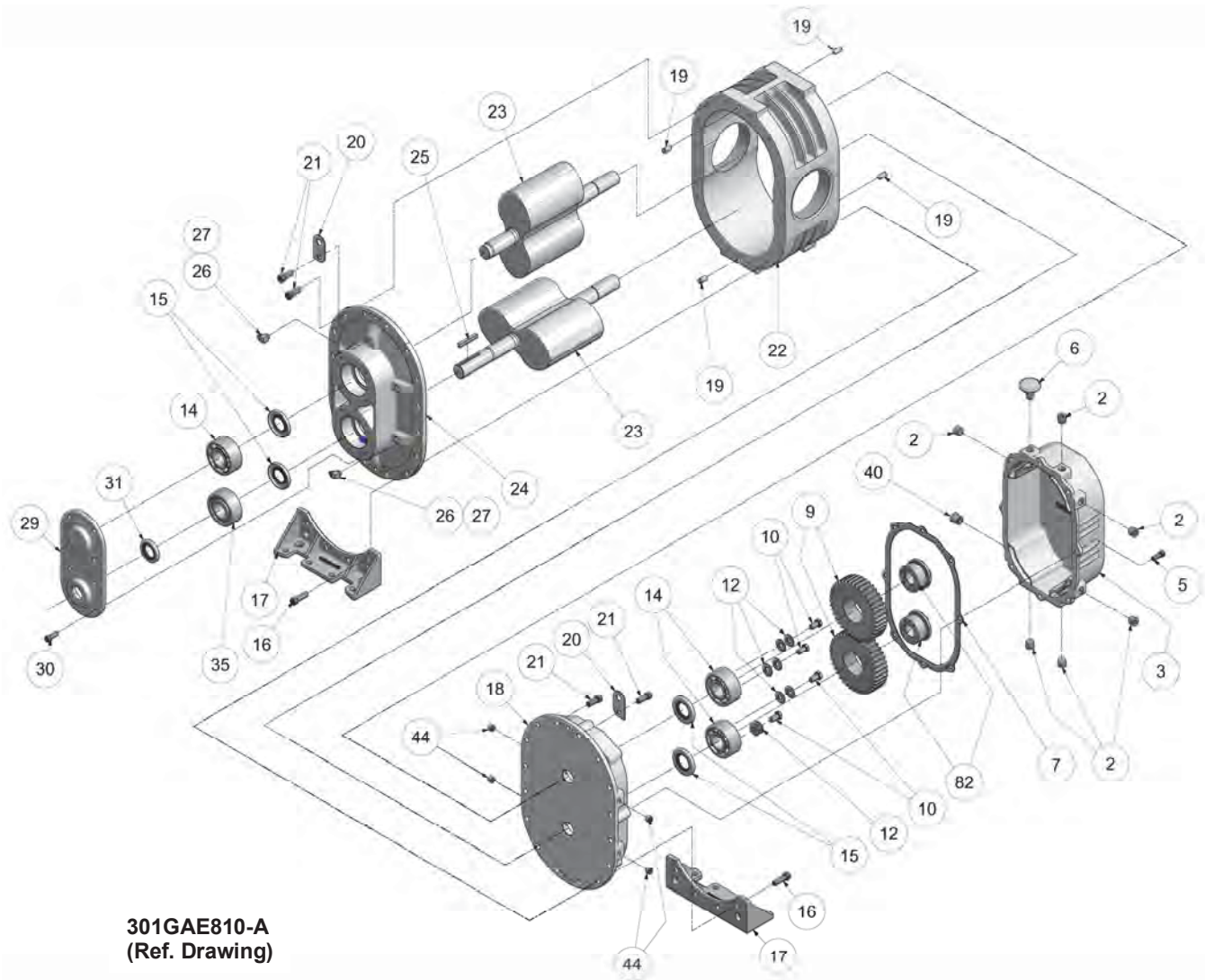


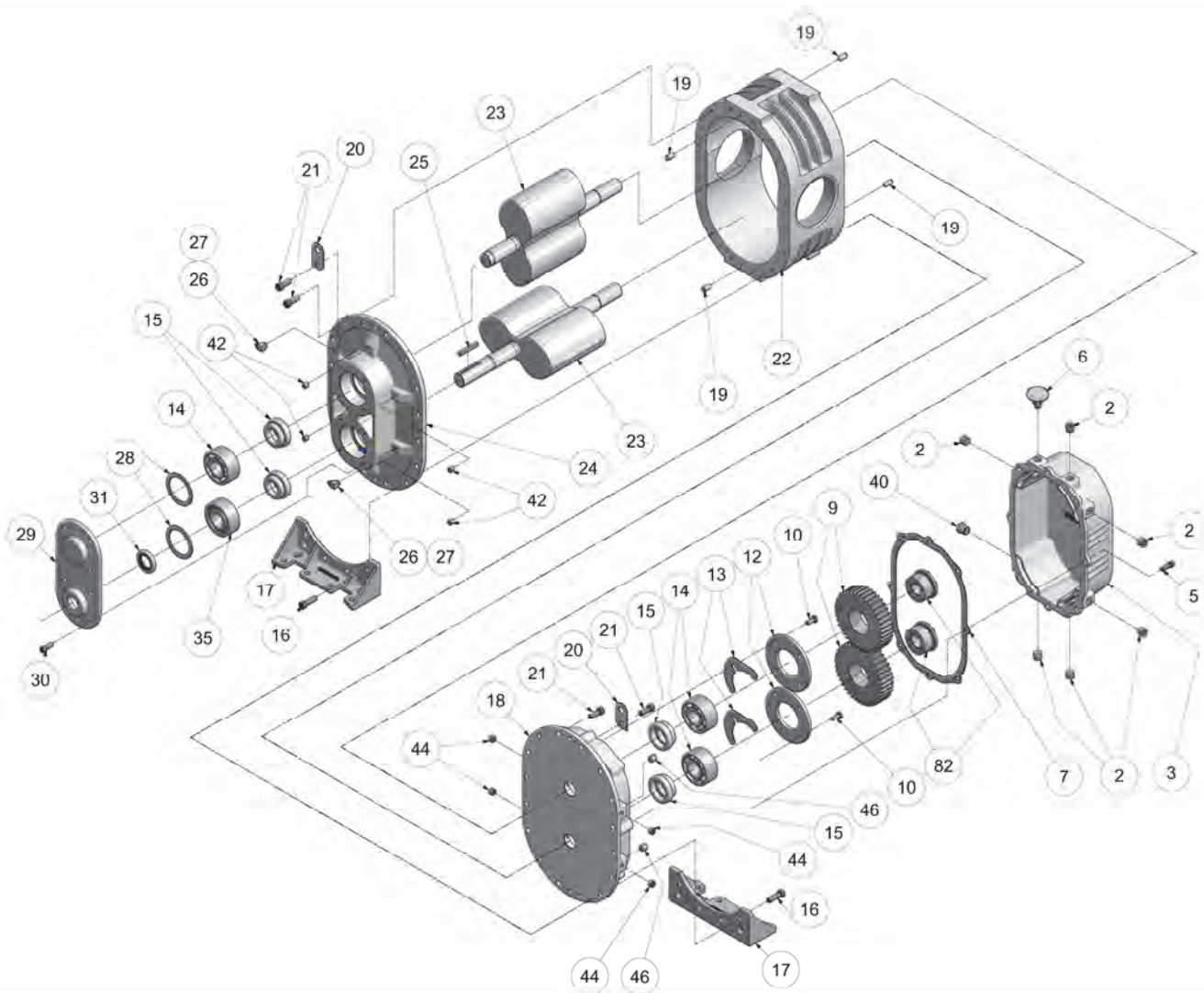


Order by Part Number and Description. Reference Numbers are for your convenience only.

Ref.	Model GAE	Lip Seal	No.	Grease Splash Lube		
				Size – 5H	Size – 5M	Size – 5L
No.	Description		Req'd	GAEH_R Δ Δ = (A or C)	GAEM_R Δ Δ = (A or C)	GAEL_R Δ Δ = (A or C)
2	Plug		6	64AC3	64AC3	64AC3
3	Gear Case		1	304GAE602	304GAE602	304GAE602
5	Screw		8	75P40	75P40	75P40
6	Breather		1	5L359	5L359	5L359
* 7	Gasket		1	300GAE715	300GAE715	300GAE715
9	Gear Kit		1	300GAE6008	300GAE6008	300GAE6008
* 10	Screws		4	655ED03P	655ED03P	655ED03P
12	Washer		8	95A3	95A3	95A3
* 14	Ball Bearing		3	8500397	8500397	8500397
* 15	Oil Seal		4	60DD714	60DD714	60DD714
16	Screw		8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.		2	300GAE166	300GAE166	300GAE166
18	Bearing Housing Gear End		1	301GAE006	301GAE006	301GAE006
19	Dowel Pin		4	62M48	62M48	62M48
20	Lifting Lug		2	200GAA451	200GAA451	200GAA451
21	Screw		24	75P55	75P55	75P55
22	Impeller Case		1	900883051701	900883051801	900883051901
23	Rotor Group					
	5" Standard Clearances		1	327GAE4028	326GAE4028	325GAE4028
	5" High Temperature Clearances		1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End		1	206GAE006	206GAE006	206GAE006
25	Key-Square		1	900639910305	900639910305	900639910305
26	Pipe Fitting		2	40E9	40E9	40E9
27	Cap		2	40P58	40P58	40P58
29	Drive Cover		1	900883050401	900883050401	900883050401
30	Screw		8	75P189	75P189	75P189
* 31	Oil Seal		1	60DD726	60DD726	60DD726
* 35	Bearing – Roller		1	12BA155	12BA155	12BA155
40	Oil Level Gauge		1	40P34	40P34	40P34
44	Screw		4	76F92	76F92	76F92
** 45	Paint, Bulk, GDP188, Aluminum		0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"		1	200GAE732	200GAE732	200GAE732
** 55	Shim Case .010"		1	201GAE732	201GAE732	201GAE732
** 56	Shim Case .0015/.002"		1	202GAE732	202GAE732	202GAE732
82	Locking Assembly		2	22G43	22G43	22G43
** 105	Overhaul Kit 5" R VERS Lip Seal, Grease Splash Lube		1	300GAE6010	300GAE6010	300GAE6010
** 900	Group-Indent & Instruction Legend Series 5" R VERS		1	205GAE4011	205GAE4011	205GAE4011

* INCLUDED IN OVERHAUL KIT.

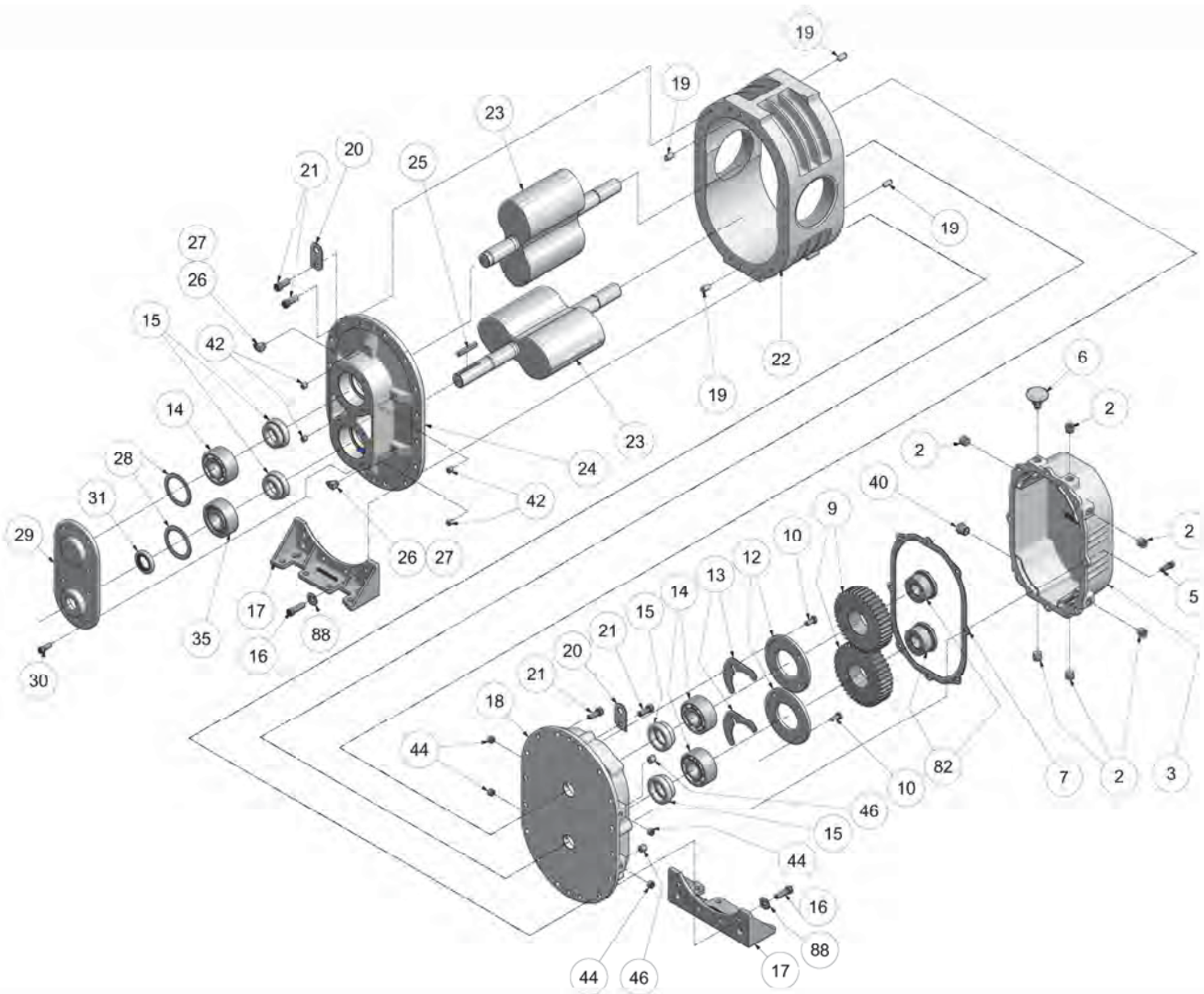
** NOT SHOWN ON ILLUSTRATION.



Order by Part Number and Description. Reference Numbers are for your convenience only.

Ref. No.	Model GAB Description	Mechanical Seal No. Req'd	Grease Splash Lube		
			Size – 3H GABH_RB	Size – 3M GABM_RB	Size -- 3L GABL_RB
2	Plug	6	64AC2	64AC2	64AC2
3	Gear Case	1	303GAB602	303GAB602	303GAB602
5	Screw	8	75P7	75P7	75P7
6	Breather	1	5L358	5L358	5L358
* 7	Gasket	1	300GAB715	300GAB715	300GAB715
9	Gear Kit	1	300GAB6008	300GAB6008	300GAB6008
* 10	Screws	4	75A33P	75A33P	75A33P
12	Bearing Retainer	2	300GAB205	300GAB205	300GAB205
* 13	Shim Set	1	900881032200	900881032200	900881032200
* 14	Ball Bearing	3	12BA143	12BA143	12BA143
* 15	Mechanical Seal	4	900871020003	900871020003	900871020003
16	Screw	4	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	303GAB166	303GAB166	303GAB166
18	Bearing Housing Gear End	1	304GAB006	304GAB006	304GAB006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	20	75P55	75P55	75P55
22	Impeller Case	1	900873034301	900873033801	900873034201
23	Rotor Group				
	3" Standard Clearances	1	307GAB4028	309GAB4028	308GAB4028
	3" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	900883030301	900883030301	900883030301
25	Key-Square	1	900639910304	900639910304	900639910304
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
* 28	Wavy Spring	2	900669170203	900669170203	900669170203
29	Drive Cover	1	900873033701	900873033701	900873033701
30	Screw	6	75P22	75P22	75P22
* 31	Oil Seal	1	60DD725	60DD725	60DD725
* 35	Bearing – Roller	1	12BA153	12BA153	12BA153
40	Oil Level Gauge	1	40P82	40P82	40P82
42	Plug	4	64AC1	64AC1	64AC1
44	Screw	4	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	4	64AC1	64AC1	64AC1
** 54	Shim Case .0025/.0035"	1	200GAB732	200GAB732	200GAB732
** 55	Shim Case .010"	1	201GAB732	201GAB732	201GAB732
** 56	Shim Case .0015/.002"	1	202GAB732	202GAB732	202GAB732
82	Locking Assembly	2	22G45	22G45	22G45
** 105	Overhaul Kit 3" R VERS Mechanical Seal, Grease Splash Lube	1	303GAB6010	303GAB6010	303GAB6010
** 900	Group-Indent & Instruction Legend Series 3" R VERS	1	303GAB4011	303GAB4011	303GAB4011

* INCLUDED IN OVERHAUL KIT.
 ** NOT SHOWN ON ILLUSTRATION

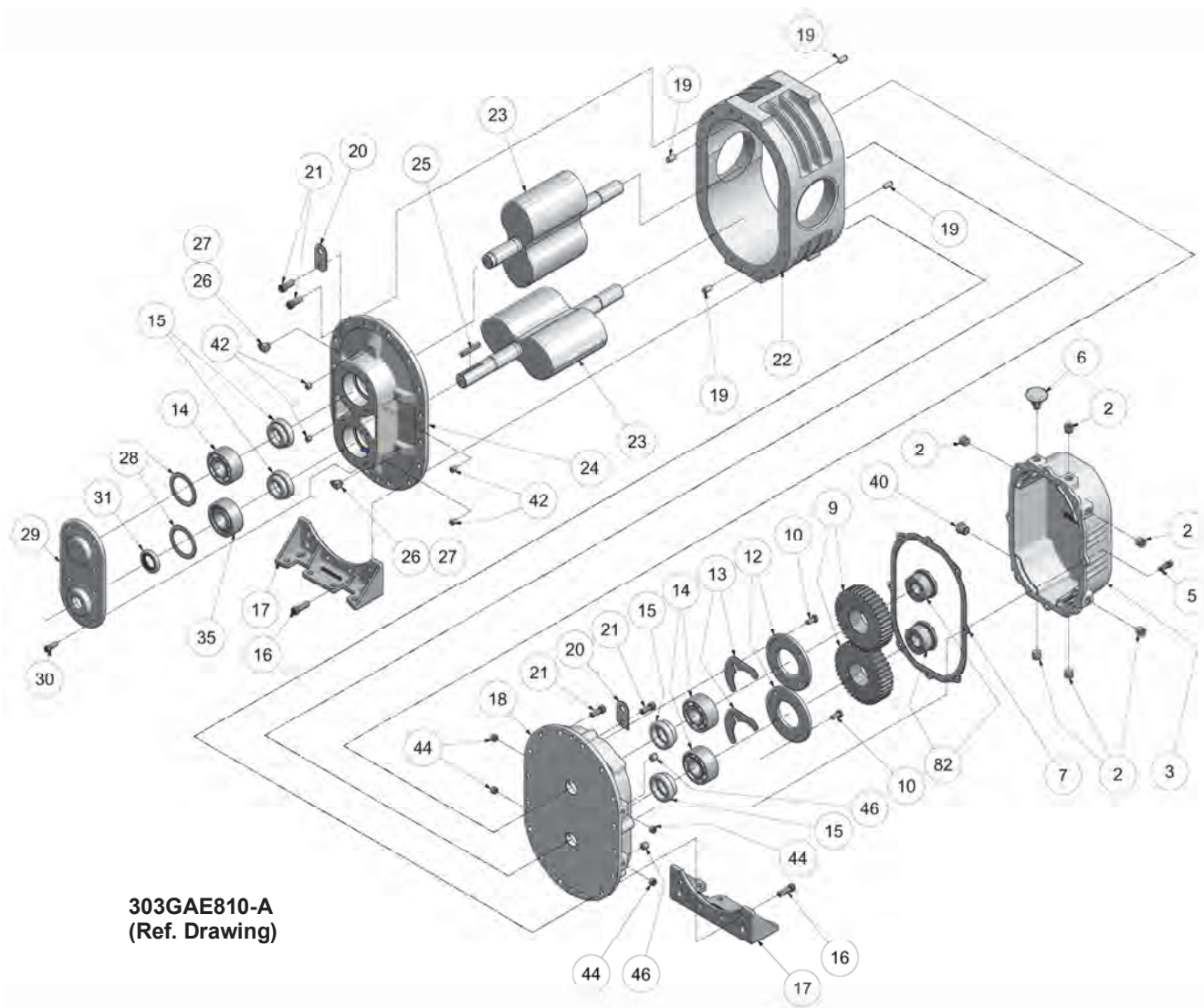


Order by Part Number and Description. Reference Numbers are for your convenience only.

Ref. No.	Model GAC Description	Mechanical Seal No. Req'd	Grease Splash Lube		
			Size – 4H GACH_RB	Size – 4M GACM_RB	Size -- 4L GACL_RB
2	Plug	6	64AC3	64AC3	64AC3
3	Gear Case	1	304GAC602	304GAC602	304GAC602
5	Screw	8	75P40	75P40	75P40
6	Breather	1	5L359	5L359	5L359
* 7	Gasket	1	301GAC715	301GAC715	301GAC715
9	Gear Kit	1	300GAC6008	300GAC6008	300GAC6008
* 10	Screws	8	75A33P	75A33P	75A33P
12	Bearing Retainer	2	900883040201	900883040201	900883040201
* 13	Shim Set	1	900881042900	900881042900	900881042900
* 14	Ball Bearing	3	12BA144	12BA144	12BA144
* 15	Mechanical Seal	4	900871020004	900871020004	900871020004
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAC166	300GAC166	300GAC166
18	Bearing Housing Gear End	1	304GAC006	304GAC006	304GAC006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	16	75P55	75P55	75P55
22	Impeller Case	1	900883042201	900883041801	900883042001
23	Rotor Group				
	4" Standard Clearances	1	307GAC4028	306GAC4028	305GAC4028
	4" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	900883041201	900883041201	900883041201
25	Key-Square	1	900639910304	900639910304	900639910304
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
* 28	Wavy Spring	2	900669170304	900669170304	900669170304
29	Drive Cover	1	900883040301	900883040301	900883040301
30	Screw	8	75P189	75P189	75P189
* 31	Oil Seal	1	60DD716	60DD716	60DD716
* 35	Bearing – Roller	1	12BA154	12BA154	12BA154
40	Oil Level Gauge	1	40P34	40P34	40P34
42	Plug	4	64AC1	64AC1	64AC1
44	Screw	4	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	4	64AC1	64AC1	64AC1
** 54	Shim Case .0025/.0035"	1	200GAC732	200GAC732	200GAC732
** 55	Shim Case .010"	1	201GAC732	201GAC732	201GAC732
** 56	Shim Case .0015/.002"	1	202GAC732	202GAC732	202GAC732
82	Locking Assembly	2	22G44	22G44	22G44
88	Washer	4	95A3	95A3	95A3
** 105	Overhaul Kit 4" R VERS Mechanical Seal, Grease Splash Lube	1	302GAC6010	302GAC6010	302GAC6010
** 900	Group-Indent & Instruction Legend Series 4" R VERS	1	201GAC4011	201GAC4011	201GAC4011

* INCLUDED IN OVERHAUL KIT.

** NOT SHOWN ON ILLUSTRATION

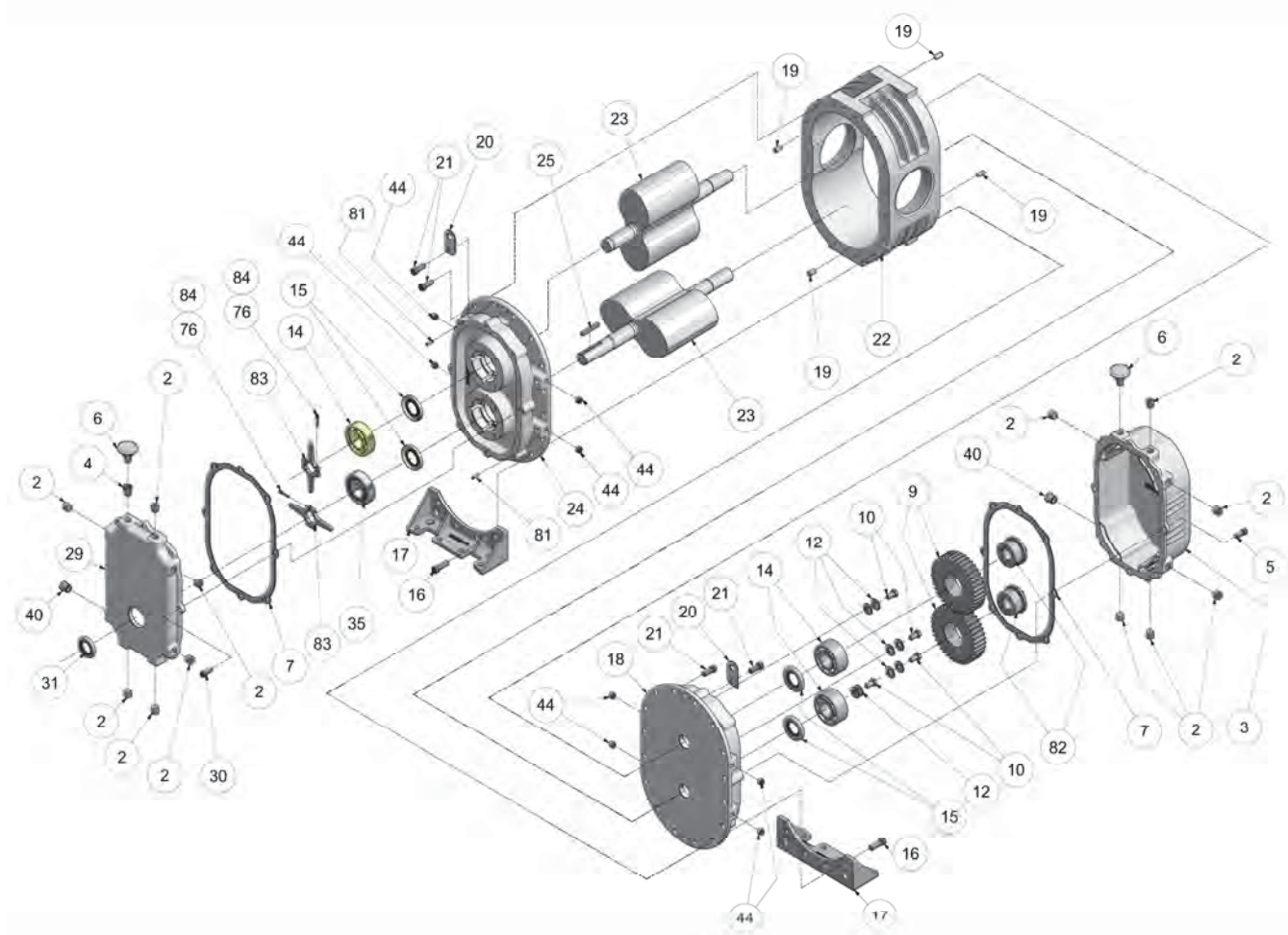


303GAE810-A
(Ref. Drawing)

Order by Part Number and Description. Reference Numbers are for your convenience only.

Ref. No.	Model GAE Description	Mechanical Seal No. Req'd	Grease Splash Lube		
			Size – 5H GAEH_RB	Size – 5M GAEM_RB	Size -- 5L GAEL_RB
2	Plug	6	64AC3	64AC3	64AC3
3	Gear Case	1	304GAE602	304GAE602	304GAE602
5	Screw	8	75P40	75P40	75P40
6	Breather	1	5L359	5L359	5L359
* 7	Gasket	1	300GAE715	300GAE715	300GAE715
9	Gear Kit.....	1	300GAE6008	300GAE6008	300GAE6008
* 10	Screws	8	75A33P	75A33P	75A33P
12	Bearing Retainer	2	900883050501	900883050501	900883050501
* 13	Shim Set	1	900881052900	900881052900	900881052900
* 14	Ball Bearing	3	8500397	8500397	8500397
* 15	Mechanical Seal.....	4	900871020005	900871020005	900871020005
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAE166	300GAE166	300GAE166
18	Bearing Housing Gear End	1	303GAE006	303GAE006	303GAE006
19	Dowel Pin.....	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	24	75P55	75P55	75P55
22	Impeller Case.....	1	900883051701	900883051801	900883051901
23	Rotor Group				
	5" Standard Clearances	1	327GAE4028	326GAE4028	325GAE4028
	5" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End.....	1	207GAE006	207GAE006	207GAE006
25	Key-Square.....	1	900639910305	900639910305	900639910305
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
* 28	Wavy Spring	2	900669170405	900669170405	900669170405
29	Drive Cover	1	900883050401	900883050401	900883050401
30	Screw	8	75P189	75P189	75P189
* 31	Oil Seal	1	60DD726	60DD726	60DD726
* 35	Bearing – Roller	1	12BA155	12BA155	12BA155
40	Oil Level Gauge	1	40P34	40P34	40P34
42	Plug	4	64AC1	64AC1	64AC1
44	Screw	4	76F92	76F92	76F92
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	4	64AC2	64AC2	64AC2
** 54	Shim Case .0025/.0035"	1	200GAE732	200GAE732	200GAE732
** 55	Shim Case .010"	1	201GAE732	201GAE732	201GAE732
** 56	Shim Case .0015/.002"	1	202GAE732	202GAE732	202GAE732
82	Locking Assembly	2	22G43	22G43	22G43
** 105	Overhaul Kit 5" R VERS Mechanical Seal, Grease Splash	1	302GAE6010	302GAE6010	302GAE6010
** 900	Group-Indent & Instruction Legend Series 5" R VERS.....	1	205GAE4011	205GAE4011	205GAE4011

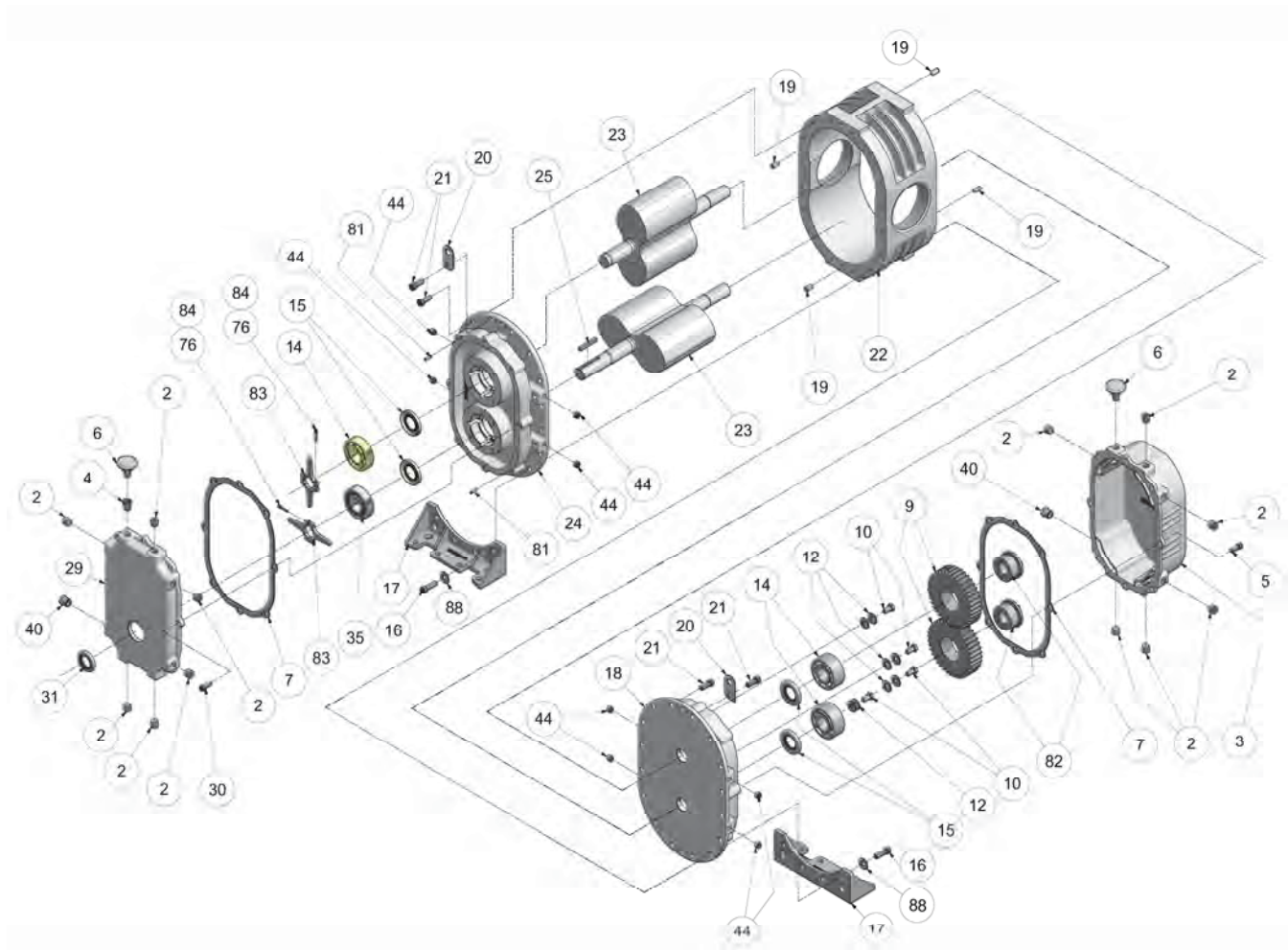
* INCLUDED IN OVERHAUL KIT.
 ** NOT SHOWN ON ILLUSTRATION



Order by Part Number and Description. Reference Numbers are for your convenience only.

Ref.	Model GAB	Lip Seal	No.	Dual Splash Lube		
				Size – 3H	Size – 3M	Size – 3L
No.	Description	Req'd		GABH_R Δ Δ = (D or F)	GABM_R Δ Δ = (D or F)	GABL_R Δ Δ = (D or F)
2	Plug	12		64AC2	64AC2	64AC2
3	Gear Case.....	1		303GAB602	303GAB602	303GAB602
5	Screw.....	8		75P7	75P7	75P7
6	Breather	2		5L358	5L358	5L358
* 7	Gasket	2		300GAB715	300GAB715	300GAB715
9	Gear Kit.....	1		300GAB6008	300GAB6008	300GAB6008
* 10	Screws	4		75A33P	75A33P	75A33P
12	Washer.....	8		95A2	95A2	95A2
* 14	Ball Bearing.....	3		12BA143	12BA143	12BA143
* 15	Oil Seal	4		900891030601	900891030601	900891030601
16	Screw.....	4		75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2		303GAB166	303GAB166	303GAB166
18	Bearing Housing Gear End.....	1		302GAB006	302GAB006	302GAB006
19	Dowel Pin.....	4		62M48	62M48	62M48
20	Lifting Lug.....	2		200GAA451	200GAA451	200GAA451
21	Screw.....	20		75P55	75P55	75P55
22	Impeller Case	1		900873034301	900873033801	900873034201
23	Rotor Group					
	3" Standard Clearances	1		307GAB4028	309GAB4028	308GAB4028
	3" High Temperature Clearances.....	1		To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1		303GAB006	303GAB006	303GAB006
25	Key-Square	1		900639910304	900639910304	900639910304
29	Drive Cover	1		302GAB477	302GAB477	302GAB477
30	Screw.....	8		75P7	75P7	75P7
* 31	Oil Seal	1		60DD725	60DD725	60DD725
* 35	Bearing – Spherical.....	1		12BA153	12BA153	12BA153
40	Oil Level Gauge.....	2		40P82	40P82	40P82
44	Screw.....	8		76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum.....	0.125		28H284	28H284	28H284
** 54	Shim Case .0025/.0035".....	1		200GAB732	200GAB732	200GAB732
** 55	Shim Case .0010".....	1		201GAB732	201GAB732	201GAB732
** 56	Shim Case .0015/.002"	1		202GAB732	202GAB732	202GAB732
76	Compound, Loctite.....	50		25BC877	25BC877	25BC877
81	Dowel Pin.....	2		62M13	62M13	62M13
82	Locking Assembly.....	2		22G45	22G45	22G45
83	Slinger.....	2		300GAB173	300GAB173	300GAB173
84	Screw.....	2		75LM13	75LM13	75LM13
** 105	Overhaul Kit 3" R VERS Lip Seal, Dual Splash Lube.....	1		301GAB6010	301GAB6010	301GAB6010
** 900	Group-Indent & Instruction Legend Series 3" R VERS.....	1		303GAB4011	303GAB4011	303GAB4011

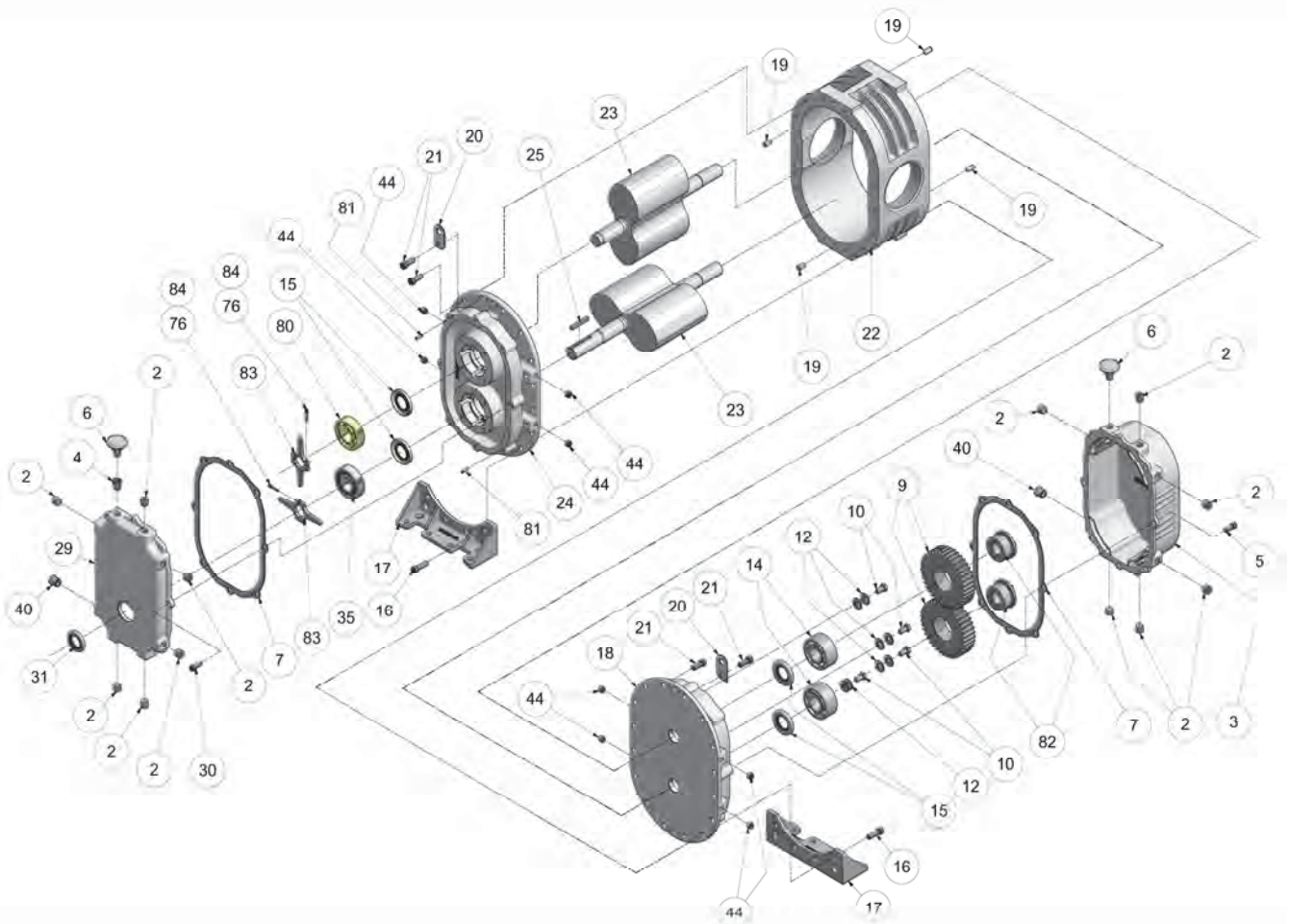
* INCLUDED IN OVERHAUL KIT.
 ** NOT SHOWN ON ILLUSTRATION



Order by Part Number and Description. Reference Numbers are for your convenience only.

Ref.	Model GAC	Lip Seal	No.	Dual Splash Lube		
				Size – 4H GACH_R Δ Δ = (D or F)	Size – 4M GACM_R Δ Δ = (D or F)	Size – 4L GACL_R Δ Δ = (D or F)
No.	Description	Req'd				
2	Plug	12	64AC3	64AC3	64AC3	64AC3
3	Gear Case.....	1	304GAC602	304GAC602	304GAC602	304GAC602
5	Screw.....	8	75P40	75P40	75P40	75P40
6	Breather	2	5L359	5L359	5L359	5L359
* 7	Gasket	2	301GAC715	301GAC715	301GAC715	301GAC715
9	Gear Kit.....	1	300GAC6008	300GAC6008	300GAC6008	300GAC6008
* 10	Screws	4	655ED03P	655ED03P	655ED03P	655ED03P
12	Washer.....	8	95A3	95A3	95A3	95A3
* 14	Ball Bearing.....	3	12BA144	12BA144	12BA144	12BA144
* 15	Oil Seal	4	60DD630	60DD630	60DD630	60DD630
16	Screw.....	8	75P56	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAC166	300GAC166	300GAC166	300GAC166
18	Bearing Housing Gear End.....	1	302GAC006	302GAC006	302GAC006	302GAC006
19	Dowel Pin.....	4	62M48	62M48	62M48	62M48
20	Lifting Lug.....	2	200GAA451	200GAA451	200GAA451	200GAA451
21	Screw.....	16	75P55	75P55	75P55	75P55
22	Impeller Case	1	900883042201	900883041801	900883042001	900883042001
23	Rotor Group					
	4" Standard Clearances	1	307GAC4028	306GAC4028	305GAC4028	305GAC4028
	4" High Temperature Clearances.....	1	To be assigned	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	303GAC006	303GAC006	303GAC006	303GAC006
25	Key-Square	1	900639910304	900639910304	900639910304	900639910304
29	Drive Cover	1	302GAC477	302GAC477	302GAC477	302GAC477
30	Screw.....	8	75P40	75P40	75P40	75P40
* 31	Oil Seal	1	60DD716	60DD716	60DD716	60DD716
* 35	Bearing – Spherical.....	1	12BA255	12BA255	12BA255	12BA255
40	Oil Level Gauge.....	2	40P34	40P34	40P34	40P34
44	Screw.....	8	76F1	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum.....	0.125	28H284	28H284	28H284	28H284
** 54	Shim Case .0025/.0035".....	1	200GAC732	200GAC732	200GAC732	200GAC732
** 56	Shim Case .0015/.002"	1	202GAC732	202GAC732	202GAC732	202GAC732
76	Compound, Loctite.....	50	25BC877	25BC877	25BC877	25BC877
81	Dowel Pin.....	2	62M13	62M13	62M13	62M13
82	Locking Assembly.....	2	22G44	22G44	22G44	22G44
83	Slinger.....	2	300GAC173	300GAC173	300GAC173	300GAC173
84	Screw.....	2	75LM14	75LM14	75LM14	75LM14
88	Washer.....	4	95A3	95A3	95A3	95A3
** 105	Overhaul Kit 4" R VERS Lip Seal, Dual Splash Lube.....	1	301GAC6010	301GAC6010	301GAC6010	301GAC6010
** 900	Group-Indent & Instruction Legend Series 4" R VERS.....	1	201GAC4011	201GAC4011	201GAC4011	201GAC4011

* INCLUDED IN OVERHAUL KIT.
 ** NOT SHOWN ON ILLUSTRATION

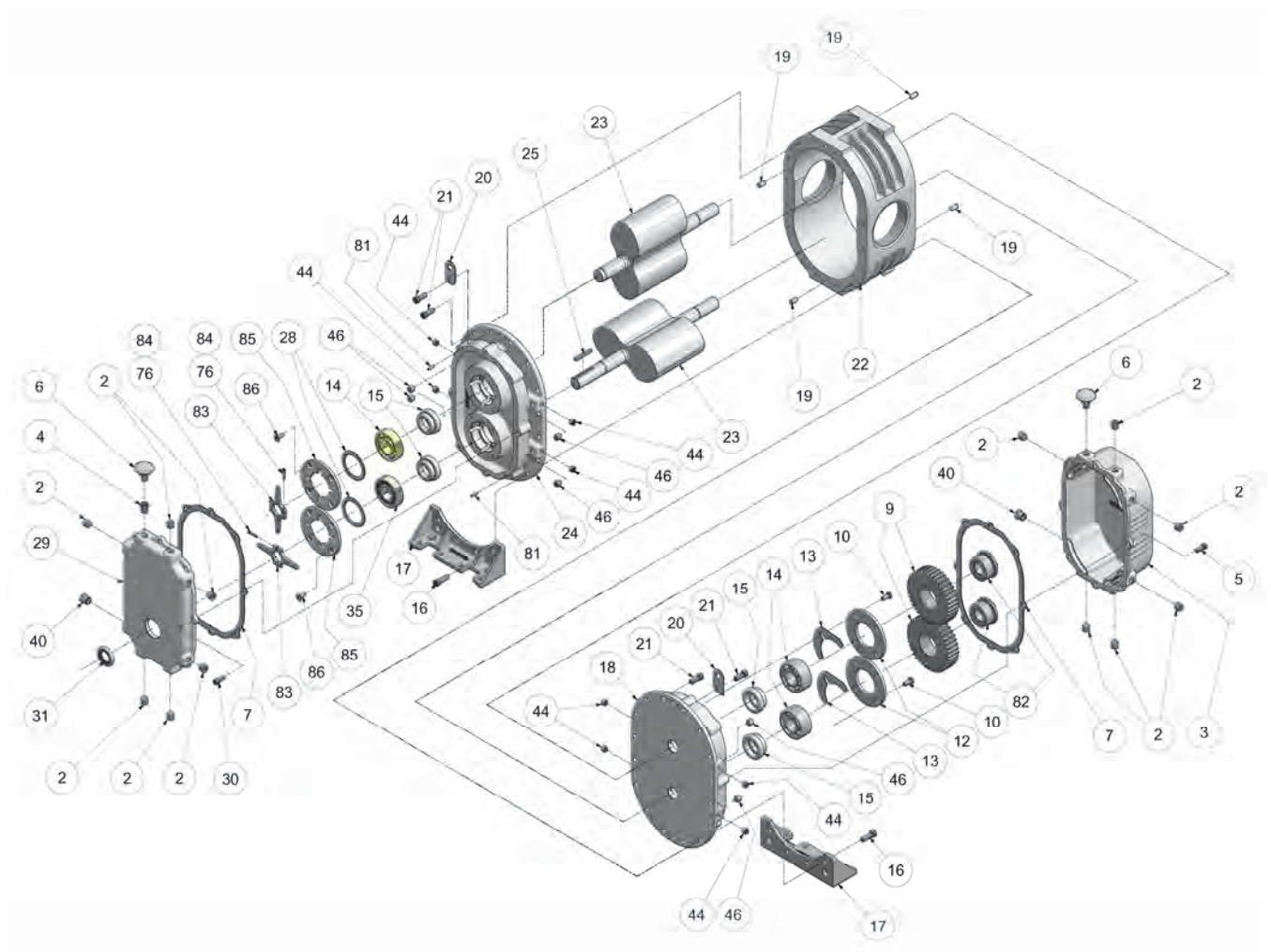


300GAE810-A
(Ref. Drawing)

Order by Part Number and Description. Reference Numbers are for your convenience only.

Ref.	Model GAE	Lip Seal	No.	Dual Splash Lube		
				Size – 5H	Size – 5M	Size – 5L
No.	Description	Req'd		GAEH_R Δ $\Delta = (D \text{ or } F)$	GAEM_R Δ $\Delta = (D \text{ or } F)$	GAEL_R Δ $\Delta = (D \text{ or } F)$
2	Plug	12		64AC3	64AC3	64AC3
3	Gear Case.....	1		304GAE602	304GAE602	304GAE602
5	Screw.....	8		75P40	75P40	75P40
6	Breather	2		5L359	5L359	5L359
* 7	Gasket	2		300GAE715	300GAE715	300GAE715
9	Gear Kit.....	1		300GAE6008	300GAE6008	300GAE6008
* 10	Screws	4		655ED03P	655ED03P	655ED03P
12	Washer.....	8		95A3	95A3	95A3
* 14	Ball Bearing.....	2		8500397	8500397	8500397
* 15	Oil Seal	4		60DD714	60DD714	60DD714
16	Screw.....	8		75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2		300GAE166	300GAE166	300GAE166
18	Bearing Housing Gear End.....	1		301GAE006	301GAE006	301GAE006
19	Dowel Pin.....	4		62M48	62M48	62M48
20	Lifting Lug.....	2		200GAA451	200GAA451	200GAA451
21	Screw.....	24		75P55	75P55	75P55
22	Impeller Case	1		900883051701	900883051801	900883051901
23	Rotor Group					
	5" Standard Clearances	1		327GAE4028	326GAE4028	325GAE4028
	5" High Temperature Clearances.....	1		To be assigned	To be assigned	To be assigned
25	Key-Square	1		900639910305	900639910305	900639910305
29	Drive Cover	1		300GAE477	300GAE477	300GAE477
30	Screw.....	8		75P40	75P40	75P40
* 31	Oil Seal	1		60DD726	60DD726	60DD726
* 35	Bearing – Spherical.....	1		12BA253	12BA253	12BA253
40	Oil Level Gauge.....	2		40P34	40P34	40P34
44	Screw.....	8		76F92	76F92	76F92
** 45	Paint, Bulk, GDP188, Aluminum.....	0.125		28H284	28H284	28H284
** 54	Shim Case .0025/.0035".....	1		200GAE732	200GAE732	200GAE732
** 55	Shim Case .010".....	1		201GAE732	201GAE732	201GAE732
** 56	Shim Case .0015/.002"	1		202GAE732	202GAE732	202GAE732
76	Compound, Loctite.....	5		25BC877	25BC877	25BC877
* 80	Bearing – Conrad.....	1		12BA254	12BA254	12BA254
81	Dowel Pin.....	2		62M13	62M13	62M13
82	Locking Assembly.....	2		22G43	22G43	22G43
83	Slinger.....	2		300GAE173	300GAE173	300GAE173
84	Screw.....	2		75LM14	75LM14	75LM14
** 105	Overhaul Kit 5" R VERS Lip Seal, Dual Splash Lube.....	1		301GAE6010	301GAE6010	301GAE6010
** 900	Group-Indent & Instruction Legend Series 5" R VERS.....	1		205GAE4011	205GAE4011	205GAE4011

* INCLUDED IN OVERHAUL KIT.
 ** NOT SHOWN ON ILLUSTRATION

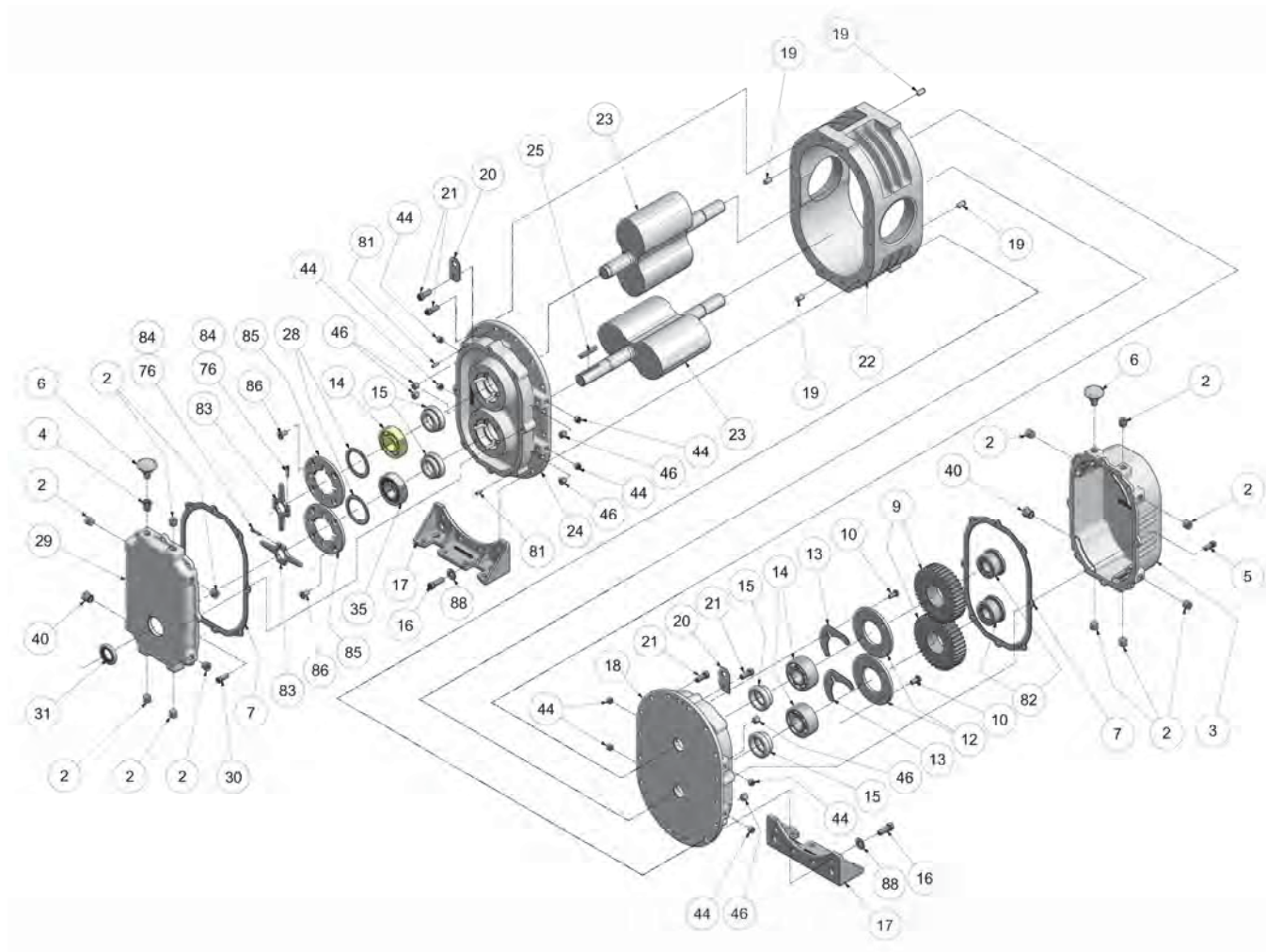


Order by Part Number and Description. Reference Numbers are for your convenience only.

