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INTRODUCTION

PURPOSE

The purpose of this manual is to provide detailed technical information and instructions that will enable a qualified technician to identify faults and perform repairs on VLT series adjustable frequency drives of 125/150 hp to 550/600 hp.

It provides the reader with a general view of the unit's main assemblies and a description of the internal processing. With this information, technicians should have a better understanding of the drive's operation to assist in troubleshooting and repair.

This manual provides instructions for the drive models and voltage ranges described in the tables on the following page.

VLT® PRODUCT OVERVIEW

VLT 4000 series drives are designed primarily for the industrial market segment. This series of drives is capable of operating only in variable torque mode and are normally found in controlling fans and pumps in industrial process environments.

VLT 5000 series drives are fully programmable for either constant torque or variable torque industrial applications. They are full-featured drives capable of operating a myriad of applications and incorporating a wide variety of control and communication options.

VLT 6000 series drives are designed for the HVAC markets. They operate only in variable torque mode and include special features and options well suited for fan and pump applications within the HVAC market.

The VLT 8000 series drives are designed for water and waste water markets. They can operate in either constant torque or variable torque with limited overload capabilities. They include specific features and options which make them well suited for use on a variety of water pumping and processing applications.

These models are available in Chassis/IP00, NEMA 1/IP21 or NEMA 12/IP54 enclosures.

⚠WARNING

Drives contain dangerous voltages when connected to line voltage. Only a competent technician should carry out service.

⚠WARNING

For dynamic test procedures, main input power is required and all line powered devices and power supplies are energized at rated voltage. Use extreme caution when conducting tests on a powered drive. Contact with powered components could result in electrical shock and personal injury.

FOR YOUR SAFETY

1. DO NOT touch electrical parts of drive when AC line is connected. After AC line is disconnected wait 20 minutes before touching any components in D-frame size units (see page 2) or 40 minutes for E-frame size units.
2. When repair or inspection is made, AC line must be disconnected.
3. STOP key on control panel does not disconnect AC line.
4. During operation and while programming parameters, motor may start without warning. Activate STOP key when changing data.

⚠CAUTION

When performing service, use proper ESD procedures to prevent damage to sensitive components.

ELECTROSTATIC DISCHARGE (ESD)

Many electronic components within the adjustable frequency drive are sensitive to static electricity. Voltages so low that they cannot be felt, seen or heard can reduce the life, affect performance, or completely destroy sensitive electronic components.

NOTE

Frame size is used throughout this manual where ever procedures or components differ between drives based upon the unit's physical size. Refer to these tables to determine D1, D2, and E1 frame size definitions.

VLT 4000 and VLT 6000 380-460 VAC

380-460 VAC	Power		Frame
Model VLT 4000 VLT 6000 HVAC			
	HP @460 VAC	kW @400 VAC	
4152, 6152	150	110	D1
4202, 6172	200	132	D1
4252, 6222	250	160	D2
4302, 6272	300	200	D2
4352, 6352	350	250	D2
4452, 6402	450	315	E1
4502, 6502	500	355	E1
4602, 6552	550 (600)*	400	E1
4652, 6602	600	450	E1

*unit can attain 600 hp

VLT 5000 380-500 VAC

380-500 VAC	Power			Frame
Model VLT 5000-P VLT 5000 FLUX	High Overload / Normal			
	HP @460 VAC	kW @400 VAC	kW @500 VAC	
5122	125 / 150	90 / 110	110 / 132	D1
5152	150 / 200	110 / 132	132 / 160	D1
5202	200 / 250	132 / 160	160 / 200	D2
5252	250 / 300	160 / 200	200 / 250	D2
5302	300 / 350	200 / 250	250 / 315	D2
5352	350 / 450	250 / 315	315 / 355	E1
5452	450 / 500	315 / 355	355 / 400	E1
5502	500 / 600	355 / 400	400 / 500	E1
5552	550 / 600	400 / 450	500 / 530	E1

VLT 8000 380-480 VAC

380-480 VAC	Power		Frame
Model VLT 8000 AQUA			
	HP @460 VAC	kW @400 VAC	
8152	150	110	D1
8202	200	132	D1
8252	250	160	D2
8302	300	200	D2
8352	350	250	D2
8452	450	315	E1
8502	500	355	E1
8602	550 (600)*	400	E1
8652	600	450	E1

*unit can attain 600 hp

VLT 4000 and VLT 6000 525-600 VAC

525-600 VAC	Power		Frame
Model VLT 4000 VLT 6000 HVAC			
	HP @575 VAC	kW @550 VAC	
4102, 6102	100	75	D1
4122, 6122	125	90	D1
4152, 6152	150	110	D1
4202, 6172	200	132	D1
4252, 6222	250	160	D2
4302, 6272	300	200	D2
4352, 6352	350	250	D2
4402, 6402	400	315	D2
4502, 6502	500	400	E1
4602, 6602	600	450	E1
4652, 6652	650	500	E1

VLT 5000 525-690 VAC

525-690 VAC	Power		Frame
Model VLT 5000-P	High overload / Normal		
	HP @575 VAC	kW @690 VAC	
5042	40 / 50	37 / 45	D1
5052	50 / 60	45 / 55	D1
5062	60 / 75	55 / 75	D1
5072	75 / 100	75 / 90	D1
5102	100 / 125	90 / 110	D1
5122	125 / 150	110 / 132	D1
5152	150 / 200	132 / 160	D1
5202	200 / 250	160 / 200	D2
5252	250 / 300	200 / 250	D2
5302	300 / 350	250 / 315	D2
5352	350 / 400	315 / 400	D2
5402	400 / 500	400 / 500	E1
5502	500 / 600	500 / 560	E1
5602	600 / 650	560 / 630	E1

VLT 8000 525-690 VAC

525-690 VAC	Power		Frame
Model VLT 8000 AQUA			
	HP @575 VAC	kW @690 VAC	
8052	50	45	D1
8062	60	55	D1
8072	75	75	D1
8102	100	90	D1
8122	125	110	D1
8152	150	132	D1
8202	200	160	D1
8252	250	200	D2
8302	300	250	D2
8352	350	315	D2
8402	400	400	D2
8502	500	500	E1
8602	600	560	E1
8652	650	630	E1

TOOLS REQUIRED

Instruction manual for the VLT series drive
Metric socket set..........................7 - 19mm
Socket extensions........................4 in. and 6 in.
(100mm - 150mm)
Torx driver set...............................T10 - T50
Torque wrench..............................6 - 170 in-lbs
(0.675 - 19 Nm)
Needle nose pliers
Magnetic sockets
Ratchet
Screwdrivers.................................standard and Philips

