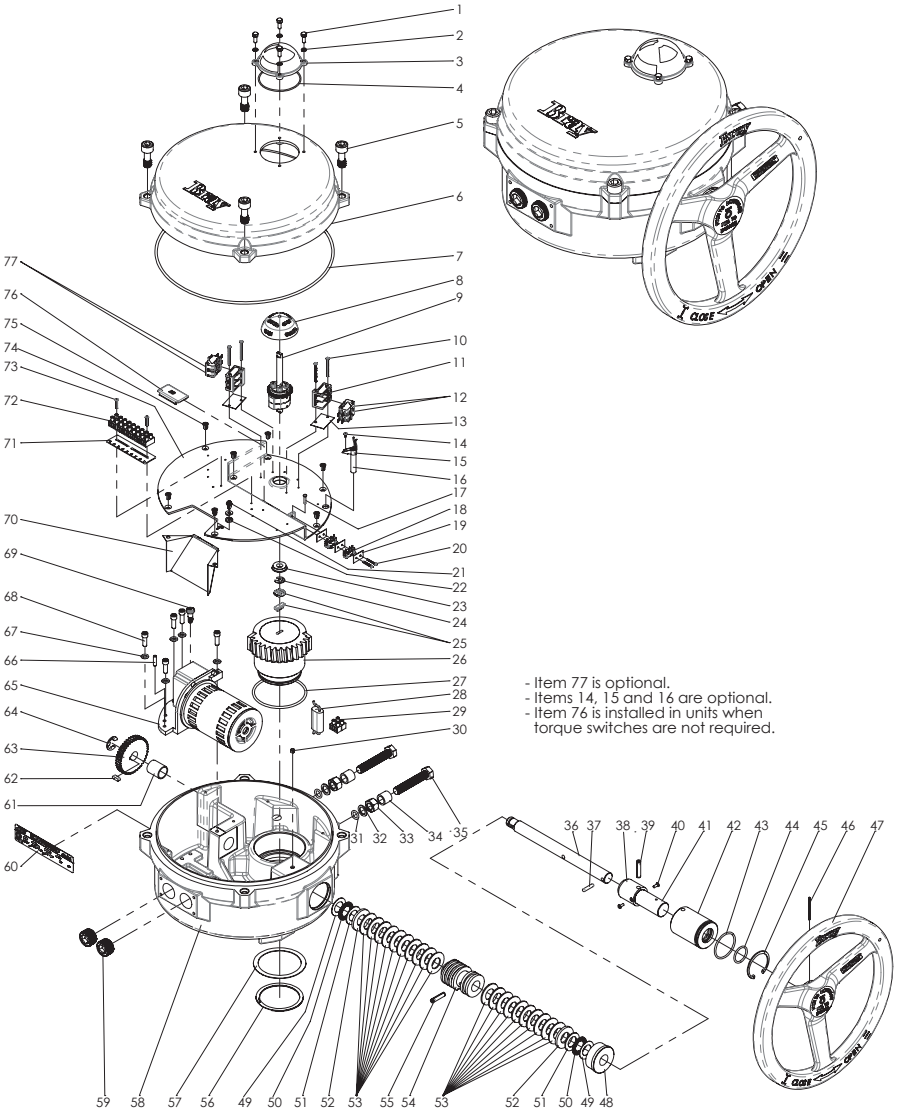


3.3.1 Series 70 – Size E12, E20, E30 – Parts

Item No.	Description
1	Indicator Cover Screws
2	Lockwasher
3	Position Indicator Cover
4	O-Ring
5	Cover Fastening Screw
6	Cover
7	O-Ring
8	Position Indicator
9	Cam Assembly
10	Switch Plate Mounting Screw
11	Switch Plate
12	Limit Switch Screw
13	Limit Switch Bracket
14	Main Open/Closed Limit Switches
15	Limit Switch Insulator
16	Heater Bracket Screw
17	Heater Mounting Bracket
18	Heater
19	Override Switch Trigger Pin
20	Override Switch
21	Override Switch Insulator
22	Override Switch Screw
23	Switch Plate Ball Bearing
24	Retaining Ring
25	Coupler
26	Worm Wheel
27	O-Ring
28	Terminal Strip
29	Capacitor
30	Spring Pin
31	O-Ring
32	Nylon Flat Washer
33	Travel Stop Nut
34	Travel Stop Spacer
35	Travel Stop Bolt
36	Worm Shaft
37	Override Drive Pin
38	Spring Pin
39	Manual Override Shaft Hub

Item No.	Description
40	Spring Plunger
41	Manual Override Shaft Stub
42	Manual Override Sleeve
43	O-Ring
44	O-Ring
45	Retaining Ring
46	Handwheel
47	Spring Pin
48	Manual Override Bushing
49	Thrust Washer
50	Thrust Roller Bearing
51	Thrust Washer
52	Disc Spring
53	Disc Spring
54	Worm
55	Spring Pin
56	Retaining Ring
57	Thrust Washer
58	Base
59	Conduit Plug
60	Name Tag
61	Bushing
62	Gear Spacer
63	Drive Gear
64	Spring Pin
65	Retaining Ring
66	Gearmotor
67	Lock Washer
68	Motor Cap Screw
69	Dowel Pin
70	Wire Entry Guard
71	Terminal Strip Marker
72	Terminal Strip
73	Terminal Block Screw
74	Ground Terminal Washer
75	Ground Terminal Screw
76	Torque Switch Cover
77	Aux Open/Closed Limit Switches

3.4 Series 70 – Size 050, 065 – Electric Actuator Exploded View

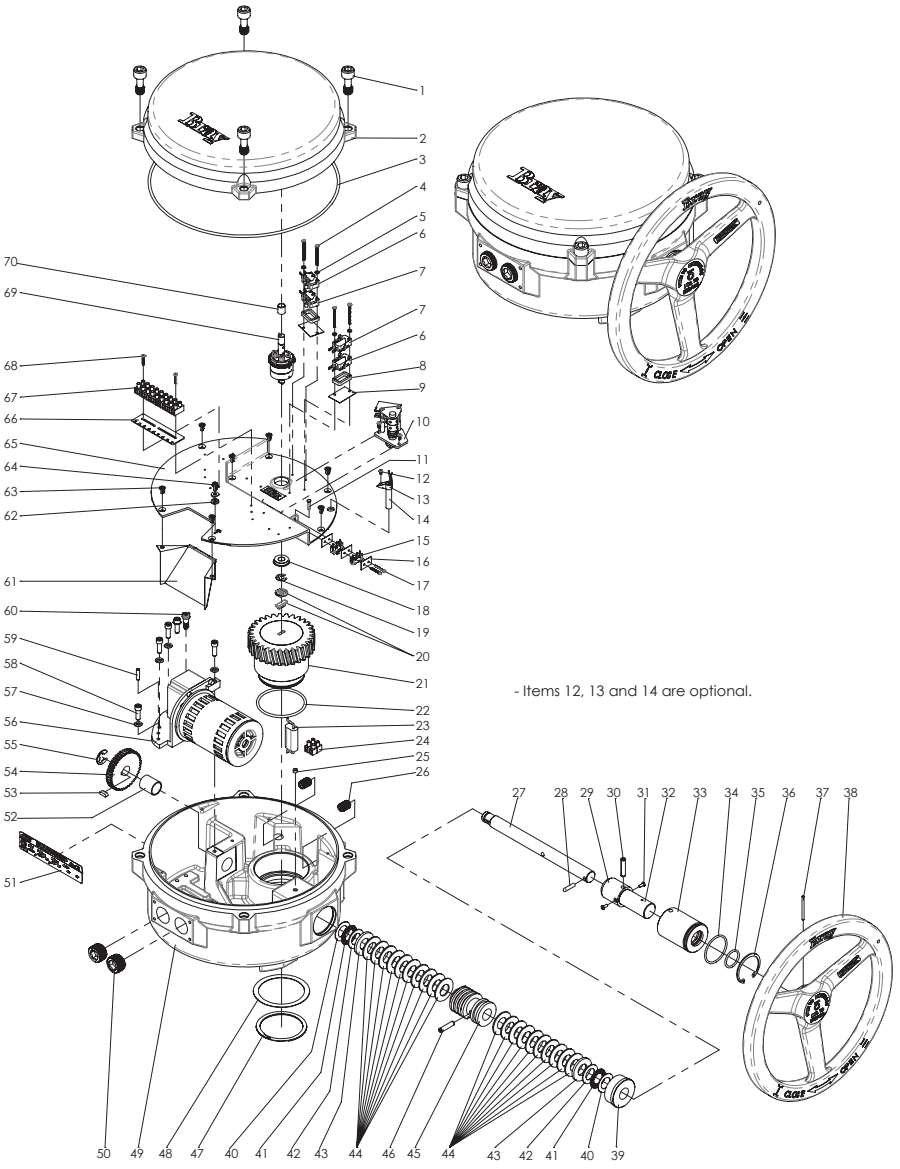


3.4.1 Series 70 – Size 050, 065 – Parts

Item No.	Description
1	Indicator Cover Screws
2	Lockwasher
3	Position Indicator Cover
4	O-Ring
5	Cover Fastening Screw
6	Cover
7	O-Ring
8	Position Indicator
9	Cam Assembly
10	Limit Switch Screw
11	Limit Switch Bracket
12	Main Open/Closed Limit Switches
13	Limit Switch Insulator
14	Heater Bracket Screw
15	Heater Mounting Bracket
16	Heater
17	Override Switch Trigger Pin
18	Override Switch
19	Override Switch Insulator
20	Override Switch Screw
21	Ground Terminal Screw
22	Ground Terminal Washer
23	Switch Plate Ball Bearing
24	Retaining Ring
25	Coupler
26	Worm Wheel
27	O-Ring
28	Capacitor
29	Terminal Strip
30	Spring Pin
31	O-Ring
32	Nylon Flat Washer
33	Travel Stop Nut
34	Travel Stop Spacer
35	Travel Stop Bolt
36	Worm Shaft
37	Override Drive Pin
38	Manual Override Shaft Hub
39	Spring Pin

Item No.	Description
40	Spring Plunger
41	Manual Override Shaft
42	Manual Override Sleeve
43	O-Ring
44	O-Ring
45	Retaining Ring
46	Spring Pin
47	Handwheel
48	Manual Override Bushing
49	Thrust Washer
50	Thrust Roller Bearing
51	Thrust Washer
52	Spherical Washer
53	Disc Spring
54	Worm
55	Spring Pin
56	Retaining Ring
57	Thrust Washer
58	Base
59	Conduit Plug
60	Name Tag
61	Bushing
62	Drive Gear Key
63	Drive Gear
64	Retaining Ring
65	Gear Motor
66	Dowel Pin
67	Lock Washer
68	Motor Cap Screw
69	Motor Shoulder Screw
70	Wire Entry Guard
71	Terminal Strip Marker
72	Terminal Strip
73	Terminal Block Screw
74	Switch Plate
75	Switch Plate Mounting Screw
76	Torque Switch Cover
77	Aux Open/Closed Limit Switches

3.5 Series 70 – Size 130, 180 – Electric Actuator Exploded View

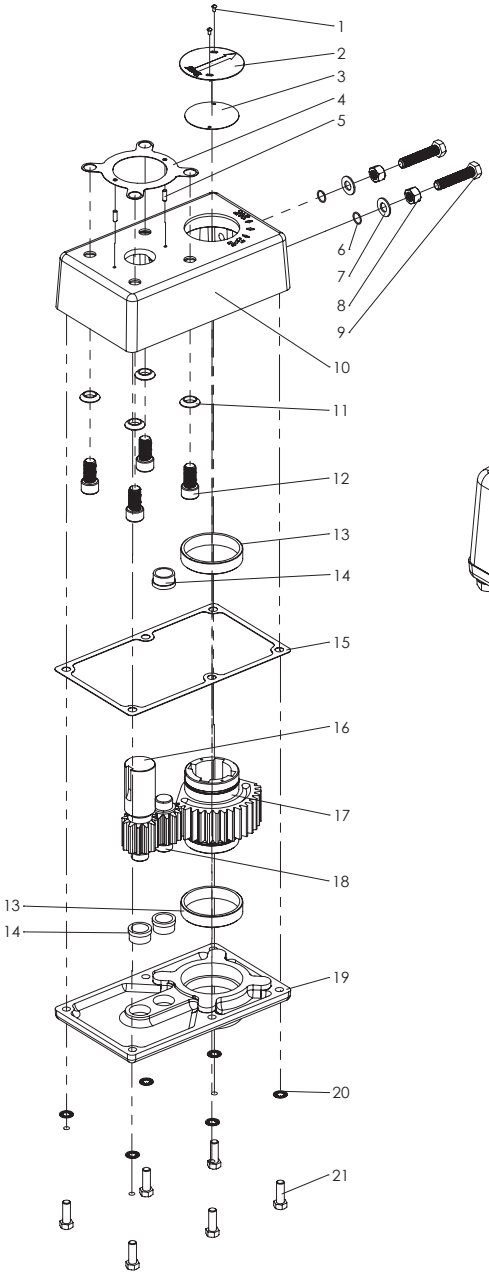


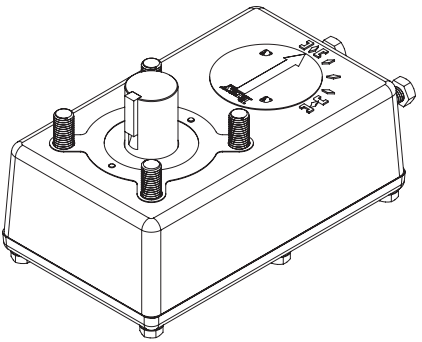
3.5.1 Series 70 – Size 130, 180 – Parts

Item No.	Description
1	Cover Fastening Screw
2	Cover
3	O-Ring
4	Limit Switch Screw
5	Flat Insulation Washer
6	Main Open/Closed Limit Switches
7	Aux Open/Closed Limit Switches
8	Switch Spacer
9	Limit Switch Insulator
10	Torque Switch Assembly
11	Override Switch Trigger Pin
12	Heater Bracket Screw
13	Heater Mounting Bracket
14	Heater
15	Override Switch
16	Override Switch Insulator
17	Override Switch Screw
18	Switch Plate Ball Bearing
19	Retaining Ring
20	Coupler
21	Worm Wheel
22	O-Ring
23	Capacitor
24	Terminal Strip
25	Spring Pin
26	Set Screw
27	Worm Shaft
28	Override Drive Pin
29	Manual Override Shaft Hub
30	Spring Pin
31	Spring Plunger
32	Manual Override Shaft Stub
33	Manual Override Sleeve
34	O-Ring
35	O-Ring
36	Retaining Ring
37	Spring Pin

Item No.	Description
38	Handwheel
39	Manual Override Bushing
40	Thrust Washer
41	Thrust Roller Bearing
42	Thrust Washer
43	Spherical Washer
44	Disc Spring
45	Worm
46	Spring Pin
47	Retaining Ring
48	Thrust Washer
49	Base
50	Conduit Plug
51	Name Tag
52	Bushing
53	Drive Gear Key
54	Drive Gear
55	Retaining Ring
56	Gear Motor
57	Lock Washer
58	Motor Cap Screw
59	Dowel Pin
60	Motor Shoulder Screw
61	Wire Entry Guard
62	Ground Terminal Washer
63	Switch Plate Mounting Screw
64	Ground Terminal Screw
65	Switch Plate
66	Terminal Strip Marker
67	Terminal Strip
68	Terminal Block Screw
69	Cam Assembly
70	Bushing

3.6 Series 70 – Size 130, 180 – 3:1 Gear Box Exploded View





3.6.1 Series 70 – Size 130, 180 – 3:1 Gear Box Parts

Item No.	Description
1	Fastening Screw
2	Position Indicator Plate
3	Position Indicator Gasket
4	Actuator/Gear Box Gasket
5	Dowel Pin
6	O-Ring
7	Washer,Flat,Nylon
8	Nut,Hex
9	Bolt,Hex Hd
10	Cover
11	Washer, Conical
12	Actuator/Gear Box Fastening Screw
13	Output Gear Bearing
14	Idler/Input Gear Bearing
15	Cover Gasket
16	Input Gear
17	Output Gear
18	Idler Gear
19	Cover
20	Lock Washer
21	Base Fastening Screw

4.0 HAZARD-FREE USE

This device left the factory in proper condition to be safely installed and operated in a hazard-free manner. The notes and warnings in this document must be observed by the user to ensure hazard-free operation of this device.

Configuration and setup procedures for this device are described in this manual. Proper configuration and setup are required for the safe operation of this device.

The control system in which this device is installed must have proper safeguards to prevent injury to personnel, or damage to equipment, should a failure of system components occur.

WARNING
Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

5.0 QUALIFIED PERSONNEL

WARNING
The actuator must only be installed, commissioned, operated and repaired by qualified personnel.

Installation, commissioning, operation and maintenance must be performed under strict observation of all applicable codes, standards and safety regulations.

As per this document, a qualified person is one who is trained in:

> The operation and maintenance of electric equipment and systems in accordance with established safety practices.
> Procedures to energize, de-energize, ground, tag and lock electrical circuits and equipment in accordance with established safety practices.
> The proper use and care of personal protective equipment (PPE) in accordance with established safety practices.
> First aid.
> In cases where the device is installed in a potentially explosive (hazardous) location – is trained in the operation, commissioning, operation and maintenance of equipment in hazardous locations.

WARNING
Reference is specifically made here to observe all applicable safety regulations for actuators installed in potentially explosive (hazardous) locations.

6.0 STORAGE

WARNING
Actuators are not weatherproof unless they are properly installed on the valve or prepared for storage. Bray cannot accept responsibility for deterioration caused on-site.

Bray Series 70 is not weatherproof until the unit is properly installed, or all conduits and applicable port connections are sealed off and prepared for storage. The units may be shipped with temporary covers to prevent foreign matter from entering through the conduit openings; however, the user is responsible for replacing with the proper sealing plugs to support its NEMA/IP ratings.

To prevent condensation from forming inside the unit, maintain a near constant external temperature and store indoors in a well ventilated, clean, dry room.

The temperature shall be between 40°F (4°C) and 85°F (29°C), with a relative humidity less than 70%.

Store units away from vibration and direct sunlight exposure, and place units on a shelf or wooden pallet in order to protect against dampness.

Keep units covered to protect against dust and dirt; if storing for long term, placing the unit inside a plastic sealed bag may be preferred.

Bray cannot accept responsibility for deterioration caused on-site once the cover is removed or due to improper storage.

For units with an internal heater, power should be supplied to the heater via conduit entry with an appropriate sealing gland.

7.0 ACTUATION

7.1 Manual Operation

The manual override operates similar to a watch adjusting knob. To engage the manual override, simply pull the handwheel to its outermost position. A yellow stripe is revealed to visually indicate manual override engagement as shown in Figure 1. The two handwheel positions, engaged and disengaged, are held in place with the use of spring plungers. The handwheel remains in position until physically moved.

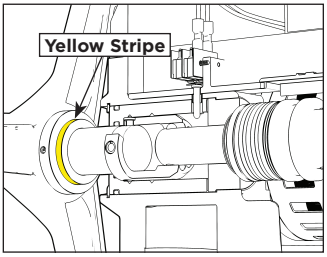


Figure 1 - Handwheel is engaged, revealing the yellow stripe.

Once the manual override is engaged, rotating the handwheel in the clockwise direction will rotate the output shaft in the clockwise (close) direction and vice-versa.

To disengage the manual override, the handwheel needs to be pushed towards the actuator until the 'yellow stripe' is hidden.

CAUTION
A label on the handwheel hub warns users not to exceed a specific 'rim pull' force, for each size of actuator.

If the 'rim pull' force is exceeded, the roll pin securing the handwheel onto the manual override shaft is designed to shear, thus preventing serious internal gearing damage.

7.2 Remote Operation

CAUTION
1. Verify that the main electric power supplied to the actuator is in compliance with the specifications on the actuator label.
2. Engaging the handwheel before or during the application of a supply voltage will prevent the actuator motor from operating.
3. If torque switches are installed in the actuator, an over-torque condition will prevent the actuator motor from operating in the direction of fault.

7.3 S70 On/Off Actuator with Interposing Relay Board (I.R.B.)

The back feeding of one actuator by another one wired in parallel is eliminated by using the I.R.B. If actuator is running Open and customer switches "instantaneously" to run Closed, the Open relay will take time to 'drop-out' and the Close relay will take time to 'pull-in' this time lapse is ~ 40ms. The time delay provided by the I.R.B. will protect the switches and gears from the controller's instantaneous command signal reversal. Current draws and field wirings are not affected by adding I.R.B.

S70 120VAC I.R.B., auxiliary switch, heater, and torque switch option are UL certified units

NOTE: The host controller should use a one second time delay for command signal reversal.

CAUTION
Apply voltage to only one direction terminal at a time.

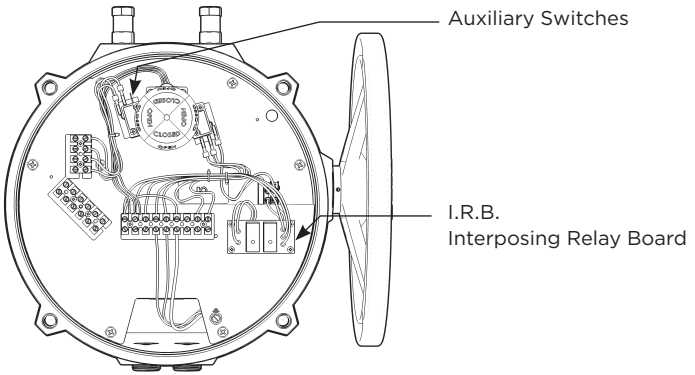


Figure 2 - S70 with I.R.B.

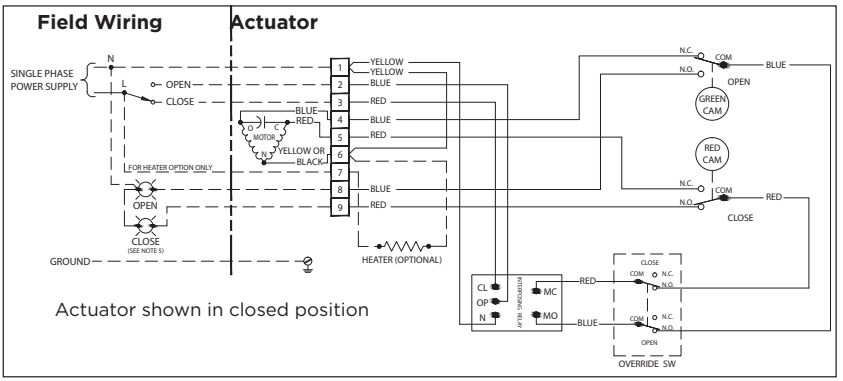


Figure 3 - Sample field wiring diagram for Series 70 actuator with I.R.B.
Actuator specific wiring diagram located inside actuator cover.

7.4 Servo NXT

To control the actuator remotely from a process controller in a modulating application, user must apply the proper supply voltage and the configured control signal to the Servo NXT electronics package. The control signal may be applied locally from a hand-held signal generator or remotely from a process controller.

For more information, please refer to the S70 Servo NXT Manual. This manual is available on the company website (bray.com).

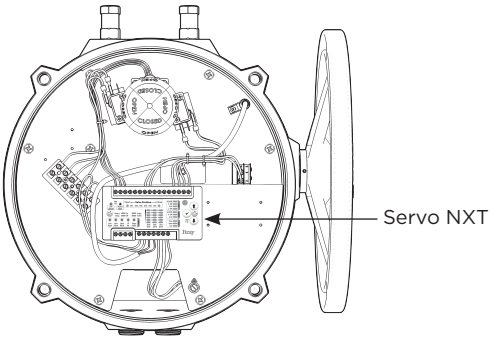


Figure 4 - S70 with Servo NXT

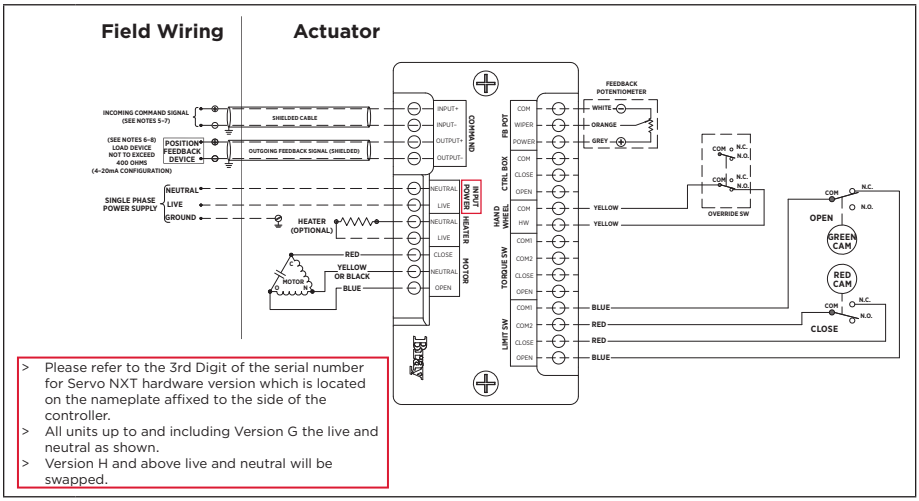


Figure 5 - Sample field wiring diagram for Series 70 actuator with Servo NXT. Actuator specific wiring diagram located inside actuator cover.

8.0 COMMISSIONING

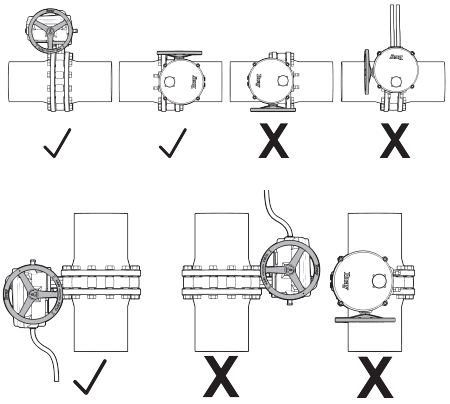
8.1 Mounting the Actuator

All Bray Series 70 electric actuators are suitable for direct mounting on Bray butterfly valves. With proper mounting hardware, the S70 actuator can be installed onto other quarter-turn valves or devices.

NOTICE
The standard mounting position for the actuator orients the unit with its handwheel in a vertical plane and parallel to the pipeline.

If the actuator is mounted on a vertical pipe, it is recommended that the unit be positioned with the conduit entries on the bottom to prevent condensation from entering the actuator through its conduits.

In all cases, the conduit should be positioned to prevent drainage into the actuator and the handwheel should not be facing down.



Follow the steps below to mount the actuator onto the valve.

1. Manually operate the actuator until the output shaft of the actuator is in line with the valve stem. If possible, select an intermediate position for both the valve and actuator.
2. If required, place the proper adapter onto the valve stem. It is recommended that a small amount of 'anti-seize' lubricant be applied to the adapter to ease assembly.
3. Mount the actuator onto the valve stem.
4. Install the furnished mounting studs by threading studs all the way into the actuator base. It may be necessary to manually operate the actuator to align the valve and actuator bolt patterns.
5. Fasten the mounting studs in place with furnished hex nuts and lock washers

8.2 Wiring the Actuator

WARNING
Turn off all power and lockout/tag out service panel before installing or modifying any electrical wiring.

1. Take the actuator cover off. The cover should be kept on hand for reference.
2. Wire the actuator as per the wiring diagram attached to the inside of the actuator cover.

NOTICE
1. Power and control wiring should use separate conduit entries.
2. A minimum of 18 AWG wire is recommended for all field wiring.
3. Terminals directly mounted on the actuator switch plate accept wire sizes ranging from 14 to 22 AWG.
4. Terminals of internally mounted electronics modules accept wire sizes ranging from 14 to 24 AWG.
5. The conduit connections must be properly sealed to maintain the weatherproof integrity of the actuator enclosure.

8.3 Setting Travel Limit Switches

NOTICE
If the unit came assembled to a valve, the switches have been factory-set and DO NOT need adjustment.

Bray uses its patented cam design along with two SPDT mechanical switches to set the 'Open' and 'Closed' position of the valve. The green cam actuates the 'open' switch when the actuator reaches the 'open' position. Similarly, the red cam actuates the 'closed' switch when the actuator reaches the 'closed' position.

Standard factory setting of the travel limit switches allows 90° travel between open and close positions. Cams for each switch are adjustable for applications where less than 90-degree travel is desired between the open and closed positions.

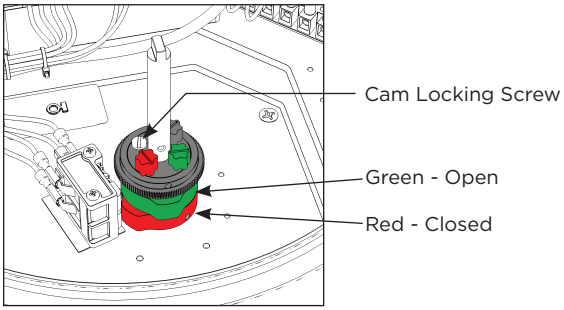


Figure 6. Two SPDT Travel Limit Switches

Follow the steps below to adjust the travel limit cams.

NOTE: For Actuator Size 130, 180, ignore steps 1 and 10.

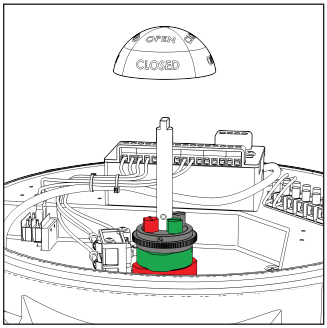


Figure 7. Indicator rotor pulled up from the indicator shaft.

1. Remove the indicator rotor by pulling away from the indicator shaft as shown in Figure 7.
2. Manually operate the actuator clockwise until the valve reaches the desired 'closed' position.
3. Loosen the cam locking screw shown in Figure 6.

NOTICE
Cam locking screw must be slackened before cam adjustments and re-tightened after cam adjustments.

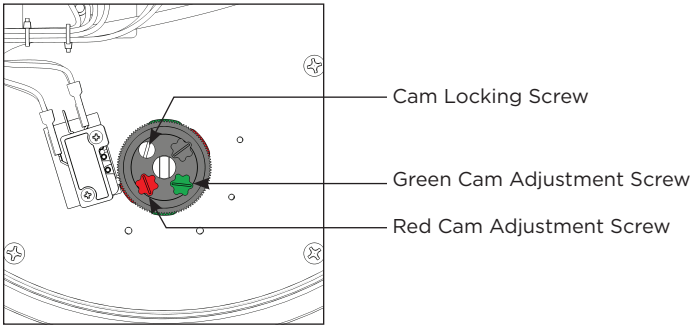


Figure 8. Top view of the indicator shaft.

NOTE: It is possible that the rotation of one cam will move the other cam. If this occurs, hold the other knobs or cams during adjustment.

4. Rotate the red cam adjustment knob by hand or with a flat head screwdriver until the red cam lobe just activates (depresses) the 'closed' switch from a clockwise direction.

NOTE: If fixed auxiliary switches are installed, the auxiliary cam will activate prior to the main cam.

5. Tighten the cam locking screw.

6. Manually operate the actuator counterclockwise until the valve reaches the desired 'open' position.
7. Loosen the cam locking screw.
8. Rotate the green cam adjustment knob until the green cam lobe activates (depresses) the 'open' switch from a counterclockwise direction.
9. Tighten the cam locking screw.
10. Place the indicator rotor back on the indicator shaft.

8.4 Setting Mechanical Travel Stops

NOTICE
If the unit came assembled to a valve, the stops have been factory-set and DO NOT need adjustment.

Mechanical travel stops are designed to prevent over travel while manually operating the actuator. They are not designed to stop the electric motor.

Mechanical travel stops are located outside of the actuator base for easy readjustment. Stainless steel lock nuts with O-ring seals hold the travel stops securely in place. Travel stop spacers are used to ensure that travel stop bolts are not engaged to where they could limit 0° to 90° electrical operation.

NOTE: Actuator Size 130, 180 does not use travel stop spacers.

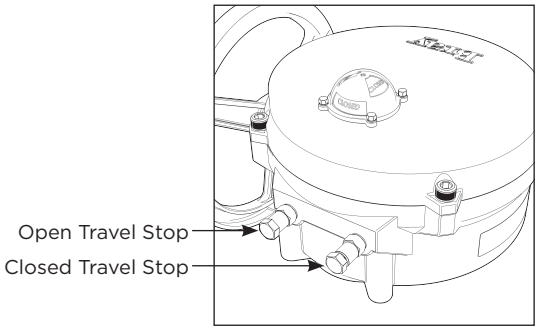


Figure 9. Mechanical Travel Stops (CW Close).

Follow the steps below to set the mechanical travels stops.

1. Manually drive the actuator to the 'closed' position.
2. Once the actuator is in the 'closed' position, rotate the handwheel clockwise:
   > ½ turn for Actuator Size E03, E06, E08.
   > 1 turn for Actuator Size E12, E20, E30.
   > ½ turn for Actuator Size 050, 065.
   > 2 turns for Actuator Size 130, 180.
3. Adjust the 'closed' travel stop bolt until the travel stop spacer is fully engaged or the travel stop bolt contacts the output segment gear.

4. Lock the travel stop bolt in position with the locknut.
5. Manually drive the actuator to the 'open' position.
6. Once the actuator is in the 'open' position, rotate the handwheel counterclockwise
   > ½ turn for Actuator Size E03, E06, E08.
   > 1 turn for Actuator Size E12, E20, E30.
   > ½ turn for Actuator Size 050, 065.
   > 2 turns for Actuator Size 130, 180.
7. Adjust the 'open' travel stop bolt until the travel stop spacer is fully engaged or the travel stop bolt contacts the output segment gear.
8. Lock the travel stop bolt in position with the locknut.

9.0 DISASSEMBLY AND ASSEMBLY

WARNING
Turn off all power and lockout/tag out service panel before installing or modifying any electrical wiring.

1. Disconnect external wiring from terminals.
2. Disconnect motor wires from the main terminal strip (motor neutral, open, and close)

NOTICE
Removal of switch plate with torque switches will void warranty.

3. To remove the switch plate:
   a. Follow after disconnecting external wires and motor wires.
   b. Unscrew the seven Phillips head mounting screws.
   c. Lift the switch plate(s) out as an assembly with the indicator shaft attached.
   d. **NOTE:** Do not misplace shaft coupler, insert, or mounting screws.

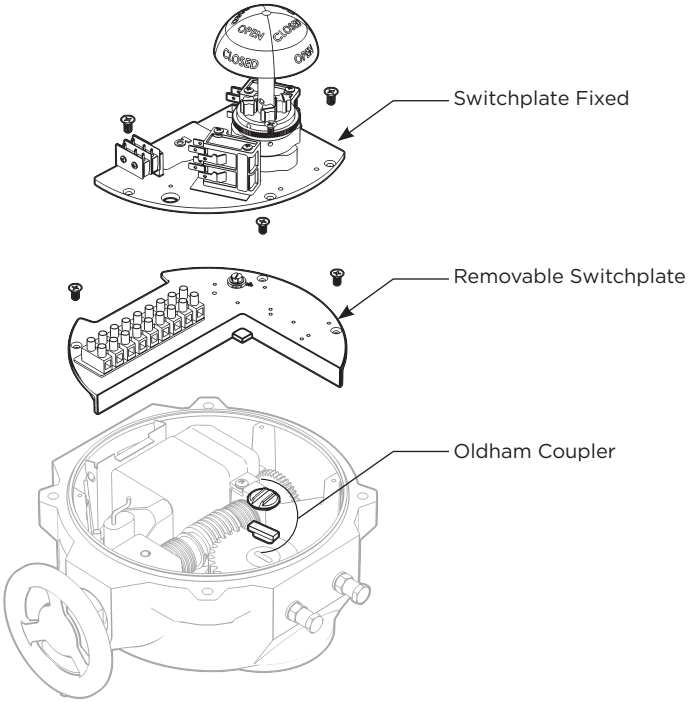


Figure 10. S70, Actuator Size E03, E06, E08 – switch plate removed.

4. To replace the switch plate:
   a. Engage handwheel.
   b. Place insert into the worm segment.
   c. Place and center shaft coupler onto insert.
   d. Align indicator shaft with groove in coupler and gently place switch plate into position.
   e. Check alignment of override switch activation pin.
   f. Slowly turn handwheel to ensure that the indicator shaft is fully engaged in coupler.
   g. Secure the switch plate with seven Phillips head mounting screws in a “star” pattern.
   h. Disengage the handwheel.
5. To remove the indicator shaft from the switch plate:
   a. Follow after removing the switch plate.
   b. Remove the retaining ring from the shaft, located underneath switch plate.
   c. Press the shaft out, from the bottom of the switch plate.
   d. **NOTE:** Provide support to top of switch plate so that components on top of the switch plate are not damaged during this procedure.
6. To remove the bearing from the switch plate:
   a. Follow after the removing the indicator shaft.
   b. Press the bearing from the top of the switch plate to remove the bearing.
   c. To replace, press bearing (700000-72701534) into switch plate from the bottom of switch plate.
7. To replace the indicator shaft in the switch plate:
   a. Gently press the indicator shaft from the top of the switch plate until the cams are flush with the top surface of the switch plate. NOTE: Provide support for the press fit bearing during this step.
   b. Replace retaining ring (070375-74503534) on the shaft, located underneath switch plate.
   c. Gently press the indicator shaft from the bottom until the retaining ring is flush with bottom of the bearing.
   d. Test indicator shaft for tight fitment and ease of rotation.
8. Other switch plate components:
   a. Most components can be removed from the switch plate without removal of the switch plate.

NOTE: Override switch assemblies are typically only removable after the switch plate has been removed. A specialty (short or 90°) screwdriver could be used for disassembly when the switch plate is still attached to the actuator base.

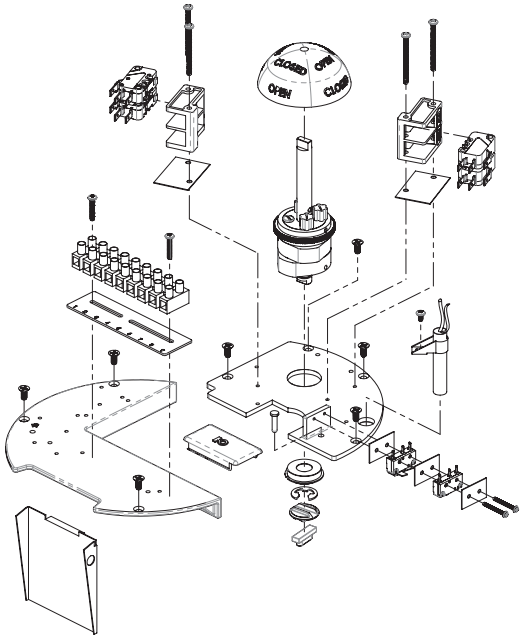


Figure 11. S70, Actuator Size E03, E06, E08 – switch plate exploded view.

9. To remove the gear motor:
   a. Follow after removing the switch plate.
   b. Disconnect the motor leads which run to the capacitor (120/220VAC motors).
   c. For Actuator Size E03, E06, and E08, unscrew the mounting screws (two lower, one upper).
   d. For Actuator Size E12, E20, and E30, unscrew the mounting screws (four lower, one upper).
   e. For Actuator Size 050 - 180, unscrew the mounting screws (five lower, one upper).
   f. Remove the motor vertically out of the unit. **NOTE:** Do not misplace the alignment pin(s), mounting screws or lockwashers.

10. To replace the gear motor:
   a. Replace alignment pin (070612-71904520).
   b. Place motor into housing and align motor with worm shaft spur gear.
   c. Secure the motor with mounting screws and lockwashers in a “star” pattern.
   d. Manually operate actuator to ensure proper alignment.
   e. Connect motor leads to capacitor (PSC motors only).

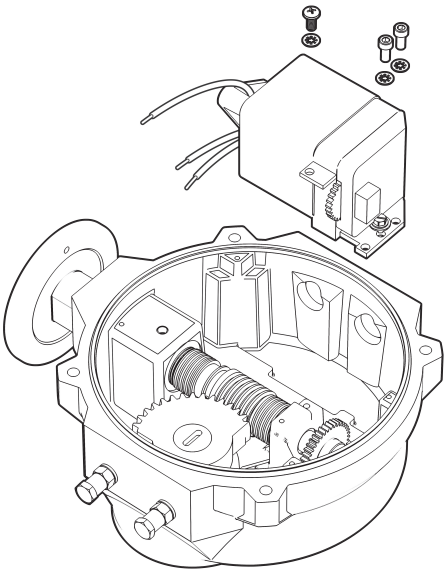


Figure 12. S70, Actuator Size E03, E06, E08 – motor removed.

11. To remove the worm shaft spur gear:
    a. Follow after removing the gear motor.
    b. For Actuator Size E03, E06, and E08:
        i. Remove spring pin using a 3/32″ [2.0 mm] punch.
        ii. Slide the gear off the end of the worm shaft.
    c. For Actuator Size E12, E20, and E30:
        i. Remove spiral retaining ring.
        ii. Remove dowel pin with 3/16″ [4.5 mm] punch.
        iii. Slide the gear off the end of the worm shaft.
    d. For Actuator Sizes 050 - 180:
        i. Remove bowed E-clip retaining ring.
        ii. Slide the gear off the end of the worm shaft.
        iii. Remove key.

12. To replace the worm shaft spur gear:
    a. Slide the gear onto the end of the worm shaft.
    b. For Actuator Size E03, E06, E08:
        i. Slide the gear (700006-75511520) onto the end of the worm shaft.
        ii. Align the mounting hole on the gear and the shaft.
        iii. Use a 3/32″ [2.0 mm] punch to replace the slot spring pin (070412-71900520).
    c. Actuator Size E12, E20, E30:
        i. Slide the gear (700012-75511520) onto the end of the worm shaft.
        ii. Align the mounting hole on the gear and shaft.
        iii. Use a 3/16” [4.5 mm] punch to replace the dowel pin (070612-71804520).
        iv. Replace the spiral retaining ring (070812-74518520).
    d. Actuator Sizes 050 - 180:
        i. Rotate the handwheel so that the keyway is visible and facing upwards.
        ii. Replace key (70E030-73100901).
        iii. Slide the gear (70E030-75503520) onto the worm shaft.
        iv. Replace bowed E-clip retaining ring (070625-74511529).

13. To remove the output drive worm wheel:
    a. Follow after removing the switch plate.
    b. Back off both mechanical travel stops.
    c. Remove the retaining ring and thrust washer from the bottom of the base.
    d. Lift the output drive worm wheel out of its base.

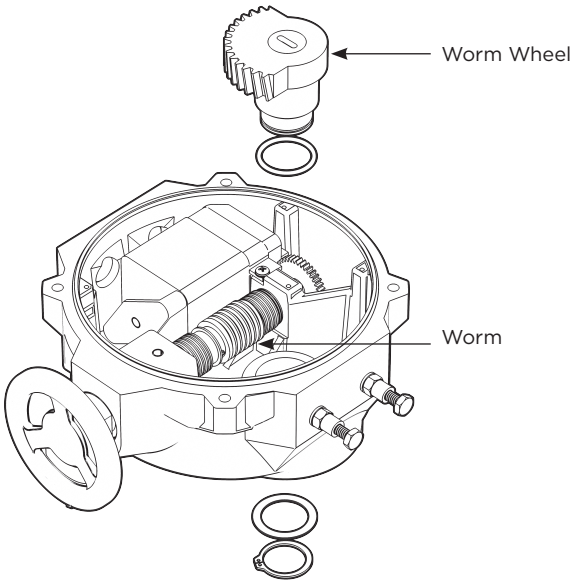


Figure 13. S70, Actuator Size E03, E06, E08 – output drive worm wheel and spur gear removed.

14. To replace the output drive worm wheel:
    a. Ensure worm wheel contains o-ring and is in good condition.
    b. Ensure that o-ring and worm wheel teeth are lubricated with grease.
    c. Place the worm wheel into the base, meshing teeth with worm gear.
    d. Replace thrust washer and retaining ring.
    e. Engage handwheel and manually drive worm wheel to ensure smooth operation.
    f. Reset mechanical travel stops after switch plate has been replaced.
15. To remove the handwheel:
    a. Engage the handwheel.
    b. Use a punch to remove the slot spring pin.
        i. Actuator Size E03, E06, E08: 3/32” [2.0 mm]punch
    c. Slide the handwheel off of the override shaft.

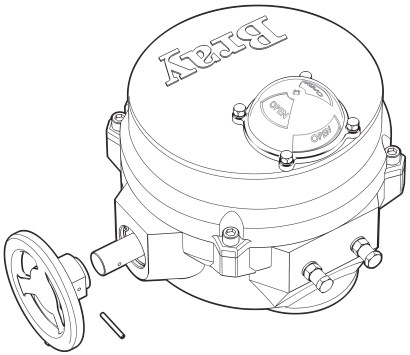


Figure 14. S70 with handwheel removed.

16. To replace the handwheel:
    a. Engage the override shaft.
    b. Slide the handwheel onto the override shaft and align mounting holes.
    c. Use a punch to fit a replacement slot spring pin.
        i. Actuator Size E03, E06, E08 slot spring pin: 070316-71900529
        ii. Actuator Size E12, E20, E30 slot spring pin: 070424-71900534
        iii. Actuator Size 050 - 180 slot spring pin: 070428-71900534
    d. Disengage the handwheel.

CAUTION
Further disassembly of the unit requires special tools and procedures, and thus will not be covered in this manual.

10.0 FIELD OR FACTORY INSTALLABLE OPTIONS

10.1 Auxiliary Switches

Auxiliary switch kits are a field or factory installable option for all Series 70 actuators. Switch kits are comprised of dry-contact (voltage free) SPDT mechanical switches which are used to indicate travel position. Switches are arranged into 2 stacks. For Actuator Size E03 - 065, stack 2 activates 3° prior to switches in stack 1. For Actuator Size 130, 180, the switch that activates 3° early depends on the direction of travel.

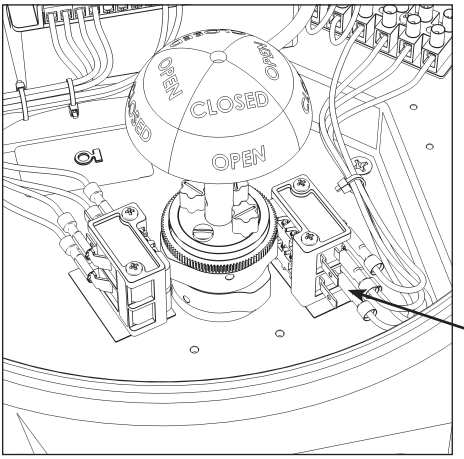


Figure 15. Fixed auxiliary switches installed in a S70 actuator.

All Series 70 actuators can be fit with one set of fixed auxiliary switches. These are a single set of switches which activate 3° before the travel limit switches. Adjustable auxiliary (Mid-Travel) switches can be fit as single independent switches or in sets. If fitted as a set, one of the switches in the set will activate 3° before the other. Each switch set is activated independently from other switch sets.

The maximum number and configuration of switches depends on Actuator size and application of the Series 70 actuator. Terminal block availability due to installation of other options may also limit the maximum number of switches.

Switch Configured for Modulating Application	Actuator Size E03, E06, E08	Actuator Size E12 thru 065	Actuator Size 130, 180
2 Limit Switches	Standard	Standard	N/A
2 Limit, 2 Fixed	70A000-22901536	70A000-22901536	Standard
2 Limit, 2 Fixed, 1 Mid	70A006-22912536	70A012-22912536	70B180-22912536
2 Limit, 2 Fixed, 2 Mid	N/A	N/A	N/A
2 Limit, 2 Fixed, 1 Set Mid	N/A	70A012-22914536	70B180-22914536
2 Limit, 2 Fixed, 2 Set Mid	N/A	N/A	N/A

Switch Configured for On/Off Applications	Actuator Size E03, E06, E08	Actuator Size E12 thru 065	Actuator Size 130, 180
2 Limit Switches	Standard	Standard	N/A
2 Limit, 2 Fixed	70A000-22901536	70A000-22901536	Standard
2 Limit, 2 Fixed, 1 Mid	70A006-22902536	70A012-22902536	70B180-22902536
2 Limit, 2 Fixed, 2 Mid	70A006-22903536	70A012-22903536	70B180-22903536
2 Limit, 2 Fixed, 1 Set Mid	70A006-22904536	70A012-22904536	70B180-22904536
2 Limit, 2 Fixed, 2 Set Mid	N/A	70A012-22905536	70B180-22905536

10.2 Heater

Bray offers an optional heater as a field or factory installable option for the Series 70 actuator to prevent condensation from forming inside the actuator. This PTC (Positive Temperature Coefficient) style heater has a unique temperature - resistance characteristic. The heater self-regulates by increasing its electrical resistance relative to its temperature. The heater does not require external thermostats or switches to control its heat output.

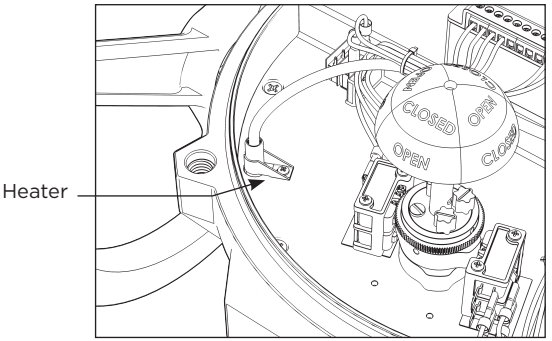


Figure 16. Heater installed on a S70 switch plate.

NOTICE
The heater must have a constant power supply to be effective

WARNING
The heater surface can reach temperatures in excess of 392°F [200°C].

Heater Kit:
> Heater with flying leads
> Mounting Bracket
> #10 Pan Head Screw, Phillips Drive

Tools Required:
> Screwdriver, 3/16” [5 mm] tip flat blade
> Screwdriver, No.1 Phillips

10.2.1 Heater Installation Procedures

WARNING
Turn off all power and lockout/tag out service panel before installing or modifying any electrical wiring.

The heater is mounted through a hole provided in the switch plate.

1. Place the heater snugly into its mounting bracket until approx. 1/2" to 1" [13mm to 25 mm] is left above the bracket.
2. Slip the heater into its mounting hole.
3. Align the fastening hole in the bracket with the threaded screw hole in the plate and fasten the heater to the switch plate.
4. Connect the heater wires to the terminal strip as indicated on the wiring diagram.

10.3 Torque Switches

Mechanical Torque switches are a factory installed and calibrated option available for all Series 70 actuators. Installation is simple, but due to the requirement for special calibration equipment, it is not available for field installation. Modifying the factory torque setting voids the actuator warranty. Removal of the switch plate invalidates factory calibration

The worm is pinned to the worm shaft, which is held in position with a stack of disc springs at both ends. The torque transmitted through the worm to the output worm gear acts directly against the disc springs, which compress proportionately. The worm and worm shaft shift axially as a result.