Ref. No.	Model GAB Description	Mechanical Seal No. Req'd	Dual Splash Lube		
			Size – 3H GABH_R Δ Δ = (E or G)	Size – 3M GABM_R Δ Δ = (E or G)	Size – 3L GABL_R Δ Δ = (E or G)
2	Plug.....	12	64AC2	64AC2	64AC2
3	Gear Case.....	1	303GAB602	303GAB602	303GAB602
5	Screw.....	8	75P7	75P7	75P7
6	Breather.....	2	5L358	5L358	5L358
* 7	Gasket.....	2	300GAB715	300GAB715	300GAB715
9	Gear Kit.....	1	300GAB6008	300GAB6008	300GAB6008
* 10	Screws.....	4	75A33P	75A33P	75A33P
12	Bearing Retainer.....	2	300GAB205	300GAB205	300GAB205
* 13	Shim Set.....	1	900881032200	900881032200	900881032200
* 14	Ball Bearing.....	3	12BA143	12BA143	12BA143
* 15	Mechanical Seal.....	4	900871020003	900871020003	900871020003
16	Screw.....	4	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	303GAB166	303GAB166	303GAB166
18	Bearing Housing Gear End.....	1	304GAB006	304GAB006	304GAB006
19	Dowel Pin.....	4	62M48	62M48	62M48
20	Lifting Lug.....	2	200GAA451	200GAA451	200GAA451
21	Screw.....	20	75P55	75P55	75P55
22	Impeller Case.....	1	900873034301	900873033801	900873034201
23	Rotor Group				
	3" Standard Clearances.....	1	307GAB4028	309GAB4028	308GAB4028
	3" High Temperature Clearances.....	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End.....	1	305GAB006	305GAB006	305GAB006
25	Key-Square.....	1	900639910304	900639910304	900639910304
* 28	Wavy Spring.....	2	900669170203	900669170203	900669170203
29	Drive Cover.....	1	302GAB477	302GAB477	302GAB477
30	Screw.....	6	75P7	75P7	75P7
* 31	Oil Seal.....	1	60DD725	60DD725	60DD725
* 35	Bearing – Spherical.....	1	12BA153	12BA153	12BA153
40	Oil Level Gauge.....	2	40P82	40P82	40P82
44	Screw.....	8	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum.....	0.125	28H284	28H284	28H284
46	Plug.....	8	64AC1	64AC1	64AC1
** 54	Shim Case .0025/.0035".....	1	200GAB732	200GAB732	200GAB732
** 55	Shim Case .010".....	1	201GAB732	201GAB732	201GAB732
** 56	Shim Case .0015/.002".....	1	202GAB732	202GAB732	202GAB732
76	Compound, Loctite.....	50	25BC877	25BC877	25BC877
81	Dowel Pin.....	2	62M13	62M13	62M13
82	Locking Assembly.....	2	22G45	22G45	22G45
83	Slinger.....	2	300GAB173	300GAB173	300GAB173
84	Screw.....	2	75LM13	75LM13	75LM13
85	Bearing Retainer.....	2	300GAB205	300GAB205	300GAB205
86	Screw.....	8	75LM214	75LM214	75LM214
** 105	Overhaul Kit 3" R VERS Mechanical Seal Dual, Splash	1	304GAB6010	304GAB6010	304GAB6010
** 900	Group-Indent & Instruction Legend Series 3" R VERS.....	1	303GAB4011	303GAB4011	303GAB4011

* INCLUDED IN OVERHAUL KIT.

** NOT SHOWN ON ILLUSTRATION

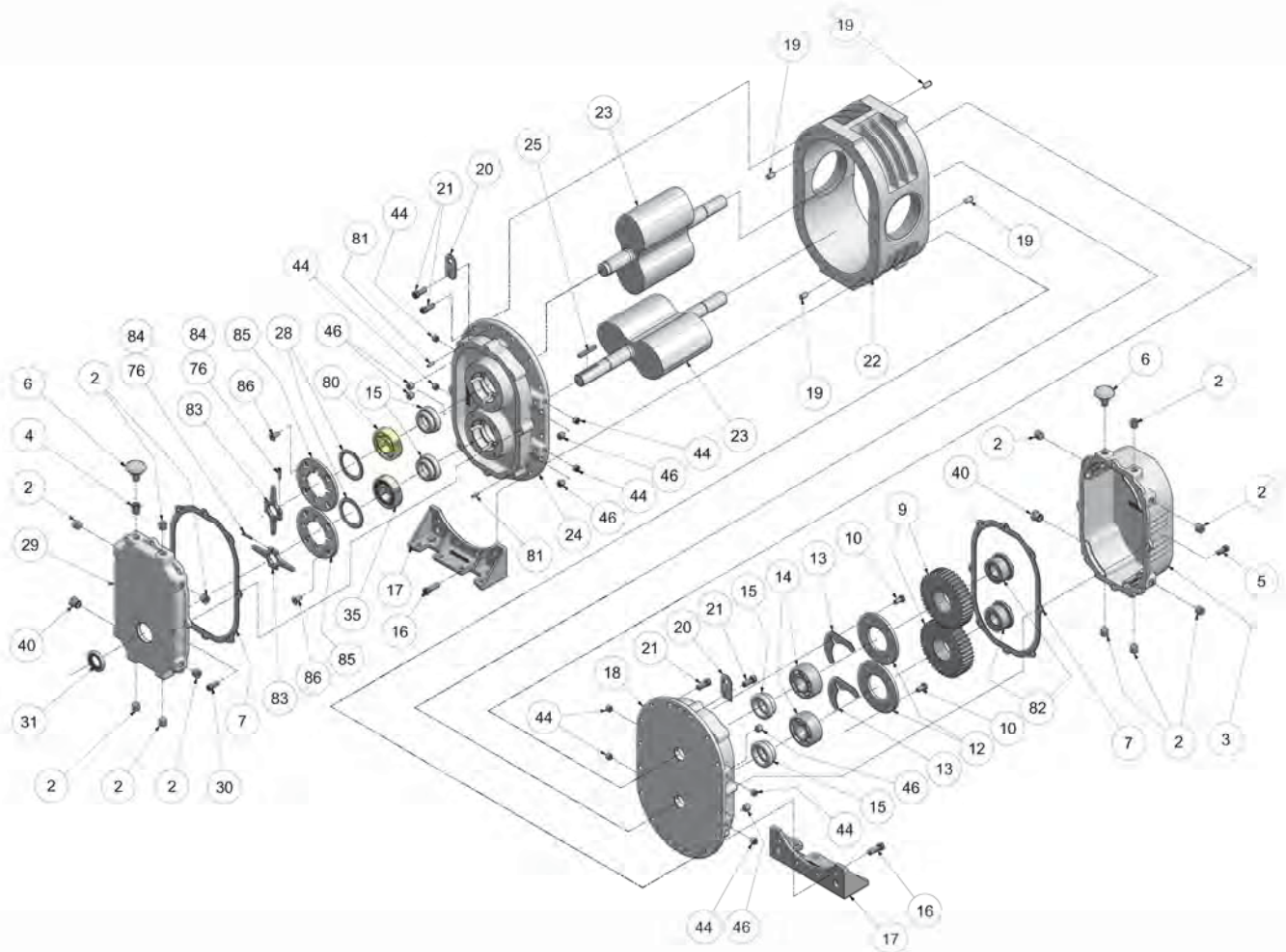


Order by Part Number and Description. Reference Numbers are for your convenience only.

Ref. No.	Model GAC Description	Mechanical Seal No. Req'd	Dual Splash Lube		
			Size – 4H GACH_R Δ Δ = (E or G)	Size – 4M GACM_R Δ Δ = (E or G)	Size – 4L GACL_R Δ Δ = (E or G)
2	Plug.....	12	64AC3	64AC3	64AC3
3	Gear Case.....	1	304GAC602	304GAC602	304GAC602
5	Screw.....	8	75P40	75P40	75P40
6	Breather.....	2	5L359	5L359	5L359
* 7	Gasket.....	2	301GAC715	301GAC715	301GAC715
9	Gear Kit.....	1	300GAC6008	300GAC6008	300GAC6008
* 10	Screws.....	8	75A33P	75A33P	75A33P
12	Bearing Retainer.....	2	900883040201	900883040201	900883040201
* 13	Shim Set.....	1	900881052900	900881052900	900881052900
* 14	Ball Bearing.....	3	12BA144	12BA144	12BA144
* 15	Mechanical Seal.....	4	900871020004	900871020004	900871020004
16	Screw.....	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAC166	300GAC166	300GAC166
18	Bearing Housing Gear End.....	1	304GAC006	304GAC006	304GAC006
19	Dowel Pin.....	4	62M48	62M48	62M48
20	Lifting Lug.....	2	200GAA451	200GAA451	200GAA451
21	Screw.....	16	75P55	75P55	75P55
22	Impeller Case.....	1	900883042201	900883041801	900883042001
23	Rotor Group				
	4" Standard Clearances.....	1	307GAC4028	306GAC4028	305GAC4028
	4" High Temperature Clearances.....	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End.....	1	305GAC006	305GAC006	305GAC006
25	Key-Square.....	1	900639910304	900639910304	900639910304
* 28	Wavy Spring.....	2	900669170304	900669170304	900669170304
29	Drive Cover.....	1	302GAC477	302GAC477	302GAC477
30	Screw.....	8	75P40	75P40	75P40
* 31	Oil Seal.....	1	60DD716	60DD716	60DD716
* 35	Bearing – Spherical.....	1	12BA255	12BA255	12BA255
40	Oil Level Gauge.....	2	40P34	40P34	40P34
44	Screw.....	8	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum.....	0.125	28H284	28H284	28H284
46	Plug.....	8	64AC1	64AC1	64AC1
** 54	Shim Case .0025/.0035".....	1	200GAC732	200GAC732	200GAC732
** 56	Shim Case .0015/.002".....	1	202GAC732	202GAC732	202GAC732
76	Compound, Loctite.....	50	25BC877	25BC877	25BC877
81	Dowel Pin.....	2	62M13	62M13	62M13
82	Locking Assembly.....	2	22G44	22G44	22G44
83	Slinger.....	2	300GAC173	300GAC173	300GAC173
84	Screw.....	2	75LM14	75LM14	75LM14
85	Bearing Retainer.....	2	300GAC205	300GAC205	300GAC205
86	Screw.....	8	75LM214	75LM214	75LM214
88	Washer.....	4	95A3	95A3	95A3
** 105	Overhaul Kit 4" R VERS Mechanical Seal, Dual Splash	1	303GAC6010	303GAC6010	303GAC6010
** 900	Group-Indent & Instruction Legend Series 4" R VERS.....	1	201GAC4011	201GAC4011	201GAC4011

* INCLUDED IN OVERHAUL KIT.

** NOT SHOWN ON ILLUSTRATION



302GAA810-A
(Ref. Drawing)

Order by Part Number and Description. Reference Numbers are for your convenience only.

Ref. No.	Model GAE Description	Mechanical Seal No. Req'd	Dual Splash Lube		
			Size – 5H GAEH_R Δ Δ= (E or G)	Size – 5M GAEM_R Δ Δ= (E or G)	Size – 5L GAEL_R Δ Δ= (E or G)
2	Plug.....	12	64AC3	64AC3	64AC3
3	Gear Case.....	1	304GAE602	304GAE602	304GAE602
5	Screw.....	8	75P40	75P40	75P40
6	Breather.....	2	5L359	5L359	5L359
* 7	Gasket.....	2	300GAE715	300GAE715	300GAE715
9	Gear Kit.....	1	300GAE6008	300GAE6008	300GAE6008
* 10	Screws.....	8	75A33P	75A33P	75A33P
12	Bearing Retainer.....	2	900883050501	900883050501	900883050501
* 13	Shim Set.....	1	900881052900	900881052900	900881052900
* 14	Ball Bearing.....	2	8500397	8500397	8500397
* 15	Mechanical Seal.....	4	900871020005	900871020005	900871020005
16	Screw.....	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAE166	300GAE166	300GAE166
18	Bearing Housing Gear End.....	1	303GAE006	303GAE006	303GAE006
19	Dowel Pin.....	4	62M48	62M48	62M48
20	Lifting Lug.....	2	200GAA451	200GAA451	200GAA451
21	Screw.....	24	75P55	75P55	75P55
22	Impeller Case.....	1	900883051701	900883051801	900883051901
23	Rotor Group				
	5" Standard Clearances.....	1	327GAE4028	326GAE4028	325GAE4028
	5" High Temperature Clearances.....	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End.....	1	304GAE006	304GAE006	304GAE006
25	Key-Square.....	1	900639910305	900639910305	900639910305
* 28	Wavy Spring.....	2	900669170405	900669170405	900669170405
29	Drive Cover.....	1	300GAE477	300GAE477	300GAE477
30	Screw.....	8	75P40	75P40	75P40
* 31	Oil Seal.....	1	60DD726	60DD726	60DD726
* 35	Bearing – Spherical.....	1	12BA253	12BA253	12BA253
40	Oil Level Gauge.....	2	40P34	40P34	40P34
44	Screw.....	8	76F92	76F92	76F92
** 45	Paint, Bulk, GDP188, Aluminum.....	0.125	28H284	28H284	28H284
46	Plug.....	8	64AC2	64AC2	64AC2
** 54	Shim Case .0025/.0035".....	1	200GAE732	200GAE732	200GAE732
** 55	Shim Case .010".....	1	201GAE732	201GAE732	201GAE732
** 56	Shim Case .0015/.002".....	1	202GAE732	202GAE732	202GAE732
76	Compound, Loctite.....	5	25BC877	25BC877	25BC877
* 80	Bearing – Conrad.....	1	12BA254	12BA254	12BA254
81	Dowel Pin.....	2	62M13	62M13	62M13
82	Locking Assembly.....	2	22G43	22G43	22G43
83	Slinger.....	2	300GAE173	300GAE173	300GAE173
84	Screw.....	2	75LM14	75LM14	75LM14
85	Bearing Retainer.....	2	300GAE205	300GAE205	300GAE205
86	Screw.....	8	75LM214	75LM214	75LM214
** 105	Overhaul Kit 5" R VERS Mechanical Seal, Dual	1	303GAE6010	303GAE6010	303GAE6010
** 900	Group-Indent & Instruction Legend Series 5" R	1	205GAE4011	205GAE4011	205GAE4011

* INCLUDED IN OVERHAUL KIT.
 ** NOT SHOWN ON ILLUSTRATION

GENERAL PROVISIONS AND LIMITATIONS

Gardner Denver (the "Company") warrants to each original retail purchaser ("Purchaser") of its products from the Company or its authorized distributor that such products are, at the time of delivery to the Purchaser, made with good material and workmanship. No warranty is made with respect to:

1. Any product which has been repaired or altered in such a way, in the Company's judgment, as to affect the product adversely.
2. Any product which has, in the Company's judgment, been subject to negligence, accident, improper storage, or improper installation or application.
3. Any product which has not been operated or maintained in accordance with the recommendations of the Company.
4. Components or accessories manufactured, warranted and serviced by others.
5. Any reconditioned or prior owned product.

Claims for items described in (4) above should be submitted directly to the manufacturer.

WARRANTY PERIOD

The Company's obligation under this Warranty is limited to repairing or, at its option, replacing, during normal business hours at an authorized service facility of the Company, any part which in its judgment proved not to be as warranted within the applicable Warranty Period as follows.

BARE BLOWERS

Basic grease lubricated bare blowers, consisting of all parts within, are warranted for 18 months from date of initial use or 24 months from date of shipment to the first purchaser, whichever occurs first. Basic dual splash lubricated bare blowers, consisting of all parts within, are warranted for 24 months from date of initial use or 30 months from date of shipment to the first purchaser, whichever occurs first. Any disassembly or partial disassembly of the blower, or failure to return the "unopened" blower per Company instructions, will be cause for denial of warranty.

OTHER COMPONENTS

All other components are warranted for 12 months from date of initial use or 18 months from date of shipment to first purchaser, whichever comes first. The Company reserves the right to withdraw the Warranty where evidence indicates application outside the stated performance area, or where there is evidence of abuse.

LABOR TRANSPORTATION AND INSPECTION

The Company will provide labor, by Company representative or authorized service personnel, for repair or replacement of any product or part thereof which in the Company's judgment is proved not to be as warranted. Labor shall be limited to the amount specified in the Company's labor rate schedule.

Labor costs in excess of the Company rate schedules caused by, but not limited to, location or inaccessibility of equipment, or labor provided by unauthorized service personnel is not provided by this warranty.

All costs of transportation of product, labor or parts claimed not to be as warranted and, of repaired or replacement parts to or from such service facilities shall be borne by the Purchaser. The Company may require the return of any part claimed not to be as warranted to one of its facilities as designated by the Company, transportation prepaid by Purchaser, to establish a claim under this warranty. Replacement parts provided under the terms of the warranty are warranted for the remainder of the Warranty Period of the product upon which installed to the same extent as if such parts were original components.

DISCLAIMER

THE FOREGOING WARRANTY IS EXCLUSIVE AND IT IS EXPRESSLY AGREED THAT, EXCEPT AS TO TITLE, THE COMPANY MAKES NO OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY.

THE REMEDY PROVIDED UNDER THIS WARRANTY SHALL BE THE SOLE, EXCLUSIVE AND ONLY REMEDY AVAILABLE TO THE PURCHASER AND IN NO CASE SHALL THE COMPANY BE SUBJECT TO ANY OTHER OBLIGATIONS OR LIABILITIES. UNDER NO CIRCUMSTANCES SHALL THE COMPANY BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, LOSSES OR DELAYS HOWSOEVER CAUSED.

No statement, representation, agreement, or understanding, oral or written, made by any agent, distributor, representative, or employee of the Company which is not contained in this Warranty will be binding upon the Company unless made in writing and executed by an officer of the Company.

This warranty shall not be effective as to any claim which is not presented within 30 days after the date upon which the product is claimed not to have been as warranted. Any action for breach of this warranty must be commenced within one year after the date upon which the cause of action occurred.

Any adjustment made pursuant to this warranty shall not be construed as an admission by the Company that any product was not as warranted.

NOTES

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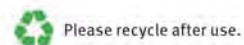
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For additional information, contact your local representative or visit:
www.contactgd.com/mobile

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NOTES

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MAINTENANCE DATA SHEET

FOR POSITIVE DISPLACEMENT BLOWER

-

SPARE PARTS

MODEL: Sutorbilt 4L, GACLBRA (modified to horizontal)
SERIAL NUMBER: S520806 & S520818

MAINTENANCE FOR ONE UNIT

Item	Type / Part number	Qty.	Maintenance /Replacement	Unit price
Oil / Blower gear side *	AEON PD*	1.5 pt.	6000 hours	34\$ for 1 L, 365 \$ for 12x1L
Grease / Blower drive side	28H282	**	500 hours	34\$ for 14 oz.
Overhaul Kit***	300GAC6010	1	When needed	428\$
Belts	VBA65	2	When needed	24\$

* AEON PD is synthetic oil with superior properties than mineral oil. If mineral oil is used instead of AEON PD oil, replacement must be done after 500 hours.

** Fill with new grease until old grease is flushed.

*** Overhaul kit consist of bearings, seals, gaskets, shims, taper pins and bearing retainer screws.

Conditions : CAD Dollar, net 30, taxes extra, price valid for 2017, minimum order of 75 \$, FOB Montreal, PQ.

B-501/2	38094	VFD, Danfoss 15HP, 380-480Vac, IP55	p/n: FC202P11KT4E55H2XGX3SXSXXXXAXBX CXXXXDX
P-701/2	38093	VFD, Danfoss 2HP, 380-480Vac, IP55	p/n: FC202P1K5T4E55H2XGX3SXSXXXXAXBX CXXXXDX

oss

Operating Guide

VLT[®] AQUA Drive FC 202

0.25–90 kW



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1

1 Introduction

1.1 Purpose of the Operating Guide

This operating guide provides information for safe installation and commissioning of the frequency converter.

The operating guide is intended for use by qualified personnel.

Read and follow the instructions to use the frequency converter safely and professionally, and pay particular attention to the safety instructions and general warnings. Always keep this operating guide available with the frequency converter.

VLT® is a registered trademark.

1.2 Additional Resources

Other resources are available to understand advanced frequency converter functions and programming.

- The *VLT® AQUA Drive FC 202 Programming Guide* provides greater detail on working with parameters and many application examples.
- The *VLT® AQUA Drive FC 202 Design Guide* provides detailed information about capabilities and functionality to design motor control systems.
- Instructions for operation with optional equipment.

Supplementary publications and manuals are available from Danfoss. See www.vlt-drives.danfoss.com/Support/Technical-Documentation/ for listings.

1.3 Manual and Software Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome.

Table 1.1 shows the manual version and the corresponding software version.

Edition	Remarks	Software version
MG20MDxx	The parameter list is updated to reflect software version 2.6x. Editorial update.	2.6x

Table 1.1 Manual and Software Version

1.4 Product Overview

1.4.1 Intended Use

The frequency converter is an electronic motor controller intended for:

- Regulation of motor speed in response to system feedback or to remote commands from external controllers. A power drive system consists of the frequency converter, the motor, and equipment driven by the motor.
- System and motor status surveillance.

Depending on configuration, the frequency converter can be used in standalone applications or form part of a larger appliance or installation.

The frequency converter is allowed for use in residential, industrial, and commercial environments in accordance with local laws, standards, and emission limits as described in the design guide.

Single-phase frequency converters (S2 and S4) installed in the EU

The following limitations apply:

- Units with an input current below 16 A and an input power above 1 kW (1.5 hp) are only intended for professional use in trades, professions, or industries and not for sale to the general public.
- Designated application areas are public pools, public water supplies, agriculture, commercial buildings, and industries. All other single-phase units are only intended for use in private low-voltage systems interfacing with public supply only at a medium or high-voltage level.
- Operators of private systems must ensure that the EMC environment complies with IEC 61000-3-6 and/or the contractual agreements.

NOTICE

In a residential environment, this product can cause radio interference, in which case supplementary mitigation measures may be required.

Foreseeable misuse

Do not use the frequency converter in applications, which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *chapter 8 Specifications*.

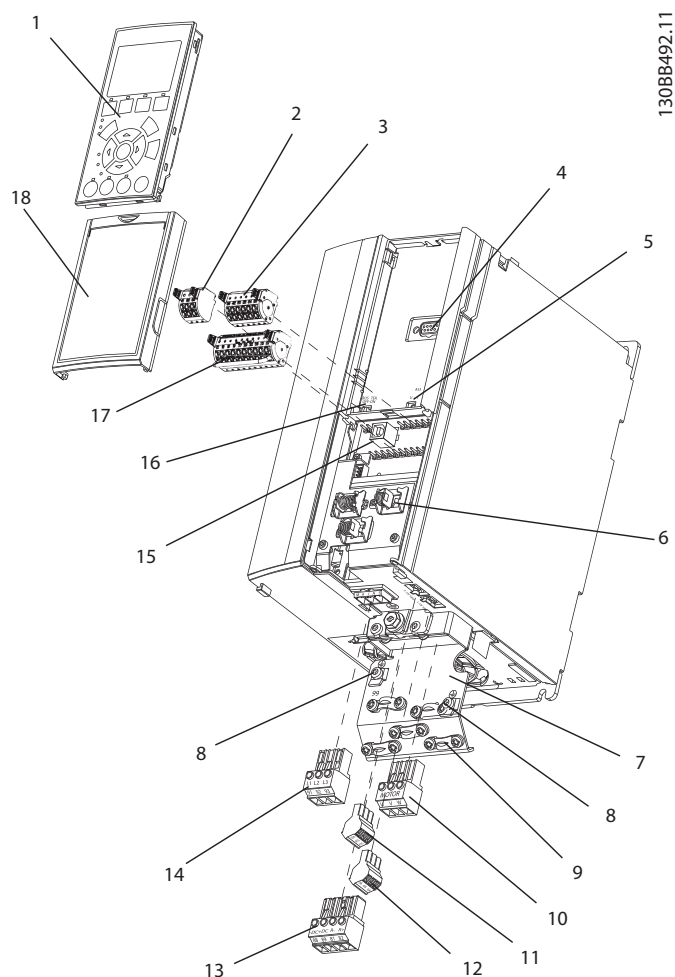
1.4.2 Features

The VLT® AQUA Drive FC 202 is designed for water and wastewater applications. The range of standard and optional features includes:

- Cascade control.
- Dry run detection.
- End-of-curve detection.
- SmartStart.
- Motor alternation.
- Deragging.
- 2-step ramps.
- Flow confirmation.
- Check valve protection.
- Safe Torque Off.
- Low flow detection.
- Pre/post lubrication.
- Pipe fill mode.
- Sleep mode.
- Real-time clock.
- User-configurable info texts.
- Warnings and alarms.
- Password protection.
- Overload protection.
- Smart logic control.
- Dual power rating (high/normal overload).

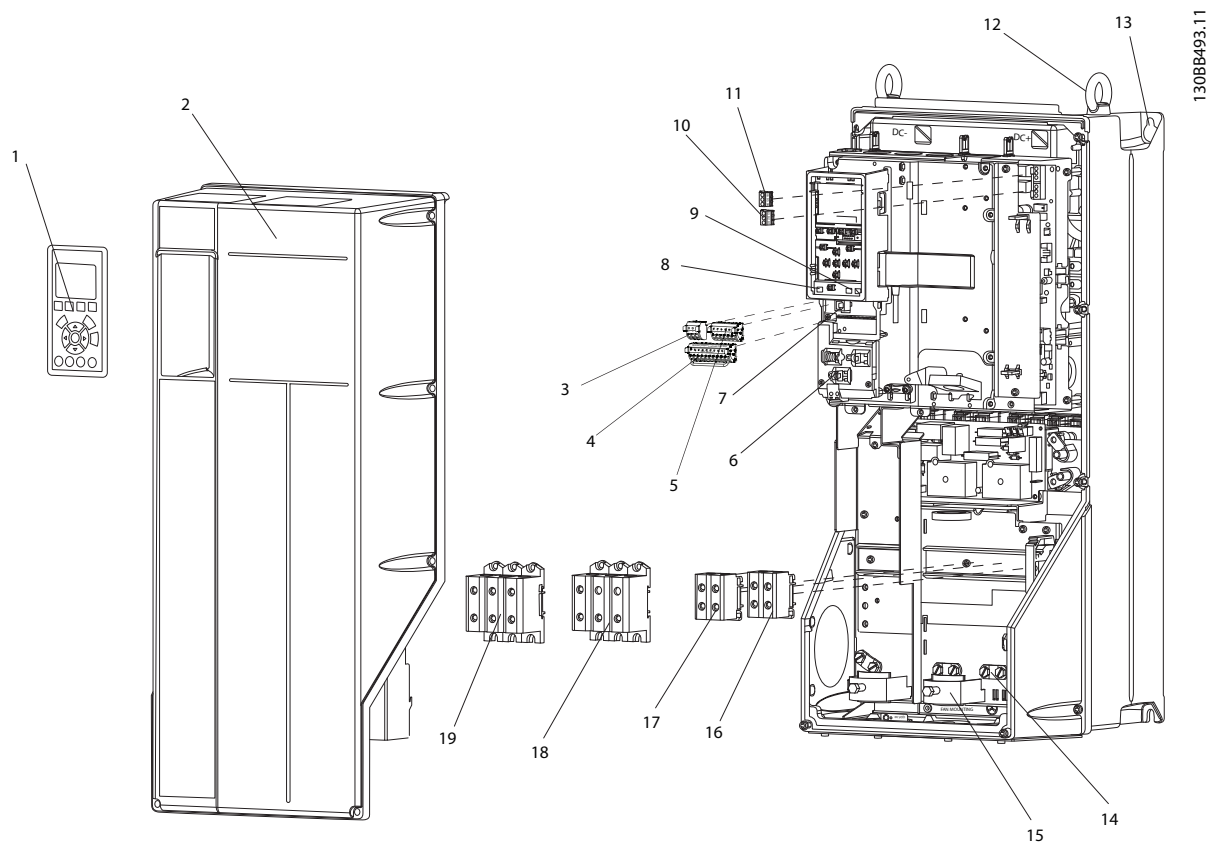
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1.4.3 Exploded Views



1	Local control panel (LCP)	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS485 fieldbus connector (+68, -69)	11	Relay 2 (01, 02, 03)
3	Analog I/O connector	12	Relay 1 (04, 05, 06)
4	LCP input plug	13	Brake (-81, +82) and load sharing (-88, +89) terminals
5	Analog switches (A53), (A54)	14	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
6	Cable shield connector	15	USB connector
7	Ground termination plate	16	Fieldbus terminal switch
8	Grounding clamp (PE)	17	Digital I/O and 24 V supply
9	Shielded cable grounding clamp and strain relief	18	Cover

Illustration 1.1 Exploded View Enclosure Size A, IP20

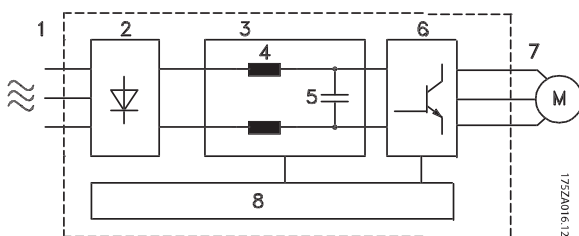


1	Local control panel (LCP)	11	Relay 2 (04, 05, 06)
2	Cover	12	Lifting ring
3	RS485 fieldbus connector	13	Mounting slot
4	Digital I/O and 24 V supply	14	Grounding clamp (PE)
5	Analog I/O connector	15	Cable shield connector
6	Cable shield connector	16	Brake terminal (-81, +82)
7	USB connector	17	Load sharing terminal (DC bus) (-88, +89)
8	Fieldbus terminal switch	18	Motor output terminals 96 (U), 97 (V), 98 (W)
9	Analog switches (A53), (A54)	19	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
10	Relay 1 (01, 02, 03)	-	-

Illustration 1.2 Exploded View Enclosure Sizes B and C, IP55 and IP66

1

Illustration 1.3 is a block diagram of the internal components of the frequency converter.



Area	Title	Functions
1	Mains input	3-phase AC mains supply to the frequency converter.
2	Rectifier	The rectifier bridge converts the AC input to DC current to supply inverter power.
3	DC bus	The intermediate DC bus circuit handles the DC current.
4	DC reactors	- Filter the intermediate DC circuit voltage. - Provide mains transient protection. - Reduce RMS current. - Raise the power factor reflected back to the line. - Reduce harmonics on the AC input.
5	Capacitor bank	- Stores the DC power. - Provides ride-through protection for short power losses.
6	Inverter	Converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor.
7	Output to motor	Regulated 3-phase output power to the motor.
8	Control circuitry	- Input power, internal processing, output, and motor current are monitored to provide efficient operation and control. - User interface and external commands are monitored and performed. - Status output and control can be provided.

Illustration 1.3 Frequency Converter Block Diagram

1.4.4 Enclosure Sizes and Power Ratings

For enclosure sizes and power ratings of the frequency converters, refer to *chapter 8.9 Power Ratings, Weight, and Dimensions*.

1.5 Approvals and Certifications



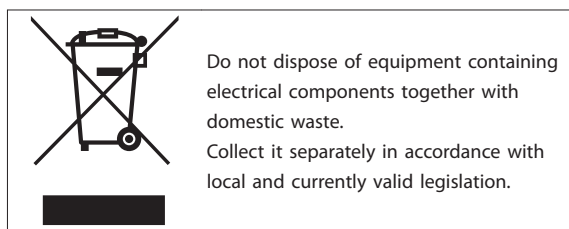
Table 1.2 Approvals and Certifications

More approvals and certifications are available. Contact the local Danfoss partner. Frequency converters of enclosure size T7 (525–690 V) are UL certified for only 525–600 V.

The frequency converter complies with UL 508C thermal memory retention requirements. For more information, refer to the section *Motor Thermal Protection* in the product-specific *design guide*.

For compliance with the European Agreement concerning International Carriage of Dangerous Goods by Inland Waterways (ADN), refer to *ADN-compliant Installation* in the product-specific *design guide*.

1.6 Disposal



2 Safety

2.1 Safety Symbols

The following symbols are used in this guide:

⚠ WARNING

Indicates a potentially hazardous situation that could result in death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation that could result in minor or moderate injury. It can also be used to alert against unsafe practices.

NOTICE

Indicates important information, including situations that can result in damage to equipment or property.

2.2 Qualified Personnel

Correct and reliable transport, storage, installation, operation, and maintenance are required for the trouble-free and safe operation of the frequency converter. Only qualified personnel are allowed to install and operate this equipment.

Qualified personnel are defined as trained staff, who are authorized to install, commission, and maintain equipment, systems, and circuits in accordance with pertinent laws and regulations. Also, the qualified personnel must be familiar with the instructions and safety measures described in this manual.

2.3 Safety Precautions

⚠ WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.

- Only qualified personnel must perform installation, start-up, and maintenance.

⚠ WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a fieldbus command, an input reference signal from the LCP, or after a cleared fault condition.

To prevent unintended motor start:

- Disconnect the frequency converter from the mains.
- Press [Off/Reset] on the LCP before programming parameters.
- Completely wire and assemble the frequency converter, motor, and any driven equipment before connecting the frequency converter to AC mains, DC supply, or load sharing.

⚠ WARNING

DISCHARGE TIME

The frequency converter contains DC-link capacitors, which can remain charged even when the frequency converter is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait the specified time after power has been removed before performing service or repair work can result in death or serious injury.

- Stop the motor.
- Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters.
- Disconnect or lock PM motor.
- Wait for the capacitors to discharge fully. The minimum duration of waiting time is specified in *Table 2.1*.
- Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.

Voltage [V]	Minimum waiting time (minutes)		
	4	7	15
200–240	0.25–3.7 kW (0.34–5 hp)	–	5.5–45 kW (7.5–60 hp)
380–480	0.37–7.5 kW (0.5–10 hp)	–	11–90 kW (15–121 hp)
525–600	0.75–7.5 kW (1–10 hp)	–	11–90 kW (15–121 hp)
525–690	–	1.1–7.5 kW (1.5–10 hp)	11–90 kW (15–121 hp)

Table 2.1 Discharge Time

⚠ WARNING

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the frequency converter properly can result in death or serious injury.

- Ensure the correct grounding of the equipment by a certified electrical installer.

⚠ WARNING

EQUIPMENT HAZARD

Contact with rotating shafts and electrical equipment can result in death or serious injury.

- Ensure that only trained and qualified personnel perform installation, start-up, and maintenance.
- Ensure that electrical work conforms to national and local electrical codes.
- Follow the procedures in this guide.

⚠ WARNING

UNINTENDED MOTOR ROTATION

WINDMILLING

Unintended rotation of permanent magnet motors creates voltage and can charge the unit, resulting in death, serious injury, or equipment damage.

- Ensure that permanent magnet motors are blocked to prevent unintended rotation.

⚠ CAUTION

INTERNAL FAILURE HAZARD

An internal failure in the frequency converter can result in serious injury when the frequency converter is not properly closed.

- Ensure that all safety covers are in place and securely fastened before applying power.

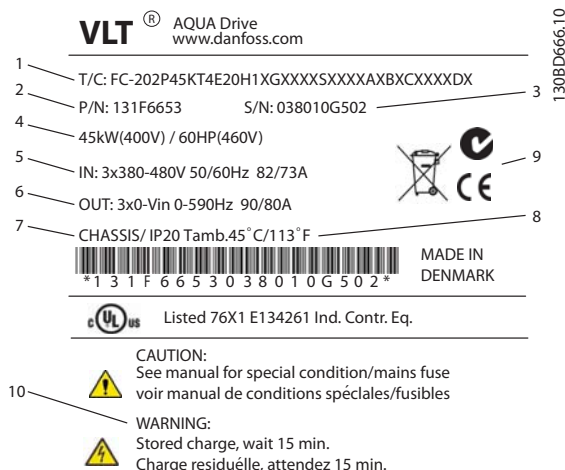
3 Mechanical Installation

3.1 Unpacking

3.1.1 Items Supplied

Items supplied may vary according to product configuration.

- Make sure the items supplied and the information on the nameplate correspond to the order confirmation.
- Check the packaging and the frequency converter visually for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.



1	Type code
2	Ordering number
3	Serial number
4	Power rating
5	Input voltage, frequency, and current (at low/high voltages)
6	Output voltage, frequency, and current (at low/high voltages)
7	Enclosure type and IP rating
8	Maximum ambient temperature
9	Certifications
10	Discharge time (Warning)

Illustration 3.1 Product Nameplate (Example)

NOTICE

Do not remove the nameplate from the frequency converter. Removing the nameplate voids the warranty.

3.1.2 Storage

Ensure that the requirements for storage are fulfilled. Refer to *chapter 8.4 Ambient Conditions* for further details.

3.2 Installation Environments

NOTICE

In environments with airborne liquids, particles, or corrosive gases, ensure that the IP/type rating of the equipment matches the installation environment. Failure to meet requirements for ambient conditions can reduce the lifetime of the frequency converter. Ensure that requirements for air humidity, temperature, and altitude are met.

Vibration and shock

The frequency converter complies with requirements for units mounted on the walls and floors of production premises, and in panels bolted to walls or floors.

For detailed ambient conditions specifications, refer to *chapter 8.4 Ambient Conditions*.

3

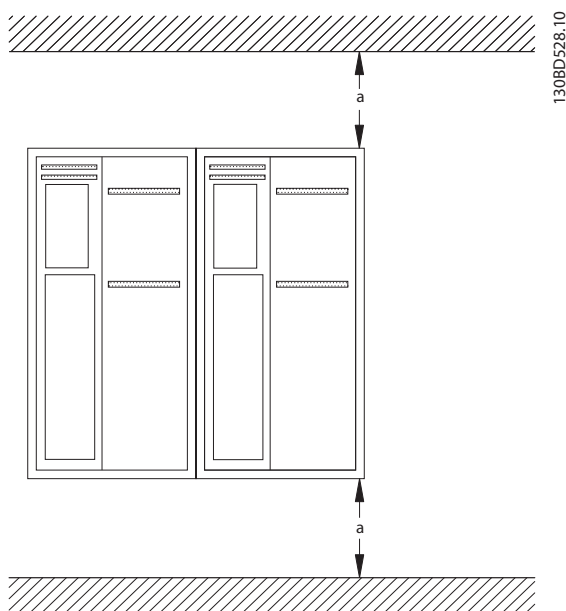
3.3 Mounting

NOTICE

Improper mounting can result in overheating and reduced performance.

Cooling

- Ensure that top and bottom clearance for air cooling is provided. See *Illustration 3.2* for clearance requirements.



Enclosure	A2–A5	B1–B4	C1, C3	C2, C4
a [mm (in)]	100 (3.9)	200 (7.9)	200 (7.9)	225 (8.9)

Illustration 3.2 Top and Bottom Cooling Clearance

Lifting

- To determine a safe lifting method, check the weight of the unit, see *chapter 8.9 Power Ratings, Weight, and Dimensions*.
- Ensure that the lifting device is suitable for the task.
- If necessary, plan for a hoist, crane, or forklift with the appropriate rating to move the unit.
- For lifting, use the hoist rings on the unit, when provided.

Mounting

- Ensure that the strength of the mounting location supports the unit weight. The frequency converter allows side-by-side installation.
- Locate the unit as near to the motor as possible. Keep the motor cables as short as possible.
- Mount the unit vertically to a solid flat surface or to the optional backplate to provide cooling airflow.
- Use the slotted mounting holes on the unit for wall mounting, when provided.

Mounting with backplate and railings

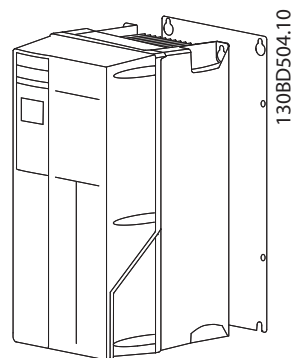


Illustration 3.3 Proper Mounting with Backplate

NOTICE

A backplate is required when mounted on railings.

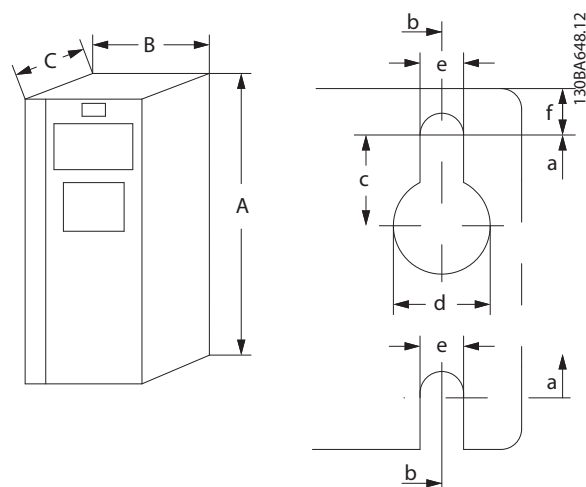


Illustration 3.4 Top and Bottom Mounting Holes (See *chapter 8.9 Power Ratings, Weight, and Dimensions*)

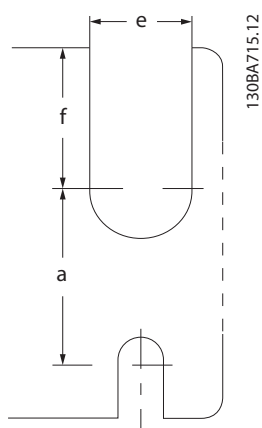


Illustration 3.5 Top and Bottom Mounting Holes (B4, C3, and C4)

4 Electrical Installation

4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

4

⚠ WARNING

INDUCED VOLTAGE

Induced voltage from output motor cables that run together can charge equipment capacitors, even with the equipment turned off and locked out. Failure to run output motor cables separately or to use shielded cables could result in death or serious injury.

- Run output motor cables separately, or
- Use shielded cables.

⚠ CAUTION

SHOCK HAZARD

The frequency converter can cause a DC current in the PE conductor. Failure to follow the recommendation may lead to the RCD not providing the intended protection.

- When a residual current-operated protective device (RCD) is used for protection against electrical shock, only an RCD of Type B is allowed on the supply side.

Overcurrent protection

- Extra protective equipment, such as short-circuit protection or motor thermal protection between frequency converter and motor, is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If not factory-supplied, the installer must provide fuses. See maximum fuse ratings in *chapter 8.8 Fuses and Circuit Breakers*.

Wire type and ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- Power connection wire recommendation: Minimum 75 °C (167 °F) rated copper wire.

See *chapter 8.1 Electrical Data* and *chapter 8.5 Cable Specifications* for recommended wire sizes and types.

4.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in *chapter 4.3 Grounding*, *chapter 4.4 Wiring Schematic*, *chapter 4.6 Motor Connection*, and *chapter 4.8 Control Wiring*.

4.3 Grounding

⚠ WARNING

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the frequency converter properly could result in death or serious injury.

- Ensure the correct grounding of the equipment by a certified electrical installer.

For electrical safety

- Ground the frequency converter in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground 1 frequency converter to another in a daisy-chain fashion (see *Illustration 4.1*).
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section: 10 mm² (7 AWG). Separately terminate 2 ground wires, both complying with the dimension requirements.

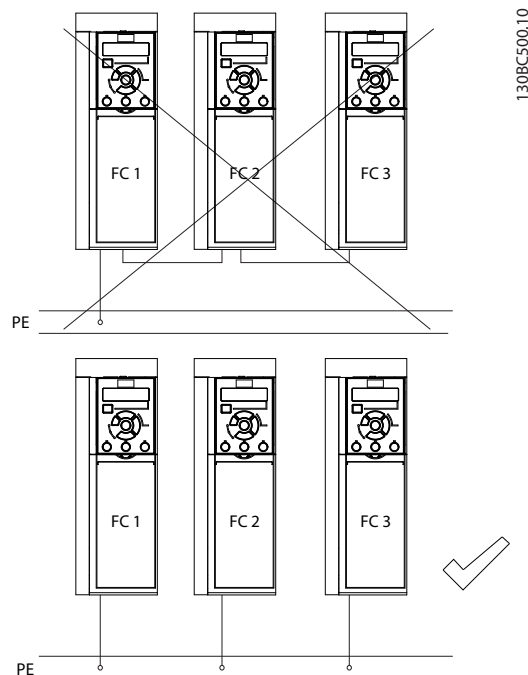


Illustration 4.1 Grounding Principle

For EMC-compliant installation

- Establish electrical contact between the cable shield and the frequency converter enclosure by using metal cable glands or by using the clamps provided on the equipment (see *chapter 4.6 Motor Connection*).
- Use high-strand wire to reduce burst transient.
- Do not use pigtails.

NOTICE**POTENTIAL EQUALIZATION**

Risk of burst transient when the ground potential between the frequency converter and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm² (6 AWG).

4.4 Wiring Schematic

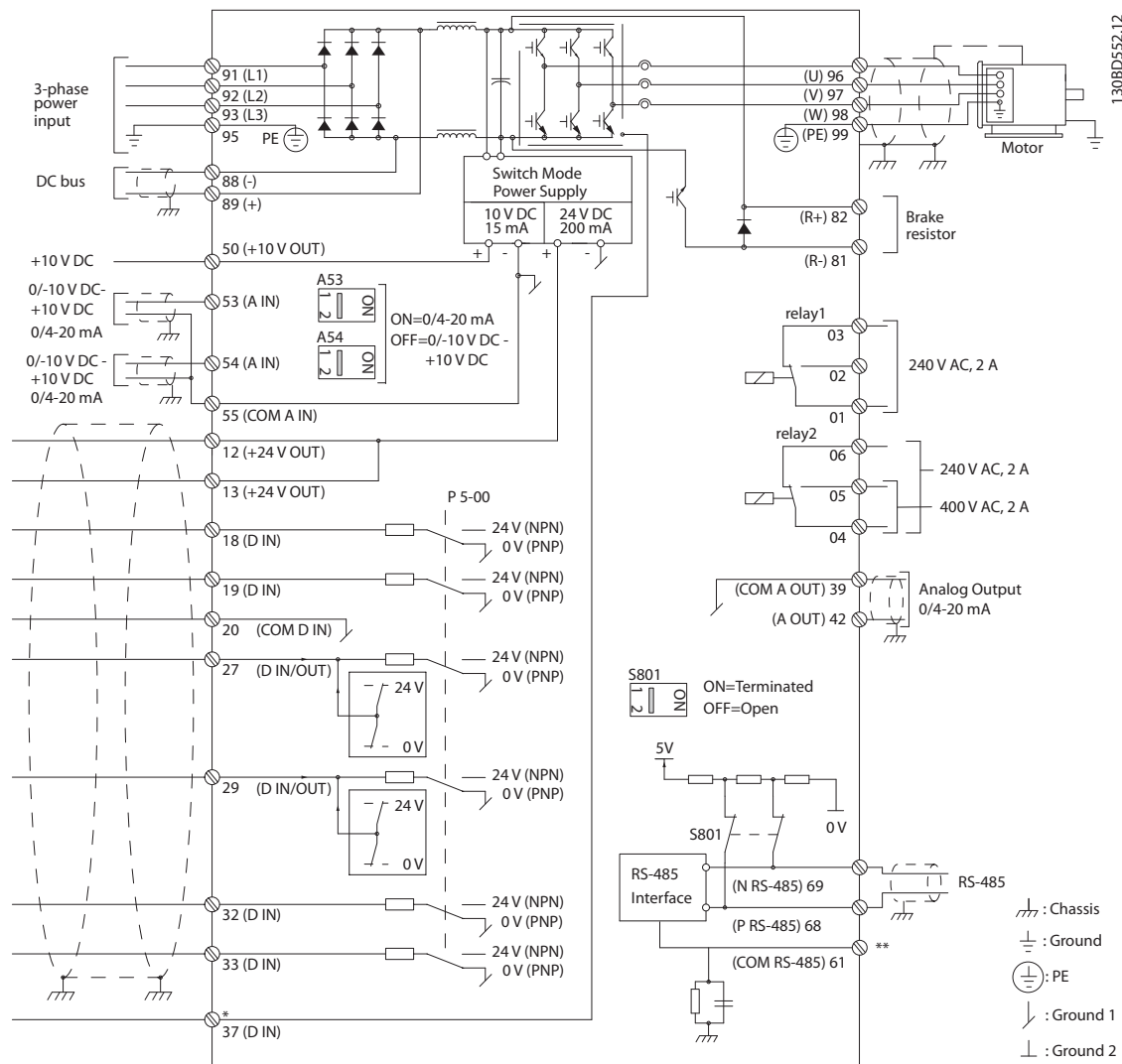


Illustration 4.2 Basic Wiring Schematic

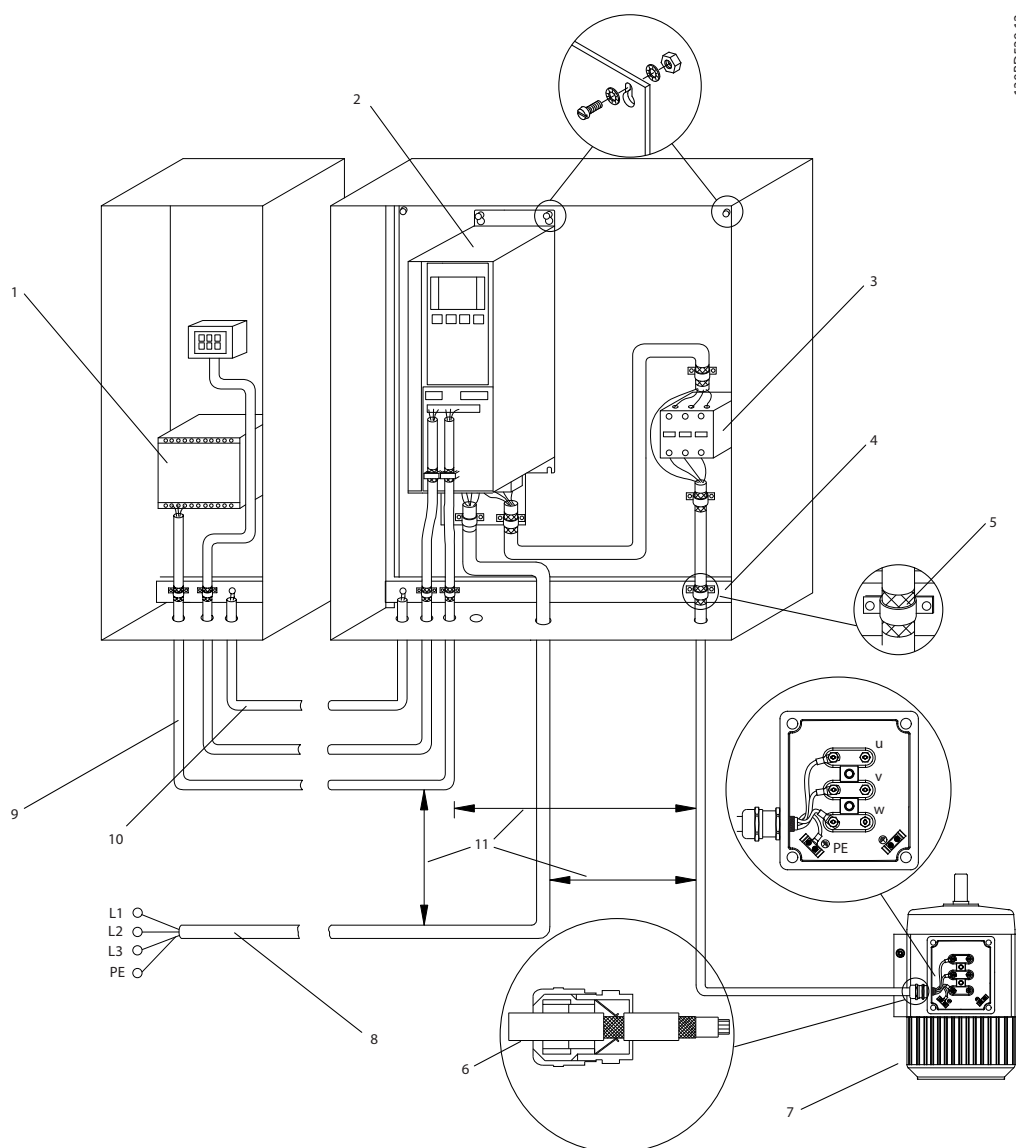
A=Analog, D=Digital

*Terminal 37 (optional) is used for Safe Torque Off. For Safe Torque Off installation instructions, refer to the VLT® Frequency Converters - Safe Torque Off Operating Guide.