Additional Tools Recommended for Testing

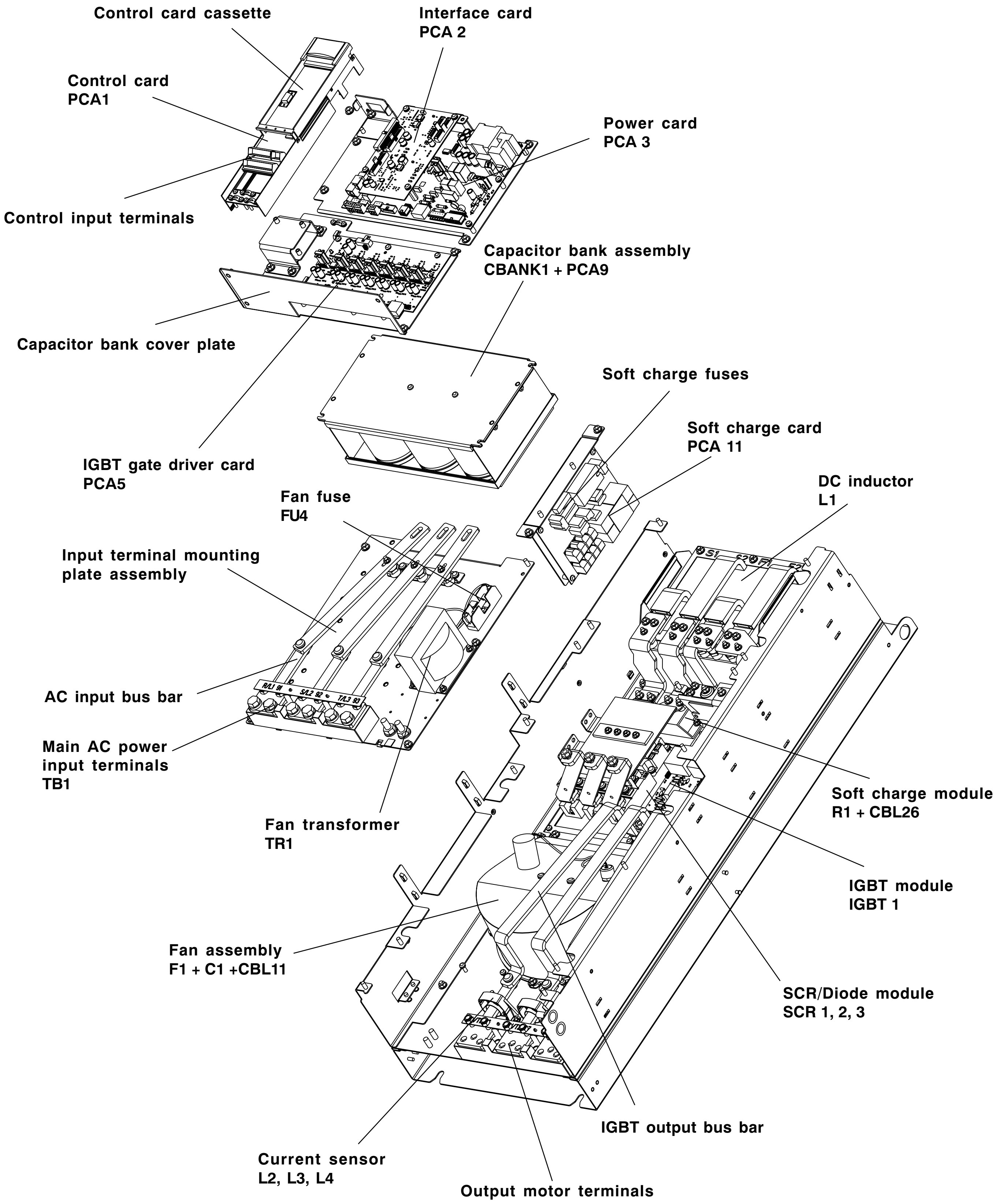
Digital volt/ohm meter
(must be rated for 1200 VDC for 690 V units)
Analog volt meter
Oscilloscope
Clamp-on style ammeter
Test cable p/n 176F8439
Signal test board p/n 176F8437

GENERAL TORQUE TIGHTENING VALUES

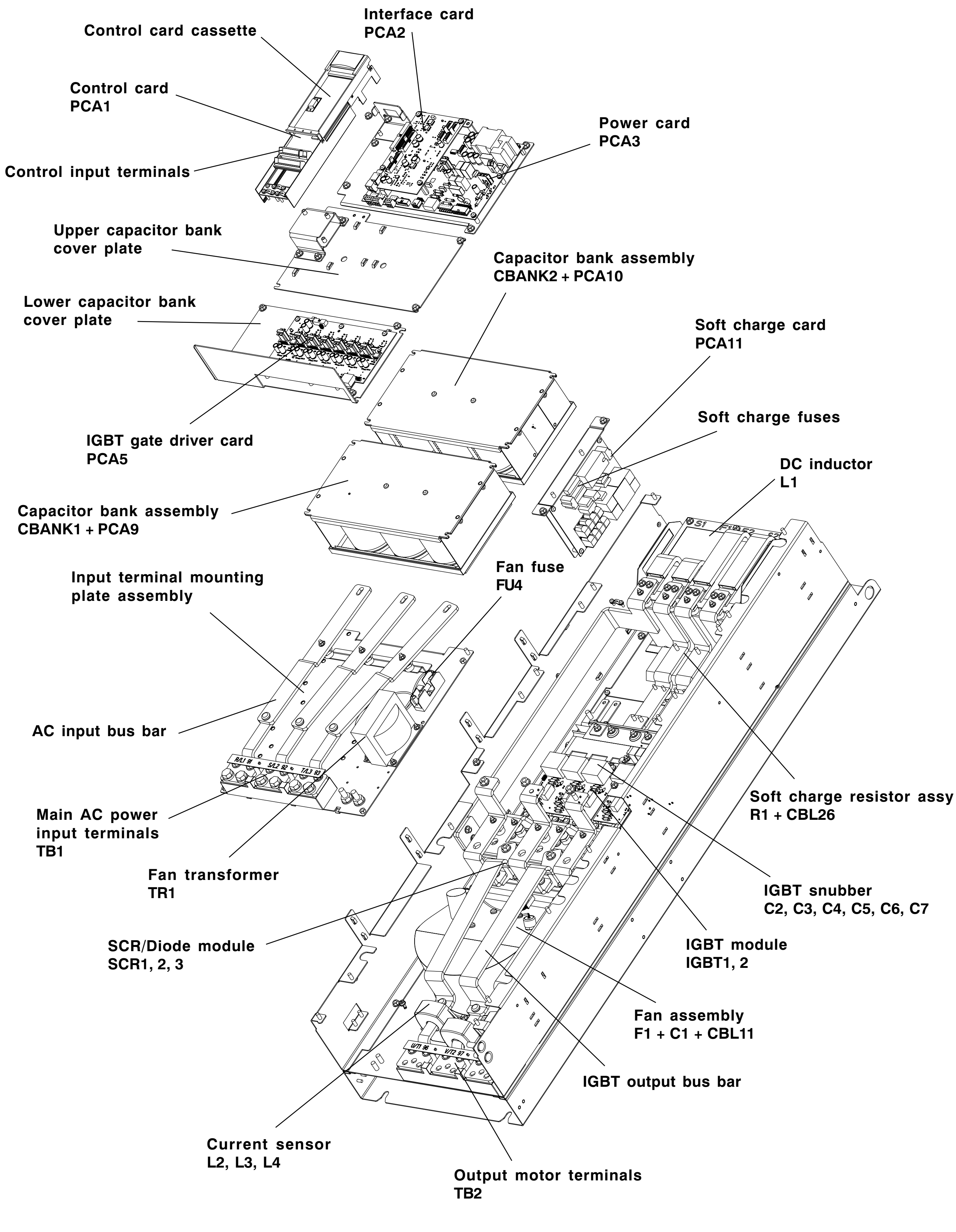
For fastening hardware described in this manual, the torque values in the table below are used. These values are not intended for SCR, diode, or IGBT fasteners. See the instructions included with those replacement parts for correct values.