A specially designed drive lever and pin is incorporated into a groove on the worm, providing the profile for the torque switching mechanism. A drive lever & pin rides in the worm gear torque sensor groove, and in turn drives a cam. The cam then actuates its electrical switch, which interrupts the power to the motor winding when the torque exceeds the setting. The motor can still be powered to run in the opposite direction. When powered in the opposite direction, the tripped torque switch will release automatically.

NOTICE
Torque switches are not field adjustable. Adjustment of torque switches in the field will void warranty.

Removal of switch plate with torque switches in the field will void warranty.

10.4 Local Control Station

The local control station is a field or factory installable option that gives the operator the ability to locally drive the Series 70 actuator with electrical power; overriding the control signal from the process controller. The control station has a red (closed) and green (open) light to provide end-of-travel indication. It also has two 3-position switches as shown in Figure 17.

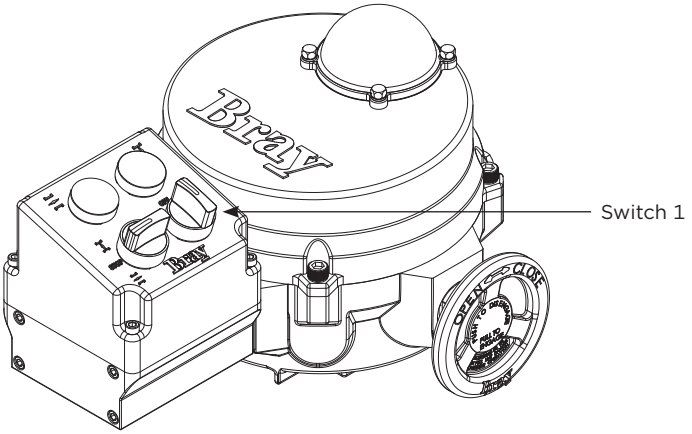


Figure 17. S70 with Control Station.

Switch 1 lets the operator choose between the following three modes of operation:

1. Local: In this mode, using switch 2 the operator can drive the actuator to open or close position, or stop the actuator; overriding any control signal from the process controller.

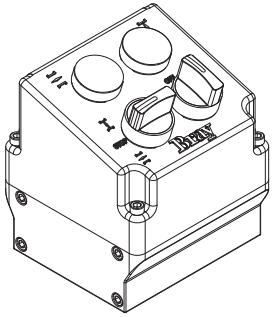
2. Off: In this mode, the actuator can only be operated manually.

3. Remote: In this mode, the actuator is controlled remotely from a process controller.

Control Station Kit
> Local Control Station Assembly
> #10-24UNC x 4.5″ Socket Head Cap Screws (Qty:4)
> O-rings (Qty:4)
> Gasket
> Wiring Diagram

Tools Required
> Screwdriver, 3/16″ [5 mm] tip flat blade
> Screwdriver, No.1 Phillips
> Hex Key, 5/32″

10.4.1 Local Control Station Installation Procedure



WARNING
Turn off all power and lockout/tag out service panel before installing or modifying any electrical wiring.

The local control station is mounted to the S70 against the conduit openings using 4 pre-drilled and tapped mounting holes.

1. Remove the S70 actuator cover and set aside in a safe location.
2. Remove all conduit plugs and external connections on the S70 that may already be in place.
3. Remove 4 short bolts and washers that were pre-installed on the exterior of the S70 base, surrounding the conduit entries.
4. Adhere the gasket to the control station base.
5. Slide o-rings onto the long mounting bolts until flush with bottom of bolt head.
6. Mount the control station to the actuator using the 4 mounting bolts.
7. Wire the control station to the actuator in accordance to the wiring diagram provided.

NOTICE
Power and control wiring should use separate conduit entries

NOTES:

> The local control station contains no terminal strips and all wiring is direct to the switches and lights via 2 x ¾" NPT or holes in bottom of housing.
> Ordering the control station with optional pin connector receptacles will eliminate the necessity of field wiring. Not all possible options are available with receptacles. Consult factory.
> Control station will be completely factory wired and tested.
> Factory will need wiring diagram drawing number of the existing unit if it is to be retrofit with a local control station. New wiring diagram will be provided based upon this information.
> Local control station can be ordered with key lockable switches.
> Local control station requires a dedicated set of auxiliary switches. These switches are required for turning on or off the lights on the control station to locally indicate actuator position.
> Alternative mounting kit can be ordered in case it is preferred to mount the control station nearby but not on the S70 actuator.

10.5 Battery Backup Unit

Bray offers a factory installable Battery Backup Unit (BBU) for the 24 V Series 70 electric actuator.

In the event of power failure, the BBU will switch the actuator to battery power to reach its fail position. After the actuator has reached its fail position, the BBU goes to 'Standby Mode' until external power is restored.

Once external power has been restored, the actuator returns to the position corresponding to the control signal present.

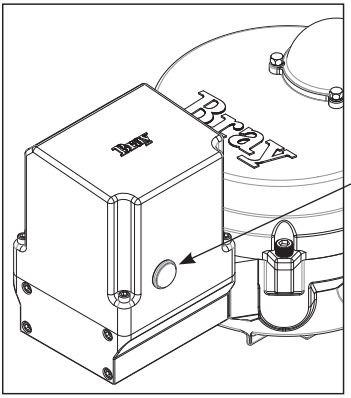


Figure 18. S70 with Battery Backup Unit.

Battery Backup Unit is available as a factory installable option. For more information, please refer to the S70 24V Actuator with BBU Manual. This manual is available on the company website (bray.com).

10.6 Indication of Remote Control

Bray offers two field or factory installable kits to indicate if a process controller has remote control of the Series 70 actuator. Remote control of the actuator can be interrupted if the actuator handwheel has been left engaged or if a local control station has been switched out of remote mode.

A dry contact (voltage free) mechanical switch provides indication if the handwheel is engaged. Alternatively, an additional dry contact (voltage free) mechanical switch can be placed in Local Control Station to provided indication if the local control station is switched out of remote mode. Both kits can be installed and wired in series to provide dual indication. Dual indication wiring is meant to indicate that remote control has been interrupted and does not distinguish between modes of interruption.

NOTE:

> Factory will need wiring diagram drawing number and model of the existing unit if it is to be retrofitted with a Remote Control Indication kit. New wiring diagram will be provided based upon this information.

> Some configurations may limit use of remote control indication kits receptacles due to number of wires entering through the conduit.

10.7 Spinner

A spinner is field or factory installable attachment to the actuator handwheel to ease and speed the manual operation of the Series 70 actuator. Actuator Size E03, E06 and E08 units mount the spinner on a lever which screws onto the back of the handwheel. Actuator Size E12 - 180 units mount the spinner on the rim of the handwheel.

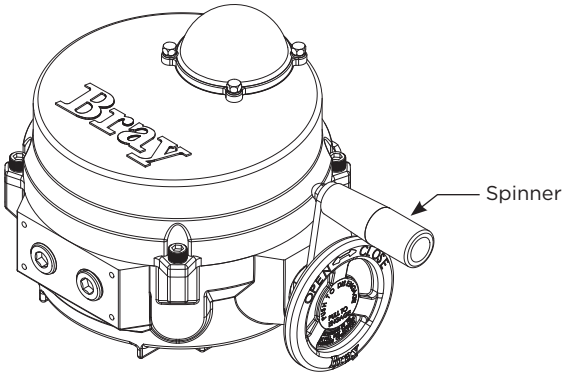


Figure 19. S70 with Handwheel Spinner Attached.

NOTICE
Care should be exercised in the use of a spinner equipped handwheel.

Rapid operation of the handwheel to close the valve may cause water hammer.

Rapid travel into a travel stop may cause damage.

Spinner Kit, Actuator Size E03, E06, E08:
> Spinner and Lever Assembly
> #10-32UNF x 3/8″ Flat Head Socket Cap.

Spinner Kit, Actuator Size E12 - 180:
> Spinner Handle
> ¼″-20UNC x ¾″ Socket Head Shoulder Bolt

Tools Required:
> Hex Key, 1/8″ (Actuator Size E03, E06, E08)
> Hex Key, 3/16″ (Actuator Sizes E12 - 180)

10.7.1 Installation Procedure

For Actuator Size E03, E06, E08 – Position the lever onto the back of the handwheel then screw the flat head cap screw in to place from behind.

For Actuator Size E12 - 180 – Place the socket head shoulder bolt through the spinner handle and screw it firmly into the handwheel rim.

10.8 Receptacles (Quick Connectors)

Bray offers plug-in receptacles as a field or factory option for quick and easy field wiring of Series 70 actuators. Cord sets to fit these connectors can also be ordered in several lengths.

Unless otherwise specified, power receptacles will be 5-pin mini style, standard duty with a black anodized aluminum finish. They conform to ANSI B93.55M except in wire color. Euro receptacles will be used for low power instrument and signal cable since they can be supplied shielded.

Wiring diagrams for plug-in receptacles for either the Bray Series 70 or the local control station will be provided as a separate diagram. Units ordered with pin connector receptacles factory installed are wired and tested

Receptacle Kit:

> Receptacle(s), male pin and male thread ½″ NPT [M20], in the quantity, style, and number of pins ordered
> Reducing bushing ¾″ to ½″ NPT [M25 to M20] for installation in Actuator Sizes E12 - 180 and control stations
> Wiring Diagram

Tools Required:

> Screwdriver, 3/16″ [5 mm] tip flat blade
> Wrench, 1″ [25mm]

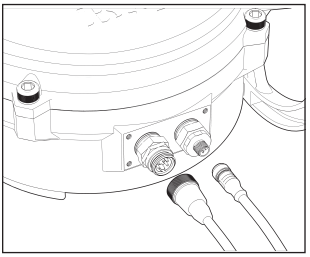


Figure 20. S70 with 5-pin receptacle and corresponding cord set.

10.8.1 Receptacles (Quick Connectors) Installation Procedure

Screw the receptacle into the actuator conduit entry using Teflon tape or similar.

Wire to the terminal strip according to the wiring diagram or the field wiring requirements.

NOTES:

> Euro receptacles use 22 AWG wire rated at 250V, 4 Amp. Pin configuration interfaces with European standards.
> Mini Receptacles use 18 AWG wire rated at 300V, 9 Amp. Pin configuration conforms to ANSI B93.55M.
> Factory will need wiring diagram drawing number and model of the existing unit if it is to be retrofit with receptacles. New wiring diagram will be provided based upon this information.
> Some configurations may limit use of receptacles due to number of wires entering through the conduit.

10.9 External Signal Feedback Potentiometer

Potentiometers are a field or factory installable option for continuous duty actuators. Actuators which are not continuous duty do not have a pot gear fitted on their indicator shafts and must be fitted with a new indicator shaft in the factory. S70 actuators fitted with electronics for modulating applications already fit a potentiometer and cannot fit a second. In this case, retransmission of position is provided through the modulating electronics package.

Feedback Potentiometer Kit:

> Potentiometer Assembly
> #6 Cross Drive Pan Head Screws (Qty:2)
> #6 Internal Lockwashers (Qty:2)
> 4-pole Terminal Strip
> Terminal Strip Marker
> Wiring Diagram

Tools Required:

> Screwdriver, 3/16″ [5 mm] tip flat blade
> Screwdriver, No.2 Phillips

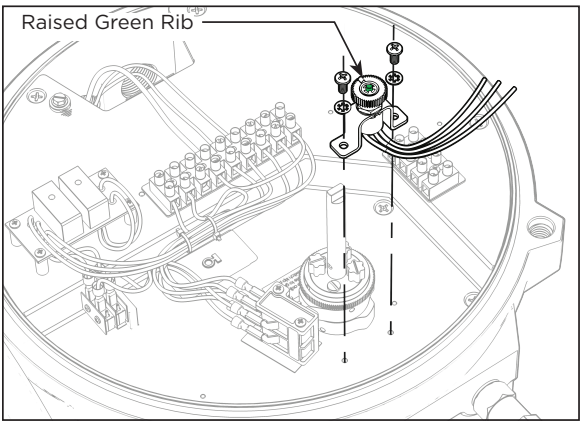


Figure 21. S70 Potentiometer installation.

Orient the actuator in the full open (counter clockwise) position.

Install the potentiometer next to the indicator shaft where two threaded holes are provided for installation.

Align the raised green rib on pot gear with the center line of the indicator shaft.

Push the assembly towards the cam to mesh the gears, then tighten the mounting screws.

Rotate the actuator handwheel so that the red cam lobe is facing the body of the potentiometer. Make sure that the cam is not touching the potentiometer assembly. Readjust the assembly position if necessary.

Cut the terminal marker to fit the 4-pole terminal strip.

Mount the 4-pole terminal strip and marker on the switch plate.

Wire the potentiometer to the terminal strip using the new wiring diagram.

Adhere the new wiring diagram sticker to the inside of the cover.

NOTE:

> Factory will need wiring diagram drawing number and model of the existing unit if it is to be retrofit with a potentiometer. New wiring diagram will be provided based upon this information.

> To ensure the potentiometer assembly was properly calibrated, the pot voltage can be measured at each state using the wiper wire (orange) and the common wire (white). At open position (green cam engagement), it should read between 0.14-0.30 VDC. At close position (red cam engagement), it should read between 2.90-3.06 VDC.

11.0 APPENDIX A - BASIC TOOLS

Common To All Units	
Terminal connections, cam adjustment	Screwdriver, 1/4″ [6 mm] flat tip blade
All switches, terminal strip, torque switch plate	Screwdriver, No.1 Phillips
Switch plate screws, capacitor	Screwdriver, No. 2 Phillips

Actuator Size E03, E06, E08		
Mounting nuts	Wrench, 1/2″	Wrench, M8
Cover captivated capscrews	Hex key, 1/4″	Hex Key, M8
Travel stop adjusting bolts and jam nuts	Wrench, 7/16″	Wrench, M6
Motor mount socket flat head capscrew	Hex key, 3/32″	
Motor mount socket head capscrew	Hex key, 9/64″	
Conduit Entry Plug (1/2″ NPT)	Hex key, 3/8″	Hex Key, M20

Actuator Size E12, E20, E30		
Mounting nuts (small pattern)	Wrench, 1/2″	Wrench, M8
Mounting nuts (large pattern)	Wrench, 3/4″	Wrench, M12
Cover captivated capscrews	Hex key, 5/16″	Hex Key, M10
Travel stop adjusting bolts and jam nuts	Wrench, 9/16″	Wrench, M10
Motor mount socket head capscrew	Hex key, 5/32″	
Conduit Entry Plug (3/4″ NPT)	Hex key, 9/16″	Hex Key, M25

Actuator Size 050, 065		
Mounting nuts (small pattern)	Wrench, 3/4″	Wrench, M12
Mounting nuts (large pattern)	Wrench, 11/8″	Wrench, M20
Cover captivated capscrews	Hex key, 3/8″	Hex Key, M20
Travel stop adjusting bolts and jam nuts	Wrench, 3/4″	Wrench, M12
Motor mount socket head shoulder bolt	Hex key, 5/32″	Hex Key, M12
Motor mount socket head capscrews	Hex key, 3/16″	
Conduit Entry Plug (3/4″ NPT)	Hex key, 9/16″	Hex Key, M25

Actuator Size 130, 180		
Mounting nuts (small pattern)	Wrench, 3/4″	Wrench, M12
Mounting nuts (large pattern)	Wrench, 11/8″	Wrench, M20
Cover captivated capscrews	Hex key, 3/8″	Hex Key, M12
Travel stop adjusting bolts	Wrench, 5/16″	Wrench, M25
Motor mount socket head shoulder bolt	Hex key, 5/32″	
Motor mount socket head capcrews	Hex key, 3/16″	
Conduit Entry Plug (3/4″ NPT)	Hex key, 9/16″	Hex Key, M25

12.0 APPENDIX B - ACTUATOR TROUBLESHOOTING CHART

Problem	Possible Cause	Solutions
Actuator does not operate	Override is engaged	Push handwheel in all the way
	Wiring is incorrect	Check wiring and power supply
	Actuator motor has reached its thermal shutdown temperature	Allow time to cool
Actuator operates in reverse directions	Field wiring is reversed	Rewire field wiring
Actuator does not fully close valve (or open valve)	Limit switches are depressed	Readjust travel limit switches
	Mechanical travel stop is stopping actuator	Adjust mechanical travel stops
	Valve torque requirement is higher than actuator output	Manually override out of seat, try angle seating or larger actuator
	Optional torque switches are activating	Valve torque exceeds actuator torque rating - consult factory
	Voltage power supply is low	Check power source.
Engaging override handwheel does not shut off motor	Override pin is corroded or damaged	Clean and check for smooth operation of the override switch pin
	Override switch is damaged	Replace switch
Disengaging override hand-wheel does not restart motor	Not completely disengaged	Push handwheel in as far as possible (no yellow showing)
	Override pin is damaged or and does not activate switch	Replace override pin
	Incorrect wiring of override switch	Check wiring
Motor runs but worm and gear segment do not	Worm gear segment is not meshing with worm	Remove switch plate and inspect, adjust travel stops to prevent gear disengaging
	Pin/Key on Worm/Motor drive gear sheared	Replace Pin/Key on drive gear
Corrosion inside unit	Condensation forming	Test heater wiring, should have constant power
	Water leaking in	Check all seals and possible water entry through conduit

NOTES

NOTES

NOTES

SINCE 1986, BRAY HAS PROVIDED FLOW CONTROL SOLUTIONS FOR A VARIETY OF INDUSTRIES AROUND THE WORLD.

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BULLETIN 400
JULY 2014

DeZURIK
APCO | HILTON

APCO SEWAGE AIR VALVES GENERATION II

Sewage Air Release Valve
Series 400 SARV

Sewage Air/Vacuum Valve
Series 401 SAVV
Patented Concave Float

Sewage Combination Air Valve
Series 440 SCAV

Generation II APCO Air Valves for Sewage Pipeline Systems

Effects of air in a pressurized closed-pipeline system must be recognized. An air pocket will decrease the cross sectional area and increase frictional pressure loss. The combined loss for two-phase flow (air and water) is always greater than the pressure loss for each phase flowing alone. Thus, air in a pipeline increases system flow resistance and increases system head against which pumps must operate.

Air may enter a piping system in many ways:

(1) Air in the pipeline when initially filled may not be completely purged.

(2) Air may be drawn in at a pump inlet by entrainment if the liquid level falls below the inlet elevation.

(3) Air in solution (about 2% by volume) will be released at points in the pipeline where the pressure is reduced, especially where the line elevation is close to the hydraulic gradient.

(4) Gas created from digested sewage.

(5) Air may be drawn in through packings, seals and flanged joints.

(6) Air may enter by vortexing at the pump.

Air in piping tends to collect at high points in the line when flow velocities are low. If the air pocket formed is large, part of it will be removed when the velocity increases. This partitioned air may or may not go through the system. It all depends on velocity, pipe size, and pipe down-slope. It may only move into the sloping straight section and then return to the summit when the velocity decreases.

While it is impossible to totally prevent accumulation of air (or gases) within the piping system, the volume can be greatly minimized by installing APCO Sewage Air Release Valves.

When air is present in a hydraulic pipeline, flows are erratic, unpredictable and have high head losses. Sewage works require Air Release Valves on pipeline high points.

All APCO Sewage Valves are furnished for 150 psi (1034 kpa). Higher pressures available. Specify if operating pressure is below 20 psi (138 kpa) for a lower durometer seat.

Backflushing Attachments Optional for All Sewage Valves

While sewage media is standing in the valve body, sediment will attempt to settle out at the bottom. This sediment may be flushed out periodically.

After installation, Sewage Valves should be inspected to determine need to backflush approximately once a year. Inspection takes only a few minutes and is simple:

1. Shut off the inlet valve.

2. Open the blow off valve and observe. If fluid drains out the valve body rapidly, flushing is not required.

Should heavy suspended solids and grease be anticipated, attachments shown are recommended for ease of flushing.

Sewage Combination Air Valve - Series 440 SCAV

- First in a single body

- No spills

- No spurts

- Shorter

- Patented Concave float

Now, APCO brings you the latest state of the art Sewage Air Valve design: a single body, double orifice "Sewage Combination Air Valve." Generation II…a new generation of air valve design.

Field tested under actual operating conditions. Incorporating all features that have made the 400 Sewage Air Release Valves and 401 Sewage Air/ Vacuum Valves the world's finest…Now in a single body-plus a new concave float – to give even greater performance and reliability.

You no longer need to dig deeper trenches or build deeper vaults because the 440 series is at least 30% shorter than other models!

Valves that won't spill or spurt before shutting off. No more messy waste flooded valve vaults to pump out – or pump station floors to mop up – it shuts off drop tight.

Take a serious look at Generation II – APCO Sewage Valves. Manufactured to our industry's highest standards providing the highest efficiency and reliability of any sewage air valve available in the market today.

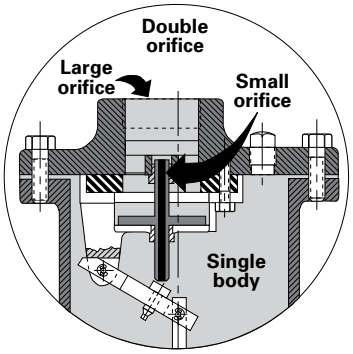
Series 440 SCAV

Model	Size	Inlet	Outlet	Height		Dia.	Weight	
				Valve	w/Attachments		Plain	w/Attachments
443	1" 25	2" NPT 50	1" NPT 25	19.5" 495	24.5" 622	9.5" 241	87 39	95 43
445	2" 50	2" NPT 50	2" NPT 50	20.5" 521	27" 686	9.5" 241	93 42	100 45
447	3" 80	3" NPT 80	3" NPT 80	23.5" 597	29.5" 749	11" 279	147 67	157 71
449	4" 100	4" NPT 100	4" NPT 100	23.5" 597	30" 762	11" 279	150 68	175 79
456	6" 150	6" 125 lb. Flange 150	6" 150	35" 889	39" 991	13.75" 349	242 110	297 135

Inch Pounds
Millimeter Kilograms

Sewage Combination Air Valve (Single Body) With Two Independent Orifices Series 440 SCAV

- Large orifice [for air out and in] (Air/Vacuum Valve function)
- Small orifice [for air release] (Under pressure function)
- Concave float



Two major complaints now remedied with APCO's introduction of the concave float.

1. Spillage

People easily tolerate and are reasonable about water spillage from valves but sewage is cause for some engineers and users alike to avoid use of Sewage Air Valves, regardless of need to a system.

During the past 30 years, the single most highly objectional complaint about the Sewage Air Valve is, "it spills" or "it spurts sewage."

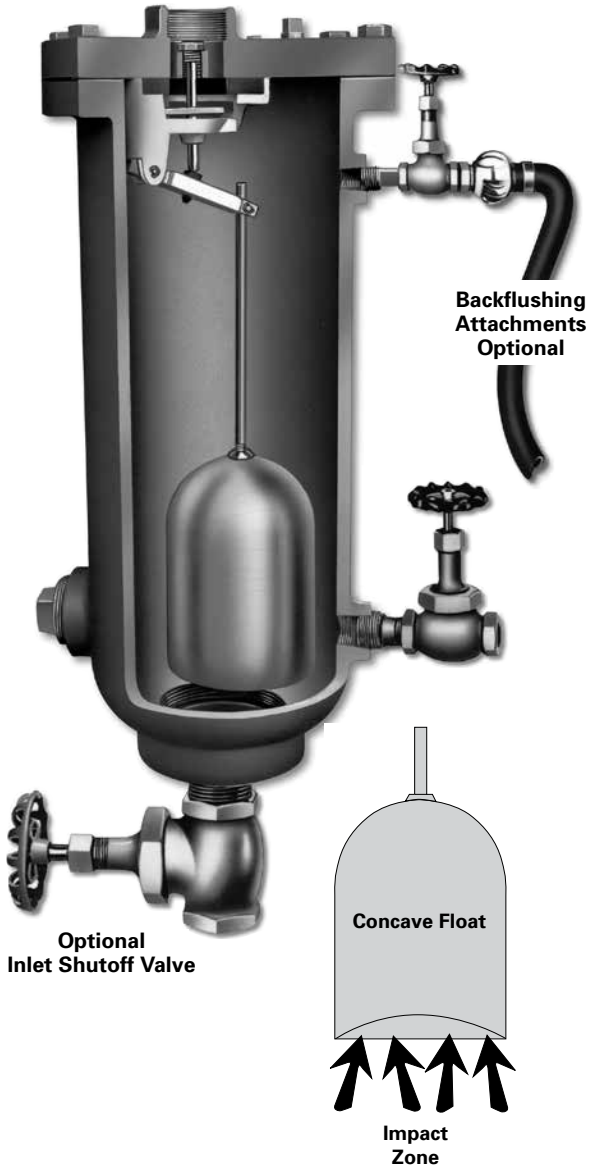
The concave float eliminates this complaint because of the unique impact zone which is extremely sensitive to sewage media entering the Sewage Air Valve. The impact zone causes instantaneous and upward movement of the float to shut-off the discharge orifice as soon as media contacts the float.

No spilling or spurting occurs even with low pressure (below 20 psi, 138 kpa).

2. Height

The second most objectional complaint has been height. Sewage Air Release Valves of standard design have been too tall, requiring deeper pipeline trenches and bigger valve vaults. These are costly requirements.

Now, the concave float with an impact zone allows fast action closure to create a greater air trap inside the Sewage Air Valve body than possible with the hemispherical style float. This new design is also 30% shorter in height.



Small Orifice		
Operating Pressure psi/kpa	**Small Orifice Diameter**	**Venting Capacity CFFAM**
0-150 0-1034	.219" 6	68
0-300 0-2068	.156" 4	95

Inch
Millimeter

Higher operating pressures available

Specifications

Specify APCO With Confidence

Sewage Combination Air Valve Series 440 SAVV

Sewage Combination Air Valve (single body, double orifice) allows large volumes of air to escape or enter through the larger diameter orifice when filling or draining a pipeline.

When the pipeline is filled and pressurized the large air/vacuum orifice shall stay closed, but the smaller diameter air release orifice shall remain operative and open to allow small pockets of air accumulation to escape automatically and independently of the large orifice.

The large air/vacuum orifice shall shut off when the free floating-center guided plug is raised into the orifice by the lifting force of the concave - bottom float. The large orifice shut-off shall be "without spilling."

The Buna-N seat must be fastened to the valve cover, without distortion, for drop-tight shut-off.

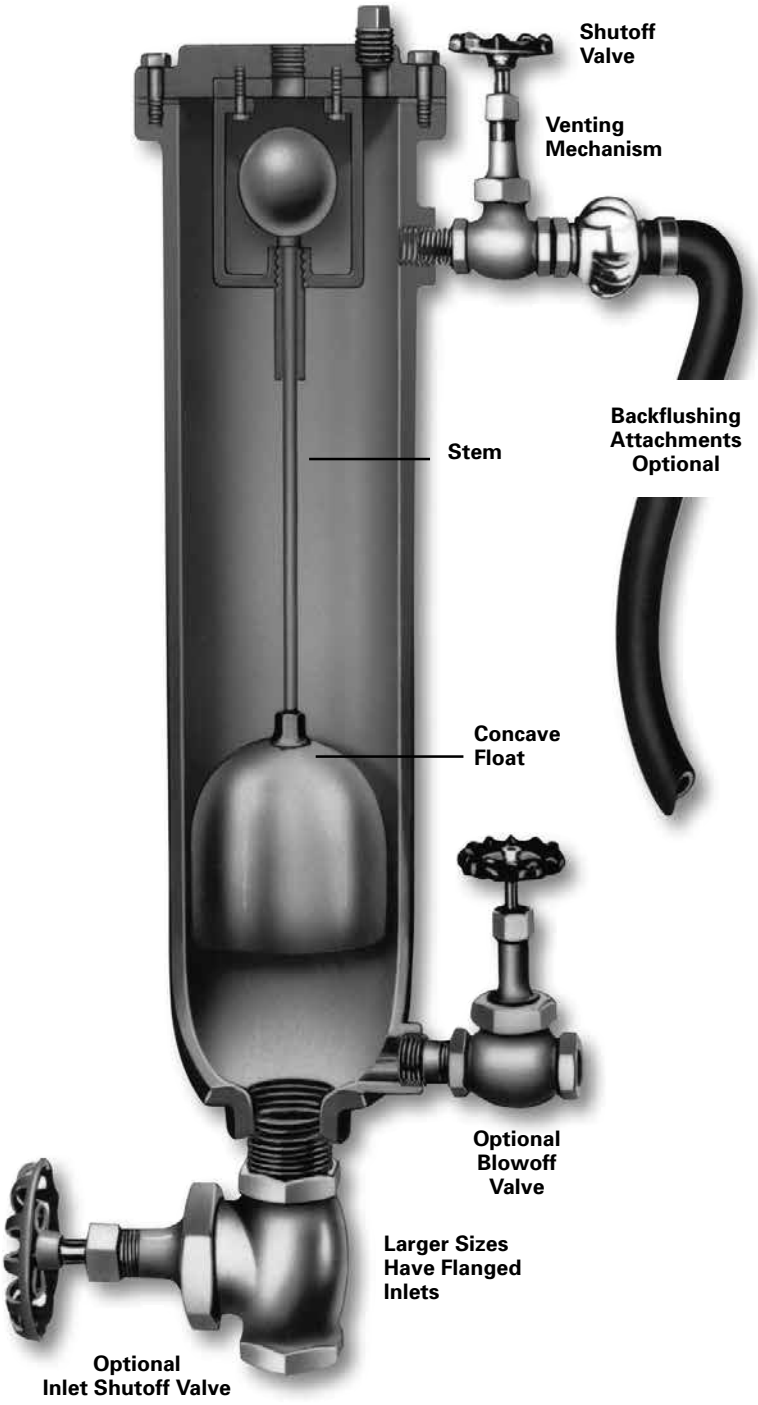
The overall height and width shall not exceed the dimensions shown on the table on page 3.

Optional - Inlet and blow off valves, quick disconnect couplings and minimum 5' (1.5m) hose for flushing. Engineer to specify.

Materials of construction shall be certified the following ASTM specifications:

Body & Cover	Cast Iron	ASTM A126 GR.B
	Ductile Iron	ASTM A536 GR 65-45-12
Patented Concave Float	Stainless Steel	ASTM A240 T304
Stem	Stainless Steel	Series T300
Needle and Seat	Buna-N	Nitrile Rubber
Plug (1"-4")(25-102mm)	Brass	ASTM B124
(6" size)(152mm)	Stainless Steel	ASTM A240 T304
Leverage Frame (1"-2")(25-51mm)	Delrin or Cast Iron (3"-4"-6")	ASTM D4181/ASTM A126 GR.B
Exterior Paint	Universal Metal Primer	FDA Approved for Potable Water

Sewage Air/Vacuum Valve - Series 401



Series 401 and larger Model APCO Sewage Air/ Vacuum Valves are specifically designed for operation on sewage and waste media.

Air/Vacuum Valves are needed to vent large volumes of air when the sewage line is filled and allow air to re-enter when draining, to prevent vacuum or column separation occurring. Sewage Air/Vacuum Valves utilize two floats, each connected to a common stem which is guided through a bushing.

The upper float shuts off instantaneously against the seat, due to the impact zone and lifting force of the much larger concave bottom float, as sewage media enters the valve body.

Once closed, and pressurized, the Air/Vacuum Valve will not open to release air. It will open under negative pressure allowing air to re-enter and prevent vacuum from forming in the line.

Dimensions and Specifications

Series 401 Sewage Air Vacuum Valve

Model	Size		Height		Major Dia.	Weight	
	Inlet	Outlet	Valve	w/Attachments		Plain	w/Attachments
401	2" NPT 50	1" NPT 25	16.25" 413	20" 508	7" 178	41 19	55 25
402	2" NPT 50	2" NPT 50	19.75" 502	23.5" 597	9.5" 241	85 39	115 52
403	3" NPT 80	3" NPT 80	19.75" 502	23.75" 603	9.5" 241	85 39	118 54
404	4" NPT 100	4" Plain 100	30" 762	35.25" 895	12" 305	130 59	200 91
406	6" FLG 150	6" Plain 150	32.5" 826	36.5" 927	16" 406	190 86	290 132
408	8" FLG 200	8" Plain 200	36" 914	40" 1016	18" 457	310 141	430 195
410	10" FLG 250	10" Plain 250	41" 1041	45" 1143	20" 508	600 272	800 363
412	12" FLG 300	12" Plain 300	47" 1194	53.5" 1359	25" 635	750 340	980 445
414	14" FLG 350	14" Plain 350	51.5" 1308	57.25" 1454	29" 737	950 431	1230 558

Inch Pounds
Millimeter Kilograms

4" (100mm) and larger flanged outlets available.

Specify APCO with Confidence - Sewage Air/Vacuum Valve Series 401

Sewage Air/Vacuum Valves shall allow unrestricted venting or re-entry of air through it during filling or draining of the force main to prevent vacuum. The Sewage Air/Vacuum Valve shall incorporate (2) stainless steel floats directly connected by a stainless steel stem, to maintain an air gap between the bottom concave float and top shut-off float. The air gap shall retard waste solids from fouling or clogging the top shut-off float. The internal baffle shall be fitted with a guide bushings and act to protect the shut-off float from direct air flow. The baffle shall retain the Buna-N seat in place, without distortion for tight shut-off.

All internals shall be easily removed thru the top cover without removing the main valve from the line. The complete valve shall withstand 500 psi (3447 kpa) test. Optional - Inlet and blow off valves, quick disconnect couplings and minimum 5' (1.5m) hose for flushing. Engineer to specify.

The valve manufacturer shall furnish professionally printed installation and maintenance instruction manuals with each valve.

Materials of construction shall be certified the following ASTM specifications:

Body, Cover and Baffle	Cast Iron	ASTM A126 GR.B
	Ductile Iron	ASTM A536 GR 65-45-12
Upper Float	Stainless Steel	ASTM A240
Patented Concave Lower Float	Stainless Steel	ASTM A240 T304
Stem, Guide Bushing	Stainless Steel	Series T300
Seat	Buna-N	Nitrile Rubber
Exterior Paint	Universal Metal Primer	FDA Approved for Potable Water

Sewage Air Release Valve - Series 400 & 450

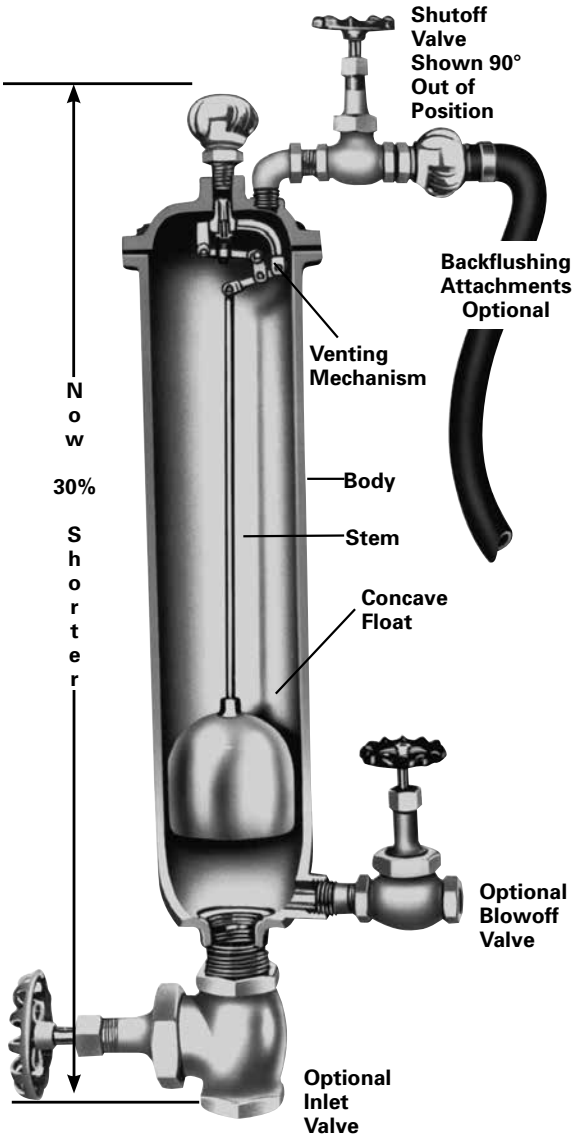
Series 400 and 450 APCO Sewage Air Release Valves are specially designed for use with sewage and waste media.

The concave float, stem and body keep the valve venting mechanism as free from contact with sewage as possible. The float hangs freely in the center of the valve body and responds instantaneously to the fall and rise of the sewage media due to the concave float.

How It Works

When sewage enters the valve, it rises, forcing air out ahead of it. Then as sewage reaches the concave float, it raises the float and float stem instantly, due to the very sensitive impact zone. This fast action closes the venting mechanism, trapping the remaining air in the valve body. This entrapped air is initially at atmospheric pressure but it's compressed after the venting mechanism closes. The sewage continues rising in the valve, until air and sewage are at the same pressure. The sewage then stops rising, leaving the venting mechanism free from contamination.

Additional gases given off by the sewage rise into the valve body, displacing and lowering the sewage level until the float drops, opening the venting mechanism allowing gases to escape. Sewage again rises to occupy the space vacated by the escaped gas, lifts the float and closes the venting mechanism. This cycle is repeated frequently as air and gas collect in the valve without spillage or spurting, due to the sensitivity of the patented concave float.



Dimensions and Specifications

Series 400 & 450 Sewage Air Release Valves

Model	Size		Height		Major Dia.	Operating Pressure psi/kpa	Orifice Dia.*	Venting Capacity CFFAM	Weight	
	Inlet	Outlet	Valve	w/Attach.					Plain	w/Attach.
400	2" NPT 50	.5" NPT 13	17.5" 445	23.5" 597	7.5" 191	0-50 0-345	.313" 8	55	41 19	55 25
	3" NPT 80					0-150 0-1034	.25 STD 6	90		
	4" NPT 100					0-300 0-2068	.156" 4	25		
450	2" NPT 50	1" NPT 25	20" 508	26.5" 673	9.5" 241	0-150 0-1034	.5" STD 13	350	85 39	118 54
	3" NPT 80					0-300 0-2068	.438" 11	520		
	4" NPT 100									

Inch / Millimeter Pounds / Kilograms ***Orifice diameter is determined by pressure, not by size.**

Specify APCO With Confidence
Sewage Air Release Valve Models 400 & 450

Sewage Air Release Valves shall have an elongated body and be designed to operate (open) while pressurized allowing entrained air in a sewage force main line, sewage pump or waste water system to escape through the air release orifice without spillage or spurting. After entrained air escapes through the air release orifice, the valve orifice shall be closed by a needle mounted on a compound lever mechanism, (energized by a concave float) and prevent media from escaping. The air release orifice will then remain closed until more air accumulates and the opening cycle repeats automatically. The internal compound lever mechanism shall be stainless steel to prevent corrosion. Optional: Inlet and blow off valves, quick disconnect couplings and minimum 5' (1.5m) hose for flushing. Engineer to specify.

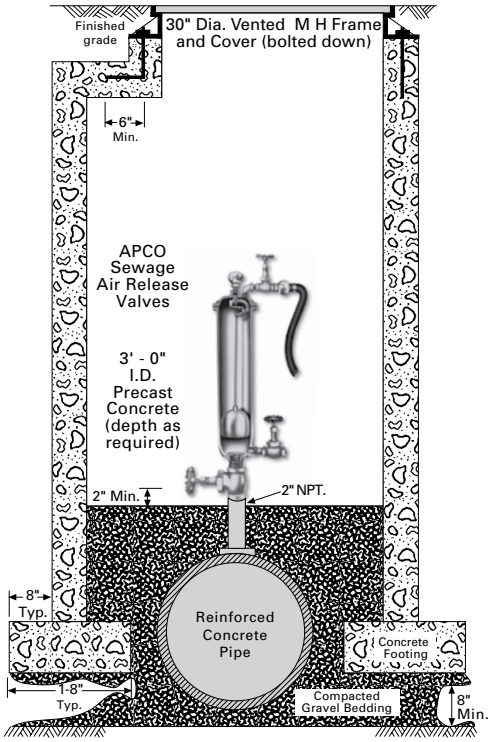
The internal linkage shall be fitted with a stem, having a stainless steel concave float threaded onto the opposite end. The concave float shall hang inside the valve body, slightly above the inlet and maintain an air gap between the lever mechanism and the waste media. The valve body and float shall withstand 500 psi (3447kpa) shell test pressure. The valve inlet shall be 2", 3", 4" NPT (50, 80, 100mm) Model 400 or 450. Engineer to specify.

Materials of construction shall be certified the following ASTM specifications:

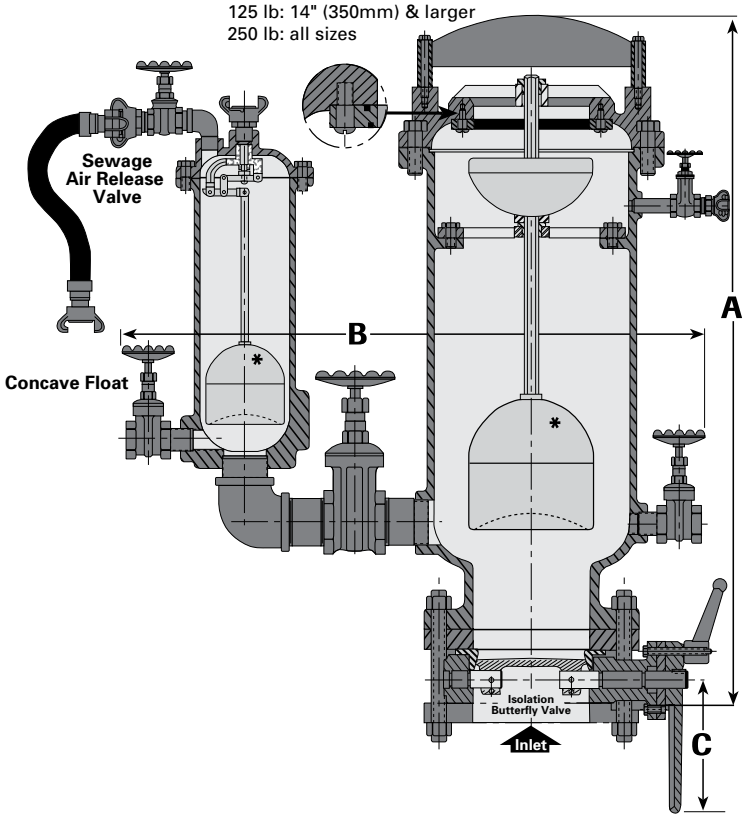
Body & Cover	Cast Iron	ASTM A126 GR.B
	Ductile Iron	ASTM A536 GR 65-45-12
Internal Linkage, Stem	Stainless Steel	Series T300
Patented Concave Float	Stainless Steel	ASTM A240 T304
Needle	Buna-N	Nitrile Rubber
Exterior Paint	Universal Metal Primer	FDA Approved for Potable Water

Custom Combination Sewage Air Valves

Typical pit installation detail for Sewage Air Valve



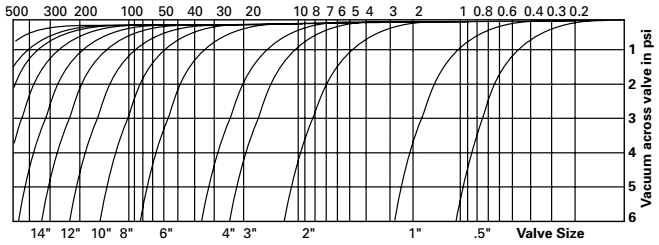
Seat Detail
Air/Vacuum Valve
125 lb: 14" (350mm) & larger
250 lb: all sizes



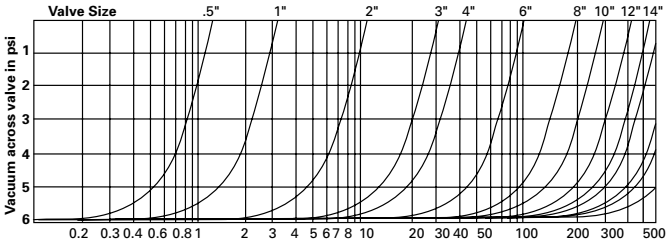
Performance graph

For Air/Vacuum Valve air inflow/outflow thru valve in standard cubic feet of free air per second, (SCFS) test conducted by:
Phillips Petroleum Company Engineering Department — Test Division Edmond Plant Feb. 2, 1961
Southern Research Institute Birmingham, Alabama May 8, 1959

Inflow



Outflow



Curves shown are actual flow capacities at 14.7 psi barometric pressure and at 70°f temperature base on actual test.

These figures are not merely flow capacities across the orifice, but flow capacities across the entire valve.

In the test set-up, air approach velocity is negligible therefore, actual flow capacity exceeds the values shown on the chart.

For accurate size selection use DeZURIK/ APCO Air Valve Computer software. Apslide available upon request.

Specify APCO With Confidence
Custom Combination Sewage Air Valve Series 400C

Custom Combination Sewage Air Valve shall be dual function; venting large volumes of air through the large orifice and small pockets of air through the small orifice before shutting off. Thereafter, while pressurized, collecting pockets of air will be vented through the small orifice automatically. Should vacuum develop in the force main, both orifices shall be open permitting large volumes of air to re-enter to break the vacuum.

The Custom Combination Sewage Air Valve shall consist of an independent large orifice Air/Vacuum Valve with an independent small orifice Air Release Valve side connected. The small orifice air valve shall be separated from the large orifice by a 2" (50mm) gate valve. The large orifice air valve shall incorporate one upper float and one lower concave float; thereby maintaining an air gap between the concave bottom float and upper shut-off float.

The small orifice air valve shall have an internal compound lever mechanism including a long float stem with a stainless steel float thereby maintaining an air gap between the float and the mechanism. The air gaps shall retard waste solids from clogging the upper shut-off float of the large orifice and the lever mechanism of the small orifice valve.

The Air/Vacuum Valve inlet shall be flanged 6" - 14" (150 - 350mm). The outlet shall be plain with hood or flanged. Engineer to specify.

The side connected Air Release Valve shall have a 2" (50mm) NPT inlet and ½" (15mm) NPT outlet. The small orifice shall be ¼" (6mm) diameter for operating (opening) pressure up to 150 psi (1034kpa) and venting capacity of 90 CFFAM.

Optional Backflushing Attachments:

Custom Combination Sewage Air Valve shall be fitted with two inlet isolation Valves: 2" (50mm) all Bronze gate valve to isolate the Air Release Valve from the Air/Vacuum Valve. One 6" - 14" (150 - 350mm) APCO Butterfly Valve or Gate Valve to isolate the Air/Vacuum Valve from the force main. Two blow off valves, two flush valves and minimum of 5' (1.5m) rubber hose with quick disconnects for back-flushing. The manufacturer shall certify venting capacity and provide maintenance manuals with each valve.

Materials of construction shall be certified to the following ASTM specifications

Body, Cover	Cast Iron	ASTM A126 GR.B
	Ductile Iron	ASTM A536 GR 65-45-12
Float Stem	Stainless Steel	Series T300
Internal Linkage	Stainless Steel	Series T300
Needle and Seat	Buna-N	Nitrile Rubber
Patented Concave Float	Stainless Steel	ASTM A240 T304
Exterior paint	Universal Metal Primer	FDA Approved for Potable Water Contact

Valve to be APCO Series 400C Custom Combination Sewage Air Valve with attachments.

Sales and Service

For information about our worldwide locations, approvals, certifications and local representative:
Web Site: www.dezurik.com **E-Mail: info@dezurik.com**

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Printed in the U.S.A.

ModMAG®
M-Series® | Electromagnetic Flow Meters

Electromagnetic Flow Meters

M2000

DESCRIPTION

The Badger Meter ModMAG® M2000 is the result of years of research and field use of electromagnetic flow meter technology. Based on Faraday's law of induction, these meters can measure water, wastewater, water-based fluids and other liquids that meet minimum electrical conductivity.

Designed, developed and manufactured under strict quality standards, this meter features sophisticated, processor-based signal conversion with accuracies of ±0.20% of rate ±1 mm/s. The wide selection of liner and electrode materials helps provide maximum compatibility and minimum maintenance over a long operating period.

The meter is best suited for bidirectional flow measurement of fluids with a conductivity > 5 µS/cm (> 20 µS/cm for demineralized water). The meter has high accuracy, is easy to use, and can be chosen for a wide variety of applications. The backlit, four-line display shows all actual flow measuring data, daily and complete information, including alarm messages. The standard transmitter has 4 programmable digital outputs, one digital input, power output and different interfaces. Integrated system self checkup makes putting into operation and service easier. For service purpose, the meter configuration can be kept or transferred to another meter without a new parametering via the optional back-up parameter function.

APPLICATION

The M2000 transmitter can be integrally mounted to the sensor or can be remote-mounted, if necessary and has many advantages over other conventional technologies. The meter targets a variety of applications and is well suited for the diverse water and wastewater treatment industry. The M2000 meter can accurately measure fluid flow—whether the fluid is water or a highly corrosive liquid, very viscous, contains a moderate amount of solids, or requires special handling. Today, electromagnetic meters are successfully used in industries including building automation, oil and gas, food and beverage, pharmaceutical, water and wastewater, and chemical.

STRAIGHT PIPE REQUIREMENTS

Run sufficient straight-pipe at the sensor inlet and outlet for optimum meter accuracy and performance. An equivalent of 3…7 diameters of straight pipe is required on the inlet (upstream) side to provide a stable flow profile. Two (2) diameters are required on the outlet (downstream) side.

In applications with limited space, the M2000 can be installed with zero straight pipe requirements and fulfils the accuracy according OIML R49 and MID Annex MI-001.

FEATURES

- Available in sizes 0.25…78 in. (6…2000 mm)
- Accuracy of ±0.2% of reading ±1 mm/s
- Flow Range 0.03…12 m/s
- Pulsed DC magnetic field for zero point stability
- Integral and remote signal converter availability
- Power Supply of 100…240V AC / 12…32V DC
- Corrosion-resistant liners for long life
- Zero Straight Run (0 x DN) OIML/MID
- User friendly programming procedure
- Empty pipe detection
- Power loss totalization
- Digital signal processor (32-bit)
- Non-volatile programming memory
- LCD display
- Rotating cover
- IP67 Housing
- Calibrated in state-of-the-art facilities
- Modbus® RTU or Modbus TCP/IP, HART, M-Bus, EtherNet/IP, BACnet/IP, BACnet MS/TP (BTL certification), Profibus DP
- Integrated data logger
- Verifications device
- NSF/ANSI/CAN 61 and 372 listed
- CSA / AWWA C715 certified
- BEACON®/AquaCUE® connectivity

Badger Meter

MAG-DS-01047-EN-30 (September 2023)

Product Data Sheet

ELECTRODES

When looking from the end of the meter into the inside bore, the two measuring electrodes are positioned at three o'clock and nine o'clock. M2000 electromagnetic meters have an "empty pipe detection" feature. This is accomplished with a third electrode positioned in the meter at twelve o'clock.