**Do not connect cable shield.

NOTICE

Actual configurations vary with unit types and optional equipment.



1	PLC	6	Cable gland
2	Frequency converter	7	Motor, 3-phase, and PE
3	Output contactor	8	Mains, 3-phase, and reinforced PE
4	Grounding rail (PE)	9	Control wiring
5	Cable insulation (stripped)	10	Equalizing minimum 16 mm ² (5 AWG)

Illustration 4.3 EMC-compliant Connection of Mains

NOTICE

EMC INTERFERENCE

Use shielded cables for motor and control wiring and separate cables for input power, motor wiring, and control wiring. Failure to isolate power, motor, and control cables can result in unintended behavior or reduced performance. Minimum clearance requirement between power, motor, and control cables is 200 mm (7.9 in).

4.5 Access

1. Remove the cover with a screwdriver (See *Illustration 4.4*) or by loosening the attaching screws (See *Illustration 4.5*).

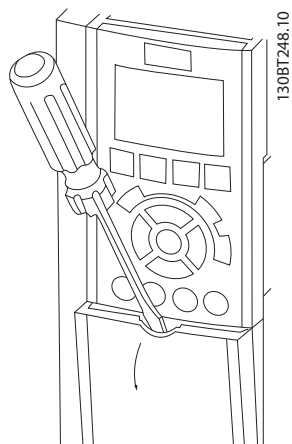


Illustration 4.4 Access to Wiring for IP20 and IP21 Enclosures

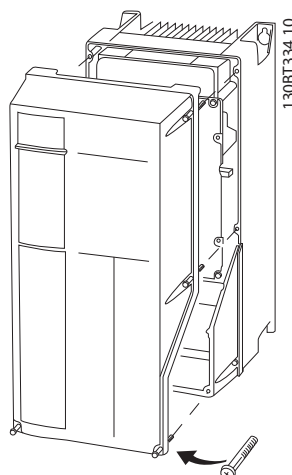


Illustration 4.5 Access to Wiring for IP55 and IP66 Enclosures

Tighten the cover screws using the tightening torques specified in *Table 4.1*.

Enclosure	IP55	IP66
A4/A5	2 (18)	2 (18)
B1/B2	2.2 (19)	2.2 (19)
C1/C2	2.2 (19)	2.2 (19)
No screws to tighten for A2/A3/B3/B4/C3/C4.		

Table 4.1 Tightening Torques for Covers [N•m (in-lb)]

4.6 Motor Connection

⚠ WARNING

INDUCED VOLTAGE

Induced voltage from output motor cables that run together can charge equipment capacitors, even with the equipment turned off and locked out. Failure to run output motor cables separately or use shielded cables could result in death or serious injury.

- Run output motor cables separately, or
- Use shielded cables.
- Comply with local and national electrical codes for cable sizes. For maximum wire sizes, see *chapter 8.1 Electrical Data*.
- Follow motor manufacturer wiring requirements.
- Motor wiring knockouts or access panels are provided at the base of IP21 (NEMA1/12) and higher units.
- Do not wire a starting or pole-changing device (for example Dahlander motor or slip ring asynchronous motor) between the frequency converter and the motor.

Procedure

1. Strip a section of the outer cable insulation.
2. Position the stripped wire under the cable clamp to establish mechanical fixation and electrical contact between the cable shield and ground.
3. Connect the ground wire to the nearest grounding terminal in accordance with the grounding instructions provided in *chapter 4.3 Grounding*, see *Illustration 4.6*.
4. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W), see *Illustration 4.6*.
5. Tighten the terminals in accordance with the information provided in *chapter 8.7 Connection Tightening Torques*.

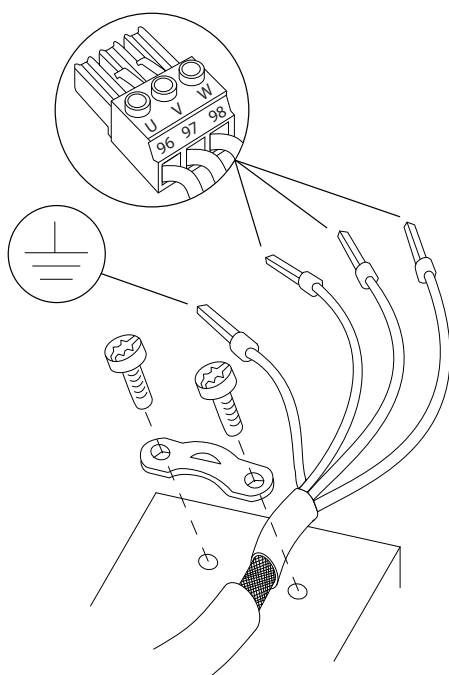


Illustration 4.6 Motor Connection

Illustration 4.7 shows mains input, motor, and grounding for basic frequency converters. Actual configurations vary with unit types and optional equipment.

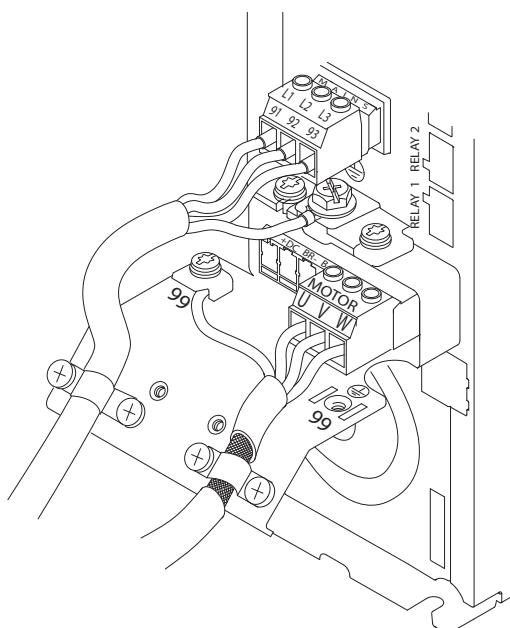


Illustration 4.7 Example of Motor, Mains, and Ground Wiring

4.7 AC Mains Connection

- Size the wiring based on the input current of the frequency converter. For maximum wire sizes, see *chapter 8.1 Electrical Data*.
- Comply with local and national electrical codes for cable sizes.

Procedure

1. Connect the 3-phase AC input power wiring to terminals L1, L2, and L3 (see *Illustration 4.7*).
2. Depending on the configuration of the equipment, connect the input power to the mains input terminals or the input disconnect.
3. Ground the cable in accordance with the grounding instructions provided in *chapter 4.3 Grounding*.
4. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), ensure that *parameter 14-50 RFI Filter* is set to [0] Off to avoid damage to the DC link and to reduce ground capacity currents in accordance with IEC 61800-3.

4.8 Control Wiring

- Isolate the control wiring from the high-power components in the frequency converter.
- When the frequency converter is connected to a thermistor, ensure that the thermistor control wiring is shielded and reinforced/double insulated. A 24 V DC supply voltage is recommended. See *Illustration 4.8*.

4.8.1 Control Terminal Types

Illustration 4.8 and Illustration 4.9 show the removable frequency converter connectors. Terminal functions and default settings are summarized in *Table 4.2*.

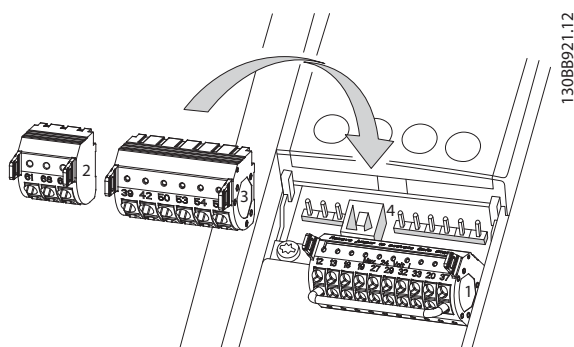


Illustration 4.8 Control Terminal Locations

4

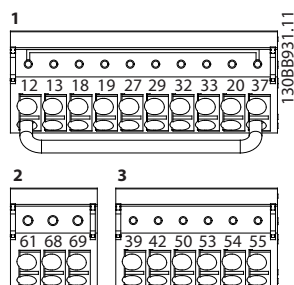


Illustration 4.9 Terminal Numbers

- **Connector 1** provides:
 - 4 programmable digital inputs terminals.
 - 2 extra digital terminals programmable as either input or output.
 - 24 V DC terminal supply voltage.
 - Optional customer supplied 24 V DC voltage.
- **Connector 2** terminals (+)68 and (-)69 are for an RS485 serial communication connection.
- **Connector 3** provides:
 - 2 analog inputs.
 - 1 analog output.
 - 10 V DC supply voltage.
 - Commons for the inputs and output.
- **Connector 4** is a USB port available for use with the MCT 10 Set-up Software.

Terminal description			
Terminal	Parameter	Default setting	Description
Digital Inputs/Outputs			
12, 13	–	+24 V DC	24 V DC supply voltage for digital inputs and external transducers. Maximum output current 200 mA for all 24 V loads.

Terminal description			
Terminal	Parameter	Default setting	Description
18	Parameter 5 -10 Terminal I 18 Digital Input	[8] Start	Digital inputs.
19	Parameter 5 -11 Terminal I 19 Digital Input	[0] No operation	
32	Parameter 5 -14 Terminal I 32 Digital Input	[0] No operation	
33	Parameter 5 -15 Terminal I 33 Digital Input	[0] No operation	
27	Parameter 5 -12 Terminal I 27 Digital Input	[2] Coast inverse	For digital input or output. Default setting is input.
29	Parameter 5 -13 Terminal I 29 Digital Input	[14] Jog	
20	–	–	Common for digital inputs and 0 V potential for 24 V supply.
37	–	Safe Torque Off (STO)	Safe input (optional). Used for STO.
Analog Inputs/Outputs			
39	–	–	Common for analog output
42	Parameter 6 -50 Terminal I 42 Output	Speed 0 – High Limit	Programmable analog output. 0–20 mA or 4– 20 mA at a maximum of 500 Ω
50	–	+10 V DC	10 V DC analog supply voltage for potenti- ometer or thermistor. 15 mA maximum
53	Parameter group 6-1* Analog Input 53	Reference	Analog input. For voltage or current. Switches A53 and A54 select mA or V.
54	Parameter group 6-2* Analog Input 54	Feedback	
55	–	–	Common for analog input
Serial Communication			

Terminal description			
Terminal	Parameter	Default setting	Description
61	–	–	Integrated RC-Filter for cable shield. ONLY for connecting the shield if EMC problems occur.
68 (+)	Parameter group 8-3* FC Port Settings	–	RS485 Interface. A control card switch is provided for termination resistance.
69 (-)	Parameter group 8-3* FC Port Settings	–	
Relays			
01, 02, 03	Parameter 5 ~40 Function Relay [0]	[9] Alarm	Form C relay output. For AC or DC voltage and resistive or inductive loads.
04, 05, 06	Parameter 5 ~40 Function Relay [1]	[5] Running	

Table 4.2 Terminal Description

Extra terminals

- 2 form C relay outputs. Location of the outputs depends on frequency converter configuration.
- Terminals on built-in optional equipment. See the manual provided with the equipment option.

4.8.2 Wiring to Control Terminals

Control terminal connectors can be unplugged from the frequency converter for ease of installation, as shown in *Illustration 4.10*.

NOTICE

Keep control wires as short as possible and separate from high-power cables to minimize interference.

1. Open the contact by inserting a small screwdriver into the slot above the contact and push the screwdriver slightly upwards.

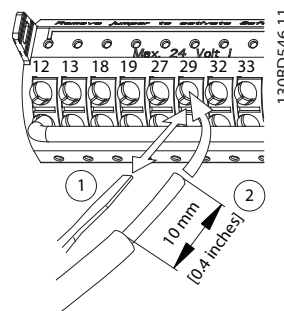


Illustration 4.10 Connecting Control Wires

2. Insert the bare control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.
4. Ensure that the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or less than optimal operation.

See *chapter 8.5 Cable Specifications* for control terminal wiring sizes and *chapter 6 Application Set-up Examples* for typical control wiring connections.

4.8.3 Enabling Motor Operation (Terminal 27)

A jumper wire is required between terminal 12 (or 13) and terminal 27 for the frequency converter to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive 24 V DC external interlock command.
- When no interlock device is used, wire a jumper between control terminal 12 (recommended) or 13 to terminal 27. The jumper provides an internal 24 V signal on terminal 27.
- When the status line at the bottom of the LCP reads *AUTO REMOTE COAST*, it indicates that the unit is ready to operate but is missing an input signal on terminal 27.
- When factory installed optional equipment is wired to terminal 27, do not remove that wiring.

4

4.8.4 Voltage/Current Input Selection (Switches)

The analog input terminals 53 and 54 allow setting of input signal to voltage (0–10 V) or current (0/4–20 mA).

Default parameter setting

- Terminal 53: Speed reference signal in open loop (see *parameter 16-61 Terminal 53 Switch Setting*).
- Terminal 54: Feedback signal in closed loop (see *parameter 16-63 Terminal 54 Switch Setting*).

NOTICE

Disconnect power to the frequency converter before changing switch positions.

1. Remove the LCP (see *Illustration 4.11*).
2. Remove any optional equipment covering the switches.
3. Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.

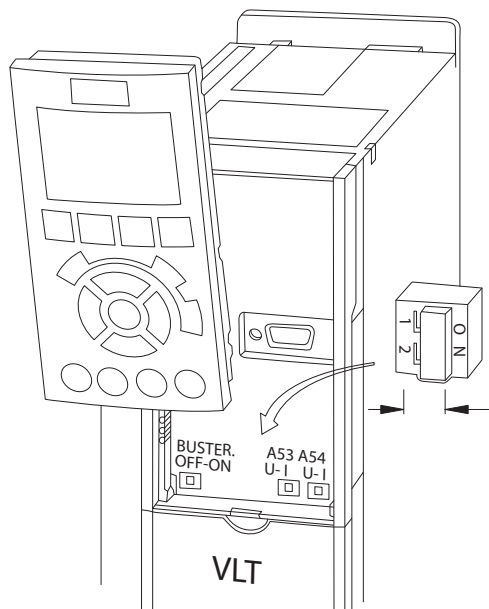


Illustration 4.11 Location of Terminal 53 and 54 Switches

To run STO, more wiring for the frequency converter is required. Refer to *VLT® Frequency Converters Safe Torque Off Operating Guide* for further information.

4.8.5 RS485 Serial Communication

Connect RS485 serial communication wiring to terminals (+)68 and (-)69.

- Use shielded serial communication cable (recommended).
- See *chapter 4.3 Grounding* for proper grounding.

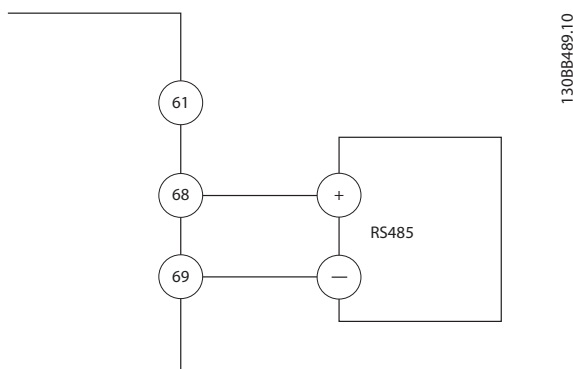


Illustration 4.12 Serial Communication Wiring Diagram

For basic serial communication set-up, select the following:

1. Protocol type in *parameter 8-30 Protocol*.
 2. Frequency converter address in *parameter 8-31 Address*.
 3. Baud rate in *parameter 8-32 Baud Rate*.
- 2 communication protocols are internal to the frequency converter:
 - Danfoss FC.
 - Modbus RTU.
 - Functions can be programmed remotely using the protocol software and RS485 connection or in *parameter group 8-** Communications and Options*.
 - Selecting a specific communication protocol changes various default parameter settings to match that protocol's specifications and makes more protocol-specific parameters available.
 - Option cards for the frequency converter are available to provide extra communication protocols. See the option card documentation for installation and operation instructions.

4.9 Installation Check List

Before completing installation of the unit, inspect the entire installation as detailed in *Table 4.3*. Check and mark the items when completed.

Inspect for	Description	☑
Auxiliary equipment	- Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers, residing on the input power side of the frequency converter, or output side to the motor. Ensure that they are ready for full-speed operation. - Check the function and installation of any sensors used for feedback to the frequency converter. - Remove any power factor correction caps on the motor. - Adjust any power factor correction caps on the mains side and ensure that they are dampened.	
Cable routing	Ensure that the motor wiring and control wiring are separated, shielded, or in 3 separate metallic conduits for high frequency interference isolation.	
Control wiring	- Check for broken or damaged wires and loose connections. - Check that the control wiring is isolated from power and motor wiring for noise immunity. - Check the voltage source of the signals, if necessary. The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly.	
Cooling clearance	Ensure that the top and bottom clearance is adequate to ensure proper airflow for cooling, see <i>chapter 3.3 Mounting</i>.	
Ambient conditions	Check that requirements for ambient conditions are met.	
Fusing and circuit breakers	- Check for proper fusing or circuit breakers. - Check that all fuses are inserted firmly and are in operational condition, and that all circuit breakers are in the open position.	
Grounding	- Check for sufficient ground connections and ensure that those connections are tight and free of oxidation. - Grounding to conduit, or mounting the back panel to a metal surface, is not a suitable grounding.	
Input and output power wiring	- Check for loose connections. - Check that the motor and mains cables are in separate conduit or separated shielded cables.	
Panel interior	- Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion. - Check that the unit is mounted on an unpainted metal surface.	
Switches	Ensure that all switch and disconnect settings are in the proper positions.	
Vibration	- Check that the unit is mounted solidly, or that shock mounts are used, as necessary. - Check for an unusual amount of vibration.	

Table 4.3 Installation Check List

⚠ CAUTION

POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE

Risk of personal injury if the frequency converter is not properly closed.

- Before applying power, ensure that all safety covers are in place and securely fastened.

5 Commissioning

5.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠ WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input power. Failure to perform installation, start-up, and maintenance by qualified personnel could result in death or serious injury.

- Installation, start-up, and maintenance must be performed by qualified personnel only.

Before applying power:

1. Close the cover properly.
2. Check that all cable glands are firmly tightened.
3. Ensure that input power to the unit is off and locked out. Do not rely on the frequency converter disconnect switches for input power isolation.
4. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase, and phase-to-ground.
5. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase, and phase-to-ground.
6. Confirm continuity of the motor by measuring Ω values on U–V (96–97), V–W (97–98), and W–U (98–96).
7. Check for proper grounding of the frequency converter and the motor.
8. Inspect the frequency converter for loose connections on the terminals.
9. Confirm that the supply voltage matches the voltage of the frequency converter and the motor.

5.2 Applying Power

Apply power to the frequency converter using the following steps:

1. Confirm that the input voltage is balanced within 3%. If not, correct the input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that any optional equipment wiring matches the installation application.

3. Ensure that all operator devices are in the OFF position. Panel doors must be closed and covers securely fastened.
4. Apply power to the unit. Do not start the frequency converter now. For units with a disconnect switch, turn it to the ON position to apply power to the frequency converter.

5.3 Local Control Panel Operation

The local control panel (LCP) is the combined display and keypad on the front of the unit.

The LCP has several user functions:

- Start, stop, and control speed when in local control.
- Show operational data, status, warnings, and cautions.
- Program frequency converter functions.
- Manually reset the frequency converter after a fault when auto reset is inactive.

An optional numeric LCP (NLCP) is also available. The NLCP operates in a manner similar to the LCP. See the product relevant *programming guide* for details on use of the NLCP.

NOTICE

For commissioning via PC, install the MCT 10 Set-up Software. The software is available for download (basic version) or for ordering (advanced version, code number 130B1000). For more information and downloads, see www.danfoss.com/BusinessAreas/DrivesSolutions/Software+MCT10/MCT10+Downloads.htm.

5.3.1 Graphic Local Control Panel Layout

The graphic local control panel (GLCP) is divided into 4 functional groups (see *Illustration 5.1*).

- A. Display area.
- B. Display menu keys.
- C. Navigation keys and indicator lights.
- D. Operation keys and reset.

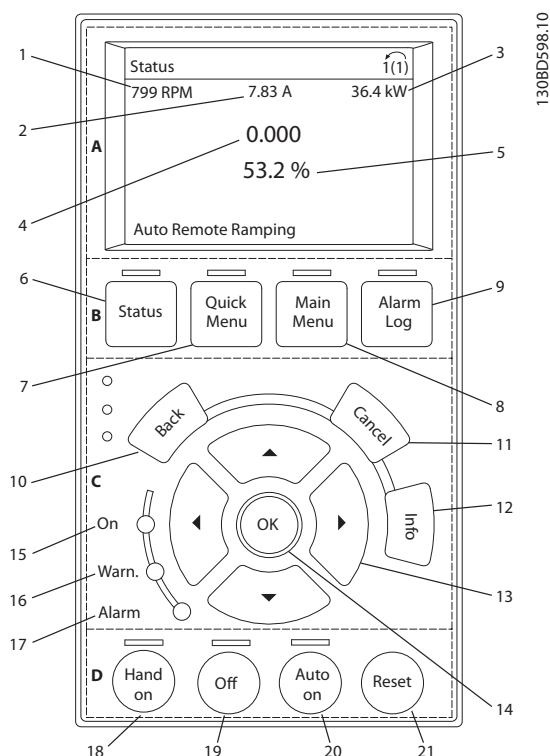


Illustration 5.1 GLCP

A. Display area

The display area is activated when the frequency converter receives power from the mains voltage, a DC bus terminal, or a 24 V DC external supply.

The information shown on the LCP can be customized for user applications. Select options in the *Quick Menu* Q3-13 *Display Settings*.

Display	Parameter	Default setting
1	Parameter 0-20 Display Line 1.1 Small	[1617] Speed [RPM]
2	Parameter 0-21 Display Line 1.2 Small	[1614] Motor Current
3	Parameter 0-22 Display Line 1.3 Small	[1610] Power [kW]
4	Parameter 0-23 Display Line 2 Large	[1613] Frequency
5	Parameter 0-24 Display Line 3 Large	[1602] Reference %

Table 5.1 Legend to Illustration 5.1, Display Area

B. Display menu keys

Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.

	Key	Function
6	Status	Shows operational information.
7	Quick Menu	Allows access to programming parameters for initial set-up instructions and many detailed application instructions.
8	Main Menu	Allows access to all programming parameters.
9	Alarm Log	Shows a list of current warnings, the last 10 alarms, and the maintenance log.

Table 5.2 Legend to Illustration 5.1, Display Menu Keys

C. Navigation keys and indicator lights (LEDs)

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local operation. There are also 3 frequency converter status indicator lights in this area.

	Key	Function
10	Back	Reverts to the previous step or list in the menu structure.
11	Cancel	Cancels the last change or command as long as the display mode is not changed.
12	Info	Press for a definition of the function being showed.
13	Navigation Keys	Press the navigation keys to move between items in the menu.
14	OK	Press to access parameter groups or to enable a selection.

Table 5.3 Legend to Illustration 5.1, Navigation Keys

	Indicator	Color	Function
15	On	Green	The ON indicator light activates when the frequency converter receives power from the mains voltage, a DC bus terminal, or a 24 V external supply.
16	Warn	Yellow	When warning conditions are met, the yellow WARN indicator light comes on and text appears in the display area identifying the problem.
17	Alarm	Red	A fault condition causes the red alarm LED to flash and an alarm text is shown.

Table 5.4 Legend to Illustration 5.1, Indicator Lights (LEDs)

D. Operation keys and reset

Operation keys are at the bottom of the LCP.

	Key	Function
18	[Hand On]	Starts the frequency converter in local control. An external stop signal by control input or serial communication overrides the local hand on.
19	Off	Stops the motor but does not remove power to the frequency converter.
20	[Auto On]	Puts the system in remote operational mode. Responds to an external start command by control terminals or serial communication.
21	Reset	Resets the frequency converter manually after a fault has been cleared.

Table 5.5 Legend to Illustration 5.1, Operation Keys and Reset

NOTICE

The display contrast can be adjusted by pressing [Status] and the [▲]/[▼] keys.

5.3.2 Parameter Settings

Establishing the correct programming for applications often requires setting functions in several related parameters. Details for parameters are provided in chapter 9.2 *Parameter Menu Structure*.

Programming data is stored internally in the frequency converter.

- For back-up, upload data into the LCP memory.
- To download data to another frequency converter, connect the LCP to that unit and download the stored settings.
- Restoring factory default settings does not change data stored in the LCP memory.

5.3.3 Uploading/Downloading Data to/from the LCP

- Press [Off] to stop the motor before uploading or downloading data.
- Press [Main Menu], select *parameter 0-50 LCP Copy* and press [OK].
- Select [1] *All to LCP* to upload data to the LCP or select [2] *All from LCP* to download data from the LCP.
- Press [OK]. A progress bar shows the uploading or downloading progress.

- Press [Hand On] or [Auto On] to return to normal operation.

5.3.4 Changing Parameter Settings

Access and change parameter settings from the *Quick Menu* or from the *Main Menu*. The *Quick Menu* only gives access to a limited number of parameters.

- Press [Quick Menu] or [Main Menu] on the LCP.
- Press [▲] [▼] to browse through the parameter groups, press [OK] to select a parameter group.
- Press [▲] [▼] to browse through the parameters, press [OK] to select a parameter.
- Press [▲] [▼] to change the value of a parameter setting.
- Press [◀] [▶] to shift digit when a decimal parameter is in the editing state.
- Press [OK] to accept the change.
- Press either [Back] twice to enter *Status*, or press [Main Menu] once to enter the *Main Menu*.

View changes

Quick Menu Q5 - Changes Made lists all parameters changed from default settings.

- The list only shows parameters, which are changed in the current edit set-up.
- Parameters, which were reset to default values, are not listed.
- The message *Empty* indicates that no parameters are changed.

5.3.5 Restoring Default Settings

NOTICE

Risk of losing programming, motor data, localization, and monitoring records by restoration of default settings. To provide a back-up, upload data to the LCP before initialization.

Restoring the default parameter settings is done by initialization of the frequency converter. Initialization is carried out through *parameter 14-22 Operation Mode* (recommended) or manually.

- Initialization using *parameter 14-22 Operation Mode* does not reset frequency converter settings such as hours run, serial communication selections, personal menu settings, fault log, alarm log, and other monitoring functions.
- Manual initialization erases all motor, programming, localization, and monitoring data and restores factory default settings.

Recommended initialization procedure via parameter 14-22 Operation Mode

1. Press [Main Menu] twice to access parameters.
2. Scroll to *parameter 14-22 Operation Mode* and press [OK].
3. Scroll to [2] *initialization* and press [OK].
4. Remove power to the unit and wait for the display to turn off.
5. Apply power to the unit.

Default parameter settings are restored during start-up. The start-up may take slightly longer than normal.

6. *Alarm 80, Drive initialized to default value* is shown.
7. Press [Reset] to return to operating mode.

Manual initialization procedure

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] at the same time while applying power to the unit (approximately 5 s or until audible click and fan starts).

Factory default parameter settings are restored during start-up. The start-up may take slightly longer than usual.

Manual initialization does not reset the following frequency converter information:

- *Parameter 15-00 Operating hours.*
- *Parameter 15-03 Power Up's.*
- *Parameter 15-04 Over Temp's.*
- *Parameter 15-05 Over Volt's.*

5.4 Basic Programming

5.4.1 Commissioning with SmartStart

The SmartStart wizard enables fast configuration of basic motor and application parameters.

- SmartStart starts automatically at first power-up or after initialization of the frequency converter.
- Follow the on-screen instructions to complete the commissioning of the frequency converter. Always reactivate SmartStart by selecting *Quick Menu Q4 - SmartStart*.
- For commissioning without use of the SmartStart wizard, refer to *chapter 5.4.2 Commissioning via [Main Menu]* or the programming guide.

NOTICE

Motor data is required for the SmartStart set-up. The required data is normally available on the motor nameplate.

The SmartStart configures the frequency converter in 3 phases, each consisting of several steps, see *Table 5.6*.

Phase		Action
1	Basic Programming	Perform the programming
2	Application Section	Select and program appropriate application: • Single pump/motor. • Motor alternation. • Basic cascade control. • Master/slave.
3	Water and Pump Features	Go to water and pump dedicated parameters.

Table 5.6 SmartStart, Setup in 3 Phases

5.4.2 Commissioning via [Main Menu]

Recommended parameter settings are intended for start-up and check-out purposes. Application settings may vary.

Enter data with power ON, but before operating the frequency converter.

1. Press [Main Menu] on the LCP.
2. Press the navigation keys to scroll to *parameter group 0-** Operation/Display* and press [OK].

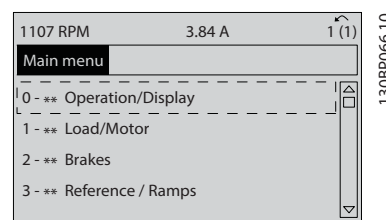


Illustration 5.2 Main Menu

3. Press the navigation keys to scroll to *parameter group 0-0* Basic Settings* and press [OK].

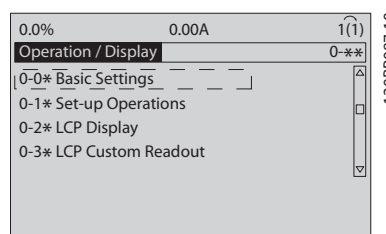


Illustration 5.3 Operation/Display

4. Press the navigation keys to scroll to *parameter 0-03 Regional Settings* and press [OK].

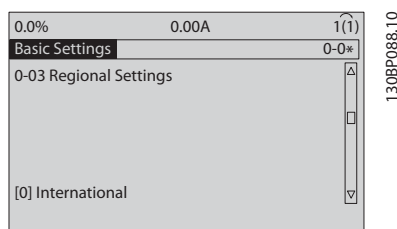


Illustration 5.4 Basic Settings

5

5. Press the navigation keys to select *[0] International* or *[1] North America* as appropriate and press [OK]. (This changes the default settings for several basic parameters).
6. Press [Main Menu] on the LCP.
7. Press the navigation keys to scroll to *parameter 0-01 Language*.
8. Select the language and press [OK].
9. If a jumper wire is in place between control terminals 12 and 27, leave *parameter 5-12 Terminal 27 Digital Input* at factory default. Otherwise, select *[0] No operation* in *parameter 5-12 Terminal 27 Digital Input*.
10. Make the application-specific settings in the following parameters:
 - 10a *Parameter 3-02 Minimum Reference.*
 - 10b *Parameter 3-03 Maximum Reference.*
 - 10c *Parameter 3-41 Ramp 1 Ramp Up Time.*
 - 10d *Parameter 3-42 Ramp 1 Ramp Down Time.*
 - 10e *Parameter 3-13 Reference Site.* Linked to Hand/Auto Local Remote.

5.4.3 Asynchronous Motor Set-up

Enter the following motor data. Find the information on the motor nameplate.

1. *Parameter 1-20 Motor Power [kW]* or *parameter 1-21 Motor Power [HP].*
2. *Parameter 1-22 Motor Voltage.*
3. *Parameter 1-23 Motor Frequency.*
4. *Parameter 1-24 Motor Current.*
5. *Parameter 1-25 Motor Nominal Speed.*

For optimum performance in VVC⁺ mode, extra motor data is required to set up the following parameters. Find the data in the motor datasheet (this data is typically not

available on the motor nameplate). Run a complete automatic motor adaptation (AMA) using *parameter 1-29 Automatic Motor Adaptation (AMA) [1] Enable Complete AMA* or enter the parameters manually. *Parameter 1-36 Iron Loss Resistance (Rfe)* is always entered manually.

6. *Parameter 1-30 Stator Resistance (Rs).*
7. *Parameter 1-31 Rotor Resistance (Rr).*
8. *Parameter 1-33 Stator Leakage Reactance (X1).*
9. *Parameter 1-34 Rotor Leakage Reactance (X2).*
10. *Parameter 1-35 Main Reactance (Xh).*
11. *Parameter 1-36 Iron Loss Resistance (Rfe).*

Application-specific adjustment when running VVC⁺

VVC⁺ is the most robust control mode. In most situations, it provides optimum performance without further adjustments. Run a complete AMA for best performance.

5.4.4 PM Motor Setup in VVC⁺

NOTICE

Only use permanent magnet (PM) motor with fans and pumps.

Initial programming steps

1. Activate PM motor operation
Parameter 1-10 Motor Construction, select *[1] PM*, non salient SPM.
2. Set *parameter 0-02 Motor Speed Unit* to *[0] RPM*.

Programming motor data

After selecting PM motor in *parameter 1-10 Motor Construction*, the PM motor-related parameters in parameter groups *1-2* Motor Data*, *1-3* Adv. Motor Data* and *1-4** are active.

The necessary data can be found on the motor nameplate and in the motor datasheet.

Program the following parameters in the listed order:

1. *Parameter 1-24 Motor Current.*
2. *Parameter 1-26 Motor Cont. Rated Torque.*
3. *Parameter 1-25 Motor Nominal Speed.*
4. *Parameter 1-39 Motor Poles.*
5. *Parameter 1-30 Stator Resistance (Rs).*
Enter line to common stator winding resistance (Rs). If only line-line data is available, divide the line-line value with 2 to achieve the line to common (startpoint) value.
6. *Parameter 1-37 d-axis Inductance (Ld).*
Enter line to common direct axis inductance of the PM motor.

If only line-line data is available, divide the line-line value by 2 to achieve the line-common (startpoint) value.

7. **Parameter 1-40 Back EMF at 1000 RPM.**
Enter line-to-line back EMF of the PM motor at 1000 RPM mechanical speed (RMS value). Back EMF is the voltage generated by a PM motor when no frequency converter is connected and the shaft is turned externally. Back EMF is normally specified for nominal motor speed or for 1000 RPM measured between 2 lines. If the value is not available for a motor speed of 1000 RPM, calculate the correct value as follows: If back EMF is for example 320 V at 1800 RPM, it can be calculated at 1000 RPM as follows: Back EMF = (Voltage / RPM)*1000 = (320/1800)*1000 = 178. This is the value that must be programmed for *parameter 1-40 Back EMF at 1000 RPM*.

Test motor operation

1. Start the motor at low speed (100–200 RPM). If the motor does not turn, check installation, general programming, and motor data.
2. Check if the start function in *parameter 1-70 PM Start Mode* fits the application requirements.

Rotor detection

This function is the recommended choice for applications where the motor starts from standstill, for example pumps or conveyors. On some motors, a sound is heard when the impulse is sent out. This does not harm the motor.

Parking

This function is the recommended choice for applications where the motor is rotating at slow speed, for example windmilling in fan applications. *Parameter 2-06 Parking Current* and *parameter 2-07 Parking Time* can be adjusted. Increase the factory setting of these parameters for applications with high inertia.

Start the motor at nominal speed. If the application does not run well, check the VVC⁺ PM settings. Recommended settings in different applications can be found in *Table 5.7*.

Application	Settings
Low inertia applications $I_{Load}/I_{Motor} < 5$	<i>Parameter 1-17 Voltage filter time const.</i> to be increased by factor 5–10. <i>Parameter 1-14 Damping Gain</i> should be reduced. <i>Parameter 1-66 Min. Current at Low Speed</i> should be reduced (<100%).
Low inertia applications $50 > I_{Load}/I_{Motor} > 5$	Keep calculated values.
High inertia applications $I_{Load}/I_{Motor} > 50$	<i>Parameter 1-14 Damping Gain</i> , <i>parameter 1-15 Low Speed Filter Time Const.</i> , and <i>parameter 1-16 High Speed Filter Time Const.</i> should be increased.
High load at low speed <30% (rated speed)	<i>Parameter 1-17 Voltage filter time const.</i> should be increased. <i>Parameter 1-66 Min. Current at Low Speed</i> should be increased (>100% for a prolonged time can overheat the motor).

Table 5.7 Recommended Settings in Different Applications

If the motor starts oscillating at a certain speed, increase *parameter 1-14 Damping Gain*. Increase the value in small steps. Depending on the motor, a good value for this parameter can be 10% or 100% higher than the default value.

The starting torque can be adjusted in *parameter 1-66 Min. Current at Low Speed*. 100% provides nominal torque as starting torque.

5.4.5 SynRM Motor Set-up with VVC⁺

This section describes how to set up a SynRM motor with VVC⁺.

NOTICE

The SmartStart wizard covers the basic configuration of SynRM motors.

Initial programming steps

To activate SynRM motor operation, select [5] *Sync. Reluctance* in *parameter 1-10 Motor Construction*.

Programming motor data

After performing the initial programming steps, the SynRM motor-related parameters in *parameter groups 1-2* Motor Data*, *1-3* Adv. Motor Data*, and *1-4* Adv. Motor Data II* are active.

Use the motor nameplate data and the motor datasheet to program the following parameters in the order listed:

1. *Parameter 1-23 Motor Frequency.*
2. *Parameter 1-24 Motor Current.*
3. *Parameter 1-25 Motor Nominal Speed.*
4. *Parameter 1-26 Motor Cont. Rated Torque.*

Run a complete AMA using *parameter 1-29 Automatic Motor Adaptation (AMA) [1] Enable Complete AMA* or enter the following parameters manually:

1. *Parameter 1-30 Stator Resistance (Rs).*
2. *Parameter 1-37 d-axis Inductance (Ld).*
3. *Parameter 1-44 d-axis Inductance Sat. (LdSat).*
4. *Parameter 1-45 q-axis Inductance Sat. (LqSat).*
5. *Parameter 1-48 Inductance Sat. Point.*

Application-specific adjustments

Start the motor at nominal speed. If the application does not run well, check the VVC+ SynRM settings. *Table 5.8* provides application-specific recommendations:

Application	Settings
Low-inertia applications $I_{Load}/I_{Motor} < 5$	Increase <i>parameter 1-17 Voltage filter time const.</i> by factor 5–10. Reduce <i>parameter 1-14 Damping Gain</i> . Reduce <i>parameter 1-66 Min. Current at Low Speed (<100%)</i> .
Low-inertia applications $50 > I_{Load}/I_{Motor} > 5$	Keep the default values.
High-inertia applications $I_{Load}/I_{Motor} > 50$	Increase <i>parameter 1-14 Damping Gain</i> , <i>parameter 1-15 Low Speed Filter Time Const.</i> , and <i>parameter 1-16 High Speed Filter Time Const.</i>
High-load at low speed <30% (rated speed)	Increase <i>parameter 1-17 Voltage filter time const.</i> Increase <i>parameter 1-66 Min. Current at Low Speed</i> to adjust the starting torque. 100% current provides nominal torque as starting torque. Working at a current level higher than 100% for a prolonged time can cause the motor to overheat.

Application	Settings
Dynamic applications	Increase <i>parameter 14-41 AEO Minimum Magnetisation</i> for highly dynamic applications. Adjusting <i>parameter 14-41 AEO Minimum Magnetisation</i> ensures a good balance between energy efficiency and dynamics. Adjust <i>parameter 14-42 Minimum AEO Frequency</i> to specify the minimum frequency at which the frequency converter should use minimum magnetization.
Motor sizes less than 18 kW (24 hp)	Avoid short ramp-down times.

Table 5.8 Recommendations for Various Applications

If the motor starts oscillating at a certain speed, increase *parameter 1-14 Damping Gain*. Increase the damping gain value in small steps. Depending on the motor, this parameter can be set to 10–100% higher than the default value.

5.4.6 Automatic Energy Optimization (AEO)

NOTICE

AEO is not relevant for permanent magnet motors.

AEO is a procedure which minimizes voltage to the motor, as a result of that reducing energy consumption, heat, and noise.

To activate AEO, set *parameter 1-03 Torque Characteristics* to [2] *Auto Energy Optim. CT* or [3] *Auto Energy Optim. VT*.

5.4.7 Automatic Motor Adaptation (AMA)

AMA is a procedure which optimizes compatibility between the frequency converter and the motor.

- The frequency converter builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the entered nameplate data.
- The motor shaft does not turn and no harm is done to the motor while running the AMA.
- Some motors may be unable to run the complete version of the test. In that case, select [2] *Enable reduced AMA*.
- If an output filter is connected to the motor, select [2] *Enable reduced AMA*.

- If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms*.
- Run this procedure on a cold motor for best results.

To run AMA

1. Press [Main Menu] to access parameters.
2. Scroll to *parameter group 1-** Load and Motor* and press [OK].
3. Scroll to *parameter group 1-2* Motor Data* and press [OK].
4. Scroll to *parameter 1-29 Automatic Motor Adaptation (AMA)* and press [OK].
5. Select [1] *Enable complete AMA* and press [OK].
6. Follow the on-screen instructions.
7. The test runs automatically and indicates when it is complete.
8. The advanced motor data is entered in *parameter group 1-3* Adv. Motor Data*.

5.5 Checking Motor Rotation

NOTICE

Risk of damage to pumps/compressors caused by motor running in wrong direction. Before running the frequency converter, check the motor rotation.

The motor runs briefly at 5 Hz or the minimum frequency set in *parameter 4-12 Motor Speed Low Limit [Hz]*.

1. Press [Main Menu].
2. Scroll to *parameter 1-28 Motor Rotation Check* and press [OK].
3. Scroll to [1] *Enable*.

The following text appears: *Note! Motor may run in wrong direction.*

4. Press [OK].
5. Follow the on-screen instructions.

NOTICE

To change the direction of rotation, remove power to the frequency converter and wait for power to discharge. Reverse the connection of any 2 of the 3 motor wires on the motor or frequency converter side of the connection.

5.6 Local-control Test

1. Press [Hand On] to provide a local start command to the frequency converter.
2. Accelerate the frequency converter by pressing [▲] to full speed. Moving the cursor left of the decimal point provides quicker input changes.
3. Note any acceleration problems.
4. Press [Off]. Note any deceleration problems.

If acceleration or deceleration problems occur, see *chapter 7.5 Troubleshooting*. See *chapter 7.4 List of Warnings and Alarms* for resetting the frequency converter after a trip.

5.7 System Start-up

The procedure in this section requires wiring and application programming to be completed. The following procedure is recommended after application set-up is completed.

1. Press [Auto On].
2. Apply an external run command.
3. Adjust the speed reference throughout the speed range.
4. Remove the external run command.
5. Check the sound and vibration levels of the motor to ensure that the system is working as intended.

If warnings or alarms occur, see *chapter 7.3 Warning and Alarm Types* or *chapter 7.4 List of Warnings and Alarms*.

6 Application Set-up Examples

The examples in this section are intended as a quick reference for common applications.

- Parameter settings are the regional default values unless otherwise indicated (selected in *parameter 0-03 Regional Settings*).
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Required switch settings for analog terminals A53 or A54 are also shown.

NOTICE

When using the optional STO feature, a jumper wire may be required between terminal 12 (or 13) and terminal 37 for the frequency converter to operate with factory default programming values.

6

6.1 Application Examples

6.1.1 Feedback

Parameters	
Function	Setting
Parameter 6-22 Terminal 54 Low Current	4 mA*
Parameter 6-23 Terminal 54 High Current	20 mA*
Parameter 6-24 Terminal 54 Low Ref./Feedb. Value	0*
Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.1 Analog Current Feedback Transducer

Parameters	
Function	Setting
Parameter 6-20 Terminal 54 Low Voltage	0.07 V*
Parameter 6-21 Terminal 54 High Voltage	10 V*
Parameter 6-24 Terminal 54 Low Ref./Feedb. Value	0*
Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.2 Analog Voltage Feedback Transducer (3-wire)

		Parameters	
		Function	Setting
FC +24 V 12○ +24 V 13○ D IN 18○ D IN 19○ COM 20○ D IN 27○ D IN 29○ D IN 32○ D IN 33○ D IN 37○ +10 V 50○ A IN 53○ A IN 54○ COM 55○ A OUT 42○ COM 39○ U - I A54	1308B677.10	Parameter 6-20 Terminal 54 Low Voltage	0.07 V*
		Parameter 6-21 Terminal 54 High Voltage	10 V*
		Parameter 6-24 Terminal 54 Low Ref./Feedb. Value	0*
		Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
		* = Default value Notes/comments: D IN 37 is an option.	

Table 6.3 Analog Voltage Feedback Transducer (4-wire)

		Parameters	
		Function	Setting
FC +24 V 12○ +24 V 13○ D IN 18○ D IN 19○ COM 20○ D IN 27○ D IN 29○ D IN 32○ D IN 33○ D IN 37○ +10 V 50○ A IN 53○ A IN 54○ COM 55○ A OUT 42○ COM 39○ U - I A53	1308B927.10	Parameter 6-12 Terminal 53 Low Current	4 mA*
		Parameter 6-13 Terminal 53 High Current	20 mA*
		Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
		Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
		* = Default value Notes/comments: D IN 37 is an option.	

Table 6.5 Analog Speed Reference (Current)

6.1.2 Speed

		Parameters	
		Function	Setting
FC +24 V 12○ +24 V 13○ D IN 18○ D IN 19○ COM 20○ D IN 27○ D IN 29○ D IN 32○ D IN 33○ D IN 37○ +10 V 50○ A IN 53○ A IN 54○ COM 55○ A OUT 42○ COM 39○ U - I A53	1308B926.10	Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
		Parameter 6-11 Terminal 53 High Voltage	10 V*
		Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
		Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
		* = Default value Notes/comments: D IN 37 is an option.	

Table 6.4 Analog Speed Reference (Voltage)

		Parameters	
		Function	Setting
FC +24 V 12○ +24 V 13○ D IN 18○ D IN 19○ COM 20○ D IN 27○ D IN 29○ D IN 32○ D IN 33○ D IN 37○ +10 V 50○ A IN 53○ A IN 54○ COM 55○ A OUT 42○ COM 39○ U - I A53	1308B683.10	Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
		Parameter 6-11 Terminal 53 High Voltage	10 V*
		Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
		Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
		* = Default value Notes/comments: D IN 37 is an option.	

Table 6.6 Speed Reference (Using a Manual Potentiometer)

6.1.3 Run/Stop

Parameters	
Function	Setting
Parameter 5-10 Terminal 18 Digital Input	[8] Start*
Parameter 5-12 Terminal 27 Digital Input	[7] External interlock
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.7 Run/Stop Command with External Interlock

Parameters	
Function	Setting
Parameter 5-10 Terminal 18 Digital Input	[8] Start*
Parameter 5-12 Terminal 27 Digital Input	[7] External interlock
* = Default value	
Notes/comments: If parameter 5-12 Terminal 27 Digital Input is set to [0] No operation, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

Table 6.8 Run/Stop Command without External Interlock

Parameters	
Function	Setting
Parameter 5-10 Terminal 18 Digital Input	[8] Start*
Parameter 5-11 Terminal 19 Digital Input	[52] Run Permissive
Parameter 5-12 Terminal 27 Digital Input	[7] External interlock
Parameter 5-40 Function Relay	[167] Start command act.
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.9 Run Permissive

6.1.4 External Alarm Reset

Parameters	
Function	Setting
Parameter 5-11 Terminal 19 Digital Input	[1] Reset
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.10 External Alarm Reset

6.1.5 RS485

		Parameters	
		Function	Setting
FC +24 V 12○ +24 V 13○ D IN 18○ D IN 19○ COM 20○ D IN 27○ D IN 29○ D IN 32○ D IN 33○ D IN 37○ +10 V 50○ A IN 53○ A IN 54○ COM 55○ A OUT 42○ COM 39○ R1 01○ 02○ 03○ R2 04○ 05○ 06○ 61○ 68○ 69○ RS-485 + -		Parameter 8-30 Protocol	FC*
		Parameter 8-31 Address	1*
		Parameter 8-32 Baud Rate	9600*
		* = Default value	
		Notes/comments: Select protocol, address, and baud rate in the above-mentioned parameters. D IN 37 is an option.	

Table 6.11 RS485 Network Connection

6.1.6 Motor Thermistor

CAUTION

THERMISTOR INSULATION

Risk of personal injury or equipment damage.

- Use only thermistors with reinforced or double insulation to meet PELV insulation requirements.

		Parameters	
		Function	Setting
VLT +24 V 12○ +24 V 13○ D IN 18○ D IN 19○ COM 20○ D IN 27○ D IN 29○ D IN 32○ D IN 33○ D IN 37○ +10 V 50○ A IN 53○ A IN 54○ COM 55○ A OUT 42○ COM 39○ U - I A53		Parameter 1-90 Motor Thermal Protection	[2] Thermistor trip
		Parameter 1-93 Thermistor Source	[1] Analog input 53
		* = Default value	
		Notes/comments: If only a warning is required, set parameter 1-90 Motor Thermal Protection to [1] Thermistor warning. D IN 37 is an option.	

Table 6.12 Motor Thermistor

7 Maintenance, Diagnostics, and Troubleshooting

This chapter includes:

- Maintenance and service guidelines.
- Status messages.
- Warnings and alarms.
- Basic troubleshooting.

7.1 Maintenance and Service

Under normal operating conditions and load profiles, the frequency converter is maintenance-free throughout its designed lifetime. To prevent breakdown, danger, and damage, examine the frequency converter at regular intervals depending on the operating conditions. Replace worn or damaged parts with original spare parts or standard parts. For service and support, contact the local Danfoss supplier.