Torque Values Table

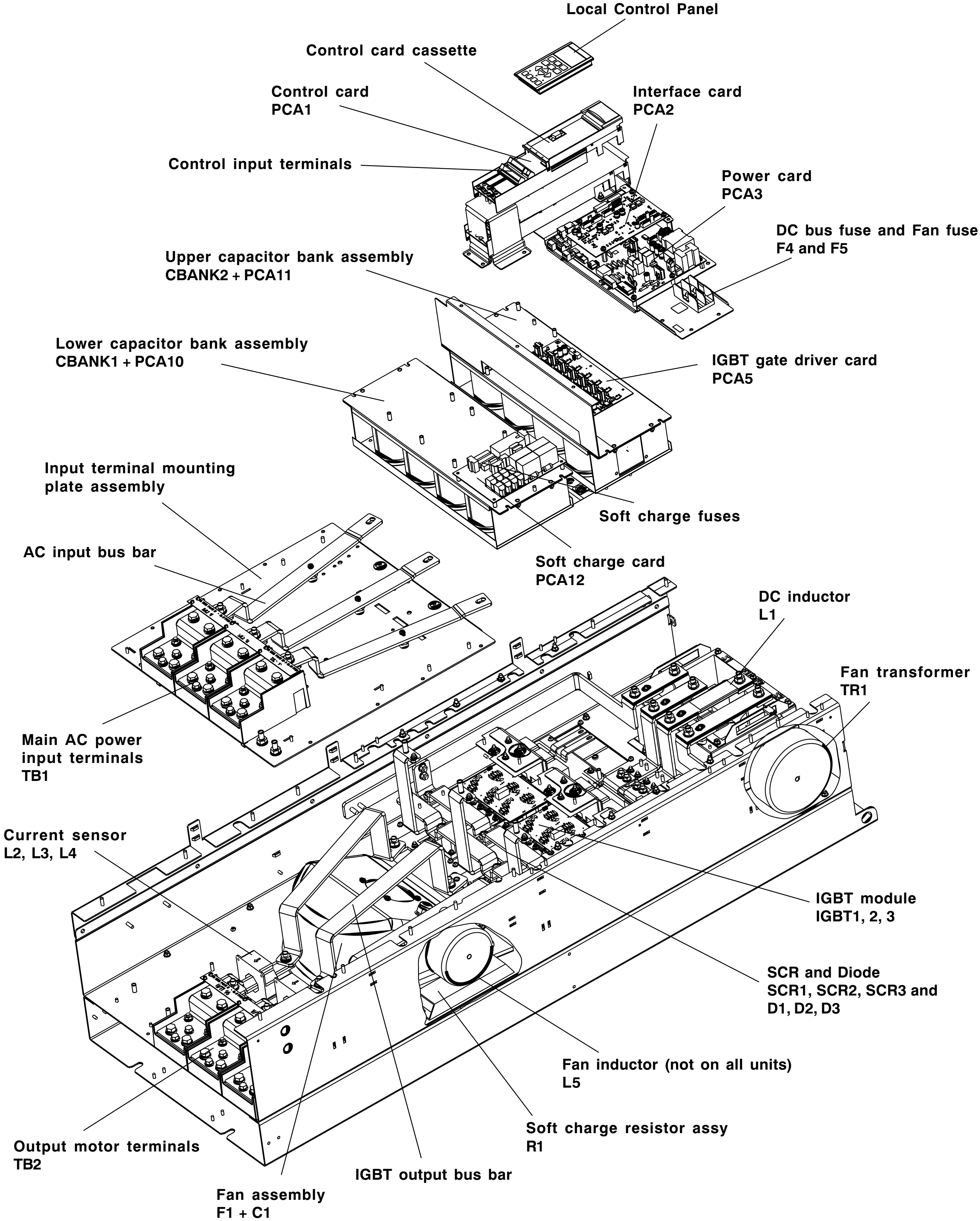
Shaft Size	Driver Size Torx / Hex	Torque (in-lbs)	Torque (Nm)
M4	T-20 / 7 mm	10	1.0
M5	T-25 / 8 mm	20	2.3
M6	T-30 / 10 mm	35	4.0
M8	T-40 / 13 mm	85	9.6
M10	T-50 / 17 mm	170	19.2



Exploded View D1 Frame Size



Exploded View D2 Frame Size



Exploded View E1 Frame Size

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Ratings Table 380-500V

Mains supply 3 x 380-500 V						
Model number		VLT 4152	VLT 4202	VLT 4252	VLT 4302	VLT 4352
		VLT 5122	VLT 5152	VLT 5202	VLT 5252	VLT 5302
		VLT 6152	VLT 6172	VLT 6222	VLT 6272	VLT 6352
		VLT 8152	VLT 8202	VLT 8252	VLT 8302	VLT 8352
Normal overload current ratings (110 %):						
Output current	Nominal [A] (380-440 V)	212	260	315	395	480
	MAX (60 sec) [A] (380-440 V)	233	286	347	434	528
	Nominal [A] (441-500 V)	190	240	302	361	443
	MAX (60 sec) [A] (441-500 V)	209	264	332	397	487
Output	Nominal [kVA] (400 V)	147	180	218	274	333
	Nominal [kVA] (460 V)	151	191	241	288	353
	Nominal [kVA] (500 V)	165	208	262	313	384
Typical shaft output	[kW] (400 V)	110	132	160	200	250
	[HP] (460 V)	150	200	250	300	350
	[kW] (500 V)	132	160	200	250	315
High overload torque (160 %):						
Output current	Nominal [A] (380-440 V)	177	212	260	315	395
	MAX (60 sec) [A] (380-440 V)	266	318	390	473	593
	Nominal [A] (441-500 V)	160	190	240	302	361
	MAX (60 sec) [A] (441-500 V)	240	285	360	453	542
Output	Nominal [kVA] (400 V)	123	147	180	218	274
	Nominal [kVA] (460 V)	127	151	191	241	288
	Nominal [kVA] (500 V)	139	165	208	262	313
Typical shaft output	[kW] (400 V)	90	110	132	160	200
	[HP] (460 V)	125	150	200	250	300
	[kW] (500 V)	110	132	160	200	250
Power loss Normal overload [W]		2619	3309	4163	4977	6107
Power loss High overload [W]		2206	2619	3309	4163	4977
Limits and Ranges						
Warning Voltage Low	DC Bus V	423	423	423	423	423
Alarm Voltage Low	DC Bus V	402	402	402	402	402
Warning Voltage High	DC Bus V	817	817	817	817	817
Alarm Voltage High	DC Bus V	855	855	855	855	855
Brake On Voltage	DC Bus V	795	795	795	795	795
Brake On Voltage (Full Duty Cycle)	DC Bus V	810	810	810	810	810
SMPS Start Voltage	DC Bus V	360	360	360	360	360
SMPS Stop Voltage	DC Bus V	330	330	330	330	330
Overcurrent Warning	VLT Out	327	392	480	582	730
Overcurrent Alarm (1.5 sec delay)	VLT Out	327	392	480	582	730
Earth Fault Alarm	VLT Out	80	95	120	151	180
Heatsink Over Temperature	Degrees C	75	80	95	95	105
Mains Phase Warning (5 sec delay)	DC Bus Ripple VAC	50	50	50	50	50
Mains Phase Alarm (25 sec delay)	DC Bus Ripple VAC	50	50	50	50	50
Fan On Low Speed Temperature	Degrees C	45	45	45	45	45
Fan On High Sped Temperature	Degrees C	50	50	50	50	50
Fan Off Temperature	Degrees C	<30	<30	<30	<30	<30
Fan Voltage Low Speed	Fan VAC	200	200	200	200	200
Fan Voltage High Speed	Fan VAC	230	230	230	230	230