If this electrode is not covered by fluid for a minimum five-second duration, the meter displays an "empty pipe detection" condition, sends out an error message, if desired, and stops measuring to maintain accuracy. When the electrode again becomes covered with fluid, the error message disappears and the meter resumes measuring.

As an option to using grounding rings, a grounding electrode (fourth electrode) can be built into the meter during manufacturing to assure proper grounding. The position of this electrode is at six o'clock.

OPERATION

The flow meter is a stainless steel tube lined with a non-conductive material. Outside the tube, two DC powered electromagnetic coils are positioned opposing each other. Perpendicular to these coils, two electrodes are inserted into the flow tube. Energized coils create a magnetic field across the whole diameter of the pipe.

As a conductive fluid flows through the magnetic field, a voltage is induced across the electrodes. This voltage is proportional to the average flow velocity of the fluid and is measured by the two electrodes. The M2000 transmitter receives the sensor's analog signal, amplifies that signal and converts it into digital information. At the processor level, the signal is analyzed through a series of sophisticated software algorithms. After separating the signal from electrical noise, it is converted into both analog and digital signals that are used to display rate of flow and totalization.

With no moving parts in the flow stream, there is no pressure lost. Also, accuracy is not affected by temperature, pressure, viscosity or density and there is practically no maintenance required.

SPECIFICATIONS

NOTE: Permanently connected equipment requires the special considerations to satisfy the CEC and the Canadian deviations in the standard, including overcurrent and fault protection as required.

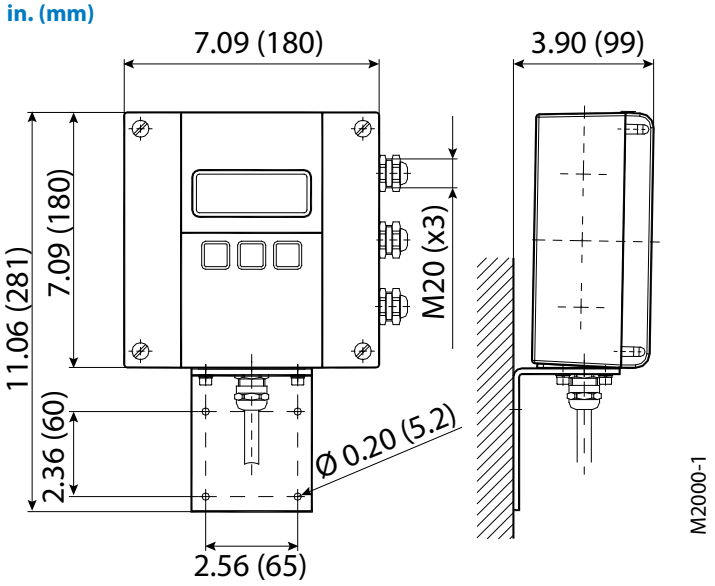
NOTE: DN represents nominal diameter in mm.

Transmitter Specifications

Flow Range	0.10…39.4 ft/s (0.03…12 m/s)
Accuracy	± 0.20% m.v. ± 1 mm/s OIML/MID: 2…28 in. (DN50…800) with 0d up and 0d downstream ±1% ≥ 0.5 ft/s (0.15 m/s)
Repeatability	± 0.1%
Power Supply	**AC Power Supply:** 100…240V AC (±10%); Typical Power: 20V A or 15W; Maximum Power: 26V A or 20W **Optional DC Power Supply:** 12…32V DC (±10%); Typical Power: 10W; Maximum Power: 14W
Analog Output	4…20 mA, 0…20 mA, 0…10 mA, 2…10 mA (programmable and scalable) Voltage sourced 24V DC isolated. Maximum loop resistance < 800 Ohms.
Digital Output	Four total, configurable 24V DC sourcing active output (up to 2),100 mA total, 50 mA each; sinking open collector output (up to four), 30V DC max, 100 mA each; solid-state relay (up to 2), 48V DC, 500 mA max, either polarity
	Absolute Digital Encoded output for connectivity to AquaCUE or BEACON cellular endpoints
Digital Input	Max 30V DC (programmable – positive zero return, external totalizer reset or preset batch start)
Frequency Output	Scalable up to 10 kHz, open collector up to 1 kHz, solid-state relay
Misc Output	High/low flow alarm (0…100% of flow), error alarm, empty pipe alarm, flow direction, preset batch alarm, 24V DC supply, ADE
Communication	RS232 Modbus RTU; RS485 Modbus RTU, HART, Profibus DP, BACnet MS/TP, Modbus TCP/IP, EtherNet/IP and BACnet/IP require separate daughterboards
Pulse Width	Scalable up to 10 kHz, passive open collector up to 10 kHz, active switched 24V DC. Up to two outputs (forward and reverse). Pulse width programmable from 1…1000 ms or 50% duty cycle.
Processing	32-bit DSP
Empty Pipe Detection	Field tunable for optimum performance based on specific application
Excitation Frequency	1 Hz, 3.75 Hz, 7.5 Hz or 15 Hz (factory optimized to pipe diameter)
Noise Dampening	Programmable 0…30 seconds
Low Flow Cut-Off	Programmable 0…10% of maximum flow
Galvanic Separation	250V
Fluid Conductivity	Minimum 5.0 µS/cm (minimum 20 µS/cm for demineralized water)
Fluid Temperature	**With Remote Transmitter:** PFA, PTFE & ETFE 302° F (150° C) **With Meter-Mounted Transmitter:** Rubber 178° F, (80° C), PFA, PTFE & ETFE 212° F (100° C)
Ambient Temperature	– 4…140° F (–20…60° C)
Relative Humidity	Up to 90 percent non-condensing

Pollution Degree	2
Installation Category	II
Altitude	8202 ft (2500 m)
Flow Direction	Unidirectional or bidirectional two separate totalizers (programmable)
Totalization	Programmable/resettable
Units of Measure	Ounce, pound, liter, US gallon, imperial gallon, barrel, hectoliter, mega gallon, cubic meter, cubic feet, acre feet
Display	4 x 20 character display with backlight
Programming	Three-button, external manual or remote
Transmitter Housing	Cast aluminum, powder-coated paint
Mounting	Meter mount or remote wall mount (bracket supplied)
Locations	Indoor and outdoor
Meter Enclosure Classification	**Standard:** NEMA 4X (IP67); **Optional:** Submersible NEMA 6P (IP68) depth of 2 m for 72 hr), remote transmitter required
Junction Box Enclosure Protection	For remote transmitter option: powder-coated die-cast aluminum, NEMA 4 (IP67)
Cable Entries	M20 cable glands (3)
Optional Stainless Steel Grounding Rings	**Meter Size** / **Thickness of one ring** / **Thickness of one ring (DIN Flanges)** Up through 10 in. / 0.135 in. (3.429 mm) / 0.12 in. (3 mm) 12…78 in. / 0.187 in. (4.750 mm) / 0.12 in. (3 mm)
NSF/ANSI/CAN 61 and 372 Listed WRAS/ACS	Models with hard rubber liner, 4 in. size and larger; PTFE liner, all sizes WRAS (hard rubber), ACS (PTFE)
OIML R49-1 MID MI-001 AWWA C715	Size range: DN50…800 / 2…28 in. Minimum straight inlet flow: 0 DN /outlet flow: 0 DN Forward and reverse (bi-directional) flow on any orientation Ratio (Q3/Q1) up to 250 Accuracy Class 1
Token Features	Data Logging (Blue token); Store/Restore (Red token); Firmware Upgrade (Black token)

M2000 Transmitter Dimensions in. (mm)



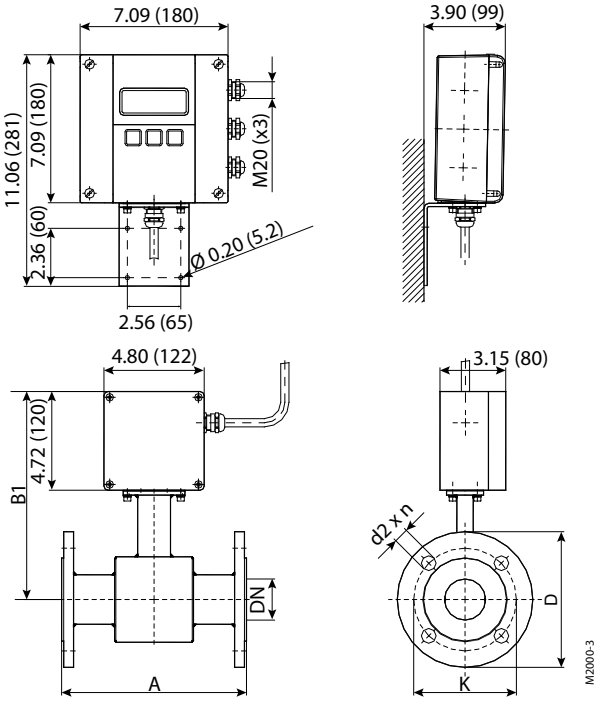
Sensor Type II Specifications

The electromagnetic sensor type II is not only available in a number of different flange process connections (DIN, ANSI, JIS, AWWA) but also in a number of liners like hard rubber, PTFE, PFA or ETFE. The sensor is configurable with up to 4 electrodes for measuring, empty pipe and grounding electrodes. Available in sizes from DN 6 TO DN 2000 and nominal pressures up to PN 100, the sensor type II is best suited for a variety of applications in the industry and the water/waste water industry.

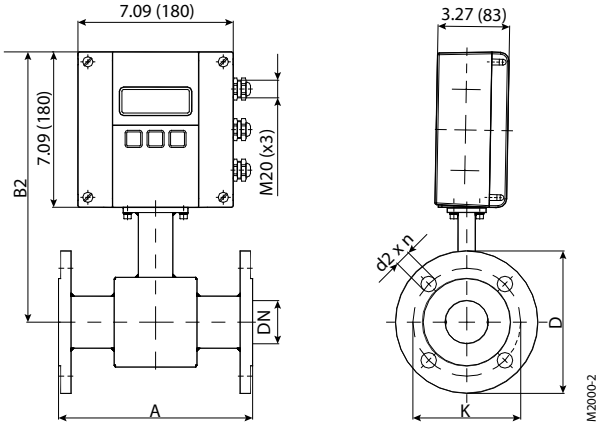
Size	1/4…78 in. (DN 6…2000)		
Flanges	**Standard:** ANSI B16.5, AWWA, ISO 1092-1, JIS and more in carbon steel; **Optional:** 304 or 316 stainless steel		
Nominal Pressure	Up to 1450 psi (100 bar)		
Pressure Rating	Line sizes 1/4…24 in: In accordance with ASME B16.5 Class 150 or Flange Rating Class 300 Line sizes 26…78 in: AWWA C-207 Class D or Class E Flange Rating		
Protection Class	NEMA 4X (IP67), optional NEMA 6P (IP68)		
Minimum Conductivity	5 µS/cm (20 µS/cm for demineralized water)		
Liner Material	Hard rubber	1…78 in. (DN 25…2000)	32…176° F (0…80° C)
	PTFE	1/2…24 in. (DN 15…600)	–40…302° F (–40…150° C)
	ETFE	12 in. (DN 300) and larger	–40…302° F (–40…150° C)
	PFA	1/4…3/8 in. (DN 6…10)	—
Housing	**Standard:** Carbon steel welded; **Optional:** 316 or 304 stainless steel		
Electrode Materials	**Standard:** Hastelloy C22; **Optional:** 316 stainless steel, gold/platinum plated, tantalum, platinum/rhodium		
Lay Length	1/4…3/4 in. (DN 6…20)	6.7 in. (170 mm)	
	1…2 in. (DN 25…50)	8.9 in. (225 mm)	
	2-1/2…4 in. (DN 65…100)	11.0 in. (280 mm)	
	5…8 in. (DN 125…200)	15.8 in. (400 mm)	
	10…14 in. (DN 250…350)	19.7 in. (500 mm)	
	16…28 in. (DN 400…700)	23.6 in. (600 mm)	
	30…40 in. (DN 750…1000)	31.5 in. (800 mm)	
	48…56 in. (DN 1200…1400)	39.4 in. (1000 mm)	
	64 in. (DN 1600)	63.0 in. (1600 mm)	
	72 in. (DN1800)	70.9 in. (1800 mm)	
	78 in. (DN2000)	78.7 in. (2000 mm)	

Sensor Type II Dimensions

Remote Version in. (mm)



Mounted Version in. (mm)



IMPORTANT: *Flange Sizes ≤ 24 in., Standard: ANSI B16.5 Class 150 RF forged carbon steel; Optional: 300 lb forged carbon steel, 316 or 304 stainless steel*
Flange Sizes > 24 in., Standard: AWWA Class D Flanges RF forged carbon steel

Flange ANSI Class 150
Up to 24 in. ASME B16.5 / > 24 in. AWWA Class D (ASME 16.47)

Size DN		A Standard		A ISO*		B1		B2		D		K		d2 x n	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
1/4	6	6.7	170	—	—	9.0	228	11.3	288	3.5	89	2.4	61	0.6 x 4	16 x 4
5/16	8	6.7	170	—	—	9.0	228	11.3	288	3.5	89	2.4	61	0.6 x 4	16 x 4
3/8	10	6.7	170	—	—	9.0	228	11.3	288	3.5	89	2.4	61	0.6 x 4	16 x 4
1/2	15	6.7	170	7.9	200	9.4	238	11.7	298	3.5	89	2.4	61	0.6 x 4	16 x 4
3/4	20	6.7	170	7.9	200	9.4	238	11.7	298	3.9	99	2.8	71	0.6 x 4	16 x 4
1	25	8.9	225	7.9	200	9.4	238	11.7	298	4.3	109	3.1	79	0.6 x 4	16 x 4
1-1/4	32	8.9	225	7.9	200	10.0	253	12.3	313	4.6	117	3.5	89	0.6 x 4	16 x 4
1-1/2	40	8.9	225	7.9	200	10.0	253	12.3	313	5.0	127	3.9	99	0.6 x 4	16 x 4
2	50	8.9	225	7.9	200	10.0	253	12.3	313	6.0	152	4.8	122	0.8 x 4	19 x 4
2-1/2	65	11.0	280	7.9	200	10.7	271	13.0	331	7.0	178	5.5	140	0.8 x 4	19 x 4
3	80	11.0	280	7.9	200	10.7	271	13.0	331	7.5	191	6.0	152	0.8 x 4	19 x 4
4	100	11.0	280	9.8	250	10.9	278	13.3	338	9.0	229	7.5	191	0.8 x 8	19 x 8
5	125	15.7	400	9.8	250	11.7	298	14.1	358	10.0	254	8.5	216	0.9 x 8	22 x 8
6	150	15.7	400	11.8	300	12.2	310	14.6	370	11.0	279	9.5	241	0.9 x 8	22 x 8
8	200	15.7	400	13.8	350	13.3	338	15.7	398	13.5	343	11.8	300	0.9 x 8	22 x 8
10	250	19.7	500	17.7	450	14.3	362	16.6	422	16.0	406	14.3	363	1.0 x 12	25 x 12
12	300	19.7	500	19.7	500	16.7	425	19.1	485	19.0	483	17.0	432	1.0 x 12	25 x 12
14	350	19.7	500	21.7	550	17.7	450	20.1	510	21.0	533	18.8	478	1.1 x 12	28 x 12
16	400	23.6	600	23.6	600	18.7	475	21.1	535	23.5	597	21.3	541	1.1 x 16	28 x 16
18	450	23.6	600	23.6	600	19.7	500	22.0	560	25.0	635	22.8	579	1.3 x 16	32 x 16
20	500	23.6	600	23.6	600	20.7	525	23.0	585	27.5	699	25.0	635	1.3 x 20	32 x 20
24	600	23.6	600	23.6	600	23.1	588	25.5	648	32.0	813	29.5	749	1.4 x 20	35 x 20
28	700	23.6	600	27.6	700	24.6	625	27.0	685	36.5	927	34.0	864	1.4 x 28	35 x 28
30	750	31.5	800	29.5	750	25.6	650	28.0	710	38.8	986	36.0	914	1.4 x 28	35 x 28
32	800	31.5	800	31.5	800	26.9	683	29.3	743	41.8	1062	38.5	978	1.6 x 28	41 x 28
36	900	31.5	800	35.4	900	28.5	725	30.9	785	46.0	1168	42.8	1087	1.6 x 32	41 x 32
40	1000	31.5	800	39.4	1000	31.1	790	33.5	850	50.8	1290	47.3	1201	1.6 x 36	41 x 36
42	1050	39.4	1000	41.3	1050	32.5	825	34.8	885	53.0	1346	49.5	1257	1.6 x 36	41 x 36
48	1200	39.4	1000	47.2	1200	35.4	900	37.8	960	59.5	1511	56.0	1422	1.6 x 44	41 x 44
54	1350	39.4	1000	53.1	1350	38.4	975	40.7	1035	66.3	1684	62.8	1595	1.9 x 44	48 x 44
56	1400	39.4	1000	55.1	1400	39.4	1000	41.7	1060	68.8	1748	65.0	1651	1.9 x 48	48 x 48
Other sizes on request															

IMPORTANT: ISO* sensor lay length according to ISO 20456

Flange ANSI Class 300 ASME B16.5

Size DN		A Standard		A ISO*		B1		B2		D		K		d2 x n	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
1/2	15	6.7	170	7.9	200	9.4	238	11.7	298	3.8	95	2.6	67	0.6 x 4	16 x 4
3/4	20	6.7	170	7.9	200	9.4	238	11.7	298	4.6	117	3.3	83	0.8 x 4	19 x 4
1	25	8.9	225	7.9	200	9.4	238	11.7	298	4.9	124	3.5	89	0.8 x 4	19 x 4
1-1/4	32	8.9	225	7.9	200	10.0	253	12.3	313	5.3	133	3.9	99	0.8 x 4	19 x 4
1-1/2	40	8.9	225	7.9	200	10.0	253	12.3	313	6.1	155	4.5	114	0.9 x 4	22 x 4
2	50	8.9	225	7.9	200	10.0	253	12.3	313	6.5	165	5.0	127	0.8 x 8	19 x 8
2-1/2	65	11.0	280	7.9	200	10.7	271	13.0	331	7.5	191	5.9	149	0.9 x 8	22 x 8
3	80	11.0	280	7.9	200	10.7	271	13.0	331	8.3	210	6.6	168	0.9 x 8	22 x 8
4	100	11.0	280	9.8	250	10.9	278	13.3	338	10.0	254	7.9	200	0.9 x 8	22 x 8
5	125	15.7	400	9.8	250	11.7	298	14.1	358	11.0	279	9.3	235	0.9 x 8	22 x 8
6	150	15.7	400	11.8	300	12.2	310	14.6	370	12.5	318	10.6	270	0.9 x 12	22 x 12
8	200	15.7	400	13.8	350	13.3	338	15.7	398	15.0	381	13.0	330	1.0 x 12	25 x 12
10	250	19.7	500	17.7	450	14.3	362	16.6	422	17.5	445	15.3	387	1.1 x 16	28 x 16
12	300	19.7	500	19.7	500	16.7	425	19.1	485	20.5	521	17.8	451	1.3 x 16	32 x 16
14	350	19.7	500	21.7	550	17.7	450	20.1	510	23.0	584	20.3	514	1.3 x 20	32 x 20
16	400	23.6	600	23.6	600	18.7	475	21.1	535	25.5	648	22.5	572	1.4 x 20	35 x 20
18	450	23.6	600	23.6	600	19.7	500	22.0	560	28.0	711	24.8	629	1.4 x 24	35 x 24
20	500	23.6	600	23.6	600	20.7	525	23.0	585	30.5	775	27.0	686	1.4 x 24	35 x 24
24	600	23.6	600	23.6	600	23.1	588	25.5	648	36.0	914	32.0	813	1.6 x 24	41 x 24
Other sizes on request															

IMPORTANT: ISO* sensor lay length according to ISO 20456

Flange EN 1092-1 / PN 10

Size DN		A Standard		A ISO*		B1		B2		D		K		d2 x n	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
8	200	15.7	400	13.8	350	13.3	338	15.7	398	13.4	340	11.6	295	0.9 x 8	22 x 8
10	250	19.7	500	17.7	450	14.3	362	16.6	422	15.6	395	13.8	350	0.9 x 12	22 x 12
12	300	19.7	500	19.7	500	16.7	425	19.1	485	17.5	445	15.7	400	0.9 x 12	22 x 12
14	350	19.7	500	21.7	550	17.7	450	20.1	510	19.9	505	18.1	460	0.9 x 16	22 x 16
16	400	23.6	600	23.6	600	18.7	475	21.1	535	22.2	565	20.3	515	1.0 x 16	26 x 16
18	450	23.6	600	23.6	600	19.7	500	22.0	560	24.2	615	22.2	565	1.0 x 20	26 x 20
20	500	23.6	600	23.6	600	20.7	525	23.0	585	26.4	670	24.4	620	1.0 x 20	26 x 20
24	600	23.6	600	23.6	600	23.1	588	25.5	648	30.7	780	28.5	725	1.2 x 20	30 x 20
28	700	23.6	600	27.6	700	24.6	625	27.0	685	35.2	895	33.1	840	1.2 x 24	30 x 24
32	800	31.5	800	31.5	800	26.9	683	29.3	743	40.0	1015	37.4	950	1.3 x 24	33 x 24
36	900	31.5	800	35.4	900	28.5	725	30.9	785	43.9	1115	41.3	1050	1.3 x 28	33 x 28
40	1000	31.5	800	39.4	1000	31.1	790	33.5	850	48.4	1230	45.7	1160	1.4 x 28	36 x 28
48	1200	39.4	1000	47.2	1200	35.4	900	37.8	960	57.3	1455	54.3	1380	1.5 x 32	39 x 32
56	1400	39.4	1000	55.1	1400	39.4	1000	41.7	1060	65.9	1675	62.6	1590	1.7 x 36	42 x 36
Other sizes on request															

IMPORTANT: ISO* sensor lay length according to ISO 20456

Flange EN 1092-1 / PN 16

Size DN		A Standard		A ISO*		B1		B2		D		K		d2 x n	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
1/4	6	6.7	170	—	—	9.0	228	11.3	288	3.5	90	2.4	60	0.6 x 4	14 x 4
5/16	8	6.7	170	—	—	9.0	228	11.3	288	3.5	90	2.4	60	0.6 x 4	14 x 4
3/8	10	6.7	170	—	—	9.0	228	11.3	288	3.5	90	2.4	60	0.6 x 4	14 x 4
1/2	15	6.7	170	7.9	200	9.4	238	11.7	298	3.7	95	2.6	65	0.6 x 4	14 x 4
3/4	20	6.7	170	7.9	200	9.4	238	11.7	298	4.1	105	3.0	75	0.6 x 4	14 x 4
1	25	8.9	225	7.9	200	9.4	238	11.7	298	4.5	115	3.3	85	0.6 x 4	14 x 4
1-1/4	32	8.9	225	7.9	200	10.0	253	12.3	313	5.5	140	3.9	100	0.7 x 4	18 x 4
1-1/2	40	8.9	225	7.9	200	10.0	253	12.3	313	5.9	150	4.3	110	0.7 x 4	18 x 4
2	50	8.9	225	7.9	200	10.0	253	12.3	313	6.5	165	4.9	125	0.7 x 4	18 x 4
2-1/2	65	11.0	280	7.9	200	10.7	271	13.0	331	7.3	185	5.7	145	0.7 x 8	18 x 8
3	80	11.0	280	7.9	200	10.7	271	13.0	331	7.9	200	6.3	160	0.7 x 8	18 x 8
4	100	11.0	280	9.8	250	10.9	278	13.3	338	8.7	220	7.1	180	0.7 x 8	18 x 8
5	125	15.7	400	9.8	250	11.7	298	14.1	358	9.8	250	8.3	210	0.7 x 8	18 x 8
6	150	15.7	400	11.8	300	12.2	310	14.6	370	11.2	285	9.4	240	0.9 x 8	22 x 8
8	200	15.7	400	13.8	350	13.3	338	15.7	398	13.4	340	11.6	295	0.9 x 12	22 x 12
10	250	19.7	500	17.7	450	14.3	362	16.6	422	15.9	405	14.0	355	1.0 x 12	26 x 12
12	300	19.7	500	19.7	500	16.7	425	19.1	485	18.1	460	16.1	410	1.0 x 12	26 x 12
14	350	19.7	500	21.7	550	17.7	450	20.1	510	20.5	520	18.5	470	1.0 x 16	26 x 16
16	400	23.6	600	23.6	600	18.7	475	21.1	535	22.8	580	20.7	525	1.2 x 16	30 x 16
18	450	23.6	600	23.6	600	19.7	500	22.0	560	25.2	640	23.0	585	1.2 x 20	30 x 20
20	500	23.6	600	23.6	600	20.7	525	23.0	585	28.1	715	25.6	650	1.3 x 20	33 x 20
24	600	23.6	600	23.6	600	23.1	588	25.5	648	33.1	840	30.3	770	1.4 x 20	36 x 20
28	700	23.6	600	27.6	700	24.6	625	27.0	685	35.8	910	33.1	840	1.4 x 24	36 x 24
32	800	31.5	800	31.5	800	26.9	683	29.3	743	40.4	1025	37.4	950	1.5 x 24	39 x 24
36	900	31.5	800	35.4	900	28.5	725	30.9	785	44.3	1125	41.3	1050	1.5 x 28	39 x 28
40	1000	31.5	800	39.4	1000	31.1	790	33.5	850	49.4	1255	46.1	1170	1.7 x 28	42 x 28
48	1200	39.4	1000	47.2	1200	35.4	900	37.8	960	58.5	1485	54.7	1390	1.9 x 32	48 x 32
56	1400	39.4	1000	55.1	1400	39.4	1000	41.7	1060	66.3	1685	62.6	1590	1.9 x 36	48 x 36
Other sizes on request															

IMPORTANT: ISO* sensor lay length according to ISO 20456

Flange EN 1092-1 / PN 25

Size DN		A Standard		A ISO*		B1		B2		D		K		d2 x n	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
1/2	15	6.7	170	7.9	200	9.4	238	11.7	298	3.7	95	2.6	65	0.6 x 4	14 x 4
3/4	20	6.7	170	7.9	200	9.4	238	11.7	298	4.1	105	3.0	75	0.6 x 4	14 x 4
1	25	8.9	225	7.9	200	9.4	238	11.7	298	4.5	115	3.3	85	0.6 x 4	14 x 4
1-1/4	32	8.9	225	7.9	200	10.0	253	12.3	313	5.5	140	3.9	100	0.7 x 4	18 x 4
1-1/2	40	8.9	225	7.9	200	10.0	253	12.3	313	5.9	150	4.3	110	0.7 x 4	18 x 4
2	50	8.9	225	7.9	200	10.0	253	12.3	313	6.5	165	4.9	125	0.7 x 4	18 x 4
2-1/2	65	11.0	280	7.9	200	10.7	271	13.0	331	7.3	185	5.7	145	0.7 x 4	18 x 8
3	80	11.0	280	7.9	200	10.7	271	13.0	331	7.9	200	6.3	160	0.7 x 8	18 x 8
4	100	11.0	280	9.8	250	10.9	278	13.3	338	9.3	235	7.5	190	0.9 x 8	22 x 8
5	125	15.7	400	9.8	250	11.7	298	14.1	358	10.6	270	8.7	220	1.0 x 8	26 x 8
6	150	15.7	400	11.8	300	12.2	310	14.6	370	11.8	300	9.8	250	1.0 x 8	26 x 8
8	200	15.7	400	13.8	350	13.3	338	15.7	398	14.2	360	12.2	310	1.0 x 8	26 x 12
10	250	19.7	500	17.7	450	14.3	362	16.6	422	16.7	425	14.6	370	1.2 x 12	30 x 12
12	300	19.7	500	19.7	500	16.7	425	19.1	485	19.1	485	16.9	430	1.2 x 12	30 x 16
14	350	19.7	500	21.7	550	17.7	450	20.1	510	21.9	555	19.3	490	1.3 x 16	33 x 16
16	400	23.6	600	23.6	600	18.7	475	21.1	535	24.4	620	21.7	550	1.4 x 16	36 x 16
18	450	23.6	600	23.6	600	19.7	500	22.0	560	26.4	670	23.6	600	1.4 x 20	36 x 20
20	500	23.6	600	23.6	600	20.7	525	23.0	585	28.7	730	26.0	660	1.4 x 20	36 x 20
24	600	23.6	600	23.6	600	23.1	588	25.5	648	33.3	845	30.3	770	1.5 x 20	39 x 20
28	700	23.6	600	27.6	700	24.6	625	27.0	685	37.8	960	34.4	875	1.7 x 24	42 x 24
32	800	31.5	800	31.5	800	26.9	683	29.3	743	42.7	1085	39.0	990	1.9 x 24	48 x 24
36	900	31.5	800	35.4	900	28.5	725	30.9	785	46.7	1185	42.9	1090	1.9 x 28	48 x 28
40	1000	31.5	800	39.4	1000	31.1	790	33.5	850	52.0	1320	47.6	1210	2.2 x 28	56 x 28
Other sizes on request															

IMPORTANT: ISO* sensor lay length according to ISO 20456

Flange EN 1092-1 / PN 40

Size DN		A Standard		A ISO*		B1		B2		D		K		d2 x n	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
1/2	15	6.7	170	7.9	200	9.4	238	11.7	298	3.7	95	2.6	65	0.6 x 4	14 x 4
3/4	20	6.7	170	7.9	200	9.4	238	11.7	298	4.1	105	3.0	75	0.6 x 4	14 x 4
1	25	8.9	225	7.9	200	9.4	238	11.7	298	4.5	115	3.3	85	0.6 x 4	14 x 4
1-1/4	32	8.9	225	7.9	200	10.0	253	12.3	313	5.5	140	3.9	100	0.7 x 4	18 x 4
1-1/2	40	8.9	225	7.9	200	10.0	253	12.3	313	5.9	150	4.3	110	0.7 x 4	18 x 4
2	50	8.9	225	7.9	200	10.0	253	12.3	313	6.5	165	4.9	125	0.7 x 4	18 x 4
2-1/2	65	11.0	280	7.9	200	10.7	271	13.0	331	7.3	185	5.7	145	0.7 x 4	18 x 8
3	80	11.0	280	7.9	200	10.7	271	13.0	331	7.9	200	6.3	160	0.7 x 8	18 x 8
4	100	11.0	280	9.8	250	10.9	278	13.3	338	9.3	235	7.5	190	0.9 x 8	22 x 8
5	125	15.7	400	9.8	250	11.7	298	14.1	358	10.6	270	8.7	220	1.0 x 8	26 x 8
6	150	15.7	400	11.8	300	12.2	310	14.6	370	11.8	300	9.8	250	1.0 x 8	26 x 8
8	200	15.7	400	13.8	350	13.3	338	15.7	398	14.8	375	12.6	320	1.2 x 8	30 x 12
10	250	19.7	500	17.7	450	14.3	362	16.6	422	17.7	450	15.2	385	1.3 x 12	33 x 12
12	300	19.7	500	19.7	500	16.7	425	19.1	485	20.3	515	17.7	450	1.3 x 12	33 x 16
14	350	19.7	500	21.7	550	17.7	450	20.1	510	22.8	580	20.1	510	1.4 x 16	36 x 16
16	400	23.6	600	23.6	600	18.7	475	21.1	535	26.0	660	23.0	585	1.5 x 16	39 x 16
18	450	23.6	600	23.6	600	19.7	500	22.0	560	27.0	685	24.0	610	1.5 x 20	39 x 20
20	500	23.6	600	23.6	600	20.7	525	23.0	585	29.7	755	26.4	670	1.7 x 20	42 x 20
24	600	23.6	600	23.6	600	23.1	588	25.5	648	35.0	890	31.3	795	1.9 x 20	48 x 20
Other sizes on request															

IMPORTANT: ISO* sensor lay length according to ISO 20456

Weight and Flow Range

Size		Estimated Weight with M2000	Flow Range	
in.	**DN**	**lb (kg)**	**US**	**Metric**
1/4	6	8 (3.5)	0.0134…5.4 GPM	0.051…20.4 l/min
5/16	8	8 (3.5)	0.0239…9.6 GPM	0.09…36.2 l/min
3/8	10	8 (3.5)	0.0373…14.9 GPM	0.141…57 l/min
1/2	15	10 (4.5)	0.084…33.6 GPM	0.318…127 l/min
3/4	20	10 (4.5)	0.149…60 GPM	0.57…226 l/min
1	25	11 (5)	0.233…93 GPM	0.88…353 l/min
1-1/4	32	13 (6)	0.382…153 GPM	1.45…579 l/min
1-1/2	40	15.5 (7)	0.6…239 GPM	2.26…905 l/min
2	50	19 (8.5)	0.93…373 GPM	3.53…1,414 l/min
2-1/2	65	27.5 (12.5)	1.58…631 GPM	0.358…143 m^3/h
3	80	31 (14)	2.39…956 GPM	0.54…217 m^3/h
4	100	42 (19)	3.73…1,494 GPM	0.85…339 m^3/h
5	125	53 (24)	5.8…2,334 GPM	1.33…530 m^3/h
6	150	60.5 (27.5)	8.4…3,361 GPM	1.91…763 m^3/h
8	200	87 (39.5)	14.9…5,975 GPM	3.39…1,357 m^3/h
10	250	129 (58.5)	23.3…9,336 GPM	5.3…2,121 m^3/h
12	300	204 (92.5)	33.6…13,444 GPM	7.6…3,054 m^3/h
14	350	262 (119)	45.7…18,299 GPM	10.4…4,156 m^3/h
16	400	344 (156)	60…23,901 GPM	13.6…5,429 m^3/h
18	450	397 (180)	76…30,250 GPM	17.2…6,870 m^3/h
20	500	470 (213)	93…37,345 GPM	21.2…8,482 m^3/h
22	550	549 (249)	113…45,188 GPM	25.7…10,263 m^3/h
24	600	617 (280)	134…53,777 GPM	30.5…12,214 m^3/h
28	700	—	183…73,197 GPM	41.6…16,625 m^3/h
30	750	930 (422)	210…84,027 GPM	47.7…19,085 m^3/h
32	800	1171 (531)	239…95,604 GPM	54.3…21,714 m^3/h
36	900	1378 (625)	302…120,999 GPM	69…27,482 m^3/h
40	1000	—	373…149,381 GPM	85…33,928 m^3/h
48	1200	1788 (811)	538…215,109 GPM	122…48,857 m^3/h
56	1400	—	732…292,787 GPM	166…66,499 m^3/h
60	1500	2112 (958)	840…336,108 GPM	191…76,338 m^3/h
64	1600	2339 (1061)	956…382,416 GPM	217…86,856 m^3/h
72	1800	3219 (1460)	1210…483,996 GPM	275…109,927 m^3/h
78	2000	4101 (1860)	1494…597,525 GPM	339…135,713 m^3/h

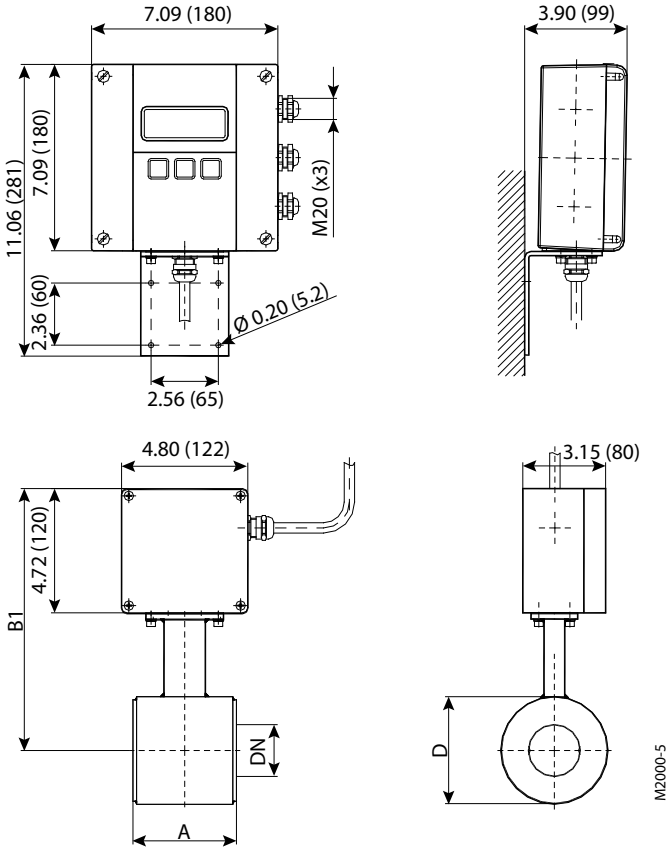
Sensor Type III Specifications

Thanks to its very short lay length, the sensor type III is often the right alternative to a lot of applications. Delivered with a PTFE liner, the sensor type III has a standard nominal pressure of PN 40.

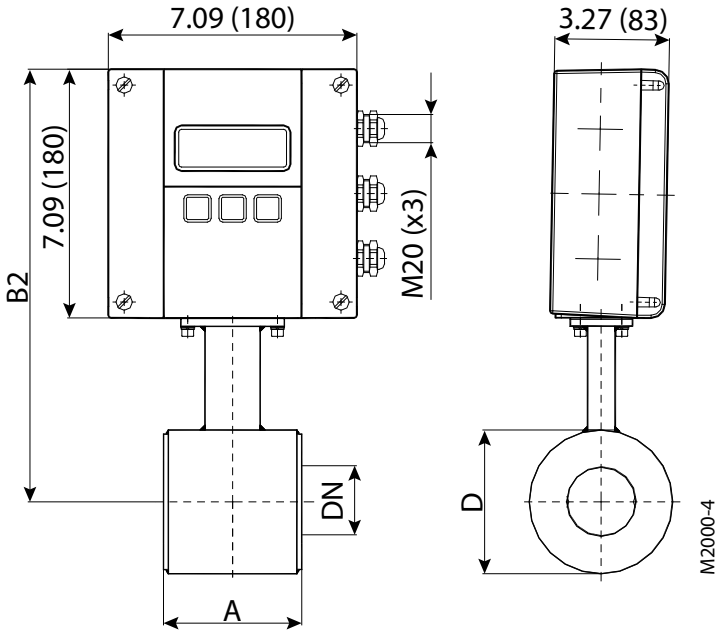
Size	1…4 in. (DN 25…100)	
Process Connection	Wafer connection (in-between flange mounting)	
Nominal Pressure	580 psi (40 bar)	
Protection Class	NEMA 4X (IP67), optional NEMA 6P (IP68)	
Minimum Conductivity	5 µS/cm (20 µS/cm for demineralized water)	
Liner Materials	PTFE	
Electrode Material	Hastelloy C (Standard), Tantal, Platinum / Gold Plated, Platinum / Rhodium	
Housing	Carbon Steel / optional stainless steel	
Lay Length	1…2 in. (DN 25…50)	4 in. (100 mm)
	2-1/2…4 in. (DN 65…100)	6 in. (150 mm)

Sensor Type III Dimensions

Remote Version
in. (mm)



Mounted Version
in. (mm)



in.	DN	A	B1	B2	D
1	25	3.94 (100)	9.37 (238)	7.24 (184)	2.91 (74)
1-1/4	32	3.94 (100)	9.57 (243)	7.44 (189)	3.31 (84)
1-1/2	40	3.94 (100)	9.76 (248)	7.64 (194)	3.70 (94)
2	50	3.94 (100)	9.96 (253)	7.83 (199)	4.09 (104)
2-1/2	65	5.91 (150)	10.47 (266)	8.35 (212)	5.08 (129)
3	80	5.91 (150)	10.67 (271)	8.54 (217)	5.51 (140)
4	100	5.91 (150)	10.98 (279)	8.86 (225)	6.14 (156)
580 psi (40 bar)					

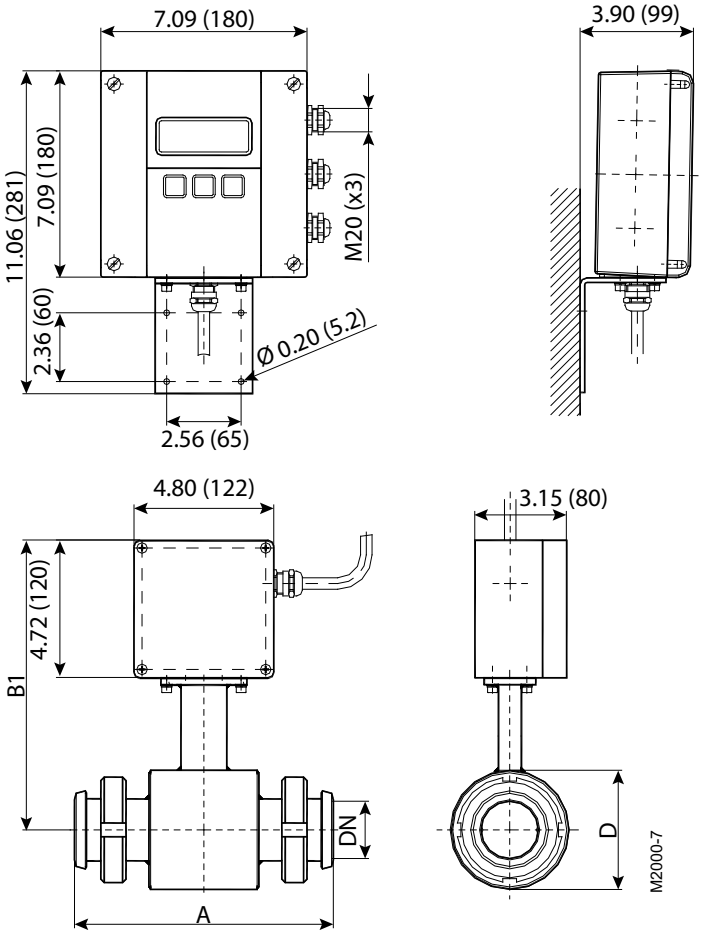
Sensor with Sanitary Process Connections Specifications

The sensor model is available with Tri-Clamp® BS4825/ISO2852, DIN11851, and more process connections. The sanitary sensor is delivered in a stainless steel housing and with PTFE/PFA lining.

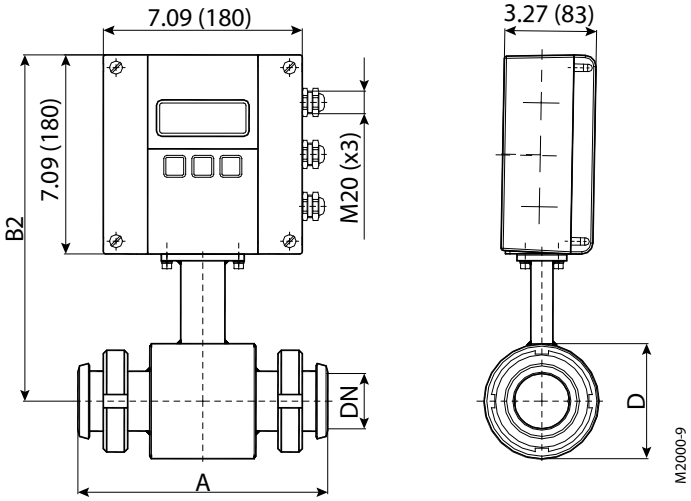
Size	3/8…4 in. (DN 10…100)		
Process Connection	Tri-Clamp BS4825/ISO2852, DIN 11851, customer specified, and more		
Nominal Pressure	145/230 psi (10/16 bar)		
Protection Class	NEMA 4X (IP67), optional NEMA 6P (IP68)		
Minimum Conductivity	5 µS/cm (20 µS/cm for demineralized water)		
Liner Materials	PTFE/PFA	–40…302° F (–40…150° C)	
Electrode Material	**Standard**: Hastelloy C; **Optional**: Tantal, Platinum / Gold plated, Platinum / Rhodium		
Housing	**Standard**: Carbon Steel; **Optional**: Stainless Steel		
Lay Length	Tri-Clamp Connection	3/8…2 in. (DN 10…50)	6 in. (145 mm)
		2-1/2…4 in. (DN 65…100)	8 in. (200 mm)
	DIN 11851 Connection	3/8…3/4 in. (DN 10…20)	7 in. (175 mm)
		1…2 in. (DN 25…50)	9 in. (225 mm)
		2-1/2…4 in. (DN 65…100)	11 in. (280 mm)

DIN 11851 Connection Dimensions

Remote Version
in. (mm)



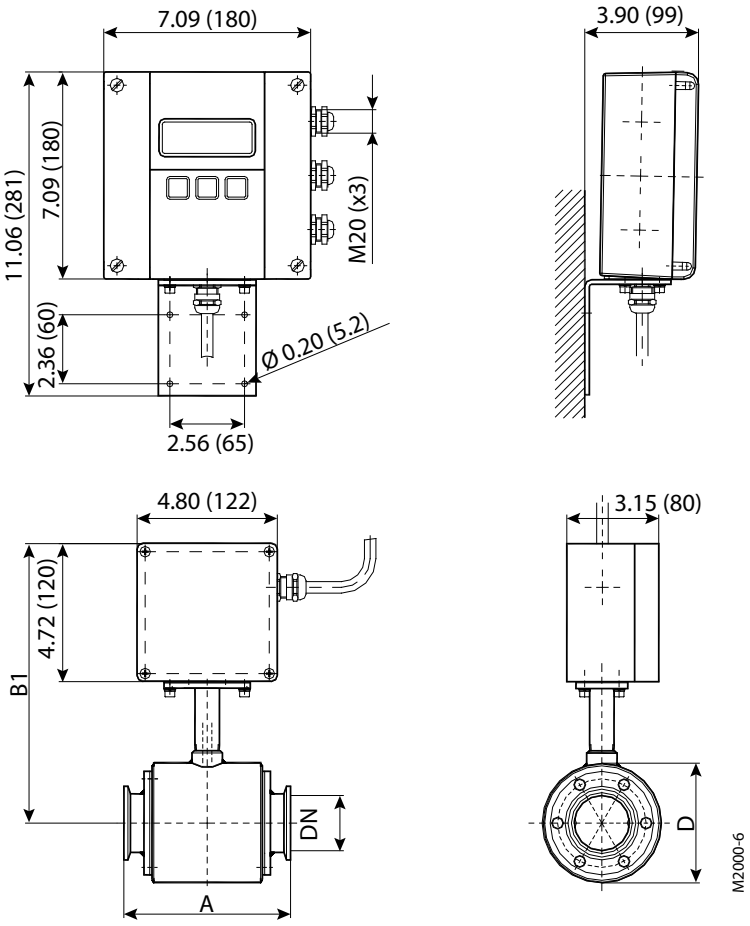
Mounted Version
in. mm



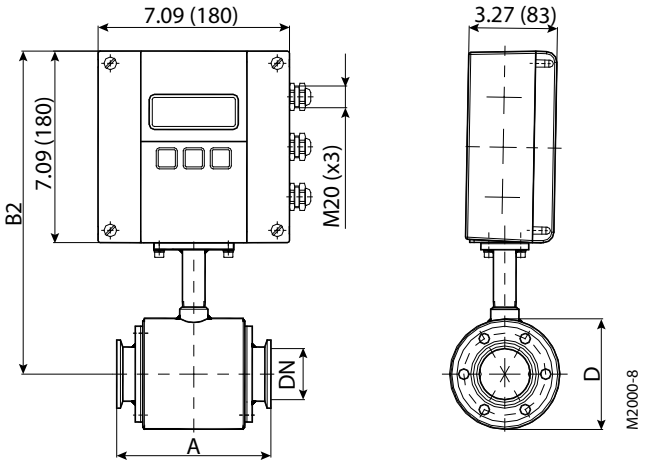
in.	DN	A	B1	B2	D
3/8	10	6.69 (170)	9.37 (238)	7.24 (184)	2.91 (74)
1/2	15	6.69 (170)	9.37 (238)	7.24 (184)	2.91 (74)
3/4	20	6.69 (170)	9.37 (238)	7.24 (184)	2.91 (74)
1	25	8.86 (225)	9.37 (238)	7.24 (184)	2.91 (74)
1-1/4	32	8.86 (225)	9.57 (243)	7.44 (189)	3.31 (84)
1-1/2	40	8.86 (225)	9.76 (248)	7.64 (194)	3.70 (94)
2	50	8.86 (225)	9.96 (253)	7.83 (199)	4.09 (104)
2-1/2	65	11.02 (280)	10.47 (266)	8.35 (212)	5.08 (129)
3	80	11.02 (280)	10.67 (271)	8.54 (217)	5.51 (140)
4	100	11.02 (280)	10.98 (279)	8.86 (225)	6.14 (156)
230 psi (16 bar)					

Tri-Clamp Connection Dimensions

Remote Version
in. (mm)

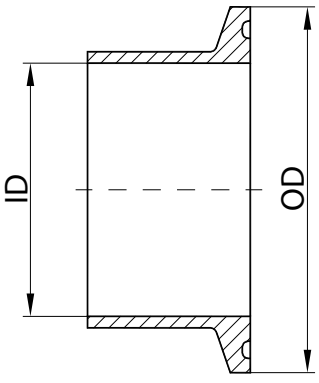


Mounted Version
in. (mm)



in.	DN	A	B1	B2	D
3/8	10	5.71 (145)	8.98 (228)	7.52 (191)	2.91 (74)
1/2	15	5.71 (145)	8.98 (228)	7.52 (191)	2.91 (74)
3/4	20	5.71 (145)	8.98 (228)	7.52 (191)	2.91 (74)
1	25	5.71 (145)	8.98 (228)	7.52 (191)	2.91 (74)
1-1/2	40	5.71 (145)	9.37 (238)	7.91 (201)	3.70 (94)
2	50	5.71 (145)	9.57 (243)	8.11 (206)	4.09 (104)
2-1/2	65	7.87 (200)	10.08 (256)	8.62 (219)	5.08 (129)
3	80	7.87 (200)	10.28 (261)	8.82 (224)	5.51 (140)
4	100	7.87 (200)	10.59 (269)	9.13 (232)	6.14 (156)
150 psi (10 bar)					

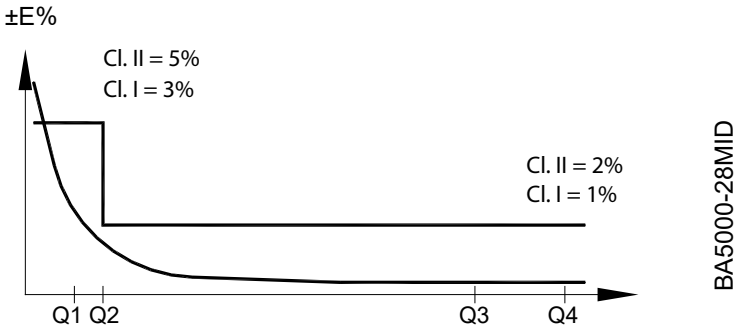
Tri-Clamp Connection



BS4825					ISO2852				
Size	OD		ID		Size	OD		ID	
in.	in.	mm	in.	mm	DN	in.	mm	in.	mm
—	—	—	—	—	10	0.98	25.0	0.55	14.0
1/2	0.98	25.0	0.37	9.4	15	1.99	50.5	0.71	18.1
3/4	0.98	25.0	0.62	15.75	20	1.99	50.5	0.90	22.9
1	1.99	50.5	0.87	22.1	25	1.99	50.5	1.13	28.7
—	—	—	—	—	32	2.52	64.0	1.51	38.4
1-1/2	1.99	50.5	1.37	34.8	40	2.52	64.0	1.74	44.3
2	2.52	64.0	1.87	47.5	50	3.05	77.5	2.22	56.3
2-1/2	3.05	77.5	2.37	60.2	65	3.58	91.0	2.84	72.1
3	3.58	91.0	2.87	72.9	80	4.17	106.0	3.32	84.3
4	4.69	119.0	3.83	97.4	100	5.12	130.0	4.32	109.7
Nominal Pressure 145 psi (10 bar)									

OIML APPROVED METER

The M2000 is type approved according to the international water meter standards OIML R49. The meter is approved as Class I and Class II for the detector sizes 2…28 inches (DN 50…800).