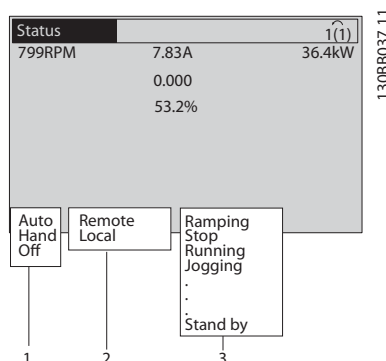
WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 Set-up Software, or after a cleared fault condition.

7.2 Status Messages

When the frequency converter is in *Status* mode, status messages are generated automatically and appear in the bottom line of the display (see *Illustration 7.1*).



1	Operating mode (see Table 7.1)
2	Reference site (see Table 7.2)
3	Operation status (see Table 7.3)

Illustration 7.1 Status Display

Table 7.1 to Table 7.3 describe the status messages shown.

Off	The frequency converter does not react to any control signal until [Auto On] or [Hand On] is pressed.
Auto On	The frequency converter is controlled from the control terminals and/or the serial communication.
Hand On	Control the frequency converter via the navigation keys on the LCP. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals override local control.

Table 7.1 Operating Mode

Remote	The speed reference is given from external signals, serial communication, or internal preset references.
Local	The frequency converter uses [Hand On] control or reference values from the LCP.

Table 7.2 Reference Site

AC Brake	[2] AC brake is selected in parameter 2-10 Brake Function. The AC brake overmagnetizes the motor to achieve a controlled slow down.
AMA finish OK	AMA was carried out successfully.
AMA ready	AMA is ready to start. Press [Hand On] to start.
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. Generative energy is absorbed by the brake resistor.

Braking max.	The brake chopper is in operation. The power limit for the brake resistor defined in <i>parameter 2-12 Brake Power Limit (kW)</i> has been reached.
Coast	• [2] <i>Coast inverse</i> was selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is not connected. • Coast activated by serial communication.
Ctrl. ramp-down	[1] <i>Control Ramp-down</i> was selected in <i>parameter 14-10 Mains Failure</i>. • The mains voltage is below the value set in <i>parameter 14-11 Mains Voltage at Mains Fault</i> at mains fault. • The frequency converter ramps down the motor using a controlled ramp down.
Current High	The frequency converter output current is above the limit set in <i>parameter 4-51 Warning Current High</i> .
Current Low	The frequency converter output current is below the limit set in <i>parameter 4-52 Warning Speed Low</i> .
DC Hold	[1] <i>DC hold</i> is selected in <i>parameter 1-80 Function at Stop</i> and a stop command is active. The motor is held by a DC current set in <i>parameter 2-00 DC Hold/Preheat Current</i> .
DC Stop	The motor is held with a DC current (<i>parameter 2-01 DC Brake Current</i>) for a specified time (<i>parameter 2-02 DC Braking Time</i>). • The DC brake cut-in speed is reached in <i>parameter 2-03 DC Brake Cut In Speed [RPM]</i> and a stop command is active. • [5] <i>DC-brake inverse</i> is selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is not active. • The DC brake is activated via serial communication.
Feedback high	The sum of all active feedbacks is above the feedback limit set in <i>parameter 4-57 Warning Feedback High</i> .
Feedback low	The sum of all active feedbacks is below the feedback limit set in <i>parameter 4-56 Warning Feedback Low</i> .

Freeze output	The remote reference is active, which holds the present speed. • [20] <i>Freeze output</i> is selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is active. Speed control is only possible via the terminal options [21] <i>Speed up</i> and [22] <i>Speed down</i>. • Hold ramp is activated via serial communication.
Freeze output request	A freeze output command was given, but the motor remains stopped until a run permissive signal is received.
Freeze ref.	[19] <i>Freeze reference</i> is selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is active. The frequency converter saves the actual reference. Changing the reference is now only possible via terminal options [21] <i>Speed up</i> and [22] <i>Speed down</i> .
Jog request	A jog command was given, but the motor remains stopped until a run permissive signal is received via a digital input.
Jogging	The motor is running as programmed in <i>parameter 3-19 Jog Speed [RPM]</i>. • [14] <i>Jog</i> was selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal (for example, terminal 29) is active. • The jog function is activated via the serial communication. • The jog function is selected as a reaction for a monitoring function (for example, for the no signal function). The monitoring function is active.
Motor check	In <i>parameter 1-80 Function at Stop</i> , [2] <i>Motor Check</i> is selected. A stop command is active. To ensure that a motor is connected to the frequency converter, a permanent test current is applied to the motor.
OVC control	Overvoltage control is activated via <i>parameter 2-17 Over-voltage Control</i> , [2] <i>Enabled</i> . The connected motor supplies the frequency converter with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the frequency converter from tripping.
PowerUnit Off	(Only frequency converters with a 24 V external supply installed). Mains supply to the frequency converter was removed, and the control card is supplied by the external 24 V.

Protection md	Protection mode is active. The unit detected a critical status (overcurrent or overvoltage). - To avoid tripping, switching frequency is reduced to 4 kHz. - If possible, protection mode ends after approximately 10 s. - Protection mode can be restricted in <i>parameter 14-26 Trip Delay at Inverter Fault</i>.
Qstop	The motor is decelerating using <i>parameter 3-81 Quick Stop Ramp Time</i> . [4] Quick stop inverse is selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is not active. - The quick stop function is activated via serial communication.
Ramping	The motor is accelerating/decelerating using the active ramp up/down. The reference, a limit value, or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in <i>parameter 4-55 Warning Reference High</i> .
Ref. low	The sum of all active references is below the reference limit set in <i>parameter 4-54 Warning Reference Low</i> .
Run on ref.	The frequency converter is running in the reference range. The feedback value matches the setpoint value.
Run request	A start command was given, but the motor remains stopped until a run permissive signal is received via digital input.
Running	The frequency converter drives the motor.
Sleep Mode	The energy-saving function is enabled. The motor has stopped, but restarts automatically when required.
Speed high	Motor speed is above the value set in <i>parameter 4-53 Warning Speed High</i> .
Speed low	Motor speed is below the value set in <i>parameter 4-52 Warning Speed Low</i> .
Standby	In auto-on mode, the frequency converter starts the motor with a start signal from a digital input or serial communication.
Start delay	In <i>parameter 1-71 Start Delay</i> , a delay starting time was set. A start command is activated, and the motor starts after the start delay time expires.
Start fwd/rev	[12] Enable start forward and [13] Enable start reverse are selected as options for 2 different digital inputs (<i>parameter group 5-1* Digital Inputs</i>). The motor starts in forward or reverse direction depending on which terminal is activated.

Stop	The frequency converter received a stop command from the LCP, digital input, or serial communication.
Trip	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, the frequency converter can be reset manually by pressing [Reset] or remotely by control terminals or serial communication.
Trip lock	An alarm occurred, and the motor is stopped. When the cause of the alarm is cleared, cycle power to the frequency converter. The frequency converter can then be reset manually by pressing [Reset], or remotely by control terminals or serial communication.

Table 7.3 Operation Status

NOTICE

In auto/remote mode, the frequency converter requires external commands to execute functions.

7.3 Warning and Alarm Types

Warnings

A warning is issued when an alarm condition is impending, or when an abnormal operating condition is present and may result in the frequency converter issuing an alarm. A warning clears by itself when the abnormal condition ceases.

Alarms

An alarm indicates a fault that requires immediate attention. The fault always triggers a trip or a trip lock. Reset the system after an alarm.

Trip

An alarm is issued when the frequency converter is tripped, meaning that the frequency converter suspends operation to prevent frequency converter or system damage. The motor coasts to a stop. The frequency converter logic continues to operate and monitor the frequency converter status. After the fault condition is remedied, the frequency converter can be reset. It is then ready to start operation again.

Resetting the frequency converter after trip/trip lock

A trip can be reset in any of 4 ways:

- Press [Reset] on the LCP.
- Digital reset input command.
- Serial communication reset input command.
- Auto reset.

Trip lock

Input power is cycled. The motor coasts to a stop. The frequency converter continues to monitor the frequency converter status. Remove input power to the frequency converter, correct the cause of the fault, and reset the frequency converter.

Warning and alarm displays

- A warning is shown in the LCP along with the warning number.
- An alarm flashes along with the alarm number.

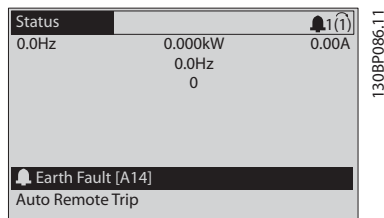
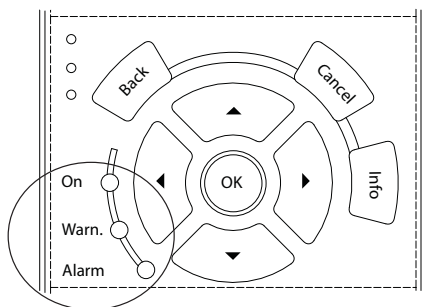


Illustration 7.2 Alarm Example

In addition to the text and alarm code in the LCP, there are 3 status indicator lights.



	Warning indicator light	Alarm indicator light
Warning	On	Off
Alarm	Off	On (flashing)
Trip lock	On	On (flashing)

Illustration 7.3 Status Indicator Lights

7.4 List of Warnings and Alarms

The warning/alarm information in this chapter defines each warning/alarm condition, provides the probable cause for the condition, and details a remedy or troubleshooting procedure.

WARNING 1, 10 Volts low

The control card voltage from terminal 50 is <10 V. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Maximum 15 mA or minimum 590 Ω.

A short circuit in a connected potentiometer or improper wiring of the potentiometer can cause this condition.

Troubleshooting

- Remove the wiring from terminal 50.
- If the warning clears, the problem is with the customer wiring.
- If the warning does not clear, replace the control card.

WARNING/ALARM 2, Live zero error

This warning or alarm only appears if programmed in *parameter 6-01 Live Zero Timeout Function*. The signal on 1 of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or signals from a faulty device cause this condition.

Troubleshooting

- Check connections on all the analog input terminals. Control card terminals 53 and 54 for signals, terminal 55 common. VLT® General Purpose I/O MCB 101 terminals 11 and 12 for signals, terminal 10 common. VLT® Analog I/O Option MCB 109 terminals 1, 3, 5 for signals, terminals 2, 4, 6 common).
- Check that the frequency converter programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

WARNING/ALARM 3, No motor

No motor has been connected to the output of the frequency converter.

WARNING/ALARM 4, Mains phase loss

A phase is missing on the supply side, or the mains voltage imbalance is too high. This message also appears in case of a fault in the input rectifier on the frequency converter. Options are programmed in *parameter 14-12 Function at Mains Imbalance*.

Troubleshooting

- Check the supply voltage and supply currents to the frequency converter.

WARNING 5, DC link voltage high

The DC-link voltage is higher than the high-voltage warning limit. The limit depends on the frequency converter voltage rating. The unit is still active.

WARNING 6, DC link voltage low

The DC-link voltage is lower than the low-voltage warning limit. The limit depends on the frequency converter voltage rating. The unit is still active.

WARNING/ALARM 7, DC overvoltage

If the DC-link voltage exceeds the limit, the frequency converter trips after some time.

Troubleshooting

- Connect a brake resistor.
- Extend the ramp time.
- Change the ramp type.
- Activate the functions in *parameter 2-10 Brake Function*.
- Increase *parameter 14-26 Trip Delay at Inverter Fault*.

WARNING/ALARM 8, DC under voltage

If the DC-link voltage drops below the undervoltage limit, the frequency converter checks if a 24 V DC back-up supply is connected. If no 24 V DC back-up supply is

connected, the frequency converter trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

- Check that the supply voltage matches the frequency converter voltage.
- Perform an input voltage test.
- Perform a soft charge circuit test.

WARNING/ALARM 9, Inverter overload

The frequency converter is about to cut out because of an overload (too high current for too long). The counter for electronic thermal inverter protection issues a warning at 98% and trips at 100%, while issuing an alarm. The frequency converter *cannot* be reset until the counter is below 90%.

Troubleshooting

- Compare the output current shown on the LCP with the frequency converter rated current.
- Compare the output current shown on the LCP with measured motor current.
- Show the thermal load on the LCP and monitor the value. When running above the frequency converter continuous current rating, the counter should increase. When running below the frequency converter continuous current rating, the counter should decrease.

WARNING/ALARM 10, Motor overload temperature

According to the electronic thermal protection (ETR), the motor is too hot. Select whether the frequency converter issues a warning or an alarm when the counter reaches 100% in *parameter 1-90 Motor Thermal Protection*. The fault occurs when the motor overload exceeds 100% for too long.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the motor current set in *parameter 1-24 Motor Current* is correct.
- Ensure the motor data in parameters *1-20* through *1-25* is set correctly.
- If an external fan is used, check that it is selected in *parameter 1-91 Motor External Fan*.
- Running AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)* tunes the frequency converter to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor overtemp

The thermistor may be disconnected. Select whether the frequency converter issues a warning or an alarm in *parameter 1-90 Motor Thermal Protection*.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply) and that the terminal switch for 53 or 54 is set for voltage. Check *parameter 1-93 Thermistor Source* selects terminal 53 or 54.
- When using digital inputs 18 or 19, check that the thermistor is connected correctly between either terminal 18 or 19 (digital input PNP only) and terminal 50.
- If a KTY sensor is used, check for correct connection between terminals 54 and 55.
- If using a thermal switch or thermistor, check that the programming if *parameter 1-93 Thermistor Source* matches sensor wiring.

WARNING/ALARM 12, Torque limit

The torque has exceeded the value in *parameter 4-16 Torque Limit Motor Mode* or the value in *parameter 4-17 Torque Limit Generator Mode*. *Parameter 14-25 Trip Delay at Torque Limit* can change this from a warning-only condition to a warning followed by an alarm.

Troubleshooting

- If the motor torque limit is exceeded during ramp-up, extend the ramp-up time.
- If the generator torque limit is exceeded during ramp down, extend the ramp-down time.
- If torque limit occurs while running, possibly increase the torque limit. Be sure that the system can operate safely at a higher torque.
- Check the application for excessive current draw on the motor.

WARNING/ALARM 13, Over current

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts about 1.5 s, then the frequency converter trips and issues an alarm. Shock loading or fast acceleration with high-inertia loads can cause this fault. If extended mechanical brake control is selected, the trip can be reset externally.

Troubleshooting

- Remove power and check if the motor shaft can be turned.
- Check that the motor size matches the frequency converter.
- Check *parameters 1-20* to *1-25* for correct motor data.

ALARM 14, Earth (ground) fault

There is current from the output phases to ground, either in the cable between the frequency converter and the motor, or in the motor itself.

Troubleshooting

- Remove power from the frequency converter and repair the ground fault.
- Check for ground faults in the motor by measuring the resistance to ground of the motor cables and the motor with a megohmmeter.
- Perform current sensor test.

ALARM 15, Hardware mismatch

A fitted option is not operational with the present control board hardware or software.

Record the value of the following parameters and contact the local Danfoss supplier:

- *Parameter 15-40 FC Type.*
- *Parameter 15-41 Power Section.*
- *Parameter 15-42 Voltage.*
- *Parameter 15-43 Software Version.*
- *Parameter 15-45 Actual Typecode String.*
- *Parameter 15-49 SW ID Control Card.*
- *Parameter 15-50 SW ID Power Card.*
- *Parameter 15-60 Option Mounted.*
- *Parameter 15-61 Option SW Version* (for each option slot).

ALARM 16, Short circuit

There is short-circuiting in the motor or motor wiring.

Troubleshooting

- Remove power from the frequency converter and repair the short circuit.

WARNING/ALARM 17, Control word timeout

There is no communication to the frequency converter.

The warning is only active when *parameter 8-04 Control Timeout Function* is NOT set to [0] Off.

If *parameter 8-04 Control Timeout Function* is set to [5] Stop and trip, a warning appears and the frequency converter ramps down until it trips, then it shows an alarm.

Troubleshooting

- Check the connections on the serial communication cable.
- Increase *parameter 8-03 Control Timeout Time*.
- Check the operation of the communication equipment.
- Verify a proper installation based on EMC requirements.

WARNING/ALARM 22, Hoist mechanical brake

When this warning is active, the LCP shows the type of issue.

0 = The torque ref. was not reached before timeout.

1 = There was no brake feedback before timeout.

WARNING 23, Internal fan fault

The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor* ([0] Disabled).

Troubleshooting

- Check the fan resistance.
- Check the soft charge fuses.

WARNING 24, External fan fault

The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor* ([0] Disabled).

Troubleshooting

- Check the fan resistance.
- Check the soft charge fuses.

WARNING 25, Brake resistor short circuit

The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The frequency converter is still operational but without the brake function. Remove power from the frequency converter and replace the brake resistor (see *parameter 2-15 Brake Check*).

WARNING/ALARM 26, Brake resistor power limit

The power transmitted to the brake resistor is calculated as a mean value over the last 120 s of run time. The calculation is based on the DC-link voltage and the brake resistance value set in *parameter 2-16 AC brake Max. Current*. The warning is active when the dissipated braking is higher than 90% of the brake resistance power. If [2] Trip is selected in *parameter 2-13 Brake Power Monitoring*, the frequency converter trips when the dissipated braking power reaches 100%.

WARNING/ALARM 27, Brake chopper fault

The brake transistor is monitored during operation. If a short circuit occurs, the brake function is disabled and a warning is issued. The frequency converter is still operational, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.

Remove power from the frequency converter and remove the brake resistor.

This alarm/warning could also occur if the brake resistor overheats. Terminals 104 and 106 are available as brake resistor Klaxon inputs, see *Brake Resistor Temperature Switch* in the *design guide*.

WARNING/ALARM 28, Brake check failed

The brake resistor is not connected or not working. Check *parameter 2-15 Brake Check*.

ALARM 29, Heat Sink temp

The maximum temperature of the heat sink has been exceeded. The temperature fault does not reset until the temperature drops below a defined heatsink temperature. The trip and reset points vary based on the frequency converter power size.

Troubleshooting

Check for the following conditions:

- Ambient temperature too high.
- Motor cable too long.
- Incorrect airflow clearance above and below the frequency converter.
- Blocked airflow around the frequency converter.
- Damaged heat sink fan.
- Dirty heat sink.

This alarm is based on the temperature measured by the heat sink sensor mounted inside the IGBT modules.

Troubleshooting

- Check the fan resistance.
- Check the soft charge fuses.
- Check the IGBT thermal sensor.

ALARM 30, Motor phase U missing

Motor phase U between the frequency converter and the motor is missing.

Troubleshooting

- Remove power from the frequency converter and check motor phase U.

ALARM 31, Motor phase V missing

Motor phase V between the frequency converter and the motor is missing.

Troubleshooting

- Remove power from the frequency converter and check motor phase V.

ALARM 32, Motor phase W missing

Motor phase W between the frequency converter and the motor is missing.

Troubleshooting

- Remove power from the frequency converter and check motor phase W.

ALARM 33, Inrush fault

Too many power-ups have occurred within a short time period. Let the unit cool to operating temperature.

WARNING/ALARM 34, Fieldbus communication fault

The fieldbus on the communication option card is not working.

WARNING/ALARM 36, Mains failure

This warning/alarm is only active if the supply voltage to the frequency converter is lost and *parameter 14-10 Mains Failure* is NOT set to [0] No Function.

Troubleshooting

- Check the fuses to the frequency converter and mains power supply to the unit.

ALARM 38, Internal fault

When an internal fault occurs, a code number defined in Table 7.4 is shown.

Troubleshooting

- Cycle power.
- Check that the option is properly installed.
- Check for loose or missing wiring.

Contact the Danfoss supplier or Danfoss service if necessary. Note the code number for further troubleshooting directions.

Number	Text
0	The serial port cannot be initialized. Contact the Danfoss supplier or Danfoss Service.
256–258	Power EEPROM data is defective or too old.
512	The control board EEPROM data is defective or too old.
513	Communication timeout reading EEPROM data.
514	Communication timeout reading EEPROM data.
515	Application-oriented control cannot recognize the EEPROM data.
516	Cannot write to the EEPROM because a write command is in progress.
517	Write command is under timeout.
518	Failure in the EEPROM.
519	Missing or invalid barcode data in EEPROM.
783	Parameter value outside of minimum/maximum limits.
1024–1279	Sending a CAN telegram failed.
1281	Digital signal processor flash timeout.
1282	Power micro software version mismatch.
1283	Power EEPROM data version mismatch.
1284	Cannot read digital signal processor software version.
1299	The option SW in slot A is too old.
1300	The option SW in slot B is too old.
1301	The option SW in slot C0 is too old.
1302	The option SW in slot C1 is too old.
1315	The option SW in slot A is not supported (not allowed).
1316	The option SW in slot B is not supported (not allowed).
1317	The option SW in slot C0 is not supported (not allowed).
1318	The option SW in slot C1 is not supported (not allowed).
1379	The option A did not respond when calculating the platform version.
1380	The option B did not respond when calculating the platform version.

Number	Text
1381	The option C0 did not respond when calculating the platform version.
1382	The option C1 did not respond when calculating the platform version.
1536	An exception in the application-oriented control is registered. Debug information written in LCP.
1792	The DSP watchdog is active. Debugging of power part data, motor-oriented control data not transferred correctly.
2049	Power data restarted.
2064–2072	H081x: Option in slot x restarted.
2080–2088	H082x: Option in slot x issued a power-up wait.
2096–2104	H983x: Option in slot x issued a legal power-up wait.
2304	Could not read any data from power EEPROM.
2305	Missing SW version from power unit.
2314	Missing power unit data from power unit.
2315	Missing SW version from power unit.
2316	Missing lo_statepage from power unit.
2324	The power card configuration is determined to be incorrect at power-up.
2325	A power card has stopped communicating while main power is applied.
2326	The power card configuration is determined to be incorrect after the delay for power cards to register.
2327	Too many power card locations are registered as present.
2330	Power size information between the power cards does not match.
2561	No communication from DSP to ATACD.
2562	No communication from ATACD to DSP (state running).
2816	Stack overflow control board module.
2817	Scheduler slow tasks.
2818	Fast tasks.
2819	Parameter thread.
2820	LCP stack overflow.
2821	Serial port overflow.
2822	USB port overflow.
2836	cfListMempool too small.
3072–5122	Parameter value is outside its limits.
5123	Option in slot A: Hardware incompatible with control board hardware.
5124	Option in slot B: Hardware incompatible with control board hardware.
5125	Option in slot C0: Hardware incompatible with control board hardware.
5126	Option in slot C1: Hardware incompatible with control board hardware.
5376–6231	Out of memory.

Table 7.4 Code Numbers for Internal Faults

ALARM 39, Heat sink sensor

No feedback from the heat sink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card. The problem could be in the power card, in the gatedrive card, or the ribbon cable between the power card and the gatedrive card.

WARNING 40, Overload of digital output terminal 27

Check the load connected to terminal 27 or remove the short circuit connection. Check *parameter 5-00 Digital I/O Mode* and *parameter 5-01 Terminal 27 Mode*.

WARNING 41, Overload of digital output terminal 29

Check the load connected to terminal 29 or remove the short circuit connection. Check *parameter 5-00 Digital I/O Mode* and *parameter 5-02 Terminal 29 Mode*.

WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7

For X30/6, check the load connected to X30/6 or remove the short circuit connection. Check *parameter 5-32 Term X30/6 Digi Out (MCB 101)*.

For X30/7, check the load connected to X30/7 or remove the short circuit connection. Check *parameter 5-33 Term X30/7 Digi Out (MCB 101)*.

ALARM 46, Power card supply

The supply on the power card is out of range.

There are 3 supplies powered by the switch mode power supply (SMPS) on the power card: 24 V, 5 V, ±18 V. When powered with 24 V DC with the VLT® 24V DC Supply MCB 107 option, only the 24 V and 5 V supplies are monitored. When powered with 3-phase mains voltage, all 3 supplies are monitored.

WARNING 47, 24 V supply low

The 24 V DC supply is measured on the control card. The external 24 V DC back-up supply may be overloaded, otherwise contact the Danfoss supplier.

WARNING 48, 1.8 V supply low

The 1.8 V DC supply used on the control card is outside of the allowable limits. The supply is measured on the control card. Check for a defective control card. If an option card is present, check for an overvoltage condition.

WARNING 49, Speed limit

When the speed is not within the specified range in *parameter 4-11 Motor Speed Low Limit [RPM]* and *parameter 4-13 Motor Speed High Limit [RPM]*, the frequency converter shows a warning. When the speed is below the specified limit in *parameter 1-86 Trip Speed Low [RPM]* (except when starting or stopping) the frequency converter trips.

ALARM 50, AMA calibration failed

Contact the Danfoss supplier or Danfoss Service.

ALARM 51, AMA check U_{nom} and I_{nom}

The settings for motor voltage, motor current, and motor power are wrong. Check the settings in *parameters 1-20 to 1-25*.

ALARM 52, AMA low I_{nom}

The motor current is too low. Check the settings.

ALARM 53, AMA motor too big

The motor is too big for the AMA to operate.

ALARM 54, AMA motor too small

The motor is too small for the AMA to operate.

ALARM 55, AMA parameter out of range

The parameter values of the motor are outside of the acceptable range. AMA does not run.

ALARM 56, AMA interrupted by user

The user has interrupted the AMA.

ALARM 57, AMA internal fault

Try to restart AMA several times, until the AMA is carried out. Repeated runs may heat the motor to a level where the resistance R_s and R_r are increased. Usually this is not critical.

ALARM 58, AMA Internal fault

Contact the Danfoss supplier.

WARNING 59, Current limit

The current is higher than the value in *parameter 4-18 Current Limit*. Ensure that motor data in parameters 1-20 to 1-25 are set correctly. Possibly increase the current limit. Be sure that the system can operate safely at a higher limit.

WARNING 60, External interlock

External interlock has been activated. To resume normal operation:

1. Apply 24 V DC to the terminal programmed for external interlock.
2. Reset the frequency converter via
 - 2a Serial communication.
 - 2b Digital I/O.
 - 2c The [Reset] key.

WARNING 62, Output frequency at maximum limit

The output frequency is higher than the value set in *parameter 4-19 Max Output Frequency*.

WARNING 64, Voltage Limit

The load and speed combination demands a motor voltage higher than the actual DC-link voltage.

WARNING/ALARM 65, Control card over temperature

The control card has reached its trip temperature of 75 °C (167 °F).

WARNING 66, Heat sink temperature low

The frequency converter is too cold to operate. This warning is based on the temperature sensor in the IGBT module. Also, a trickle amount of current can be supplied to the frequency converter whenever the motor is stopped by setting *parameter 2-00 DC Hold/Preheat Current* at 5% and *parameter 1-80 Function at Stop*.

Troubleshooting

- Check the temperature sensor.
- Check the sensor wire between the IGBT and the gatedrive card.

ALARM 67, Option module configuration has changed

One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

ALARM 68, Safe Stop activated

STO is activated.

Troubleshooting

- To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital I/O, or by pressing [Reset]).

ALARM 69, Power card temperature

The temperature sensor on the power card is either too hot or too cold.

Troubleshooting

- Check the operation of the door fans.
- Check that the filters for the door fans are not blocked.
- Check that the gland plate is properly installed on IP21/IP54 (NEMA 1/12) frequency converters.

ALARM 70, Illegal FC configuration

The control card and power card are incompatible.

Troubleshooting

- Contact the supplier with the type code of the unit from the nameplate and the part numbers of the cards to check compatibility.

ALARM 71, PTC 1 safe stop

Safe Torque Off is activated from the VLT® PTC Thermistor Card MCB 112 (motor too warm). Normal operation can be resumed when the MCB 112 applies 24 V DC to T37 again (when the motor temperature reaches an acceptable level) and when the digital input from the MCB 112 is deactivated. When that happens, a reset signal must be sent (via bus, digital I/O, or by pressing [Reset]).

NOTICE

If automatic restart is enabled, the motor may start when the fault is cleared.

ALARM 72, Dangerous failure

Safe Torque Off (STO) with trip lock. Unexpected signal levels on Safe Torque Off (STO) and digital input from the VLT® PTC Thermistor Card MCB 112.

WARNING 73, Safe Stop auto restart

Safe Torque Off (STO). With automatic restart enabled, the motor can start when the fault is cleared.

WARNING 76, Power unit setup

The required number of power units does not match the detected number of active power units. When replacing an enclosure size F module, this warning occurs if the power-specific data in the module power card does not match the rest of the frequency converter. If the power card connection is lost, the unit also triggers this warning.

Troubleshooting

- Confirm that the spare part and its power card are the correct part number.
- Ensure that the 44-pin cables between the MDCIC and power cards are mounted properly.

WARNING 77, Reduced power mode

This warning indicates that the frequency converter is operating in reduced power mode (that is, less than the allowed number of inverter sections). This warning is generated on power cycle when the frequency converter is set to run with fewer inverters and remains on.

ALARM 79, Illegal power section configuration

The scaling card is the incorrect part number or not installed. Also, the MK102 connector on the power card could not be installed.

ALARM 80, Drive initialised to default value

Parameter settings are initialized to default settings after a manual reset.

Troubleshooting

- Reset the unit to clear the alarm.

ALARM 81, CSIV corrupt

CSIV (Customer-specific initialization values) file has syntax errors.

ALARM 82, CSIV parameter error

CSIV (Customer-specific initialization values) failed to initialize a parameter.

ALARM 85, Dang fail PB

PROFIBUS/PROFIsafe error.

ALARM 92, No flow

A no-flow condition is detected in the system. *Parameter 22-23 No-Flow Function* is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the frequency converter after clearing the fault.

ALARM 93, Dry pump

A no-flow condition in the system with the frequency converter operating at high speed can indicate a dry pump. *Parameter 22-26 Dry Pump Function* is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the frequency converter after clearing the fault.

ALARM 94, End of curve

The feedback is lower than the setpoint. This condition can indicate leakage in the system. *Parameter 22-50 End of Curve Function* is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the frequency converter after clearing the fault.

ALARM 95, Broken belt

Torque is below the torque level set for no load, indicating a broken belt. *Parameter 22-60 Broken Belt Function* is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the frequency converter after clearing the fault.

ALARM 100, Derag limit fault

The *Deragging* feature failed during execution. Check the pump impeller for blockage.

WARNING/ALARM 104, Mixing fan fault

The fan monitor checks that the fan is spinning at frequency converter power-up or whenever the mixing fan is turned on. If the fan is not operating, the fault is issued. The mixing-fan fault can be configured as a warning or an alarm trip by *parameter 14-53 Fan Monitor*.

Troubleshooting

- Cycle power to the frequency converter to determine if the warning/alarm returns.

WARNING 250, New spare part

A component in the frequency converter has been replaced. To resume normal operation, reset the frequency converter.

WARNING 251, New typecode

The power card or other components have been replaced and the type code changed.

Troubleshooting

- Reset to remove the warning and resume normal operation.

7.5 Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power.	See <i>Table 4.3</i> .	Check the input power source.
	Missing or open fuses, or circuit breaker tripped.	See <i>Open fuses and tripped circuit breaker</i> in this table for possible causes.	Follow the recommendations provided.
	No power to the LCP.	Check the LCP cable for proper connection or damage.	Replace the faulty LCP or connection cable.
	Shortcut on control voltage (terminal 12 or 50) or at control terminals.	Check the 24 V control voltage supply for terminals 12/13 to 20-39 or 10 V supply for terminals 50-55.	Wire the terminals properly.
	Incompatible LCP (LCP from VLT® 2800 or 5000/6000/8000/FCD or FCM).	–	Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N 130B1107).
	Wrong contrast setting.	–	Press [Status] + [▲]/[▼] to adjust the contrast.
	Display (LCP) is defective.	Test using a different LCP.	Replace the faulty LCP or connection cable.
	Internal voltage supply fault or SMPS is defective.	–	Contact supplier.
Intermittent display	Overloaded supply (SMPS) due to improper control wiring or a fault within the frequency converter.	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, the problem is in the control wiring. Check the wiring for short circuits or incorrect connections. If the display continues to cut out, follow the procedure for display dark.
Motor not running	Service switch is open or missing motor connection.	Check if the motor is connected and the connection is not interrupted (by a service switch or other device).	Connect the motor and check the service switch.
	No mains power with 24 V DC option card.	If the display is functioning but no output, check that mains power is applied to the frequency converter.	Apply mains power to run the unit.
	LCP stop.	Check if [Off] has been pressed.	Press [Auto On] or [Hand On] (depending on operating mode) to run the motor.
	Missing start signal (Standby).	Check <i>parameter 5-10 Terminal 18 Digital Input</i> for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting).	Check <i>parameter 5-12 Terminal 27 Digital Input</i> for correct setting for terminal 27 (use default setting).	Apply 24 V on terminal 27 or program this terminal to <i>No operation</i> .
	Wrong reference signal source.	Check the following: - Reference signal: Local, remote, or bus reference. - Preset reference. - Terminal connection. - Scaling of terminals. - Reference signal availability.	Program the correct settings. Check <i>parameter 3-13 Reference Site</i> . Set preset reference active in <i>parameter group 3-1* References</i> .
Motor running in wrong direction	Motor rotation limit.	Check that <i>parameter 4-10 Motor Speed Direction</i> is programmed correctly.	Program the correct settings.
	Active reversing signal.	Check if a reversing command is programmed for the terminal in <i>parameter group 5-1* Digital inputs</i> .	Deactivate reversing signal.
	Wrong motor phase connection.	–	See <i>chapter 5.5 Checking Motor Rotation</i> .

Symptom	Possible cause	Test	Solution
Motor is not reaching maximum speed	Frequency limits are set incorrectly.	Check the output limits in <i>parameter 4-13 Motor Speed High Limit [RPM]</i> , <i>parameter 4-14 Motor Speed High Limit [Hz]</i> and <i>parameter 4-19 Max Output Frequency</i> .	Program the correct limits.
	Reference input signal is not scaled correctly.	Check the reference input signal scaling in <i>parameter group 6-0* Analog I/O Mode</i> and <i>parameter group 3-1* References</i> . Check the reference limits in <i>parameter group 3-0* Reference Limit</i> .	Program the correct settings.
Motor speed unstable	Possible incorrect parameter settings.	Check the settings of all motor parameters, including all motor compensation settings. For closed-loop operation, check the PID settings.	Check the settings in <i>parameter group 1-6* Load Depen. Setting</i> . For closed-loop operation, check the settings in <i>parameter group 20-0* Feedback</i> .
Motor runs rough	Possible overmagnetization.	Check for incorrect motor settings in all motor parameters.	Check the motor settings in <i>parameter groups 1-2* Motor Data</i> , <i>1-3* Adv Motor Data</i> , and <i>1-5* Load Indep. Setting</i> .
Motor does not brake	Possible incorrect settings in the brake parameters. Possible too short ramp-down times.	Check the brake parameters. Check the ramp time settings.	Check <i>parameter groups 2-0* DC Brake</i> and <i>3-0* Reference Limits</i> .
Open power fuses or circuit breaker trip	Phase-to-phase short circuit.	The motor or panel has a short phase-to-phase. Check the motor and panel phase for short circuits.	Eliminate any short circuits detected.
	Motor overload.	Motor is overloaded for the application.	Perform a start-up test and verify that the motor current is within the specifications. If the motor current exceeds the nameplate full load current, the motor may run only with reduced load. Review the specifications for the application.
	Loose connections.	Perform a pre-startup check for loose connections.	Tighten any loose connections.
Mains current imbalance >3%	Problem with the mains power (See <i>alarm 4, Mains phase loss</i> description).	Rotate input power leads into the frequency converter 1 position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check the mains supply.
	Problem with the frequency converter.	Rotate input power leads into the frequency converter 1 position: A to B, B to C, C to A.	If imbalance leg stays on the same input terminal, it is a problem with the unit. Contact the supplier.
Motor current imbalance >3%	Problem with the motor or motor wiring.	Rotate output motor cables 1 position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check the motor and motor wiring.
	Problem with the frequency converter.	Rotate output motor cables 1 position: U to V, V to W, W to U.	If imbalance leg stays on same output terminal, it is a problem with the frequency converter. Contact the Danfoss supplier.
Frequency converter acceleration problems	Motor data was entered incorrectly.	If warnings or alarms occur, see <i>chapter 7.4 List of Warnings and Alarms</i> . Check that motor data is entered correctly.	Increase the ramp-up time in <i>parameter 3-41 Ramp 1 Ramp Up Time</i> . Increase the current limit in <i>parameter 4-18 Current Limit</i> . Increase the torque limit in <i>parameter 4-16 Torque Limit Motor Mode</i> .
Frequency converter deceleration problems	Motor data was entered incorrectly.	If warnings or alarms occur, see <i>chapter 7.4 List of Warnings and Alarms</i> . Check that motor data is entered correctly.	Increase the ramp-down time in <i>parameter 3-42 Ramp 1 Ramp Down Time</i> . Enable overvoltage control in <i>parameter 2-17 Over-voltage Control</i> .

Symptom	Possible cause	Test	Solution
Acoustic noise or vibration	Resonances.	Bypass critical frequencies by using parameters in <i>parameter group 4-6* Speed Bypass</i> .	Check if noise and/or vibration have been reduced to an acceptable limit.
		Turn off overmodulation in <i>parameter 14-03 Overmodulation</i> .	
		Change the switching pattern and frequency in <i>parameter group 14-0* Inverter Switching</i> .	
		Increase resonance dampening in <i>parameter 1-64 Resonance Damping</i> .	

Table 7.5 Troubleshooting

8 Specifications

8.1 Electrical Data

8.1.1 Mains Supply 1x200–240 V AC

Type designation	P1K1	P1K5	P2K2	P3K0	P3K7	P5K5	P7K5	P15K	P22K
Typical shaft output [kW]	1.1	1.5	2.2	3.0	3.7	5.5	7.5	15	22
Typical shaft output at 240 V [hp]	1.5	2.0	2.9	4.0	4.9	7.5	10	20	30
Protection rating IP20/Chassis	A3	–	–	–	–	–	–	–	–
Protection rating IP21/Type 1	–	B1	B1	B1	B1	B1	B2	C1	C2
Protection rating IP55/Type 12	A5	B1	B1	B1	B1	B1	B2	C1	C2
Protection rating IP66/NEMA 4X	A5	B1	B1	B1	B1	B1	B2	C1	C2
Output current									
Continuous (3x200–240 V) [A]	6.6	7.5	10.6	12.5	16.7	24.2	30.8	59.4	88
Intermittent (3x200–240 V) [A]	7.3	8.3	11.7	13.8	18.4	26.6	33.4	65.3	96.8
Continuous kVA at 208 V [kVA]	2.4	2.7	3.8	4.5	6.0	8.7	11.1	21.4	31.7
Maximum input current									
Continuous (1x200–240 V) [A]	12.5	15	20.5	24	32	46	59	111	172
Intermittent (1x200–240 V) [A]	13.8	16.5	22.6	26.4	35.2	50.6	64.9	122.1	189.2
Maximum pre-fuses [A]	20	30	40	40	60	80	100	150	200
Additional specifications									
Maximum cable cross-section (mains, motor, brake) [mm ² (AWG)]	0.2–4 (4–10)					10 (7)	35 (2)	50 (1/0)	95 (4/0)
Maximum cable cross-section for mains with disconnect switch [mm ² (AWG)]	5.26 (10)	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	25 (3)	50 (1/0)	2 x 50 (2 x 1/0) ^{9) 10)}
Maximum cable cross-section for mains without disconnect switch [mm ² (AWG)]	5.26 (10)	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	25 (3)	50 (1/0)	95 (4/0)
Cable insulation temperature rating [°C (°F)]	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)
Estimated power loss ³⁾ at rated maximum load [W] ⁴⁾	44	30	44	60	74	110	150	300	440
Efficiency ⁵⁾	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

Table 8.1 Mains Supply 1x200–240 V AC, Normal Overload 110% for 1 Minute, P1K1–P22K

8.1.2 Mains Supply 3x200–240 V AC

Type designation	PK25		PK37		PK55		PK75	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	0.25		0.37		0.55		0.75	
Typical shaft output at 208 V [hp]	0.34		0.5		0.75		1	
Protection rating IP20/Chassis ⁶⁾	A2		A2		A2		A2	
Protection rating IP21/Type 1								
Protection rating IP55/Type 12	A4/A5		A4/A5		A4/A5		A4/A5	
Protection rating IP66/NEMA 4X								
Output current								
Continuous (3x200–240 V) [A]	1.8		2.4		3.5		4.6	
Intermittent (3x200–240 V) [A]	2.7	2.0	3.6	2.6	5.3	3.9	6.9	5.1
Continuous kVA at 208 V [kVA]	0.65		0.86		1.26		1.66	
Maximum input current								
Continuous (3x200–240 V) [A]	1.6		2.2		3.2		4.1	
Intermittent (3x200–240 V) [A]	2.4	1.8	3.3	2.4	4.8	3.5	6.2	4.5
Maximum pre-fuses [A]	10		10		10		10	
Additional specifications								
Maximum cable cross-section ²⁾ for mains, motor, brake, and load sharing [mm ² (AWG)]	4, 4, 4 (12, 12, 12) (minimum 0.2 (24))							
Maximum cable cross-section ²⁾ for mains disconnect [mm ² (AWG)]	6, 4, 4 (10, 12, 12)							
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	21 (0.03)		29 (0.04)		42 (0.06)		54 (0.07)	
Efficiency ⁵⁾	0.94		0.94		0.95		0.95	

Table 8.2 Mains Supply 3x200–240 V AC, PK25–PK75

Type designation	P1K1		P1K5		P2K2		P3K0		P3K7	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	1.1		1.5		2.2		3.0		3.7	
Typical shaft output at 208 V [hp]	1.5		2		3		4		5	
Protection rating IP20/Chassis ⁶⁾	A2		A2		A2		A3		A3	
Protection rating IP21/Type 1										
Protection rating IP55/Type 12	A4/A5		A4/A5		A4/A5		A5		A5	
Protection rating IP66/NEMA 4X										
Output current										
Continuous (3x200–240 V) [A]	6.6		7.5		10.6		12.5		16.7	
Intermittent (3x200–240 V) [A]	9.9	7.3	11.3	8.3	15.9	11.7	18.8	13.8	25	18.4
Continuous kVA at 208 V [kVA]	2.38		2.70		3.82		4.50		6.00	
Maximum input current										
Continuous (3x200–240 V) [A]	5.9		6.8		9.5		11.3		15.0	
Intermittent (3x200–240 V) [A]	8.9	6.5	10.2	7.5	14.3	10.5	17.0	12.4	22.5	16.5
Maximum pre-fuses [A]	20		20		20		32		32	
Additional specifications										
Maximum cable cross-section ²⁾ for mains, motor, brake, and load sharing [mm ² (AWG)]	4, 4, 4 (12, 12, 12) (minimum 0.2 (24))									
Maximum cable cross-section ²⁾ for mains disconnect [mm ²] [(AWG)]	6, 4, 4 (10, 12, 12)									
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	63 (0.09)		82 (0.11)		116 (0.16)		155 (0.21)		185 (0.25)	
Efficiency ⁵⁾	0.96		0.96		0.96		0.96		0.96	

Table 8.3 Mains Supply 3x200–240 V AC, P1K1–P3K7

Type designation	P5K5		P7K5		P11K		P15K	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	3.7	5.5	5.5	7.5	7.5	11	11	15
Typical shaft output at 208 V [hp]	5.0	7.5	7.5	10	10	15	15	20
IP20/Chassis ⁷⁾	B3		B3		B3		B4	
Protection rating IP21/Type 1	B1		B1		B1		B2	
Protection rating IP55/Type 12								
Protection rating IP66/NEMA 4X								
Output current								
Continuous (3x200–240 V) [A]	16.7	24.2	24.2	30.8	30.8	46.2	46.2	59.4
Intermittent (3x200–240 V) [A]	26.7	26.6	38.7	33.9	49.3	50.8	73.9	65.3
Continuous kVA at 208 V [kVA]	6.0	8.7	8.7	11.1	11.1	16.6	16.6	21.4
Maximum input current								
Continuous (3x200–240 V) [A]	15.0	22.0	22.0	28.0	28.0	42.0	42.0	54.0
Intermittent (3x200–240 V) [A]	24.0	24.2	35.2	30.8	44.8	46.2	67.2	59.4
Maximum pre-fuses [A]	63		63		63		80	
Additional specifications								
IP20 maximum cable cross-section ²⁾ for mains, brake, motor, and load sharing [mm ² (AWG)]	10, 10, – (8, 8, –)		10, 10, – (8, 8, –)		10, 10, – (8, 8, –)		35, –, – (2, –, –)	
Protection rating IP21 maximum cable cross-section ²⁾ for mains, brake, and load sharing [mm ² (AWG)]	16, 10, 16 (6, 8, 6)		16, 10, 16 (6, 8, 6)		16, 10, 16 (6, 8, 6)		35, –, – (2, –, –)	
Protection rating IP21 maximum cable cross-section ²⁾ for motor [mm ² (AWG)]	10, 10, – (8, 8, –)		10, 10, – (8, 8, –)		10, 10, – (8, 8, –)		35, 25, 25 (2, 4, 4)	
Maximum cable cross-section ²⁾ for mains disconnect [mm ² (AWG)]	16, 10, 10 (6, 8, 8)						35 (2)	
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	239 (0.33)	310 (0.42)	239 (0.33)	310 (0.42)	371 (0.51)	514 (0.7)	463 (0.63)	602 (0.82)
Efficiency ⁵⁾	0.96		0.96		0.96		0.96	

Table 8.4 Mains Supply 3x200–240 V AC, P5K5–P15K

Specifications

VLT® AQUA Drive FC 202

Type designation	P18K		P22K		P30K		P37K		P45K	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	15	18.5	18.5	22	22	30	30	37	37	45
Typical shaft output at 208 V [hp]	20	25	25	30	30	40	40	50	50	60
Protection rating IP20/Chassis ⁷⁾	B4		C3		C3		C4		C4	
Protection rating IP21/Type 1	C1		C1		C1		C2		C2	
Protection rating IP55/Type 12										
Protection rating IP66/NEMA 4X										
Output current										
Continuous (3x200–240 V) [A]	59.4	74.8	74.8	88.0	88.0	115	115	143	143	170
Intermittent (3x200–240 V) [A]	89.1	82.3	112	96.8	132	127	173	157	215	187
Continuous kVA at 208 V [kVA]	21.4	26.9	26.9	31.7	31.7	41.4	41.4	51.5	51.5	61.2
Maximum input current										
Continuous (3x200–240 V) [A]	54.0	68.0	68.0	80.0	80.0	104	104	130	130	154.0
Intermittent (3x200–240 V) [A]	81.0	74.8	102	88.0	120	114	156	143	195	169.0
Maximum pre-fuses [A]	125		125		160		200		250	
Additional specifications										
Protection rating IP20 maximum cable cross-section for mains, brake, motor, and load sharing [mm ² (AWG)]	35 (2)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
Protection ratings IP21, IP55, IP66 maximum cable cross-section for mains and motor [mm ² (AWG)]	50 (1)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
Protection ratings IP21, IP55, IP66 maximum cable cross-section for brake, and load sharing [mm ² (AWG)]	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
Maximum cable cross-section ²⁾ for disconnect [mm ² (AWG)]	50, 35, 35 (1, 2, 2)						95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	624 (0.85)	737 (1)	740 (1)	845 (1.2)	874 (1.2)	1140 (1.6)	1143 (1.6)	1353 (1.8)	1400 (1.9)	1636 (2.2)
Efficiency ⁵⁾	0.96		0.97		0.97		0.97		0.97	

Table 8.5 Mains Supply 3x200–240 V AC, P18K–P45K

8.1.3 Mains Supply 1x380–480 V AC

Type designation	P7K5	P11K	P18K	P37K
Typical shaft output [kW]	7.5	11	18.5	37
Typical shaft output at 240 V [hp]	10	15	25	50
Protection rating IP21/Type 1	B1	B2	C1	C2
Protection rating IP55/Type 12	B1	B2	C1	C2
Protection rating IP66/NEMA 4X	B1	B2	C1	C2
Output current				
Continuous (3x380–440 V) [A]	16	24	37.5	73
Intermittent (3x380–440 V) [A]	17.6	26.4	41.2	80.3
Continuous (3x441–480 V) [A]	14.5	21	34	65
Intermittent (3x441–480 V) [A]	15.4	23.1	37.4	71.5
Continuous kVA at 400 V [kVA]	11.0	16.6	26	50.6
Continuous kVA at 460 V [kVA]	11.6	16.7	27.1	51.8
Maximum input current				
Continuous (1x380–440 V) [A]	33	48	78	151
Intermittent (1x380–440 V) [A]	36	53	85.5	166

Type designation	P7K5	P11K	P18K	P37K
Continuous (1x441–480 V) [A]	30	41	72	135
Intermittent (1x441–480 V) [A]	33	46	79.2	148
Maximum pre-fuses [A]	63	80	160	250
Additional specifications				
Maximum cable cross-section for mains, motor, and brake [mm ²] (AWG)]	10 (7)	35 (2)	50 (1/0)	120 (4/0)
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	300 (0.41)	440 (0.6)	740 (1)	1480 (2)
Efficiency ⁵⁾	0.96	0.96	0.96	0.96

Table 8.6 Mains Supply 1x380–480 V AC, Normal Overload 110% for 1 Minute, P7K5–P37K

8.1.4 Mains Supply 3x380–480 V AC

Type designation	PK37		PK55		PK75		P1K1		P1K5	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	0.37		0.55		0.75		1.1		1.5	
Typical shaft output at 460 V [hp]	0.5		0.75		1.0		1.5		2.0	
Protection rating IP20/Chassis ⁶⁾	A2		A2		A2		A2		A2	
Protection rating IP55/Type 12	A4/A5		A4/A5		A4/A5		A4/A5		A4/A5	
Protection rating IP66/NEMA 4X	A4/A5		A4/A5		A4/A5		A4/A5		A4/A5	
Output current										
Continuous (3x380–440 V) [A]	1.3		1.8		2.4		3.0		4.1	
Intermittent (3x380–440 V) [A]	2.0	1.4	2.7	2.0	3.6	2.6	4.5	3.3	6.2	4.5
Continuous (3x441–480 V) [A]	1.2		1.6		2.1		2.7		3.4	
Intermittent (3x441–480 V) [A]	1.8	1.3	2.4	1.8	3.2	2.3	4.1	3.0	5.1	3.7
Continuous kVA at 400 V [kVA]	0.9		1.3		1.7		2.1		2.8	
Continuous kVA at 460 V [kVA]	0.9		1.3		1.7		2.4		2.7	
Maximum input current										
Continuous (3x380–440 V) [A]	1.2		1.6		2.2		2.7		3.7	
Intermittent (3x380–440 V) [A]	1.8	1.3	2.4	1.8	3.3	2.4	4.1	3.0	5.6	4.1
Continuous (3x441–480 V) [A]	1.0		1.4		1.9		2.7		3.1	
Intermittent (3x441–480 V) [A]	1.5	1.1	2.1	1.5	2.9	2.1	4.1	3.0	4.7	3.4
Maximum pre-fuses [A]	10		10		10		10		10	
Additional specifications										
Protection ratings IP20, IP21 maximum cable cross-section ²⁾ for mains, motor, brake, and load sharing [mm ² (AWG)]	4, 4, 4 (12, 12, 12) (minimum 0.2 (24))									
Protection ratings IP55, IP66 maximum cable cross-section ²⁾ for mains, motor, brake, and load sharing [mm ² (AWG)]	4, 4, 4 (12, 12, 12)									
Maximum cable cross-section ²⁾ for disconnect [mm ² (AWG)]	6, 4, 4 (10, 12, 12)									
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	35 (0.05)		42 (0.06)		46 (0.06)		58 (0.08)		62 (0.08)	
Efficiency ⁵⁾	0.93		0.95		0.96		0.96		0.97	