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Ratings Table 380-500V

Mains supply 3 x 380-500 V					
Model number		VLT 4452	VLT 4502	VLT 4602	VLT 4652
		VLT 5352	VLT 5452	VLT 5502	VLT 5552
		VLT 6402	VLT 6502	VLT 6552	VLT 6602
		VLT 8452	VLT 8502	VLT 8602	VLT 8652
Normal overload current ratings (110 %):					
Output current	Nominal [A] (380-440 V)	600	658	745	800
	MAX (60 sec) [A] (380-440 V)	660	724	820	880
	Nominal [A] (441-500 V)	540	590	678	730
	MAX (60 sec) [A] (441-500 V)	594	649	746	803
Output	Nominal [kVA] (400 V)	416	456	516	554
	Nominal [kVA] (460 V)	430	470	540	582
	Nominal [kVA] (500 V)	468	511	587	632
Typical shaft output	[kW] (400 V)	315	355	400	450
	[HP] (460 V)	450	500	550/600	600
	[kW] (500 V)	355	400	500	530
High overload torque (160 %):					
Output current	Nominal [A] (380-440 V)	480	600	658	695
	MAX (60 sec) [A] (380-440 V)	720	900	987	1043
	Nominal [A] (441-500 V)	443	540	590	678
	MAX (60 sec) [A] (441-500 V)	665	810	885	1017
Output	Nominal [kVA] (400 V)	333	416	456	482
	Nominal [kVA] (460 V)	353	430	470	540
	Nominal [kVA] (500 V)	384	468	511	587
Typical shaft output	[kW] (400 V)	250	315	355	400
	[HP] (460 V)	350	450	500	550
	[kW] (500 V)	315	355	400	500
Power loss Normal overload [W]		7630	7701	8879	9428
Power loss High overload [W]		6005	6960	7691	7964
Limits and Ranges					
Warning Voltage Low	DC Bus V	423	423	423	423
Alarm Voltage Low	DC Bus V	402	402	402	402
Warning Voltage High	DC Bus V	817	817	817	817
Alarm Voltage High	DC Bus V	855	855	855	855
Brake On Voltage	DC Bus V	795	795	795	795
Brake On Voltage (Full Duty Cycle)	DC Bus V	810	810	810	810
SMPS Start Voltage	DC Bus V	360	360	360	360
SMPS Stop Voltage	DC Bus V	330	330	330	330
Overcurrent Warning	VLT Out	888	1202	1202	1202
Overcurrent Alarm (1.5 sec delay)	VLT Out	888	1202	1202	1202
Earth Fault Alarm	VLT Out	265	322	352	405
Heatsink Over Temperature	Degrees C	85	85	85	85
Mains Phase Warning (5 sec delay)	DC Bus Ripple VAC	70	70	70	70
Mains Phase Alarm (25 sec delay)	DC Bus Ripple VAC	70	70	70	70
Fan On Low Speed Temperature	Degrees C	45	45	45	45
Fan On High Sped Temperature	Degrees C	50	50	50	50
Fan Off Temperature	Degrees C	<30	<30	<30	<30
Fan Voltage Low Speed	Fan VAC	200	200	200	200
Fan Voltage High Speed	Fan VAC	230	230	230	230

Ratings Table 525-600V / 525-690V

Mains supply 3 x 525-690 V: 5000 & 8000 Series							
Mains supply 3 x 525-600 V: 4000 & 6000 Series							
Model number		VLT 4152	VLT 4202	VLT 4252	VLT 4302	VLT 4352	VLT 4402
		VLT 5122	VLT 5152	VLT 5202	VLT 5252	VLT 5302	VLT 5352
		VLT 6152	VLT 6172	VLT 6222	VLT 6272	VLT 6352	VLT 6402
		VLT 8152	VLT 8202	VLT 8252	VLT 8302	VLT 8352	VLT 8402
Normal overload current ratings (110 %):							
Output current	Nominal [A] (525-550 V)	162	204	253	303	360	418
	MAX (60 sec) [A] (525-550 V)	178	224	278	333	396	460
	Nominal [A] (551-690 V)	155	192	242	290	344	400
	MAX (60 sec) [A] (551-690 V)	171	211	266	319	378	440
Output	Nominal [kVA] (550 V)	154	194	241	289	343	398
	Nominal [kVA] (575 V)	154	191	241	289	343	398
	Nominal [kVA] (690 V)	185	229	289	347	411	478
Typical shaft output	[kW] (550 V)	110	132	160	200	250	315
	[HP] (575 V)	150	200	250	300	350	400
	[kW] (690 V)	132	160	200	250	315	400
High overload torque (160 %):							
Output current	Nominal [A] (525-550 V)	137	162	204	253	303	360
	MAX (60 sec) [A] (525-550 V)	206	243	306	380	455	540
	Nominal [A] (551-690 V)	131	155	192	242	290	344
	MAX (60 sec) [A] (551-690 V)	197	233	288	363	435	516
Output	Nominal [kVA] (550 V)	131	154	194	241	289	343
	Nominal [kVA] (575 V)	130	154	191	241	289	343
	Nominal [kVA] (690 V)	157	185	229	289	347	411
Typical shaft output	[kW] (550 V)	90	110	132	160	200	250
	[HP] (575 V)	125	150	200	250	300	350
	[kW] (690 V)	110	132	160	200	250	315
Power loss Normal overload [W]		3114	3612	4293	5155	5821	6149
Power loss High overload [W]		2665	2953	3451	4275	4875	5185
Limits and Ranges							
Warning Voltage Low	DC Bus V	585	585	585	585	585	585
Alarm Voltage Low	DC Bus V	553	553	553	553	553	553
Warning Voltage High	DC Bus V	1109	1109	1109	1109	1109	1109
Alarm Voltage High	DC Bus V	1120	1120	1120	1120	1120	1120
Brake On Voltage	DC Bus V	1084	1084	1084	1084	1084	1084
Brake On Voltage (Full Duty Cycle)	DC Bus V	1099	1099	1099	1099	1099	1099
SMPS Start Voltage	DC Bus V	508	508	508	508	508	508
SMPS Stop Voltage	DC Bus V	478	478	478	478	478	478
Overcurrent Warning	VLT Out	361	466	683	683	827	1038
Overcurrent Alarm (1.5 sec delay)	VLT Out	361	466	683	683	827	1038
Earth Fault Alarm	VLT Out	66	78	96	121	145	172
Heatsink Over Temperature	Degrees C	75	80	100	100	100	100
Mains Phase Warning (5 sec delay)	DC Bus Ripple VAC	70	70	70	70	70	70
Mains Phase Alarm (25 sec delay)	DC Bus Ripple VAC	70	70	70	70	70	70
Fan On Low Speed Temperature	Degrees C	45	45	45	45	45	45
Fan On High Sped Temperature	Degrees C	50	50	50	50	50	50
Fan Off Temperature	Degrees C	<30	<30	<30	<30	<30	<30
Fan Voltage Low Speed	Fan VAC	200	200	200	200	200	200
Fan Voltage High Speed	Fan VAC	230	230	230	230	230	230