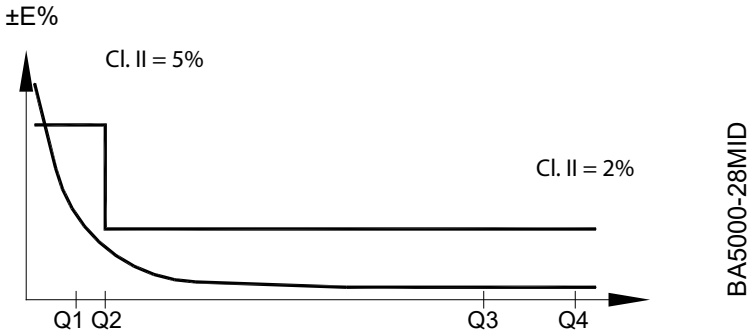


Q2/Q1 = 1.6 and Q4/Q3 = 1.25

Meter Size		Flow Rates [m^3/h]				Ratio Q3/Q1
		Q1	Q2	Q3	Q4	
DN 50	2 in.	0.252	0.4032	63	78.75	250
DN 65	2-1/2 in.	0.4	0.64	100	125	250
DN 80	3 in.	0.64	1.024	160	200	250
DN 100	4 in.	1	1.6	250	312.5	250
DN 125	5 in.	1.6	2.56	400	500	250
DN 150	6 in.	2.52	4.032	630	787.5	250
DN 200	8 in.	4	6.4	1000	1250	250
DN 250	10 in.	6.4	10.24	1600	2000	250
DN 300	12 in.	10	16	2500	3125	250
DN 350	14 in.	10	16	2500	3125	250
DN 400	16 in.	16	25.6	4000	5000	250
DN 450	18 in.	25.2	40.32	6300	7875	250
DN 500	20 in.	25.2	40.32	6300	7875	250
DN 600	24 in.	25.2	40.32	6300	7875	250
DN 800	28 in.	40	64	10000	12500	250
OIML R49	Class 1 and Class 2					

MID APPROVED METER

The M2000 is type approved according to Directive 2004/22/EC of the European Parliament and Council of March 31, 2004 Measuring Instruments (MID) Annex MI-001. The meter is approved for the detector sizes 2…28 inches (DN 50…800).



Q2/Q1 = 1.6 and Q4/Q3 = 1.25

Meter Size		Flow Rates [m^3/h]				Ratio Q3/Q1
		Q1	Q2	Q3	Q4	
DN 50	2 in.	0.252	0.4032	63	78.75	250
DN 65	2-1/2 in.	0.4	0.64	100	125	250
DN 80	3 in.	0.64	1.024	160	200	250
DN 100	4 in.	1	1.6	250	312.5	250
DN 125	5 in.	1.6	2.56	400	500	250
DN 150	6 in.	2.52	4.032	630	787.5	250
DN 200	8 in.	4	6.4	1000	1250	250
DN 250	10 in.	6.4	10.24	1600	2000	250
DN 300	12 in.	10	16	2500	3125	250
DN 350	14 in.	10	16	2500	3125	250
DN 400	16 in.	16	25.6	4000	5000	250
DN 450	18 in.	25.2	40.32	6300	7875	250
DN 500	20 in.	25.2	40.32	6300	7875	250
DN 600	24 in.	25.2	40.32	6300	7875	250
DN 800	28 in.	40	64	10000	12500	250
MID MI-001						

The conformity declaration of above certificate is according to module B (type approval) and D (quality insurance of production).

PART NUMBER CONSTRUCTION

ModMAG® Model M2000

Model Code: [M] [A] [ ] [ ] [ ] [H] [ ] [ ] [ ] [ ] [C] [ ] [ ] [D] [B] [A] [ ] [ ] [ ]

General area

Size

DN 6	1/4 IN.	liner PFA / 304 SST	002
DN 8	5/16 IN.	liner PFA / 304 SST	003
DN 10	3/8 IN.	liner PFA / 304 SST	004
DN 15	1/2 IN.		005
DN 20	3/4 IN.		007
DN 25	1 IN.		010
DN 32	1-1/4 IN.		012
DN 40	1-1/2 IN.		015
DN 50	2 IN.		020
DN 65	2-1/2 IN.		025
DN 80	3 IN.		030
DN 100	4 IN.		040
DN 125	5 IN.		050
DN 150	6 IN.		060
DN 200	8 IN.		080
DN 250	10 IN.		100
DN 300	12 IN.		120
DN 350	14 IN.		140
DN 400	16 IN.		160
DN 450	18 IN.		180
DN 500	20 IN.		200
	22 IN.		220
DN 600	24 IN.		240
DN 700	28 IN.		280
	30 IN.		300
DN 800	32 IN.		320
DN 900	36 IN.		360
DN 1000	40 IN.		400
	42 IN.		420
DN 1200	48 IN.		480
	54 IN.		540
DN 1400	56 IN.		560

Process connection

EN 1092-1 PN 40	FEE
EN 1092-1 PN 25	FED
EN 1092-1 PN 16	FEC
EN 1092-1 PN 10	FEB
ASME Class 300	FAB
ASME Class 150	FAA
TriClamp ISO 2852	TAE
TriClamp BS 4825	TAB
Threads DIN 11851	DAA
Wafer	WAA

Flange and Housing material

Carbon Steel (Standard)	C1
Carbon Steel w/ C5M Paint	C2
304 Stainless Steel Connection / Housing	S3
316 Stainless Steel Connection / Housing	S7
Carbon Steel Process Connections (Std. Paint) / 316 Stainless Steel Housing	C4

Liner Material

Hard Rubber		H
PTFE	for sizes > DN10 (3/8 IN.)	P
PFA	DN 6...DN 10 (1/4... 3/8 IN.) with PFA liner	A
ETFE	for sizes > DN250 (10 IN.)	T

Electrodes / Measuring, Empty pipe, Grounding

Hastelloy C-22 (Standard / Measuring Empty pipe & Grounding)	A
Hastelloy C-22 (Standard / Measuring & Empty pipe)	J
AISI 316/1.4571	B
Tantalum	C
Platinum/Rhodium	D

Grounding rings

No Grounding Rings	X
304 Stainless Steel Grounding Rings	A
316 Stainless Steel Grounding Rings	B

Meter Lay Length

Standard	S
ISO 20456	O

Transmitter, Power Supply, Hardware

100/240V AC; Meter-Mounted	SA	AA	C
100/240V AC; Remote-Mounted	RA	AA	C
12...32V DC; Meter-Mounted	SA	AB	C
12...32V DC; Remote-Mounted	RA	AB	C

Junction Box (for remote mounted version)

Aluminum Enclosure; IP67 (Type 6/4X) Rating		A
Aluminum Enclosure; IP68 (Type 6P) Rating	(submersible option)	B
Stainless Steel Enclosure; IP67 (Type 6/4X) Rating		C
Stainless Steel Enclosure; IP68 (Type 6P) Rating	(submersible option)	D
None | Used for "Sensor-Mounted" Transmitter Configurations		X

Remote Cable Length (for remote mounted version)

15 ft.	5 m	MA
30 ft.	10 m	MB
50 ft.	15 m	MC
65 ft.	20 m	MD
80 ft.	25 m	ME
100 ft.	30 m	MF
115 ft.	35 m	MG
130 ft.	40 m	MH
150 ft.	45 m	MJ
165 ft.	50 m	MK
180 ft.	55 m	MM
200 ft.	60 m	MN
215 ft.	65 m	MP
230 ft.	70 m	MQ
245 ft.	75 m	MR
260 ft.	80 m	MS
280 ft.	85 m	MT
295 ft.	90 m	MU
310 ft.	95 m	MV
330 ft.	100 m	NW
360 ft.	110 m	NB
390 ft.	120 m	ND
425 ft.	130 m	NF
460 ft.	140 m	NH
500 ft.	150 m	NK
None | Used for "Sensor-Mounted" Transmitters Configuration		WW

Input/Output Channel

Standard Input/Output	D	B	A

Communications

Standard Communication (RS232 Modbus RTU)	B
Modbus RTU (RS-485)	L
HART	P
Profibus DP	E
Modbus TCP/IP	G
EtherNet/IP; ODVA	H
M-Bus wired	M
BACnet/IP	N
BACnet MS/TP	Q

Wiring Method

Twist Tight; 5 ft. (1.52 m)	TF
Twist Tight; 10 ft. (3.05 m)	TH
Twist Tight; 25 ft. (7.62 m)	TJ
Twist Tight; 75 ft. (22.86 m)	TK
None | No Endpoint (Standard)	XX

Programming

Gallons/gallons per minute (North America Standard)	NA
Gallons/cubic feet per minute	NC
Gallons/cubic meters per second	ND
Cubic Meters/gallons per minute	NE
Cubic Feet/gallons per minute	NJ
Cubic Feet/cubic feet per minute	NK
Cubic Feet/cubic meters per hour	NL
Liters/gallons per minute	NM
Million Gallons/gallons per minute	NS
Gallons/millions gallons per day	NT
Acre Feet/gallons per minute	NU
Second-Foot Day/cubic feet per second	NV
Standard (Default Metric units based on size)	EA
m^3/s and m^3	EB
m^3/min and m^3	EC
m^3/h and m^3	ED
L/s and L	EE
L/min and L	EF
L/h and L	EG

Testing & Tagging

0.2%	3-Point Calibration; Factory (Standard)	F
0.2%	3-Point Calibration in Factory / Stainless steel Tag	S
0.5%	1-Point Calibration; Factory	L
0.5%	1-Point Calibration in Factory / Stainless steel Tag	M
OIML R49 Cl 1 TYPE CALIBRATED; 3PT; Q1-Q3		N
3rd Party Calibrated		3
3rd Party Calibrated w/ Stainless Steel Tag		T
State of Kansas Certified (North America only)		K

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Translated Document Number: MAG-DS-01896-ES-21, MAG-DS-03224-FR-18

Solids Handling
Electric Motor Driven

Submersible Pumps

Models
SF4A
SF4A-X
Size 4”

SF Series®
VARIOUS PATENTS APPLY

C/US

FM APPROVED
X-PROOF MOTORS FOR CLASS I, DIV. 1, GROUPS C&D LOCATIONS
(X-Proof Version Only)

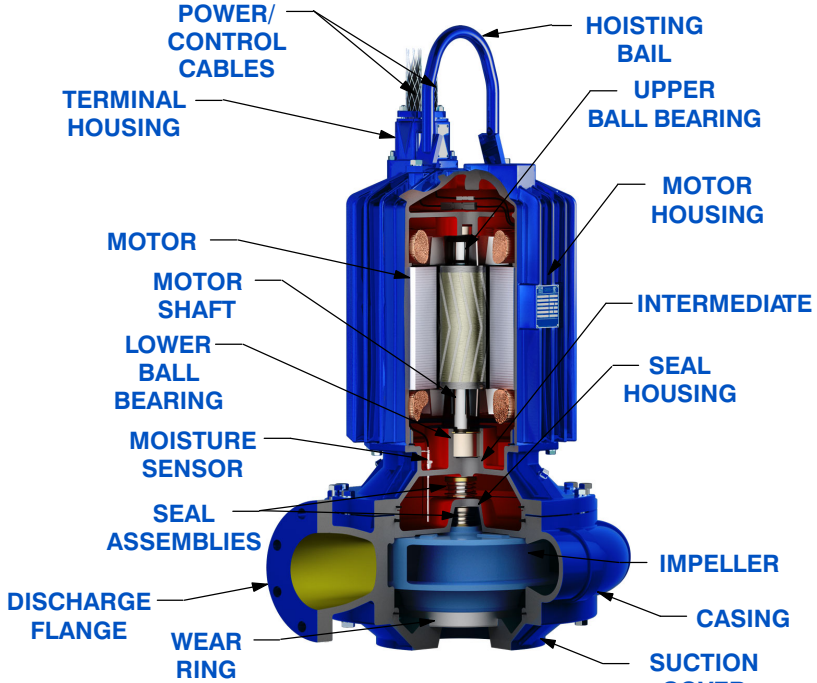
The Gorman-Rupp Infinity® brand of SF Series® channel pumps provide superior pumping efficiency while maintaining a 3-inch (76,2 mm) spherical solids passage.

Key Features:

- NEMA premium efficiency motors
- Externally adjustable face clearance
- Press-fit motor with finned motor housing provides superior motor cooling, even in a submersed state, resulting in increased motor life
- NEMA Class H motor insulation
- Easy, in-the-field cable changes
- Standard moisture detection in both the seal and motor chambers
- CSA-C/US and Factory Mutual (FM) Approved for Class I, Division I, Group C and D Haz Loc Applications (X-Proof Model)

Optional Accessories:

- G-R Hard Iron Impeller
- Control Panel (Consult SF Series Motor Data Reference for Customer-Supplied Control Panel)
- Submersible Transducer or Ball Type Float Switches
- Slide Rail Installation Components
  - Guide shoe w/Rubber Seal
  - Base Elbow and Rail Brackets
- Trash Stand Installation Components
  - Trash Stand
  - Discharge Elbow



TYPICAL CROSS-SECTION

PUMP DETAILS

Pump Models		SF4A/SF4A-X
Agency Approvals		FM/CSA-C/US
Discharge Flange		4" ANSI w/ Flat Face
Impeller Type / Material		Two Vane Enclosed/ Ductile Iron
Wear Ring		Ductile Iron
Spherical Solids Handling		3" (76 mm) Non-Deformable Diameter
Motor Housing (Including Seal Plate and Intermediate)		Gray Iron 30
Pump Casing		Ductile Iron
Motor Shaft/Shaft Sleeve		17–4 PH Stainless Steel
O-Rings		Buna-N and Fluorocarbon (DuPont Viton® or Equivalent)
Bearings: Type/Lubrication	Upper	Single Row Ball/Permanent Lubrication
	Lower	Double Row Ball/Permanent Lubrication
External Hardware		303/304 Stainless Steel
External Surface Protection		Epoxy Paint
Seal Type		Tandem, Mechanical, Oil Lubricated Upper, Self-Lubricated Lower
Sealing Faces: Rotating/Stationary	Upper	Carbon/Ceramic
	Lower	Silicon Carbide/Silicon Carbide
Seal Elastomers		Buna-N Upper, Fluorocarbon (DuPont Viton® or Equivalent) Lower
Max. Liquid Temperature		104°F (40°C)

MOTOR DETAILS

Speed		60 Hz, 1750 RPM		
Motor Design		Inverter-Duty Rated, Air-Filled Enclosure, Squirrel Cage, Induction Start		
Motor Efficiency Rating		NEMA Premium Efficiency (IEC IE3)		
Insulation		Class H, Rated 356°F (180°C)		
Max. Submergence		65 Feet (20 Meters)		
Min. Submergence		1/2 Motor Covered		
Max. Starts per Hour		10		
Max. Rated Output Power		15 (11,2)	20 (14,9)	24.0 (17,9)
Amp Draw @ Max. Rated Power: Full Load/ Locked Rotor				
	208V/3P	46.8/416	58.6/416	
	230V/3P	42.4/376	53.0/376	61.6/376
	460V/3P	21.2/188	26.5/188	30.8/188
	575V/3P	17.0/150	21.2/150	24.6/150
NEMA Motor Code		L	J	G
Service Factor		1.15	1.15	1.15
Efficiency: 100%/75%/50% Load		91%/89%/83%	91%/89%/86%	92%/92%/91%
Power Factor: 100%/75%/50% Load		0.74/0.68/0.53	0.80/0.75/0.62	0.82/0.78/0.67
Field Connection		Across-the-Line		
Moisture Sensor		Single Probe Monitoring Both Seal and Motor Chambers		
Thermal Overload		One Thermostat per Phase, Self-Resetting		

CABLE DETAILS

Voltage		208-230/460V	575V
Power Cable	No. Cables/Conductors per	1/6	1/6
	Gauge	(3) 4 AWG PWR & (3) 10 AWG GND/GC	(3) 8 AWG PWR & (3) 10 AWG GND/GC
	Type/Material	GGC/CPE	GGC/CPE
	Nominal Cable O.D.	1.05" (26,7 mm)	0.97" (24,6 mm)
Control Cable	No. Cables/Conductors per	1/4	
	Gauge	14 AWG	
	Type/Material	SOOW/CPE	
	Nominal Cable O.D.	0.61" (15,5 mm)	
Length		32 Feet (10 Meters) Standard, 164 Feet (50 Meters) Maximum	

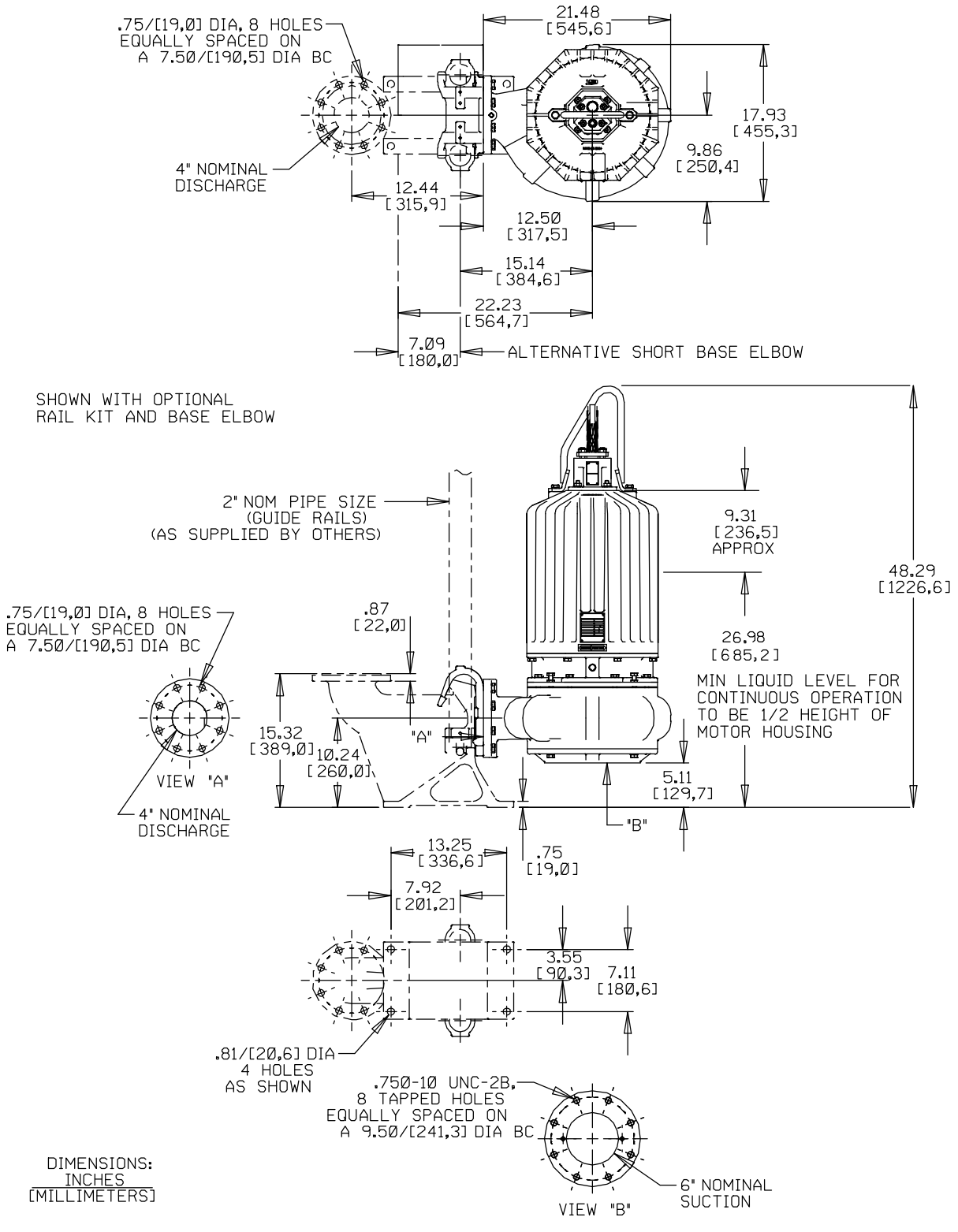
GORMAN-RUPP PUMPS

www.grpumps.com

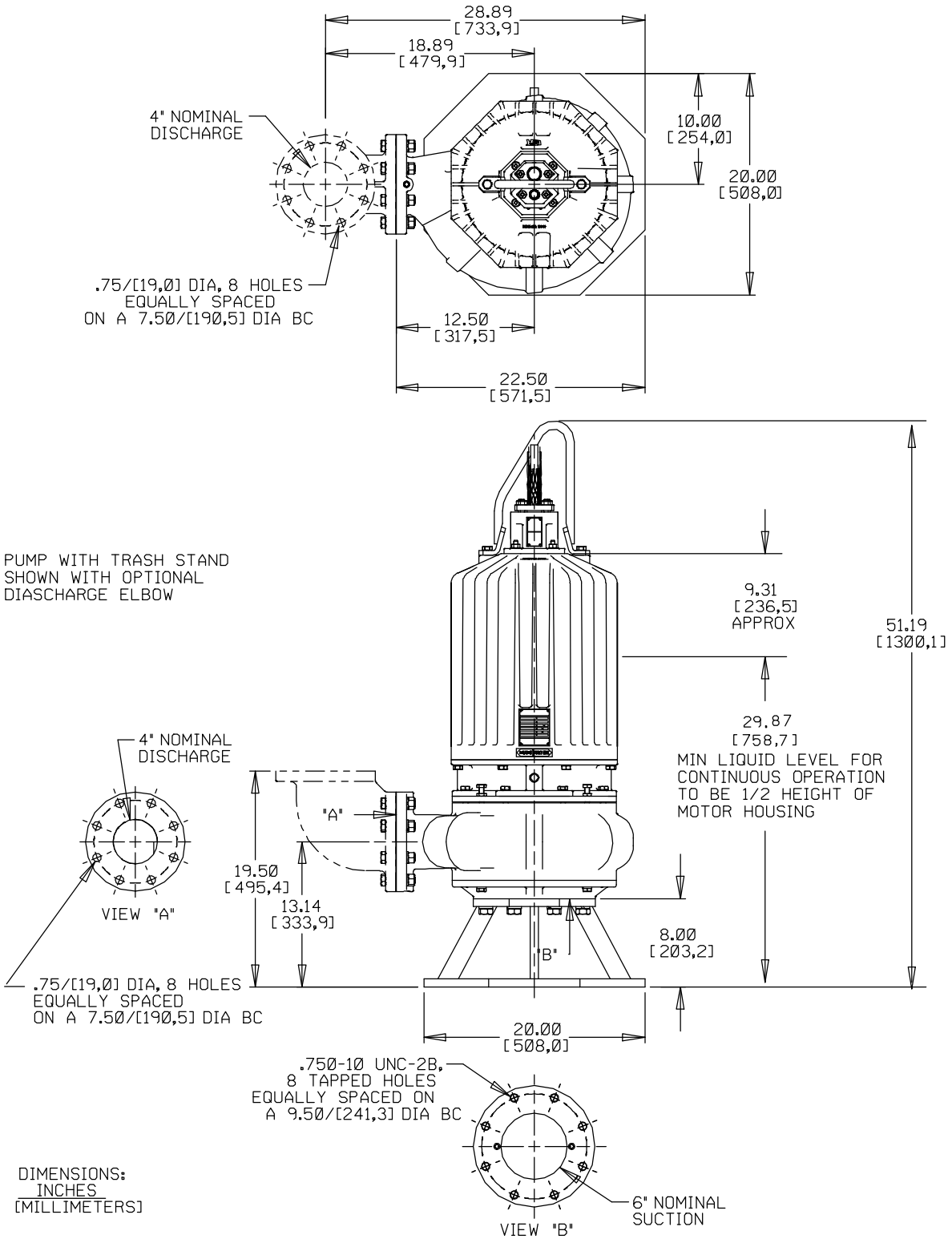
Specifications Subject to Change Without Notice

Printed in U.S.A.

Specification Data	MODELS SF4A/SF4A-X SLIDE RAIL VERSION APPROXIMATE DIMENSIONS and WEIGHTS			
SECTION 133, PAGE 200.2		**NET WT:** (pump only)	**647 LBS.**	**[293,5 KG.]**
		(comb. cable wt. per meter [3.2 ft.])	**3.7 LBS.**	**[1,7 KG.]**
		SHIPPING WT: (pump only)	**677 LBS.**	**[307,1 KG.]**
		CRATE SIZE:	**15.6 CU. FT.**	**[0,44 CU. M.]**



Specification Data	MODELS SF4A/SF4A-X TRASH VERSION APPROXIMATE DIMENSIONS and WEIGHTS			
SECTION 133, PAGE 200.3		**NET WT:** (pump only)	**670 LBS.**	**[303,9 KG.]**
		(comb. cable wt. per meter [3.2 ft.])	**3.7 LBS.**	**[1,7 KG.]**
		SHIPPING WT: (pump only)	**700 LBS.**	**[317,5 KG.]**
		CRATE SIZE:	**17.5 CU. FT.**	**[0,50 CU. M.]**



PERFORMANCE CURVE

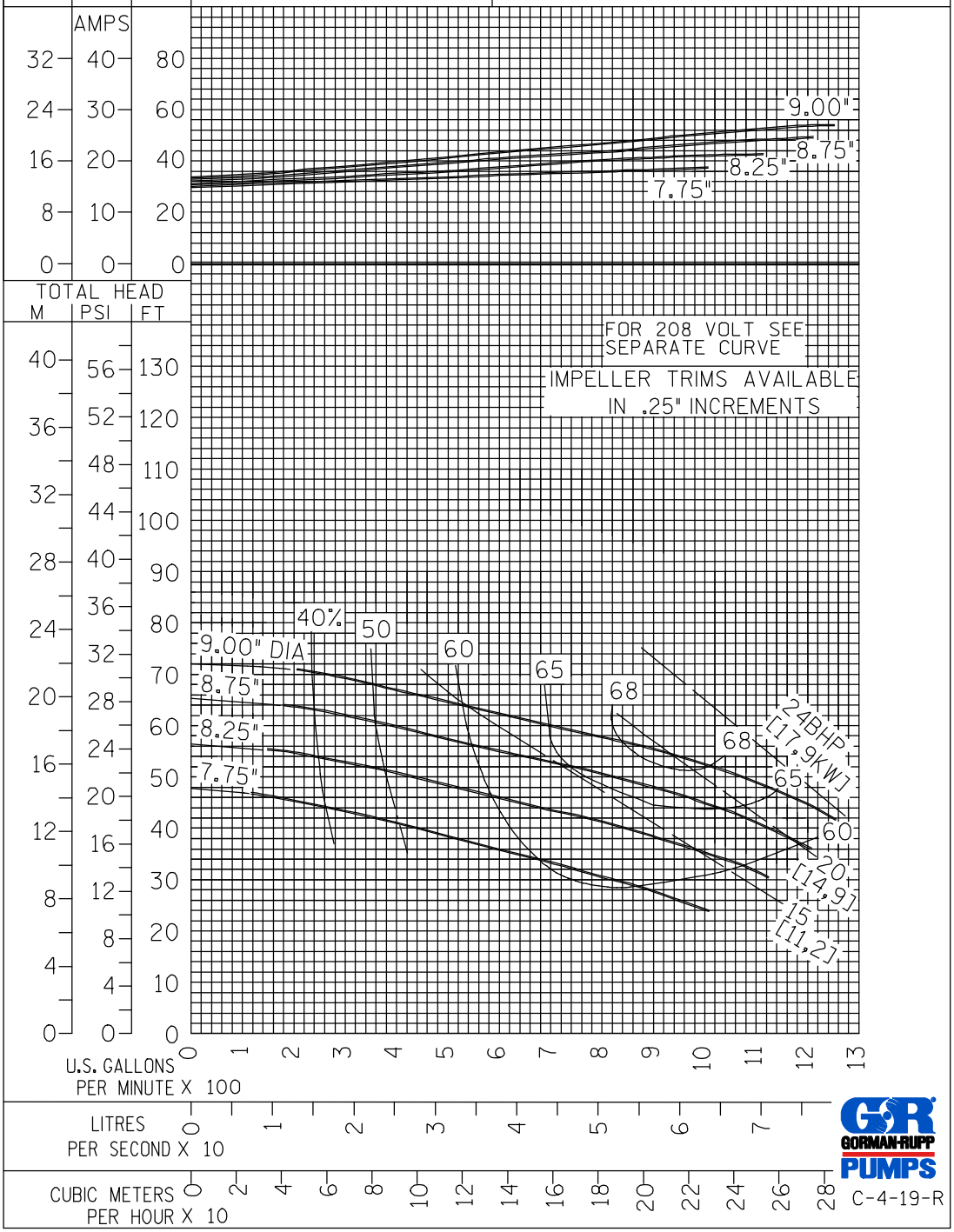
HYDRAULIC EFFICIENCY SHOWN

3.00" DIA. SPHERICAL SOLIDS

CURVE SF4A-1 MODEL SF4A SF4A-X

SIZE 4" IMP. DIA. NOTED

SP.GR. 1.0 RPM 1750



C-4-19-R

PERFORMANCE CURVE

HYDRAULIC
EFFICIENCY SHOWN

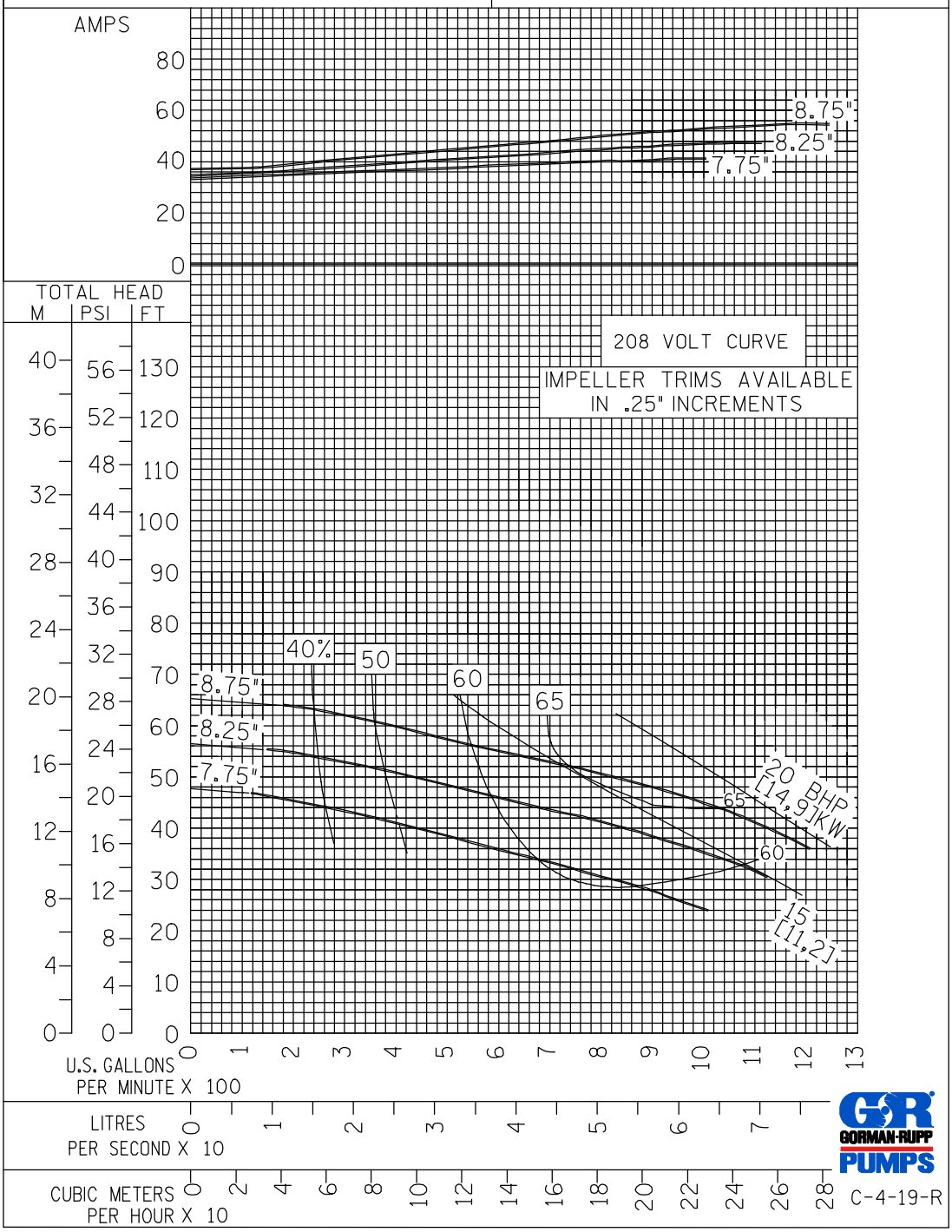
208 VOLT CURVE

3.00" DIA. SPHERICAL SOLIDS

CURVE SF4A-2 MODEL SF4A SF4A-X

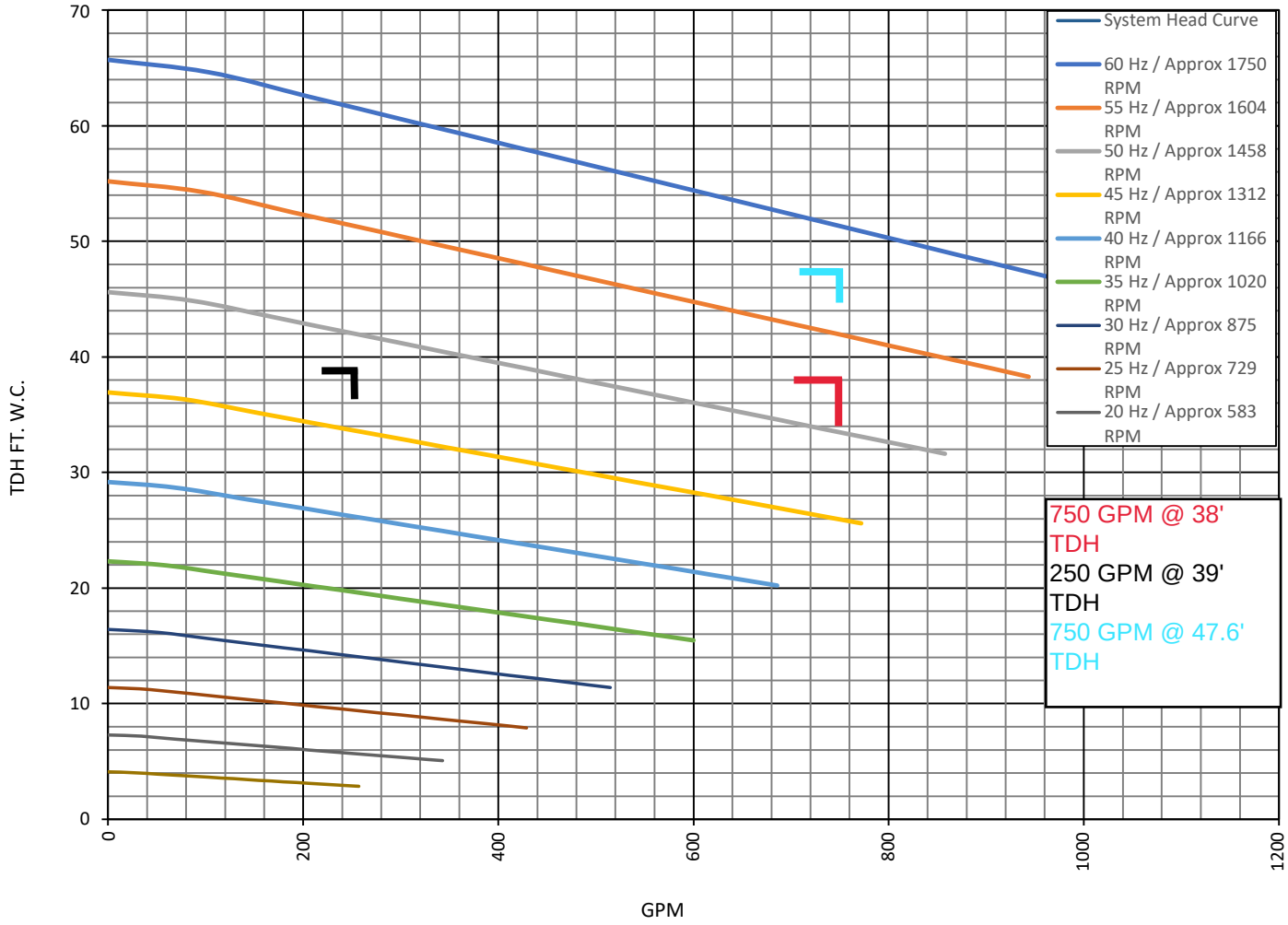
SIZE 4" IMP. DIA. NOTED

SP.GR. 1.0 RPM 1750



C-4-19-R

VOLUTE	_____	CURVE	__SF4A_____
IMPELLER	_____	MODEL	_____
SIZE	_____	IMP. DIA.	___8.75____
SP.GR.	1.0	RPM	NOTED



Pump Data Sheet - Crane Barnes.60

Company: Blake
Name: KWD Upgrade
Date: 02/08/2024

1) Maximum flow to recycle, no discharge - 750 GPM
2) Maximum flow to discharge, no recycle - 250 GPM
3) Max flow to discharge & 500 gpm to Recycle -750 GPM

Pump:

Size:	4ESHDG / 4XESHDG	Dimensions:	
Type:	envie ESH 4" SolidsHan	Suction:	4 in
Synch Speed:	1800 rpm	Discharge:	4 in
Dia:	215 mm		
Curve:	---		

Fluid:

Name:	Water		
SG:	1	Vapor Pressure:	0.256 psi a
Density:	62.4 lb/ft³	Atm Pressure:	14.7 psi a
Viscosity:	1.1 cP		
Temperature:	60 °F	Margin Ratio:	1

Search Criteria:

Flow:	750 US gpm	Near Miss:	---
Head:	48 ft	Static Head:	0 ft

Pump Limits:

Temperature:	104 °F	Sphere Size:	3 in
Wkg Pressure:	---		

Motor:

Standard:	NEMA	Size:	20 hp
Enclosure:	TEFC	Speed:	1800 rpm
Frame:	256T		
Sizing Criteria:	Max Power on Design Curve		

Pump Selection Warnings:

None

--- Duty Point ---

Flow:	750 US gpm
Head:	48.1 ft
Eff:	66.5%
Power:	13.6 hp
NPSHr:	10.6 ft
Speed:	1740 rpm

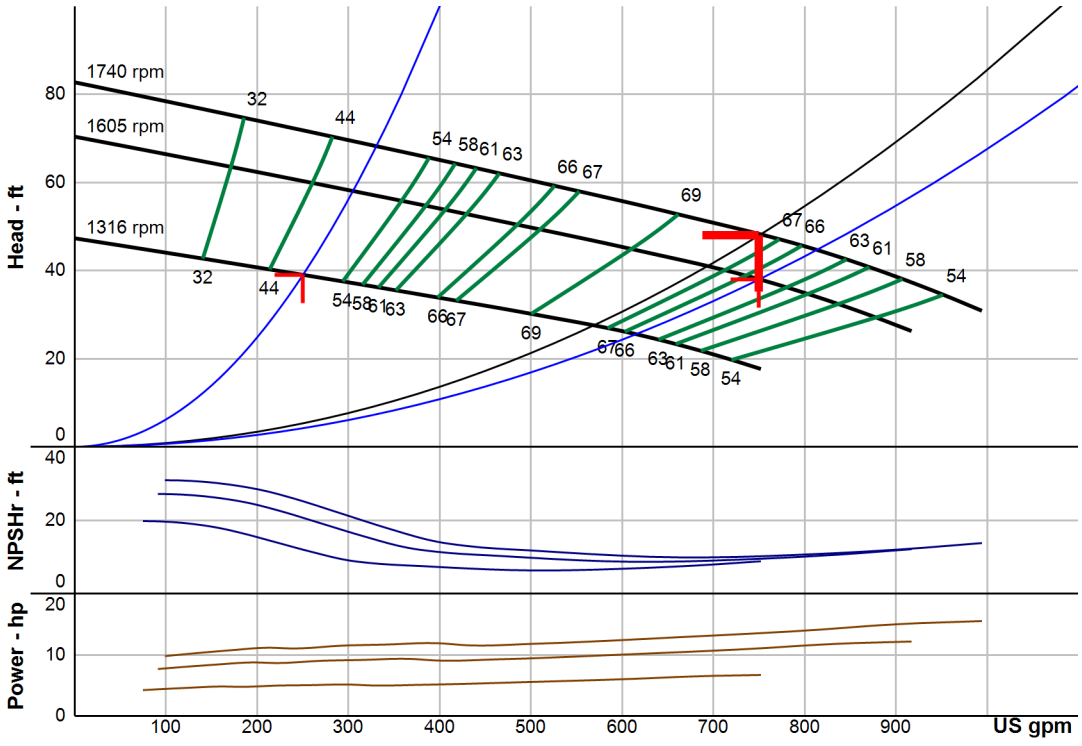
--- Design Curve ---

Shutoff Head:	83.7 ft
Shutoff dP:	36.3 psi
Min Flow:	80 US gpm

BEP: 68.5% @ 665 US gpm
NOL Power:
16 hp @ 991 US gpm

--- Max Curve ---

Max Power:
19.8 hp @ 1000 US gpm



Operating Points:

Data Point	Speed	Flow	Head	NPSHr	Efficiency	Power	Min Flow
	rpm	US gpm	ft	ft	%	hp	US gpm
Primary	1740	750	48.1	10.6	66.5	13.6	80
1	1605	750	38	10.1	65.1	11.1	80
2	1316	250	39	12.2	48.9	5.04	80

*DURA*PULSE GS4 AC Drives – Introduction

*DURA*PULSE GS4 AC Drives																					
Motor Rating	**HP**	**1**	**2**	**3**	**5**	**7.5**	**10**	**15**	**20**	**25**	**30**	**40**	**50**	**60**	**75**	**100**	**125**	**150**	**175**	**215**	**250**	**300**
	kW	**0.75**	**1.5**	**2.2**	**3.7**	**5.5**	**7.5**	**11**	**15**	**18.5**	**22**	**30**	**37**	**45**	**55**	**75**	**90**	**110**	**132**	**160**	**185**	**220**
230V Single-Phase Input / 230V Three-Phase Output		✓	✓	✓	✓	✓	✓	✓	✓	✓												
230V Three-Phase Input/Output		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
460V Three-Phase Input/Output		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Overview

The *DURA*PULSE GS4 series of AC drives includes many of the same standard features as our GS family of drives including dynamic braking, PID, removable keypad, and RS-485 Modbus communication.

The GS4 drive expands the *DURA*PULSE family by adding single-phase input capability (ALL 230VAC drives can be supplied single-phase), a built-in PLC, serial BACnet, and optional EtherNet/IP and ModTCP cards. GS4 QuickStart menus simplify configuration by consolidating the most-often-used parameters into concise groups.

*DURA*PULSE GS4 AC drives also offer sensorless vector control for improved speed regulation. The smart keypad is designed with defaults to quickly allow you to configure the drive, set the speed, start and stop the drive, and monitor critical parameters of your application. In addition, up to four drive configurations can be stored in the keypad, and transferred to additional *DURA*PULSE GS4 drives of the same model. Users can also store up to 32 parameters of their choice in a custom Quick-Start menu.

*DURA*PULSE GS4 offers three analog inputs, two analog outputs, one frequency output, ten digital inputs, two digital outputs, two SPDT relay outputs, and two STO inputs. All of the analog and digital I/O (except the Start/Stop and STO inputs) can be configured for a wide variety of input or output functions. Three option cards expand the I/O offering with a relay output card, an AC input card, and a combo DC I/O card.

Features

- Wide Offering from 1 to 300 hp
- Single-Phase/Three-Phase 230VAC Three-Phase 460VAC
- Single-Phase UL Ratings – 230VAC input for 1 to 100 hp models (see selection tables for derated output)
- Dual Rating Design – CT/VT Ratings (Light & Heavy Duty)
- Flexible Carrier Frequency to 15khz and Output Frequency to 599Hz
- STO – Safe Torque Off (TUV Certified)
- Built-in PLC to support up to 10k steps
- Free downloadable software for Drive Configuration and PLC Programming
- Field-upgradable Firmware via USB port (Drive, Keypad, & Communication Option Cards)
- Hot-Pluggable LCD Text-Based Keypad (IP20/ NEMA 1) can be remotely mounted
- Embedded Quick-Start Menus
- Local/Remote control mode selection from the Keypad or digital/comm input with Hand/ Off/Auto Control
- Display Units of Measure of your choice (GPM, FPM, etc.)
- Momentary Power Loss Restarts
- 100kA Short Circuit Current Rating
- Built-In DC Choke (some models)
- Flange-Mount Capability for frame sizes A to F (1 to 215 hp)
- Conduit Box(s) for NEMA 1 (Frame sizes D0 to G)
- Expanded I/O capability – 110V Inputs, Relay Outputs, combo DC I/O card
- Analog I/O – Configurable 3 Inputs and 2 Outputs
- Auto Speed Search capability
- Multi-Motor (Motor#1,#2) Control
- Dynamic Braking – Optional Dynamic Braking Units and Comprehensive offering of Resistors
- PID Controller – Including Sleep and Wake
- Password Protection
- RTD and/or PTC Input Motor Protection
- Parameter Organization similar to GS3 – GS3 Operational (External User PLC) control will work with minimal changes required.
- Calendar function allows a user to program the PLC with ON/OFF control in chronological order, daylight savings time, etc.
- Modularized design eases maintenance and expansion, including quick replacement of fans
- High speed communication interfaces with MODBUS RTU and BACnet protocols built in, with optional communication cards: MODBUS TCP, EtherNet/IP
- Circuit boards have conformal coating for improved environmental tolerance
- Excellent heat-sink design; able to operate at 50°C ambient temperature
- Fire Mode – Run fire mode during emergencies to have uninterrupted smoke removal and system pressure
- Multi-pump control: fixed quantity, fixed displacement, and fixed time-circulating control; able to control up to 8 pumps (Optional multi-control relay output card is required.)
- Two-year warranty
- CE, TUV, UL, cUL

Accessories

- AC line reactors
- EMI filters
- RF filter
- Braking resistors
- Braking units (for models 20hp and above)
- Fuses
- Conduit boxes
- Flange-Mount Kits
- Replacement cooling fans
- Replacement keypad (and remote-mount bezel kit)
- I/O Option Cards
- EtherNet/IP comm card
- Modbus TCP comm card
- Four and eight-port RS-485 multi-drop termination boards
- GSoft2 drive configuration software
- GSLogic PLC programming software
- USB-485M – USB to RS-485 PC adapter (see "Communications Products" chapter for detailed information)
- Detailed descriptions and specifications for GS accessories are available in the "GS/ DURApulse Accessories" section.

Typical Applications

- Conveyors
- Compressors
- Material handling
- Extruding
- Grinding
- Shop tools
- Fans
- Pumps
- HVAC
- Mixing

DURAPULSE GS4 AC Drives – Selection

Selecting the Proper Drive Rating

Selecting the Proper Drive Rating

Determine Motor Voltage and Full-Load Amperage (FLA)

Motor voltage and FLA are located on the nameplate of the motor.
NOTE: FLA of motors that have been rewound may be higher than stated.

Determine Motor Overload Requirements

Many applications experience temporary overload conditions due to starting requirements or impact loading. Most AC drives are designed to operate at 150% overload for 60 seconds. If the application requires an overload greater than 150% or longer than 60 seconds, the AC drive must be oversized.
NOTE: Applications that require replacement of existing motor starters with AC drives may require up to 600% overload.

Determine Application Type: Constant Torque or Variable Torque

This torque requirement has a direct effect on which drive to select. Variable Torque applications are generally easier to start; typically fans and pumps. Most other applications outside fans and pumps fall into the Constant Torque category (machine control, conveyors, etc.). If you are unsure of the application, assume Constant Torque. The specification, derating, and selection tables (begining pg.tGSX-83) are generally segregated by Constant Torque and Variable Torque.

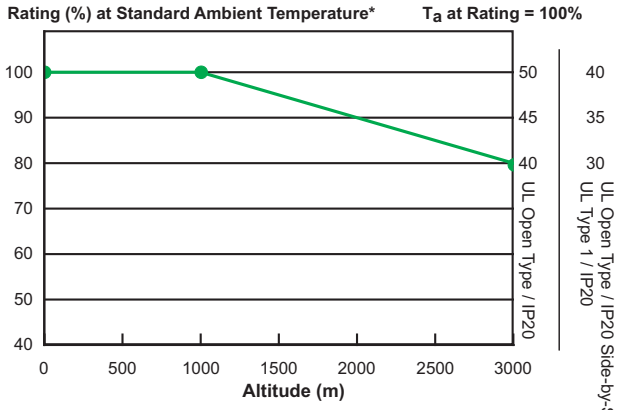
Installation Altitude

AC drives rely on air flow for cooling. As the altitude increases, the air becomes less dense, and this drop in air density decreases the cooling properties of the air. Therefore, the AC drive must be oversized to compensate for the decrease in cooling. GS4 drives are designed to operate at 100% capacity at altitudes up to 1000 meters.
NOTE: For use above 1000m, the AC drive must be derated as described below.

Derate Output Current Based on Altitude Above 1000 Meters

- If the AC drive is installed at an altitude of 0–1000m, follow normal operation restrictions.
- If installed at an altitude of 1000–3000m, decrease 1% of the rated current or lower 0.5°C of temperature for every 100m increase in altitude.
- Maximum altitude for Corner Grounded is 2000m.