Table 8.7 Mains Supply 3x380–480 V AC, PK37–P1K5

Specifications

VLT® AQUA Drive FC 202

Type designation	P2K2		P3K0		P4K0		P5K5		P7K5	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	2.2		3.0		4.0		5.5		7.5	
Typical shaft output at 460 V [hp]	2.9		4.0		5.3		7.5		10	
Protection rating IP20/Chassis ⁶⁾	A2		A2		A2		A3		A3	
Protection rating IP55/Type 12	A4/A5		A4/A5		A4/A5		A5		A5	
Protection rating IP66/NEMA 4X										
Output current										
Continuous (3x380–440 V) [A]	5.6		7.2		10		13		16	
Intermittent (3x380–440 V) [A]	8.4	6.2	10.8	7.9	15.0	11.0	19.5	14.3	24.0	17.6
Continuous (3x441–480 V) [A]	4.8		6.3		8.2		11		14.5	
Intermittent (3x441–480 V) [A]	7.2	5.3	9.5	6.9	12.3	9.0	16.5	12.1	21.8	16.0
Continuous kVA at 400 V [kVA]	3.9		5.0		6.9		9.0		11.0	
Continuous kVA at 460 V [kVA]	3.8		5.0		6.5		8.8		11.6	
Maximum input current										
Continuous (3x380–440 V) [A]	5.0		6.5		9.0		11.7		14.4	
Intermittent (3x380–440 V) [A]	7.5	5.5	9.8	7.2	13.5	9.9	17.6	12.9	21.6	15.8
Continuous(3x441–480 V) [A]	4.3		5.7		7.4		9.9		13.0	
Intermittent (3x441–480 V) [A]	6.5	4.7	8.6	6.3	11.1	8.1	14.9	10.9	19.5	14.3
Maximum pre-fuses [A]	20		20		20		30		30	
Additional specifications										
Protection ratings IP20, IP21 maximum cable cross-section ²⁾ for mains, motor, brake, and load sharing [mm ² (AWG)]	4, 4, 4 (12, 12, 12) (minimum 0.2 (24))									
Protection ratings IP55, IP66 maximum cable cross-section ²⁾ for mains, motor, brake, and load sharing [mm ² (AWG)]	4, 4, 4 (12, 12, 12)									
Maximum cable cross-section ²⁾ for disconnect [mm ² (AWG)]	6, 4, 4 (10, 12, 12)									
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	88 (0.12)		116 (0.16)		124 (0.17)		187 (0.25)		225 (0.31)	
Efficiency ⁵⁾	0.97		0.97		0.97		0.97		0.97	

Table 8.8 Mains Supply 3x380–480 V AC, P2K2–P7K5

Type designation	P11K		P15K		P18K		P22K		P30K	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	7.5	11	11	15	15	18.5	22.0	22.0	22.0	30
Typical shaft output at 460 V [hp]	10	15	15	20	20	25	30	30	30	40
Protection rating IP20/Chassis ⁷⁾	B3		B3		B3		B4			B4
Protection rating IP21/Type 1	B1		B1		B1		B2		B2	
Protection rating IP55/Type 12	B1		B1		B1		B2		B2	
Protection rating IP66/NEMA 4X										
Output current										
Continuous (3x380–440 V) [A]	–	24	24	32	32	37.5	37.5	44	44	61
Intermittent (60 s overload) (3x380–440 V) [A]	–	26.4	38.4	35.2	51.2	41.3	60	48.4	70.4	67.1
Continuous (3x441–480 V) [A]	–	21	21	27	27	34	34	40	40	52
Intermittent (60 s overload) (3x441–480 V) [A]	–	23.1	33.6	29.7	43.2	37.4	54.4	44	64	61.6
Continuous kVA at 400 V [kVA]	–	16.6	16.6	22.2	22.2	26	26	30.5	30.5	42.3
Continuous kVA at 460 V [kVA]	–	16.7	16.7	21.5	21.5	27.1	27.1	31.9	31.9	41.4
Maximum input current										
Continuous (3x380–440 V) [A]	–	22	22	29	29	34	34	40	40	55
Intermittent (60 s overload) (3x380–440 V) [A]	–	24.2	35.2	31.9	46.4	37.4	54.4	44	64	60.5
Continuous (3x441–480 V) [A]	–	19	19	25	25	31	31	36	36	47
Intermittent (60 s overload) (3x441–480 V) [A]	–	20.9	30.4	27.5	40	34.1	49.6	39.6	57.6	51.7
Maximum pre-fuses [A]	–	63		63		63		63		80
Additional specifications										
Protection ratings IP21, IP55, IP66 maximum cable cross-section ²⁾ for mains, brake, and load sharing [mm ² (AWG)]	16, 10, 16 (6, 8, 6)						35, –, – (2, –, –)			
Protection ratings IP21, IP55, IP66 maximum cable cross-section ²⁾ for motor [mm ² (AWG)]	10, 10,– (8, 8,–)						35, 25, 25 (2, 4, 4)			
Protection rating IP20 maximum cable cross-section ²⁾ for mains, brake, motor, and load sharing [mm ² (AWG)]	10, 10,– (8, 8,–)						35, –, – (2, –, –)			
Maximum cable cross-section ²⁾ for disconnect [mm ² (AWG)]	16, 10, 10 (6, 8, 8)									
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	291 (0.4)	392 (0.53)	291 (0.4)	392 (0.53)	379 (0.52)	465 (0.63)	444 (0.61)	525 (0.72)	547 (0.75)	739 (1)
Efficiency ⁵⁾	0.98		0.98		0.98		0.98		0.98	

Table 8.9 Mains Supply 3x380–480 V AC, P11K–P30K

Specifications
VLT® AQUA Drive FC 202

Type designation	P37K		P45K		P55K		P75K		P90K	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	30	37	37	45	45	55	55	75	75	90
Typical shaft output at 460 V [hp]	40	50	50	60	60	75	75	100	100	125
Protection rating IP20/Chassis ⁶⁾	B4		C3		C3		C4		C4	
Protection rating IP21/Type 1	C1		C1		C1		C2		C2	
Protection rating IP55/Type 12	C1		C1		C1		C2		C2	
Protection rating IP66/NEMA 4X										
Output current										
Continuous (3x380–440 V) [A]	61	73	73	90	90	106	106	147	147	177
Intermittent (60 s overload) (3x380–440 V) [A]	91.5	80.3	110	99	135	117	159	162	221	195
Continuous (3x441–480 V) [A]	52	65	65	80	80	105	105	130	130	160
Intermittent (60 s overload) (3x441–480 V) [A]	78	71.5	97.5	88	120	116	158	143	195	176
Continuous kVA at 400 V [kVA]	42.3	50.6	50.6	62.4	62.4	73.4	73.4	102	102	123
Continuous kVA at 460 V [kVA]	41.4	51.8	51.8	63.7	63.7	83.7	83.7	104	103.6	128
Maximum input current										
Continuous (3x380–440 V) [A]	55	66	66	82	82	96	96	133	133	161
Intermittent (60 s overload) (3x380–440 V) [A]	82.5	72.6	99	90.2	123	106	144	146	200	177
Continuous (3x441–480 V) [A]	47	59	59	73	73	95	95	118	118	145
Intermittent (60 s overload) (3x441–480 V) [A]	70.5	64.9	88.5	80.3	110	105	143	130	177	160
Maximum pre-fuses [A]	100		125		160		250		250	
Additional specifications										
Protection rating IP20 maximum cable cross-section for mains and motor [mm² (AWG)]	35 (2)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
Protection rating IP20 maximum cable cross-section for brake and load sharing [mm² (AWG)]	35 (2)		50 (1)		50 (1)		95 (4/0)		95 (4/0)	
Protection ratings IP21, IP55, IP66 maximum cable cross-section for mains and motor [mm² (AWG)]	50 (1)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
Protection ratings IP21, IP55, IP66 maximum cable cross-section for brake and load sharing [mm² (AWG)]	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
Maximum cable cross-section ²⁾ for mains disconnect [mm² (AWG)]	50, 35, 35 (1, 2, 2)						95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	570 (0.78)	698 (0.95)	697 (0.95)	843 (1.1)	891 (1.2)	1083 (1.5)	1022 (1.4)	1384 (1.9)	1232 (1.7)	1474 (2)
Efficiency ⁵⁾	0.98		0.98		0.98		0.98		0.99	

Table 8.10 Mains Supply 3x380–480 V AC, P37K–P90K

8.1.5 Mains Supply 3x525–600 V AC

Type designation	PK75		P1K1		P1K5		P2K2	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	0.75		1.1		1.5		2.2	
Typical shaft output [hp]	1		1.5		2		3	
Protection rating IP20/Chassis Protection rating IP21/Type 1	A3		A3		A3		A3	
Protection rating IP55/Type 12	A5		A5		A5		A5	
Output current								
Continuous (3x525–550 V) [A]	1.8		2.6		2.9		4.1	
Intermittent (3x525–550 V) [A]	2.7	2.0	3.9	2.9	4.4	3.2	6.2	4.5
Continuous (3x551–600 V) [A]	1.7		2.4		2.7		3.9	
Intermittent (3x551–600 V) [A]	2.6	1.9	3.6	2.6	4.1	3.0	5.9	4.3
Continuous kVA at 550 V [kVA]	1.7		2.5		2.8		3.9	
Continuous kVA at 550 V [kVA]	1.7		2.4		2.7		3.9	
Maximum input current								
Continuous (3x525–600 V) [A]	1.7		2.4		2.7		4.1	
Intermittent (3x525–600 V) [A]	2.6	1.9	3.6	2.6	4.1	3.0	6.2	4.5
Maximum pre-fuses [A]	10		10		10		20	
Additional specifications								
Maximum cable cross-section ²⁾ for mains, motor, brake, and load sharing [mm ² (AWG)]	4,4,4 (12,12,12) (minimum 0.2 (24))							
Maximum cable cross-section ²⁾ for mains disconnect [mm ² (AWG)]	6,4,4 (10,12,12)							
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	35 (0.05)		50 (0.07)		65 (0.09)		92 (0.13)	
Efficiency ⁵⁾	0.97		0.97		0.97		0.97	

Table 8.11 Mains Supply 3x525–600 V AC, PK75–P2K2

Specifications

VLT® AQUA Drive FC 202

Type designation	P3K0		P4K0		P5K5		P7K5	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	3.0		4.0		5.5		7.5	
Typical shaft output [hp]	4		5		7.5		10	
Protection rating IP20/Chassis Protection rating IP21/Type 1	A2		A2		A3		A3	
IP55/Type 12	A5		A5		A5		A5	
Output current								
Continuous (3x525–550 V) [A]	5.2		6.4		9.5		11.5	
Intermittent (3x525–550 V) [A]	7.8	5.7	9.6	7.0	14.3	10.5	17.3	12.7
Continuous (3x551–600 V) [A]	4.9		6.1		9.0		11.0	
Intermittent (3x551–600 V) [A]	7.4	5.4	9.2	6.7	13.5	9.9	16.5	12.1
Continuous kVA at 550 V [kVA]	5.0		6.1		9.0		11.0	
Continuous kVA at 550 V [kVA]	4.9		6.1		9.0		11.0	
Maximum input current								
Continuous (3x525–600 V) [A]	5.2		5.8		8.6		10.4	
Intermittent (3x525–600 V) [A]	7.8	5.7	8.7	6.4	12.9	9.5	15.6	11.4
Maximum pre-fuses [A]	20		20		32		32	
Additional specifications								
Maximum cable cross-section ²⁾ for mains, motor, brake, and load sharing [mm ² (AWG)]	4,4,4 (12,12,12) (minimum 0.2 (24))							
Maximum cable cross-section ²⁾ for mains disconnect [mm ² (AWG)]	6,4,4 (10,12,12)							
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	122 (0.17)		145 (0.2)		195 (0.27)		261 (0.36)	
Efficiency ⁵⁾	0.97		0.97		0.97		0.97	

Table 8.12 Mains Supply 3x525–600 V AC, P3K0–P7K5

Type designation	P11K		P15K		P18K		P22K		P30K		P37K	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	7.5	11	11	15	15	18.5	18.5	22	22	30	30	37
Typical shaft output [hp]	10	15	15	20	20	25	25	30	30	40	40	50
Protection rating IP20/ Chassis	B3		B3		B3		B4		B4		B4	
Protection rating IP21/ Type 1	B1		B1		B1		B2		B2		C1	
Protection rating IP55/ Type 12												
Protection rating IP66/ NEMA 4X												
Output current												
Continuous (3x525–550 V) [A]	11.5	19	19	23	23	28	28	36	36	43	43	54
Intermittent (3x525– 550 V) [A]	18.4	21	30	25	37	31	45	40	58	47	65	59
Continuous (3x551–600 V) [A]	11	18	18	22	22	27	27	34	34	41	41	52
Intermittent (3x551– 600 V) [A]	17.6	20	29	24	35	30	43	37	54	45	62	57
Continuous kVA at 550 V [kVA]	11	18.1	18.1	21.9	21.9	26.7	26.7	34.3	34.3	41.0	41.0	51.4
Continuous kVA at 575 V [kVA]	11	17.9	17.9	21.9	21.9	26.9	26.9	33.9	33.9	40.8	40.8	51.8
Maximum input current												
Continuous at 550 V [A]	10.4	17.2	17.2	20.9	20.9	25.4	25.4	32.7	32.7	39	39	49
Intermittent at 550 V [A]	16.6	19	28	23	33	28	41	36	52	43	59	54
Continuous at 575 V [A]	9.8	16	16	20	20	24	24	31	31	37	37	47
Intermittent at 575 V [A]	15.5	17.6	26	22	32	27	39	34	50	41	56	52
Maximum pre-fuses [A]	40		40		50		60		80		100	
Additional specifications												
Protection rating IP20, maximum cable cross- section ²⁾ for mains, brake, motor, and load sharing [mm ² (AWG)]	10, 10,– (8, 8,–)						35,–,– (2,–,–)					
Protection ratings IP21, IP55, IP66 maximum cable cross-section ²⁾ for mains, brake, and load sharing [mm ² (AWG)]	16, 10, 10 (6, 8, 8)						35,–,– (2,–,–)					
Protection ratings IP21, IP55, IP66 maximum cable cross-section ²⁾ for motor [mm ² (AWG)]	10, 10,– (8, 8,–)						35, 25, 25 (2, 4, 4)					
Maximum cable cross- section ²⁾ for mains disconnect [mm ² (AWG)]	16, 10, 10 (6, 8, 8)										50, 35, 35 (1, 2, 2)	
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	220 (0.3)	300 (0.41)	220 (0.3)	300 (0.41)	300 (0.41)	370 (0.5)	370 (0.5)	440 (0.6)	440 (0.6)	600 (0.82)	600 (0.82)	740 (1)
Efficiency ⁵⁾	0.98		0.98		0.98		0.98		0.98		0.98	

Table 8.13 Mains supply 3x525–600 V AC, P11K–P37K

Specifications

VLT® AQUA Drive FC 202

Type designation	P45K		P55K		P75K		P90K	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	37	45	45	55	55	75	75	90
Typical shaft output [hp]	50	60	60	75	75	100	100	125
Protection rating IP20/Chassis	C3		C3		C4		C4	
Protection rating IP21/Type 1	C1		C1		C2		C2	
Protection rating IP55/Type 12								
Protection rating IP66/NEMA 4X								
Output current								
Continuous (3x525–550 V) [A]	54	65	65	87	87	105	105	137
Intermittent (3x525–550 V) [A]	81	72	98	96	131	116	158	151
Continuous (3x525–600 V) [A]	52	62	62	83	83	100	100	131
Intermittent (3x525–600 V) [A]	78	68	93	91	125	110	150	144
Continuous kVA at 525 V [kVA]	51.4	61.9	61.9	82.9	82.9	100	100.0	130.5
Continuous kVA at 575 V [kVA]	51.8	61.7	61.7	82.7	82.7	99.6	99.6	130.5
Maximum input current								
Continuous at 550 V [A]	49	59	59	78.9	78.9	95.3	95.3	124.3
Intermittent at 550 V [A]	74	65	89	87	118	105	143	137
Continuous at 575 V [A]	47	56	56	75	75	91	91	119
Intermittent at 575 V [A]	70	62	85	83	113	100	137	131
Maximum pre-fuses [A]	150		160		225		250	
Additional specifications								
Protection rating IP20 maximum cable cross-section for mains and motor [mm ² (AWG)]	50 (1)				150 (300 MCM)			
Protection rating IP20 maximum cable cross-section for brake and load sharing [mm ² (AWG)]	50 (1)				95 (4/0)			
Protection ratings IP21, IP55, IP66 maximum cable cross-section for mains and motor [mm ² (AWG)]	50 (1)				150 (300 MCM)			
Protection ratings IP21, IP55, IP66 maximum cable cross-section for brake and load sharing [mm ² (AWG)]	50 (1)				95 (4/0)			
Maximum cable cross-section ²⁾ for mains disconnect [mm ² (AWG)]	50, 35, 35 (1, 2, 2)				95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	740 (1)	900 (1.2)	900 (1.2)	1100 (1.5)	1100 (1.5)	1500 (2)	1500 (2)	1800 (2.5)
Efficiency ⁵⁾	0.98		0.98		0.98		0.98	

Table 8.14 Mains supply 3x525–600 V AC, P45K–P90K

8.1.6 Mains Supply 3x525–690 V AC

Type designation	P1K1		P1K5		P2K2		P3K0		P4K0		P5K5		P7K5	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	1.1		1.5		2.2		3.0		4.0		5.5		7.5	
Typical shaft output [hp]	1.5		2		3		4		5		7.5		10	
IP20/Chassis	A3		A3		A3		A3		A3		A3		A3	
Output current														
Continuous (3x525–550 V) [A]	2.1		2.7		3.9		4.9		6.1		9.0		11.0	
Intermittent (3x525–550 V) [A]	3.2	2.3	4.1	3.0	5.9	4.3	7.4	5.4	9.2	6.7	13.5	9.9	16.5	12.1
Continuous (3x551–690 V) [A]	1.6		2.2		3.2		4.5		5.5		7.5		10.0	
Intermittent (3x551–690 V) [A]	2.4	1.8	3.3	2.4	4.8	3.5	6.8	5.0	8.3	6.1	11.3	8.3	15.0	11.0
Continuous kVA at 525 V [kVA]	1.9		2.5		3.5		4.5		5.5		8.2		10.0	
Continuous kVA at 690 V [kVA]	1.9		2.6		3.8		5.4		6.6		9.0		12.0	
Maximum input current														
Continuous (3x525–550 V) [A]	1.9		2.4		3.5		4.4		5.5		8.1		9.9	
Intermittent (3x525–550 V) [A]	2.9	2.1	3.6	2.6	5.3	3.9	6.6	4.8	8.3	6.1	12.2	8.9	14.9	10.9
Continuous (3x551–690 V) [A]	1.4		2.0		2.9		4.0		4.9		6.7		9.0	
Intermittent (3x551–690 V) [A]	2.1	1.5	3.0	2.2	4.4	3.2	6.0	4.4	7.4	5.4	10.1	7.4	13.5	9.9
Additional specifications														
Maximum cable cross-section ²⁾ for mains, motor, brake, and load sharing [mm ² (AWG)]	4, 4, 4 (12, 12, 12) (minimum (24))													
Maximum cable cross-section ²⁾ for mains disconnect [mm ² (AWG)]	6, 4, 4 (10, 12, 12)													
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	44 (0.06)		60 (0.08)		88 (0.12)		120 (0.16)		160 (0.22)		220 (0.3)		300 (0.41)	
Efficiency ⁵⁾	0.96		0.96		0.96		0.96		0.96		0.96		0.96	

Table 8.15 A3 Enclosure, Mains Supply 3x525–690 V AC IP20/Protected Chassis, P1K1–P7K5

Specifications
VLT® AQUA Drive FC 202

Type designation	P11K		P15K		P18K		P22K		P30K	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW]	5.9	7.5	7.5	11	11	15	15	18.5	18.5	22
Typical shaft output at 550 V [hp]	7.5	10	10	15	15	20	20	25	25	30
Typical shaft output at 690 V [kW]	7.5	11	11	15	15	18.5	18.5	22	22	30
Typical shaft output at 690 V [hp]	10	15	15	20	20	25	25	30	30	40
IP20/Chassis	B4		B4		B4		B4		B4	
IP21/Type 1	B2		B2		B2		B2		B2	
IP55/Type 12										
Output current										
Continuous (3x525–550 V) [A]	11	14	14.0	19.0	19.0	23.0	23.0	28.0	28.0	36.0
Intermittent (60 s overload) (3x525–550 V) [A]	17.6	15.4	22.4	20.9	30.4	25.3	36.8	30.8	44.8	39.6
Continuous (3x551–690 V) [A]	10	13	13.0	18.0	18.0	22.0	22.0	27.0	27.0	34.0
Intermittent (60 s overload) (3x551–690 V) [A]	16	14.3	20.8	19.8	28.8	24.2	35.2	29.7	43.2	37.4
Continuous kVA at 550 V [kVA]	10	13.3	13.3	18.1	18.1	21.9	21.9	26.7	26.7	34.3
Continuous kVA at 690 V [kVA]	12	15.5	15.5	21.5	21.5	26.3	26.3	32.3	32.3	40.6
Maximum input current										
Continuous at 550 V [A]	9.9	15	15.0	19.5	19.5	24.0	24.0	29.0	29.0	36.0
Intermittent (60 s overload) at 550 V [A]	15.8	16.5	23.2	21.5	31.2	26.4	38.4	31.9	46.4	39.6
Continuous (at 690 V) [A]	9	14.5	14.5	19.5	19.5	24.0	24.0	29.0	29.0	36.0
Intermittent (60 s overload) at 690 V [A]	14.4	16	23.2	21.5	31.2	26.4	38.4	31.9	46.4	39.6
Additional specifications										
Maximum cable cross-section ² for mains, motor, brake, and load sharing [mm ² (AWG)]	35, 25, 25 (2, 4, 4)									
Maximum cable cross-section ²⁾ for mains disconnect [mm ² (AWG)]	16,10,10 (6, 8, 8)									
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	150 (0.2)	220 (0.3)	150 (0.2)	220 (0.3)	220 (0.3)	300 (0.41)	300 (0.41)	370 (0.5)	370 (0.5)	440 (0.6)
Efficiency ⁵⁾	0.98		0.98		0.98		0.98		0.98	

Table 8.16 B2/B4 Enclosure, Mains Supply 3x525–690 V AC IP20/IP21/IP55 – Chassis/NEMA 1/NEMA 12, P11K–P22K

Type designation	P37K		P45K		P55K		P75K/N75K ⁸⁾		P90K/N90K ⁸⁾	
High/normal overload ¹⁾	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW]	22	30	30	37	37	45	45	55	55	75
Typical shaft output at 550 V [hp]	30	40	40	50	50	60	60	75	75	100
Typical shaft output at 690 V [kW]	30	37	37	45	45	55	55	75	75	90
Typical shaft output at 690 V [hp]	40	50	50	60	60	75	75	100	199	125
IP20/Chassis	B4		C3		C3		D3h		D3h	
IP21/Type 1	C2		C2		C2		C2		C2	
IP55/Type 12										
Output current										
Continuous (3x525–550 V) [A]	36.0	43.0	43.0	54.0	54.0	65.0	65.0	87.0	87.0	105
Intermittent (60 s overload) (3x525–550 V) [A]	54.0	47.3	64.5	59.4	81.0	71.5	97.5	95.7	130.5	115.5
Continuous (3x551–690 V) [A]	34.0	41.0	41.0	52.0	52.0	62.0	62.0	83.0	83.0	100
Intermittent (60 s overload) (3x551–690 V) [A]	51.0	45.1	61.5	57.2	78.0	68.2	93.0	91.3	124.5	110
Continuous kVA at 550 V [kVA]	34.3	41.0	41.0	51.4	51.4	61.9	61.9	82.9	82.9	100
Continuous kVA at 690 V [kVA]	40.6	49.0	49.0	62.1	62.1	74.1	74.1	99.2	99.2	119.5
Maximum input current										
Continuous at 550 V [A]	36.0	49.0	49.0	59.0	59.0	71.0	71.0	87.0	87.0	99.0
Intermittent (60 s overload) at 550 V [A]	54.0	53.9	72.0	64.9	87.0	78.1	105.0	95.7	129	108.9
Continuous at 690 V [A]	36.0	48.0	48.0	58.0	58.0	70.0	70.0	86.0	–	–
Intermittent (60 s overload) at 690 V [A]	54.0	52.8	72.0	63.8	87.0	77.0	105	94.6	–	–
Additional specifications										
Maximum cable cross-section for mains and motor [mm² (AWG)]	150 (300 MCM)									
Maximum cable cross-section for brake and load sharing [mm² (AWG)]	95 (3/0)									
Maximum cable cross-section ²⁾ for mains disconnect [mm² (AWG)]	95 (3/0)						185, 150, 120 (350 MCM, 300 MCM, 4/0)		–	
Estimated power loss ³⁾ at rated maximum load [W (hp)] ⁴⁾	600 (0.82)	740 (1)	740 (1)	900 (1.2)	900 (1.2)	1100 (1.5)	1100 (1.5)	1500 (2)	1500 (2)	1800 (2.5)
Efficiency ⁵⁾	0.98		0.98		0.98		0.98		0.98	

Table 8.17 B4, C2, C3 Enclosure, Mains Supply 3x525–690 V AC IP20/IP21/IP55 – Chassis/NEMA1/NEMA 12, P30K–P75K

For fuse ratings see chapter 8.8 Fuses and Circuit Breakers.

1) High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

2) The 3 values for the maximum cable cross-section are for single core, flexible wire, and flexible wire with sleeve, respectively.

3) Applies for dimensioning of frequency converter cooling. If the switching frequency is higher than the default setting, the power losses may increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598–2, refer to www.danfoss.com/vltenergyefficiency.

4) Efficiency measured at nominal current. For energy efficiency class see chapter 8.4.1 Ambient Conditions. For part load losses see www.danfoss.com/vltenergyefficiency.

5) Measured using 5 m (16 ft) shielded motor cables at rated load and rated frequency.

6) Enclosure sizes A2+A3 can be converted to IP21 using a conversion kit. See also chapters Mechanical mounting and IP21/Type 1 Enclosure kit in the design guide.

7) Enclosure sizes B3+B4 and C3+C4 can be converted to IP21 using a conversion kit. See also chapters Mechanical mounting and IP21/Type 1 Enclosure kit in the design guide.

8) Enclosure sizes for N75K, N90K are D3h for IP20/Chassis, and D5h for IP54/Type 12.

9) Two wires are required.

10) Variant not available in IP21.

8.2 Mains Supply

Mains supply (L1, L2, L3)

Supply voltage	200–240 V $\pm 10\%$
Supply voltage	380–480 V $\pm 10\%$
Supply voltage	525–600 V $\pm 10\%$
Supply voltage	525–690 V $\pm 10\%$

Mains voltage low/mains drop-out:

During low mains voltage or a mains drop-out, the frequency converter continues until the DC-link voltage drops below the minimum stop level. Typically, this corresponds to 15% below the lowest rated supply voltage of the frequency converter. Power-up and full torque cannot be expected at mains voltage <10% below the lowest rated supply voltage of the frequency converter.

Supply frequency	50/60 Hz $\pm 4/-6\%$
------------------	-----------------------

The frequency converter power supply is tested in accordance with IEC61000-4-28, 50 Hz $\pm 4/-6\%$.

Maximum imbalance temporary between mains phases	3.0% of rated supply voltage
True power factor (λ)	≥ 0.9 nominal at rated load
Displacement power factor ($\cos\phi$) near unity	(>0.98)
Switching on input supply L1, L2, L3 (power-ups) ≤ 7.5 kW (10 hp)	Maximum 2 times/minute
Switching on input supply L1, L2, L3 (power-ups) 11–90 kW (15–125 hp)	Maximum 1 time/minute
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

The unit is suitable for use on a circuit capable of delivering not more than 100000 RMS symmetrical Amperes, 240/480/600/690 V maximum.

8

8.3 Motor Output and Motor Data

Motor output (U, V, W)

Output voltage	0–100% of supply voltage
Output frequency	0–590 Hz ¹⁾
Switching on output	Unlimited
Ramp times	1–3600 s

1) Dependent on power size.

Torque characteristics, normal overload

Starting torque (constant torque)	Maximum 110% for 1 minute, once in 10 minutes ²⁾
Overload torque (constant torque)	Maximum 110% for 1 minute, once in 10 minutes ²⁾

Torque characteristics, high overload

Starting torque (constant torque)	Maximum 150/160% for 1 minute, once in 10 minutes ²⁾
Overload torque (constant torque)	Maximum 150/160% for 1 minute, once in 10 minutes ²⁾

2) Percentage relates to the nominal torque of the frequency converter, dependent on power size.

8.4 Ambient Conditions

Environment

Enclosure size A	IP20/Chassis, IP21/Type 1, IP55/Type 12, IP66/Type 4X
Enclosure size B1/B2	IP21/Type 1, IP55/Type 12, IP66/Type 4X
Enclosure size B3/B4	IP20/Chassis
Enclosure size C1/C2	IP21/Type 1, IP55/Type 12, IP66/Type 4X
Enclosure size C3/C4	IP20/Chassis
Enclosure kit available ≤ enclosure size A	IP21/TYPE 1/IP4X top
Vibration test enclosure A/B/C	1.0 g
Maximum relative humidity	5–95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 721-3-3), uncoated	Class 3C2
Aggressive environment (IEC 721-3-3), coated	Class 3C3
Test method according to IEC 60068-2-43 H2S (10 days)	
Ambient temperature	Maximum 50 °C (122 °F)

Derating for high ambient temperature, see chapter Special Conditions in the design guide.

Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance	-10 °C (14 °F)
Temperature during storage/transport	-25 to +65/70 °C (-13 to 149/158 °F)
Maximum altitude above sea level without derating	1000 m (3281 ft)
Maximum altitude above sea level with derating	3000 m (9843 ft)

Derating for high altitude, see chapter Special Conditions in the design guide.

EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3
Energy efficiency class ¹⁾	IE2

1) Determined according to EN50598-2 at:

- Rated load.
- 90% rated frequency.
- Switching frequency factory setting.
- Switching pattern factory setting.

8.5 Cable Specifications

Maximum motor cable length, shielded/armored	150 m (492 ft)
Maximum motor cable length, unshielded/unarmored	300 m (984 ft)
Maximum cross-section to motor, mains, load sharing, and brake ¹⁾	
Maximum cross-section to control terminals, rigid wire	1.5 mm ² or 2 x 0.75 mm ² (16 AWG)
Maximum cross-section to control terminals, flexible cable	1 mm ² (18 AWG)
Maximum cross-section to control terminals, cable with enclosed core	0.5 mm ² (20 AWG)
Minimum cross-section to control terminals	0.25 mm ² (24 AWG)

1) See electrical data tables in chapter 8.1 Electrical Data for more information.

It is mandatory to ground the mains connection properly using T95 (PE) of the frequency converter. The ground connection cable cross-section must be at least 10 mm² (8 AWG) or 2 rated mains wires terminated separately according to EN 50178. See also chapter 4.3.1 Grounding . Use unshielded cable.

8.6 Control Input/Output and Control Data

Control card, RS485 serial communication

Terminal number	68 (PTX+, RX+), 69 (N,TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS485 serial communication circuit is functionally separated from other central circuits and galvanically isolated from the supply voltage (PELV).

Specifications

VLT® AQUA Drive FC 202

Analog inputs

Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switches S201 and S202
Voltage mode	Switch S201/S202 = OFF (U)
Voltage level	0–10 V (scaleable)
Input resistance, R_i	Approximately 10 k Ω
Maximum voltage	± 20 V
Current mode	Switch S201/S202=On (I)
Current level	0/4–20 mA (scaleable)
Input resistance, R_i	Approximately 200 Ω
Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Maximum error 0.5% of full scale
Bandwidth	200 Hz

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

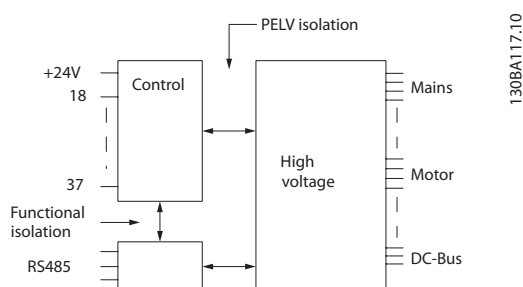


Illustration 8.1 PELV Isolation of Analog Inputs

Analog output

Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4–20 mA
Maximum resistor load to common at analog output	500 Ω
Accuracy on analog output	Maximum error 0.8% of full scale
Resolution on analog output	8 bit

The analog output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Digital inputs

Programmable digital inputs	4 (6)
Terminal number	18, 19, 27 ¹⁾ , 29 ¹⁾ , 32, 33,
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic 0 PNP	<5 V DC
Voltage level, logic 1 PNP	>10 V DC
Voltage level, logic 0 NPN	>19 V DC
Voltage level, logic 1 NPN	<14 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 k Ω

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

1) Terminals 27 and 29 can also be programmed as output.

Digital output

Programmable digital/pulse outputs	2
Terminal number	27, 29 ¹⁾
Voltage level at digital/frequency output	0–24 V
Maximum output current (sink or source)	40 mA
Maximum load at frequency output	1 k Ω
Maximum capacitive load at frequency output	10 nF
Minimum output frequency at frequency output	0 Hz
Maximum output frequency at frequency output	32 kHz
Accuracy of frequency output	Maximum error 0.1% of full scale
Resolution of frequency outputs	12 bit

1) Terminal 27 and 29 can also be programmed as input.

The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Pulse inputs

Programmable pulse inputs	2
Terminal number pulse	29, 33
Maximum frequency at terminal 29, 33	110 kHz (push-pull driven)
Maximum frequency at terminal 29, 33	5 kHz (open collector)
Minimum frequency at terminal 29, 33	4 Hz
Voltage level	See Digital inputs
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 k Ω
Pulse input accuracy (0.1–1 kHz)	Maximum error 0.1% of full scale

Control card, 24 V DC output

Terminal number	12, 13
Maximum load	200 mA

The 24 V DC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analog and digital inputs and outputs.

Relay outputs

Programmable relay outputs	2
Relay 01 terminal number	1-3 (break), 1-2 (make)
Maximum terminal load (AC-1) ¹⁾ on 1-3 (NC), 1-2 (NO) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15) ¹⁾ (inductive load @ $\cos\phi$ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) ¹⁾ on 1-2 (NO), 1-3 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13) ¹⁾ (inductive load)	24 V DC, 0.1 A
Relay 02 terminal number	4-6 (break), 4-5 (make)
Maximum terminal load (AC-1) ¹⁾ on 4-5 (NO) (resistive load) ^{2) 3)}	400 V AC, 2 A
Maximum terminal load (AC-15) ¹⁾ on 4-5 (NO) (inductive load @ $\cos\phi$ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) ¹⁾ on 4-5 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13) ¹⁾ on 4-5 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1) ¹⁾ on 4-6 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15) ¹⁾ on 4-6 (NC) (inductive load @ $\cos\phi$ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) ¹⁾ on 4-6 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13) ¹⁾ on 4-6 (NC) (inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO)	24 V DC, 10 mA, 24 V AC, 20 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

1) IEC 60947 parts 4 and 5.

The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).

2) Overvoltage category II.

3) UL applications 300 V AC 2 A.

Specifications

VLT® AQUA Drive FC 202

Control card, 10 V DC output

Terminal number	50
Output voltage	10.5 V $\pm$ 0.5 V
Maximum load	25 mA

The 10 V DC supply is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control characteristics

Resolution of output frequency at 0–590 Hz	$\pm$ 0.003 Hz
System response time (terminals 18, 19, 27, 29, 32, 33)	$\leq$ 2 ms
Speed control range (open loop)	1:100 of synchronous speed
Speed accuracy (open loop)	30–4000 RPM: Maximum error of $\pm$ 8 RPM

All control characteristics are based on a 4-pole asynchronous motor.

Control card performance

Scan interval	5 ms
---------------	------

Control card, USB serial communication

USB standard	1.1 (full speed)
USB plug	USB type B "device" plug

NOTICE

8

Connection to a PC is carried out via a standard host/device USB cable.

The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

The USB connection is not galvanically isolated from protective earth. Use only an isolated laptop/PC as a connection to the USB connector on the frequency converter, or an isolated USB cable/converter.

8.7 Connection Tightening Torques

Enclosure	Torque [N•m (in-lb)]					
	Mains	Motor	DC connection	Brake	Ground	Ground
A2	1.8 (16)	1.8 (16)	1.8 (16)	1.8 (16)	3 (27)	0.6 (5)
A3	1.8 (16)	1.8 (16)	1.8 (16)	1.8 (16)	3 (27)	0.6 (5)
A4	1.8 (16)	1.8 (16)	1.8 (16)	1.8 (16)	3 (27)	0.6 (5)
A5	1.8 (16)	1.8 (16)	1.8 (16)	1.8 (16)	3 (27)	0.6 (5)
B1	1.8 (16)	1.8 (16)	1.5 (13)	1.5 (13.3)	3 (27)	0.6 (5)
B2	4.5 (40)	4.5 (40)	3.7 (33)	3.7 (33)	3 (27)	0.6 (5)
B3	1.8 (16)	1.8 (16)	1.8 (16)	1.8 (16)	3 (27)	0.6 (5)
B4	4.5 (40)	4.5 (40)	4.5 (40)	4.5 (40)	3 (27)	0.6 (5)
C1	10 (89)	10 (89)	10 (89)	10 (89)	3 (27)	0.6 (5)
C2	14/24 (124/221) ¹⁾	14/24 (124/221) ¹⁾	14 (124)	14 (124)	3 (27)	0.6 (5)
C3	10 (89)	10 (89)	10 (89)	10 (89)	3 (27)	0.6 (5)
C4	14/24 (124/221) ¹⁾	14/24 (124/221) ¹⁾	14 (124)	14 (124)	3 (27)	0.6 (5)

Table 8.18 Terminal Tightening Torques

1) For different cable dimensions x/y, where $x \leq 95 \text{ mm}^2$ (3 AWG) and $y \geq 95 \text{ mm}^2$ (3 AWG).

8.8 Fuses and Circuit Breakers

Use recommended fuses and/or circuit breakers on the supply side as protection if there is component break-down inside the frequency converter (first fault).

NOTICE

Use of fuses on the supply side is mandatory for IEC 60364 (CE) and NEC 2009 (UL) compliant installations.

Recommendations

- gG type fuses.
- Moeller type circuit breakers. For other circuit breaker types, ensure that the energy into the frequency converter is equal to or lower than the energy provided by Moeller types.

Use of recommended fuses and circuit breakers ensures that possible damage to the frequency converter is limited to damage inside the unit. For further information, see *Application Note Fuses and Circuit Breakers*.

The fuses in *chapter 8.8.1 CE Compliance* to *chapter 8.8.2 UL Compliance* are suitable for use on a circuit capable of delivering 100000 A_{rms} (symmetrical), depending on the frequency converter voltage rating. With the proper fusing, the frequency converter short circuit current rating (SCCR) is 100000 A_{rms} .

8.8.1 CE Compliance

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A2	0.25–2.2 (0.34–3)	gG-10 (0.25–1.5) gG-16 (2.2)	gG-25	PKZM0-25	25
A3	3.0–3.7 (4–5)	gG-16 (3) gG-20 (3.7)	gG-32	PKZM0-25	25
A4	0.25–2.2 (0.34–3)	gG-10 (0.25–1.5) gG-16 (2.2)	gG-32	PKZM0-25	25
A5	0.25–3.7 (0.34–5)	gG-10 (0.25–1.5) gG-16 (2.2–3) gG-20 (3.7)	gG-32	PKZM0-25	25
B1	5.5–11 (7.5–15)	gG-25 (5.5) gG-32 (7.5)	gG-80	PKZM4-63	63
B2	15 (20)	gG-50	gG-100	NZMB1-A100	100
B3	5.5–11 (7.5–15)	gG-25	gG-63	PKZM4-50	50
B4	15–18 (20–24)	gG-32 (7.5) gG-50 (11) gG-63 (15)	gG-125	NZMB1-A100	100
C1	18.5–30 (25–40)	gG-63 (15) gG-80 (18.5) gG-100 (22)	gG-160 (15–18.5) aR-160 (22)	NZMB2-A200	160
C2	37–45 (50–60)	aR-160 (30) aR-200 (37)	aR-200 (30) aR-250 (37)	NZMB2-A250	250
C3	22–30 (30–40)	gG-80 (18.5) aR-125 (22)	gG-150 (18.5) aR-160 (22)	NZMB2-A200	150
C4	37–45 (50–60)	aR-160 (30) aR-200 (37)	aR-200 (30) aR-250 (37)	NZMB2-A250	250

Table 8.19 200–240 V, Enclosure Sizes A, B, and C

Specifications

VLT® AQUA Drive FC 202

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A2	1.1–4.0 (1.5–5)	gG-10 (0.37-3) gG-16 (4)	gG-25	PKZM0-25	25
A3	5.5–7.5 (7.5–10)	gG-16	gG-32	PKZM0-25	25
A4	1.1–4.0 (1.5–5)	gG-10 (0.37-3) gG-16 (4)	gG-32	PKZM0-25	25
A5	1.1–7.5 (1.5–10)	gG-10 (0.37-3) gG-16 (4-7.5)	gG-32	PKZM0-25	25
B1	11–18.5 (15–25)	gG-40	gG-80	PKZM4-63	63
B2	22–30 (30–40)	gG-50 (18.5) gG-63 (22)	gG-100	NZMB1-A100	100
B3	11–18 (15–24)	gG-40	gG-63	PKZM4-50	50
B4	22–37 (30–50)	gG-50 (18.5) gG-63 (22) gG-80 (30)	gG-125	NZMB1-A100	100
C1	37–55 (50–75)	gG-80 (30) gG-100 (37) gG-160 (45)	gG-160	NZMB2-A200	160
C2	75–90 (100–125)	aR-200 (55) aR-250 (75)	aR-250	NZMB2-A250	250
C3	45–55 (60–75)	gG-100 (37) gG-160 (45)	gG-150 (37) gG-160 (45)	NZMB2-A200	150
C4	75–90 (100–125)	aR-200 (55) aR-250 (75)	aR-250	NZMB2-A250	250

Table 8.20 380–480 V, Enclosure Sizes A, B, and C

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A2	1.1–4.0 (1.5–5)	gG-10	gG-25	PKZM0-25	25
A3	5.5–7.5 (7.5–10)	gG-10 (5.5) gG-16 (7.5)	gG-32	PKZM0-25	25
A5	1.1–7.5 (1.5–10)	gG-10 (0.75–5.5) gG-16 (7.5)	gG-32	PKZM0-25	25
B1	11–18 (15–24)	gG-25 (11) gG-32 (15) gG-40 (18.5)	gG-80	PKZM4-63	63
B2	22–30 (30–40)	gG-50 (22) gG-63 (30)	gG-100	NZMB1-A100	100
B3	11–18.5 (15–25)	gG-25 (11) gG-32 (15)	gG-63	PKZM4-50	50
B4	22–37 (30–50)	gG-40 (18.5) gG-50 (22) gG-63 (30)	gG-125	NZMB1-A100	100
C1	37–55 (50–75)	gG-63 (37) gG-100 (45) aR-160 (55)	gG-160 (37–45) aR-250 (55)	NZMB2-A200	160
C2	75–90 (100–125)	aR-200 (75)	aR-250	NZMB2-A250	250
C3	45–55 (60–75)	gG-63 (37) gG-100 (45)	gG-150	NZMB2-A200	150
C4	75–90 (100–125)	aR-160 (55) aR-200 (75)	aR-250	NZMB2-A250	250

Table 8.21 525–600 V, Enclosure Sizes A, B, and C

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Danfoss	Maximum trip level [A]
A3	1.1 (1.5)	gG-6	gG-25	CTI25M 10-16	16
	1.5 (2)	gG-6	gG-25	CTI25M 10-16	16
	2.2 (3)	gG-6	gG-25	CTI25M 10-16	16
	3 (4)	gG-10	gG-25	CTI25M 10-16	16
	4 (5)	gG-10	gG-25	CTI25M 10-16	16
	5.5 (7.5)	gG-16	gG-25	CTI25M 10-16	16
	7.5 (10)	gG-16	gG-25	CTI25M 10-16	16
B2	11 (15)	gG-25	gG-63	–	–
	15 (20)	gG-25	gG-63	–	–
	18 (24)	gG-32	–	–	–
	22 (30)	gG-32	–	–	–
C2	30 (40)	gG-40	–	–	–
	37 (50)	gG-63	gG-80	–	–
	45 (60)	gG-63	gG-100	–	–
	55 (75)	gG-80	gG-125	–	–
	75 (100)	gG-100	gG-160	–	–
C3	37 (50)	gG-100	gG-125	–	–
	45 (60)	gG-125	gG-160	–	–

Table 8.22 525–690 V, Enclosure Sizes A, B, and C

8.8.2 UL Compliance

Recommended maximum fuse													
Power [kW (hp)]	Maxi- mum prefuse size [A]	Buss- mann JFHR2	Buss- mann RK1	Buss- mann J	Buss- mann T	Buss- mann CC	Buss- mann CC	Buss- mann CC	SIBA RK1	Littelfu se RK1	Ferraz- Shawmut CC	Ferraz- Shawmut RK1	Ferraz- Shawmut J
1.1 (1.5)	15	FWX-15	KTN-R15	JKS-15	JJN-15	FNQ- R-15	KTK- R-15	LP- CC-15	5017906- 016	KLN- R15	ATM-R15	A2K-15R	HSJ15
1.5 (2)	20	FWX-20	KTN-R20	JKS-20	JJN-20	FNQ- R-20	KTK- R-20	LP- CC-20	5017906- 020	KLN- R20	ATM-R20	A2K-20R	HSJ20
2.2 (3)	30 ¹⁾	FWX-30	KTN-R30	JKS-30	JJN-30	FNQ- R-30	KTK- R-30	LP- CC-30	5012406- 032	KLN- R30	ATM-R30	A2K-30R	HSJ30
3.0 (4)	35	FWX-35	KTN-R35	JKS-35	JJN-35	–	–	–	–	KLN- R35	–	A2K-35R	HSJ35
3.7 (5)	50	FWX-50	KTN-R50	JKS-50	JJN-50	–	–	–	5014006- 050	KLN- R50	–	A2K-50R	HSJ50
5.5 (7.5)	60 ²⁾	FWX-60	KTN-R60	JKS-60	JJN-60	–	–	–	5014006- 063	KLN- R60	–	A2K-60R	HSJ60
7.5 (10)	80	FWX-80	KTN-R80	JKS-80	JJN-80	–	–	–	5014006- 080	KLN- R80	–	A2K-80R	HSJ80
15 (20)	150	FWX- 150	KTN- R150	JKS-150	JJN-150	–	–	–	2028220- 150	KLN- R150	–	A2K-150R	HSJ150
22 (30)	200	FWX- 200	KTN- R200	JKS-200	JJN-200	–	–	–	2028220- 200	KLN- R200	–	A2K-200R	HSJ200

Table 8.23 1x200–240 V, Enclosure Sizes A, B, and C

1) Siba allowed up to 32 A.

2) Siba allowed up to 63 A.

Recommended maximum fuse													
Power [kW (hp)]	Maxi- mum pre- fuse size [A]	Buss- mann JFHR2	Buss- mann RK1	Buss- mann J	Buss- mann T	Buss- mann CC	Buss- mann CC	Buss- mann CC	SIBA RK1	Littelfu se RK1	Ferraz- Shawmut CC	Ferraz- Shawmut RK1	Ferraz- Shawmut J
7.5 (10)	60	FWH-60	KTS-R60	JKS-60	JJS-60	–	–	–	5014006- 063	KLS-R60	–	A6K-60R	HSJ60
11 (15)	80	FWH-80	KTS-R80	JKS-80	JJS-80	–	–	–	2028220- 100	KLS-R80	–	A6K-80R	HSJ80
22 (30)	150	FWH- 150	KTS- R150	JKS-150	JJS-150	–	–	–	2028220- 160	KLS-R150	–	A6K-150R	HSJ150
37 (50)	200	FWH- 200	KTS- R200	JKS-200	JJS-200	–	–	–	2028220- 200	KLS-200	–	A6K-200R	HSJ200

Table 8.24 1x380–500 V, Enclosure Sizes B and C

- KTS-fuses from Bussmann may substitute KTN for 240 V frequency converters.
- FWH-fuses from Bussmann may substitute FWX for 240 V frequency converters.
- JJS-fuses from Bussmann may substitute JJN for 240 V frequency converters.
- KLSR fuses from Littelfuse may substitute KLN R fuses for 240 V frequency converters.
- A6KR fuses from Ferraz-Shawmut may substitute A2KR for 240 V frequency converters.

Power [kW (hp)]	Recommended maximum fuse					
	Bussmann Type RK1 ¹⁾	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann	Bussmann Type CC
0.25–0.37 (0.34–0.5)	KTN-R-05	JKS-05	JJN-05	FNQ-R-5	KTK-R-5	LP-CC-5
0.55–1.1 (0.75–1.5)	KTN-R-10	JKS-10	JJN-10	FNQ-R-10	KTK-R-10	LP-CC-10
1.5 (2)	KTN-R-15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15
2.2 (3)	KTN-R-20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20
3.0 (4)	KTN-R-25	JKS-25	JJN-25	FNQ-R-25	KTK-R-25	LP-CC-25
3.7 (5)	KTN-R-30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30
5.5–7.5 (7.5–10)	KTN-R-50	JKS-50	JJN-50	–	–	–
11 (15)	KTN-R-60	JKS-60	JJN-60	–	–	–
15 (20)	KTN-R-80	JKS-80	JJN-80	–	–	–
18.5–22 (25–30)	KTN-R-125	JKS-125	JJN-125	–	–	–
30 (40)	KTN-R-150	JKS-150	JJN-150	–	–	–
37 (50)	KTN-R-200	JKS-200	JJN-200	–	–	–
45 (60)	KTN-R-250	JKS-250	JJN-250	–	–	–

Table 8.25 3x200–240 V, Enclosure Sizes A, B, and C

Power [kW (hp)]	Recommended maximum fuse							
	SIBA Type RK1	Littelfuse Type RK1	Ferraz- Shawmut Type CC	Ferraz- Shawmut Type RK1 ²⁾	Bussmann Type JFHR2 ³⁾	Littelfuse JFHR2	Ferraz- Shawmut JFHR2 ⁴⁾	Ferraz- Shawmut J
0.25–0.37 (0.34–0.5)	5017906-005	KLN-R-05	ATM-R-05	A2K-05-R	FWX-5	–	–	HSJ-6
0.55–1.1 (0.75–1.5)	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R	FWX-10	–	–	HSJ-10
1.5 (2)	5017906-016	KLN-R-15	ATM-R-15	A2K-15-R	FWX-15	–	–	HSJ-15
2.2 (3)	5017906-020	KLN-R-20	ATM-R-20	A2K-20-R	FWX-20	–	–	HSJ-20
3.0 (4)	5017906-025	KLN-R-25	ATM-R-25	A2K-25-R	FWX-25	–	–	HSJ-25
3.7 (5)	5012406-032	KLN-R-30	ATM-R-30	A2K-30-R	FWX-30	–	–	HSJ-30
5.5–7.5 (7.5–10)	5014006-050	KLN-R-50	–	A2K-50-R	FWX-50	–	–	HSJ-50
11 (15)	5014006-063	KLN-R-60	–	A2K-60-R	FWX-60	–	–	HSJ-60
15 (20)	5014006-080	KLN-R-80	–	A2K-80-R	FWX-80	–	–	HSJ-80
18.5–22 (25–30)	2028220-125	KLN-R-125	–	A2K-125-R	FWX-125	–	–	HSJ-125
30 (40)	2028220-150	KLN-R-150	–	A2K-150-R	FWX-150	L25S-150	A25X-150	HSJ-150
37 (50)	2028220-200	KLN-R-200	–	A2K-200-R	FWX-200	L25S-200	A25X-200	HSJ-200
45 (60)	2028220-250	KLN-R-250	–	A2K-250-R	FWX-250	L25S-250	A25X-250	HSJ-250

Table 8.26 3x200–240 V, Enclosure Sizes A, B, and C

- 1) KTS-fuses from Bussmann may substitute KTN for 240 V frequency converters.
- 2) A6KR fuses from Ferraz-Shawmut may substitute A2KR for 240 V frequency converters.
- 3) FWH-fuses from Bussmann may substitute FWX for 240 V frequency converters.
- 4) A50X fuses from Ferraz-Shawmut may substitute A25X for 240 V frequency converters.