Ratings Table 525-600V / 525-690V

Mains supply 3 x 525-690 V: 5000 & 8000 Series				
Mains supply 3 x 525-600 V: 6000 Series				
Model number		VLT 5402	VLT 5502	VLT 5602
		VLT 6502	VLT 6602	VLT 6652
		VLT 8502	VLT 8602	VLT 8652
Normal overload current ratings (110 %):				
Output current	Nominal [A] (525-550 V)	523	596	630
	MAX (60 sec) [A] (525-550 V)	575	656	693
	Nominal [A] (551-690 V)	500	570	630
	MAX (60 sec) [A] (551-690 V)	550	627	693
Output	Nominal [kVA] (550 V)	498	568	600
	Nominal [kVA] (575 V)	498	568	627
	Nominal [kVA] (690 V)	598	681	753
Typical shaft output	[kW] (550 V)	400	450	500
	[HP] (575 V)	500	600	650
	[kW] (690 V)	500	560	630
High overload torque (160 %):				
Output current	Nominal [A] (525-550 V)	429	523	596
	MAX (60 sec) [A] (525-550 V)	644	785	894
	Nominal [A] (551-690 V)	410	500	570
	MAX (60 sec) [A] (551-690 V)	615	750	855
Output	Nominal [kVA] (550 V)	409	498	568
	Nominal [kVA] (575 V)	408	498	568
	Nominal [kVA] (690 V)	490	598	681
Typical shaft output	[kW] (550 V)	315	400	450
	[HP] (575 V)	400	500	600
	[kW] (690 V)	400	500	560
Power loss Normal overload [W]		7249	8727	9673
Power loss High overload [W]		5818	7671	8715
Limits and Ranges				
Warning Voltage Low	DC Bus V	585	585	585
Alarm Voltage Low	DC Bus V	553	553	553
Warning Voltage High	DC Bus V	1109	1109	1109
Alarm Voltage High	DC Bus V	1130	1130	1130
Brake On Voltage	DC Bus V	1084	1084	1084
Brake On Voltage (Full Duty Cycle)	DC Bus V	1099	1099	1099
SMPS Start Voltage	DC Bus V	508	508	508
SMPS Stop Voltage	DC Bus V	478	478	478
Overcurrent Warning	VLT Out	824	987	1170
Overcurrent Alarm (1.5 sec delay)	VLT Out	824	987	1170
Earth Fault Alarm	VLT Out	205	250	285
Heatsink Over Temperature	Degrees C	75	75	75
Mains Phase Warning (5 sec delay)	DC Bus Ripple VAC	70	70	70
Mains Phase Alarm (25 sec delay)	DC Bus Ripple VAC	70	70	70
Fan On Low Speed Temperature	Degrees C	45	45	45
Fan On High Sped Temperature	Degrees C	50	50	50
Fan Off Temperature	Degrees C	<30	<30	<30
Fan Voltage Low Speed	Fan VAC	200	200	200
Fan Voltage High Speed	Fan VAC	230	230	230

Ratings Table 525-600V / 525-690V

Mains supply 3 x 525-690 V: 5000 & 8000 Series						
Mains supply 3 x 525-600 V: 4000 & 6000 Series						
Model number		NA*	NA*	NA*	VLT 4102	VLT 4122
		VLT 5042	VLT 5052	VLT 5062	VLT 5072	VLT 5102
		NA*	NA*	NA*	VLT 6102	VLT 6122
		VLT 8052	VLT 8062	VLT 8072	VLT 8102	VLT 8122
Normal overload current ratings (110 %):						
Output current	Nominal [A] (525-550 V)	56	76	90	113	137
	MAX (60 sec) [A] (525-550 V)	62	84	99	124	151
	Nominal [A] (551-690 V)	54	73	86	108	131
	MAX (60 sec) [A] (551-690 V)	59	80	95	119	144
Output	Nominal [kVA] (550 V)	53	72	86	108	131
	Nominal [kVA] (575 V)	54	73	86	108	130
	Nominal [kVA] (690 V)	65	87	103	129	157
Typical shaft output	[kW] (550 V)	37	45	55	75	90
	[HP] (575 V)	50	60	75	100	125
	[kW] (690 V)	45	55	75	90	110
High overload torque (160 %):						
Output current	Nominal [A] (525-550 V)	48	56	76	90	113
	MAX (60 sec) [A] (525-550 V)	77	90	122	135	170
	Nominal [A] (551-690 V)	46	54	73	86	108
	MAX (60 sec) [A] (551-690 V)	74	86	117	129	162
Output	Nominal [kVA] (550 V)	46	53	72	86	108
	Nominal [kVA] (575 V)	46	54	73	86	108
	Nominal [kVA] (690 V)	55	65	87	103	129
Typical shaft output	[kW] (550 V)	30	37	45	55	75
	[HP] (575 V)	40	50	60	75	100
	[kW] (690 V)	37	45	55	75	90
Power loss Normal overload [W]		1458	1717	1913	2262	2662
Power loss High overload [W]		1355	1459	1721	1913	2264
Limits and Ranges						
Warning Voltage Low	DC Bus V	585	585	585	585	585
Alarm Voltage Low	DC Bus V	553	553	553	553	553
Warning Voltage High	DC Bus V	1109	1109	1109	1109	1109
Alarm Voltage High	DC Bus V	1130	1130	1130	1130	1130
Brake On Voltage	DC Bus V	1084	1084	1084	1084	1084
Brake On Voltage (Full Duty Cycle)	DC Bus V	1099	1099	1099	1099	1099
SMPS Start Voltage	DC Bus V	508	508	508	508	508
SMPS Stop Voltage	DC Bus V	478	478	478	478	478
Overcurrent Warning	VLT Out	256	256	256	256	256
Overcurrent Alarm (1.5 sec delay)	VLT Out	256	256	256	256	256
Earth Fault Alarm	VLT Out	23	27	37	43	54
Heatsink Over Temperature	Degrees C	75	75	75	75	75
Mains Phase Warning (5 sec delay)	DC Bus Ripple VAC	70	70	70	70	70
Mains Phase Alarm (25 sec delay)	DC Bus Ripple VAC	70	70	70	70	70
Fan On Low Speed Temperature	Degrees C	45	45	45	45	45
Fan On High Sped Temperature	Degrees C	50	50	50	50	50
Fan Off Temperature	Degrees C	<30	<30	<30	<30	<30
Fan Voltage Low Speed	Fan VAC	200	200	200	200	200
Fan Voltage High Speed	Fan VAC	230	230	230	230	230

NA* use existing 525 - 600 V drive

SECTION 1
OPERATOR INTERFACE AND DRIVE CONTROL

INTRODUCTION

VLT drives are designed with self-diagnostic circuitry to isolate fault conditions and activate display messages which greatly simplify troubleshooting and service. The operating status of the drive is displayed in real-time. Virtually every command given to the drive results in some indication on the local control panel (LCP) display. Fault logs are maintained within the drive for fault history.

The drive monitors supply and output voltages along with the operational condition of the motor and load. When the drive issues a warning or alarm, it cannot be assumed that the fault lies within the drive itself. In fact, for most service calls, the fault condition will be found outside of the drive. Most of the warnings and alarms that the drive displays are generated by response to faults outside of the drive. This service manual provides techniques and test procedures to help isolate a fault condition whether in the drive or elsewhere.

Familiarity with the information provided on the display is important. Additional diagnostic data can be accessed easily through the LCP.

Normal Display

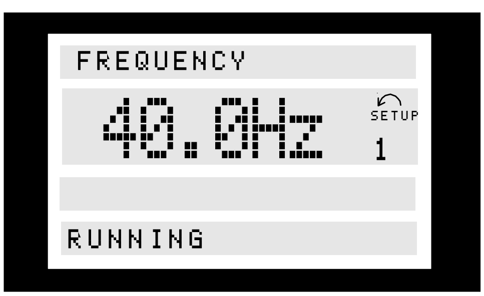
In normal operational mode after start up, the top line of the display (line 1) identifies the value displayed in line 2. The large display (line 2) shows a value, in this case the drive output in hertz. The setup number and direction of motor rotation is also shown. The bottom line (line 4) is the status line. This line displays the current operational status of the drive. The illustration below indicates that the drive is running at 40 HZ output.

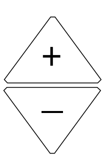
Line 1

Line 2

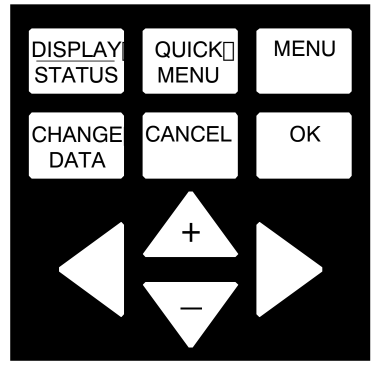
Line 3

Line 4

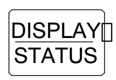




Pressing the up [+] or down [-] keys on the keypad in this mode changes the data shown in line 2. Thirty-one different diagnostic values are identified (in line 1) and displayed (in line 2) by scrolling through the display data. Setpoints, feedback, operational hours, digital and analog input status, relay output status, and many other system functions are identified and their values shown in real-time.