GS4 Derating for Altitude



*Standard Ambient Temperature = 50°C for UL Open Type / IP20
*Standard Ambient Temperature =
40°C for UL Type 1 / IP 20 & UL Open Type / IP20 Side-by-Side

(continued next page)

DURAPULSE GS4 AC Drives – Selection

Selecting the Proper Drive Rating (continued from previous page)

Determine Maximum Enclosure Internal Temperature

AC drives generate a significant amount of heat and can cause the internal temperature of an enclosure to exceed the rating of the GS4 drive, even when the ambient temperature is less than 104°F (40°C). Enclosure ventilation and/or cooling may be required to reduce maximum internal temperature to 104°F (40°C) or less. Ambient temperature measurements/calculations should be made for the maximum expected temperature. When permissible, flange mounting the AC drive (mounting with the drive heatsink in open ambient air) can greatly reduce heating in the enclosure.

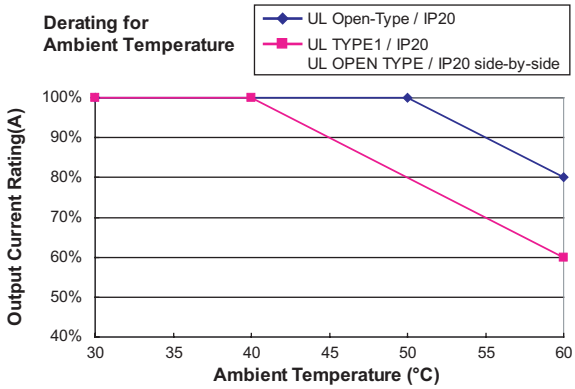
NOTE: For use above 104°F (40°C), the AC drive must be derated as described below.

Derate Output Current Based on Temperature Above 104°F (40°C) or 122°F (50°C)

Drive Derating by Temperature and Protection Level

Protection Level *	***Derating***
UL Type I / IP20	When the GS4 drive is operating at rated current, the ambient temperature has to be between -10°C and +40°C. When ambient temperature exceeds 40°C, decrease the rated current by 2% for every 1°C temperature increase. Maximum allowable temperature is 60°C.
UL Open Type ** / IP00/IP20	When the GS4 drive is operating at rated current, the ambient temperature has to be between -10°C and +50°C. When ambient temperature exceeds 50°C, decrease the rated current by 2% for every 1°C temperature increase. Maximum allowable temperature is 60°C.

** For more information about environmental ratings, refer to the "Operating Temperature and Protection Level" table (pg.tGSX-100).*
*** Open Type temperature ratings apply to GS4 frame sizes A–C with top covers removed, and frame sizes D0–G without conduit boxes (pg.tGSX-100).*



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DURAPULSE GS4 AC Drives – Selection

Selecting the Proper Drive Rating (continued from previous page)

Derate Output Current Based on Carrier Frequency (if necessary)

Carrier Frequency Effects

AC Drives rectify the incoming 50 or 60Hz line power resulting in DC power at 0Hz. The resulting DC power is then pulse-width modulated and supplied to the motor by the drive's power electronics. IGBTs invert the DC power, simulating a sine wave at the desired frequency (that's what allows variable speed in AC induction motors). The speed at which the IGBTs are turned ON and OFF is called Carrier Frequency. In GS4 drives, the Carrier Frequency can range from 2kHz to 15kHz. Though Carrier Frequency can be adjusted, there are trade-offs between High Carrier Frequencies and Low Carrier Frequencies.

Benefits of Higher Carrier Frequencies:

- Better efficiency (lower harmonic losses) in the motor
- Lower audible noise

Benefits of Lower Carrier Frequencies:

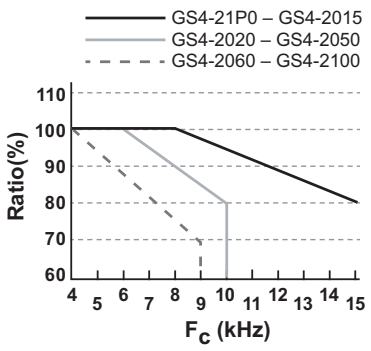
- Better efficiency in the drive
- Lower EMI (electrical noise)
- Reduced reflective wave peak voltage

As a general rule, the Carrier Frequency should be set as low as possible without creating unacceptable audible noise in the motor. Smaller systems can have higher Carrier Frequencies, but larger drives (>20 or 30hp) should not have Carrier Frequencies set higher than 6kHz. Heavy Duty applications typically run around 2–4 kHz.

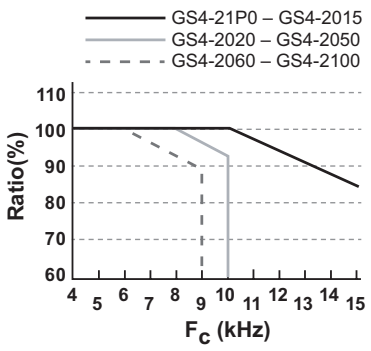
The following Variable Torque (VT) and Constant Torque (CT) derating curves are for drives with 3-phase input power. The 230VAC, CT curves also apply equally whether the drive is supplied with 3-phase or 1-phase input power.

230V Variable Torque Carrier Frequency Derating

For 230V Variable Torque
50°C UL Open Type
40°C UL Type 1 or Open Type side-by-side

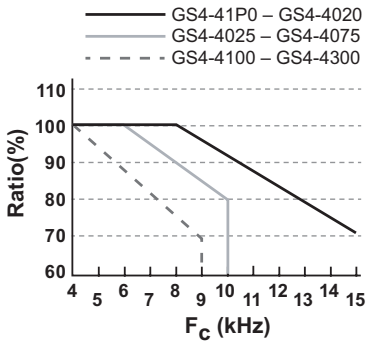


For 230V Variable Torque
40°C UL Open Type
30°C UL Type 1 or Open Type side-by-side

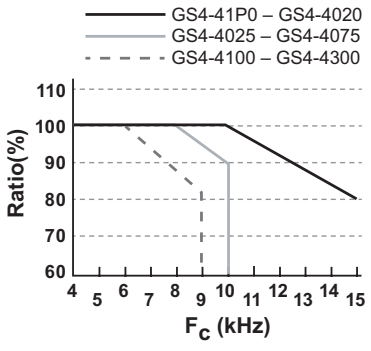


460V Variable Torque Carrier Frequency Derating

For 460V Variable Torque
50°C UL Open Type
40°C UL Type 1 or Open Type side-by-side



For 460V Variable Torque
40°C UL Open Type
30°C UL Type 1 or Open Type side-by-side



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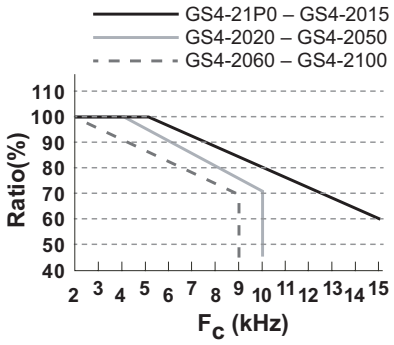
DURAPULSE GS4 AC Drives – Selection

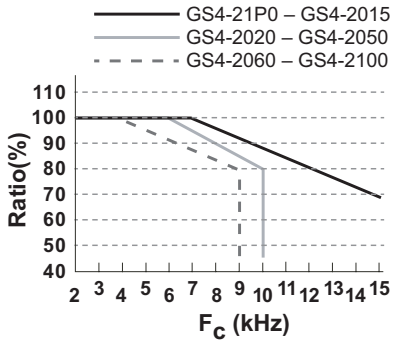
Selecting the Proper Drive Rating (continued from previous page)

230V Constant Torque Carrier Frequency Derating

For 230V Constant Torque
50°C UL Open Type
40°C UL Type 1 or Open Type side-by-side

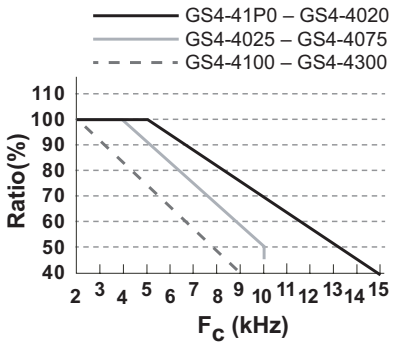


For 230V Constant Torque
40°C UL Open Type
30°C UL Type 1 or Open Type side-by-side

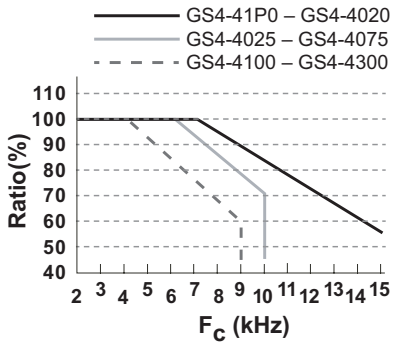


460V Constant Torque Carrier Frequency Derating

For 460V Constant Torque
50°C UL Open Type
40°C UL Type 1 or Open Type side-by-side



For 460V Constant Torque
40°C UL Open Type
30°C UL Type 1 or Open Type side-by-side



DURAPULSE GS4 AC Drives – Selection Specs

GS4 Drive Model Selection Tables

230V Class GS4 Specifications – Constant & Variable Torque Frame Sizes A, B (1hp–15hp)											
Model Name				GS4-21P0	GS4-22P0	GS4-23P0	GS4-25P0	GS4-27P5	GS4-2010	GS4-2015
Price				$525.00	$578.00	$653.00	$739.00	$835.00	$932.00	$1,125.00
Frame Size				A				B		
Output Rating	**Constant Torque (CT)**	**Max Motor Output (1-phase / 3-phase)**	**hp**	0.5 / 1	0.75 / 2	1 / 3	2 / 5	3 / 7.5	3 / 10	5 / 15
			kW	0.37 / 0.75	0.55 / 1.5	0.75 / 2.2	1.5 / 3.7	2.2 / 5.5	2.2 / 7.5	3.7 / 11
		Rated Output Capacity (1-phase / 3-phase)	**kVA**	1.0 / 1.9	1.3 / 2.8	2.0 / 4.0	3.2 / 6.4	4.4 / 9.6	4.4 / 12	6.8 / 19
		Rated Output Current (1-phase / 3-phase)	**A**	2.4 / 4.8	3.2 / 7.1	5 / 10	8 / 16	11 / 24	11 / 31	17 / 47
		Carrier Frequency	**kHz**	2 to 6						
	Variable Torque (VT)	**Max Motor Output**	**hp**	1	2	3	5	7.5	10	15
			kW	0.75	1.5	2.2	3.7	5.5	7.5	11
		Rated Output Capacity	**kVA**	2.0	3.2	4.4	6.8	10	13	20
		Rated Output Current	**A**	5	8	11	17	25	33	49
		Carrier Frequency	**kHz**	2 to 15						
Input Rating *	**CT**	**Rated Input Current * (1-phase / 3-phase)**	**A**	6.4 / 6.1	9.7 / 11	15 / 15	20 / 18.5	26 / 26	26 / 34	40 / 50
	VT			6.4	12	16	20	28	36	52
	Rated Voltage/Frequency			1-phase/3-phase 200–240 VAC (-15% to +10%), 50/60Hz						
	Operating Voltage Range			170–265 VAC						
	Frequency Tolerance			47–63 Hz						
	Short Circuit Withstand (SCCR) (A, rms symmetrical)			100kA						
IE2 Efficiency - Relative Power Loss				3.1%	2.8%	2.5%	2.1%	2.3%	2.1%	2.2%
Weight (kg [lb])				2.6 [5.7]				5.4 [11.9]		
**Watt Loss @ 100% I (W) ** **				61	88	115	159	264	335	529
Cooling Method				natural convection	fan					
Dynamic Braking				built in						
DC Choke				optional						
EMI Filter				optional						

** For Use With Three-Phase Motors Only. If 3-phase power source is non-symmetrical, refer to "Circuit Connections – RFI Jumper" in the GS4 AC Drives User Manual, Chapter 2 (www.automationdirect.com). Please refer to "GS4 DURApulse Accessories – Fusing" (pg.tGSX-161) for input fusing information.*

*** Watt loss is reduced if the GS4 drive is flange mounted (frame sizes A through F).*

DURAPULSE GS4 AC Drives – Selection Specifications

230V Class GS4 Specifications – Constant & Variable Torque Frame Sizes C–E (7.5 hp–100hp)											
Model Name				GS4-2020	GS4-2025	GS4-2030	GS4-2040	GS4-2050	GS4-2060	GS4-2075	GS4-2100
Price				$1,586.00	$1,723.00	$1,953.00	$3,449.00	$3,961.00	$5,282.00	$5,932.00	$6,913.00
Frame Size				C			D		E		
Output Rating	Constant Torque (CT)	Max Motor Output (1-phase / 3-phase)	hp	7.5/20	10/25	10/30	10/40	10/50	15/60	20/75	25/100
			kW	5.5/15	7.5/18.5	7.5/22	7.5/30	7.5/37	11/45	15/55	18.5/75
		Rated Output Capacity (1-phase / 3-phase)	kVA	10/25	13/28	13/34	13/45	13/55	20/68	26/81	30/96
		Rated Output Current (1-phase / 3-phase)	A	25/62	33/71	33/86	33/114	33/139	49/171	65/204	75/242
		Carrier Frequency	kHz	2 to 6							
	Variable Torque (VT)	Max Motor Output	hp	20	25	30	40	50	60	75	100
			kW	15	18.5	22	30	37	45	55	75
		Rated Output Capacity	kVA	26	30	36	48	58	72	86	102
		Rated Output Current	A	65	75	90	120	146	180	215	255
		Carrier Frequency	kHz	2 to 10			2 to 6				
Input Rating *	CT	Rated Input Current * (1-phase / 3-phase)	A	58/68	76/78	76/95	63/118	63/136	94/162	124/196	143/233
	VT			72	83	99	124	143	171	206	245
	Rated Voltage/Frequency			1-phase/3-phase 200–240 VAC (-15% to +10%), 50/60Hz							
	Operating Voltage Range			170–265 VAC							
	Frequency Tolerance			47–63 Hz							
	Short Circuit Withstand (SCCR) (A, rms symmetrical)			100kA							
IE2 Efficiency - Relative Power Loss				2.3%	2.4%	2.3%	1.9%	2.1%	1.9%	1.9%	2.7%
Weight (kg [lb])				9.8 [21.6]			38.5 [84.9]		64.8 [143]		
Watt Loss @ 100% I (W) **				616	733	865	1099	1311	1518	1709	2139
Cooling Method				fan							
Dynamic Braking				built in			optional Dynamic Braking Unit (DBU)				
DC Choke				optional			built in				
EMI Filter				optional							

** For Use With Three-Phase Motors Only. If 3-phase power source is non-symmetrical, refer to "Circuit Connections – RFI Jumper" in the GS4 AC Drives User Manual, Chapter 2 (www.automationdirect.com). Please refer to "GS4 DURApulse Accessories – Fusing" (pg.tGSX-161) for input fusing information.*

*** Watt loss is reduced if the GS4 drive is flange mounted (frame sizes A through F).*

DURApulse GS4 AC Drives – Selection Specifications

460V Class GS4 Specifications – Constant & Variable Torque Frame Sizes A, B (1hp–20hp)										
Model Name				GS4-41P0	GS4-42P0	GS4-43P0	GS4-45P0	GS4-47P5	GS4-4010	GS4-4015	GS4-4020
Price				$535.00	$578.00	$643.00	$750.00	$835.00	$920.00	$1,095.00	$1,388.00
Frame Size				A					B		
Output Rating	**Constant Torque (CT)**	**Max Motor Output**	**hp**	1	2	3	5	7.5	10	15	20
			kW	0.75	1.5	2.2	3.7	5.5	7.5	11	15
		Rated Output Capacity	**kVA**	2.3	3.0	4.5	6.5	8.8	14	18	24
		Rated Output Current	**A**	2.9	3.8	5.7	8.1	11	17	23	30
		Carrier Frequency	**kHz**	2 to 6							
	Variable Torque (VT)	**Max Motor Output**	**hp**	1	2	3	5	7.5	10	15	20
			kW	0.75	1.5	2.2	3.7	5.5	7.5	11	15
		Rated Output Capacity	**kVA**	2.4	3.2	4.8	7.2	9.6	14	19	25
		Rated Output Current	**A**	3	4	6	9	12	18	24	32
		Carrier Frequency	**kHz**	2 to 15							
Input Rating *	**CT**	**Rated Input Current**	**A**	4.1	5.6	8.3	13	16	19	25	33
	VT			4.3	5.9	8.7	14	17	20	26	35
	Rated Voltage/Frequency			3-phase 380–480 VAC (-15% to +10%), 50/60Hz							
	Operating Voltage Range			323–528 VAC							
	Frequency Tolerance			47–63 Hz							
	Short Circuit Withstand (SCCR) (A, rms symmetrical)			100kA							
IE2 Efficiency - Relative Power Loss				2.6%	2.3%	2.2%	2.0%	1.9%	2.1%	2.0%	1.8%
Weight (kg [lb])				2.6 [5.7]					5.4 [11.9]		
Watt Loss @ 100% I (W) **				59	74	104	141	180	292	380	518
Cooling Method				natural convection		fan					
Dynamic Braking				built in							
DC Choke				optional							
EMI Filter				optional							

** For Use With Three-Phase Motors Only.*
If 3-phase power source is non-symmetrical, refer to "Circuit Connections – RFI Jumper" in the GS4 AC Drives User Manual, Chapter 2 (www.automationdirect.com).
Please refer to "GS4 DURApulse Accessories – Fusing" (pg.tGSX-161) for input fusing information.
*** Watt loss is reduced if the GS4 drive is flange mounted (frame sizes A through F).*

DURApulse GS4 AC Drives – Selection Specifications

460V Class GS4 Specifications – Constant & Variable Torque Frame Sizes C, D0, D (25hp–100hp)										
Model Name				GS4-4025	GS4-4030	GS4-4040	GS4-4050	GS4-4060	GS4-4075	GS4-4100
Price				$1,674.00	$1,914.00	$2,406.00	$2,907.00	$3,400.00	$3,942.00	$5,400.00
Frame Size				C			D0		D	
Output Rating	**Constant Torque (CT)**	**Max Motor Output**	**hp**	25	30	40	50	60	75	100
			kW	18.5	22	30	37	45	55	75
		Rated Output Capacity	**kVA**	29	34	45	55	69	84	114
		Rated Output Current	**A**	36	43	57	69	86	105	143
		Carrier Frequency	**kHz**	2 to 6						
	Variable Torque (VT)	**Max Motor Output**	**hp**	25	30	40	50	60	75	100
			kW	18.5	22	30	37	45	55	75
		Rated Output Capacity	**kVA**	30	36	48	58	73	88	120
		Rated Output Current	**A**	38	45	60	73	91	110	150
		Carrier Frequency	**kHz**	2 to 10						
Input Rating *	**CT**	**Rated Input Current**	**A**	38	45	60	70	96	108	149
	VT			40	47	63	74	101	114	157
	Rated Voltage/Frequency			3-phase 380–480 VAC (-15% to +10%), 50/60Hz						
	Operating Voltage Range			323–528 VAC						
	Frequency Tolerance			47–63 Hz						
	Short Circuit Withstand (SCCR) (A, rms symmetrical)			100kA						
IE2 Efficiency - Relative Power Loss				1.6%	1.6%	1.6%	1.6%	1.6%	1.4%	1.3%
Weight (kg [lb])				9.8 [21.6]			27.0 [59.5]		38.5 [84.9]	
Watt Loss @ 100% I (W) **				507	635	866	993	1147	1413	1742
Cooling Method				fan						
Dynamic Braking				built in			optional Dynamic Braking Unit (DBU)			
DC Choke				optional			built in			
EMI Filter				optional						

** For Use With Three-Phase Motors Only.*
If 3-phase power source is non-symmetrical, refer to "Circuit Connections – RFI Jumper" in the GS4 AC Drives User Manual, Chapter 2 (www.automationdirect.com).
Please refer to "GS4 DURApulse Accessories – Fusing" (pg.tGSX-161) for input fusing information.
*** Watt loss is reduced if the GS4 drive is flange mounted (frame sizes A through F).*

DURAPULSE GS4 AC Drives – Selection Specifications

460V Class GS4 Specifications – Constant & Variable Torque Frame Sizes E, F, G (125hp–300hp)										
Model Name				GS4-4125	GS4-4150	GS4-4175	GS4-4200	GS4-4250	GS4-4300
Price				$7,389.00	$8,315.00	$9,902.00	$11,338.00	$15,529.00	$18,129.00
Frame Size				E		F		G	
Output Rating	Constant Torque (CT)	Max Motor Output	hp	125	150	175	215	250	300
			kW	90	110	132	160	185	220
		Rated Output Capacity	kVA	136	167	197	235	280	348
		Rated Output Current	A	171	209	247	295	352	437
		Carrier Frequency	kHz	2 to 6					
	Variable Torque (VT)	Max Motor Output	hp	125	150	175	215	250	300
			kW	90	110	132	160	185	220
		Rated Output Capacity	kVA	143	175	207	247	295	367
		Rated Output Current	A	180	220	260	310	370	460
		Carrier Frequency	kHz	2 to 9					
Input Rating *	CT	Rated Input Current	A	159	197	228	285	361	380
	VT			167	207	240	300	380	400
	Rated Voltage/Frequency			3-phase 380–480 VAC (-15% to +10%), 50/60Hz					
	Operating Voltage Range			323–528 VAC					
	Frequency Tolerance			47–63 Hz					
	Short Circuit Withstand (SCCR) (A, rms symmetrical)			100kA					
IE2 Efficiency - Relative Power Loss				1.2%	1.2%	1.3%	1.3%	1.4%	1.5%
Weight (kg [lb])				64.8 [143]		86.5 [191]		134 [295]	
Watt Loss @ 100% I (W) ****				2092	2599	3081	3783	4589	5772
Cooling Method				fan					
Dynamic Braking				optional					
DC Choke				built in					
EMI Filter				optional					

** For Use With Three-Phase Motors Only.*
If 3-phase power source is non-symmetrical, refer to "Circuit Connections – RFI Jumper" in the GS4 AC Drives User Manual, Chapter 2 (www.automationdirect.com).
Please refer to "GS4 DURApulse Accessories – Fusing" (pg.tGSX-161) for input fusing information.
*** Watt loss is reduced if the GS4 drive is flange mounted (frame sizes A through F; frame G is not capable of flange mounting).*

DURAPULSE GS4 AC Drives – General Specifications

GS4 General Specifications (Applicable to All Models)		
Control Characteristics	Control Method	1: V/F (V/Hz control); 2: SVC (sensorless vector control)
	Starting Torque	Up to 120% Variable Torque (VT) or 150% Constant Torque (CT) for one minute
	V/F Curve	4 point adjustable V/Hz curve and square curve
	Speed Response Ability	5Hz
	Torque Limit	VT: 170% output current CT: 180% output current
	Torque Accuracy	±5%
	Max Output Frequency (Hz)	230V series: 599.00 Hz (75hp & above: 400.00 Hz) 460V series: 599.00 Hz (125hp & above: 400.00 Hz)
	Output Frequency Accuracy	Digital command: ±0.01%, -10°C to +40°C Analog command: ±0.1%, 25±10°C
	Output Frequency Resolution	Digital command: 0.01Hz Analog command: (0.03) x (max output frequency) / 60Hz [±11 bit]
	Overload Tolerance	VT duty: rated output current is 120% for 60 seconds CT duty: rated output current is 150% for 60 seconds
	Frequency Setting Signal	+10V to -10V, 0 to 10V, 4–20mA, 0–20mA
	Accel/Decel Time	0.00–600.00 / 0.0–6000.0 seconds
	Main Control Function	Fault restart; Parameter copy; Dwell; BACnet communication; Momentary power loss ride-through; Speed search; Over-torque detection; Torque limit; 16-step speed (max); Accel/Decel time switch; S-curve accel/decel; 3-wire sequence; Auto-Tuning (rotational, stationary); Frequency upper/lower limit settings; Cooling fan on/off switch; Slip compensation; Torque compensation; JOG frequency; MODBUS communication (RS-485 RJ45, max 115.2 kbps); DC injection braking at start/stop; Smart stall; PID control (with sleep function); Energy saving control; Optional ModbusTCP or EtherNet/IP communication/control
	Fan Control	230V model GS4-2020 and above: PMW control 230V model GS4-2015 and below: ON/OFF switch control 460V model GS4-4025 and above: PMW control 460V model GS4-4020 and below: ON/OFF switch control
Protection Characteristics	Motor Protection	Electronic thermal relay protection
	Over-current Protection	For drive model 230V and 460V: Over-current protection for 240% rated current Current clamp: VT duty 170–175%; CT duty 180–185%
	Over-voltage Protection	230V: drive will stop when DC-BUS voltage exceeds 410V 460V: drive will stop when DC-BUS voltage exceeds 820V
	Over-temperature Protection	Built-in temperature sensor
	Stall Prevention	Independent stall prevention during acceleration, deceleration, and running
	Restart After Instantaneous Power Failure	Up to 20 seconds (parameter settable)
	Ground Leakage Current Protection	Leakage current is higher than 50% of rated current of the AC motor drive
	Hi-Pot Test	UL508C; EN 61800-5-1
	Conformal Coating	IEC-60721-3-3
Agency Approvals		CE, Reach, RoHS, TUV, cULus; (Accessories are CE; Agency approvals other than CE do not apply to accessory conduit box kits, fan kits, flange mount kits, and braking resistors.) *To obtain the most current agency approval information, see the Agency Approval Checklist section on the specific part number's web page.*

DURAPULSE GS4 AC Drives – Optional GS4-Specific Internal Accessories List

Accessories Available for GS4 AC Drives Only

GS4 AC Drives Software and Accessories Internal or Attached to GS4 Drive

Model Number	Frame Size	GS4 Drive Software	GS4 PLC Software	Drive Keypad*	Keypad Mounting Bezel	I/O Modules	Communication Modules	Conduit Boxes	Cooling Fans*	Flange Mount Kits
		pg.tGSX-93	pg.tGSX-94	pg.tGSX-95	pg.tGSX-95	pg.tGSX-91	pg.tGSX-92	pg.tGSX-98	230V pg.tGSX-96 460V pg.tGSX-97	pg.tGSX-99
GS4-21P0	A	GSOFT2	GSLOGIC	GS4-KPD	GS4-BZL	GS4-06CDD GS4-06NA GS4-06TR	GS4-CM-ENETIP GS4-CM-MODTCP	n/a	n/a	GS4-FMKIT-A
GS4-22P0									GS4-FAN-AM	GS4-FMKIT-1
GS4-23P0										
GS4-25P0										GS4-FMKIT-A
GS4-27P5	B							n/a	GS4-FAN-BM1 GS4-FAN-BB	GS4-FMKIT-B
GS4-2010									GS4-FAN-BM2 GS4-FAN-BB	
GS4-2015										
GS4-2020	C							n/a	GS4-FAN-CM GS4-FAN-CB1	GS4-FMKIT-C
GS4-2025										
GS4-2030										
GS4-2040	D**							GS4-CBX-D	GS4-FAN-DM GS4-FAN-DB	n/a
GS4-2050										
GS4-2060	E**							GS4-CBX-E	GS4-FAN-EM1 GS4-FAN-EB	n/a
GS4-2075										
GS4-2100									GS4-FAN-EM2 GS4-FAN-EB	
GS4-41P0	A							n/a	n/a	GS4-FMKIT-A
GS4-42P0									GS4-FAN-AM	GS4-FMKIT-1
GS4-43P0										
GS4-45P0										GS4-FMKIT-A
GS4-47P5										
GS4-4010	B							n/a	GS4-FAN-BM1 GS4-FAN-BB	GS4-FMKIT-B
GS4-4015									GS4-FAN-BM2 GS4-FAN-BB	
GS4-4020										
GS4-4025	C							n/a	GS4-FAN-CM GS4-FAN-CB2	GS4-FMKIT-C
GS4-4030										
GS4-4040										
GS4-4050	D0**							GS4-CBX-D0	GS4-FAN-D0M GS4-FAN-DB	n/a
GS4-4060										
GS4-4075	D**							GS4-CBX-D	GS4-FAN-DM GS4-FAN-DB	n/a
GS4-4100										
GS4-4125	E**							GS4-CBX-E	GS4-FAN-EM2 GS4-FAN-DB	n/a
GS4-4150										
GS4-4175	F**							GS4-CBX-F	GS4-FAN-FM GS4-FAN-FB	n/a
GS4-4200										
GS4-4250	G							GS4-CBX-G	GS4-FAN-GM	n/a
GS4-4300										

** Keypads and Cooling Fans are pre-installed and included with the GS4 Drives. They are field-replaceable and available for purchase separately as spare or replacement parts.*

*** GS4 drives in D0, D, E and F frames can be flanged mounted and do not require a flange mount kit.*

Note: Refer to the page numbers shown above for more complete information about the accessory products.

DURAPULSE GS4 AC Drives – Optional External Accessories List

Accessories Available for GS4 AC Drives

GS4 AC Drives Accessories External or Remote from GS4 Drive

Model Number	Frame Size	Braking Units		Braking Resistors		Reactors	EMI Filters	Fusing
		Quantity	pg.tGSX-138	Quantity	pg.tGSX-138	pg.tGSX-119	pg.tGSX-154	pg.tGSX-161
GS4-21P0	A	n/a		1	GS-BR-080W200	Refer to Reactors Specification pages due to multiple factors of variability	KMF325A	Refer to Fusing Specification pages due to multiple factors of variability
GS4-22P0				1	GS-BR-200W091			
GS4-23P0				1	GS-BR-300W070			
GS4-25P0				1	GS-BR-400W040			
GS4-27P5	B	n/a		1	GS-BR-1K0W020		KMF370A	
GS4-2010				1	GS-BR-1K0W020			
GS4-2015				1	GS-BR-1K5W013			
GS4-2020	C	n/a		2	GS-BR-1K0W4P3		KMF3100A	
GS4-2025				2	GS-BR-1K0W4P3			
GS4-2030				2	GS-BR-1K5W3P3			
GS4-2040	D	2	GS-1DBU	4	GS-BR-1K0W5P1		MIF3150	
GS4-2050		2	GS-2DBU	4	GS-BR-1K2W3P9			
GS4-2060	E	2	GS-2DBU	4	GS-BR-1K5W3P3		MIF3400B	
GS4-2075		3	GS-2DBU	6	GS-BR-1K2W3P9			
GS4-2100		4	GS-2DBU	8	GS-BR-1K2W3P9			
GS4-41P0	A	n/a		1	GS-BR-080W750		KMF318A	
GS4-42P0				1	GS-BR-200W360			
GS4-43P0				1	GS-BR-300W250			
GS4-45P0				1	GS-BR-400W150			
GS4-47P5				1	GS-BR-1K0W075			
GS4-4010	B	n/a		1	GS-BR-1K0W075		KMF350A	
GS4-4015				1	GS-BR-1K5W043			
GS4-4020				2	GS-BR-1K0W016			
GS4-4025	C	n/a		2	GS-BR-1K0W016		KMF370A	
GS4-4030				2	GS-BR-1K5W013			
GS4-4040				4	GS-BR-1K0W016			
GS4-4050	D0	1	GS-4DBU	4	GS-BR-1K2W015		MIF375	
GS4-4060		1	GS-4DBU	4	GS-BR-1K5W013		MIF3150	
GS4-4075	D	2	GS-3DBU	8	GS-BR-1K0W5P1		MIF3150	
GS4-4100		2	GS-4DBU	8	GS-BR-1K2W015			
GS4-4125	E	2	GS-4DBU	8	GS-BR-1K5W013		MIF3400B	
GS4-4150		1	GS-5DBU	10	GS-BR-1K2W015			
GS4-4175	F	1	GS-6DBU	12	GS-BR-1K5W012		MIF3400B	
GS4-4200		1	GS-6DBU	12	GS-BR-1K5W012			
GS4-4250	G	1	GS-7DBU	14	GS-BR-1K5W012		MIF3800 + (3) TOR254	
GS4-4300		2	GS-5DBU	20	GS-BR-1K2W015			

WARNING: REFER TO THE PAGE NUMBERS SHOWN ABOVE FOR INFORMATION ABOUT THE PRODUCT SPECIFICATIONS AND THE CONDITIONS UNDER WHICH THE PRODUCT SELECTIONS ARE APPLICABLE.

GS4-Specific Optional Accessories – Input/Output Expansion Cards

Accessories Applicable Only to GS4 AC Drives

Please refer to the "GS/DURApulse AC Drives – Accessories " section for accessories applicable to multiple families of GS/DURApulse AC Drives, including GS4.

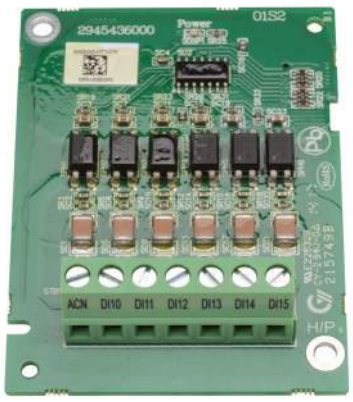
Input/Output Expansion Cards

Optional I/O cards allow additional inputs and outputs to be added to the GS4 internal I/O. (Only one I/O card can be installed at a time.)

GS4 *DURA*PULSE Drives Input/Output Expansion Cards

Part Number	Price	Description	Terminals	Specifications	Wire Size	Placement*	GS Drive
GS4-06CDD*	$33.50	DURAPULSE combination discrete I/O module, selectable sinking or sourcing 24VDC input, 24VDC output, 4-point input, 2-point output, 1 input common(s), 1 output common(s), 50mA resistive output current.	COM	(1) Common for Input Terminals	20~24 AWG	slot #3	GS4 – all
			DI10–DI13	(4) Discrete Inputs; selectable sinking or sourcing Internal power available: 24VDC ±5% 200mA, 5W External power: 24VDC (30V max, 19V min), 30W ON: activation 6.5mA @ ≥ 9VDC OFF: leakage 10μA ≤ 3VDC			
			DO10–DO11	(2) Discrete Outputs (photocoupler) Duty-cycle: 50% Max. output frequency: 100Hz Max. current: 50mA resistive Max. voltage: 48VDC			
			DOC	(1) Common for Output Terminals			
GS4-06NA*	$36.00	DURAPULSE discrete input module, sinking 120VAC input, 6-point input, 1 input common(s).	ACN	(1) AC power common for Input Terminal (Neutral)	20~24 AWG	slot #3	GS4 – all
			DI10–DI15	(6) Discrete Inputs; sinking Input voltage: 100–130 VAC Input frequency: 47–63 Hz Input impedance: 27kΩ Terminal response time: ON: 10ms OFF: 20ms			
GS4-06TR*	$55.00	DURAPULSE relay output module, Form A (SPST-NO) relays, 6-point output, 6 output common(s), 3 Amps resistive output current, 1.2 Amps inductive output current, 250VAC/30VDC input.	R10–R15	(6) separate commons for each relay	20~26 AWG	slot #3	GS4 – all
			RO10–RO15	(6) normally open relay output Resistive load: 5A(NO) / 250VAC 5A(NO) / 30VDC Inductive load (COSØ 0.4) 2A(NO) / 250VAC			

** GS4 AC drives have three option card slots; each slot will hold only one option card designed for that particular slot. I/O cards are designed for slot #3, and will not fit in any other slot.*

GS4-06CDD	GS4-06NA	GS4-06TR
		

GS4-Specific Optional Accessories – Communication Interface Cards

Accessories Applicable Only to GS4 AC Drives

Please refer to the "GS/DURApulse AC Drives – Accessories " section for accessories applicable to multiple families of GS/DURApulse AC Drives, including GS4.

Communication Cards

Communication interface cards provide EtherNet/IP™ or ModbusTCP communication capability. Only one communication card can be installed at a time.

GS4 *DURA*PULSE Drives Communication Interface Cards					
Part Number	**Price**	**Description**	**Specifications**	**Placement***	**GS Drive**
GS4-CM-ENETIP*	$110.00	DURAPULSE communication card, EtherNet/IP	Interface: EtherNet/IP RJ45 with MDI/MDIX auto-detect Number of ports: 1 (16 connections max) Transmission method: IEEE 802.3, IEEE 802.3u Transmission cable: Category 5e shielding 100MHz Transmission speed: 10/100 Mbps Auto-Detect Network protocol: ICMP, IP, TCP, UDP, DHCP, Modbus TCP, EtherNet/IP Power supply voltage: 5VDC (supplied by the GS4 AC drive) Insulation voltage: 500VDC Power consumption: 0.8W Weight: 25g Noise immunity ESD (IEC 61800-5-1, IEC 61000-4-2) EFT (IEC 61800-5-1, IEC 61000-4-4) Surge Test (IEC 61800-5-1, IEC 61000-4-5) Conducted Susceptibility Test (IEC 61800-5-1, IEC 61000-4-6) Operation: -10°C to +50°C [14°F to 122°F] (temperature), 90% (humidity) Storage: -25°C to +70°C [-13°F to +158°F] (temperature), 95% (humidity) Vibration / Shock immunity: IEC 61800-5-1, IEC 60068-2-6/IEC 61800-5-1, IEC 60068-2-27 Ethernet timeout functionality for Ethernet/IP connections GS4-CM-ENETIP supports 4 EtherNet/IP connections and also supports 4 ModTCP connections. These ModTCP connections cannot start/stop or change command frequency in the drive, but can be used to monitor the drive and change Parameters. Ethernet timeout functionality *for ModTCP connections* is *not* supported on the EtherNet/IP card.	slot #1	GS4 – all
GS4-CM-MODTCP*	$97.00	DURAPULSE communication card, ModbusTCP	Interface: Ethernet RJ45 with MDI/MDX auto-detect Number of ports: 1 (4 connections max) Transmission method: IEEE 802.3, IEEE 802.3u Transmission cable: Category 5e shielding 100MHz Transmission speed: 10/100 Mbps Auto-Detect Network protocol: ICMP, IP, TCP, UDP, DHCP, Modbus TCP Power supply voltage: 5VDC (supplied by the GS4 AC drive) Insulation voltage: 500VDC Power consumption: 0.8W Weight: 25g Noise immunity ESD (IEC 61800-5-1, IEC 61000-4-2) EFT (IEC 61800-5-1, IEC 61000-4-4) Surge Test (IEC 61800-5-1, IEC 61000-4-5) Conducted Susceptibility Test (IEC 61800-5-1, IEC 61000-4-6) Operation: -10°C to +50°C [14°F to 122°F] (temperature), 90% (humidity) Storage: -25°C to +70°C [-13°F to +158°F] (temperature), 95% (humidity) Vibration / Shock immunity: IEC 61800-5-1, IEC 60068-2-6/IEC 61800-5-1, IEC 60068-2-27 Ethernet Timeout functionality for ModTCP connections	slot #1	GS4 – all

** GS4 AC drives have three option card slots; each slot will hold only one option card designed for that particular slot. Communication interface cards are designed for slot #1, and will not fit in any other slot.*

GS4-CM-ENETIP	*GS4-CM-MODTCP*
	

GS4/GS10/GS20(X) Accessories – Software
GSoft2 Drive Configuration Software

Optional Accessory Software Applicable Only to AC Drive Series:

- GS4
- GS10
- GS20(X)

GSoft2 Drive Configuration Software – Available for *FREE* Download

GS20(X) *DURA*PULSE Drives GSOFT2 Drive Configuration Software			
Part Number	***Price****	***Description***	***For GS Drive***
GSOFT2	$10.50	Drive Configuration Software for GS4 and GS20(X) AC drives	GS4 – all GS10 – all GS20(X) – all
USB-485M	$60.00	PC adapter, USB A to RS-485 (RJ45/RJ12).	GS4/GS10
USB-CBL-AB3	$12.00	Programming cable, USB A to USB B, 3ft cable length.	GS4 – all (for Drive FW only) GS20(X)
**** GSOFT2 can be downloaded for free or purchased on USB from AutomationDirect.com (search for GSOFT2).***			

GSOFT2 Drive Configuration Software

GSoft2 is the configuration software for the Automation Direct GS4 and GS10/GS20(X) family of drives. It is designed to allow you to connect a personal computer to the drive, and perform a variety of functions.

GSoft2 includes an integral help file with software instructions. GSoft2 can be downloaded for free or purchased on USB from AutomationDirect.com (search for GSoft2).

Functions

- Create new drive configurations
- Upload/download drive configurations
- Edit drive configurations
- Archive/store multiple drive configurations on your PC
- Trend drive operation parameters (not available with GS10)
- Tune the drive PID loop
- View real time key operating parameters
- Start/Stop drive and switch directions, provided drive is set up for remote operation
- View drive faults

Computer System Requirements

GSoft2 will run on PCs that meet the following requirements:

- Windows OS: ***7***: 32 & 64 bit, ***8***: 32 & 64 bit, ***8.1***: 32 & 64 bit, ***10***: 64 bit, 11
- Internet Explorer 9.0 or higher (for HTML help support)
- 32 Mb of available memory
- 10 Mb hard drive space
- Available USB port

GS4/GS20(X) Accessories – Software
GSLogic PLC Programming Software

Optional Accessory Software Applicable Only to AC Drive Series:

- GS4
- GS20(X)

GSLOGIC Drive Configuration Software – Available for *FREE* Download

GS20(X) *DURA*PULSE Drives GSLogic PLC Programming Software

Part Number	Price*	Description	For GS Drive
GSLOGIC	$10.50	Windows PLC Logic Software for GS4 and GS20(X) AC drives	GS4 - all GS20(X) – all
USB-485M	$60.00	PC adapter, USB A to RS-485 (RJ45/RJ12).	GS4
USB-CBL-AB3	$12.00	Programming cable, USB A to USB B, 3ft cable length.	GS20(X)

** GSLOGIC can be downloaded for free or purchased on USB from AutomationDirect.com (search for GSLOGIC).*

PLC Summary

The GS4 and GS20(X) drives include a built-in PLC. Programmed in ladder logic, the PLC provides a comprehensive set of instructions and 2,000 (GS20(X)) or 10,000 (GS4) steps of programming capacity. GSLogic PLC software includes a Help File which contains the detailed information needed to use the PLC.

The PLC functionality is included with every GS4 and GS20(X) drive, and can be accessed over communications by external PLCs (over serial Modbus), or by the drive (using built-in PLC instructions). The PLC is perfectly suited for applications where digital and analog I/O requirements are small. For applications with complex PLC programming or large I/O requirements, please consider Click, Productivity, or Do-More/BRX. All of these PLCs can be easily integrated with the GS drive family or PLC. The GS4-KPD keypad is capable of storing multiple PLC programs.

There are two methods for communicating from the PLC to the drive. The first method is to use the WPR and RPR instructions available in the PLC's library. These two instructions can read from or write to any AC drive parameter in the same physical drive. The second method is to use Modbus RTU. The PLC is a Serial Modbus slave only. A Modbus RTU master can communicate with the PLC via serial only; optional communication cards cannot address the PLC. If communication cards (EtherNet/IP or Modbus TCP) are the desired method of communication, the drive includes PLC Buffers parameters that can be used. Simply write the needed information from the PLC into the drive's PLC buffer parameters using the WPR instruction. The Modbus TCP or EtherNet/IP cards can then read the VFD parameters.

GSLogic Introduction

GSLogic is the drive PLC programming software for the AutomationDirect GS4 and GS20(X) family of drives. It is designed to enable you to perform a variety of drive PLC programming functions. Windows editing functions like cut, copy, paste, multiple windows, etc., are supported. GSLogic also provides for register editing, settings, file reading, saving, online monitoring settings, and other convenience functions, such as:

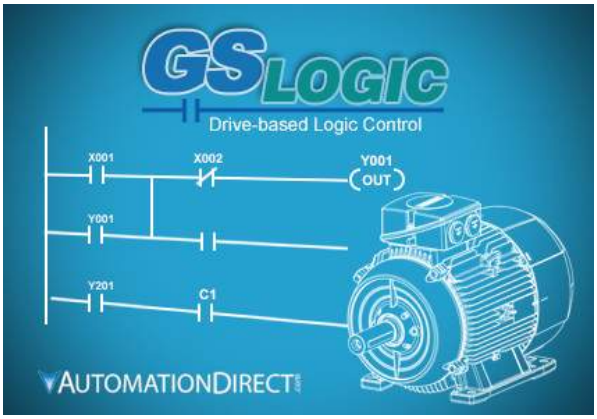
- Upload/download drive PLC program files to the onboard PLC
- Create new drive PLC programs
- Edit drive PLC programs
- Archive/store multiple drive PLC programs on your PC or the GS4-KPD drive keypad
- Control drive PID loops (FPID instructions)
- View in real time all drive PLC registers
- Print drive PLC program files

GSLogic includes an integral help file that includes software instructions, how to use GSLogic, and how to use the GS drive PLC.

GSLogic System Requirements

GSLogic is a Windows-based programming software environment. Please check the following requirements when choosing your PC configuration:

- Windows OS: ***7***: 32 & 64 bit, ***8***: 32 & 64 bit, ***8.1***: 32 & 64 bit, ***10***: 64 bit
- SVGA 1024x768 pixels resolution (1280x1024 pixels resolution recommended)
- 300MB free hard-disk space
- RAM: Windows 7 & higher
  with GUI version 2.0.0.x or higher; RAM = 2GB memory (4GB recommended)
  with GUI version 1.10 or lower; RAM = 512MB free RAM (1GB recommended)
- USB Port required for project transfer to drive
- USB-485M serial adapter required (GS4 only)



GS4/GS10/GS20(X) Optional Accessories – External Keypad Mounting Kit / Spare Keypad

Accessories Applicable Only to GS4, GS10, and GS20(X) AC Drives

Please refer to the "GS/DURApulse AC Drives – Accessories " section for accessories applicable to multiple families of GS/DURApulse AC Drives,

Keypad (Spare/Replacement)

NOTE: The keypad described below is included with the GS4 AC Drive, and is also available for purchase separately as a spare/replacement component for GS4, or an optional upgrade for GS10/GS20(X).

Keypad Panel-Mounting Kit

NOTE: The keypad panel-mounting kit described below is an optional accessory that is NOT included with the GS10/GS20(X) AC drive.

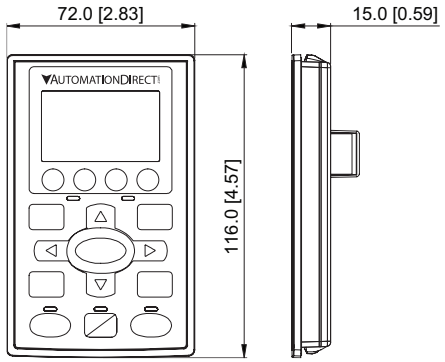
GSx Series *DURA*PULSE Drives Keypad and Keypad Panel-Mounting Kit			
Part Number	***Price***	***Description***	***For GS Drive***
GS4-KPD*	$107.00	Spare or replacement keypad for GS4 AC drives; optional advanced keypad for GS20(X) drives; includes RJ45 connector; great for maintenance or back-up programs.	GS4 – all GS10 – all GS20(X) – all
GS4-BZL*	$29.50	Keypad Panel-Mounting Kit for remote surface mounting or embedded mounting of the AC drive removable keypad; hardware included. Use a standard Cat5e RJ45 patch cable (not included) to connect a remote-mounted keypad to the drive. Max cable length for remote-mounted keypad = 5m.	GS4 – all GS10 – all GS20(X) – all

** A keypad is included with each GS4 AC Drive; additional keypads are available for spare/replacement components.*
*** The keypad mounting kit is an optional accessory that is NOT included with the GS4 AC drive; for mounting the keypad remotely from the drive.*
Note: Keypad firmware can only be upgraded when connected to a GS4 drive.

GS4-KPD

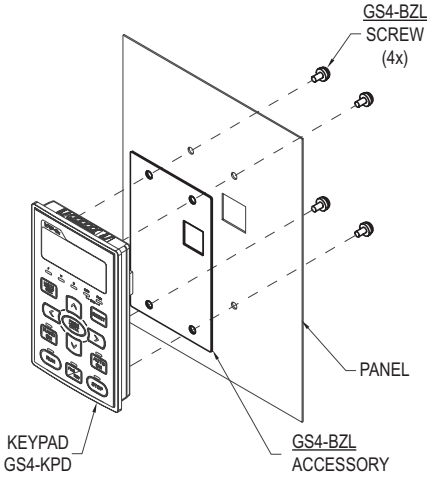
RJ45 Connector

Dimensions (mm [in])

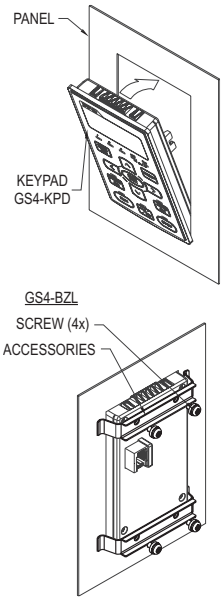


GS4-BZL

Wall Mounting



Embedded Mounting



GS4-Specific Optional Accessories – Spare/Replacement Cooling Fans

Accessories Applicable Only to GS4 AC Drives

Please refer to the "GS/DURApulse AC Drives – Accessories " section for accessories applicable to multiple families of GS/DURApulse AC Drives, including GS4.

Cooling Fans for 230V GS4 Drives (Spare/Replacement)

NOTE: The fans described below are included with the applicable GS4 AC Drive, and are also available for purchase separately as spare/replacement components.

GS4 230V Models – (GS4-2xxx) – Fan Selection Table

Drive Model	Fan Model *			Description	Size	Voltage	Amps / Fan	Fans / Kit
	Part #	Price	Photo					
GS4-22P0 GS4-23P0 GS4-25P0	GS4-FAN-AM	$28.00		Frame A main	40mm	24	0.15	1
GS4-27P5	GS4-FAN-BM1	$34.50		Frame B main	80mm	24	0.33	1
	GS4-FAN-BB	$27.00		Frame B board level	40mm	24	0.18	1
GS4-2010 GS4-2015	GS4-FAN-BM2	$52.00		Frame B main	80mm	24	0.51	1
	GS4-FAN-BB	$27.00		Frame B board level	40mm	24	0.18	1
GS4-2020 GS4-2025 GS4-2030	GS4-FAN-CM	$49.00		Frame C main	92mm	24	0.75	1
	GS4-FAN-CB1	$28.00		Frame C board level	40mm	24	0.18	1
GS4-2040 GS4-2050	GS4-FAN-DM	$174.00		Frame D main	92mm	24	0.75	2
	GS4-FAN-DB	$58.00		Frame D board level	70mm	24	0.33	1
GS4-2060 GS4-2075	GS4-FAN-EM1	$239.00		Frame E main	120mm	24	1.08	2
	GS4-FAN-EB	$119.00		Frame E board level	120mm	24	0.76	1
GS4-2100	GS4-FAN-EM2	$303.00		Frame E main	92mm 120mm 120mm	24	0.75 1.08 1.08	3
	GS4-FAN-EB	$119.00		Frame E board level	120mm	24	0.76	1

** These fans are included with the GS4 drive, and also available separately as spare or replacement components. Electrical connectors are included.*

GS4-Specific Optional Accessories – Spare/Replacement Cooling Fans

Accessories Applicable Only to GS4 AC Drives

Please refer to the "GS/DURApulse AC Drives – Accessories " section for accessories applicable to multiple families of GS/DURApulse AC Drives, including GS4.