Power [kW (hp)]	Recommended maximum fuse					
	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
–	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
1.1–2.2 (1.5–3)	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3 (4)	KTS-R-15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4 (5)	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5 (7.5)	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5 (10)	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11 (15)	KTS-R-40	JKS-40	JJS-40	–	–	–
15 (20)	KTS-R-50	JKS-50	JJS-50	–	–	–
22 (30)	KTS-R-60	JKS-60	JJS-60	–	–	–
30 (40)	KTS-R-80	JKS-80	JJS-80	–	–	–
37 (50)	KTS-R-100	JKS-100	JJS-100	–	–	–
45 (60)	KTS-R-125	JKS-125	JJS-125	–	–	–
55 (75)	KTS-R-150	JKS-150	JJS-150	–	–	–
75 (100)	KTS-R-200	JKS-200	JJS-200	–	–	–
90 (125)	KTS-R-250	JKS-250	JJS-250	–	–	–

Table 8.27 3x380–480 V, Enclosure Sizes A, B, and C

Power [kW (hp)]	Recommended maximum fuse							
	SIBA Type RK1	Littelfuse Type RK1	Ferraz- Shawmut Type CC	Ferraz- Shawmut Type RK1	Bussmann JFHR2	Ferraz- Shawmut J	Ferraz- Shawmut JFHR2 ¹⁾	Littelfuse JFHR2
–	5017906-006	KLS-R-6	ATM-R-6	A6K-6-R	FWH-6	HSJ-6	–	–
1.1–2.2 (1.5–3)	5017906-010	KLS-R-10	ATM-R-10	A6K-10-R	FWH-10	HSJ-10	–	–
3 (4)	5017906-016	KLS-R-15	ATM-R-15	A6K-15-R	FWH-15	HSJ-15	–	–
4 (5)	5017906-020	KLS-R-20	ATM-R-20	A6K-20-R	FWH-20	HSJ-20	–	–
5.5 (7.5)	5017906-025	KLS-R-25	ATM-R-25	A6K-25-R	FWH-25	HSJ-25	–	–
7.5 (10)	5012406-032	KLS-R-30	ATM-R-30	A6K-30-R	FWH-30	HSJ-30	–	–
11 (15)	5014006-040	KLS-R-40	–	A6K-40-R	FWH-40	HSJ-40	–	–
15 (20)	5014006-050	KLS-R-50	–	A6K-50-R	FWH-50	HSJ-50	–	–
22 (30)	5014006-063	KLS-R-60	–	A6K-60-R	FWH-60	HSJ-60	–	–
30 (40)	2028220-100	KLS-R-80	–	A6K-80-R	FWH-80	HSJ-80	–	–
37 (50)	2028220-125	KLS-R-100	–	A6K-100-R	FWH-100	HSJ-100	–	–
45 (60)	2028220-125	KLS-R-125	–	A6K-125-R	FWH-125	HSJ-125	–	–
55 (75)	2028220-160	KLS-R-150	–	A6K-150-R	FWH-150	HSJ-150	–	–
75 (100)	2028220-200	KLS-R-200	–	A6K-200-R	FWH-200	HSJ-200	A50-P-225	L50-S-225
90 (125)	2028220-250	KLS-R-250	–	A6K-250-R	FWH-250	HSJ-250	A50-P-250	L50-S-250

Table 8.28 3x380–480 V, Enclosure Sizes A, B, and C

1) Ferraz-Shawmut A50QS fuses may substitute A50P fuses.

	Recommended maximum fuse									
Power [kW (hp)]	Bussmann Type RK1	Bussman n Type J	Bussmann Type T	Bussmann Type CC	Bussman n Type CC	Bussman n Type CC	SIBA Type RK1	Littelfuse Type RK1	Ferraz- Shawmut Type RK1	Ferraz- Shawmut J
0.75– 1.1 (1–1.5)	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5	5017906-005	KLS-R-005	A6K-5-R	HSJ-6
1.5–2.2 (2–3)	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10	5017906-010	KLS-R-010	A6K-10-R	HSJ-10
3 (4)	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15	5017906-016	KLS-R-015	A6K-15-R	HSJ-15
4 (5)	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20	5017906-020	KLS-R-020	A6K-20-R	HSJ-20
5.5 (7.5)	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25	5017906-025	KLS-R-025	A6K-25-R	HSJ-25
7.5 (10)	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30	5017906-030	KLS-R-030	A6K-30-R	HSJ-30
11–15 (15–20)	KTS-R-35	JKS-35	JJS-35	–	–	–	5014006-040	KLS-R-035	A6K-35-R	HSJ-35
18 (24)	KTS-R-45	JKS-45	JJS-45	–	–	–	5014006-050	KLS-R-045	A6K-45-R	HSJ-45
22 (30)	KTS-R-50	JKS-50	JJS-50	–	–	–	5014006-050	KLS-R-050	A6K-50-R	HSJ-50
30 (40)	KTS-R-60	JKS-60	JJS-60	–	–	–	5014006-063	KLS-R-060	A6K-60-R	HSJ-60
37 (50)	KTS-R-80	JKS-80	JJS-80	–	–	–	5014006-080	KLS-R-075	A6K-80-R	HSJ-80
45 (60)	KTS-R-100	JKS-100	JJS-100	–	–	–	5014006-100	KLS-R-100	A6K-100-R	HSJ-100
55 (75)	KTS-R-125	JKS-125	JJS-125	–	–	–	2028220-125	KLS-R-125	A6K-125-R	HSJ-125
75 (100)	KTS-R-150	JKS-150	JJS-150	–	–	–	2028220-150	KLS-R-150	A6K-150-R	HSJ-150
90 (125)	KTS-R-175	JKS-175	JJS-175	–	–	–	2028220-200	KLS-R-175	A6K-175-R	HSJ-175

Table 8.29 3x525–600 V, Enclosure Sizes A, B, and C

	Recommended maximum fuse							
Power [kW (hp)]	Maximum pre-fuse [A]	Bussmann E52273 RK1/JDDZ	Bussmann E4273 J/JDDZ	Bussmann E4273 T/JDDZ	SIBA E180276 RK1/JDDZ	Littelfuse E81895 RK1/JDDZ	Ferraz- Shawmut E163267/E2137 RK1/JDDZ	Ferraz- Shawmut E2137 J/HSJ
11–15 (15–20)	30	KTS-R-30	JKS-30	JJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
22 (30)	45	KTS-R-45	JKS-45	JJS-45	5014006-050	KLS-R-045	A6K-45-R	HST-45
30 (40)	60	KTS-R-60	JKS-60	JJS-60	5014006-063	KLS-R-060	A6K-60-R	HST-60
37 (50)	80	KTS-R-80	JKS-80	JJS-80	5014006-080	KLS-R-075	A6K-80-R	HST-80
45 (60)	90	KTS-R-90	JKS-90	JJS-90	5014006-100	KLS-R-090	A6K-90-R	HST-90
55 (75)	100	KTS-R-100	JKS-100	JJS-100	5014006-100	KLS-R-100	A6K-100-R	HST-100
75 (100)	125	KTS-R-125	JKS-125	JJS-125	2028220-125	KLS-150	A6K-125-R	HST-125
90 (125)	150	KTS-R-150	JKS-150	JJS-150	2028220-150	KLS-175	A6K-150-R	HST-150

Table 8.30 3x525–690 V, Enclosure Sizes B and C

8.9 Power Ratings, Weight, and Dimensions

Enclosure size [kW (hp)]		A2		A3		A4	A5
3x525–690 V	T7	–		–		–	–
3x525–600 V	T6	–		0.75–7.5 (1–10)		–	0.75–7.5 (1–10)
3x380–480 V	T4	0.37–4.0 (0.5–5)		5.5–7.5 (7.5–10)		0.37–4.0 (0.5–5)	0.37–7.5 (0.5–10)
1x380–480 V	S4	–		–		1.1–4.0 (1.5–5)	–
3x200–240 V	T2	0.25–3.0 (0.34–4)		3.7 (0.5)		0.25–2.2 (0.34–3)	0.25–3.7 (0.34–5)
1x200–240 V	S2	–		1.1 (1.5)		1.1–2.2 (1.5–3)	1.1 (1.5)
IP		20	21	20	21	55/66	55/66
NEMA		Chassis	Type 1	Chassis	Type 1	Type 12/4X	Type 12/4X
Height [mm (in)]							
Height of backplate	A ¹⁾	268 (10.6)	375 (14.8)	268 (10.6)	375 (14.8)	390 (15.4)	420 (16.5)
Height with de-coupling plate for fieldbus cables	A	374 (14.7)	–	374 (14.7)	–	–	–
Distance between mounting holes	a	257 (10.1)	350 (13.8)	257 (10.1)	350 (13.8)	401 (15.8)	402 (15.8)
Width [mm (in)]							
Width of backplate	B	90 (3.5)	90 (3.5)	130 (5.1)	130 (5.1)	200 (7.9)	242 (9.5)
Width of backplate with 1 C option	B	130 (5.1)	130 (5.1)	170 (6.7)	170 (6.7)	–	242 (9.5)
Width of backplate with 2 C options	B	90 (3.5)	90 (3.5)	130 (5.1)	130 (5.1)	–	242 (9.5)
Distance between mounting holes	b	70 (2.8)	70 (2.8)	110 (4.3)	110 (4.3)	171 (6.7)	215 (8.5)
Depth²⁾ [mm (in)]							
Without option A/B	C	205 (8.1)	205 (8.1)	205 (8.1)	205 (8.1)	175 (6.9)	200 (7.9)
With option A/B	C	220 (8.7)	220 (8.7)	220 (8.7)	220 (8.7)	175 (6.9)	200 (7.9)
Screw holes [mm (in)]							
	c	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.25 (0.32)	8.2 (0.32)
	d	ø11 (0.43)	ø11 (0.43)	ø11 (0.43)	ø11 (0.43)	ø12 (0.47)	ø12 (0.47)
	e	ø5.5 (0.22)	ø5.5 (0.22)	ø5.5 (0.22)	ø5.5 (0.22)	ø6.5 (0.26)	ø6.5 (0.26)
	f	9 (0.35)	9 (0.35)	9 (0.35)	9 (0.35)	6 (0.24)	9 (0.35)
Maximum weight [kg (lb)]		4.9 (10.8)	5.3 (11.7)	6.6 (14.6)	7 (15.4)	9.7 (21.4)	14 (31)
1) See <i>Illustration 3.4</i> and <i>Illustration 3.5</i> for top and bottom mounting holes.							
2) Depth of enclosure varies with different options installed.							

Table 8.31 Power Ratings, Weight, and Dimensions, Enclosure Sizes A2-A5

Specifications
Operating Guide

Enclosure size [kW (hp)]		B1	B2	B3	B4	C1	C2	C3	C4
3x525–690 V	T7	–	11–30 (15–40)	–	–	–	37–90 (50–125)	–	–
3x525–600 V	T6	11–18.5 (15–25)	22–30 (30–40)	11–18.5 (15–25)	22–37 (30–50)	37–55 (50–75)	75–90 (100–125)	45–55 (60–75)	75–90 (100–125)
3x380–480 V	T4	11–18.5 (15–25)	22–30 (30–40)	11–18.5 (15–25)	22–37 (30–50)	37–55 (50–75)	75–90 (100–125)	45–55 (60–75)	75–90 (100–125)
1x380–480 V	S4	7.5 (10)	11 (15)	–	–	18 (24)	37 (50)	–	–
3x200–240 V	T2	5.5–11 (7.5–15)	15 (20)	5.5–11 (7.5–15)	15–18.5 (20–25)	18.5–30 (25–40)	37–45 (50–60)	22–30 (30–40)	37–45 (50–60)
1x200–240 V	S2	1.5–3.7 (2–5)	7.5 (10)	–	–	15 (20)	22 (30)	–	–
IP NEMA		21/55/66 Type 1/12/4X	21/55/66 Type 1/12/4X	20 Chassis	20 Chassis	21/55/66 Type 1/12/4X	21/55/66 Type 1/12/4X	20 Chassis	20 Chassis
Height [mm (in)]									
Height of backplate	A ¹⁾	480 (18.9)	650 (25.6)	399 (15.7)	520 (20.5)	680 (26.8)	770 (30.3)	550 (21.7)	660 (26)
Height with de-coupling plate for fieldbus cables	A	–	–	419 (16.5)	595 (23.4)	–	–	630 (24.8)	800 (31.5)
Distance between mounting holes	a	454 (17.9)	624 (24.6)	380 (15)	495 (19.5)	648 (25.5)	739 (29.1)	521 (20.5)	631 (24.8)
Width [mm (in)]									
Width of backplate	B	242 (9.5)	242 (9.5)	165 (6.5)	231 (9.1)	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)
Width of backplate with 1 C option	B	242 (9.5)	242 (9.5)	205 (8.1)	231 (9.1)	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)
Width of backplate with 2 C options	B	242 (9.5)	242 (9.5)	165 (6.5)	231 (9.1)	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)
Distance between mounting holes	b	210 (8.3)	210 (8.3)	140 (5.5)	200 (7.9)	272 (10.7)	334 (13.1)	270 (10.6)	330 (13)
Depth²⁾[mm (in)]									
Without option A/B	C	260 (10.2)	260 (10.2)	248 (9.8)	242 (9.5)	310 (12.2)	335 (13.2)	333 (13.1)	333 (13.1)
With option A/B	C	260 (10.2)	260 (10.2)	262 (10.3)	242 (9.5)	310 (12.2)	335 (13.2)	333 (13.1)	333 (13.1)
Screw holes [mm (in)]									
	c	12 (0.47)	12 (0.47)	8 (0.32)	–	12 (0.47)	12 (0.47)	–	–
	d	ø19 (0.75)	ø19 (0.75)	12 (0.47)	–	ø19 (0.75)	ø19 (0.75)	–	–
	e	ø9 (0.35)	ø9 (0.35)	6.8 (0.27)	8.5 (0.33)	ø9 (0.35)	ø9 (0.35)	8.5 (0.33)	8.5 (0.33)
	f	9 (0.35)	9 (0.35)	7.9 (0.31)	15 (0.59)	9.8 (0.39)	9.8 (0.39)	17 (0.67)	17 (0.67)
Maximum weight [kg (lb)]		23 (51)	27 (60)	12 (26.5)	23.5 (52)	45 (99)	65 (143)	35 (77)	50 (110)
1) See <i>Illustration 3.4</i> and <i>Illustration 3.5</i> for top and bottom mounting holes.									
2) Depth of enclosure varies with different options installed.									

Table 8.32 Power Ratings, Weight, and Dimensions, Enclosure Sizes B1–B4, C1–C4

9 Appendix

9.1 Symbols, Abbreviations, and Conventions

°C	Degrees Celsius
°F	Degrees Fahrenheit
AC	Alternating current
AEO	Automatic energy optimization
AWG	American wire gauge
AMA	Automatic motor adaptation
DC	Direct current
EMC	Electro-magnetic compatibility
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
FC	Frequency converter
I_{INV}	Rated inverter output current
I_{LIM}	Current limit
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the frequency converter
IP	Ingress protection
LCP	Local control panel
MCT	Motion control tool
n_s	Synchronous motor speed
$P_{M,N}$	Nominal motor power
PELV	Protective extra low voltage
PCB	Printed circuit board
PM Motor	Permanent magnet motor
PWM	Pulse width modulation
RPM	Revolutions per minute
Regen	Regenerative terminals
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage

Table 9.1 Symbols and Abbreviations

Conventions

Numbered lists indicate procedures. Bullet lists indicate other information.

Italicized text indicates:

- Cross-reference.
- Link.
- Parameter name.
- Parameter group name.
- Parameter option.
- Footnote.

All dimensions in drawings are in [mm] (in).

9.2 Parameter Menu Structure

NOTICE

The availability of some parameters depends on the hardware configuration (installed options and power rating).

0-00	Operation / Display	1-03	Torque Characteristics	1-79	Pump Start Max Time to Trip	3-90	Digital Pot/Meter	5-31	Terminal 29 Digital Output
0-01	Basic Settings	1-04	Overload Mode	1-80	Stop Adjustments	3-90	Step Size	5-32	Term X30/6 Digi Out (MCB 101)
0-02	Language	1-06	Clockwise Direction	1-81	Function at Stop	3-91	Ramp Time	5-33	Term X30/7 Digi Out (MCB 101)
0-03	Motor Speed Unit	1-07	Motor Selection	1-82	Min Speed for Function at Stop [RPM]	3-92	Power Restore	5-34	Relays
0-04	Regional Settings	1-10	Motor Construction	1-83	Min Speed for Function at Stop [Hz]	3-93	Maximum Limit	5-40	Function Relay
0-05	Operating State at Power-up	1-11	WVC+ PM/SYN RM	1-86	Trip Speed Low [RPM]	3-94	Minimum Limit	5-41	On Delay, Relay
0-06	Local Mode Unit	1-14	Damping Gain	1-87	Trip Speed Low [Hz]	3-95	Ramp Delay	5-42	Off Delay, Relay
0-07	Set-up Operations	1-15	Low Speed Filter Time Const.	1-90	Motor Temperature	4-00	Limits / Warnings	5-50	Pulse Input
0-08	Active Set-up	1-16	High Speed Filter Time Const.	1-91	Motor Thermal Protection	4-01	Motor Limits	5-51	Term. 29 Low Frequency
0-09	Programming Set-up	1-17	Voltage filter time const.	1-92	Motor External Fan	4-10	Motor Speed Direction	5-52	Term. 29 High Frequency
0-10	This Set-up Linked to	1-20	Motor Data	1-93	Thermistor Source	4-11	Motor Speed Low Limit [RPM]	5-53	Term. 29 Low Ref./Feedb. Value
0-11	Readout: Linked Set-ups	1-21	Motor Power [kW]	1-94	ATEX ETR curlim. speed reduction	4-12	Motor Speed Low Limit [Hz]	5-54	Term. 29 High Ref./Feedb. Value
0-12	Readout: Prog. Set-ups / Channel	1-22	Motor Power [HP]	1-98	ATEX ETR interpul. points freq.	4-13	Motor Speed High Limit [RPM]	5-55	Pulse Filter Time Constant #29
0-13	LCP Display	1-23	Motor Voltage	1-99	ATEX ETR interpul. points current	4-14	Motor Speed High Limit [Hz]	5-56	Term. 33 Low Frequency
0-14	Display Line 1.1 Small	1-24	Motor Frequency	2-00	Brakes	4-16	Torque Limit Motor Mode	5-57	Term. 33 High Frequency
0-15	Display Line 1.2 Small	1-25	Motor Current	2-01	DC-Brake	4-17	Torque Limit Generator Mode	5-58	Term. 33 Low Ref./Feedb. Value
0-16	Display Line 1.3 Small	1-26	Motor Nominal Speed	2-02	DC Hold/Preheat Current	4-18	Current Limit	5-59	Pulse Filter Time Constant #33
0-17	Display Line 2 Large	1-27	Motor Cont. Rated Torque	2-03	DC Brake Current	4-19	Max Output Frequency	5-60	Pulse Output
0-18	Display Line 3 Large	1-28	Motor Rotation Check	2-04	DC Braking Time	4-50	Warning Current Low	5-61	Terminal 27 Pulse Output Variable
0-19	My Personal Menu	1-29	Automatic Motor Adaptation (AMA)	2-07	DC Brake Cut In Speed [RPM]	4-51	Warning Current High	5-62	Pulse Output Max Freq #27
0-20	LCP Custom Readout	1-30	Adv. Motor Data	2-10	Parking Time	4-52	Warning Speed Low	5-63	Terminal 29 Pulse Output Variable
0-21	Custom Readout Unit	1-31	Stator Resistance (Rs)	2-11	Brake Energy Funct.	4-54	Warning Reference Low	5-65	Pulse Output Max Freq #29
0-22	Custom Readout Min Value	1-32	Rotor Resistance (Rr)	2-12	Brake Function	4-55	Warning Reference High	5-66	Terminal X30/6 Pulse Output Variable
0-23	Custom Readout Max Value	1-33	Stator Leakage Reactance (X1)	2-13	Brake Resistor (ohm)	4-56	Warning Feedback Low	5-80	I/O Options
0-24	Display Text 1	1-34	Rotor Leakage Reactance (X2)	2-15	Brake Power Limit (kW)	4-57	Warning Feedback High	5-81	Bus Controlled
0-25	Display Text 2	1-35	Main Reactance (Xh)	2-16	Brake Check	4-60	Bypass Speed From [RPM]	5-90	Digital & Relay Bus Control
0-26	Display Text 3	1-36	Iron Loss Resistance (Rfe)	2-17	AC brake Max. Current	4-61	Bypass Speed To [RPM]	5-93	Pulse Out #27 Timeout Preset
0-27	LCP keypad	1-37	d-axis Inductance (Ld)	3-00	Over-voltage Control	4-62	Bypass Speed To [Hz]	5-94	Pulse Out #29 Bus Control
0-28	[Hand on] Key on LCP	1-38	q-axis Inductance (Lq)	3-02	Reference Limits	4-64	Semi-Auto Bypass Set-up	5-96	Pulse Out #29 Timeout Preset
0-29	[Auto on] Key on LCP	1-39	Motor Poles	3-03	Minimum Reference	5-00	Digital I/O mode	5-97	Pulse Out #X30/6 Bus Control
0-30	[Reset] Key on LCP	1-40	Back EMF at 1000 RPM	3-04	Maximum Reference	5-01	Digital I/O Mode	5-98	Pulse Out #X30/6 Timeout Preset
0-31	[Off/Reset] Key on LCP	1-41	d-axis Inductance Sat. (LdSat)	3-10	Reference Function	5-02	Analog I/O Mode	6-00	Analog I/O Mode
0-32	[Drive Bypass] Key on LCP	1-42	Position Detection Gain	3-11	References	5-03	Live Zero Timeout Time	6-01	Live Zero Timeout Function
0-33	Copy/Save	1-43	Torque Calibration	3-13	Preset Reference	5-10	Terminal 18 Digital Input	6-10	Terminal 53 Low Voltage
0-34	LCP Copy	1-44	Inductance Sat. Point	3-14	Jog Speed [Hz]	5-11	Terminal 19 Digital Input	6-11	Terminal 53 High Voltage
0-35	Set-up Copy	1-45	Motor Magnetisation at Zero Speed	3-15	Reference Site	5-12	Terminal 20 Digital Input	6-12	Terminal 53 Low Current
0-36	Password	1-50	Min Speed Normal Magnetising [RPM]	3-16	Reference 1 Source	5-13	Terminal 21 Digital Input	6-13	Terminal 53 High Current
0-37	Access to Main Menu w/o Password	1-51	Min Speed Normal Magnetising [Hz]	3-17	Reference 2 Source	5-14	Terminal 22 Digital Input	6-14	Terminal 53 Low Ref./Feedb. Value
0-38	Personal Menu Password	1-52	V/f Characteristic - V	3-19	Reference 3 Source	5-15	Terminal 23 Digital Input	6-15	Terminal 53 High Ref./Feedb. Value
0-39	Access to Personal Menu w/o Password	1-53	Flying Start Test Pulses Current	3-20	Jog Speed [RPM]	5-16	Terminal 24 Digital Input	6-16	Terminal 53 Filter Time Constant
0-40	Bus Password Access	1-54	Flying Start Test Pulses Frequency	3-21	Ramp 1	5-17	Terminal 25 Digital Input	6-17	Terminal 53 Live Zero
0-41	Clock Settings	1-55	Load Depen. Setting	3-22	Ramp 2	5-18	Terminal 26 Digital Input	6-20	Analog Input 54
0-42	Date and Time	1-60	Low Speed Load Compensation	3-23	Ramp 3	5-19	Terminal 27 Digital Input	6-21	Terminal 54 Low Voltage
0-43	Date Format	1-61	High Speed Load Compensation	3-24	Other Ramps	5-20	Terminal 28 Digital Input	6-22	Terminal 54 High Voltage
0-44	Time Format	1-62	Slip Compensation	3-25	Jog Ramp Time	5-21	Terminal 29 Digital Input	6-23	Terminal 54 Low Current
0-45	DST/Summertime	1-63	Slip Compensation Time Constant	3-26	Quick Stop Ramp Time	5-22	Terminal 30 Digital Input	6-24	Terminal 54 High Current
0-46	DST/Summertime Start	1-64	Resonance Damping	3-27	Initial Ramp Time	5-23	Terminal 31 Digital Input	6-25	Terminal 54 Low Ref./Feedb. Value
0-47	DST/Summertime End	1-65	Resonance Damping Time Constant	3-28	Check Valve Ramp Time	5-24	Terminal 32 Digital Input	6-26	Terminal 54 Filter Time Constant
0-48	Clock Fault	1-66	Min. Current at Low Speed	3-29	Check Valve Ramp End Speed [RPM]	5-25	Terminal 33 Digital Input	6-27	Terminal 54 Live Zero
0-49	Working Days	1-67	Start Adjustments	3-30	Check Valve Ramp End Speed [Hz]	5-30	Digital Outputs	6-30	Analog Input X30/11
0-50	Additional Working Days	1-70	PM Start Mode	3-31	Final Ramp Time		Terminal 27 Digital Output		
0-51	Additional Non-Working Days	1-71	Start Delay	3-32					
0-52	Date and Time Readout	1-72	Start Function	3-33					
0-53	Load and Motor	1-73	Flying Start	3-34					
0-54	General Settings	1-74	Compressor Start Max Speed [RPM]	3-35					
0-55	Configuration Mode	1-75	Compressor Start Max Speed [Hz]	3-36					
0-56	Motor Control Principle	1-76		3-37					

6-31	Terminal X30/11 High Voltage	8-37	Maximum Inter-Char Delay	10-22	CAN Fieldbus	12-34	CIP Product Code	14-22	Special Functions
6-34	Term. X30/11 Low Ref/Feedb. Value	8-4*	FC MC protocol set	10-0*	Common Settings	12-35	EDS Parameter	14-0*	Inverter Switching
6-35	Term. X30/11 High Ref/Feedb. Value	8-40	Telegram Selection	10-00	CAN Protocol	12-37	COS Inhibit Timer	14-00	Switching Pattern
6-36	Term. X30/11 Filter Time Constant	8-42	PCD Write Configuration	10-01	CAN Baud Select	12-38	COS Filter	14-01	Switching Frequency
6-37	Term. X30/11 Live Zero	8-43	PCD Read Configuration	10-02	MAC ID	12-4*	Modbus TCP	14-03	Overmodulation
6-4*	Analog Input X30/12	8-5*	Digital/Bus	10-05	Readout Transmit Error Counter	12-40	Status Parameter	14-04	PWM Random
6-40	Terminal X30/12 Low Voltage	8-50	Coasting Select	10-06	Readout Receive Error Counter	12-41	Slave Message Count	14-1*	Mains On/Off
6-41	Terminal X30/12 High Voltage	8-51	Quick Stop Select	10-07	Readout Bus Off Counter	12-42	Slave Exception Message Count	14-10	Mains Failure
6-44	Term. X30/12 Low Ref/Feedb. Value	8-52	DC Brake Select	10-1*	DeviceNet	12-8*	Other Ethernet Services	14-11	Mains Voltage at Mains Fault
6-45	Term. X30/12 High Ref/Feedb. Value	8-53	Start Select	10-10	Process Data Type Selection	12-80	FTP Server	14-12	Function at Mains Imbalance
6-46	Term. X30/12 Filter Time Constant	8-54	Reversing Select	10-11	Process Data Config Write	12-81	HTTP Server	14-16	Kin. Backup Gain
6-47	Term. X30/12 Live Zero	8-55	Set-up Select	10-12	Process Data Config Read	12-82	SMTP Service	14-2*	Reset Functions
6-5*	Analog Output 42	8-56	Preset Reference Select	10-13	Warning Parameter	12-83	SNMP Agent	14-20	Reset Mode
6-50	Terminal 42 Output	8-8*	FC Port Diagnostics	10-14	Net Reference	12-84	Address Conflict Detection	14-21	Automatic Restart Time
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Ulsnaes 1
DK-6300 Graasten
vlt-drives.danfoss.com



B-501/2 - Filter, Silencer, Solberg, FS-230P-300



SMALL COMPACT FILTER SILENCERS WITH STANDARD FILTER DESIGN "FS" Series 1/2" - 3" MPT

APPLICATIONS

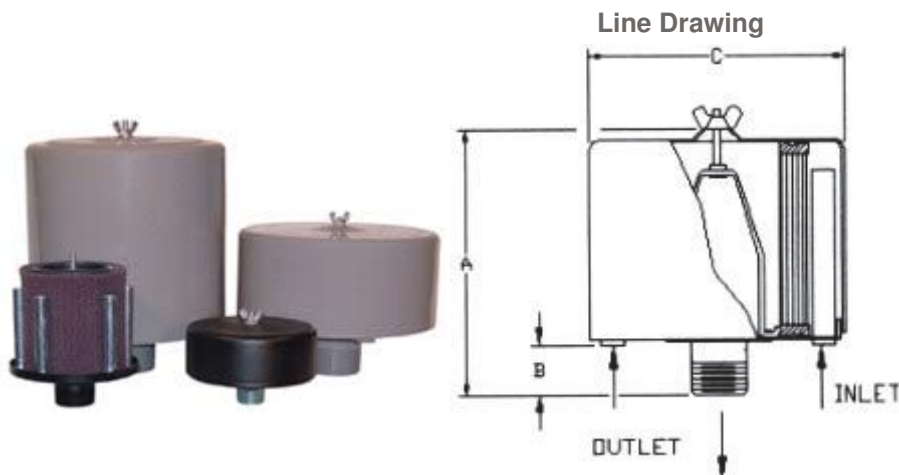
- ☐ Blowers-PD Type
- ☐ Blowers-Side Channel
- ☐ Compressor-Screw
- ☐ Construction/Contractor Industry
- ☐ Engines
- ☐ Hydraulic Breathers - fine filtration
- ☐ Medical
- ☐ Pneumatic Conveying Systems
- ☐ Waste Water Aeration
- ☐ Workshop
- ☐ Compressor-Piston
- ☐ Dental
- ☐ Industrial & Severe Duty
- ☐ Sparging

FEATURES & SPECIFICATIONS

- ☐ :99%+ removal efficiency std: Paper=2 micron, Polyester=5 micron
- ☐ Durable carbon steel construction with powder coated finish or galvanized steel
- ☐ Filter change out differential: 10"-15" in. H₂O above initial delta P
- ☐ Fully drawn weatherhood - no welds to rust or vibrate apart
- ☐ Interchangeable elements: Polyester, Paper, HEPA
- ☐ Low pressure drop center bracket and outlet pipe design
- ☐ Pressure drop graphs available upon request
- ☐ Temp (continuous): min -15° F (-26° C) max 220° F (104° C)
- ☐ Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- ☐ Typical noise attenuation up to 15 dB's (due to the wide range of applications and machines these units are used on, a single graph is insufficient. Please inquire for your specific requirement)

OPTIONS

- ☐ 1/8" tap holes for differential pressure gauges
- ☐ Available in *Stainless Steel*
- ☐ Epoxy coated housings
- ☐ Hot dipped galvanized housings
- ☐ Special connections, BSPT/Metric
- ☐ Various elements available



*All measurements are shown in standards.

Typical Lead Times:		Normally in stock
■ 1 - 2 weeks	■ 3 - 4 weeks	■ 5 - 7 weeks
		■ 8 + weeks

Add To Order	Model Number	Element Type	Outlet in. NPT or FLG	Connection Style	Dim A in.	Dim B in.	Dim C in.	Rated Flow Piston SCFM	Rated Flow Screw Blower Fan SCFM	Element Parent Flow SCFM	Tube Count	Approx. Weight lbs.	CAD
■	FS-15-050	Polyester	0.5	MPT	4	1.5	6	10	10	35	1	1.8	CAD
■	FS-15-075	Polyester	0.75	MPT	4	1.5	6	20	25	35	2	2	CAD
■	FS-15-100	Polyester	1	MPT	4	1.5	6	25	35	35	3	2.1	CAD
■	FS-19P-100	Polyester	1	MPT	6.63	1.5	6	35	55	100	3	3	CAD
■	FS-19P-125	Polyester	1.25	MPT	6.63	1.63	6.1	55	70	100	5	3.3	CAD
■	FS-19P-150	Polyester	1.5	MPT	6.63	1.5	6	70	85	100	5	3.5	CAD

	FS-231P-200	Polyester	2	MPT	12.25	2.25	10	135	135	300	5	14	
	FS-31P-200	Polyester	2	MPT	7.25	2.25	10	85	135	195	5	7.8	
	FS-231P-250	Polyester	2.5	MPT	12.5	2.5	10	195	195	300	9	14.5	
	FS-31P-250	Polyester	2.5	MPT	7.5	2.5	10	100	195	195	5	8.2	
	FS-231P-300	Polyester	3	MPT	13	3	10	200	300	300	9	15	
	FS-14-050	Paper	0.5	MPT	4	1.5	6	10	10	35	1	1.8	
	FS-14-075	Paper	0.75	MPT	4	1.5	6	20	25	35	2	2	
	FS-14-100	Paper	1	MPT	4	1.5	6	25	35	35	3	2.1	
	FS-18P-100	Paper	1	MPT	6.63	1.5	6	35	55	100	3	3	
	FS-18P-125	Paper	1.25	MPT	6.63	1.63	6.1	55	70	100	5	3.3	
	FS-18P-150	Paper	1.5	MPT	6.63	1.5	6	70	85	100	5	3.5	
	FS-230P-200	Paper	2	MPT	12.25	2.25	10	135	135	300	5	14	
	FS-30P-200	Paper	2	MPT	7.25	2.25	10	85	135	195	5	8.2	
	FS-230P-250	Paper	2.5	MPT	12.5	2.5	10	195	195	300	9	14.5	
	FS-30P-250	Paper	2.5	MPT	7.5	2.5	10	100	195	195	5	8.2	
	FS-230P-300	Paper	3	MPT	13	3	10	200	300	300	9	15	

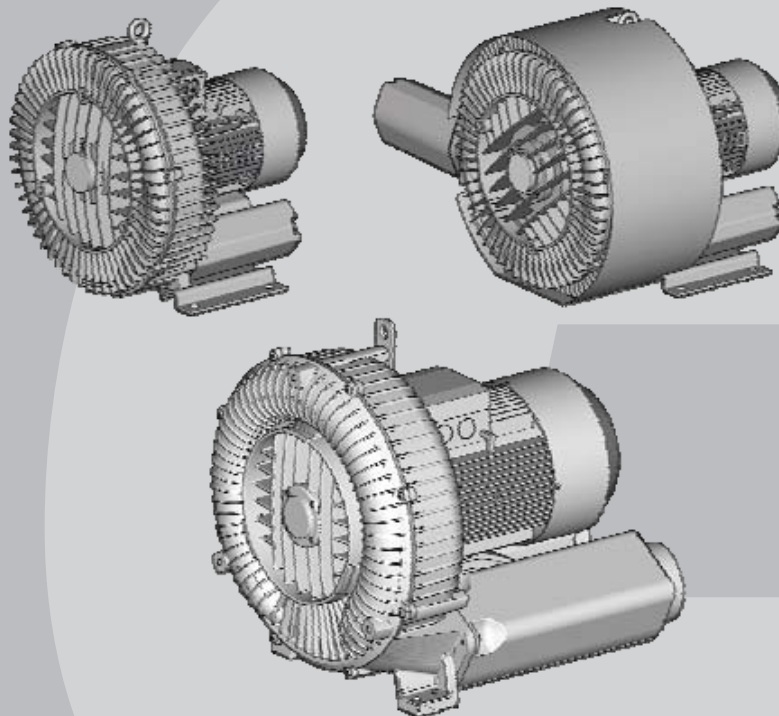
Solberg Mfg.

1151 W. Ardmore Ave.·Itasca, IL 60143·(630)773-1363· Fax: (630)773-0727

SFS_2-2

B601/2 - Blower, Elmo G200 2BH-1510-7HH56-Z

Operating instructions G-BH1, G-BH9



2BH1 1
2BH1 2
2BH1 3
2BH1 4
2BH1 5
2BH1 6
2BH1 8
2BH1 9
2BH9 23



G-Serie
G-Series

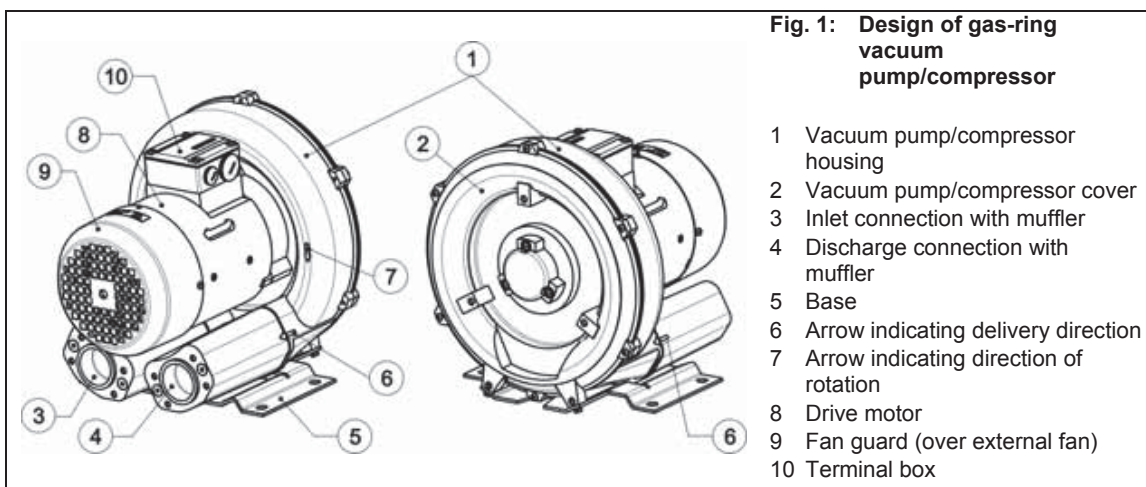
Seitenkanal
Side Channel



E-251

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1 Safety

1.1 Definitions

To point out dangers and important information, the following signal words and symbols are used in these operating instructions:

1.1.1 Safety alert symbol

The **safety alert symbol**  is located in the safety precautions in the highlighted heading field on the left next to the signal word (DANGER, WARNING, CAUTION).

Safety precautions **with** a safety alert symbol indicate a danger of **injuries**.

Be sure to follow these safety precautions to protect against **injuries or death!**

Safety precautions **without** a safety alert symbol indicate a danger of **damage**.

1.1.2 Signal words

DANGER	The signal words are located in the safety precautions in the highlighted heading field.
WARNING	
CAUTION	They follow a certain hierarchy and indicate (in conjunction with the safety alert symbol, see Chapter 1.1.1) the seriousness of the danger and the type of warning .
NOTICE	
NOTE	

See the following explanations:

 DANGER
Danger of injuries. Indicates an imminently hazardous situation, that will result in death or serious injury if the corresponding measures are not taken.

 WARNING
Danger of injuries. Indicates a potentially hazardous situation, that could result in death or serious injury if the corresponding measures are not taken.

 CAUTION
Danger of injuries. Indicates a potentially hazardous situation, that may result in minor or moderate injury if the corresponding measures are not taken.

CAUTION

Danger of damage.

Indicates a potentially hazardous situation that may result in **property damage** if the corresponding measures are not taken.

NOTICE

Indicates a possible **disadvantage**, i.e. undesirable conditions or consequences can occur if the corresponding measures are not taken.

NOTE

Indicates a possible **advantage** if the corresponding measures are taken; tip.

1.2 General safety precautions

WARNING

Improper use of the unit can result in serious or even fatal injuries!

These operating instructions

- must have been read completely and understood before beginning any work with or at the pump-motor unit,
- must be strictly observed,
- must be available at the operating location of the pump-motor unit.

WARNING

Improper use of the unit can result in serious or even fatal injuries!

Only operate the pump-motor unit

- for the purposes indicated under "Intended Use"!
- with the fluids indicated under 'Intended Use'!
- with the values indicated under 'Technical Data'!

WARNING

Improper use of the unit can result in serious or even fatal injuries!

All work on and with the pump-motor unit (transport, installation, operation, shut-down, maintenance, disposal) may only be carried out by **trained, reliable expert personnel!**

⚠ WARNING

When working on the unit, there is a danger of injury, e.g. in the form of cuts/cutting off, crushing and burns!

During all work on and with the pump-motor unit (transport, installation, operation, shut-down, maintenance, disposal) wear **personal safety equipment** (safety helmet, protective gloves, safety shoes)!

⚠ WARNING

Hair and clothing can be pulled into the unit or caught and wound up moving parts!

Do not wear long, loose hair or wide, loose clothes! Use a hair net!

⚠ DANGER

Electrical danger!

Work on electrical installations may be carried out by trained and authorized electricians only!

⚠ DANGER

Electrical danger!

Before beginning work on the unit or system, the following measures must be carried out:

- Deenergize.
- Secure against being switched on again.
- Determine whether deenergized.
- Ground and short-circuit.
- Cover or block off adjacent energized parts.

⚠ DANGER

Electrical danger!

Do not open the motor terminal box until absence of electricity has been ensured!

⚠ WARNING

Danger due to vacuum and gauge pressure: sudden escape of fluids (skin and eye injuries), sudden drawing in of hair and clothing!

Danger due to escaping fluid: Burns!

Use mounting elements, connections, lines, fittings and containers with sufficient freedom from leaks and strength for the pressures which occur.

Check the mounting elements, connections, lines, fittings and containers for strength, leaks and firm seating at regular intervals!

⚠ WARNING

Danger from rotating parts (external fan, impeller, shaft):

Cutting/cutting off of extremities, Grasping/winding up of hair and clothing!

Danger due to vacuum and gauge pressure: sudden escape of fluids (skin and eye injuries), sudden drawing in of hair and clothing!

Danger due to escaping fluid: Burns!

Start-up and operation only under the following conditions:

- The pump-motor unit must be completely assembled. When doing so, pay particular attention to the following components:
 - the vacuum pump/compressor cover,
 - the muffler on inlet and discharge connections,
 - the fan guard.
- The pipes/hoses must be connected to inlet and discharge connections.
- Inlet and discharge connections and the connected pipes/hoses may not be closed, clogged or soiled.
- Check the mounting elements, connections of the pipe/hose connections, lines, fittings and containers for strength, leaks and firm seating at regular intervals.

⚠ WARNING

Danger from rotating parts (external fan, impeller, shaft):

Cutting/cutting off of extremities, Grasping/winding up of hair and clothing!

Danger due to vacuum and gauge pressure: sudden escape of fluids (skin and eye injuries), sudden drawing in of hair and clothing!

Danger due to escaping fluid: Burns!

Before beginning work on the pump-motor unit, take the following measures:

- Shut down pump-motor unit and secure against being switched on again.
- Attach a sign on the system controller and on the control elements for the pump-motor unit: "DANGER! Maintenance work on vacuum pump/compressor! Do not switch on!"
- Wait for pump-motor unit to come to a complete stop. Observe run-on time!
- Allow pump-motor unit to cool!
- Shut-off lines. Release pressure.
- Make sure that no vacuum or gauge pressure is present in the lines/tanks to be opened.
- Make sure that no fluids can escape.

⚠ WARNING**Danger from rotating impeller:
Cutting/cutting of off extremities!**

The rotating impeller is accessible with the inlet and discharge connections open!

Do not reach into the unit through open connections!

Do not insert objects into the unit through the openings!

⚠ WARNING**Danger from rotating impeller:
Cutting/cutting of off extremities!**

The rotating impeller is accessible with the inlet and discharge connections open!

With free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere without piping, the following therefore applies:

Provide the inlet and discharge connections of the pump-motor unit either with additional mufflers or with additional piping of a sufficient length to prevent access to the impeller!

⚠ WARNING**Danger of burns from hot surfaces of the pump-motor unit and from hot fluids!**

High temperatures of up to approx. 160°C [320°F] can occur on the surface of the pump-motor unit.

Cover the pump-motor unit with a suitable touch protection (e.g. perforated plate cover or wire cover). Do not touch during operation! Allow to cool after shut-down!

1.3 Residual risks**⚠ WARNING****Danger zone:**

Hot surface up to approx. 160°C [320°F].

Hazard:

Possible burns.

Protective measures:

Cover the pump-motor unit with a suitable touch protection (e.g. perforated plate cover or wire cover).

⚠ WARNING**Danger zone:**

Fan guard

Hazard:

Long, loose hair can be drawn into external fan through fan guard grate, even with fan guard mounted!

Protective measures:

Wear hair net!

⚠ WARNING**Danger zone:**

Missing or defective muffler inlet or discharge connection.

Hazard:

Possible serious hearing damage due to emitted noise.

Protective measures:

Have missing or defective mufflers replaced. Conduct a noise measurement in the system after installing the pump-motor unit. The following measures can be taken from 85 dB(A) and must be taken from 90 dB(A):

- Mark noise area with a warning sign.
- Wear hearing protection.

⚠ WARNING**Danger zone:**

Environment of pump-motor unit.

Hazard:

Possible serious hearing damage due to emitted noise.

Protective measures:

Conduct a noise measurement in the system during operation after installing the pump-motor unit.

The following measures can be taken from 85 dB(A) and must be taken from 90 dB(A):

- Mark noise area with a warning sign.
- Wear hearing protection.
- With free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere without piping, attach an additional muffler.

2 Intended Use

This operating manual

- is intended for side channel compressors of the G-BH1 and G-BH9 series, types 2BH1 1 2BH1 2 2BH1 3 2BH1 4 2BH1 5 2BH1 6 2BH1 8 2BH1 9 2BH9 23,
- contains instructions bearing on transport and handling, installation, commissioning, operation, shut-down, storage, servicing and disposal of the G-BH1, G-BH9,
- must be completely read and understood by all operating and servicing personnel before beginning to work with or on the G-BH1, G-BH9,
- must be strictly observed,
- must be available at the site of operation of the G-BH1, G-BH9.

About the operating and servicing personnel of the G-BH1, G-BH9

- These persons must be trained and authorized for the work to be carried out.
- Work on electrical installations may be carried out by trained and authorized electricians only.

The G-BH1, G-BH9

- are pump-motor units for generating vacuum or gauge pressure;
- are used to **extract, pump and compress the following gases**:
 - Air,
 - Non-flammable, non-aggressive, non-toxic and non-explosive gases or gas-air mixtures.
 - With differing gases/gas-air mixtures, inquire with the Service Department.
- are equipped with one of the following kind of drive motors:
 - 3-phase AC drive motor with a standard or explosion-protected design
 - Single-phase AC drive motor

These operating instructions apply **only to** pump-motor units with a **standard design**. For an explosion-protected design (EEx e II), see the separate operating instructions.

- are intended for industrial applications,
- are designed for continuous operation. With increased switch-on frequency (6x per hour with equal pauses and operating times) or with increased gas inflow and ambient temperature, the excess temperature limit of the coil and the bearing can be exceeded. Consult the manufacturer when using under such conditions.

When operating the G-BH1, G-BH9 the limits listed in Chapter 3, "Technical Data", Pg. 7 ff. must always be complied with.

Foreseeable Misuse

It is prohibited

- to use the G-BH1, G-BH9 in applications other than industrial applications unless the necessary protection is provided on the system, e.g. guards suitable for children's fingers;
- to use the device in rooms in which explosive gases can occur if the G-BH1, G-BH9 is not expressly intended for this purpose;
- to extract, to deliver and to compress explosive, flammable, corrosive or toxic fluids, unless the G-BH1, G-BH9 is specifically designed for this purpose;
- to operate the G-BH1 with values other than those specified in Chapter 3, "Technical Data", Pg. 7 ff.

Any unauthorized modifications of the G-BH1, G-BH9 are prohibited for safety reasons.

The operator is only permitted to perform the maintenance and service work described in these operating instructions.

Maintenance and servicing work which goes beyond this may only be carried out by companies which have been authorised by the manufacturer (ask the service department for details).

3 Technical Data

3.1 Mechanical data

Weight

Single-impeller design		
Type	Weight	
	[kg] approx.	[lbs] approx.
2BH1100-7..0.	9	20
2BH1200-7..0.	9	20
2BH1300-7..0.	9	20
2BH1300-7..1.	10	22
2BH1300-7..2.	11	24
2BH1330-7..0.	10	22
2BH1330-7..1.	11	24
2BH1330-7..2.	12	26
2BH1400-7..0.	13	29
2BH1400-7..1.	16	35
2BH1400-7..2.	17	37
2BH1430-7..0.	14	31
2BH1430-7..1.	17	37
2BH1430-7..2.	18	40
2BH1500-7..0.	20	44
2BH1500-7..1.	22	49
2BH1500-7..2.	23	51
2BH1500-7..3.	25	55
2BH1530-7..0.	21	46
2BH1530-7..1.	23	51
2BH1530-7..2.	24	53
2BH1530-7..3.	26	57
2BH1600-7..0.	27	60
2BH1600-7..1.	30	66
2BH1600-7..2.	36	79
2BH1600-7..3.	40	88
2BH1600-7..6.	32	71
2BH1600-7..7.	39	86
2BH1630-7..0.	29	64
2BH1630-7..1.	32	71
2BH1630-7..2.	37	82
2BH1630-7..3.	43	95
2BH1630-7..6.	34	75
2BH1630-7..7.	40	88

Single-impeller design		
Type	Weight	
	[kg] approx.	[lbs] approx.
2BH180.-7..0.	117	258
2BH180.-7..1.	126	278
2BH180.-7..2.	132	291
2BH183.-7..0.	120	265
2BH183.-7..1.	129	284
2BH183.-7..2.	135	298
2BH190.-7..0.	179	395
2BH190.-7..1.	198	437
2BH190.-7..3.	210	463
2BH193.-7..0.	179	395
2BH193.-7..1.	198	437
2BH193.-7..3.	209	463
2BH923.-...P	167	368
2BH923.-...Q	145	320
2BH923.-...H	151	333

Two-impeller design		
Type	Weight	
	[kg] approx.	[lbs] approx.
2BH1310-7..2.	15	33
2BH1410-7..3.	25	55
2BH1410-7..4.	27	60
2BH1510-7..4.	40	88
2BH1510-7..5.	44	97
2BH1610-7..1.	43	95
2BH1610-7..2.	48	106
2BH1610-7..3.	54	119
2BH1610-7..4.	66	146
2BH1610-7..5.	73	161
2BH1610-7..7.	50	110
2BH1610-7..8.	62	137
2BH1640-7..3.	54	119
2BH1640-7..4.	69	152
2BH1640-7..5.	75	165
2BH1640-7..8.	62	137
2BH181.-7..1.	171	377
2BH181.-7..2.	177	390

Two-impeller design		
Type	Weight	
	[kg] approx.	[lbs] approx.
2BH181.-7..3.	203	448
2BH181.-7..4.	215	474
2BH184.-7..2.	177	390
2BH184.-7..3.	203	448
2BH191.-7..1.	274	604
2BH191.-7..2.	288	635
2BH191.-7..3.	299	659
2BH191.-7..4.	309	681
2BH1940-7B.2.	275	606
2BH1940-7B.3.	314	692
2BH1940-7B.4.	324	714
2BH1943-7..2.	330	728
2BH1943-7..3.	339	747
2BH1943-7..4.	349	769

Minimum distances

Minimum distance to fan guard (for sucking in cooling air):

Type	[mm]	[inches]
2BH1 1.. - 2BH1 4	34	1.34
2BH1 5.. - 2BH1 9	53	2.09
2BH923...	52	2.05

Minimum distance to face of vacuum pump/compressor cover:

Type	[mm]	[inches]
2BH1 1.. - 2BH1 5	20	0.79
2BH1 6..	30	1.18
2BH1 8.. - 2BH1 9	40	1.57
2BH923..	52	2.05

Noise level

Measuring-surface sound-pressure level as per EN ISO 3744, measured at a distance of 1 m [3.28 ft] at an operating point of approximately 2/3 of the permissible total pressure difference with the lines connected without a vacuum or pressure relief valve, tolerance ± 3 dB (A).