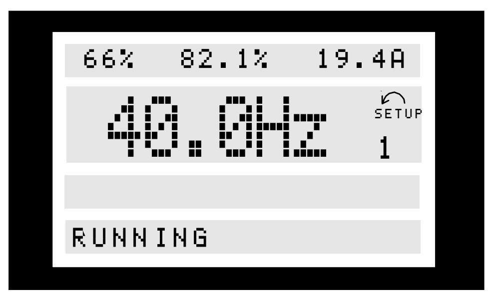


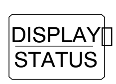
On the VLT 4000/6000/8000 series drives, the [DISPLAY/ STATUS] key is identified as the [DISPLAY MODE] key and operates in the same manner described.



Pressing the [DISPLAY/STATUS] key on the keypad toggles between the default setting and the programmable three meter display in line 1.

Line 1





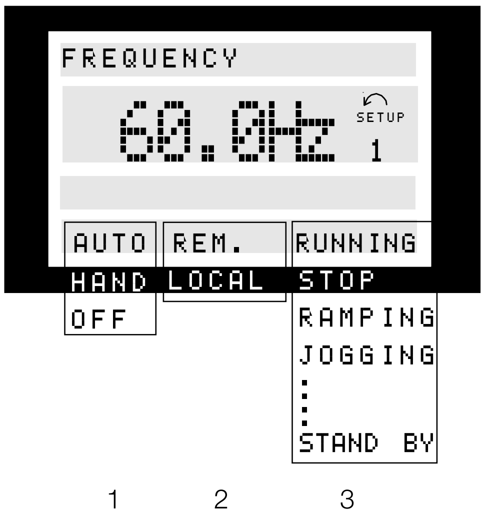
To identify the 3 meters displayed in line 1, press and hold the [DISPLAY/STATUS] key. The identity of the meter is displayed while the key is pressed.

The values displayed in lines 1 and 2 can be programmed from a list of options. See programming in the operator's manual for details.

Status Display

The status line of the display (line 4) reports inputs commanding drive operations.

The VLT 5000 series drives have a slightly different status display format than the VLT 4000/6000/8000 series drives.



1. For the VLT 4000/6000/8000, the first status display indicates where the start command comes from, automatic or hand start. In auto start, the drive looks for a remote start signal. In hand start, the drive receives a local input through the [HAND START] key.

2. The second status display indicates where the speed command comes from, remote or local. Local responds to the [+] and [-] keys on the keypad. Remote looks for an external reference signal.

3. The third display shows the operational status of the drive: running, stopped, stand by, ramping, and so on.

For the VLT 5000 series, the status display on line 4 is not segmented. It shows the operational status of the drive with the local or remote indication as part of the display title.

Tables 1-1 and 1-2 list the displays shown in the status line and define their meaning. Because the VLT 5000 series and VLT 4000/6000/8000 series have different display status indications, the definitions appear in separate tables.

Familiarity with the status display provides information regarding the operational mode of the drive. The status line displays are not programmable.

Factory Default Display Settings

Any of the values shown by scrolling through the display in line 2 are also available to display in the three meter displays on line 1. See the drive instruction manual for procedures on programming drive parameters.

Factory default values and associated parameters for VLT 5000 series drives are shown below.

Line 1 displays:	Line 2 display:
010 Reference (%)	009 Frequency (Hz)
011 Motor current (A)	
012 Power (kW)	

Factory default values and associated parameters for VLT 4000 /6000/8000 series drives are shown below.

Line 1 displays:	Line 2 display:
008 Reference (%)	007 Frequency (Hz)
009 Motor current (A)	
010 Power (hp)	

Table 1-1 defines the status line display shown in VLT 5000 series drives.

Table 1-1. VLT 5000 Series Status Definitions

DISPLAY	DESCRIPTION
AUTO MOTOR ADAPT	Automatic motor adaptation enabled in parameter 107, *Automatic Motor Adaptation, AMA* and drive performing adaptation function.
BRAKE CHECK OK	Brake check function is completed and brake resistor and transistor tested successfully.
BRAKING	Drive brake is functioning and motor is being slowed.
BRAKING MAX	Drive brake functioning at maximum. Drive brakes to its maximum when running 100% duty cycle.
CATCH UP	Drive output frequency increased by percentage value selected in parameter 219, *Catch up/Slow down Value*.
CONTROL READY	Condition causing UNIT NOT READY status has been rectified and drive is ready for operation.
CURRENT HIGH	Warning of drive output current higher than value set in parameter 224, *Warning: High Current*. Drive will continue to operate.
CURRENT LOW	Warning of drive output current lower than value set in parameter 223, *Warning: Low Current*. Drive will continue to operate.
EXCEPTIONS XXXX	Control microprocessor stopped for unknown cause and drive not operating. Cause may be due to noise on the power line, motor leads or control wires.
FEEDBACK HIGH	Warning of a feedback signal higher than value set in parameter 228, *Warning: High Feedback*. Drive will continue to operate.
FEEDBACK LOW	Warning of a feedback signal lower than value set in parameter 227, *Warning: Low Feedback*. Drive will continue to operate.
FREEZE OUTPUT	Drive output frequency frozen at current rate via digital input or serial communication.
FREQUENCY HIGH	Warning of drive frequency higher than value set in parameter 226, *Warning: High Frequency*. Drive will continue to operate.
FREQUENCY LOW	Warning of drive frequency lower than value set in parameter 225, *Warning: Low Frequency*. Drive will continue to operate.
LOCAL/DC STOP	Local control selected and drive stopped via a DC braking signal on terminal 27 or serial communication.
LOCAL/LCP STOP	Local control selected and drive is stopped via control panel. Coast signal on terminal 27 high.
LOCAL/QSTOP	Local control selected and drive stopped via a quick-stop signal on terminal 27 or serial communication.
LOCAL/RAMPING	Local control selected and motor speed and drive output frequency is changing.
LOCAL/RUN JOG	Local control selected and drive is running at a fixed frequency set in parameter 213, *Jog Frequency* via digital input or serial communication.
LOCAL/RUN OK	Local control selected and motor is running and speed corresponds to reference.
LOCAL/STOP	Local control selected and drive stopped via control panel, digital input or serial communication.
LOCAL/UNIT READY	Local control selected and 0 V on terminal 27.

Table 1-1. VLT 5000 Series Status Definitions (continued)

DISPLAY	DESCRIPTION
OFF1	Stop command (Ramp Down) received via serial communication, and Fieldbus selected in parameter 512.
OFF2	Stop command (Coast) received via serial communication, and Fieldbus selected in parameter 512.
OFF3	Stop command (Q Stop) received via serial communication, and Fieldbus selected in parameter 512.
OVER VOLTAGE CONTROL	Parameter 400, *Overvoltage Control*, enabled. Drive is attempting to avoid a trip from overvoltage by extending decel ramp time.
QUICK DISCHARGE OK	Quick discharge function has been completed successfully.
REM/BUS JOG1	Remote control selected and Fieldbus selected in parameter 512. Jog 1 command has been given via serial communication.
REM/BUS JOG2	Remote control selected and Fieldbus selected in parameter 512. Jog 2 command has been given via serial communication.
REM/DC STOP	Remote control selected and drive stopped via a DC stop signal on a digital input or serial communication.
REM/LCP STOP	Remote control selected and drive is stopped via control panel. Coast signal on terminal 27 high. Start command via remote digital input or serial communication is overridden.
REM/QSTOP	Remote control selected and drive stopped via a quick-stop signal on terminal 27 or serial communication.
REM/RAMPING	Remote control selected and motor speed and drive output frequency is changing.
REM/RUN JOG	Remote control selected and drive is running at a fixed frequency set in parameter 213, *Jog Frequency* via digital input or serial communication.
REM/RUN OK	Remote control selected and motor is running and speed corresponds to reference.
REM/STOP	Remote control selected and drive stopped via control panel, digital input or serial communication.
REM/UNIT READY	Remote control selected and 0 V on terminal 27.
SLOW DOWN	Drive output frequency reduced by percentage value selected in parameter 219, *Catch up/Slow down Value*.
STAND BY	Drive will start when a start signal received via digital input or serial communication.
START FORW./REV	Input on digital inputs and parameter data are in conflict.
START INHIBIT	OFF1, OFF2, OFF3 condition has been rectified. Drive cannot start until OFF1 bit is toggled (OFF1 set from 1 to 0 then to 1). Fieldbus selected in parameter 512.
UNIT NOT READY	Drive not ready for operation because of a trip or because OFF1, OFF2 or OFF3 is a logic ‘0.’ (Only on units with external 24 VDC supply.)