Cooling Fans for 460V GS4 Drives (Spare/Replacement)

NOTE: The fans described below are included with the applicable GS4 AC Drive, and are also available for purchase separately as spare/replacement components.

GS4 460V Models – (GS4-4xxx) – Fan Selection Table

Drive Model	Fan Model *			Description	Size	Voltage	Amps / Fan	Fans / Kit
	Part #	Price	Photo					
GS4-43P0 GS4-45P0 GS4-47P5	GS4-FAN-AM	$28.00		Frame A main	40mm	24	0.15	1
GS4-4010	GS4-FAN-BM1	$34.50		Frame B main	80mm	24	0.33	1
	GS4-FAN-BB	$27.00		Frame B board level	40mm	24	0.18	1
GS4-4015 GS4-4020	GS4-FAN-BM2	$52.00		Frame B main	80mm	24	0.51	1
	GS4-FAN-BB	$27.00		Frame B board level	40mm	24	0.18	1
GS4-4025 GS4-4030 GS4-4040	GS4-FAN-CM	$49.00		Frame C main	92mm	24	0.75	1
	GS4-FAN-CB2	$34.50		Frame C board level	40mm	12	0.60	1
GS4-4050 GS4-4060	GS4-FAN-D0M	$98.00		Frame D0 main	80mm	24	0.75	2
	GS4-FAN-DB	$58.00		Frame D board level	70mm	24	0.33	1
GS4-4075 GS4-4100	GS4-FAN-DM	$174.00		Frame D main	92mm	24	0.75	2
	GS4-FAN-DB	$58.00		Frame D board level	70mm	24	0.33	1
GS4-4125 GS4-4150	GS4-FAN-EM2	$303.00		Frame E main	92mm 120mm 120mm	24	0.75 1.08 1.08	3
	GS4-FAN-EB	$119.00		Frame E board level	120mm	24	0.76	1
GS4-4175 GS4-4200	GS4-FAN-FM	$431.00		Frame F main	92mm	24	0.76	4
	GS4-FAN-FB	$126.00		Frame F board level	120mm	24	1.08	1
GS4-4250 GS4-4300	GS4-FAN-GM	$902.00		Frame G main	250mm	48	2.2	2

** These fans are included with the GS4 drive, and also available separately as spare or replacement components. Electrical connectors are included.*

GS4-Specific Optional Accessories – Conduit Boxes

Accessories Applicable Only to GS4 AC Drives

Please refer to the "GS/DURApulse AC Drives – Accessories " section for accessories applicable to multiple families of GS/DURApulse AC Drives, including GS4.

Conduit Boxes

Optional Conduit Box Kits can be ordered separately. These kits bolt onto the bottom of the applicable GS4 drive to provide a convenient connection point for conduit entry, allowing the GS4 to maintain a IP20/NEMA 1 environmental protection rating; especially useful for GS4 drives mounted outside of an electrical control panel.

Note: GS4 Frames A through C have integral conduit box space built into the drive. No separate conduit boxes are necessary or available.

GS4 Frame Sizes D0–G – Conduit Box Selection Table

Drive		Conduit Box **			Description
Model	Frame*	Part #	Price	Photo	
GS4-4060, GS4-4050	D0	GS4-CBX-D0	$163.00		NEMA 1 conduit box kit for use with GS4 frame size DO AC drive; mounting hardware included
GS4-2040, GS4-2050; GS4-4075, GS4-4100	D	GS4-CBX-D	$163.00		NEMA 1 conduit box kit for use with GS4 frame size D AC drive; mounting hardware included
GS4-2060, GS4-2075, GS4-2100; GS4-4125, GS4-4150	E	GS4-CBX-E	$188.00		NEMA 1 conduit box kit for use with GS4 frame size E AC drive; mounting hardware included
GS4-4150, GS4-4200	F	GS4-CBX-F	$271.00		NEMA 1 conduit box kit for use with GS4 frame size F AC drive; mounting hardware included
GS4-4250, GS4-4300	G	GS4-CBX-G	$513.00		NEMA 1 conduit box kit for use with GS4 frame size G AC drive; mounting hardware included

** GS4 Frame Sizes A through C have integral conduit box space built into the drive; separate conduit boxes are not necessary nor available.*
*** Conduit Box Kits include mounting hardware; box base, box cover, bushings, and screws.*
Conduit box dimensions are shown with the AC drive dimensions, as mounted on the drive.

GS4-Specific Optional Accessories – Flange Mounting Kits

Flange Mounting Kits

Optional GS4 drive flange mounting kits allow the heat sinks on the back of select GS4 drives to be positioned through the back of the control enclosure. Since a majority of the heat generated by the GS4 drive will be outside the enclosure, heat load will be reduced and a smaller enclosure may possibly be used. These flange mounting kits are applicable to GS4 drive frame sizes A through C.

NOTE: GS4 Frames D0, D, E, and F have integral flange mounting hardware; additional Flange Mounting Kit not required (see cutout dimensions below). Frame size G cannot be flange-mounted.

GS4 Frame Sizes A–C – Flange Mounting Kit Selection Table

Drive		Flange Mounting Kit **			Description
Model	Frame*	Part #	Price	Photo	
GS4-22P0 GS4-23P0 GS4-43P0	A	GS4-FMKIT-1	$74.00		GS4 series Flange Mounting Kit, NEMA 1; for use with multiple GS4 Frame A drives; adapter plate and mounting hardware included
GS4-21P0 GS4-25P0 GS4-41P0 GS4-42P0 GS4-45P0 GS4-47P5	A	GS4-FMKIT-A	$62.00		GS4 series Flange Mounting Kit, NEMA 1; for use with multiple GS4 Frame A drives; mounting hardware included
GS4-27P5 GS4-2010 GS4-2015 GS4-4010 GS4-4015 GS4-4020	B	GS4-FMKIT-B	$70.00		GS4 series Flange Mounting Kit, NEMA 1; for use with GS4 Frame B drives; mounting hardware included
GS4-2020 GS4-2025 GS4-2030 GS4-4025 GS4-4030 GS4-4040	C	GS4-FMKIT-C	$79.00		GS4 series Flange Mounting Kit, NEMA 1; for use with GS4 Frame C drives; mounting hardware included

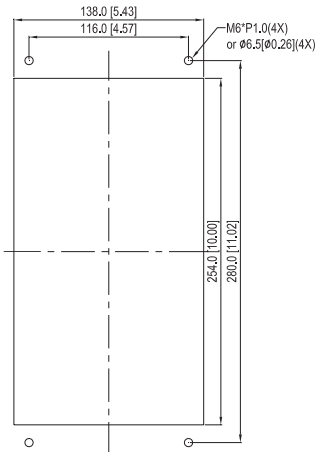
* *See panel cutout dimensions below for GS4 Frames A, B, C.*

* *GS4 Frames D0, D, E, and F have integral flange mounting hardware; additional Flange Mounting Kit not required. See Appendix A of the GS4 User Manual for panel cut-out dimensions for frames D0, E, F.*

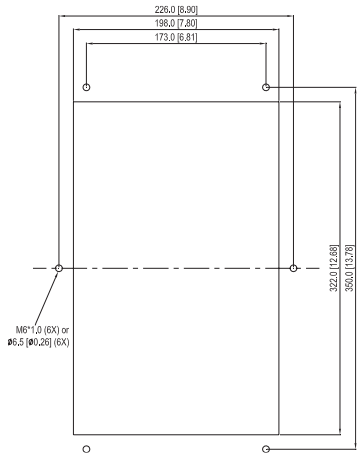
* *Frame size G cannot be flange-mounted.*

GS4 Flange Mounting Kit Cutout Dimensions (mm [in])

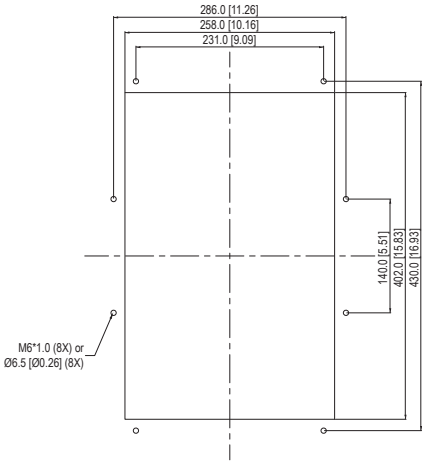
Frame A



Frame B



Frame C

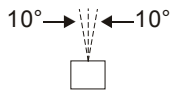


*DURA*PULSE GS4 AC Drives Specifications – Installation

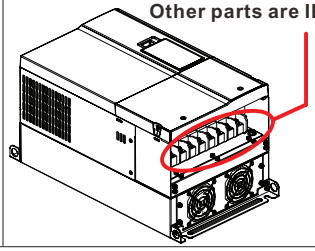
Understanding the installation requirements for your *DURA*PULSE AC drive will help to ensure that it operates within its environmental and electrical limits.

Note: Never use only this catalog for installation instructions or operation of equipment; refer to the User Manual, GS4_UMW.

Environmental Conditions for GS4 AC Drives

Condition	Operation	Storage	Transportation
Installation Location	IEC60364-1/IEC60664-1 Pollution degree 2, Indoor use only	n/a	n/a
Ambient Temperature	see separate Operating Temperature table below	-25°C to +70°C	
Relative Humidity	Max 90%, non-condensing, non-frozen	Max 95%, non-condensing, non-frozen	
Air Pressure	86 to 106 kPa		70 to 106 kPa
Pollution Level	IEC721-3-3, no concentrate		
	Class 3C2; Class 3S2	Class 2C2; Class 2S2	Class 1C2; Class 1S2
Altitude	0–1000m (see separate derating section for altitudes of 1000–3000m)	n/a	n/a
Package Drop	n/a	ISTA procedure 1A(according to weight) IEC60068-2-31	
Vibration	1.0mm, peak to peak value range from 2Hz to 13.2Hz; 0.7G–1.0G range from 13.2Hz to 55Hz; 1.0G range from 55Hz to 512Hz. Comply with IEC 60068-2-6		
Impact	IEC/EN 60068-2-27		
Installation Orientation	Max allowed offset angle ±10° (from vertical installation position) 		

Operating Temperature and Protection Level

Frame Size		***Top cover***	***Conduit Box***	***Protection Level***	***Operating Temperature***
A–C	***230V: 1.0–30 hp 460V: 1.0–40 hp***	With top cover removed	Standard conduit plate	IP20 / UL Open Type	-10–50°C [14–122°F]
		With top cover in place		IP20 / UL Type1 / NEMA 1	-10–40°C [14–104°F]
D0–G	***230V: >30hp 460V: >40hp***	N/A	With conduit box	IP20 / UL Type1 / NEMA 1	-10–40°C [14–104°F]
	230V: >30hp 460V: >40hp	N/A	Without conduit box	IP00 / IP20 / UL Open Type * **Only the circled area is IP00. Other parts are IP20.** 	-10–50°C [14–122°F]

**** Only the exposed terminal blocks are IP00; the other components are IP20***

WARNING: AC DRIVES GENERATE A LARGE AMOUNT OF HEAT WHICH MAY DAMAGE THE AC DRIVE. AUXILIARY COOLING METHODS MAY BE REQUIRED TO AVOID EXCEEDING MAXIMUM OPERATING TEMPERATURE. WHEN POSSIBLE, CONSIDER FLANGE MOUNTING TO LOWER ENCLOSURE TEMPERATURES.

WARNING: MAXIMUM AMBIENT TEMPERATURES MUST NOT EXCEED 50°C (122°F), OR 40°C (104°F), FOR ALL GS4 MODELS.

DURAPULSE GS4 AC Drives Specifications – Air Flow and Power (Heat) Dissipation

GS4 AC Drives Air Flow and Power (Heat) Dissipation

Model Number	Airflow Rate[1] for Cooling						Power (Heat) Dissipation[2]		
	Flow Rate[1] (cfm)			Flow Rate[1] (m^3/hr)			Power Dissipation[2] (Watt)		
	External	Internal	Total	External	Internal	Total	External (Heat sink)	Internal	Total
GS4-21P0	–	–	–	–	–	–	33	27	60
GS4-22P0	14	–	14	24	–	24	56	31	87
GS4-23P0	14	–	14	24	–	24	79	36	115
GS4-25P0	10	–	10	17	–	17	113	46	159
GS4-27P5	40	14	54	68	24	92	197	67	264
GS4-2010	66	14	80	112	24	136	249	86	335
GS4-2015	58	14	73	99	24	123	409	121	530
GS4-2020	166	12	178	282	20	302	455	161	616
GS4-2025	166	12	178	282	20	302	549	184	733
GS4-2030	166	12	178	282	20	302	649	216	865
GS4-2040	179	30	209	304	51	355	913	186	1099
GS4-2050	179	30	209	304	51	355	1091	220	1311
GS4-2060	228	73	301	387	124	511	1251	267	1518
GS4-2075	228	73	301	387	124	511	1401	308	1709
GS4-2100	246	73	319	418	124	542	1770	369	2139
GS4-41P0	–	–	–	–	–	–	33	25	58
GS4-42P0	–	–	–	–	–	–	45	29	74
GS4-43P0	14	–	14	24	–	24	71	33	104
GS4-45P0	10	–	10	17	–	17	103	38	141
GS4-47P5	10	–	10	17	–	17	134	46	180
GS4-4010	40	14	54	68	24	92	216	76	292
GS4-4015	66	14	80	112	24	136	287	93	380
GS4-4020	58	14	73	99	24	123	396	122	518
GS4-4025	99	21	120	168	36	204	369	138	507
GS4-4030	99	21	120	168	36	204	476	158	634
GS4-4040	126	21	147	214	36	250	655	211	866
GS4-4050	179	30	209	304	51	355	809	184	993
GS4-4060	179	30	209	304	51	355	929	218	1147
GS4-4075	179	30	209	304	51	355	1156	257	1413
GS4-4100	186	30	216	316	51	367	1408	334	1742
GS4-4125	257	73	330	437	124	561	1693	399	2092
GS4-4150	223	73	296	379	124	503	2107	491	2598
GS4-4175	224	112	336	381	190	571	2502	579	3081
GS4-4200	289	112	401	491	190	681	3096	687	3783
GS4-4250	–		454	–		771	–		4589
GS4-4300			454			771			5772

The required airflow shown in chart is for installing a single GS4 drive in a confined space.
When installing multiple GS4 drives, the required air volume would be the cumulative air volume for all drives in the enclosure.

Heat dissipation shown in the chart is for installing a single GS4 drive in a confined space.
When installing multiple drives, the volume of heat dissipation should be the cumulative heat dissipation of all drives in the enclosure.
Heat dissipation for each model is calculated by rated voltage, current and default carrier frequency.

1) External flow rate is across the heat sink. Internal flow rate is through the chassis.
Published flow rates are the result of active cooling using fans; factory-installed in the drive.
Unpublished flow rates (-) are the result of passive cooling in drives without factory-installed fans.
2) When calculating power dissipation (Watt Loss) use the total value if the drive is foot mounted, or the internal value if the drive is flange mounted. Where only a total value is published, these models cannot be flange mounted.

Dimensions for Minimum Clearance * (mm / in)

Frame Size	Above & Below	Side to Non-Heat Source	Side to Heat Source	Front
A–C	60 / 2.4	30 / 1.2	10 / 0.4	0 / 0
D(0)–F	100 / 4.0	50 / 2.0	n/a	0 / 0
G	200 / 7.9	100 / 4.0	2 x B	0 / 0

*** The minimum mounting clearances stated in this table applies to GS4 drives frames A to G. Failure to follow the minimum mounting clearances may cause the fan to malfunction and cause a heat dissipation problem.**

DURAPULSE GS4 AC Drives Specifications – Terminals

Main Circuit Terminals	
Terminal	***Description***
R/L1	Input Power – phase 1
S/L2	Input Power – phase 2
T/L3	Input Power – phase 3
U/T1, V/T2, W/T3	AC Drive Output
+1, +2	DC Choke Connection (frames A–C)
B1, B2	Braking Resistor Connection (frames A–C)
+1/DC+, -/DC-	External Dynamic Brake Unit (frames D–G)
⏚	Ground

Control Circuit Terminals

Terminal	***Description***	***Remarks***
+10V	Potentiometer Power Supply	Analog frequency setting: +10VDC 20mA max output
-10V		Analog frequency setting: -10VDC 20mA max output
+24V	Digital Control Signal Source	+24V±5%, 200mA max output; use with DCM
AI1	Analog Input 1	Range: 0–10V or 0/4–20mA = 0–Max Output Frequency AI1 switch = SW3; factory setting is 0–10V Impedance: 20kΩ (SW3 = 0–10V); 250Ω (SW3 = 0/4–20mA)
AI2	Analog Input 2	Range: 0/4–20mA or 0–10V = 0–Max Output Frequency AI2 Switch = SW4; factory setting is 0–20mA Impedance: 250Ω (SW4 = 0/4–20mA); 20kΩ (SW4 = 0–10V);
AI3	Analog Input 3	Impedance: 20kΩ Range: -10VDC to +10 VDC = 0–Max Output Frequency *Note: For -10V to +10V operation, connect the pot to +10V and -10V. Keep the pot wiper connected to AI3.*
ACM	Analog Common	Common for analog terminals
AO1	Analog Output 1	-10 to +10V max output current 2mA; max load 5kΩ Resolution: 0–10V corresponds to max operation frequency Range: 0–10V or -10 to +10V AO1 Switch = SW1, factory setting is 0–10V
AO2	Analog Output 2 (internal circuit same as AO1)	0–10V max output current 2mA; max load 5kΩ 0–20mA max output current 20mA; max load 500Ω Resolution: 0–10V corresponds to max operation frequency Range: 0–10V or 0/4–20mA AO2 Switch = SW2; factory setting is 0–10V
DIC	Digital Input Common Rail	Common terminal for multi-function inputs; Can be tied to DCM (for sinking) or to +24V (for sourcing)
DI1–DI8	Digital Inputs 1 thru 8	ON: the activation current is 3.3mA ≥ 11VDC OFF: leakage current tolerance is 1.4mA ≤ 5VDC
DCM	Digital Signal Common	Refer to terminals FO, FWD, REV
DO1	Digital Output 1	The AC motor drive releases various monitor signals such as drive in operation, frequency attained, and overload indication via transistor (open collector). Range: 5–48 VDC. Use with DOC.
DO2	Digital Output 2 (internal circuit same as DO1)	Multi-function Output 2 (photocoupler). Range: 5–48 VDC. Use with DOC.
DOC	Digital Output Common	Max 5–48 VDC, 50mA (user supplied)
+24V	STO Control Signal Source	Safe Torque Off function. Refer to Appendix E: Safe Torque Off for more details.
ECM	EStop Common	
SCM1	STO Input 1 Common	
SCM2	STO Input 2 Common	
STO1	STO Input 1	
STO2	STO Input 2	
FO	Digital Frequency Output	High-speed pulse output. Use with DCM. Digital Frequency Out = Drive Output Frequency [Hz] x P3.38 [Frequency Output Multiplier]. Duty-cycle: 50% ±1% Min load impedance: 1kΩ/100pf Max current: 30mA Max voltage: 30VDC
FWD	Forward Command	Use with DCM. ON = forward running OFF = deceleration to stop
R1	R1 Relay Common	Resistive Load: 3A(N.O.) / 3A(N.C.); 250VAC 5A(N.O.) / 3A(N.C.); 30VDC Inductive Load (COS 0.4): 1.2A(N.O.) / 1.2A(N.C.); 250VAC These terminals are to output monitoring signals, such as drive in operation, frequency attained, or overload indication. Note: R1 and R2 have N.O. and N.C. contacts.
R1C	R1 Relay N.C.	
R1O	R1 Relay N.O.	
R2	R2 Relay Common	
R2C	R2 Relay N.C.	
R2O	R2 Relay N.O.	
REV	Reverse Command	Use with DCM. ON = reverse running OFF = deceleration to stop
RJ45-1	RJ45 Port 1 (RS-485)	Pins 1,2,7,8: Reserved Pins 3,6: SGND Pin 4: SG- Pin 5: SG+ (RJ45-1 and RJ45-2 are connected internally to ports SG+ and SG- below)
RJ45-2	RJ45 Port 2 (RS-485)	
SG+, SG-, SGND	Modbus RS-485 (SG+ and SG- are connected internally to the two RJ45 ports above)	
⏚	Digital Control Ground	

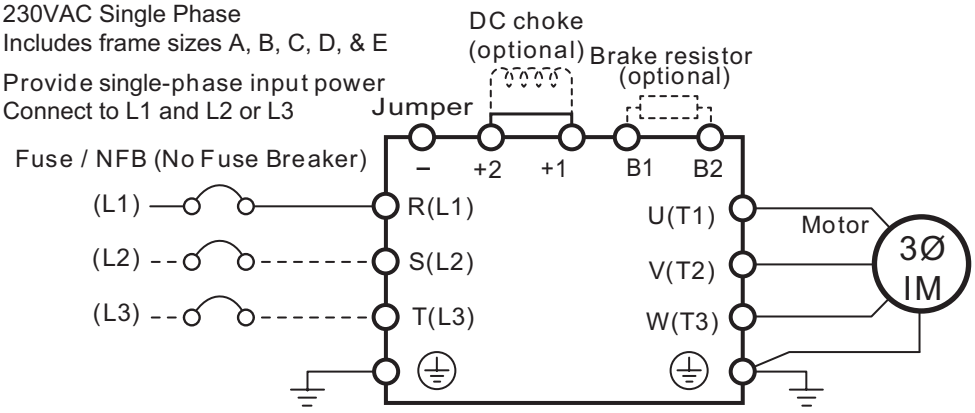
DURAPULSE GS4 AC Drives – Basic Wiring Diagram

Power Wiring Diagram: GS4 230V Models – Single-Phase

Note: Users MUST connect wiring according to the circuit diagram shown below. (Refer to user manual GS4-UMW for additional specific wiring information.)
Note: We specify DC chokes, but we do not stock them.

GS4-2xxx models,
230VAC Single Phase
Includes frame sizes A, B, C, D, & E

Provide single-phase input power
Connect to L1 and L2 or L3



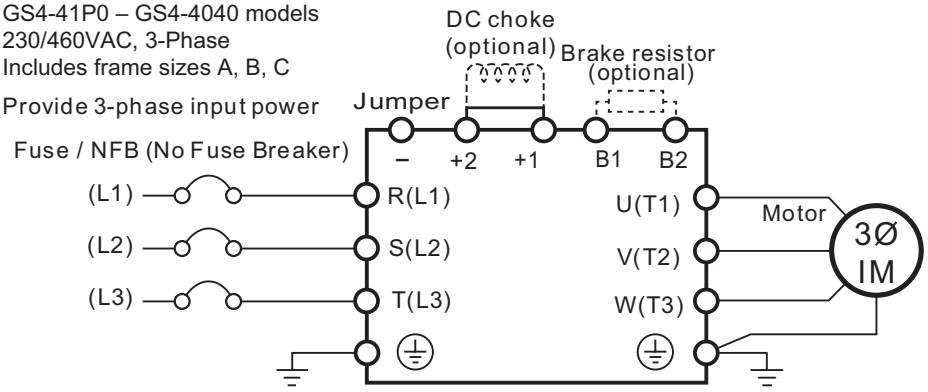
Connect 230VAC, Single-Phase power to any two of the R, S, or T terminals

Power Wiring Diagram: GS4 Frame Size A, B, C Models – Three-Phase

Note: Users MUST connect wiring according to the circuit diagram shown below. (Refer to user manual GS4-UMW for additional specific wiring information.)
Note: We specify DC chokes, but we do not stock them.

GS4-21P0 – GS4-2030
GS4-41P0 – GS4-4040 models
230/460VAC, 3-Phase
Includes frame sizes A, B, C

Provide 3-phase input power



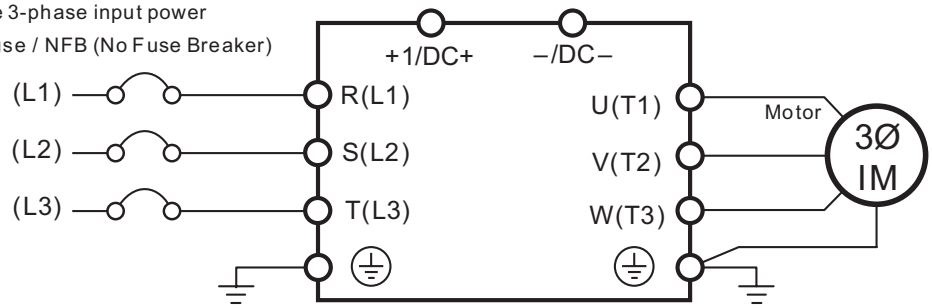
Power Wiring Diagram: GS4 Frame Size D0, D, E, F Models – Three-Phase

Note: Users MUST connect wiring according to the circuit diagram shown below. (Refer to user manual GS4-UMW for additional specific wiring information.)

GS4-2040 – GS4-2100
GS4-4050 – GS4-200 models
230/460VAC, 3-Phase
Includes frame sizes D0, D, E, F

Provide 3-phase input power

+1/DC+ & -/DC- terminals are for the connection of an optional GS-xDBU dynamic braking unit.
Do NOT connect a braking resistor directly to terminals +1/DC+ and -/DC-. Connecting a resistor directly to these terminals will damage the GS4 drive!



DURAPULSE GS4 AC Drives – Basic Wiring Diagram

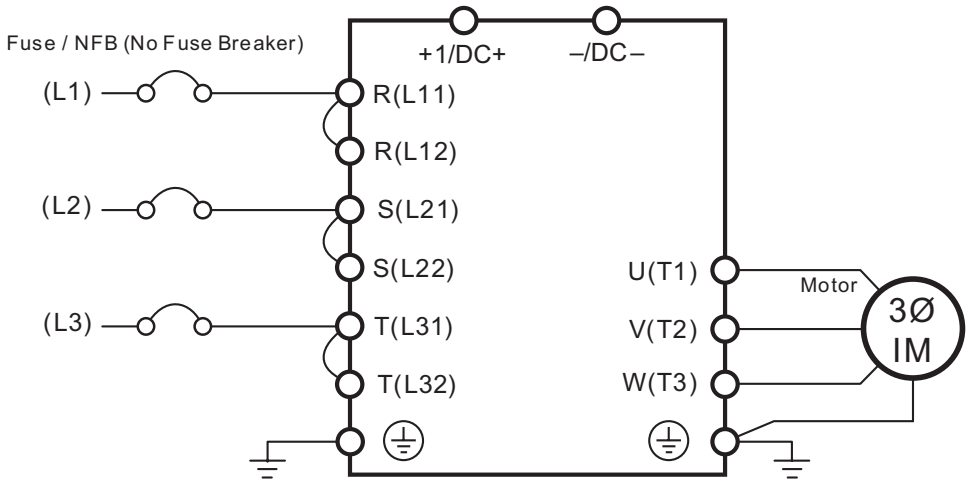
Power Wiring Diagram: GS4 Frame Size G Models – Three-Phase

Note: Users MUST connect wiring according to the circuit diagram shown below. (Refer to user manual GS4-UMW for additional specific wiring information.)

GS4-4250 &
GS4-4300 models
460VAC, 3-Phase

Provide 3-phase input power

+1/DC+ & -/DC- terminals are for the connection of an optional GS-xDBU dynamic braking unit.
Do NOT connect a braking resistor directly to terminals +1/DC+ and -/DC-. Connecting a resistor directly to these terminals will damage the GS4 drive!

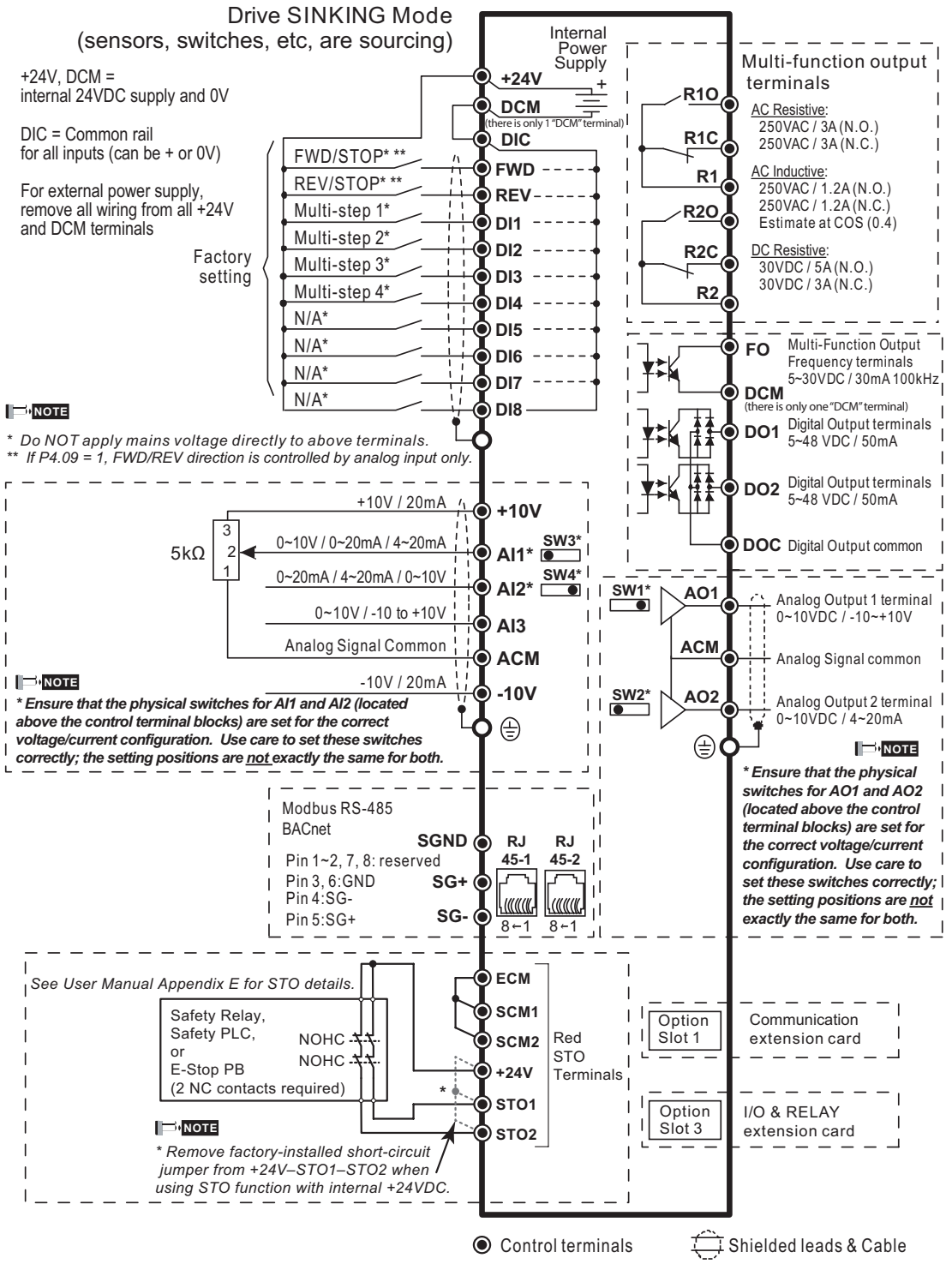


DURAPULSE GS4 AC Drives – Basic Wiring Diagram

Control Wiring Diagram: Full I/O with Sinking Inputs (field devices are sourcing)

Note: Users must connect wiring according to the circuit diagram shown below.

WARNING: DO NOT PLUG A MODEM OR TELEPHONE INTO THE DURAPULSE RJ45 SERIAL COMM PORT, OR PERMANENT DAMAGE MAY RESULT.

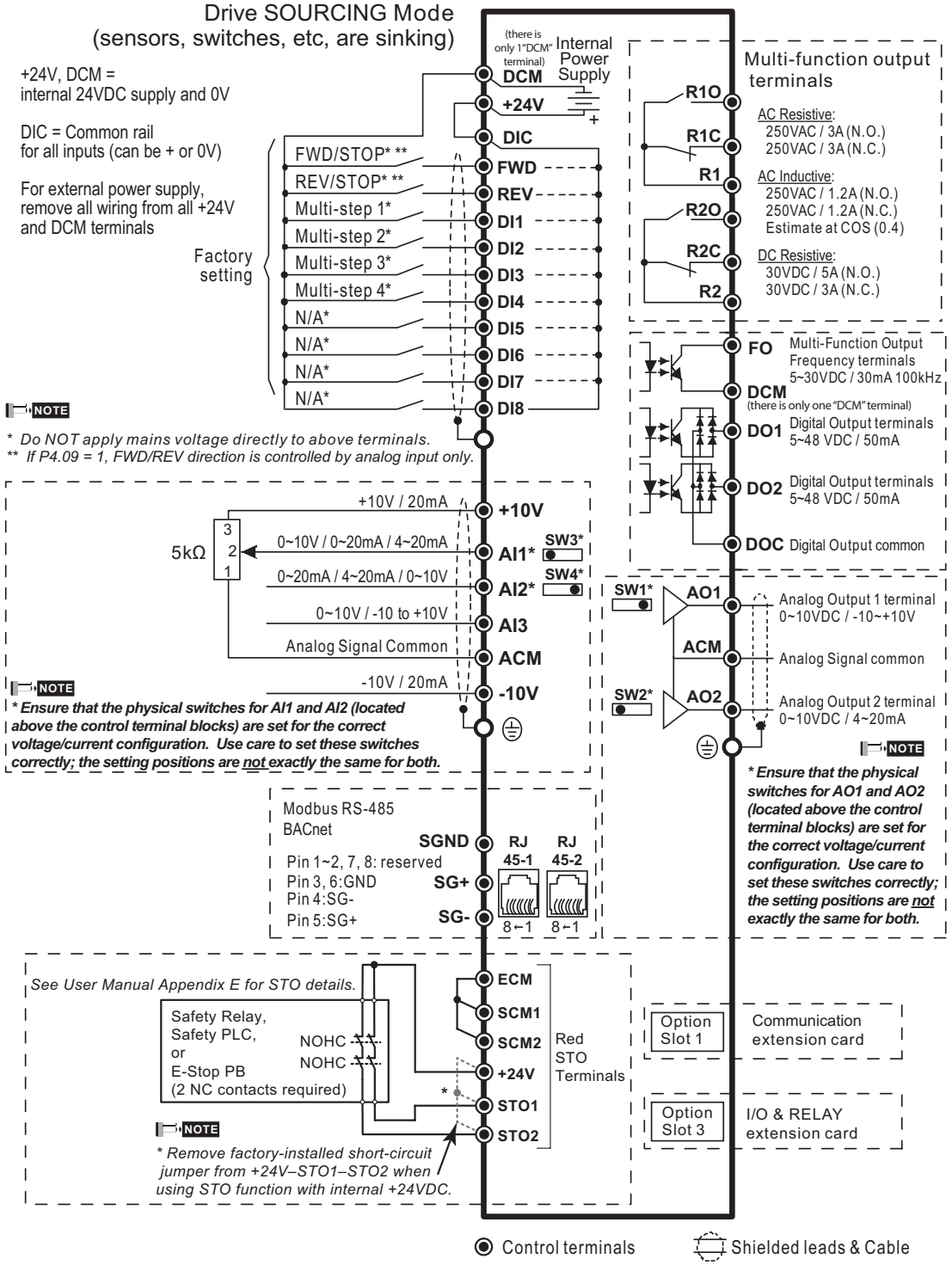


DURAPULSE GS4 AC Drives – Basic Wiring Diagram

Control Wiring Diagram: Full I/O with Sourcing Inputs (field devices are sinking)

Note: Users must connect wiring according to the circuit diagram shown below.

WARNING: DO NOT PLUG A MODEM OR TELEPHONE INTO THE DURAPULSE RJ45 SERIAL COMM PORT, OR PERMANENT DAMAGE MAY RESULT.



DURAPULSE GS4 AC Drives – Dimensions

GS4 DURAPULSE Frame Sizes by Drive Model

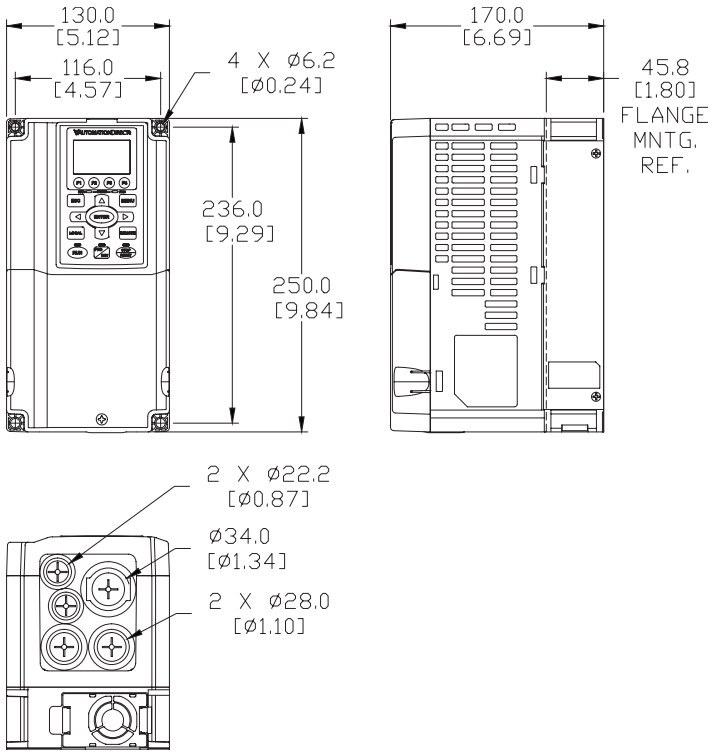
GS4 DURAPULSE Frame Sizes by Drive Model												
A		B		C		D0	D		E		F	G
230V	460V	230V	460V	230V	460V	460V	230V	460V	230V	460V	460V	460V
GS4-21P0	GS4-41P0	GS4-27P5	GS4-4010	GS4-2020	GS4-4025	GS4-4050	GS4-2040	GS4-4075	GS4-2060	GS4-4125	GS4-4175	GS4-4250
GS4-22P0	GS4-42P0	GS4-2010	GS4-4015	GS4-2025	GS4-4030	GS4-4060	GS4-2050	GS4-4100	GS4-2075	GS4-4150	GS4-4200	GS4-4300
GS4-23P0	GS4-43P0	GS4-2015	GS4-4020	GS4-2030	GS4-4040	–	–	–	GS4-2100	–	–	–
GS4-25P0	GS4-45P0	–	–	–	–	–	–	–	–	–	–	–
–	GS4-47P5	–	–	–	–	–	–	–	–	–	–	–

Dimensions – GS4 AC Drives

Units = (mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings.

Dimensions – Frame Size A

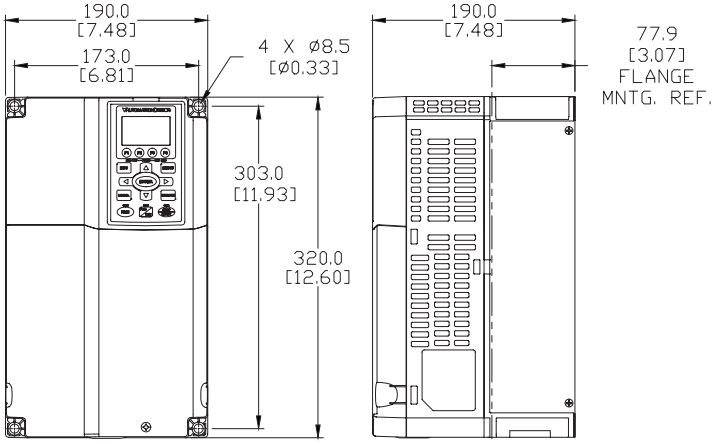


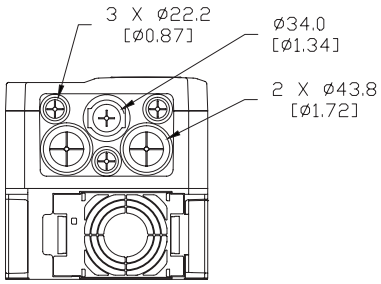
DURAPULSE GS4 AC Drives – Dimensions

Dimensions – GS4 AC Drives (Units = mm [in])

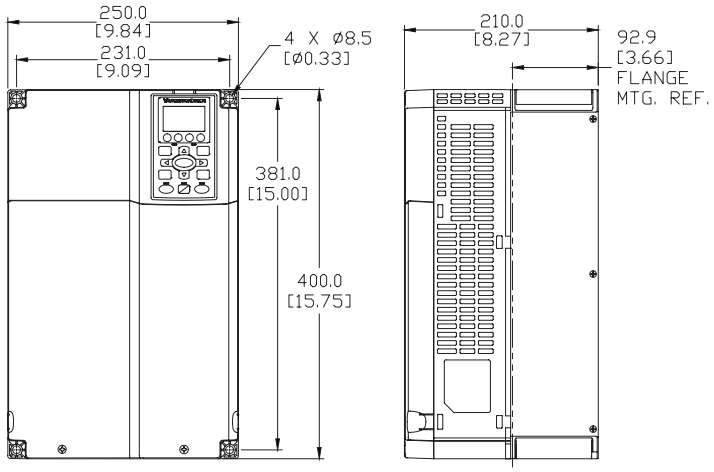
See our website: www.AutomationDirect.com for complete engineering drawings.

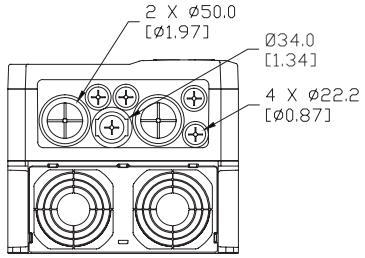
Dimensions – Frame Size B





Dimensions – Frame Size C



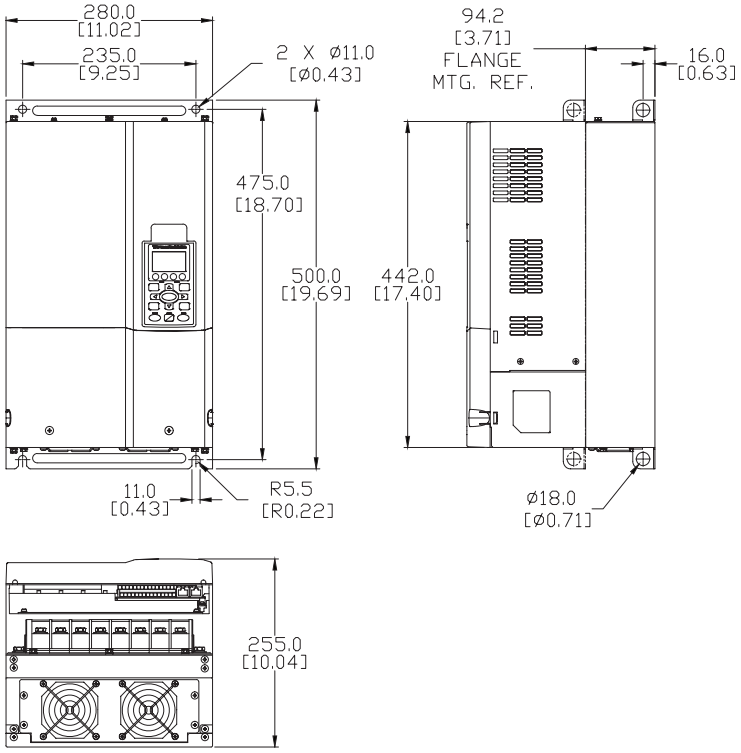


DURAPULSE GS4 AC Drives – Dimensions

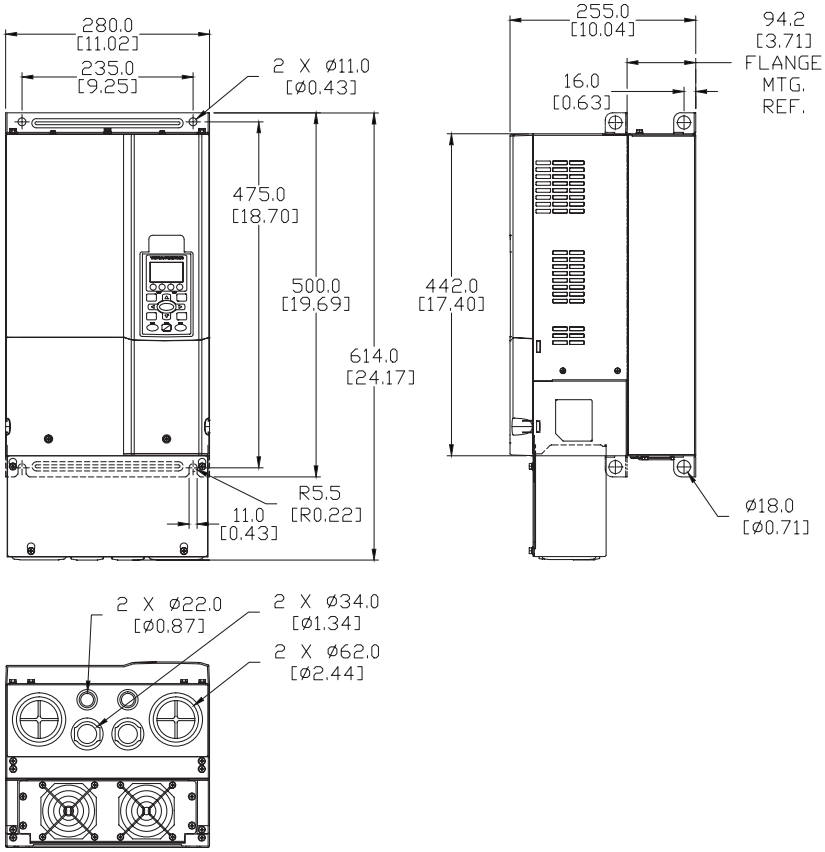
Dimensions – GS4 AC Drives (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings.

Dimensions – Frame Size D0



Dimensions – Frame Size D0 with Conduit Box

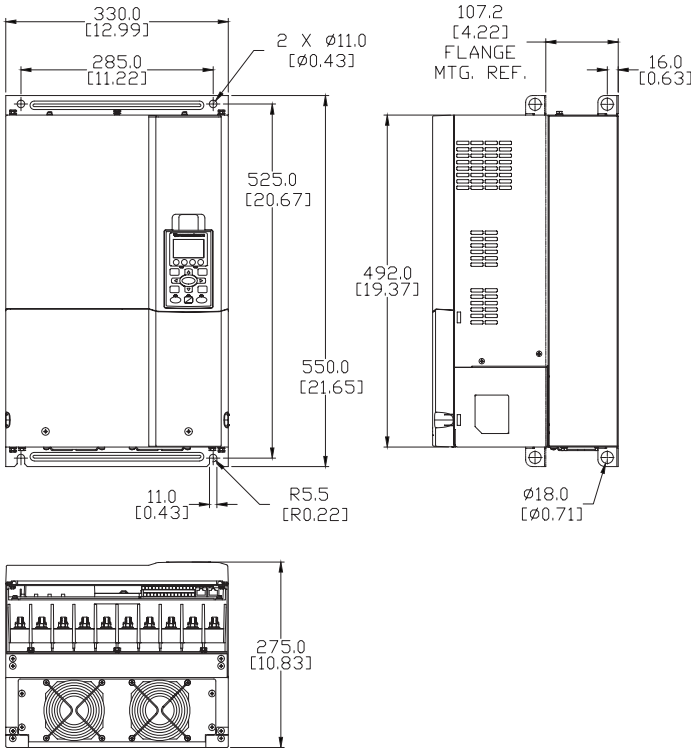


DURAPULSE GS4 AC Drives – Dimensions

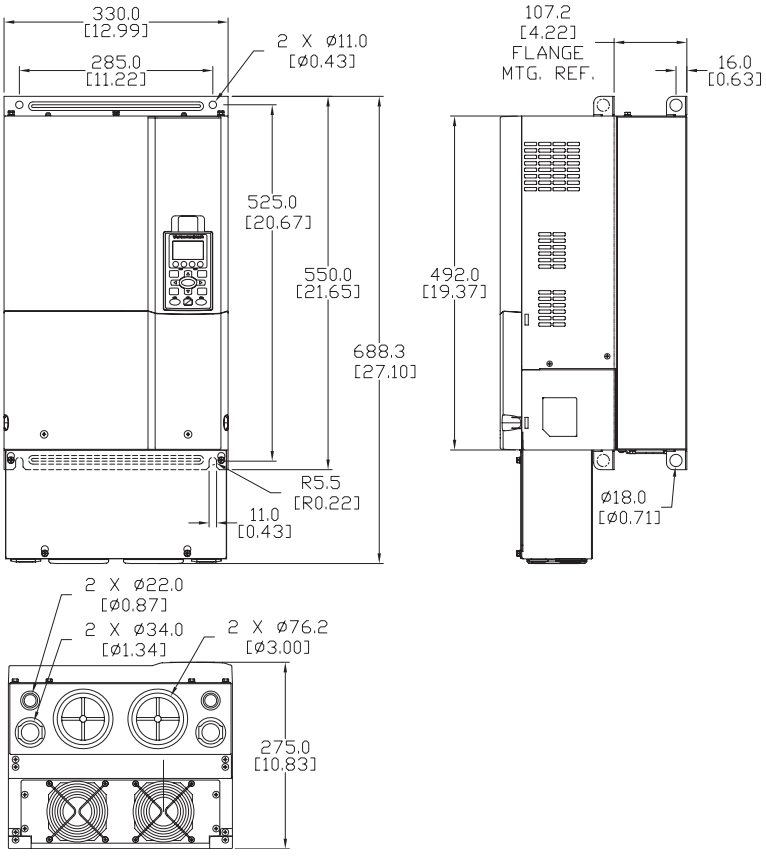
Dimensions – GS4 AC Drives (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings.