Single-impeller design		
Type	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz approx.	60 Hz approx.
2BH1100-7..0.	52	55
2BH1200-7..0.	57	61
2BH1300-7..0.	53	56
2BH1300-7..1.	53	56
2BH1300-7..2.	53	56
2BH1330-7..0.	53	56
2BH1330-7..1.	53	56
2BH1330-7..2.	53	56
2BH1400-7..0.	63	64
2BH1400-7..1.	63	64
2BH1400-7..2.	63	64
2BH1430-7..0.	63	64
2BH1430-7..1.	63	64
2BH1430-7..2.	63	64
2BH1500-7..0.	64	70
2BH1500-7..1.	64	70
2BH1500-7..2.	64	70
2BH1500-7..3.	64	70
2BH1530-7..0.	64	70
2BH1530-7..1.	64	70
2BH1530-7..2.	64	70
2BH1530-7..3.	64	70
2BH1600-7..0.	69	72
2BH1600-7..1.	69	72
2BH1600-7..2.	69	72
2BH1600-7..3.	69	72
2BH1600-7..6.	69	72
2BH1600-7..7.	69	72
2BH1630-7..0.	69	72

Single-impeller design		
Type	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz approx.	60 Hz approx.
2BH1630-7..1.	69	72
2BH1630-7..2.	69	72
2BH1630-7..3.	69	72
2BH1630-7..6.	69	72
2BH1630-7..7.	69	72
2BH180.-7..0.	70	74
2BH180.-7..1.	70	74
2BH180.-7..2.	70	74
2BH183.-7..0.	70	74
2BH183.-7..1.	70	74
2BH183.-7..2.	70	74
2BH190.-7..0.	74	79
2BH190.-7..1.	74	79
2BH190.-7..3.	74	79
2BH193.-7..0.	75	80
2BH193.-7..1.	75	80
2BH193.-7..3.	75	80
2BH923..	79	81

Two-impeller design		
Type	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz approx.	60 Hz approx.
2BH1310-7..2.	55	61
2BH1410-7..3.	66	69
2BH1410-7..4.	66	69
2BH1510-7..4.	72	74
2BH1510-7..5.	72	74
2BH1610-7..1.	73	76
2BH1610-7..2.	73	76
2BH1610-7..3.	73	76
2BH1610-7..4.	73	76
2BH1610-7..5.	73	76
2BH1610-7..7.	73	76
2BH1610-7..8.	73	76
2BH1640-7..3.	74	78
2BH1640-7..4.	74	78
2BH1640-7..5.	74	78
2BH1640-7..8.	74	---
2BH181.-7..1.	74	---
2BH181.-7..2.	74	78
2BH181.-7..3.	74	78
2BH181.-7..4.	74	78
2BH184.-7..2.	74	78
2BH184.-7..3.	74	78
2BH191.-7..1.	74	84
2BH191.-7..2.	74	84
2BH191.-7..3.	74	84
2BH1940-7B.2.	75	84
2BH1940-7B.3.	75	84
2BH1940-7B.4.	75	84
2BH1943-7..2.	75	84
2BH1943-7..3.	75	84
2BH1943-7..4.	75	84

Sound power level

Sound power level L_w as per EN ISO 3744, tolerance ± 3 dB (A).

Two-impeller design		
Type	Sound power level L_w [dB (A)]	
	50 Hz	60 Hz
2BH191.	-	98
2BH1940	-	98
2BH1943	-	99
2BH923..	-	93

Tightening torques for screw connections

The following values apply if no other information is available.

With non-electrical connections, property classes of 8.8 and 8 or higher as per ISO 898-1 are assumed.

Tightening torques for non-electrical connections		
Thread	[Nm]	[ft lbs]
M4	2.7 - 3.3	1.99 - 4.44
M5	3.6 - 4.4	2.65 - 3.25
M6	7.2 - 8.8	5.31 - 6.5
M8	21.6 - 26.4	15.9 - 19.5
M10	37.8 - 46.2	27.9 - 34.1
M12	63.0 - 77.0	46.5 - 56.8

The following information for electrical connection applies to all terminal board connections with the exception of terminal strips.

Tightening torques for electrical connections		
Thread	[Nm]	[ft lbs]
M4	0.8 - 1.2	0.59 - 0.89
M5	1.8 - 2.5	1.33 - 1.84

Especially for metal and plastic threaded cable glands and pipe unions, the following values apply:

Tightening torques for metal threaded glands/unions		
Thread	[Nm]	[ft lbs]
M12x1,5	4 - 6	2.95 - 4.43
M16x1,5	5 - 7.5	3.69 - 5.53
M25x1,5	6 - 9	4.43 - 6.64
M32x1,5	8 - 12	5.9 - 8.85
M40x1,5		

Tightening torques for plastic threaded glands/unions		
Thread	[Nm]	[ft lbs]
M12x1,5	2 - 3.5	1.48 - 2.58
M16x1,5	3 - 4	2.21 - 2.95
M25x1,5	4 - 5	2.95 - 3.69
M32x1,5	5 - 7	3.69 - 5.16
M40x1,5		

3.2 Electrical data

See rating plate.

3.3 Operating conditions

Temperatures

Temperature of pumped gases:	max. permissible temperature: +40°C [+104°F] Nominal value: +15°C [+59°F] Pump-motor units for higher fluid temperatures on request.
Ambient temperature:	max. permissible temperature: +40°C [+104°F] min. permissible temperature: -15°C [+5°F] Nominal value: +25°C [+77°F] Ambient temperatures between 25°C [+77°F] and 40°C [+104°F] affect the permissible total pressure difference. At higher temperatures the winding may be damaged and the grease change interval may be shortened.

Installation altitude

Max. of 1,000 m [3,280 ft] above sea level.

When installing the pump-motor unit at an altitude of more than 1,000 m [3,280 ft] above sea level, first inquire with the Service department.

Pressures

Min. suction pressure:	See rating plate
Max. discharge pressure in compressor mode:	See rating plate
* The total pressure difference, shown on the rating plate, applies only for the following conditions: • Ambient temperature: 25°C • Pressure for vacuum operation: 1013 mbar at pressure connection; • Pressure for compressor operation: 1013 mbar at suction connection; • Intake temperature (temperature of conveyed gases at suction connection): 15°C For ambient temperatures between 25°C and 40°C, the total pressure difference specified on the rating plate must be reduced (at 40°C by 10%). Consultation with the manufacturer is essential for such operational conditions.	

4 Transport and Handling

⚠ WARNING
Tipping or falling can lead to crushing, broken bones etc.! Sharp edges can cause cuts! Wear personal safety equipment (gloves, safety shoes and protective helmet) during transport!

⚠ WARNING
Danger from tipping or falling loads! Prior to transport and handling make sure that all components are securely assembled and secure or remove all components the fasteners of which have been loosened!

Manual handling:

⚠ WARNING
Danger from lifting heavy loads! Manual handling of the unit is only permitted within the following limits: • max. 30 kg [max. 66 lbs] for men • max. 10 kg [max. 22 lbs] for women • max. 5 kg [max. 11 lbs] for pregnant women For the weight of the pump-motor unit, see Chapter 3.1, "Mechanical data", Section "Weight", Pg. 7. For weights above the given values use suitable lifting appliances and handling equipment!

Handling by means of lifting equipment:

⚠ WARNING
Danger from tipping or falling loads! When transporting with lifting equipment, observe the following basic rules: • Before each transport, check the tight fit of the eye bolt/lifting attachment, see "Tightening torques for screw connections", p. 10. • The lifting capacity of lifting equipment and lifting gear must be at least equal to the unit's weight. For the weight of the pump-motor unit, see Chapter 3.1, "Mechanical data", Section "Weight", Pg. 7. • The pump-motor unit must be secured so that it cannot tip or fall. • Do not stand or walk under suspended loads!

The transport must be carried out in different ways depending on the type:

- 2BH11., 2BH12., 2BH13., 2BH14., 2BH15. (single-impeller): Manual handling
- 2BH15. (two-impeller), 2BH16., 2BH18., 2BH19., 2BH923...
Transport with crane, hooked onto eye bolt/lifting attachment (1 attachment point)
- 2BH1943:
Transport with crane, hooked with lifting belts onto eye bolt and onto the holes in the two feet of the vacuum pump/compressor housing (3 attachment points).

For **transport with a crane**, the pump-motor unit can be hooked into the crane hook as follows:

- directly on the eye bolt/lifting attachment (With 2BH194 the eye bolt and the two foot holes should be used)

or possibly

- with lifting belts.

Eye bolt/lifting attachment:

Types with a weight of up to 30 kg [66 lbs] are **not** equipped with an eye bolt/lifting attachment (2BH11., 2BH12., 2BH13., 2BH14., 2BH15 [single-impeller]).

Types with a weight of more than 30 kg [66 lbs] are equipped with an eye bolt/lifting attachment as **standard** (2BH15. [two-impeller], 2BH16., 2BH18., 2BH19., 2BH9...).

The eye bolt/lifting attachment is mounted on the vacuum pump/compressor housing.

In case of possible removal and remounting of the eye bolt, it must be ensured that the eye level is positioned exactly in the axis direction of the pump-motor unit. Lay shims under the eye bolt if necessary.

The eye bolt/lifting attachment must be firmly tightened.

Loads laterally to the ring level are not permissible. Heavy impact loads during transport must be avoided.

5 Installation

WARNING

Improper use of the unit can result in serious or even fatal injuries!

Have you read the safety precautions in Chapter 1, "Safety", Pg. 3 f.?

Otherwise you may not carry out any work with or on the pump-motor unit!

DANGER

Danger from missing view into area of pump-motor unit!

When operating the control elements without a view into the area of the pump-motor unit, there is a danger that the pump-motor unit will be switched on while other persons are still performing work on it. Extreme injuries are possible!

Provide control elements at a location with a view of the pump-motor unit.

DANGER

Electrical danger!

The pump-motor unit must be installed so that the electrical device cannot be damaged by external influences!

In particular, the feed pipes must be securely routed, e.g. in cable ducts, in the floor etc.

WARNING

Danger from balance damage caused by vibration!

Vibrating environments can cause balance damage!

Install the pump-motor unit on a solid foundation or on a solid mounting surface.

Check screw glands/unions for mounting the pump-motor unit on the mounting surface regularly for strength and firm seating.

WARNING

Danger from crushing due to pump-motor unit tipping over!

Wear personal safety equipment (protective gloves and safety shoes). Handle the unit with the appropriate care. Install the pump-motor unit on a solid foundation or on a solid mounting surface! Check screw glands/unions for mounting the pump-motor unit on the mounting surface regularly for strength.

WARNING

Danger of fire from flammable substances!

The pump-motor unit must never come into contact with flammable substances.

WARNING

Danger of burns from hot surfaces of the pump-motor unit and from hot fluids!

High temperatures of up to approx. 160°C [320°F] can occur on the surface of the pump-motor unit.

The pump-motor unit must be installed so that accidental touch of its surface is not possible. Cover the pump-motor unit with a suitable touch protection (e.g. perforated plate cover or wire cover).

WARNING

Danger of injuries from flying parts!

Select installation so that parts that are thrown out through the grate if the external fan breaks cannot hit persons!

CAUTION

Danger of tripping and falling!

Make sure the unit does not present a danger of tripping. Lay cables and pipes so that they cannot be reached during operation (recessed in floor, in ducts on the wall etc.).

CAUTION

Danger of overheating due to hot surface of pump-motor unit!

High temperatures can occur on the surface of the pump-motor unit.

Temperature sensitive parts, such as lines or electronic components, may not come into contact with the surface of the pump-motor unit.

The pump-motor unit is ready to connect on delivery. However, if the time from delivery to commissioning of the pump-motor unit exceeds a certain period, the lubrication of the rolling bearings must be renewed.

See Chapter 8.2, "Storage conditions", Section "Lubrication of rolling bearings after longer storage", Pg. 24 for information on this topic.

Carry out the following work to install the pump-motor unit:

- Installation and securing,
- Attachment of the included loose muffler if necessary,
- Attachment of threaded flange or hose flange (available as accessories) for the connection of inlet or discharge pipe to the muffler,
- Electrical connection,
- Connection of inlet and discharge connection to the system.

5.1 Installation

WARNING

For an installation that differs from the following specifications, it is necessary to inquire with the Service Department!

Ambient conditions:

The pump-motor unit is suitable for installation in the following environments:

- In a dusty or damp environment,
 - in buildings,
 - in the open.
- When properly installed in the open, the pump-motor unit must be protected from exposure to intensive sunlight, e.g. by attaching a protective roof. Otherwise, no special protective devices against the effects of weathering are required.

The drive motors of the pump-motor units have the following design:

- with degree of protection IP55 (see rating plate),
- with tropicalized insulation.

Installation conditions:

The pump-motor unit must be installed as follows:

- on level surfaces,
 - at a maximum height of 1000 m [3280 ft] above sea level.
- When installing at an altitude of more than 1,000 m [3,280 ft] above sea level, first inquire with the Service Department.

Minimum distances:

To ensure sufficient cooling of the pump-motor unit, it is absolutely necessary that the required minimum distances to the **fan guard** and to the **face of the vacuum pump/compressor cover** be maintained. see Chapter 3.1, "Mechanical data", Section "Minimum distances", Pg. 8.

The minimum distances to the face of the vacuum pump/compressor cover are especially important when installing on the vacuum pump/compressor cover or near a wall.

CAUTION

To ensure sufficient cooling of the pump-motor unit, also observe the following:

- Ventilation screens and openings must remain clear.
- Discharge air of other units may not be directly sucked in again!

Noise radiation:

To reduce the noise radiation, the following must be observed:

- Do not mount pump-motor unit on noise-conducting or noise-radiating parts (e.g. thin walls or sheet-metal plates).
- Provide pump-motor unit with sound-insulating intermediate layers (e.g. rubber buffers under the base of the pump-motor unit) if necessary.
- Install the pump-motor unit on a stable foundation or on a rigid mounting surface. This provides for smooth, low-vibration running of the pump-motor unit.

Components for reducing noise on the pump-motor unit:

- **Mufflers** (included as standard equipment):
On delivery the pump-motor units are equipped with attached mufflers as standard. The noise radiation is considerably reduced by the mufflers. See Fig. 2 to Fig. 9, Pg. 18 ff.
- **Additional silencer** (available as an accessory for the 2BH1):
The additional mufflers enable a further noise reduction. They may only be used with free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere **without piping**.

- **Sound protection hood** (available as an accessory for the 2BH1):
Noise protection hoods are suitable for installation in rooms and in the open. They reduce both the total sound pressure level and tonal components that are perceived as particularly annoying.

Installation variants/axis position:

Basically, when installing the pump-motor unit, the following variants are possible with a different axis position (horizontal or vertical):

- Horizontal installation
- Vertical installation on the vacuum pump/compressor cover ("cover installation")
- Vertical mounting on the wall

Basically, all variants are possible with all type.

Exceptions

- For the 2BH1943, vertical axis mounting on the compressor cover ("cover position") is necessary.
- For the 2BH923, only horizontal axis mounting and vertical axis mounting on the compressor cover are possible.
- For units with condensate water opening, horizontal axis mounting with a foot below is necessary.

Horizontal axis mounting

The foot of the unit has fastening holes.

- Screw the foot of the unit to the base using suitable screws.
All fastening holes must have screws!

Vertical axis mounting on the compressor cover ("cover position")

For vertical axis mounting on the compressor cover, use spring elements.

Spring elements are available as accessories and come in a set of 3. The upper part has a threaded stud and the lower part a threaded hole.

- fFastening spring elements to the unit:
Screw threaded studs of the spring elements into the holes on the front side of the compressor cover and tighten.
- Fastening the unit with spring elements to the foundation:
Select suitable fastening elements for the threaded hole.
Screw spring elements over the threaded hole into the base or foundation.

Vertical axis mounting on the wall with the compressor cover pointing downward

For vertical axis mounting of the unit on the wall, the unit is fastened using the holes in the foot. The foot of the unit has fastening holes.

- Place the unit with the foot to the wall on a base plate with sufficient load-bearing capability in the mounting position.
- Screw the foot of the unit to the wall using suitable screws.
All fastening holes must have screws!
- Remove the base plate.

Eye bolt/lifting attachment:

After set-up, the eye bolt/lifting attachment can be removed.

5.2 Electrical connection (motor)

DANGER

Electrical danger!

Malpractice can result in severe injuries and material damage!

DANGER

Electrical danger!

The electrical connection may be carried out by trained and authorized electricians only!

DANGER

Electrical danger!

Before beginning work on the unit or system, the following measures must be carried out:

- Deenergize.
- Secure against being switched on again.
- Determine whether deenergized.
- Ground and short-circuit.
- Cover or block off adjacent energized parts.

CAUTION

Incorrect connection of the motor can lead to serious damage to the unit!

Regulations:

The electrical connection must be carried out as follows:

- according to the applicable national and local laws and regulations,
- according to the applicable system-dependent prescriptions and requirements,
- according to the applicable regulations of the utility company.

Electrical power supply:

Observe the **rating plate**.

It is imperative that the operating conditions correspond to the data given on the rating plate!

Deviations permissible without reduction in performance:

- ± 5 % voltage deviation
- ± 2 % frequency deviation

Connection to drive-motor terminal box:

Open the required cable entry openings on the terminal box. Here the following two cases are differentiated:

- The cable entry opening is prefabricated and provided with a sealing plug.
- Screw out sealing plug.

OR

- The cable entry opening is closed off with a casting skin (only on pump-motor units with drive-motor axis heights of 100 to 160 in standard design).
- Break out casting skin using a suitable tool. For example, use a metal pin with a corresponding diameter or a chisel and hammer.

CAUTION

When pounding out the casting skin on the cable entry openings in the terminal box, the terminal box or its parts can be damaged (e.g. terminal board, cable connections).

Proceed with suitable caution and precision when doing so! Prevent flash formation!

Mount cable glands on the terminal box. Proceed as follows:

- Select one cable gland in each case which is suitable for the cable diameter.
- Insert this cable gland in the opening of the terminal box.
Use a reducer if necessary.
- Screw on the cable gland so that no moisture, dirt etc. can penetrate into the terminal box.

Carry out the connection and the arrangement of the jumpers in accordance with the **circuit diagram in the terminal box**.

Connect the protective conductor to the terminal with the following symbol:



The electrical connection must be carried out as follows:

- The electrical connection must be permanently safe.
- There may be no protruding wire ends.
- Clearance between bare live parts and between bare live parts and ground: ≥ 5.5 mm [0.217"] (at a nominal voltage of $U_N \leq 690V$).
- For the tightening torques for terminal board connections (except terminal strips), see Chapter 3.1, "Mechanical data", Section "Tightening torques for screw connections", Pg. 10.
- For terminals with clamping straps (e.g. as per DIN 46282), the conductors must be inserted so that approximately the same clamping height results on both sides of the bar. Individual conductors must therefore be bent into a U-shape or connected with a cable lug (DIN 46234).

This also applies to:

- the protective conductor,
- the outer ground conductor.

Both conductors can be recognized from their color (green/yellow).

⚠ DANGER**Electrical danger!**

The terminal box must be free from

- foreign bodies,
- dirt,
- humidity.

Terminal box cover and cable entries must be tightly closed so as to make them dustproof and waterproof. Check for tightness at regular intervals.

⚠ DANGER**Electrical danger!**

Clearance between bare live parts and between bare live parts and ground:

at least **5.5 mm [0.217"]** (at a nominal voltage of $U_N \leq 690V$).

There may be no protruding wire ends!

For motor overload protection:

- Use motor circuit breakers.
- This must be adjusted to the specified nominal current (see rating plate).

⚠ DANGER
Electrical danger! There is danger of an electrical shock when a defective pump-motor unit is touched! Mount motor circuit breaker. Have electrical equipment checked regularly by an electrician.

Interference immunity of drive motor:

For drive motors with integrated sensors, the operator must provide for a sufficient interference immunity itself. Select a suitable sensor signal cable (e.g. with screening, connection as for a motor power-supply cable) and analyzing unit.

Operation with frequency converter:

⚠ WARNING
Pump-motor units with a UL approbation may not be operated on frequency converters in the US without testing by a suitable test agency!

With a power supply by a frequency converter, the following must be observed:

- High-frequency current and voltage harmonics in the motor supply cables can lead to emitted electromagnetic interference. This is dependent on the converter design (type, manufacturer, interference suppression measures).
- Be sure to observe the EMC notes of the converter manufacturer!
- Use screened power supply cables if necessary. For optimal screening, the screen must be conductively connected over a large area to the metal terminal box of the drive motor with a screwed metal gland.
- In the case of drive motors with integrated sensors (e.g. PTC thermistors) interference voltage can occur on the sensor cable depending on the converter type.
- Limit speed:
see specifications on the rating plate.

5.3 Connecting pipes/hoses (vacuum pump/compressor)

Mufflers:

The pump-motor units are delivered with mufflers (indicated with arrows in the following illustrations) for the inlet and discharge connections as standard equipment.

On delivery the mufflers are already mounted on the following pump-motor units.

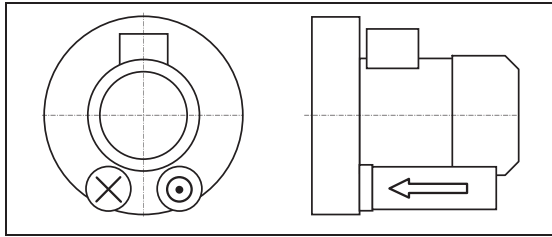


Fig. 2: 2BH1... (single-impeller pump-motor units), 2BH9 23

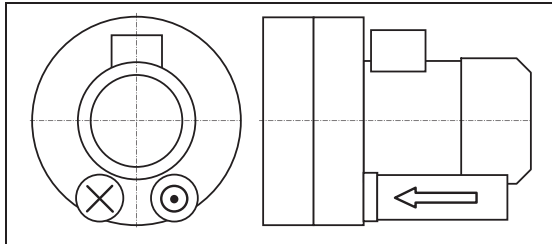


Fig. 3: 2BH1640 (two-impeller pump-motor unit with double-flow design)

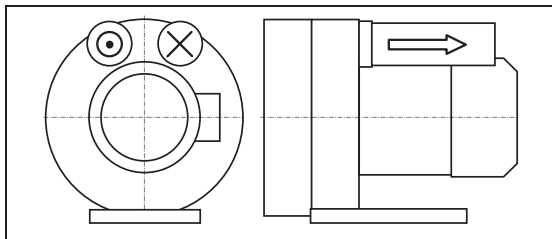


Fig. 4: 2BH1840-7G... (two-impeller pump-motor unit with double-flow design)

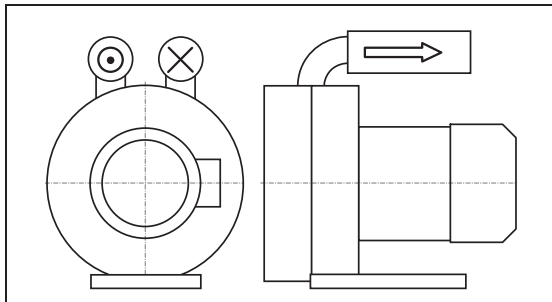


Fig. 5: 2BH1840-7J... (two-impeller pump-motor unit with double-flow design)

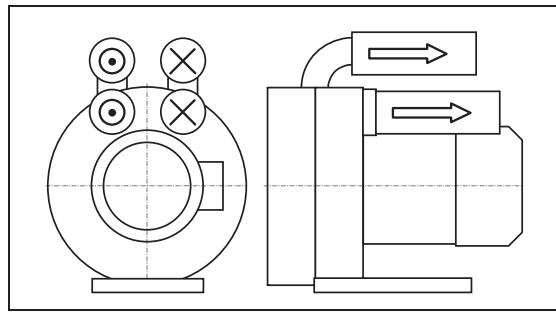


Fig. 6: 2BH1840-7L... (two-impeller pump-motor unit with double-flow design)

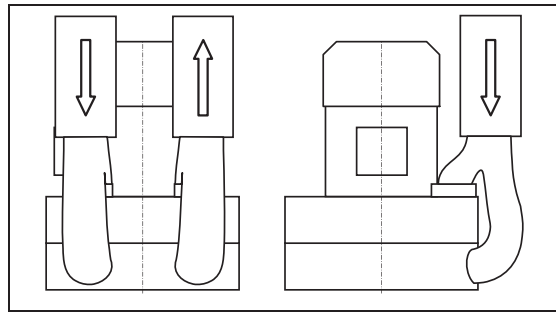


Fig. 7: 2BH1943 (two-impeller pump-motor unit with double-flow design)

On two-impeller pump-motor units with a two-stage design of the types 2BH1310 to 2BH1910 the discharge-side muffler is included loose for packing-related reasons and must be mounted by the customer.

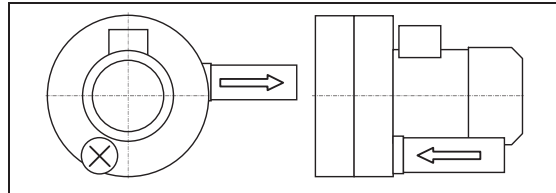


Fig. 8: 2BH1310 ... 2BH1610, 2BH1910 (two-impeller pump-motor units with a two-stage design)

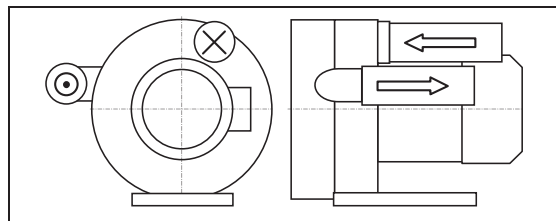


Fig. 9: 2BH1810 (two-impeller pump-motor unit with a two-stage design)

⚠ WARNING**Danger from rotating impeller:
Cutting/cutting of off extremities!**

The rotating impeller is accessible with the inlet and discharge connections open!

With free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere without piping, the following therefore applies:

Provide the inlet and discharge connections of the pump-motor unit either with additional mufflers or with additional piping of a sufficient length to prevent access to the impeller!

Connections:

To prevent foreign bodies from entering the unit, all connections are sealed off when delivered. Do not remove the sealing plugs until immediately before connecting the pipes/hoses.

The following applies for the arrangement of the pipe/hose connections:

The **pumped gases** are sucked in via the inlet connection (see Chapter 5.3.1, Pg. 19) and discharged via the discharge connection (see Chapter 5.3.2, Pg. 19).

The **shaft rotating direction** is marked with an arrow on the back of the vacuum pump/compressor housing (Fig. 1, Pg. 2, Item 7).

The **delivery direction of the gases** is marked with arrows on both connections (Fig. 1, Pg. 2, Item 6).

⚠ WARNING**Danger from interchanging inlet and pressure line!**

Interchanged inlet and pressure lines can lead to damage to the pump-motor unit and the system, and as a result of this to serious injuries!

Make sure that the inlet and pressure line cannot be confused when connecting.

Look for the clear marking with the arrow indicating the delivery direction on the inlet and discharge connections.

⚠ WARNING**Danger due to vacuum and gauge pressure!****Danger due to escaping fluid!**

During operation, connected pipes and vessels are vacuumized or pressurized!

Use only mounting elements, connections, lines, fittings and containers with sufficient freedom from leaks and strength for the pressures which occur.

Make sure that the mounting elements and connections are mounted sufficiently firmly and leak-free!

CAUTION

If the pumped gases are passed on on the discharge side in a closed pipe system, then it must be ensured that the pipe system is adapted to the maximum discharge pressure. See Chapter 3.3: "Operating conditions", Section "Pressures", Pg. 11. Connect a pressure relief valve upstream if necessary.

NOTICE

Attach pipes/hoses free of mechanical tensions. Support the weight of the pipes/hoses.

5.3.1 Inlet connection

The inlet connection with the related muffler (Fig. 1, Pg. 2, Item 3) is marked with an arrow pointing into the vacuum pump/compressor. Connect the inlet pipe here. The pumped gases are sucked in via this.

Procedure: see Chapter 5.3.3.

⚠ WARNING**Danger from solid bodies and impurities in the pump-motor unit!**

If solid bodies penetrate into the pump-motor unit, blades of the impellers can break and broken pieces can be thrown out.

Install a filter in the inlet pipe.

Replace filter regularly!

5.3.2 Discharge connection

The discharge connection with the related muffler (Fig. 1, Pg. 2, Item 4) is marked with an arrow pointing out of the vacuum pump/compressor. Connect the discharge pipe here. The pumped gases are discharged via this. Procedure: see Chapter 5.3.3.

5.3.3 Procedure when connecting pipes/hoses

Attach the pipes/hoses to the unit as described in the following. The pipes/hoses are connected differently to inlet and discharge connections depending on the muffler design and the type of line (pipe or hose):

- Muffler with inside threads:
The pipe is screwed directly into the muffler.
- Muffler without inside thread:
 - Screw threaded flange (available as an accessory) onto the muffler.
 - Screw the pipe into the threaded flange.
- Hose connection:
 - for 2BH1 Screw the hose flange (available as an accessory) onto the silencer.
 - Push the hose onto the hose flange and secure it with a hose clamp. See Chapter 3.1, "Mechanical data", Section "Tightening torques for screw connections", Pg. 10 for information on this topic.

6 Commissioning

WARNING

Improper use of the unit can result in serious or even fatal injuries!

Have you read the safety precautions in Chapter 1, "Safety", Pg. 3 f.? Otherwise you may not carry out any work with or on the pump-motor unit!

WARNING

Danger from rotating parts (external fan, impeller, shaft): Cutting/cutting off of extremities, Grasping/winding up of hair and clothing!

Danger due to vacuum and gauge pressure: sudden escape of fluids (skin and eye injuries), sudden drawing in of hair and clothing!

Danger due to escaping fluid: Burns!

Start-up and operation only under the following conditions:

- The pump-motor unit must be completely assembled. When doing so, pay particular attention to the following components:
 - the vacuum pump/compressor cover,
 - the muffler on inlet and discharge connections,
 - the fan guard.
- The pipes/hoses must be connected to inlet and discharge connections.
- Inlet and discharge connections and the connected pipes/hoses may not be closed, clogged or soiled.
- Check the mounting elements, connections of the pipe/hose connections, lines, fittings and containers for strength, leaks and firm seating at regular intervals.

6.1 Preparation

WARNING

Danger from closed connections!

With closed/soiled intake or discharge connections vacuum or gauge pressure results in the pump-motor unit.

This can overheat and damage the drive motor winding.

Before start-up, make sure that the inlet and discharge connections are not closed, clogged or soiled!

CAUTION

Before starting up again after a longer standstill: Measure the insulation resistance of the motor. With values $\leq 1 \text{ k}\Omega$ per volt of nominal voltage, the winding is too dry.

Measures before start-up:

- If a shut-off device is installed in the discharge pipe:
Make sure that the unit is NOT operated with the shut-off device closed.
- Before starting up the pump-motor unit, observe the values specified on the rating plate. Specifications on the drive-motor nominal current apply at a gas entry and ambient temperature of $+40^\circ \text{C}$ [104°F].
- Adjust the motor circuit breaker to the drive-motor nominal current.

Check direction of rotation:

- The intended rotating direction of the shaft is marked with arrows on the vacuum pump/compressor housing (Fig. 1, Pg. 2, Item. 7).
- The gas delivery direction is marked with arrows on the inlet and discharge connections (Fig. 1, Pg. 2, Item 6).
- Make sure the pipes/hoses on the inlet and discharge connections are properly connected.
- Switch the pump-motor unit on briefly and then off again.
- Compare the actual rotating direction of the external fan with the intended shaft rotating direction indicated with the arrows shortly before the pump-motor unit comes to a standstill.
- If necessary, reverse the direction of rotation of the motor.

⚠ WARNING

Danger due to rotating parts! Danger due to vacuum and gauge pressure! Danger due to escaping fluid!

Test runs may also only be conducted with the pump-motor unit completely mounted.

⚠ DANGER

Electrical danger!

The electrical connection may be carried out by trained and authorized electricians only!

⚠ DANGER

Electrical danger!

Before beginning work on the unit or system, the following measures must be carried out:

- Deenergize.
- Secure against being switched on again.
- Determine whether deenergized.
- Ground and short-circuit.
- Cover or block off adjacent energized parts.

6.2 Start-up and shut-down**Start-up**

- Open shut-off device in intake/discharge pipe.
- Switch on power supply for drive motor.

Shut-down:

- Switch off power supply for drive motor.
- Close shut-off device in intake/discharge pipe.

Check operating speeds:

Observe the operating speed specified on the rating plate. This may not be exceeded, as otherwise the noise radiation, vibration behavior, grease consumption duration and bearing change interval worsen. To prevent damage as a result of higher speeds, it may be necessary to inquire with the Service Department as to the maximum speed.

⚠ WARNING

Danger of hearing damage due to noise radiation!

For the noise emission of the pump-motor unit measured by the manufacturer, see Chapter 3.1, "Mechanical data", Section "Noise level", Pg. 8. However, the actual noise emission during operation is highly dependent on the installation and system conditions. Conduct a noise measurement in the system during operation after installing the pump-motor unit. The following measures can be taken from 85 dB(A) and must be taken from 90 dB(A):

- Mark noise area with a warning sign.
- Wear hearing protection.
- With free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere without piping, attach an additional muffler.

7 Operation

WARNING

Improper use of the unit can result in serious or even fatal injuries!

Have you read the safety precautions in Chapter 1, "Safety", Pg. 3 f.?

Otherwise you may not carry out any work with or on the pump-motor unit!

Also **be sure** to read the safety precautions in Chapter 6, "Commissioning", Pg. 21!

CAUTION

Danger of bearing damage!

Heavy mechanical impacts must be avoided during operating and while at a standstill.

Starting up and shutting down

See Chapter 6, "Commissioning", Sub-Chapter 6.2, "Start-up and shut-down", Pg. 22.

Also be sure to observe the following important notes especially for operation:

WARNING

Danger of burns from hot surfaces of the pump-motor unit and from hot fluids!

High temperatures of up to approx. 160°C [320°F] can occur on the surface of the pump-motor unit.

Do not touch during operation!

Allow to cool after shut-down!

CAUTION

Danger of overheating due to hot surface of pump-motor unit!

High temperatures of up to approx. 160°C [320°F] can occur on the surface of the pump-motor unit.

Temperature sensitive parts, such as lines or electronic components, may not come into contact with the surface of the pump-motor unit.

CAUTION

Danger of overheating!

During operation the standstill heating may, if installed, **not** be switched on!

CAUTION

Danger of rusting due to collection of condensed water in drive motor area!

On drive motors with closed condensed water openings:

Remove closures occasionally to allow any water which has collected to drain off.

8 Shut-Down and Longer Standstills

8.1 Preparing for shut-down or longer standstill

WARNING

Improper use of the unit can result in serious or even fatal injuries!

Have you read the safety precautions in Chapter 1, "Safety", Pg. 3 f.?

Otherwise you may not carry out any work with or on the pump-motor unit!

CAUTION

Danger of rusting due to collection of condensed water in drive motor area!

On drive motors with closed condensed water openings:

Remove closures occasionally to allow any water which has collected to drain off.

CAUTION

Danger of bearing damage!

Avoid mechanical shocks during operation and shut-down.

Prior to shut-down or longer standstill, proceed as follows:

- Switch off the pump-motor unit.
- Close shut-off device in inlet and pressure line if installed.
- Disconnect pump-motor unit from power supply.
- Release pressure.
When doing so, open pipes/hoses slowly and carefully so that the vacuum or gauge pressure in the pump-motor unit can be released.
- Remove pipes/hoses.
- Provide mufflers on inlet and discharge side with sealing plugs.

8.2 Storage conditions

To prevent standstill damage during storage, the environment must provide the following conditions:

- dry,
- dust-free,
- low-vibration ($V_{\text{eff}} \leq 2.8 \text{ mm/s}$ [0.11"/sec]).
- Ambient temperature:
min. -30°C [-22°F]
max. 40°C [+104°F].

CAUTION

Danger of overheating due to high temperature!

When storing in an environment with a temperature of over 40°C [104°F], the winding may be damaged and the grease change interval may be shortened.

Lubrication of rolling bearings after longer storage:

The new pump-motor unit may at first be stored following delivery. If the time from deliver to commissioning exceeds the following periods, the lubrication of the rolling bearings must be renewed:

- Under advantageous storage conditions (as specified above): 4 years.
- Under disadvantageous storage conditions (e.g. high humidity, salty air, sandy or dusty air): 2 years.

In these cases open rolling bearings must be relubricated and closed rolling bearings must be completely replaced. In this case be sure to inquire with the Service Department. In particular, exact information with regard to the procedure and grease type are required.

WARNING

Improper use of the unit can result in serious or even fatal injuries!

All maintenance work on the pump-motor unit must always be performed by the Service Department!

Maintenance work on the pump-motor unit may only be conducted by the operator itself when the related **maintenance manual** on hand!

Inquire with the Service Department!

Commissioning after longer standstill:

Before recommissioning after a longer standstill, measure the insulation resistance of the drive motor. With values $\leq 1 \text{ k}\Omega$ per volt of nominal voltage, the winding is too dry.

9 Servicing

WARNING

Improper use of the unit can result in serious or even fatal injuries!

Have you read the safety precautions in Chapter 1, "Safety", Pg. 3 f.?

Otherwise you may not carry out any work with or on the pump-motor unit!

WARNING

Improper use of the unit can result in serious or even fatal injuries!

All maintenance work on the pump-motor unit must always be performed by the Service Department!

Maintenance work on the pump-motor unit may only be conducted by the operator itself when the related **maintenance manual** on hand!

Inquire with the Service Department!

9.1 Emptying/Rinsing/Cleaning

Before any maintenance/servicing work, empty, rinse and clean the outside of the unit.

- Empty unit with air and rinse until all residues have been removed.
- Clean the outside of the unit with compressed air.
 - Wear gloves and protective safety glasses.
 - Secure the surrounding area.
 - Clean the entire surface of the unit and exterior fan with compressed air.

9.2 Repairs/troubleshooting

Fault	Cause	Remedy	Carried out by
Motor does not start; no motor noise.	At least two power supply leads interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
Motor does not start; humming noise..	One power supply lead interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
	Impeller is jammed.	Open vacuum pump/compressor cover, remove foreign body, clean.	Service*)
		Check or correct impeller gap setting if necessary.	Service
	Impeller defective.	Replace impeller.	Service*)
Protective motor switch trips when motor is switched on. Power consumption too high.	Rolling bearing on drive motor side or vacuum pump/compressor side defective.	Replace motor bearing or vacuum pump/compressor bearing.	Service*)
	Winding short-circuit.	Have winding checked.	Electrician
	Motor overloaded. Throttling does not match specification on rating plate.	Reduce throttling.	Service*)
		Clean filters, mufflers and connection pipes if necessary.	Service*)
	Compressor is jammed.	See fault: "Motor does not start; humming noise." with cause: "Impeller is jammed.".	Service*)

Fault	Cause	Remedy	Carried out by
Pump-motor unit does not generate any or generates insufficient pressure difference.	Leak in system.	Seal leak in the system.	Operator
	Wrong direction of rotation.	Reverse direction of rotation by interchanging two connecting leads.	Electrician
	Incorrect frequency (on pump-motor units with frequency converter).	Correct frequency.	Electrician
	Shaft seal defective.	Replace shaft seal.	Service ^{*)}
	Different density of pumped gas.	Take conversion of pressure values into account. Inquire with Service Department.	Service
	Change in blade profile due to soiling.	Clean impeller, check for wear and replace if necessary.	Service ^{*)}
Abnormal flow noises.	Flow speed too high.	Clean pipes. Use pipe with larger cross-section if necessary.	Operator
	Muffler soiled.	Clean muffler inserts, check condition and replace if necessary.	Service ^{*)}
Abnormal running noise.	Ball bearing lacking grease or defective.	Regrease or replace ball bearing.	Service ^{*)}
Compressor leaky.	Seals on muffler defective.	Check muffler seals and replace if necessary.	Service ^{*)}
	Seals in motor area defective.	Check motor seals and replace if necessary.	Service

^{*)} Only when the maintenance manual is at hand: rectification by the operator.

9.3 Service/After-sales service

Our Service is available for work (in particular the installation of spare parts, as well as maintenance and repair work), not described in these operating instruction.

A list of spare parts with an exploded drawing is available on the Internet at www.gd-elmorietschle.com.

Observe the following when **returning** pump-motor unit:

- The pump-motor unit must be delivered complete, i.e. not dismantled.
- The pump-motor unit may not present a danger to the workshop personnel.
Each pump motor unit on delivery to the workshop must be accompanied with a fully completed "Statement on health safety and on the protection of the environment", Pg. 29.
- The original rating plate of the pump-motor unit must be properly mounted, intact and legible.
All warranty claims are voided for pump-motor units delivered for a damage expertise without the original rating plate or with a destroyed original rating plate.
- In case of warranty claims, the manufacturer must be informed of the operating conditions, operating duration etc. and additional detailed information provided on request if necessary.

10 Disposal

Have the entire pump-motor unit scrapped by a suitable disposal company. No special measures are required when doing so.

For additional information on disposing of the unit, ask the Service Department.

11 Explosion-Protected Design

An additional set of operating instructions with supplementary or specific information is provided with these pump-motor units.

EU declaration of conformity

Manufacturer: Gardner Denver Deutschland GmbH
Industriestraße 26
97616 Bad Neustadt
Germany

Responsible for documentation: Holger Krause
Industriestraße 26
97616 Bad Neustadt
Germany

Designation: G series Side channel blower
G-BH1, G-BH9
Types 2BH1 1 2BH1 2 2BH1 3 2BH1 4
 2BH1 5 2BH1 6 2BH1 8 2BH1 9
 2BH9 23

The side channel blower described above meets the following applicable Community harmonisation legislation:

2004/108/EC^{*)} Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC

2006/42/EC Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC

The protection targets of the directive 2006/95/EC have been met

Harmonised standards applied:

EN 1012-1:2010	Compressors and vacuum pumps - Safety requirements - Part 1: Air compressors
EN 1012-2:1996 +A1:2009	Compressors and vacuum pumps - Safety requirements - Part 2: Vacuum pumps
EN ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction
EN 60204-1:2006	Safety of machinery - Electrical equipment of machines Part 1: General requirements

Bad Neustadt, 26.09.2011

(Place and date of issue)

Thomas Kurth, Managing Director

(Name and function)


(Signature)

^{*)} Only applicable for version with frequency converter 2FC

664.44434.40.000



Statement on health safety and on the protection of the environment

- For the safety of our employees and to comply with statutory requirements on handling substances harmful to the health and the environment, this statement must be enclosed, fully completed, with **each** unit/system sent.
- **Without the fully completed statement, repair/disposal is not possible and delays are unavoidable!**
- The statement is to be completed and signed by suitably qualified, authorised personnel at the operating organisation.
- In the case of shipment to Germany, the statement is to be completed in German or English.
- The statement is to be attached to the outside of the packing on shipment.
- If necessary, the carrier is to be informed.

1. **Product designation (type):**

2. **Serial number (no. BN):**

3. **Reason for sending:**

4. **The unit/system**

☐ has **not** come into contact with hazardous substances. There will be **no** hazards for personnel or the environment during repair/disposal. Continue with "6. Legally binding statement"

☐ has come into contact with hazardous substances. Continue with "5. Information on the contamination"

5. **Information on the contamination** (if necessary provide more information on an additional sheet)

The unit/system was used in the following application:

.....
and has come into contact with the following classifiable substances or substances presenting a hazard to health/environment:

Trade name:	Chemical designation:	Hazardous substance class:	Properties (e.g. toxic, inflammable, caustic, radioactive):

☐ The unit/system has been emptied in accordance with the operating instructions, flushed and cleaned externally.

☐ Safety data sheets in accordance with the applicable regulations are enclosed (..... sheet).

☐ The following safety precautions are necessary for handling (e.g. personal protective equipment):

.....
.....

6. **Legally binding statement**

I herewith guarantee that the details specified are true and complete and that I, as signatory, am in a position to judge that this is so.

We are aware that we are liable to the contractor for any damages arising from incomplete or incorrect specifications. We are obliged to indemnify the contractor against claims for damages by third parties arising from incomplete or incorrect specifications. We are aware that, irrespective of this statement, we are directly liable to third parties - in particular including the contractor's employees tasked with repair/disposal.

Company/institute:

Name, position: Phone:

Street: Fax:

Post code, city:

Country: Stamp:

Date, signature:

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**Gardner
Denver**

Elmo Rietschle is a brand of
Gardner Denver's Industrial Products
Group and part of Blower Operations.



B-7911 - Blower, Cincinnati LM-4, 4.3" X 2.9" Width Alum wheel
B7914 - Blower, Cincinnati, LM-6, Direct drive

cincinnati fan

Form: OMM-01-0509
Effective: 5/4/09
Supersedes OMM-01-0207
Part No.: 01218

Installation, Safety, Operation & Maintenance Instructions And Parts List For Models PB, PBS, SPB, LM and LMF. Arrangement 4 Blowers

NOTE

READ ENTIRE MANUAL, INCLUDING "SECTION IV. INITIAL UNIT STARTUP" BEFORE
ATTEMPTING TO INSTALL AND OPERATE THIS EQUIPMENT.

BLOWER SPECIFICATIONS

BLOWER SERIAL NUMBER: _____ **MFG. DATE:** _____

NOTE: The serial number above is a required reference for any assistance. It is stamped on the blower nameplate.

BLOWER SPECIFICATIONS:

Model: _____ **Arrangement:** _____ **Rotation:** _____ **Discharge:** _____

Nominal Inlet Size: _____ (in Inches) **Wheel Size and Type:** _____

BLOWER PERFORMANCE DATA: (If entered on order)

CFM: _____ **SP:** _____ (Inches of Water Gauge) **Motor BHP:** _____

Density: _____ **Altitude:** _____ (Ft. above S.L.) **Airstream Temperature:** _____ °F.

Fan RPM: _____ **Maximum Safe Fan RPM:** _____ **DO NOT EXCEED THIS RPM**

MOTOR DATA: (This section is completed only if the motor was supplied by Cincinnati Fan)

HP: _____ **RPM:** _____ **Voltage:** _____ **Phase:** _____

Hz: _____ **Frame Size:** _____ **Enclosure:** _____ **Efficiency:** _____

IF Motor is EXP, Class(es) & Group(s) are: _____

Manufacturers Model Number: _____ **CFV Part Number:** _____

ATTENTION: RECEIVING DEPARTMENT

All Cincinnati Fan products are packaged to minimize any damage during shipment. The freight carrier is responsible for delivering all items in their original condition as received from Cincinnati Fan. The individual receiving this equipment is responsible for inspecting this unit for any obvious or concealed damage. If any damage is found, it should be noted on the bill of lading before the freight is accepted and the receiver must file a claim with the freight carrier.

LONG TERM STORAGE NOTICE

If this blower will NOT be installed and put into operation within 30 days, refer to the "Long Term Storage Instructions" on pages 12 and 13. Failure to follow all applicable long term storage instructions, will void your warranty. This blower should be stored indoors in a clean, dry location.

⚠ DANGER

				
Hazardous voltage can cause electrical shock and death.	High speed rotating equipment can cause severe personal injury.	Lock out/Tag out to prevent personal injury <u>BEFORE</u> starting <u>ANY</u> service or inspection.	Avoid injury. <u>NEVER</u> operate without <u>ALL</u> required safety guards in place.	Avoid injury. You <u>MUST</u> read and understand all instructions in this manual <u>BEFORE</u> installing.

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I. GENERAL

A. Unpacking:

Be careful not to damage or deform any parts of the blower when removing it from the packaging container. **All the packaging material should be kept in the event the blower needs to be returned.**

Handling:

Handling of the blower should be performed by trained personnel and be consistent with all safe handling practices. Verify that all lifting equipment is in good operating condition and has the proper lifting capacity. The blower should be lifted using well-padded chains, cables or lifting straps with spreader bars. Some blower models have lifting eye locations provided in the blower base. **NEVER lift the blower by an inlet or discharge flange, motor shaft, motor eye bolt, or any other part of the blower assembly that could cause distortion of the blower assembly.**

B. Safety Instructions & Accessories:

1. Safety Instructions:

All installers, operators and maintenance personnel should read AMCA Publication 410-96, “**Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans**”. This manual is included with the blower. Additional copies can be requested by writing us at Cincinnati Fan, 7697 Snider Rd., Mason, OH 45040-9135

2. Sound:

Some blowers can generate sound that could be hazardous to personnel. It is the responsibility of the user to measure the sound levels of the blower and/or system, determine the degree of personnel exposure, and comply with all applicable safety laws and requirements to protect personnel from excessive noise.

3. Air Pressure and Suction:

In addition to the normal dangers of rotating machinery, the blower can present additional hazards from the suction or pressure created at the blower inlet or discharge. Suction at the blower inlet can draw materials into the blower where they become high velocity projectiles at the discharge and cause severe personal injury or death. It can also be extremely dangerous to persons in close proximity to the inlet or discharge as the forces involved can overcome the strength of most individuals.

WARNING

NEVER OPERATE A BLOWER WITH A NON-DUCTED INLET AND/OR DISCHARGE. IF THE BLOWER INLET AND/OR DISCHARGE IS NON-DUCTED, IT IS THE USERS RESPONSIBILITY TO INSTALL AN INLET AND/OR DISCHARGE GUARD.

4. Temperature:

Many blowers, blower components and all motors operate at temperatures that could burn someone if they come in contact with them. If this potential hazard could exist in your installation, steps must be taken by the user to protect anyone from coming in contact with this equipment.

5. Spark Resistance; (Per AMCA Standard 99-0401-86 and ISO 13499)

DANGER

NO GUARANTEE OF ANY LEVEL OF SPARK RESISTANCE IS IMPLIED BY SPARK RESISTANT CONSTRUCTION. IT HAS BEEN DEMONSTRATED THAT ALUMINUM IMPELLERS RUBBING ON RUSTY STEEL CAN CAUSE HIGH INTENSITY SPARKS. AIR STREAM MATERIAL AND DEBRIS OR OTHER SYSTEM FACTORS CAN ALSO CAUSE SPARKS.

6. Safety Accessories;

Guards:

All moving parts must be guarded to protect personnel. Safety requirements can vary, so the number and types of guards required to meet company, local, state and OSHA regulations must be determined and specified by the actual user or operator of the equipment.

NEVER start any blower without having all required safety guards properly installed. All blowers should be checked on a regular schedule, for missing or damaged guards. If any required guards are found to be missing or defective, the power to the blower should be immediately turned off and locked out in accordance with OSHA regulations. Power to the blower should **NOT** be turned back on until the required guards have been repaired or replaced.

This blower can become dangerous due to a potential “windmill” effect, even though all electrical power has been turned off or disconnected. The blower wheel should be carefully secured to prevent any rotational turning **BEFORE** working on any parts of the blower/motor assembly that could move.

7. Access or Inspection Doors:

DANGER

NEVER OPEN ANY ACCESS OR INSPECTION DOORS WHILE THE BLOWER IS OPERATING. SERIOUS INJURY OR DEATH COULD RESULT FROM THE EFFECTS OF AIR PRESSURE, AIR SUCTION OR MATERIAL THAT IS BEING CONVEYED. DISCONNECT OR LOCK OUT POWER TO THE BLOWER AND LET THE BLOWER WHEEL COME TO A COMPLETE STOP BEFORE OPENING ANY TYPE OF ACCESS OR INSPECTION DOOR.

II. INSTALLATION

A. Vibration:

Before any mounting method is selected, the user should be aware of the effects vibration will have on the blower, motor and other parts. Improper blower installation can cause excessive vibration causing premature wheel and/or motor bearing failure, that is not covered under warranty. Vibration eliminator pads, springs or bases should be properly installed to prevent any blower vibration from transmitting to the foundation, support structure or ducting.