Table 1-2 defines the status line display shown in VLT 4000/ 6000/8000 series drives.

Table 1-2. VLT 4000/6000/8000 Series Status Definitions

DISPLAY	DESCRIPTION
CONTROL POINT	
AUTO	Drive in Auto mode, which means that Run/Stop control is carried out remotely via input control terminals and/or serial communication.
HAND	Drive in Hand mode, which means that Run/Stop control is carried out via keys on the keypad.
OFF	OFF/STOP activated either by means of keypad or by digital input terminals.
REFERENCE LOCATION	
REM.	REMOTE selected, which means reference is set via input control terminals or serial communication.
LOCAL	LOCAL selected, which means reference is set with [+] and [-] keys on keypad.
DRIVE STATUS	
AMA RUN	Automatic motor adaptation enabled in parameter 107, *Automatic Motor Adaptation, AMA* and drive performing adaptation function.
AMA STOP	Automatic motor adaptation completed. Drive is now ready for operation after *Reset* enabled. Motor may start after drive reset.
AUTO RAMP	Parameter 208, *Automatic Ramp*, enabled. Drive is attempting to avoid a trip from overvoltage by extending decel ramp time.
CTR.READY	This status only active when a Profibus option card is installed.
DC STOP	DC brake enabled in parameters 114 through 116.
FRZ.OUT	Drive output frequency frozen at fixed rate from input command.
FRZ.REQ	Start command to run at current frequency given but motor will not start until a *Run Permission* signal is received via a digital input.
JOG	Jog enabled via digital input or serial communication. Drive is running at a fixed frequency set in parameter 209, *Jog Frequency.*
JOG REQ.	Start command to run at jog frequency given but motor will not start until a *Run Permission* signal is received via a digital input.
NOT READY	Drive not ready for operation because of a trip or because OFF1, OFF2 or OFF3 is a logic ‘0.’
RAMPING	Motor speed and drive output frequency is changing.
RUN REQ.	Start command given but motor will not start until a *Run Permission* signal is received via digital input.
RUNNING	Motor running and speed corresponds to reference.
SLEEP	Parameter 403, *Sleep Mode Timer,* enabled. Motor stopped in sleep mode. It can restart automatically.
SLEEP.BST	Sleep boost function in parameter 406, *Boost Setpoint,* enabled. Drive is ramping up to boost setpoint.
STANDBY	Drive able to start motor when a start command is received.
START	*Reversing and start* on terminal 19, parameter 303, *Digital Inputs*, and *Start* on terminal 18, parameter 302, *Digital Inputs,* are both enabled. Motor will remain stopped until either signal becomes logic ‘0.’
START DEL	Start delay time programmed in parameter 111, *Start Delay*. When delay time expires, drive will start and ramp up to reference frequency.
START IN.	This status only displayed if parameter 599, *Profidrive* [1] selected and OFF2 or OFF3 is a logic ‘0.’
STOP	Motor stopped via a stop signal from serial communication.
UN.READY	Unit ready for operation but digital input terminal 27 is logic ‘0’ and/or a *Coasting Command* received via serial communication.
XXXX	Control microprocessor stopped for unknown cause and drive not operating. Cause may be noise on the power line, motor leads or control wires.

WARNINGS AND ALARMS

When the drive fault circuitry detects a fault condition, or a pending fault, a warning or alarm is issued. A flashing display on the LCP indicates an alarm or warning condition and the associated number code on line 2. A warning may precede an alarm. Table 1-3, *Fault Messages*, defines whether or not a warning precedes an alarm and whether the drive suspends operations (trips).

Alarms

An alarm causes the drive to trip (suspend operation). The drive has three trip conditions which are displayed on line 1:

TRIP (AUTO RESTART) means the drive is programmed to restart automatically after the fault is removed. The number of automatic reset attempts may be continuous or limited to a programmed number of attempts. This will change to TRIP (RESET) if the selected number of automatic reset attempts is exceeded.

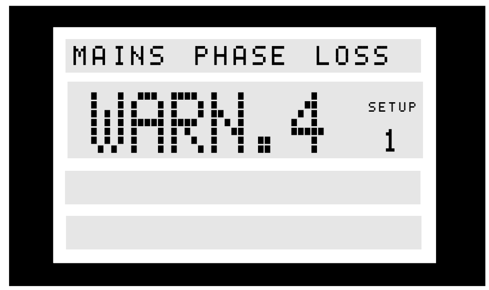
TRIP (RESET) requires resetting the drive prior to operation after a fault is cleared. The drive can be reset manually by pressing the reset key on the keypad, a digital input, or a serial bus command. For VLT 5000 series drives, the stop and reset key are the same. If the stop/rest key is used to reset the drive, the start key must be pressed to initiate a run command in either local or remote.

TRIPLOCK (DISC> MAINS) requires that the main AC input power to the drive must be disconnected long enough for the display to go blank. The fault condition must be removed and power reapplied. Following power up, the fault indication will change to TRIP (RESET) and allow for manual, digital, or serial bus reset.

Line 2 displays alarm and the associated number while line 3 identifies the alarm in plain language.

Warnings

During a warning, the drive will remain operational, although the warning will flash for as long as the condition exists. The drive may, however, take action to reduce the warning condition. For example, if the warning displayed were *Torque Limit* (Warning 12), the drive would be reducing speed to compensate for the over current condition. In some cases, if the condition is not corrected or grows worse, an alarm condition would be activated and the drive output to the motor terminated. Line 1 identifies the warning in plain language and line 2 identifies the warning number.

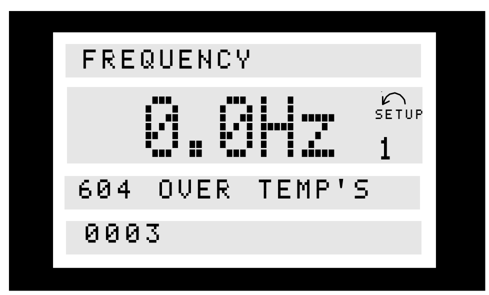


SERVICE FUNCTIONS

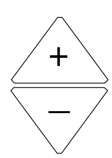
Service information for the drive can be shown on display lines 3 and 4. Twenty-six different items can be accessed. Included in the data are counters that tabulate operating hours, power ups and trips; fault logs that store drive status values present at the 20 most recent events that stopped the drive; and drive nameplate data. The service information is accessed by displaying items in the drive's 600s parameter group.

Line 3

Line 4



Parameter settings are displayed by pressing the [MENU] key on the LCP keypad.



Use the [+] and [-] keys on the LCP keypad to scroll through parameters.

See the operator's manual for detailed information on accessing and displaying parameters and for descriptions and procedures for service information available in the 600s parameter group.