Dimensions – Frame Size D



Dimensions – Frame Size D with Conduit Box

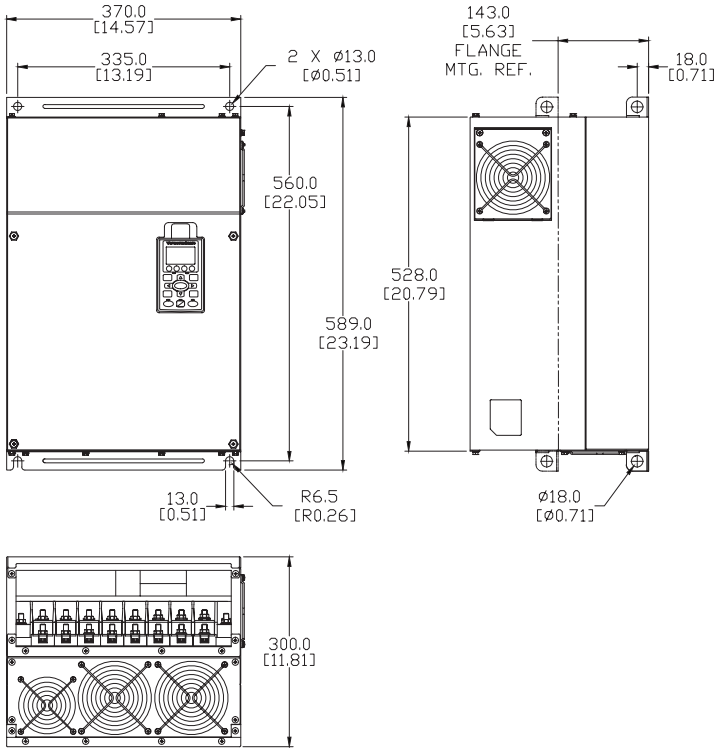


DURAPULSE GS4 AC Drives – Dimensions

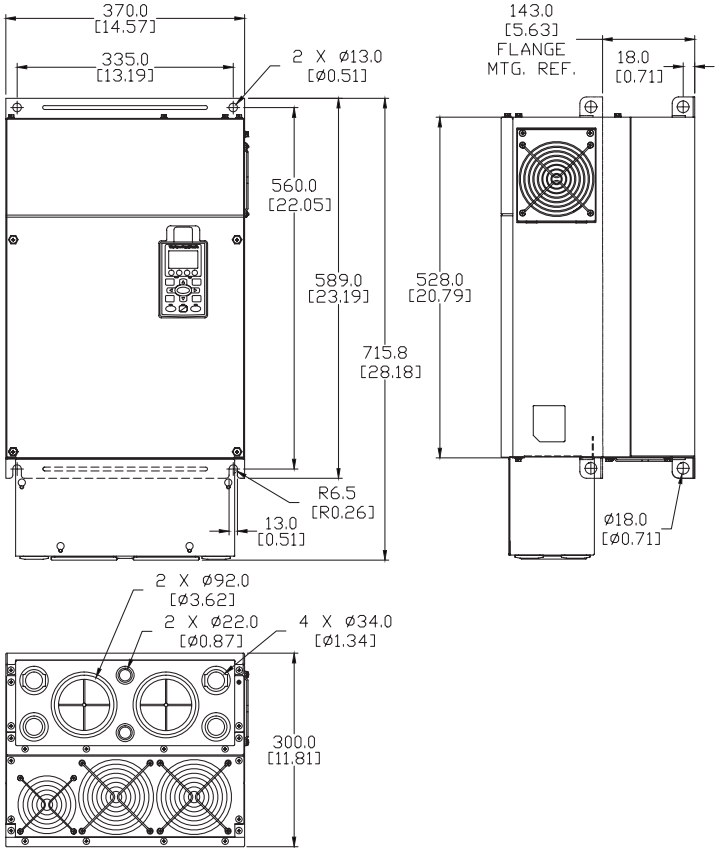
Dimensions – GS4 AC Drives (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings.

Dimensions – Frame Size E



Dimensions – Frame Size E with Conduit Box

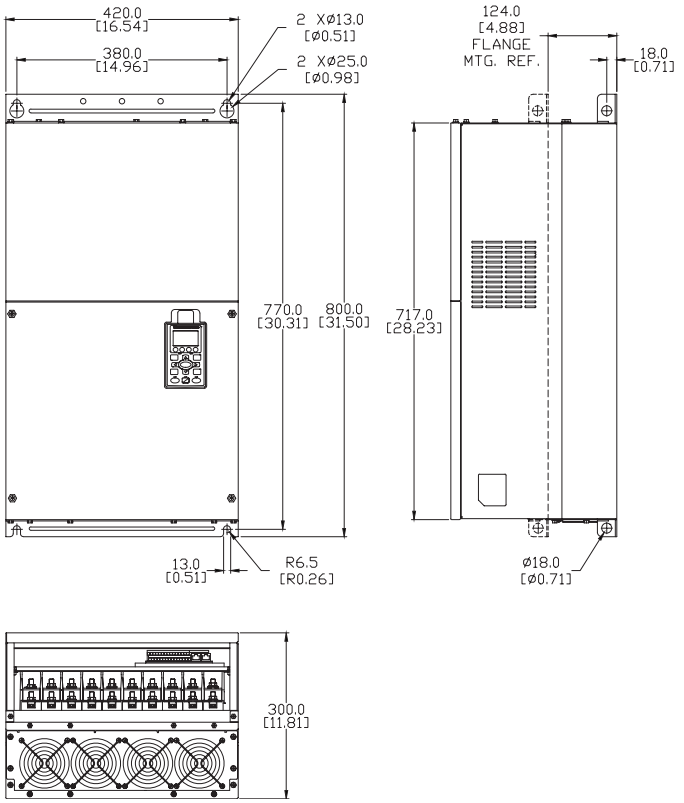


DURAPULSE GS4 AC Drives – Dimensions

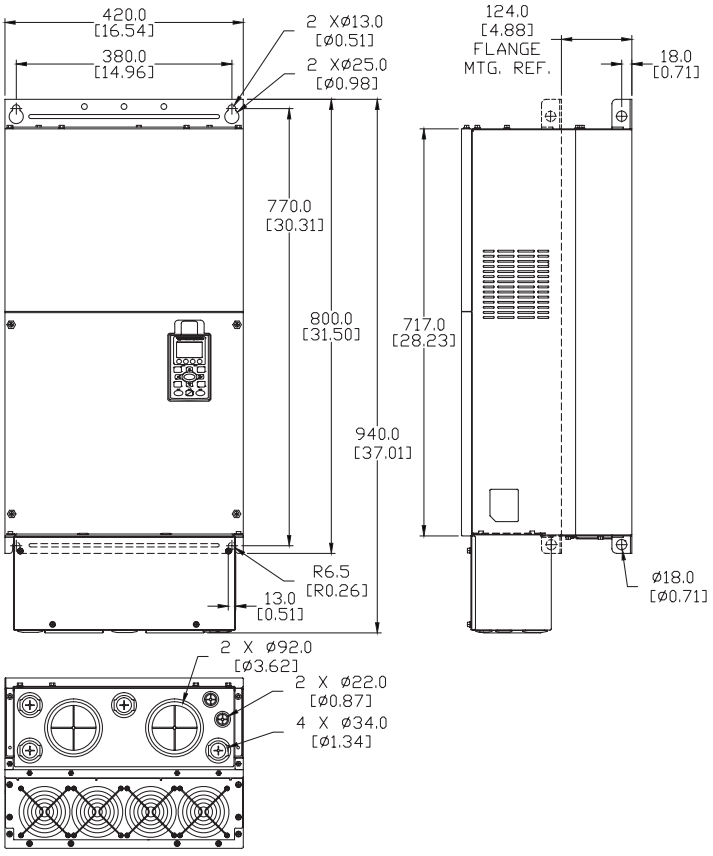
Dimensions – GS4 AC Drives (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings.

Dimensions – Frame Size F



Dimensions – Frame Size F with Conduit Box

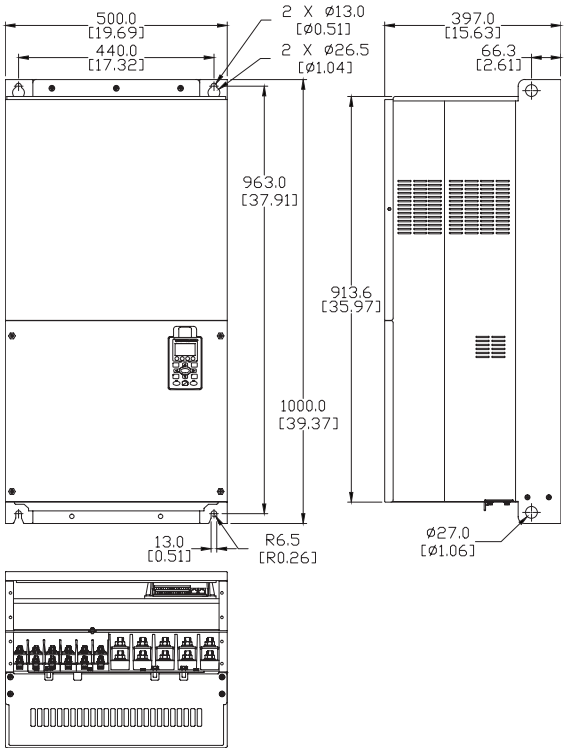


DURAPULSE GS4 AC Drives – Dimensions

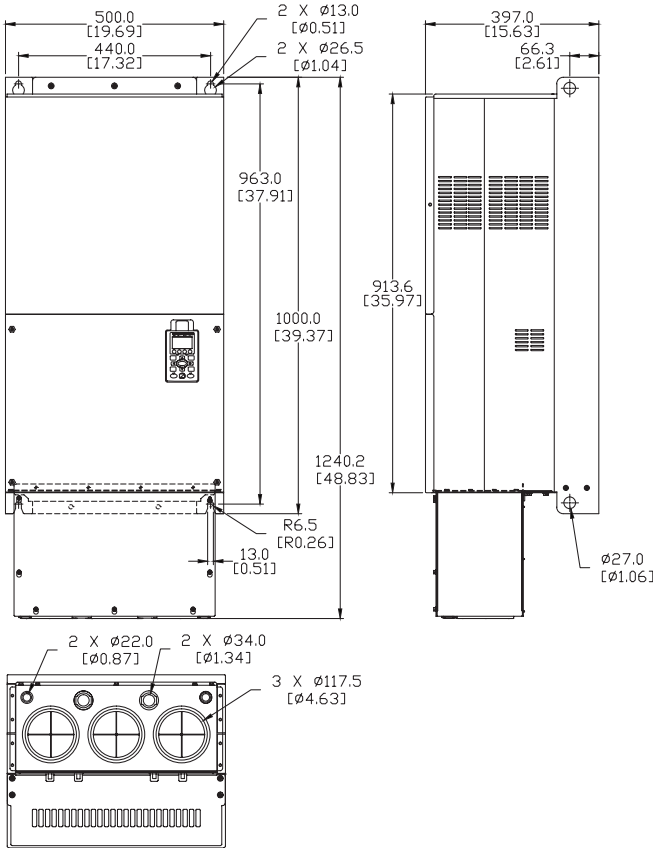
Dimensions – GS4 AC Drives (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings.

Dimensions – Frame Size G

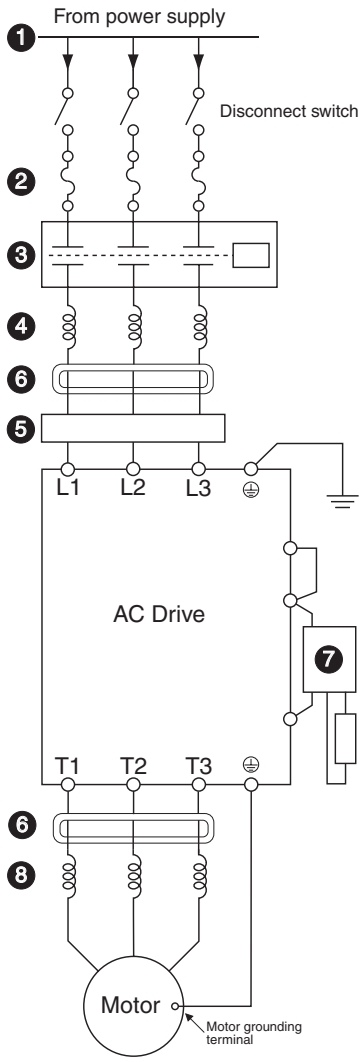


Dimensions – Frame Size G with Conduit Box



AC Drives Optional Accessories – Overview

Drive Accessories
(not all accessories are applicable for every drive model)



1 Power Supply

Please follow the specific power supply requirements as detailed in the specific drive manual.

2 Fuses

Input fuses protect the AC drive from excessive input current due to line surges, short circuits, and ground faults. They are recommended for all installations and may be required for UL-listed installations.

3 Contactor (Optional)

Do not use a contactor or disconnect switch for run/stop control of the AC drive and motor. This will reduce the operating life cycle of the AC drive. Cycling a power circuit switching device while the AC drive is in run mode should be done only in emergency situations.

4 Input Line Reactor (Optional)

See the Line Reactors section at www.automationdirect.com for more information.

Input line reactors protect the AC drive from transient overvoltage conditions, typically caused by utility capacitor switching. The input line reactor also reduces the harmonics associated with AC drives. Input line reactors are recommended for all installations.

5 EMI filter (Optional)

See the EMI Filters section at www.automationdirect.com for more information.

Input EMI filters reduce electromagnetic interference or noise on the input side of the AC drive. They are required for CE compliance and recommended for installations prone to or sensitive to electromagnetic interference.

6 RF filter (Optional)

RF filters reduce the radio frequency interference or noise on the input or output side of the inverter.

7 Braking Unit and/or Braking Resistor (Optional)

Dynamic braking allows the AC drive to produce additional braking (stopping) torque. AC drives can typically produce between 15% & 20% braking torque without the addition of any external components. The addition of optional braking may be required for applications that require rapid deceleration or high inertia loads.

8 Output Load Reactor or Voltage Time (dV/dT) Filter (Optional)

Output line reactors protect the motor insulation against AC drive short circuits and IGBT reflective wave damage, and also "smooth" the motor current waveform, allowing the motor to run cooler. They are **recommended for operating "noninverter-duty" motors and when the length of wiring between the AC drive and motor is less than 100 feet.**

Voltage Time filters provide enhanced protection for motors with distances up to 1,000 feet.

Voltage Time filters provide even more protection against wave reflection and reduce common mode noise. They are recommended when the length of wiring between the AC drive and motor is from 100 feet up to 1,000 feet.

See www.automationdirect.com for specific product offerings.

GS4 DURApulse Drives Accessories – Line-Side Reactors

Line-Side Reactors for GS4/*DURA*PULSE AC Drives – Selection Specifications

Supply: 230V, 1Ø, 50/60 Hz (*Constant* Torque; reactor installed *Line* Side)									
GS4 Model	Derated Output (hp)*	CT: 1Ø Input Amps (rms)**	Saturation Amps (rms)	Inductance (mH)		Max Motor kW	LR Model	Rated Amps	LR 3% Inductance
				3% Impedance	5% Impedance				
GS4-21P0	0.5	4.2	7.6	2.506	4.176	0.37	LR2-20P5-1PH	4.9	3.74
GS4-22P0	0.75	5.6	10.1	1.879	3.132	0.25	LR-21P0-1PH	8	2.29
GS4-23P0	1	8.7	15.7	1.210	2.016	0.25	LR-21P0-1PH	8	2.29
GS4-25P0	2	14	25	0.752	1.253	0.37	LR-22P0-1PH	12.0	1.53
GS4-27P5	3	19	34	0.554	0.923	0.75	LR-23P0-1PH	17.0	1.08
GS4-2010	3	19	34	0.554	0.923	0.75	LR-23P0-1PH	17.0	1.08
GS4-2015	5	30	54	0.351	0.585	3.7	LR-2010	30.8	0.342
GS4-2020	7.5	43	77	0.245	0.408	5.5	LR-2015	46.2	0.220
GS4-2025	10	57	103	0.184	0.307	7.5	LR-2020	59.4	0.172
GS4-2030	10	57	103	0.184	0.307	7.5	LR-2020	59.4	0.172
GS4-2040	10	57	103	0.184	0.307	7.5	LR-2020	59.4	0.172
GS4-2050	10	57	103	0.184	0.307	7.5	LR-2020	59.4	0.172
GS4-2060	15	85	153	0.124	0.206	11	LR-2025	74.8	0.138
GS4-2075	20	113	203	0.093	0.155	15	LR-2040	114	0.0886
GS4-2100	25	130	234	0.081	0.135	18.5	LR-2050	143	0.0699

** Drive output HP is derated when supplied single phase.*
*** Amperage ratings expressed in the column CT: 1Ph Input Amps (rms) are with a line reactor installed on the line side of the drive.*

GS4 DURApulse Drives Accessories – Load-Side Reactors

Load-Side Reactors for GS4/*DURA*PULSE AC Drives – Selection Specifications

Supply: 230V, 1Ø, 50/60 Hz (*Constant* Torque; reactor installed *Load* Side)									
GS4 Model	HP	CT: 3Ø Output Amps (rms)*	Saturation Amps (rms)	Inductance (mH)		Max Motor kW	LR Model	Rated Amps	LR 3% Inductance
				3% Impedance	5% Impedance				
GS4-21P0	0.5	2.4	4.3	2.893	4.822	0.37	LR-20P5	2.4	4.2
GS4-22P0	0.75	3.2	5.8	2.170	3.617	0.55	LR-21P0	4.6	2.46
GS4-23P0	1	5.0	9.0	1.397	2.328	0.75	LR-21P0	4.6	2.46
GS4-25P0	2	8	14	0.868	1.447	1.5	LR-23P0	10.6	0.97
GS4-27P5	3	11	20	0.640	1.066	2.2	LR-23P0	10.6	0.97
GS4-2010	3	11	20	0.640	1.066	2.2	LR-23P0	10.6	0.97
GS4-2015	5	17	31	0.405	0.675	3.7	LR-25P0	16.7	0.626
GS4-2020	7.5	25	45	0.283	0.471	5.5	LR-27P5	24.2	0.434
GS4-2025	10	33	59	0.213	0.354	7.5	LR-2010	30.8	0.342
GS4-2030	10	33	59	0.213	0.354	7.5	LR-2010	30.8	0.342
GS4-2040	10	33	59	0.213	0.354	7.5	LR-2010	30.8	0.342
GS4-2050	10	33	59	0.213	0.354	7.5	LR-2010	30.8	0.342
GS4-2060	15	49	88	0.143	0.238	11	LR-2015	46.2	0.22
GS4-2075	20	65	117	0.108	0.179	15	LR-2020	59.4	0.172
GS4-2100	25	75	135	0.093	0.156	18.5	LR-2025	74.8	0.138

** Amperage ratings are 3-phase output reactor ratings when the drive is supplied with a single-phase input.*

GS4 *DURA*PULSE Drives Accessories – Line/Load Reactors

Line/Load Reactors for GS4/*DURA*PULSE AC Drives – Selection Specifications

Supply: 230V, 3Ø, 50/60 Hz (*Variable* Torque; reactor installed *Line* or *Load* Side)									
GS4 Model	hp	VT: 3Ø Output Amps (rms)	Saturation Amps (rms)	Inductance (mH)		Max Motor kW	LR Model*	Rated Amps	LR 3% Inductance
				3% Impedance	5% Impedance				
GS4-21P0	1	5	8.7	2.536	4.226	0.75	LR-21P0	4.6	2.46
GS4-22P0	2	8	12.8	1.585	2.641	1.5	LR-23P0*	10.6	0 .97
GS4-23P0	3	11	18	1.152	1.921	2.2	LR-23P0	10.6	0.97
GS4-25P0	5	17	29	0.746	1.244	3.7	LR-25P0	16.7	0.626
GS4-27P5	7.5	25	43	0.507	0.845	5.5	LR-27P5	24.2	0.434
GS4-2010	10	33	56	0.320	0.534	7.5	LR-2010	30.8	0.342
GS4-2015	15	49	85	0.216	0.359	11	LR-2015	46.2	0.22
GS4-2020	20	65	112	0.163	0.271	15	LR-2020	59.4	0.172
GS4-2025	25	75	128	0.169	0.282	18.5	LR-2025	74.8	0.138
GS4-2030	30	90	155	0.141	0.236	22	LR-2040*	114	0.0886
GS4-2040	40	120	205	0.106	0.176	30	LR-2040	114	0.0886
GS4-2050	50	146	250	0.087	0.146	37	LR-2050	143	0.0699
GS4-2060	60	180	308	0.070	0.117	45	not available*	169	0.0624
GS4-2075	75	215	367	0.059	0.098	55		211	0.0487
GS4-2100	100	255	436	0.049	0.082	75		273	0.0364

** Some GS4 drive and reactor combinations do not fit the typical "pattern" of having similar part numbers, due to some GS4 models having higher outputs than previous GS DURApulse drives.*

Supply: *460V*, 3Ø, 50/60 Hz (*Variable* Torque; reactor installed *Line* or *Load* Side)									
GS4 Model	hp	VT: 3Ø Output Amps (rms)	Saturation Amps (rms)	Inductance (mH)		Max Motor kW	LR Model	Rated Amps	LR 3% Inductance
				3% Impedance	5% Impedance				
GS4-41P0	1	3	5.2	8.102	13.503	0.75	LR-41P0	2.1	8.927
GS4-42P0	2	4	6.8	6.077	10.128	1.5	LR-42P0	3.4	5.790
GS4-43P0	3	6	10.3	4.050	6.751	2.2	LR-43P0	4.8	4.270
GS4-45P0	5	9	14.6	2.700	4.500	3.7	LR-45P0	7.6	2.770
GS4-47P5	7.5	12	20	2.025	3.375	5.5	LR-47P5	11	1.680
GS4-4010	10	18	31	1.174	1.957	7.5	LR-4010	14	1.290
GS4-4015	15	24	41	0.881	1.468	11	LR-4015	21	0.912
GS4-4020	20	32	54	0.660	1.101	15	LR-4020	27	0.694
GS4-4025	25	38	65	0.639	1.066	18.5	LR-4025	34	0.569
GS4-4030	30	45	77	0.541	0.901	22	LR-4030	40	0.469
GS4-4040	40	60	103	0.405	0.675	30	LR-4040	52	0.387
GS4-4050	50	73	124	0.334	0.556	37	LR-4050	65	0.295
GS4-4060	60	91	155	0.267	0.445	45	LR-4060	77	0.227
GS4-4075	75	110	189	0.221	0.368	55	LR-4075	96	0.196
GS4-4100	100	150	257	0.162	0.270	75	LR-4100	124	0.152
GS4-4125	125	180	308	0.135	0.224	90	LR-4125	156	0.117
GS4-4150	150	220	376	0.110	0.184	110	LR-4150	180	0.103
GS4-4175	175	260	445	0.098	0.163	132	LR-4200	240	0.0839
GS4-4200	215	310	531	0.078	0.130	160	LR-4250	302	0.0654
GS4-4250	250	370	634	0.066	0.109	185	LR-4250	302	0.0654
GS4-4300	300	460	787	0.054	0.090	220	LR-4300	361	0.0565

GS/*DURA*PULSE Drives Accessories – Line/Load Reactors

Line/Load Reactors for GS/*DURA*PULSE AC Drives – Additional Specifications

Line Reactors – LR Series – Additional Specifications							
Part Number	Price	Product Weight	Wire Range	Terminal Torque	Temperature Range		Environment
					Operating	Storage	
LR-20P5	Retired	4.0 lb [1.8 kg]	#12–#18 AWG	10 lb·in	-40 – 104 °F [-40 – 40 °C]	-40 – 149 °F [-40 – 65 °C]	NEMA: open IP00 no corrosive gases
LR-21P0-1PH	$78.00	2.8 lb [1.3 kg]	#12–#18 AWG	10 lb·in			
LR-22P0-1PH	$86.00	4.3 lb [2.0 kg]	#12–#18 AWG	20 lb·in			
LR-23P0-1PH	$187.00	4.3 lb [2.0 kg]	#12–#18 AWG	20 lb·in			
LR-23P0	$148.00	4.0 lb [1.8 kg]	#12–#18 AWG	10 lb·in			
LR-25P0	$194.00	8.0 lb [3.6 kg]	#18–#4 AWG	20 lb·in			
LR-27P5	$206.00	8.0 lb [3.6 kg]	#18–#4 AWG	20 lb·in			
LR-2010	$242.00	12 lb [5.4 kg]	#18–#4 AWG	20 lb·in			
LR-2015	$285.00	12 lb [5.4 kg]	#18–#4 AWG	20 lb·in			
LR-2020	$312.00	12 lb [5.4 kg]	#18–#4 AWG	20 lb·in			
LR-2025	$460.00	15 lb [6.8 kg]	#18–#4 AWG	#18–#16 AWG: 25 lb·in #14–#6 AWG: 30 lb·in #4 AWG: 35 lb·in			
LR-2030	$490.00	33 lb [15 kg]	2/0 – #6AWG (AL or CU)	120			
LR-2040	$574.00	33 lb [15 kg]	2/0 – #6AWG (AL or CU)	120			
LR-2050	$670.00	36 lb [16 kg]	250kcmil – #6AWG (AL or CU)	275			
LR-4010	$196.00	4.0 lb [1.8 kg]	#12–#18 AWG	10 lb·in			
LR-4015	$237.00	8.0 lb [3.6 kg]	#18–#4 AWG	20 lb·in			
LR-4020	$276.00	8.0 lb [3.6 kg]	#18–#4 AWG	20 lb·in			
LR-4025	$290.00	10 lb [4.5 kg]	#18–#4 AWG	20 lb·in			
LR-4030	$347.00	10 lb [4.5 kg]	#18–#4 AWG	20 lb·in			
LR-4040	$382.00	15 lb [6.8 kg]	#18–#4 AWG	20 lb·in			
LR-4050	$448.00	25 lb [11 kg]	#22–#4 AWG	#22–#16 AWG: 25 lb·in #14–#6 AWG: 30 lb·in #4 AWG: 35 lb·in			
LR-4060	$462.00						
LR-4075	$700.00	33 lb [15 kg]	2/0 – #6AWG (AL or CU)	120 lb·in			
LR-4100	$840.00	46 lb [21 kg]	250kcmil – #6AWG (AL or CU)	275 lb·in			
LR-4125	$962.00	46 lb [21 kg]	250kcmil – #6AWG (AL or CU)	275 lb·in			
LR-4150	$1,114.00	46 lb [21 kg]	250kcmil – #6AWG (AL or CU)	275 lb·in			
LR-4200	$1,238.00	74 lb [34 kg]	(1) 600kcmil – #4 AWG (2) 250kcmil – 1/0	500 lb·in			
LR-4250	$1,403.00	74 lb [34 kg]	(2)* 350kcmil – #4 AWG (AL or CU)	275 lb·in			
LR-4300	$1,546.00	74 lb [34 kg]	(2)* 350kcmil – #4 AWG (AL or CU)	275 lb·in			
LR-5010	$202.00	4.0 lb [1.8 kg]	#12–#18 AWG	10 lb·in			

** LR-4250 & LR-4300 have dual-connector lugs, and will require multiple conductors per phase of the appropriate size to fit the lugs.*

GS4 *DURA*PULSE Drives Accessories – Dynamic Braking Component Selection – GS4

Braking Component Selection for GS4 DURApulse AC Drives

GS4 AC Drive Braking Component Selection

Drive Voltage	Motor Power		125% Braking Torque @ 10% Duty Cycle**							Max Braking Torque		
				Braking Unit		Braking Resistor						
	(hp)	(kW)	AC Drive Model # GS4-	Quantity	Part # GS-	Quantity	Part # GS-BR-	Brake Torque (kg·m)	Total Brake Current (A)	Min Resistor Value (Ω)	Max Total Brake Current (A)	Peak Power (kW)
230V	1	0.7	21P0	0	n/a	1	080W200	0.5	1.9	63.3	6	2.3
	2	1.5	22P0			1	200W091	1.0	4.2	47.5	8	3.0
	3	2.2	23P0			1	300W070	1.5	5.4	38.0	10	3.8
	5	3.7	25P0			1	400W040	2.5	9.5	19.0	20	7.6
	7.5	5.5	27P5			1	1K0W020	3.7	19	14.6	26	9.9
	10	7.5	2010			1	1K0W020	5.1	19	14.6	26	9.9
	15	11	2015			1	1K5W013	7.5	29	12.6	28	10.6
	20	15	2020			2	1K0W4P3	10.2	44	8.3	46	17.5
	25	18	2025			2	1K0W4P3	12.2	44	8.3	46	17.5
	30	22	2030			2	1K5W3P3	14.9	58	5.8	66	25.1
	40	30	2040	2	1DBU	4	1K0W5P1	20.3	75*	4.8*	80*	30.4*
	50	37	2050	2	2DBU	4	1K2W3P9	25.1	97*	3.2*	120*	45.6*
	60	45	2060	2	2DBU	4	1K5W3P3	30.5	118*	3.2*	120*	45.6*
	75	55	2075	3	2DBU	6	1K2W3P9	37.2	145*	2.1*	180*	68.4*
	100	75	2100	4	2DBU	8	1K2W3P9	50.8	190*	1.6*	240*	91.2*
460V	1	0.7	41P0	0	n/a	1	080W750	0.5	1	190	4	3.0
	2	1.5	42P0			1	200W360	1	2.1	126.7	6	4.6
	3	2.2	43P0			1	300W250	1.5	3	108.6	7	5.3
	5	3.7	45P0			1	400W150	2.5	5.1	84.4	9	6.8
	7.5	5.5	47P5			1	1K0W075	3.7	10.2	54.3	14	10.6
	10	7.5	4010			1	1K0W075	5.1	10.2	47.5	16	12.2
	15	11	4015			1	1K5W043	7.5	17.6	42.2	18	13.7
	20	15	4020			2	1K0W016	10.2	24	26.2	29	22.0
	25	18	4025			2	1K0W016	12.2	24	23.0	33	25.1
	30	22	4030			2	1K5W013	14.9	29	23.0	33	25.1
	40	30	4040			4	1K0W016	20.3	47.5	14.1	54	41.0
	50	40	4050	1	4DBU	4	1K2W015	25.1	50*	12.7*	60*	45.6*
	60	45	4060	1	4DBU	4	1K5W013	30.5	59*	12.7*	60*	45.6*
	75	55	4075	2	3DBU	8	1K0W5P1	37.2	76*	9.5*	80*	60.8*
	100	75	4100	2	4DBU	8	1K2W015	50.8	100*	6.3*	120*	91.2*
	125	90	4125	2	4DBU	8	1K5W013	60.9	117*	6.3*	120*	91.2*
	150	110	4150	1	5DBU	10	1K2W015	74.5	126*	6.0*	126*	95.8*
	175	132	4175	1	6DBU	12	1K5W012	89.4	190*	4.0*	190*	144.4*
	200	160	4200	1	6DBU	12	1K5W012	108.3	190*	4.0*	190*	144.4*
	250	185	4250	1	7DBU	14	1K5W012	125.3	225*	3.4*	225*	172.1*
	300	220	4300	2	5DBU	20	1K2W015	148.9	252*	3.0*	252*	190.5*

** These values are per individual DBU, as seen between DBU terminals B1 and B2.*
*** 10% Duty Cycle with maximum ON (braking) time of 10 seconds.*

GS/*DURA*PULSE Drives Accessories – Braking Unit Specifications for GS3 & GS4 *DURA*PULSE AC Drives

Braking Units for GS3 & GS4 DURApulse AC Drives

Overview

Braking units are applied to absorb the motor regeneration energy when the three-phase induction motor stops by deceleration.

GS-xDBU braking units, used with GS series braking resistors, provide optimum braking performance.

Note: Braking units are available ONLY for DURApulse drives.

WARNING: TO AVOID INJURY OR MECHANICAL DAMAGE, PLEASE REFER TO USER MANUAL GS-DB_UMP BEFORE WIRING.

Dynamic Braking Unit Specifications – for GS3 & GS4 *DURA*PULSE AC Drives

Braking Unit Part Number		GS-1DBU	GS-2DBU	GS-3DBU	GS-4DBU	GS-5DBU	GS-6DBU	GS-7DBU
Price		$269.00	$269.00	$364.00	$364.00	$1,517.00	$1,578.00	$1,732.00
Nominal Voltage (VAC)		230		460				
Max Motor Capacity (hp/[kW])		20 [15]	30 [22]	40 [30]	60 [45]	150 [110]	200 [160]	250 [185]
Output Rating	**Max Discharge Current (A) @ 10% Duty Cycle***	40	60	40	60	126	190	225
	Continuous Discharge Current (A)	15	20	15	18	45	50	100
	Braking Startup Voltage (VDC)	330/345/360/ 380/400/415 ±3V		600/690/720/ 760/800/830 ±6V		618/642/667/690/ 725/750 ±6V		
	Maximum On-Time (s)	10						
Input DC Voltage (VDC)		200–400		400–800		400–750		
Min Equivalent Resistor for Each Braking Unit (Ω)		10	6.8	20	13.6	6	4	3.4
Protection	**Power CHARGE Lamp/LED**	Comes ON until DC bus voltage (+P – -N) drops below 50VDC				Comes ON when DC bus voltage (DC+ – DC-) rises above 300VDC. Goes OFF when DC bus voltage (DC+ – DC-) drops below 100VDC.		
	Braking ACT Lamp/LED	ON during braking						
	Fault ERR Lamp	ON if a fault has occurred				n/a		
	Overcurrent Level LED (A)	n/a				190	290	340
	Overheat LED	n/a				Comes ON > 176°F [80°C]; Goes OFF < 149°F [65°C]		
	Heat Sink Overheat Temperture	203°F [95°C]				n/a		
	Alarm Output Relay Contact	5A @ 120VAC/28VDC (RA,RB,RC)				3A @ 250VAC/28VDC (RA,RC)		
Environment	**Installation Location**	indoor (no corrosive gases; no metallic dust)						
	Operating Temperature	14°F to 122 °F [-10 to +50 °C]						
	Storage Temperature	-4 to +140 °F [-20 to +60 °C]						
	Humidity	less than 90% RH, non-condensing						
	Vibration	9.8 m/s^2 [1G] under 20Hz ; 2m/s^2 [0.2G] at 20–50 Hz						
Mechanical Configuration		IP50 wall-mount enclosed				IP10 wall-mount enclosed		

** 10% Duty Cycle with maximum ON (braking) time of 10 seconds*

GS/DURAPULSE Accessories –

Braking Resistors for AC Drives

Overview

Braking resistors are used to increase the control torque of the AC drive, for frequently repeated ON-OFF cycles of the AC drive, or for decelerating a load with large inertia.

For GS3 Durapulse drive models 20 hp and above, a dynamic braking unit must be used in conjunction with the braking resistor, as shown in the Durapulse AC drive Braking Units table.

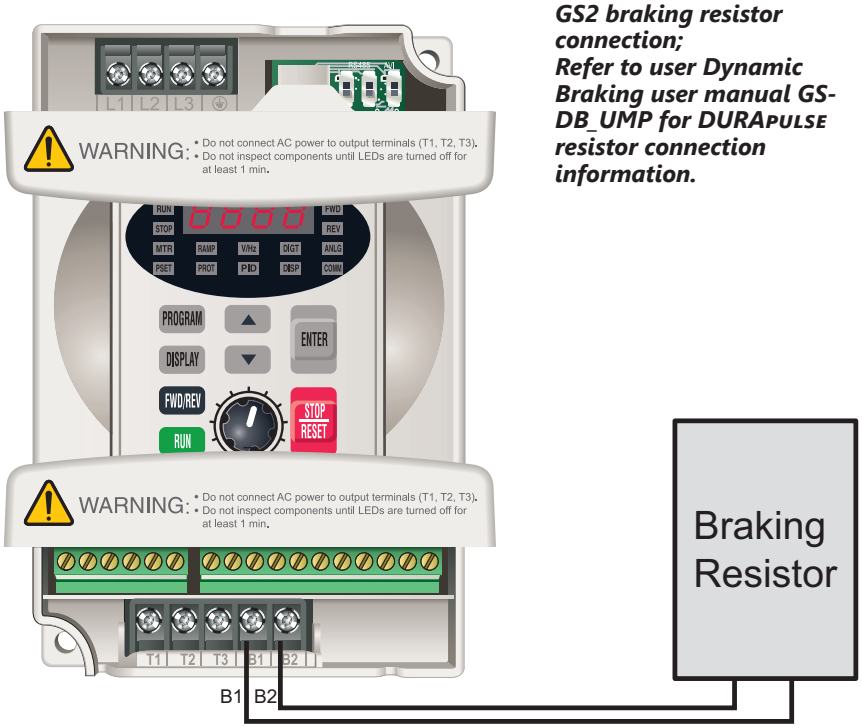
For additional information, please refer to the dynamic braking manual, GS-DB_UMP.

GS-25P0-BR

GS-27P5-BR

GS-2020-BR-ENC

GS-2020-BR-ENC without Cover



GS2 braking resistor connection; Refer to user Dynamic Braking user manual GS-DB_UMP for DURAPULSE resistor connection information.

GS/DURAPULSE Drives Accessories –

Braking Resistor Specs for AC Drives

Braking Resistor Specifications				
Part Number	*Price*	*Power (W)*	*Resistance (Ω)*	*Type*
GS-20P5-BR	$17.00	80	200	open
GS-21P0-BR	$17.00	80	200	
GS-22P0-BR	$41.50	300	100	
GS-23P0-BR	$41.50	300	70	
GS-25P0-BR	$49.50	400	40	
GS-27P5-BR	$49.50	500	30	
GS-2010-BR-ENC	$344.00	1000	20	enclosed
GS-2015-BR-ENC	$597.00	2400	13.6	
GS-2020-BR-ENC	$662.00	3000	10	
GS-2025-BR-ENC	$809.00	4800	8	
GS-2030-BR-ENC	$795.00	4800	6.8	
GS-2040-BR-ENC	$662.00	3000	10	
GS-2050-BR-ENC	$809.00	4800	8	
GS-41P0-BR	$26.00	80	750	open
GS-42P0-BR	$58.00	300	400	
GS-43P0-BR	$58.00	300	250	
GS-45P0-BR	$70.00	400	150	
GS-47P5-BR	$70.00	500	100	
GS-4010-BR	$165.00	1000	75	
GS-4015-BR-ENC	$344.00	1000	50	enclosed
GS-4020-BR-ENC	$427.00	1500	40	
GS-4025-BR-ENC	$1,017.00	4800	32	
GS-4030-BR-ENC	$1,017.00	4800	27.2	
GS-4040-BR-ENC	$1,017.00	6000	20	
GS-4050-BR-ENC	$1,198.00	9600	16	
GS-4060-BR-ENC	$1,198.00	9600	13.6	
GS-4075-BR-ENC	$1,017.00	6000	20	
GS-4100-BR-ENC	$1,198.00	9600	13.6	
GS-BR-080W200	$17.00	80	200	open
GS-BR-080W750	$17.00	80	750	
GS-BR-200W091	$34.50	200	91	
GS-BR-200W360	$34.50	200	360	
GS-BR-300W070	$41.50	300	70	
GS-BR-300W250	$39.00	300	250	
GS-BR-300W400	$32.00	300	400	
GS-BR-400W040	$49.50	400	40	
GS-BR-400W150	$46.50	400	150	
GS-BR-500W100	$38.50	500	100	
GS-BR-750W140	$68.00	750	140	
GS-BR-1K0W4P3	$110.00	1000	4.3	
GS-BR-1K0W5P1	$110.00	1000	5.1	
GS-BR-1K0W016	$110.00	1000	16	
GS-BR-1K0W020	$110.00	1000	20	
GS-BR-1K0W075	$110.00	1000	75	
GS-BR-1K2W3P9	$121.00	1200	3.9	
GS-BR-1K2W015	$121.00	1200	15	
GS-BR-1K5W3P3	$144.00	1500	3.3	
GS-BR-1K5W012	$144.00	1500	12	
GS-BR-1K5W013	$144.00	1500	13	
GS-BR-1K5W043	$144.00	1500	43	

GS4 *DURA*PULSE Accessories – EMI Filters Selection

Selection (GS4)

The optional EMI Filters listed here are available for use with the GS4 drive. Selection of these accessories is application-specific and may improve drive performance. Additional information regarding filter installation and operation is available in the AutomationDirect white paper, "Applied EMI/RFI Techniques," downloadable from AutomationDirect.com.

EMI Filters Selection for GS4 AC Drives

Model*	Description	EMI Filter **	Max Power kW [max/ph]	Max Torque kg·cm [lb·in]	SCCR Rating (kA)
GS4-21P0	230V 1ph/3ph 1.0 hp	KMF325A	20.8 [6]	17.7 [2]	5
GS4-22P0	230V 1ph/3ph 2.0 hp				
GS4-23P0	230V 1ph/3ph 3.0 hp				
GS4-25P0	230V 1ph/3ph 5.0 hp				
GS4-27P5	230V 1ph/3ph 7.5 hp	KMF370A	58.1 [16.8]	44.2 [5]	5
GS4-2010	230V 1ph/3ph 10hp				
GS4-2015	230V 1ph/3ph 15hp				
GS4-4025	460V 3ph 25hp				
GS4-4030	460V 3ph 30hp				
GS4-4040	460V 3ph 40hp				
GS4-2020	230V 3ph 20hp	KMF3100A	83 [24]	44.2 [5]	10
GS4-2025	230V 3ph 25hp				
GS4-2030	230V 3ph 30hp				
GS4-41P0	460V 3ph 1.0 hp	KMF318A	14.9 [4.3]	17.7 [2]	5
GS4-42P0	460V 3ph 2.0 hp				
GS4-43P0	460V 3ph 3.0 hp				
GS4-45P0	460V 3ph 5.0 hp				
GS4-47P5	460V 3ph 7.5 hp				
GS4-4010	460V 3ph 10hp	KMF350A	41.5 [12]	44.2 [5]	10
GS4-4015	460V 3ph 15hp				
GS4-4020	460V 3ph 20hp				
GS4-4050	460V 3ph 50hp	MIF375	62.3 [18]	53.1 [6}	10
GS4-2040	230V 3ph 40hp	MIF3150	124.6 [36]	177 [20]	10
GS4-2050	230V 3ph 50hp				
GS4-4060	460V 3ph 60hp				
GS4-4075	460V 3ph 75hp				
GS4-4100	460V 3ph 100hp				
GS4-2060	230V 3ph 60hp	MIF3400B	332.2 [96]	265.5 [30]	30
GS4-2075	230V 3ph 75hp				
GS4-2100	230V 3ph 100hp				
GS4-4125	460V 3ph 125hp				
GS4-4150	460V 3ph 150hp				
GS4-4175	460V 3ph 175hp				
GS4-4200	460V 3ph 200hp				
GS4-4250	460V 3ph 250hp	MIF3800 & Qty. 3 TOR254	664.3 [192]	265.5 [30]	30
GS4-4300	460V 3ph 300hp				

** EMI filter selections for GS4-2xxx models are the same whether that particular model is supplied 1-Phase or 3-Phase 230VAC.*
*** Part numbers are Roxburgh EMI Filters available from AutomationDirect at the web link embedded with each part number listed above.*

GS4 *DURA*PULSE Accessories – Fusing

Fuse Selection for GS4 AC Drives

The fuses shown in the table below are available from AutomationDirect. Further information, including dimensional information, is available at AutomationDirect.com.

Fuse Specification Chart GS4 *DURA*PULSE Drives

Drive Model	For Three-Phase Input Power							For Single-Phase Input Power						
	HP	Input Power			Input Fuse ***			HP	Input Power			Input Fuse ***		
		Ø	Volts	GS4 Amps	Fuse Amps	Fast Acting Class T	Edison Class J*		Ø	Volts	GS4 Amps	Fuse Amps	Fast Acting Class T	Edison Class J*
GS4-21P0	1	3	230	6.4	10	TJN10	JHL10	0.5	1	230	6.4	10	TJN10	JHL10
GS4-22P0	2	3	230	12	15	TJN15	JHL15	0.75	1	230	9.7	15	TJN15	JHL15
GS4-23P0	3	3	230	16	25	TJN25	JHL25	1	1	230	15	20	TJN20	JHL20
GS4-25P0	5	3	230	20	35	TJN35	JHL35	2	1	230	20	30	TJN30	JHL30
GS4-27P5	7.5	3	230	28	50	TJN50	JHL50	3	1	230	26	40	TJN40	JHL40
GS4-2010	10	3	230	36	70	TJN70	JHL70	3	1	230	26	40	TJN40	JHL40
GS4-2015	15	3	230	52	100	TJN100	JHL100	5	1	230	40	70	TJN70	JHL70
GS4-2020	20	3	230	72	125	TJN125	JHL125	7.5	1	230	58	100	TJN100	JHL100
GS4-2025	25	3	230	83	150	TJN150	JHL150	10	1	230	76	125	TJN125	JHL125
GS4-2030	30	3	230	99	175	TJN175	JHL175	10	1	230	76	125	TJN125	JHL125
GS4-2040**	40	3	230	124	175	TJN175	JHL175	10	1	230	63	90	TJN90	JHL90
GS4-2050**	50	3	230	143	200	TJN200	JHL200	10	1	230	63	90	TJN90	JHL90
GS4-2060	60	3	230	171	250	TJN250	JHL250	15	1	230	94	150	TJN150	JHL150
GS4-2075	75	3	230	206	300	TJN300	JHL300	20	1	230	124	175	TJN175	JHL175
GS4-2100	100	3	230	245	350	TJN350	JHL350	25	1	230	143	200	TJN200	JHL200
GS4-41P0	1	3	460	4.3	6	TJS6	JHL6							
GS4-42P0	2	3	460	5.9	10	TJS10	JHL10							
GS4-43P0	3	3	460	8.7	15	TJS15	JHL15							
GS4-45P0	5	3	460	14	20	TJS20	JHL20							
GS4-47P5	7.5	3	460	17	25	TJS25	JHL25							
GS4-4010	10	3	460	20	35	TJS35	JHL35							
GS4-4015	15	3	460	26	45	TJS45	JHL45							
GS4-4020	20	3	460	35	60	TJS60	JHL60							
GS4-4025	25	3	460	40	70	TJS70	JHL70							
GS4-4030	30	3	460	47	90	TJS90	JHL90							
GS4-4040**	40	3	460	63	125	TJS100	JHL100							
GS4-4050	50	3	460	74	100	TJS110	JHL110							
GS4-4060	60	3	460	101	125	TJS150	JHL150							
GS4-4075	75	3	460	114	150	TJS150	JHL150							
GS4-4100	100	3	460	157	200	TJS200	JHL200							
GS4-4125	125	3	460	167	250	TJS250	JHL250							
GS4-4150	150	3	460	207	300	TJS300	JHL300							
GS4-4175	175	3	460	240	350	TJS350	JHL350							
GS4-4200	200	3	460	300	450	TJS450	JHL450							
GS4-4250	250	3	460	380	500	TJS500	JHL500							
–	–					Fast Acting Current Limiting Class L								
GS4-4300	300	3	460	400	700	LCU700								

single-phase input power not applicable for 460V

** High-speed Class J*
*** Includes DC choke*
**** The fuses listed above are available from AutomationDirect.com. (Individual web links are associated with each part number listed above.)*

Kennebec Water District

Lagoon Upgrade Project

Engineering for Remote IO control cabinet with VFD's and pumps

BY:

Automatrix

Winthrop, Maine

Table of Contents

SECTION 1

CONTROL CABINETS AND ENCLOSURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Cabinets and Construction

2. Control Devices

3. Uninterruptable Power Supply (UPS)

4. Surge Protective Devices (PLC/RIO Panel Power)

5. DC Power Supply

6. Panel Accessories

1.2 SUBMITTALS

A. Shop drawings, product data, and reports

B. Shop Drawings for Equipment Panels: Include project-specific wiring schematic diagram (with wire numbers for all wires), outline drawing, construction diagram and dimensions as described in ANSI/NEMA ICS 1 and NFPA 79

1.3 REGULATORY REQUIREMENTS

A. Conform to requirements of NEC Article 409, NFPA 79, UL 508Aand all local and federal regulations.

A-1000/193 12/19/22 16137 -2 Control Cabinets and Enclosures

PART 2 PRODUCTS

2.1 CABINETS

A. Construction: NEMA 250, Type as specified, indicated on the Drawings or below

B. Cabinet materials and ratings shall be as follows (unless otherwise indicated on the drawings):

1. Dry Locations: NEMA 12 metallic

2. Damp locations and wet locations: NEMA 4 metallic

3. Corrosive locations: NEMA 4X Metallic and Non-Metallic Boxes

4. Wet Corrosive locations: NEMA 4X Metallic and Non-Metallic

C. Finish: Metallic cabinets shall have a brushed finish

D. Covers: Continuous hinge held closed by flush latch operable by screwdriver or handle

E. Panel for Mounting Terminal Blocks or Electrical Components: 12 gauge steel, white enamel finish

2.2 CONTROL SWITCHES AND PILOT DEVICES

A. Mounting Hole: 30.5mm

B. Contact: NEMA ICS 2; Form C

C. Contact Rating: NEMA ICS 2; A150, 10 amps

D. Type: Industrial heavy duty oil tight type, waterproof (NEMA 4) or explosion proof (NEMA 7) as required and/or indicated on the Drawings, pushbuttons, selector switches, and stop buttons

E. Indicating Lights: LED. Lens color as indicated on Drawings. Lights which are not illuminated during normal equipment operation, such as “Fault” and “Warning”, shall be push-to-test.

F. Legend Plates with markings and weatherproof requirements as indicated on the Drawings. Legend plates for emergency stops shall be yellow background.

G. Manufacturers

1. Eaton/Cutler-Hammer, Model 10250T (w/Logic Level Blocks or class I, Div. 2 rated blocks as required)

2. Allen-Bradley, 800T/800H (w/PenTuff Blocks or class I, Div. 2 rated blocks as required)

3. Equal by Square D

4. or equal

2.3 CONTROL RELAYS

A. Contacts: Form C, convertible contacts, each relay shall include at least one spare set of contacts

B. Contact Rating:

1. Relays for non-motor loads: Pilot Duty Rating NEMA C300, R300; 15 Amp @ 120VAC inductive, 7.5A @ 240VAC inductive, 7 Amp @ 277VAC general purpose, 7 Amp @ 30VDC resistive

2. Relays for motor loads: Rated insulation voltage 250V IEC, 300V UL; 1/3HP @ 120VAC, 3/4HP @ 240VAC.

C. Coil Voltage: 120 volts, 60 Hz., AC unless otherwise required for application.

D. Relay: Interposing/isolation relay, square base, rail mounted

E. Electrical life (cycles): 100,000 minimum

G. Manufacturers

1. Allen Bradley: Bulletin 700, 700-HC for non-motor loads, 700-HK for motor loads

2. Eaton/Cutler Hammer

3. Square D

4. or equal

2.4 TERMINAL BLOCKS

A. Type - Modular construction type, 35mm DIN rail mounted, tubular pressure screw connectors

B. Physical

1. Wire Size: 22-10 AWG

2. Rated Voltage: 600 V

3. Rated Current: 30 A

C. Manufacturers

1. Allen Bradley

2. Entrelec

3. Phoenix Contact

4. Or equal

2.5 DIN RAIL

A. DIN rail shall be zinc plated steel and chromate passivated. Rail shall be 35mm wide and 7.5mm or 15mm deep. Rails may be raised with conductive standoffs. Raised rails shall be 15mm deep. Rails shall not be angled.