WARNING

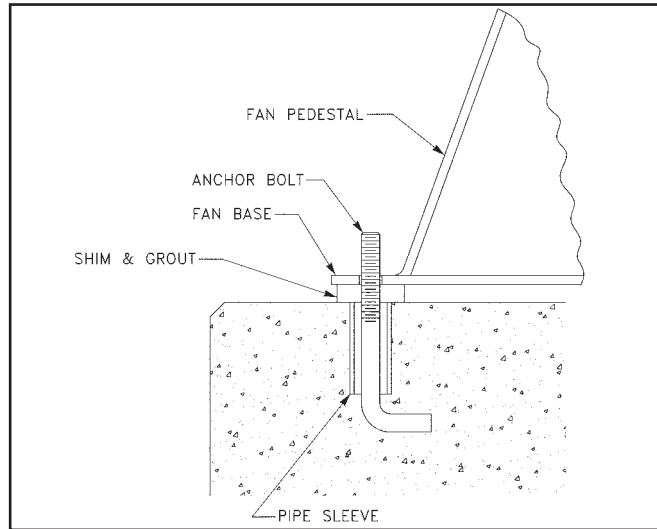
SHUT THE BLOWER DOWN IMMEDIATELY IF THERE IS ANY SUDDEN INCREASE IN VIBRATION.

B. Mounting Methods:

1. Floor Mounted Units;

Centrifugal blowers should be mounted on a flat, level, concrete foundation weighing 2-3 times the weight of the complete blower/motor assembly. It is recommended that the foundation be at least 6 inches larger than the base of the blower. The foundation should include anchor bolts such as shown in **Fig. 1** on page 4. Place the blower over the anchor bolts and shim under each bolt until the blower is level. After shimming, flat washers, lock washers and lock nuts should be tightened at each anchor bolt. Any gaps between the blower base and the foundation should be grouted. If the blower will be sitting on some type of vibration pads or mounts, follow the recommended mounting procedures supplied with the vibration elimination equipment.

Fig. 1



2. Elevated Units;

Improper mounting of elevated blowers can cause vibration problems. The structure that the blower/motor assembly will be mounted on must be strong enough to support at least 3 times the weight of the entire blower/motor assembly. **An insufficient support will cause excessive vibration and lead to premature wheel and/or motor bearing failure.** Bracing of the support structure must be sufficient enough to prevent any side sway. The entire structure should be welded at all connection joints to maintain constant alignment of the platform.



DANGER

THE IMPROPER DESIGN OF AN ELEVATED PLATFORM STRUCTURE COULD RESULT IN A RESONANT CONDITION, AND CONSEQUENTLY, CAUSE A LIFE THREATENING, CATASTROPHIC, STRUCTURAL FAILURE.

C. Duct Work Connections:

All duct connections to the blower should include flexible connectors between the ducting and the blower inlet and/or discharge. This will eliminate distortion, noise and vibration from transmitting to the duct and building. The connectors should be selected to handle the operating conditions for air volume and pressure that the blower will produce. **All ducting or accessories, added by the user, should be independently supported. DO NOT use the blower/motor assembly to support any additional weight.** Inlet and/or discharge duct elbows should be located a minimum of 2 blower wheel diameters from the blower. Any duct elbows located closer than 2 wheel diameters to the blower inlet or discharge **WILL** reduce the air performance and blower efficiency. Any duct elbows near the blower discharge should be in the **same rotational direction** as the **blower rotation**.

Non-Ducted Blower Inlet:

Any blower with no ducting on the inlet **must** have an inlet guard. The blower should be located so the blower inlet is, at least, 1 wheel diameter away from any wall or bulkhead to eliminate a reduction in air flow.

Non-Ducted Blower Discharge:

Any blower with no ducting on the discharge **must** have a discharge guard.

D. Safety Guards:

Cincinnati Fan offers guards, as optional, to keep your blower in compliance with OSHA safety regulations. These include inlet or discharge guards. Any blowers built with high temperature construction, a "heat slinger guard" is standard. It is the responsibility of the user to make sure this blower meets all local, state and OSHA safety regulations. If you have a specific guard requirement not covered by OSHA, please contact the local Cincinnati Fan sales office for assistance.

E. Dampers and Valves: (Airflow control devices)

If the blower is supplied with any type of air flow control device, it should be closed before initial start-up of the blower to minimize overloading of the motor. Any airflow control device, with bearings, should be maintained in accordance with the manufacturers instructions. Any air flow control device, with an automatic control mechanism, should be adjusted per the manufacturers recommendations.

F. Set Screw and Taper-lock Bushing Torque Values:

All blower wheel set screws are tightened to the proper torque prior to shipment. Some wheels may have taper-lock hubs and split, taper-lock bushings to secure the wheel to the motor shaft.

NOTE: Check all set screw or taper-lock bushing torques. Forces encountered during shipment, handling, rigging and temperature can affect factory settings. For correct torque values, see **Tables 1** and **2** below.

Table 1

SET SCREW TORQUE VALUES		
Diameter & Number of Treads/Inch	Hex Wrence Size (Across Flats)	Required Torque (Inch Pounds)
1/4-20	1/8"	65
5/16-18	5/32"	165
3/8-16	3/16"	228
7/16-14	7/32"	348
1/2-13	1/4"	504
5/8-11	5/16"	1104

Table 2

TORQUE VALUES FOR TAPER-LOCK BUSHINGS	
Taper-lock Bushing Size	Required Torque (Inch Pounds)
H	95
B	192
P	192
Q	350
R	350

CAUTION

Set screws should **NEVER** be used more than once. If the set screws are loosened, they **MUST** be replaced. Use only knurled, cup-point, set screws with a nylon locking patch.

III. ELECTRICAL

A. Disconnect Switches:

All blower motors should have an independent disconnect switch located in close visual proximity to turn off the electrical service to the blower motor. **Disconnects must be locked out in accordance with OSHA "lock out-tag out" procedures any time inspection or maintenance is being performed on the blower and/or motor assembly. The "lock out-tag out" procedure should be performed by a licensed electrician or authorized personnel.**

All disconnects should be sized in accordance with the latest NEC codes (National Electric Codes) and any local codes and should be installed only by a licensed electrician. "Slow blow" or "time delay" fuses or breakers should be used since the initial start-up time for the blower motor, although rare, can be up to 10 seconds.

B. Motors:

DANGER

ALL WIRING CONNECTIONS, INSPECTION AND MAINTENANCE OF ANY MOTOR MUST BE PERFORMED BY A LICENSED ELECTRICIAN IN ACCORDANCE WITH THE MOTOR MANUFACTURERS RECOMMENDATIONS, ALL ELECTRICAL CODES AND OSHA REGULATIONS. FAILURE TO PROPERLY INSTALL, MAKE WIRING CONNECTIONS, INSPECT OR PERFORM ANY MAINTENANCE TO A MOTOR CAN RESULT IN MOTOR FAILURE, PROPERTY DAMAGE, EXPLOSION, ELECTRICAL SHOCK AND DEATH.

1. **DO NOT** connect or operate a motor without reading the motor manufacturers instructions supplied with the blower. The basic principle of motor maintenance is: **KEEP THE MOTOR CLEAN AND DRY.** This requires periodic inspections of the motor. The frequency of the inspections depends on the type of motor, the service and environment it will be subjected to and the motor manufacturers instructions.
2. **Cleaning:** Cleaning should be limited to exterior surfaces only. **Follow motor manufacturers cleaning instructions.**
3. **Lubrication:** Most small motors have sealed bearings that are permanently lubricated for the life of the motor. Some larger motors have grease plugs that should be replaced with grease fittings to perform re-lubrication. These motors, or any motor with grease fittings, should be lubricated in accordance with the motor manufacturers recommendations. Lubrication frequency depends on the motor horsepower, speed and service. **BE SURE** you use compatible grease and **DO NOT** over grease.
4. **Location:** If the motor will be outside and subjected to the weather, it is recommended that a weather cover be installed to keep rain and snow off of the motor. No motors are guaranteed to be "watertight". Be careful to allow enough openings between the motor and the motor cover to let the motor "breathe". If the back end of the motor is covered, the cover should be no closer than 3" to the back of the motor for proper ventilation.

5. **Wiring Connections:** All wiring connections should be made for the proper voltage and phase as shown on the motor nameplate. Connections should follow the motor manufacturers recommendations as shown on the wiring schematic. This wiring diagram will be located on the outside of the motor, inside of the motor conduit box or on the motor nameplate. **Reversing some wires might be necessary to get the correct blower rotation.**
6. **Motors with Thermal Overload Protection:** If a motor is equipped with thermal overloads, the thermal overload must be wired per the wiring schematic to be operable. **There are 3 types of thermal overloads:**
- a. **Automatic:** These will automatically shut the motor down if the internal temperature exceeds the design limits.

 DANGER

MAKE SURE YOU LOCK OUT THE POWER TO THE MOTOR BEFORE INSPECTING ANY MOTOR WITH AUTOMATIC THERMALS. WHEN THE THERMALS COOL DOWN, THEY WILL ALLOW THE MOTOR TO AUTOMATICALLY START UP AGAIN, UNLESS YOU HAVE LOCKED OUT THE POWER TO THE MOTOR.

- b. **Manual:** These motors will have a button on them. If the motor overheats, it will shut down. After you have inspected the motor and eliminated the over heating problem, you will need to “reset” it by pushing the button. **You should still lock out the power BEFORE inspecting the motor.**
 - c. **Thermostats:** This type of thermal is a temperature sensing device **ONLY**. If the motor overheats, the thermostats will open or close (depending on the type) and send a “signal” to the electrical box. **THEY WILL NOT TURN THE MOTOR OFF.** These are pilot circuit devices that must be connected to the magnetic starter circuit.
7. **EXPLOSION PROOF Motors:** No motor is explosion proof. Explosion proof (EXP) motors are designed so if there is an explosion **WITHIN** the motor, the explosion will be **CONTAINED INSIDE** the motor and not allowed to get out to the atmosphere. All explosion proof motors must be selected based on the atmosphere and/or the environment the motor will be operating in. Explosion proof motors are designed, rated, and labeled for their operating conditions based on Classes, Groups and “T” Codes. **The Class, Group and “T” Code of an EXP motor MUST be selected based on the atmosphere and/or environmental conditions the motor will be operating in. Consult the NEC (National Electric Code) and the NFPA (National Fire Protection Association) for the proper EXP motor Class, Group and “T” Code required for your specific application and location.**

 DANGER

IF AN EXPLOSION PROOF MOTOR IS USED IN AN AREA CONTAINING VOLITILE LIQUIDS, GASES, FUMES OR DUST FOR WHICH THE MOTOR WAS NOT DESIGNED TO OPERATE IN, AN EXPLOSION AND/OR FIRE CAN OCCUR.

NOTICE:

- a. All EXP motors have some type of thermal overload as required by UL (Underwriters Laboratories). Refer to all of Section 6 above.
- b. All EXP motors are required to have the UL (Underwriters Laboratories) and CSA (Canadian Standards Association) listing numbers on the motor name plate or on a separate plate attached to the motor. The Class, Group and “T” Code the motor is designed for must also be listed.

8. Normal Motor Operating Temperatures:

Using your hand to test the normal running temperature of a motor can be a very painful experience;

The normal operating temperature of a fully loaded, open type, electric motor operating in a 70°F. (21° C.) ambient temperature is 174°F. (79° C.)

C. Maximum Blower Speed and Motor Speed Controllers:

If you will be using any type of motor speed controller with this blower, **DO NOT** exceed the **maximum safe blower speed**. Installing and using a speed control device requires special training and certification as required by the speed control manufacturer. See the manufacturers instructions for proper use, installation and wiring connections for the maximum speed settings. It may also be necessary to “block out” some speeds to eliminate a resonant vibration problem. The maximum safe blower speed is shown on the data sheet shipped with the blower. If you have lost the data sheet, contact Cincinnati Fan or our sales office for your area. You must have the serial number from the **blower** name plate for us to determine the maximum safe blower speed. Cincinnati Fan will only extend the motor manufacturers warranty, when used with a speed controlling device, if the motor has the words “**Inverter Duty**” marked on the motor name plate. If the motor does not have “**Inverter Duty**” marked on the motor name plate, and you have a motor failure, you will be required to contact the motor manufacturer for any service or warranty claims.

IV. INITIAL UNIT STARTUP

NOTICE: Failure to complete and document all the following pre-startup and both post-startup checks, listed in sections A (below) and B on page 8, could void all warranties.

A. Pre-Startup & Post-Startup Checks: (Check blocks as each step is completed. Retain this for your records.)

A1. Pre-Startup Checks Completed By: _____

DATE: _____

A2. 8 Hour, Post-Startup Checks Completed By: _____

DATE: _____

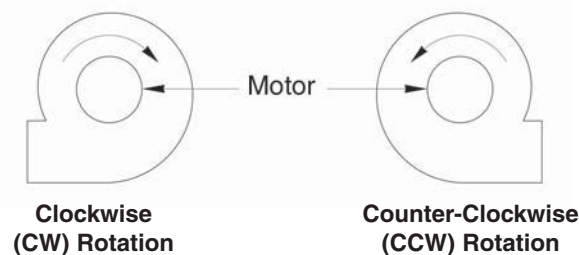
A3. 3 Day, Post-Startup Checks Completed By: _____

DATE: _____

MAKE SURE POWER TO THE MOTOR IS LOCKED OUT BEFORE STARTING PRE-STARTUP OR POST-STARTUP CHECKS.

1. ☐ ☐ ☐ If possible, **CAREFULLY** spin the blower wheel by hand to ensure it rotates freely and no rubbing or clicking noise is heard.
2. ☐ ☐ ☐ Check all blower, foundation and duct work hardware to make sure it is tight.
3. ☐ ☐ ☐ Check all blower wheel set screws to make sure they are tight per **Table 1** on page 5.
4. ☐ ☐ ☐ If the wheel has a taper-lock bushing, make sure the bolts are tightened per **Table 2** on page 5.
5. ☐ ☐ ☐ Make certain there is no foreign material in the blower or duct work that can become a projectile.
6. ☐ ☐ ☐ Make sure any inspection doors in the duct work are securely bolted or locked.
7. ☐ ☐ ☐ Ensure all electrical power components are properly sized and matched for your electrical system.
8. ☐ ☐ ☐ Check that all required guards are properly secured.
9. ☐ ☐ ☐ Any dampers should be fully opened and closed to make sure there is no binding or interference.
10. ☐ ☐ ☐ If your blower is mounted on an elevated support structure, make sure the structure is welded at all the joint connections and the structure is properly braced to prevent "side sway".
11. ☐ ☐ ☐ Close any dampers to minimize load on motor. Especially on blowers with high temperature construction. **Never** subject a "cold" blower to a "hot" gas stream. If the blower will be handling "hot gases" greater than 150°F (65°C) it is imperative that the blower be subjected to a gradual rate of temperature increase, not to exceed 15°F/minute (8°C/minute). The same temperature limits are also important when the blower is experiencing a drop in temperature until the temperature drops down to 150°F (65°C). Only, when the entire blower has reached an equilibrium temperature of 150°F (65°C), or less, should the power be turned off.
12. ☐ ☐ ☐ Make sure the power source connections to the blower motor are per the motor manufacturers instructions.
13. ☐ ☐ ☐ Make sure the blower wheel is stationary prior to startup. **Starting a blower with a wheel that is rotating backwards can cause wheel damage.**
14. ☐ ☐ ☐ Apply power to the blower motor momentarily (i.e. "bump start") to check for proper blower wheel rotation. If the blower is rotating in the wrong direction, reconnect the motor leads per the motor manufacturers wiring schematic. **Blower rotation is determined by viewing the blower from the motor side of the blower, NOT from the inlet side.** After reconnecting the leads, repeat this step. **See Fig. 2 below.**

Fig. 2



15. ☐ ☐ ☐ Apply power to the blower motor and let it come up to full speed. **Turn off the power.** Look and listen for any unusual noise or mechanical abnormality while the blower wheel is still spinning. If any are noticed, lock out the power, wait for the blower wheel to come to a complete stop, locate the cause and correct it.
16. ☐ ☐ ☐ Unlock power and start the blower.
17. ☐ ☐ ☐ Measure, record and keep the following motor data for future reference and comparison:
(Single phase motors will only have L1 and L2 leads)

Amperage draw on each motor lead: L1 _____ L2 _____ L3 _____

(Running amps SHOULD NOT exceed the motor nameplate amps for the voltage being operated on)

Voltage coming to motor leads: L1 _____ L2 _____ L3 _____

(Should be about the same input voltage on all leads)

B. Vibration:

The blower was balanced at the factory to comply with ANSI/AMCA Standard 204-05, Category BV-2. However, rough handling in shipment and/or erection, weak and/or non-rigid foundations, and misalignment may cause a vibration problem after installation. After installation, the vibration levels should be checked by personnel experienced with vibration analysis and vibration analysis equipment.

NOTE:

The blower **SHOULD NOT** be operated if the vibration velocity of the fan exceeds 0.50 inches per second, filter out, if the blower is rigidly mounted. If the blower is mounted on isolators or on an isolator base, it **SHOULD NOT** be operated if the vibration velocity of the blower exceeds 0.75 inches per second, filter out.

Vibration readings for direct driven blowers should be taken on the motor at the top, sides and end as per **Fig. 3** below. After you have taken your vibration readings, write them down in the spaces below and keep for future comparison.

DANGER

If the blower is going to be conveying material, it is the users responsibility to periodically turn the blower off and lock out the power. The blower wheel should then be checked for material build-up and/or erosion. If material has built up on any parts of the wheel, it **MUST** be removed and cleaned before it is put back into service. If any parts of the wheel have been eroded, the wheel **MUST** be replaced. Failure to perform this inspection can cause excessive vibration that will damage the blower and/or motor bearings. When vibration becomes excessive, it will lead to complete blower failure that could cause property damage, severe personal injury and death. The user must determine the frequency of this inspection based on the actual circumstances of their operation, **BUT** checking the vibration readings should **NEVER** exceed a 12 month period. For the AMCA/ANSI standard for vibration limits, see Fig. 4 on page 9.

Fig. 3

VIBRATION METER PROBE POSITIONS

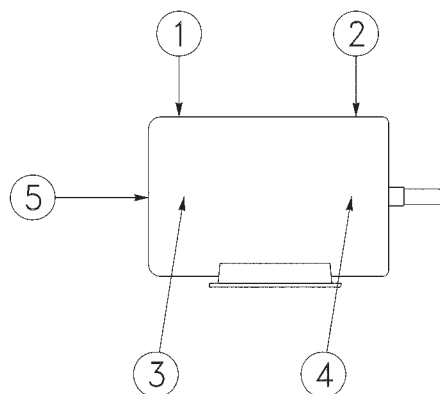
For Arrangement 4 Blowers

1	2	3	4	5
---	---	---	---	---

A _____

B _____

C _____

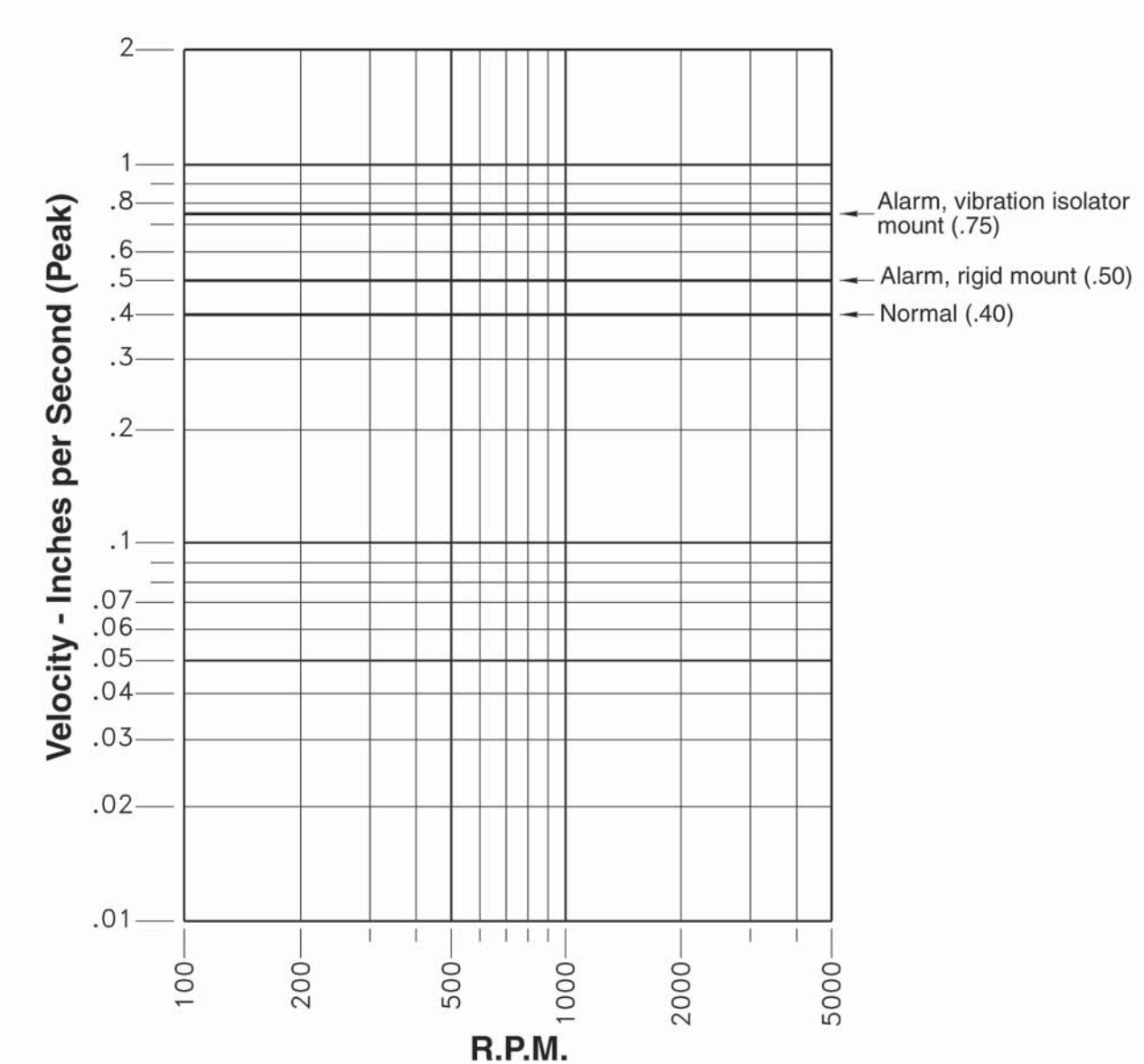


A Pre-Startup Readings taken by: _____ Date: _____

B 8 Hour Post-Startup Readings taken by: _____ Date: _____

C 3 Day Post-Startup Readings taken by: _____ Date: _____

Fig. 4 Vibration Severity Chart



V. ROUTINE INSPECTION & MAINTENANCE

Periodic inspection of all the blower parts is the key to good maintenance and trouble-free operation. The frequency of inspections must be determined by the user and is dependent upon the severity of the application. **BUT**, it should **NEVER** exceed a 12 month period. The user should prepare an inspection and maintenance schedule and make sure it is adhered to.

WARNING

BEFORE STARTING ANY INSPECTION OR MAINTENANCE, BE SURE BLOWER IS TURNED OFF, POWER IS LOCKED OUT AND THE BLOWER WHEEL HAS BEEN CAREFULLY SECURED TO PREVENT WIND MILLING. IF THE OPERATING CONDITIONS OF THE BLOWER ARE TO BE CHANGED (SPEED, PRESSURE, TEMPERATURE, ETC.) CONSULT CINCINNATI FAN, OR OUR SALES OFFICE FOR YOUR TERRITORY, TO DETERMINE IF THE UNIT WILL OPERATE SAFELY AT THE NEW CONDITIONS.

A. Hardware:

All blower and foundation hardware should be checked to make sure it is tight. Wheel set screws or taper-lock bushings should be tightened to the torque values shown in **Tables 1 and 2** on page 5.

NOTE: If any set screws have come loose, they must be thrown away and replaced. **NEVER** use set screws more than once. **Replace with knurled, cup-point set screws with a nylon locking patch.**

B. Motor Bearing Lubrication:

1. Motor Bearings:

Most smaller motors have sealed bearings that never require re-lubrication for the life of the motor. For any motors with grease fittings, consult the motor manufacturers recommendations with reference to the lubrication frequency and the type of grease that should be used.

DO NOT over grease the motor bearings. Generally, 1-2 shots should be enough. Use a hand operated grease gun at no more than 40 PSI. **IF POSSIBLE, CAREFULLY lubricate the motor bearings while the motor is running.**

C. Wheel Balance:

All blower wheels are balanced at the factory. It is not uncommon that additional “trim balancing” is required after the blower is assembled. Trim balancing of the blower assembly, in the field, is typically always necessary for all replacement wheels. **After any wheel is installed, the final balance of the entire blower assembly should be checked.** Refer to Section B on page 8 and Fig. 4 on page 9. Air stream material or chemicals can cause abrasion or corrosion of the blower parts. This wear is generally uneven and, over time, will lead to the wheel becoming unbalanced, causing excessive vibration. When that happens, the wheel must be rebalanced or replaced. The other air stream components should also be inspected for wear or structural damage and cleaned or replaced if necessary. **After cleaning any blower wheel, it should be balanced and then “trim balanced” on the motor shaft.**

There are three ways to balance a blower wheel:

1. Add balancing weights for fabricated aluminum, steel or stainless steel wheels:

Balance weights should be rigidly attached to the wheel at a location that will not interfere with the blower housing nor disrupt air flow. They should (if at all possible) be welded to the wheel. When trim balancing the wheel, **on the blower**, be sure to ground the welder **directly** to the blower wheel. Otherwise, the welding current will likely pass through the motor and damage the motor bearings.

2. Grinding off material for cast aluminum wheels:

If you are grinding on the wheel to remove material, be very careful not to grind too much in one area. That could affect the structural integrity of the wheel.

3. Forward curved wheels, Model LM only (also known as squirrel cage or multivane wheels).

These wheels have balancing clips attached to individual blades around the wheel. That is the only proper way to balance this type of wheel.

NOTE:

Removing any forward curve wheel from the blower to clean it, requires special attention when reinstalling the wheel back into the blower housing. Make sure you reinstall the wheel so the proper wheel-to-inlet clearance is maintained. Failure to do this will affect the blowers airflow (CFM), static pressure (SP) capabilities and efficiency. Consult Cincinnati Fan or our local sales office for your area for assistance if necessary.

D. Vibration:

As mentioned previously in this manual, excessive vibration can cause premature motor bearing failure that could lead to catastrophic failure of the blower. After performing any routine maintenance, the vibration readings should be taken again. New readings should be taken (maximum every 12 months) and compared to the readings you recorded in **Figure 3**, on page 8, during the initial startup. **If any major differences are present, the cause should be determined and corrected before the blower is put back into operation.**

The most common causes of vibration problems are:

1. Wheel unbalance.
2. Mechanical looseness.
3. Poor blower inlet and/or discharge conditions.
4. Foundation stiffness.

E. Dampers and Valves: (Airflow control devices)

Turn off and lock out power to the blower motor. Any dampers or valves should be periodically inspected to make sure all parts are still operable within their full range and there is no interference with any other damper or blower components. Any bearings or seals should be checked for their proper function. The manufacturers maintenance instructions should be followed.

F. Safety Equipment & Accessories:

It is the users responsibility to make sure that all safety guards required by the company, local, state and OSHA regulations are properly attached and fully functional at all times. If any guards become defective or non-functional at any time, **the power to the blower MUST be turned off and locked out** until complete repairs and/or replacements have been made, installed and inspected by authorized personnel.

Any accessories used in conjunction with the blower should also be inspected to make sure they are functioning within their intended limits and design specifications. The manufacturers maintenance manuals should be referred to for correct maintenance procedures. These accessories include, but are not limited to, the following:

Shaft seals, inspection doors, vibration isolators or vibration bases, air flow or pressure measuring equipment, hoods, controls, special coatings, silencers, expansion joints, valves, flexible connectors and filters.

VI. ORDERING REPLACEMENT PARTS:

Under normal conditions, you should not need any spare or replacement parts for at least 24 months after shipment from Cincinnati Fan. That does not include any wear due to abrasion, corrosion, excessive temperatures, abuse, mis-use, accident or any severe conditions the fan was not designed for.

NOTICE:

1. If this blower is vital to any process that could cost you lost revenue, we strongly recommend that you keep a replacement blower wheel and motor at your location.
2. If this blower is vital for the safety of any people and/or animals, we strongly recommend that you keep a complete blower/motor assembly, as originally ordered, at your location.

To order any parts or complete units, contact us for the name of our sales office for your area. Or you can find them on our website at: www.cincinnati-fan.com

WE MUST HAVE THE BLOWER SERIAL NUMBER FROM THE BLOWER NAME PLATE TO IDENTIFY PARTS CORRECTLY.

VII. TROUBLESHOOTING

DANGER

Troubleshooting should only be performed by trained personnel. Any potential electrical problems should only be checked by a licensed electrician. All safety rules, regulations and procedures **MUST** be followed. Failure to follow proper procedures can cause property damage, severe bodily injury and death.

Potential problems and causes listed below are in no order of importance or priority. The causes are only a list of the most common items to check to correct a problem. If you find the cause of a problem, **DO NOT** assume it is the **ONLY** cause of that problem. Different problems can have the same causes.

PROBLEM	CAUSE
Excessive Vibration	1. Loose mounting bolts, wheel set screws, taper-lock hubs. 2. Worn or corroded blower wheel. 3. Accumulation of foreign material on blower wheel. 4. Bent motor shaft. 5. Worn motor bearings. 6. Motor out of balance. 7. Inadequate structural support. 8. Support structure not sufficiently cross braced. 9. Weak or resonant foundation. 10. Foundation not flat and level.
Airflow (CFM) Too Low	1. Blower wheel turning in wrong direction (rotation). 2. Actual system static pressure (SP) is higher than expected. 3. Motor speed (RPM) too low. 4. Dampers or valves not adjusted properly. 5. Leaks or obstructions in duct work. 6. Filters dirty. 7. Inlet and/or discharge guards are clogged. 8. Duct elbow too close to blower inlet and/or discharge. 9. Improperly designed duct work 10. Blower wheel not properly located relative to the inlet bell (LM Model only).
Airflow (CFM) Too High	1. Actual system static pressure (SP) is lower than expected. 2. Motor speed (RPM) too high. 3. Filter not in place. 4. Dampers or valves not adjusted properly.

PROBLEM	CAUSE
Motor Overheating	NOTE: A normal motor will operate at 174°F. See B-8 on page 6. 1. Actual system static pressure (SP) is lower than expected. 2. Voltage supplied to motor is too high or too low. 3. Motor speed (RPM) too high or defective motor. 4. Air density higher than expected. 5. Motor wired incorrectly or loose wiring connections. 6. Cooling fan cover on back of motor is clogged. (Fan cooled motors only.)
Excessive Noise	1. Wheel rubbing inside of housing. 2. Worn or corroded blower wheel. 3. Accumulation of foreign material on blower wheel. 4. Loose mounting bolts, wheel set screws, or taper-lock hubs. 5. Bent motor shaft. 6. Worn motor bearings. 7. Motor out of balance. 8. Motor bearings need lubrication. 9. Vibration originating elsewhere in system. 10. System resonance or pulsation. 11. Inadequate or faulty design of blower support structure. 12. Blower operating near “stall” condition due to incorrect system design or installation.
Fan Doesn't Operate	1. Motor wired incorrectly. 2. Incorrect voltage supply. 3. Defective fuses or circuit breakers. 4. Power turned off elsewhere. 5. Motor wired incorrectly or loose wiring connections. 6. Defective motor.

VIII. LONG TERM STORAGE INSTRUCTIONS: (Storage exceeding 30 days after receipt of equipment)

NOTE: Failure to adhere to these instructions voids all warranties in their entirety.

1. Storage site selection:
 - a. Level, well-drained, firm surface, in clean, dry and warm location. Minimum temperature of 50°F (10°C).
 - b. Isolated from possibility of physical damage from construction vehicles, erection equipment, etc.
 - c. Accessible for periodical inspection and maintenance.
2. The blower should be supported under each corner of its base to allow it to “breathe”. Supports (2 x 4's, timbers, or railroad ties) should be placed diagonally under each corner.
3. If the equipment is to be stored for more than three (3) months, the entire blower assembly must be loosely covered with plastic, **but not tightly wrapped**.
4. Storage Maintenance:

A periodic inspection and maintenance log, by date and action taken, must be developed and maintained for each blower. See example below. Each item must be checked monthly.

EXAMPLE:

Storage / Maintenance Schedule Log

ITEM	ACTION	DATES CHECKED
1	Re-inspect units to insure any protective devices used are functioning properly. Check for scratches in the finish which will allow corrosion or rust to form.	
2	Rotate wheel a minimum of 10 full revolutions to keep the motor bearing grease from separating and drying out. <i>This is a critical step.</i>	

Long Term Storage instructions continued on page 13.

5. General Motor Procedure:

If the motor is not put into service immediately, the motor must be stored in a clean, dry, warm location. Minimum temperature of 50°F. (10°C,). Several precautionary steps must be performed to avoid motor damage during storage.

- a. Use a "Megger" each month to ensure that integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
- b. **DO NOT** lubricate the motor bearings during storage. Motor bearings are packed with grease at the factory.
- c. If the storage location is damp or humid, the motor windings **must** be protected from moisture. This can be done by applying power to the motor's space heaters, (IF AVAILABLE) while the motor is in storage. If the motor does not have space heaters, storing it in a damp or humid location will, very quickly, cause internal corrosion and motor failure which is not warranted.

NOTE:

For specific storage instructions, for the actual motor and any accessory parts that were supplied, refer to the manufacturer's instructions.

IX. LIMITED WARRANTY:

Cincinnati Fan & Ventilator Company (Seller) warrants products of its own manufacture, against defects of material and workmanship under normal use and service for a period of eighteen (18) months from date of shipment or twelve (12) months from date of installation, whichever occurs first. This warranty does not apply to any of Seller's products or any part thereof which has been subject to extraordinary wear and tear, improper installation, accident, abuse, misuse, overloading, negligence or alteration. This warranty does not cover systems or materials not of Seller's manufacture. On products furnished by Seller, but manufactured by others, such as motors, Seller extends the same warranty as Seller received from the manufacturer thereof. Expenses incurred by Purchaser's in repairing or replacing any defective product will not be allowed except where authorized in writing and signed by an officer of the Seller.

The obligation of the Seller under this warranty shall be limited to repairing or replacing F.O.B. the Seller's plant, or allowing credit at Seller's option. **THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EITHER EXPRESSED OR IMPLIED INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND OF ALL OTHER OBLIGATIONS AND LIABILITIES OF THE SELLER. THE PURCHASER ACKNOWLEDGES THAT NO OTHER REPRESENTATIONS WERE MADE TO PURCHASER OR RELIED UPON BY PURCHASER WITH RESPECT TO THE QUALITY OR FUNCTION OF THE PRODUCTS HEREIN SOLD.**

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X. PARTS DRAWING:

PLEASE NOTE

Cincinnati Fan manufactures many models and arrangements with special variations. For that reason, the maintenance manuals contained on our website do not include a parts drawing nor the completed blower or fan specifications on page 1. For the parts drawing of all the standard components and specifications for the specific blower or fan that you have, please contact our local Cincinnati Fan sales office for your area.

You will need to give them the serial number shown on the blower or fan nameplate so they can supply you the correct information.

Click on “**Contact a Sales Rep**” on our website for the name and contact information for our local sales office for your area. **www.cincinnati-fan.com**

RDO[®] PRO-X Process Optical Dissolved Oxygen Probe

DO-501 - Transmitter, Dissolved Oxygen, Optical RDO Pro-x (10m cable)



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The presence of the Waste Electrical and Electronic Equipment (WEEE) marking on the product indicates that the device is not to be disposed via the municipal waste collection system of any member state of the European Union.

For products under the requirement of WEEE directive, please contact your distributor for the proper decontamination information and take back program, which will facilitate the proper collection, treatment, recovery, recycling, and safe disposal of the device.

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Optical RDO PRO-X Dissolved Oxygen Probe Specifications

Optical RDO PRO-X Dissolved Oxygen Probe	
Sensor Type	Optical (luminescent) dissolved oxygen sensor
RDO PRO-X Probe	Range: 0 to 50 mg/L concentration
	Accuracy: ± 0.1 mg/L, 0 to 8 mg/L
	± 0.2 mg/L, 8 to 20 mg/L
	$\pm 10\%$ of reading, 20 to 50 mg/L
	Resolution: 0.01 mg/L
	Response time: T90 < 45 sec; T95 < 60 sec @ 25°C
	Storage conditions: -5° to 60° C (23° to 140° F)
RDO-X Sensor Cap	Usage life: 2 years typical
	Storage conditions: 1° to 60° C (33° to 140° F), in factory container
Temperature sensor	Range: 0° to 50° C (32° to 122° F)
	Accuracy: $\pm 0.1^\circ$ C typical
	Resolution: 0.01° C
Transmitter/local display	Optional, or use with Con TROLL PRO System
Communications options	Modbus/RS485, 4-20 mA, SDI-12
Max. power consumption	50 mA at 12 VDC
Measure current	6 mA typical at 24 VDC
Idle current (no measurement or communication)	160 μ A typical at 24 VDC
Maximum cable length	Up to 1,219 m (4,000 ft) (for Modbus and 4-20 mA) or up to 60.96 (200 ft) for SDI-12
Cable options	10 m fixed stripped-and-tinned; Twist-lock connector with user-selectable cable length
Internal mounting thread	1¼ - 11 ½ NPT
IP rating	IP-67 with cap off, IP-68 with cap installed
Compliance	Heavy industrial, IEC 61000-6-2:2005
Salinity compensation	Fixed or real-time capable (using controller)
Barometric pressure	Fixed or real-time capable (using controller)
Maximum pressure	150 psi from 0 to 50° C; 300 psi @ 25° C
Warranty	Probe: 3 years from date of shipment RDO-X Sensor Cap: 2 years in typical applications
Methods	Standard Methods 4500-O; In-Situ Methods 1002-8-2009, 1003-8-2009, 1004-8-2009 (EPA approved)

Introduction

The RDO PRO-X Probe is a rugged, reliable instrument designed to deliver accurate dissolved oxygen (DO) data across a wide measurement range and to reduce maintenance costs. The probe features the latest optical technology for DO measurement.

System Description

The RDO PRO-X system consists of the following items.

- Black probe body with removable nose cone
- Optical RDO-X Sensor Cap
- Titanium thermistor

RuggedCable System

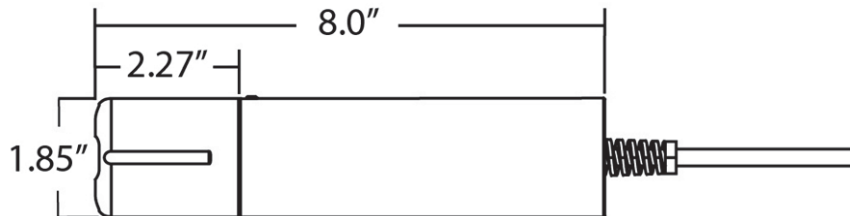
- 10-m standard length with stripped-and-tinned ends
- Customized lengths with titanium twist-lock connectors



1	Cable end, stripped-and-tinned
2	Nose cone
3	RDO-X Sensor Cap
4	Thermistor



1	Probe
2	Cable end, twist-lock connector and RuggedCable System

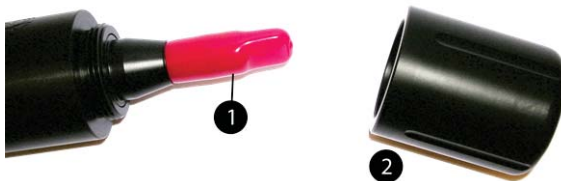


Serial Numbers

The probe serial number is engraved on the side of the unit. The cap serial number is programmed on the memory chip inside the cap.

Unpack the Probe

1. Remove the probe from the box and other packaging materials.
2. Unscrew the nose cone from the probe and remove the red protective dust cap from the sensor. Save the dust cap for later use.



1	Dust cap
2	Nose cone

3. Remove the RDO cap from the storage sleeve.



4. Align the arrow on the cap with the index mark on the probe and firmly press the cap onto the probe, without twisting, until it seals over the probe body.



1	Alignment arrow on cap
2	Cap installed over lens
3	Nose cone



Do not allow moisture or atmospheric humidity inside the cap. Keep the cap in its sealed package until you are ready to install it. Install promptly. Ensure that O-ring grooves are dry and that the O-ring is not rolled or pinched inside the cap. The typical cap lifetime is two years after the first reading has been taken.

5. Reattach the nose cone.

Calibrate the RDO PRO-X Probe

Calibrate the sensor with the Comm Kit Software and the RDO PRO Communication Device, or calibrate the sensor directly with your controller.

1-Point Calibration

The optical Rugged Dissolved Oxygen sensor is very stable. The factory calibration should produce readings within 3% accuracy. If you require readings with greater accuracy we recommend that you perform a 1-point, 100% water-saturated air calibration as described below.

Water-Saturated Air

1. Remove the storage cap from the top of the calibration chamber and replace it with the vented calibration cap.



1	Storage cap
2	Vented calibration cap

Figure 6.1 Storage cap and vented calibration cap shown together

2. Place the sponge wafer in the bottom of the calibration chamber and saturate with approximately 10 mL water.
3. Gently dry the instrument and sensing material with a paper towel, making sure there is no water or debris on the instrument or on the sensing surface.
4. Place the instrument into the calibration chamber about 2.5 cm (1 in.) above the water-saturated sponge.



Figure 6.2 Calibration chamber with water-saturated sponge

5. Allow 5 to 10 minutes for temperature stabilization prior to starting the calibration procedure. Do not leave the instrument in the calibration chamber for more than 30

minutes. This can allow condensation to form on the sensing material, which will produce false low readings after calibration. If condensation does occur, remove the instrument, dry the sensing material, place the instrument in the chamber, and calibrate.

2-Point Calibration

100% and 0% Saturation

We recommend that you perform the 0 % oxygen calibration only if you intend to measure dissolved oxygen at a concentration of less than 4 mg/L.

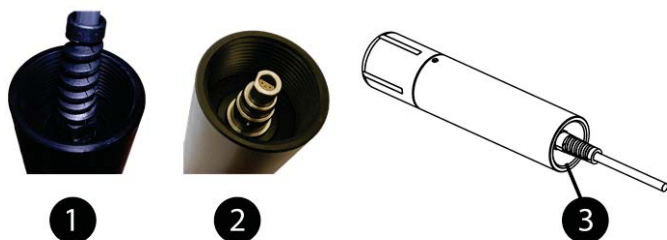
1. Set up the calibration procedure as previously described, and perform a water-saturated air calibration.
2. Remove the water-saturated sponge from the calibration chamber and fill the chamber to the fill line with approximately 60 mL of fresh sodium sulfite solution.



2. Place the instrument into the solution. Leave at least 13 mm (0.5 in.) between the surface of the sensing material and the bottom of the chamber.
3. Ensure that the temperature sensor is completely submerged in the solution.
4. Allow at least 5 minutes for the temperature to stabilize prior to performing the calibration procedure.
5. Once calibration is complete, remove the sensor, and thoroughly rinse to remove all of the sodium sulfite.

Probe Deployment

The cable end of the RDO PRO-X Probe is internally threaded (1¼ - 11½ NPT) and can be attached to a male threaded pipe. When deployed, make sure that the nose cone and thermistor are completely submerged.



1	10 m cable attached
2	Twist-lock connector
3	1 1/4 NPT threading

Care and Maintenance

Clean the RDO-X Sensor Cap

1. The cap and nose cone must remain on the probe.
2. Rinse the sensor with clean water from a squirt bottle or spray bottle.
3. Gently wipe with a soft-bristled brush or soft cloth if biofouling is present. Use Alconox to remove grease.
4. If extensive fouling or mineral build-up is present, soak the cap end in vinegar for 15 minutes, then soak in deionized (DI) water for 15 minutes.



Do not use organic solvents—they will damage the sensing element. Do not remove the cap from the sensor prior to cleaning.

5. After cleaning, perform a 1- or 2-point user calibration or calibration check.

Clean the Optical Window

1. Clean the optical window only when you change the cap. See full instructions in the sensor cap replacement kit.
2. Remove the cap and gently wipe the lens with the supplied lens cloth.



Do not wet the lens area with water or any solution. Use only the supplied lens cloth for cleaning. Do not use any other cloth or material.

Clean the Probe

With the RDO cap installed on probe, gently scrub the probe with a soft-bristled brush or nylon dish scrubber. Use Alconox to remove grease or other matter. Soak in vinegar and DI water to remove mineral deposits or extensive fouling.

RDO-X Sensor Cap Storage

Prior to installation—Store in factory supplied container.

Installed—Store in the calibration chamber with the storage cap attached and a few drops of clean water.

Replace the RDO-X Sensor Cap

The RDO cap has a 2-year typical life after the sensor takes its first reading. Replacement caps are available from In-Situ Inc. or your authorized In-Situ distributor.

1. Remove the probe nose cone.
2. Use a lint-free cloth to remove any moisture from the probe.

-
3. Pull the used RDO cap off of the sensor, without twisting.
 4. Remove the existing O-rings from the sensor.



Ensure that there is no moisture in the O-ring grooves. Do not touch or clean the lens with anything other than the supplied lens wipe.

5. Use your finger to apply a very light layer of silicone-based lubricant around the O-ring grooves.
6. Place the O-rings on the sensor. Apply another thin layer of lubricant to the O-rings and grooves.



Note: Do not transfer grease to the lens or sensor pins.

7. Clean the sensor lens with the wipe provided in the kit and allow it to thoroughly dry. Inspect for scratches or dirt.
8. Remove the new cap from its sealed packaging and attach it to the sensor, being careful to press firmly, without twisting, until it seals over the lens. Make sure that the O-rings are not pinched or rolled between the cap and sensor.
9. Replace the nose cone.
10. Perform a 1- or 2-point calibration.

Maintain Desiccant

Desiccant installed in a controller or transceiver protects probe electronics from condensation. A desiccant pack changes color from blue to pink as it becomes saturated with moisture.



It is extremely important to use the proper size desiccant for your deployment and to change desiccant often. Desiccant should be changed before the entire pack has turned pink, and you should use enough to effectively keep cables and probes dry until your next scheduled maintenance. Desiccant lifespan is dependent on site conditions.

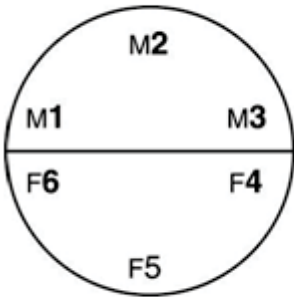
Controller Requirements and Connections

The RDO PRO-X Probe may be connected to a controller or logger for communication via the following options.

- Analog (4-20 mA) provides a configurable 4-20 mA current loop output
- SDI-12
- RS485 Modbus
- RS232 to Modbus

Wiring Overview

Refer to diagrams on the following pages. Trim and insulate unused wires. The shielded wire should be connected to a chassis ground or earth ground.

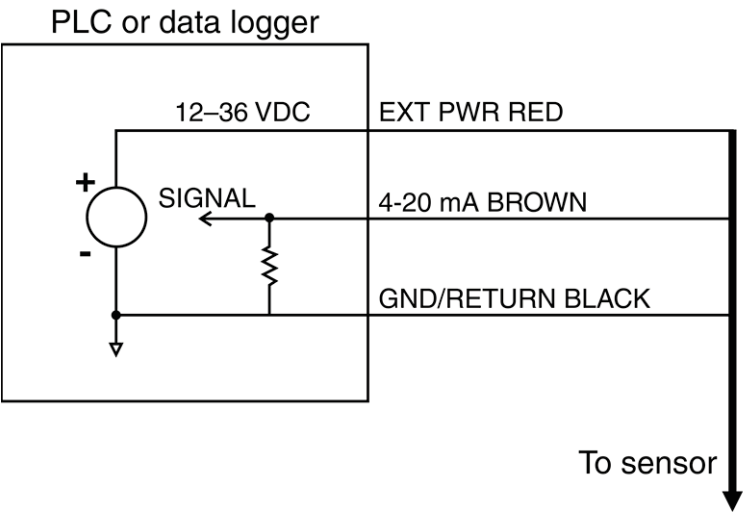
	Signal	Color
	Ground/Return	Black
	External Power	Red
	4-20 mA	Brown
	RS485 (-)	Green
	RS485 (+)	Blue
	SDI-12	White



The inside of the controller must be kept free of moisture and humidity. Condensed moisture can migrate through the wiring and cause the probe to fail. Therefore, desiccant should be installed in the controller and be replaced on a regular basis.

Analog (4-20 mA) 3-wire

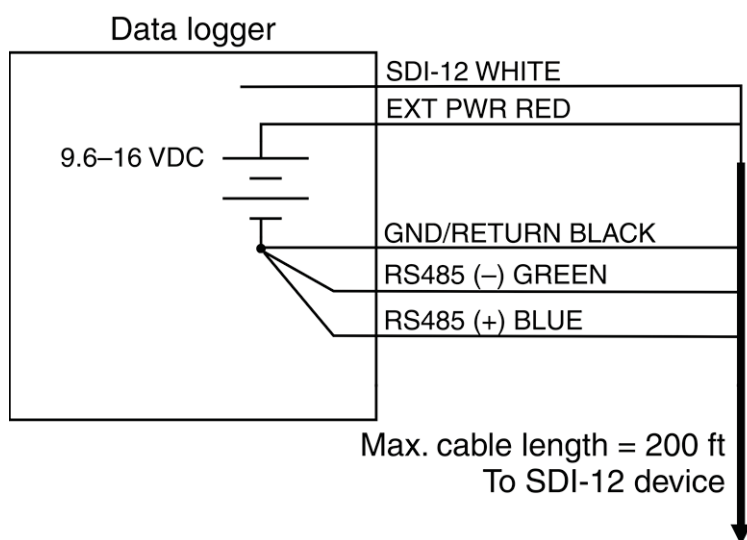
Signal	Color
Ground/Return	Black
External Power (12-36 VDC)	Red
4-20 mA	Brown



Cable length must not exceed 1219 m (4000 ft.)
 Analog signal must be enabled in Win-Situ 5 Software or the
 Comm Kit Software prior to use.

SDI-12 (3-wire)

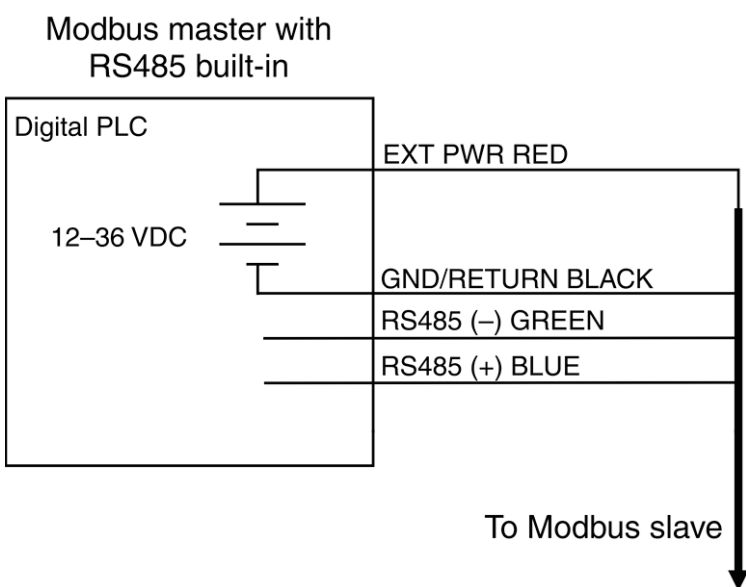
Signal	Color
Ground/Return	Black
External Power (9.6-16 VDC)	Red
RS485 (-)	Green
RS485 (+)	Blue
SDI-12	White



Cable length must not exceed 60.96 m (200 ft.)

Modbus Master with Built-in RS485

Signal	Color
Ground/Return	Black
External Power (12-36 VDC)	Red
RS485 (-)	Green
RS485 (+)	Blue



Cable length must not exceed 1219 m (4000 ft.)