2.6 UNINTERRUPTABLE POWER SUPPLY (UPS)

A. A UPS shall be provided for the Pump Control Panel Cabinet as specified herein and elsewhere where shown on the contract drawings or referred to in the specifications.

B. The UPS shall be rated for 120 VAC, 60 Hz, true sine wave output online full time.

C. The UPS shall have a rating sufficient to supply and operate each control panel and its components for a duration of 30 minutes under full load without any external power applied.

D. Minimum size: 1500VA

E. The UPS shall provide protection from surges and lightning.

F. The battery shall be maintenance free and shall not emit explosive or corrosive gases during charge or discharge.

G. Status lights shall be visible indicating normal AC line power and battery charge.

H. The UPS shall operate properly in an ambient temperature of 0 to 40□C.

I. Manufacturers

1. American Power Conversion

2. Equal by Eaton

3. Or equal

2.7 SURGE PROTECTIVE DEVICE (PLC/RIO PANEL POWER – SINGLE PHASE)

A. Provide surge protection in the panel for the incoming power on panels that contain the following:

1. PLC

2. RIO

3. Uninterruptable power supply

B. Surge Current: 35kA (minimum)

C. SCCR: 25kA

D. Provide fuses for the surge protector.

E. Manufacturers:

1. Square D, model SDSA1175

2. Eaton

3. Citel

4. Or equal

2.8 DC POWER SUPPLY

A. Switching type DC power supply.

B. Input: As indicated or as required for application

C. Output: 24Vdc (nominal). Nominal values of Wattage and Current indicated in the Drawings or as required for application. Output shall be adjustable between 24 and 28VDC. Negative terminal of output shall be grounded.

D. Power supply shall deliver 25% additional current continuously and deliver 150% of rated current for up to 5 seconds.

E. Overload Handling: Fold-Forward (Current rises, voltage drops to maintain constant power during overload up to max peak current)

F. Manufacturer

1. Phoenix Contact: Quint SFB

2. Puls: QT series

3. Or equal

2.9 PANEL ACCESSORIES

A. Provide plastic wire duct/wireway with snap-on cover mounted to the backplate. Wire duct shall be rated for high temperature and sized to provide a minimum of 30% spare fill capacity and arranged to allow ease of wiring.

Manufacturers: Panduit (Type F),
Iboco, or equal.

B. Provide documentation pocket mounted to inside of panel door to hold panel drawings.

C. Provide LED interior light with door switch in all panels which exceed 3’ width.

D. Label all devices, components, and terminal strips. Labels shall not be affixed to devices or components, but rather to the back panel on which the devices and components are mounted. Provide engraved tags or equal.

2.10 FABRICATION

A. All electrical panels shall have a short circuit current rating (SCCR) and/or available interrupting current (AIC) rating.

1. Equipment Ampere Interrupting Capacity (AIC) and/or Short Circuit Current Rating (SCCR): Electrical equipment shall be labeled in accordance with NFPA 70 and have an Ampere Interrupting Capacity rating or Short Circuit Current Rating of equal to or greater than the following:

1. 480 volt equipment: 35,000 amps

2. 208 or 240 volt equipment: 22,000 amps

B. Provide 10% spare I/O capacity wired to terminal blocks.

C. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.

D. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

E. Install a switched light and a convenience receptacle, accessible inside each cabinet.

F. Label all devices, components, and terminal strips. Labels shall not be affixed to devices or components, but rather to the back panel on which the devices and components are mounted. Provide lamicoid tags or equal.

G. Wire all internal panel devices that require field wiring connections to a field wiring terminal strip.

H. Fabricate in accordance with National Electric Code, Article 409 and UL 508A.

I. Provide wire markers on each end of each conductor as specified in 16075.

J. Control Cabinets shall be large enough such that there is a minimum clear space of 3 inches on the sides or 4 inches on the bottom for access while connecting or servicing field wiring. Clear space need only be provided on either the side or bottom of the enclosure adjacent to the field wiring terminal strip. If there are terminal strips on both the side and bottom, clear space shall be provided to each terminal strip.

K. Control Cabinets containing a UPS shall be large enough such that no part of the UPS is in front of any devices, terminals, wire duct, DIN rail, etc.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install cabinets and enclosures plumb; anchor securely to structural supports with materials and methods.

1. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors, preset inserts or beam clamps. Do not use spring steel clips and clamps.

2. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

3. Do not use powder-actuated anchors.

4. Hanger rods shall be subjected to tension only. Lateral and axial movements shall be accommodated by proper linkage in the rod assembly.

5. Fabricate supports from support channel rigidly welded or bolted to present a neat appearance. Galvanized structural steel may be used where galvanized support channel is allowed. Use stainless steel hexagon head bolts with spring lock washers under all nuts. Coat ends of galvanized steel channel that has been cut
with zinc-rich paint in accordance with ASTM A-780.

6. Install freestanding electrical equipment on 4 inch concrete housekeeping pads.

7. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide channel supports to stand cabinet 1 inch off wall.

8. Use standoffs for all surface mounted conduit to maintain ¼ inch space between conduits and walls.

B. Neatly train and lace field wiring and terminate all field wiring on terminal blocks.

C. Clean debris from inside of enclosures and control panels.

D. Clean outside of enclosures and control panels.

E. Repair scratches per manufacturers recommendations.

F. Dented enclosures and control panels shall be replaced.

END OF SECTION

SECTION 2

AC SUBMERSIBLE MOTORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Three Phase Motors

1.2 REFERENCES

A. ANSI/NEMA MG 1 - Motors and Generators.

B. ANSI/NEMA MG 3 – Sound Level Prediction for Installed Rotating Electrical Machines

C. ANSI/NFPA 70 - National Electrical Code.

D. ANSI/IEEE 112 – IEEE Standard for Polyphase Induction Motors and Generators

1.3 SUBMITTALS

A. Factory test reports for all 3-phase motors 20 hp and larger. Test report shall include:

1. No load current

2. Full load current

3. Breakdown torque

4. Locked rotor (starting) current

5. Locked rotor torque

6. Hi-potential test

B. Product data and manufacturer's installation instructions.

C. Operation and maintenance data.

1. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.4 QUALITY ASSURANCE

A. Qualifications - Manufacturer/Company specializing in manufacture of electric motors for industrial use, and their accessories, with minimum 3 years documented product development, testing, and manufacturing experience.

B. Regulatory Requirements

1. Conform to National Electrical Code

2. Conform to local energy code.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. GormanRupp SF4A Pump

B. Barns 4ESHDG200N4

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Motors - Design for continuous operation in 40 degrees C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type.

B. Efficiency: Motors shall be premium efficiency type, as defined in NEMA MG 1

C. Visible Nameplate - Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency, AFBMA bearing numbers, manufacture date. Stainless steel nameplate attached with stainless steel pins.

D. Electrical Connection - Oversized, diagonally split, cast-iron junction boxes with gaskets. Box provided with threaded conduit connection. Box shall be adjustable to all four mounting positions.

E. Enclosures – Enclosures shall be TEFC (Totally Enclosed Fan Cooled). Fans for TEFC motors shall be non-sparking bronze-alloy or reinforced plastic.

F. Motors less than 250 watts and intended for intermittent service need not conform to these specifications.

2.3 THREE PHASE MOTORS

A. Starting Torque - Between one and one and one-half times full load torque.

B. Starting Current - Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque - NEMA Design B characteristics, unless specified otherwise.

D. Design, Construction, Testing, and Performance - Conform to ANSI/NEMA MG 1 for Design B motors, unless specified otherwise.

E. Insulation System - NEMA Class F or better.

F. Motor Frames - NEMA standard T-frames of all cast iron construction with end brackets of cast iron.

G. Bearings - Double shielded with waterproof non-washing grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 20, L-10 life of 26,280 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension.

H. Sound Power Levels - To ANSI/NEMA MG 3 not over 90 dBa.

I. Vertical Motors - Equip with oil-lubricated thrust bearings.

J. Variable Frequency Drive Applications –

1. Motors powered by variable frequency drives shall be specifically designed to continuously operate within a 15-60 Hz range for variable torque applications and 20-60 Hz range for constant torque applications.

2. Motors shall be inverter duty rated and shall meet NEMA MG-1 Parts 30 and 31.

SECTION 3

AC VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. AC variable frequency drives (VFD).

1.2 REFERENCES

A. ANSI/NEMA ICS 3 - Industrial Systems

B. NEMA ICS 7.0 – Industrial Controls & Systems for VFDs

C. IEEE 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

1.3 SUBMITTALS

A. Shop drawings, product data and reports.

B. Project specific wiring diagrams.

C. Operation and Maintenance Data

1.4 DELIVERY, STORAGE AND HANDLING

A. Store drive in a warm, dry, non-corrosive location in original shipping carton to prevent damage.

1.5 SPARE PARTS

A. One printed circuit board control card of each type furnished.

B. Six fuses of each type furnished.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Automation Direct DuraPulse GS4

2.2 AC VARIABLE FREQUENCY DRIVE

A. The variable frequency AC drive shall convert 3 phase, 60 hertz input power to a variable AC frequency and voltage for controlling the speed of AC squirrel cage motors. The converter shall use a diode bridge rectifier to convert incoming AC power to a constant DC voltage bus. The inverter section shall be a voltage source design with a sine-weighted pulse-width modulated output. The output voltage is to vary

proportionally with the output frequency to maintain a constant volts/hertz value up to 60 hz.

B. Include in the controller, power conversion components, power control logic devices and regulator circuitry. Provide full digital control of frequency and voltage.

C. The variable frequency drives shall all be by one manufacturer and shall be wall mounted in an enclosure as specified below.

D. Low Harmonic Input Matrix Filter: Where shown on the drawings, provide a Low Harmonic Input Filter (type HG7 by TCI or equal) upstream of the VFD in the VFD enclosure. The filter shall ensure that harmonics injected in the electrical system do not exceed 7% (typically 5%-6%). Provide power contactors interlocked with the VFD to connect the filter capacitors only when the motor speed is higher than a field programmable setpoint (initial setpoint from the factory shall be 40Hz, unless otherwise noted).

E. Provide VFDs large enough to handle the nameplate full load current of the installed motor; do not select VFDs based solely on motor HP. Verify the nameplate full load current of the installed motor and provide the appropriately sized VFD for the installed motor.

F. The VFD and all associated equipment shall have a short circuit current rating (SCCR) of at least that specified in 16050.

G. The variable torque drives shall be rated for 100% continuous current, 110% current for one minute. Constant torque drives shall be rated for 100% continuous current, 150% current for one minute.

H. The drive shall also include as functional components: capacitors for DC bus, single control logic board, terminal blocks for connection of incoming power, motor terminations, operator controls and transient suppressor.

I. Include motor current overload protection.

J. Provide keypad and backlit display for display and control, to be mounted on the front panel of the VFD enclosure.

K. Enclosure: NEMA 12 (unless otherwise shown on drawings) with a thermostatically controlled cabinet fan. Other components specified herein and shown on the drawings shall be installed in the enclosure.

L. Provide 5% line reactor (in additional to the any integral drive impedance), unless drive is provided with a low harmonic filters.

M. Provide a dV/dt output filter where shown on drawings.

N. Provide a fused surge protection device for VFD power in the VFD enclosure; the surge protection device rating shall be as recommended by the VFD manufacturer.

2.3 VARIABLE DRIVE FUNCTIONS

A. Frequency Accuracy ±0.5%.

B. Operating Frequency Range Output: 0-60 Hz.

C. Adjustable Two Step Acceleration and Deceleration Times: 0.1-1600 seconds.

D. Lower Limit Frequency Adjustment: 0-60 Hz.

E. Upper Limit Frequency Adjustment: 0-60 Hz.

2.4 VARIABLE DRIVE CONTROLS

A. Speed control, start/stop control, local/remote control on keypad.

B. Remote speed adjustment from 4-20 mA control signal, where indicated.

C. Remote start/stop.

D. Drive run and stop indicating lights.

E. Contact closure for external indication of drive running and fault (rating 120 VAC, 1 AMP).

F. Elapsed time meter.

G. Other interlocks, indicating lights and controls indicated on Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install drive equipment in control panels as shown on the Drawings.

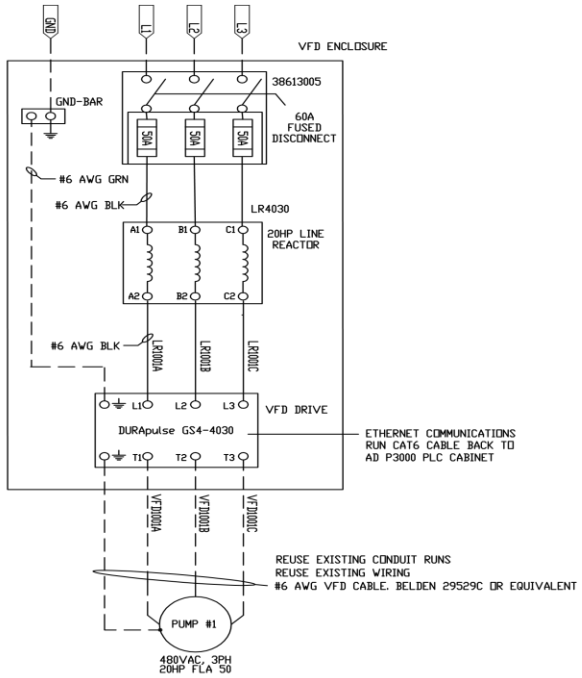
B. Provide services of a factory trained technician for startup and training, a minimum of one day per type of drive installed, per location.

END OF SECTION

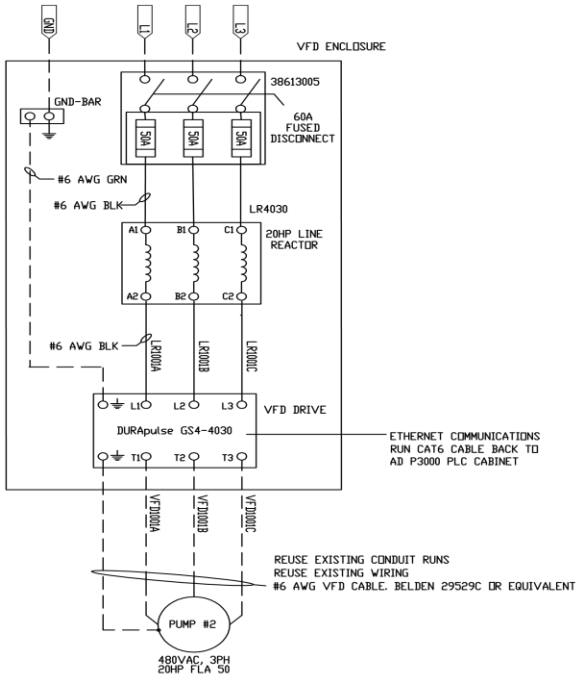
SECTION 4

LAGOON PUMPS 1 & 2 VFD CABINET SCHEMATICS

LAGOON PUMP 1 480VAC SCHEMATIC



LAGOON PUMP 2 480VAC SCHEMATIC



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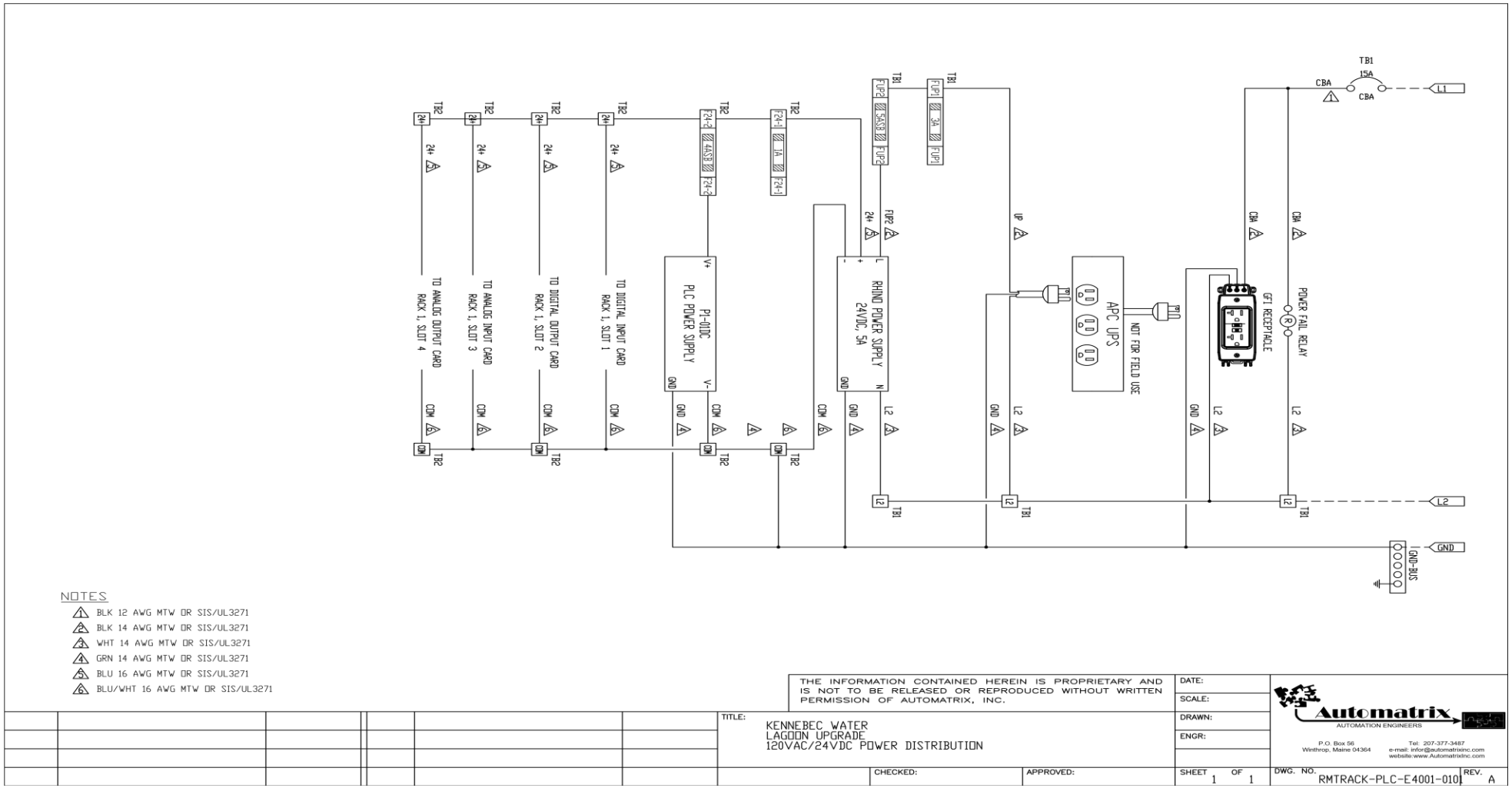
SECTION 5

REMOTE IO CABINET SCHEMATICS



NOTES

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2. BLK 14 AWG MTW OR SIS/UL3271
3. WHT 14 AWG MTW OR SIS/UL3271
4. GRN 14 AWG MTW OR SIS/UL3271
5. BLU 16 AWG MTW OR SIS/UL3271
6. BLU/WHT 16 AWG MTW OR SIS/UL3271

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KENNEBEC WATER
LAGOON UPGRADE
120VAC/24VDC POWER DISTRIBUTION

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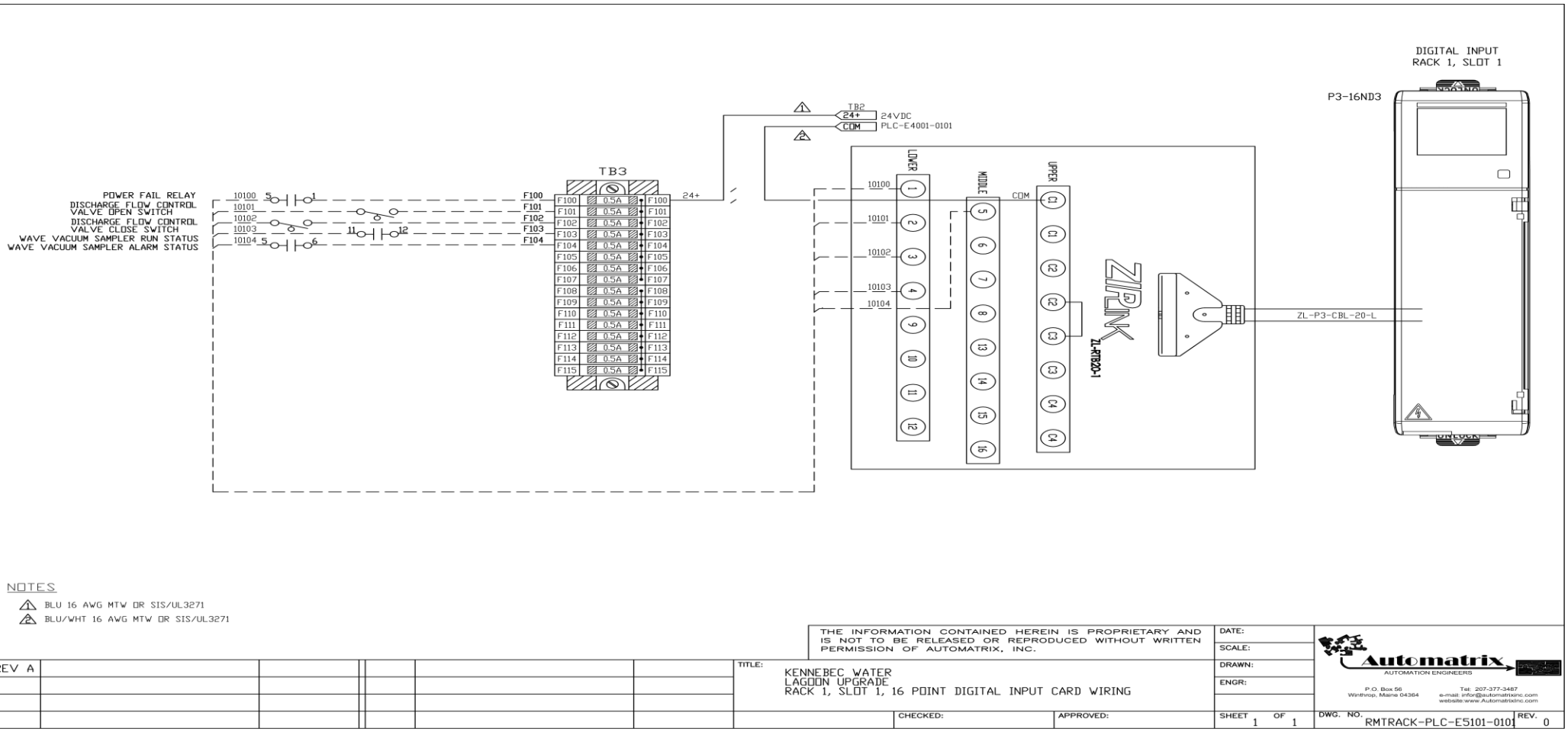
DIGITAL INPUT
RACK 1, SLOT 1
P3-16ND3
TB2
24+
COM
24VDC
PLC-E4001-0101
TB3
POWER FAIL RELAY
DISCHARGE FLOW CONTROL VALVE OPEN SWITCH
DISCHARGE FLOW CONTROL VALVE CLOSE SWITCH
WAVE VACUUM SAMPLER RUN STATUS
WAVE VACUUM SAMPLER ALARM STATUS
10100
10101
10102
10103
10104
F100
F101
F102
F103
F104
0.5A
24+
LOWER
MIDDLE
UPPER
COM
ZL-RTB20-1
ZL-P3-CBL-20-L
NOTES
BLU 16 AWG MTW OR SIS/UL3271
BLU/WHT 16 AWG MTW OR SIS/UL3271
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KENNEBEC WATER
LAGOON UPGRADE
RACK 1, SLOT 1, 16 POINT DIGITAL INPUT CARD WIRING
SHEET 1 OF 1
DWG. NO. RMTRACK-PLC-E5101-0101
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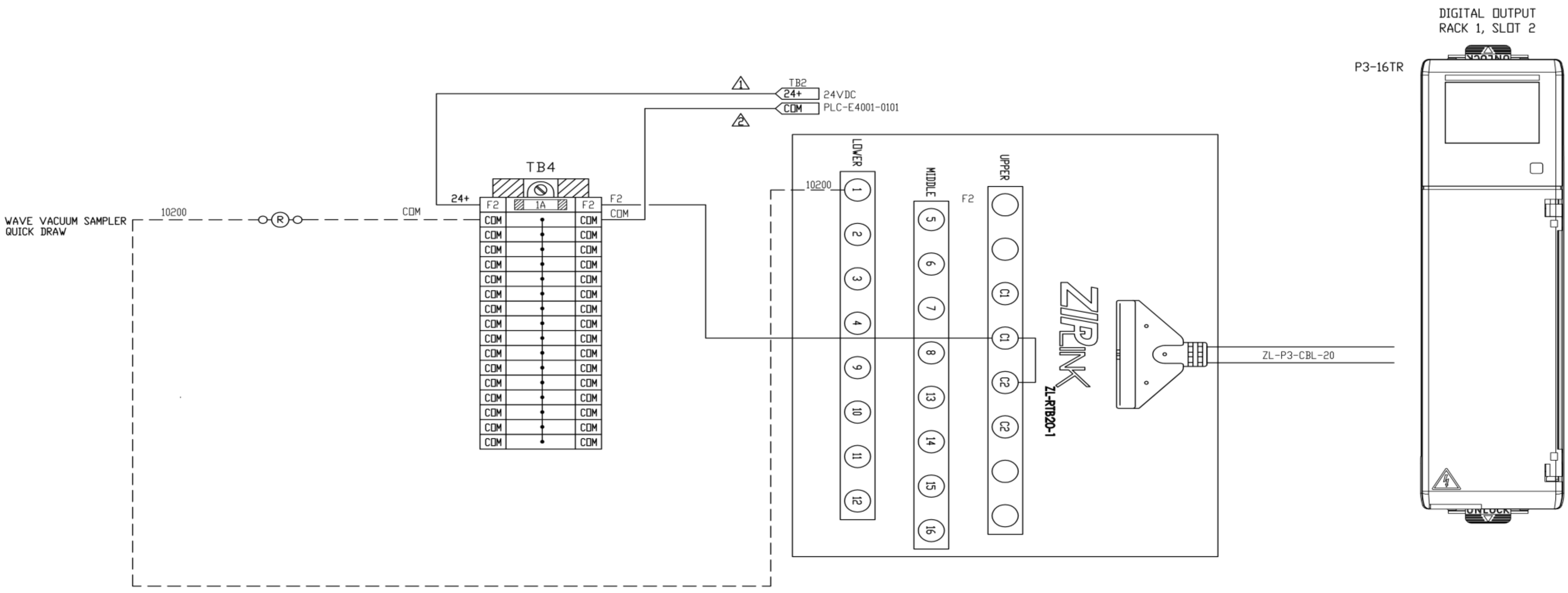

NOTES

1. BLU 16 AWG MTW OR SIS/UL3271
2. BLU/WHT 16 AWG MTW OR SIS/UL3271

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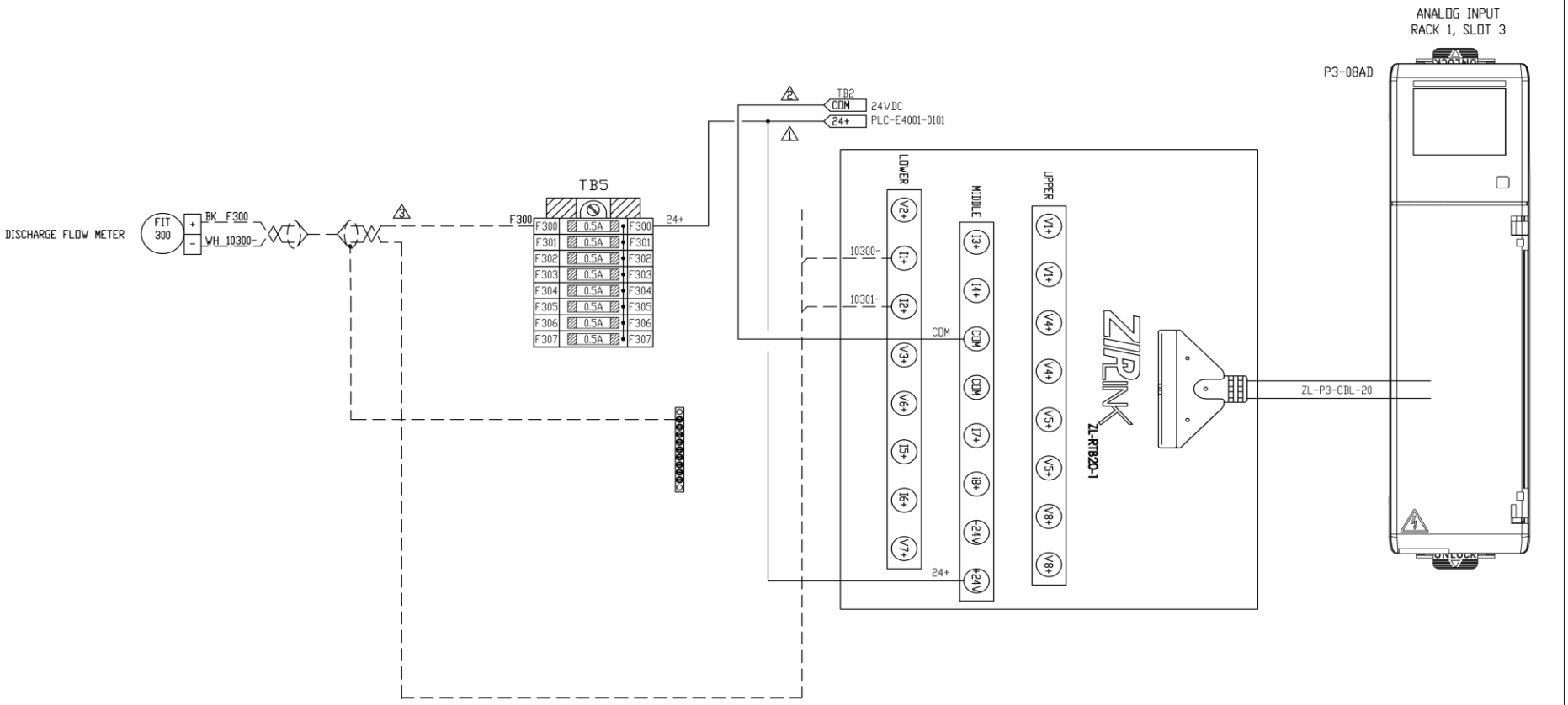
ANALOG INPUT
RACK 1, SLOT 3
P3-08AD
TB2
COM
24VDC
24+
PLC-E4001-0101
TB5
DISCHARGE FLOW METER
FIT 300
BK_F300
WH_10300-
F300
24+
10300-
10301-
COM
LOWER
MIDDLE
UPPER
ZIPLINK
ZL-RTB20-1
ZL-P3-CBL-20
NOTES
1 BLU 16 AWG MTW OR SIS/UL3271
2 BLU/WHT 16 AWG MTW OR SIS/UL3271
3 18 AWG 2/C SHIELDED TWISTED PAIR - BLK/WHT
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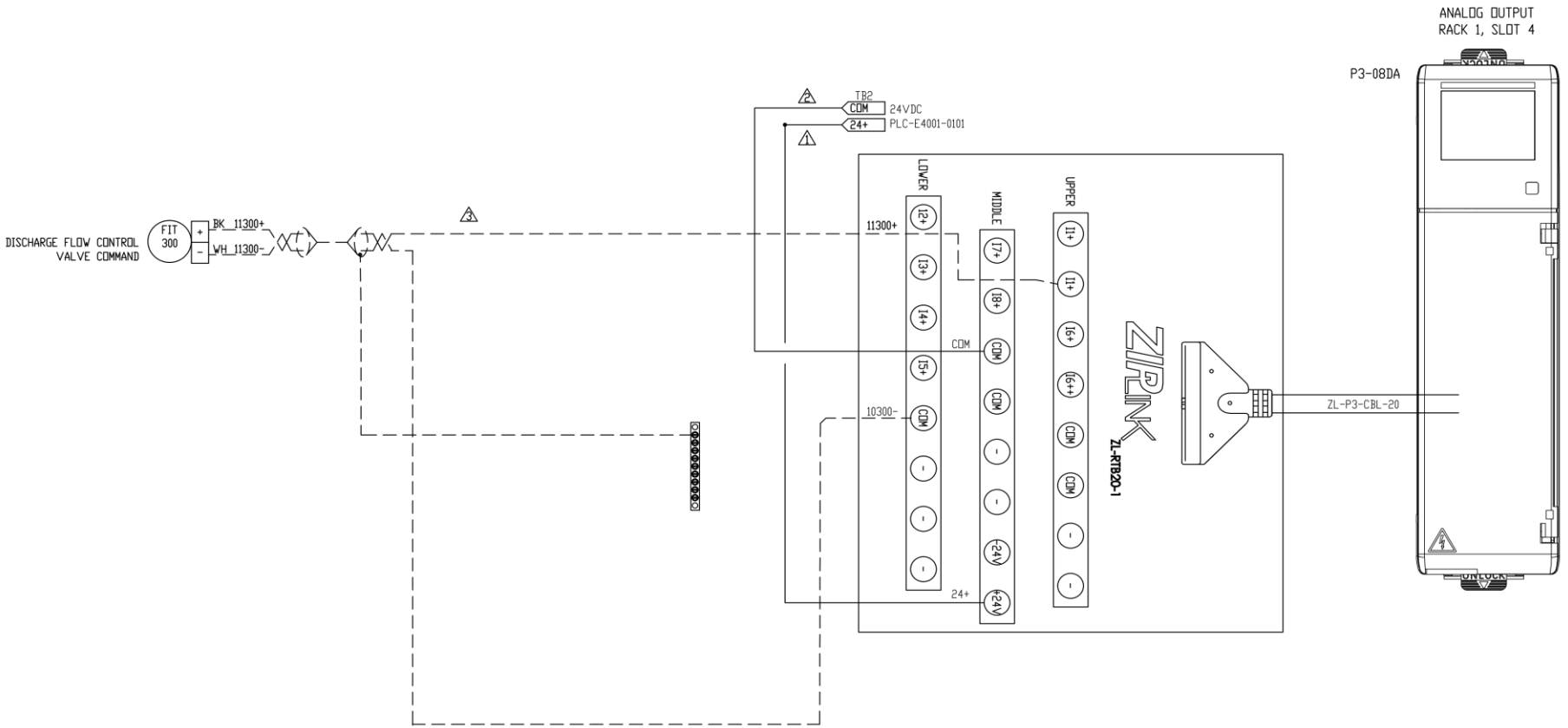

NOTES

1. BLU 16 AWG MTW OR SIS/UL3271
2. BLU/WHT 16 AWG MTW OR SIS/UL3271
3. 18 AWG 2/C SHIELDED TWISTED PAIR - BLK/WHT

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LAGOON UPGRADE
RACK 1, SLOT 4, 8 POINT ANALOG OUTPUT CARD WIRING

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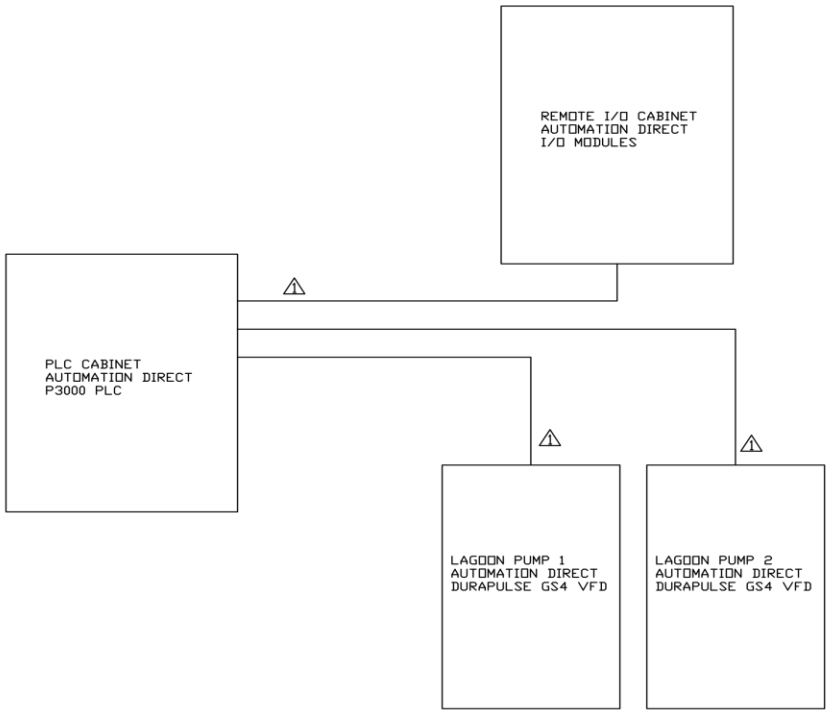

NOTES

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SECTION 6

ELECTRICAL EQUIPMENT LOCATION

1.1 REMOTE IO CABINET LOCATION

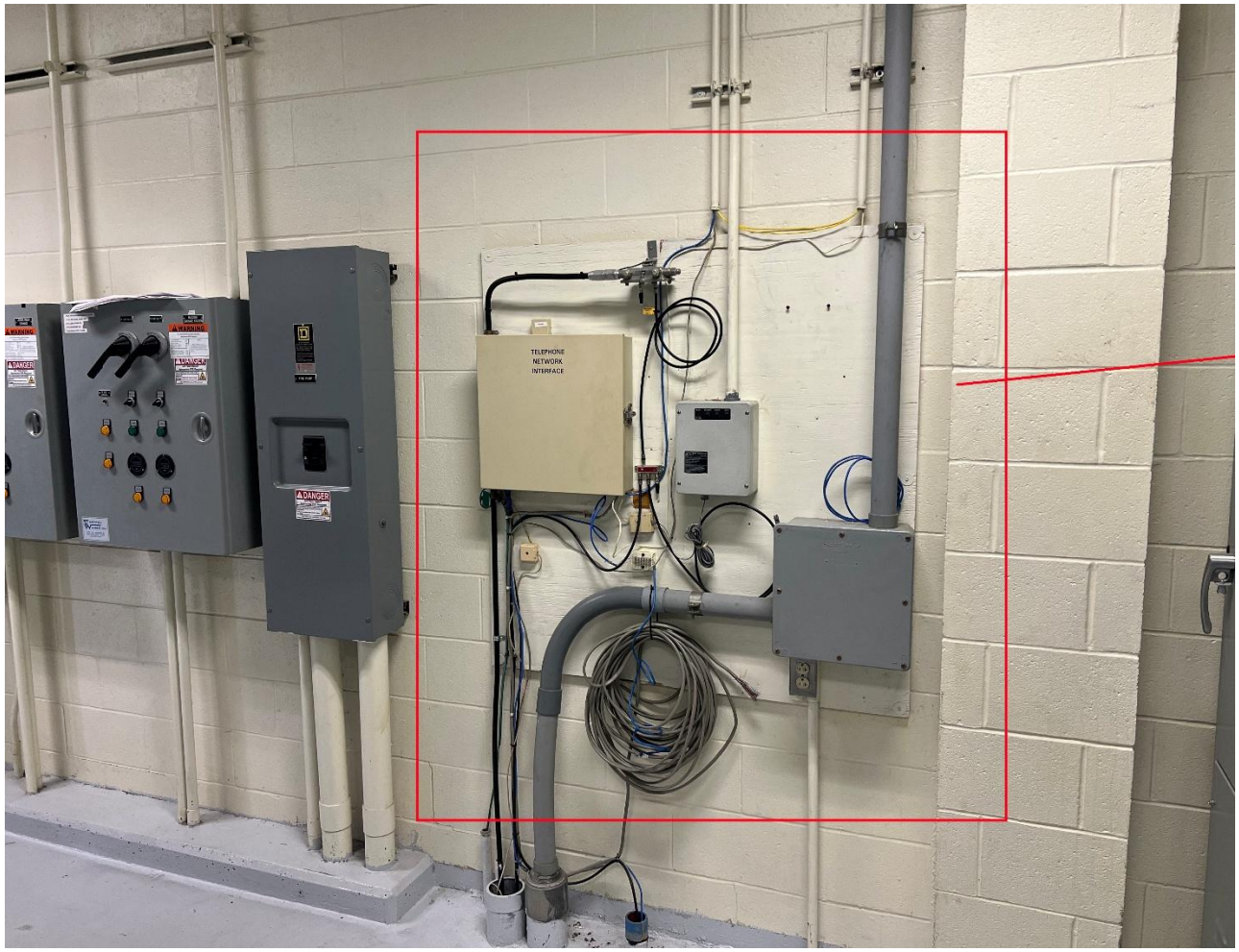
The remote IO cabinet will be mounted on the wall, in the picture shown.

1.2 VFD MCC BUCKETS

Below are the locations in the electrical room of the two buckets to power the VFD's

1.3 VFD PANELS

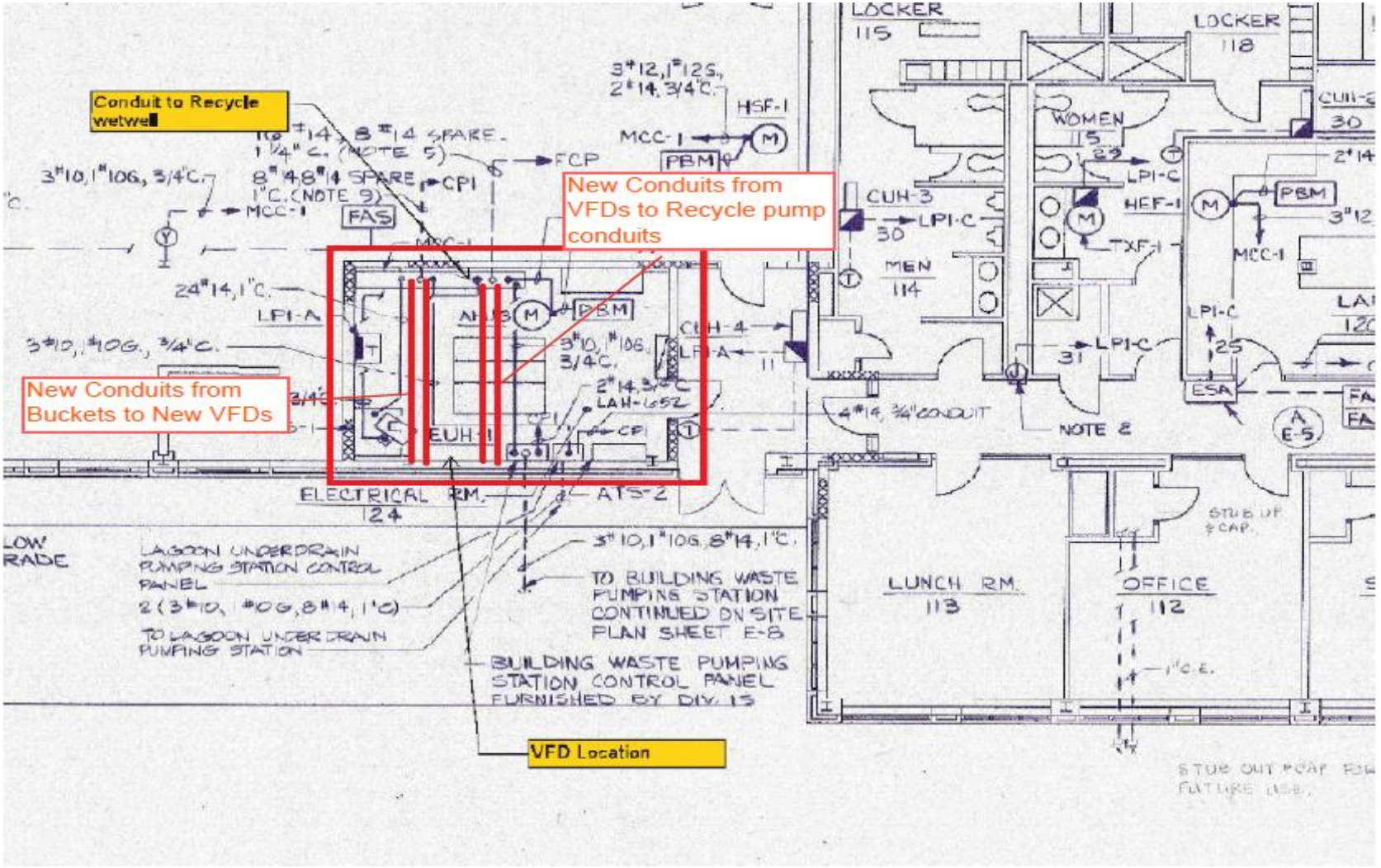
Below shows the location for the two VFD panels



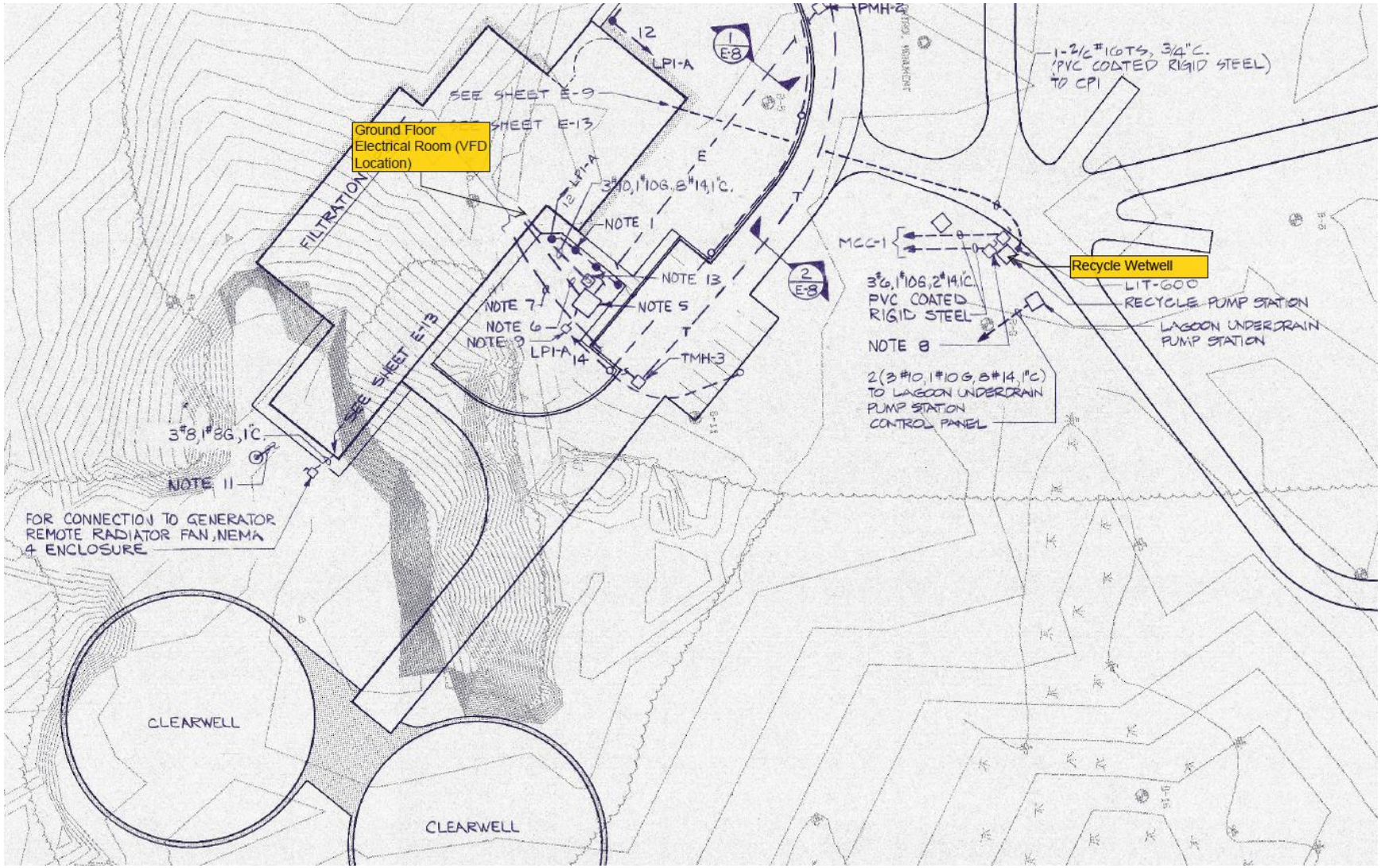
Existing communications and power equipment, wires and conduits will be relocated by Owner prior to start of construction. VFD enclosure will be located in this area.

1.4 ELECTRICAL ROOM LOCATION

Below shows the location of the Motor Control Center (MCC). The new conduits for the infeed to the VFDs will run from the bucket up overhead and down into the VFD enclosure. The new conduit runs from the load side of the VFDs will run from the VFD enclosure, overhead and down to the existing conduits for the recycle pumps.



1.5 OUTSIDE LAYOUT



SECTION 7

SCADA AND PLC CONTROL

1.1 SCADA

A. SCADA screens for this project will be created and modified using Kennebec Water District's (KWD) existing HMI at the Water Treatment Plant running on Inductive Automation Ignition. The design and functionality of the screens will follow the functional description in item 1.3 of this section

1.2 PLC

A. The PLC code for this project will be created and modified using KWD's existing programming running Automation Direct Productivity Suite Software. The PLC will connect over Ethernet to the New Remote IO cabinet and the two new Automation Direct DuraPulse GS4 VFD's. The PLC code will follow the Functional Description, in item 1.3 of this section.

1.3 Functional Description

A. This functional description will describe how the P3000 PLC will control the VFDs and the control valves. This system will use 3 modes of control.

1. Discharge Only Mode, will close the 8" Recycle flow control valve (0%) and open the 4" Discharge flow control valve (100%). The flow control to the VFD will be based upon a discharge outfall setpoint from the SCADA system

2. Recycle Only Mode, will open the 8" Recycle flow control valve (100%) and close the 4" Discharge flow control valve (0%) . The flow control to the VFD will be based upon a flow Setpoint from the SCADA system.

3 Both Discharge and Recycle Mode, the VFD and the two flow control valves will be controlled by setpoints within the SCADA system.

B. Control conditions, Each pump will have a Hand, Off, Auto (HOA) switch in SCADA. The pumps will alternate between each start/stop cycle.

C. Recycle water can only happen when the plant is running.

D. The SCADA and PLC should allow the operator to select from one of the three modes. But if the Lagoon level reaches a high setpoint the system will automatically switch the mode to both discharge and recycle mode until it hits a low level setpoint, then the mode can be changed.

E. The level of the Lagoon will specify if the system will run or not. The protocol to get level data is that the system will run for 1 hour then stop all flow for 5 minutes and collect level data. The new level data will determine if the system will start back up and run for another hour.

END OF SECTION