FAULT MESSAGE TABLE

Table 1-3 lists the drive's fault messages and indicates whether a warning, alarm, or a trip-locks occurs. After a trip-lock, input power must be removed, the cause of the fault corrected, and the input power restored to reset the drive.

Wherever an "X" is placed under both warning and alarm, a warning precedes the alarm. An alarm always precedes, or simultaneously accompanies, a trip-lock. Which faults are reported may vary depending on the particular drive model.

Table 1-3. Fault Messages

No.	Description	Warning	Alarm	Trip Locked
1	Under 10 volts (10 VOLT LOW)	X		
2	Live zero fault (LIVE ZERO ERROR)	X	X	
4	Input phase imbalance (MAINS IMBALANCE)	X	X	X
5	Voltage warning high (DC LINK VOLTAGE HIGH)	X		
6	Voltage warning low (DC LINK VOLTAGE LOW)	X		
7	Overvoltage (DC LINK OVERVOLT)	X	X	
8	Undervoltage (DC LINK UNDERVOLT)	X	X	
9	Inverter overloaded (INVERTER TIME)	X	X	
10	Motor overloaded (MOTOR TIME)	X	X	
11	Motor temp high (MOTOR THERMISTOR)	X	X	
12	Current limit reached (CURRENT LIMIT)	X	X	
13	Overcurrent (OVERCURRENT)		X	X
14	Ground fault detected (EARTH FAULT)		X	X
15	Switch mode power fault (SWITCH MODE FAULT)		X	X
16	Short circuit (CURR.SHORT CIRCUIT)		X	X
17	Serial communication timeout (STD BUSTIMEOUT)	X	X	
18	HP field bus timeout (HPFB TIMEOUT)	X	X	
19	Fault in EEPROM on power card (EE ERROR POWER)	X		
20	Fault in EEPROM on control card (EE ERROR CONTROL)	X		
22	Auto motor adaptation fault (AMA FAULT)		X	
29	Heat-sink temperature high (HEAT SINK OVERTEMP.)		X	X
30	Motor phase U missing (MISSING MOT.PHASE U)		X	
31	Motor phase V missing (MISSING MOT.PHASE V)		X	
32	Motor phase W missing (MISSING MOT.PHASE W)		X	
34	HPFB communication fault (HPFB COMM. FAULT)	X	X	
35	Out of frequency range (OUT FREQ RNG/ROT LIM)	X		
37	Inverter fault (GATE DRIVE FAULT)		X	X
39	Check parameters 104 and 106 (CHECK P.104 & P.106)	X		
40	Check parameters 103 and 105 (CHECK P.103 & P.106)	X		
41	Motor too large (MOTOR TOO BIG)	X		
42	Motor too small (MOTOR TOO SMALL)	X		
60	Safety stop (EXTERNAL FAULT)		X	
61	Output frequency low (FOUT < FLOW)	X		
62	Output frequency high (FOUT > FHIGH)	X		
63	Output current low (I MOTOR < I LOW)	X	X	
64	Output current high (I MOTOR > I HIGH)	X		
65	Feedback low (FEEDBACK < FDB LOW)	X		
66	Feedback high (FEEDBACK > FDB HIGH)	X		
67	Reference low (REF. < REF. LOW)	X		
68	Reference high (REF. > REF. HIGH)	X		
69	Temperature auto derate (TEMP.AUTO DERATE)	X		
99	Unknown fault (UNKNOWN ALARM)		X	X

DRIVE INPUTS AND OUTPUTS

The drive operates by receiving control input signals. The drive can also output status data or control auxiliary devices. Control input is connected to the drive in three possible ways. One way for drive control is through the keypad on the front of the drive when operating in local (hand) mode. These inputs include start, stop, reset, and speed reference.

Another control source is through serial communication from a serial bus. A serial communication protocol supplies commands and references to the drive, can program the drive, and reads status data from the drive. The serial bus connects to the drive through the RS-485 serial port or through a communication option card.

The third way is through signal wiring connected to the drive control terminals (see Figure 1-1). The drive control terminals are located below the drive keypad. Improperly connected control wiring can be the cause of a motor not operating or the drive not responding to a remote input.

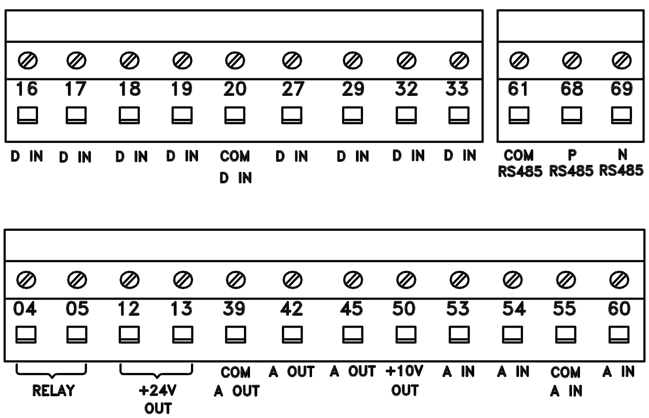


Figure 1-1. Control Terminals

Input Signals

The drive can receive two types of remote input signals: digital or analog. Digital inputs are wired to terminals 16, 17, 18, 19, 20 (common), 27, 29, 32, and 33. Analog inputs are wired to terminals 53, 54, and 55 (common), or terminal 60.

Analog signals can be either voltage (0 to +10 VDC) connected to terminals 53 and 54, or current (0 to 20 mA or 4 to 20 mA) connected to terminal 60. Analog signals can be varied like dialing a rheostat up and down. The drive can be programmed to increase or decrease output in relation to the amount of current or voltage. For example, a sensor or external controller may supply a variable current or voltage. The drive output, in turn, regulates the speed of the motor connected to the drive in response to the analog signal.

Digital signals are a simple binary 0 or 1 which, in effect, act as a switch. Digital signals are controlled by a 0 to 24 VDC signal. A voltage signal lower than 5 VDC is a logic 0. A voltage higher than 10 VDC is a logic 1. Zero is open, one is close. Digital inputs to the drive are switched commands such as start, stop, reverse, coast, reset, and so on. (Do not confuse these digital inputs with serial communication formats where digital bytes are grouped into communication words and protocols.)

The RS-485 serial communication connector is wired to terminals (+) 68 and (-) 69. Terminal 61 is common and may be used for terminating shields only when the control cable is run between VLT drives, not between drives and other devices. See *Grounding Shielded Cables* in this section for correct methods for terminating shielded control cable.

Output Signals

The drive also produces output signals that are carried through either the RS-485 serial bus or terminals 42 and 45. Output terminals 42 and 45 operate in the same manner as the inputs. These terminals can be programmed for either a variable analog signal in mA or a digital signal (0 or 1) in 24 VDC. In addition, the terminals can provide a pulse reference of 0 to 32,000 pulses. Output analog signals generally indicate the drive frequency, current, torque and so on to an external controller or system. Digital outputs can be control signals used to open or close a damper, for example, or send a start or stop command to auxiliary equipment.

Additional terminals are 01, 02, and 03, which are a Form C relay output. Terminals 04 and 05 are a Form A low voltage relay output.

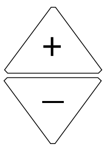
Terminals 12 and 13 provide 24 VDC low voltage power, often used to supply power to the digital input terminals (16-33). Those terminals must be supplied with power from either terminal 12 or 13, or from a customer supplied external 24 VDC power source. Improperly connected control wiring is a common service issue for a motor not operating or the drive not responding to a remote input.

Control Terminals

Control terminals must be programmed. Each terminal has specific functions it is capable of performing and a numbered parameter associated with it. See Table 1-4 below. The setting selected in the parameter enables the function of the terminal.

It is important to confirm that the control terminal is programmed for the correct function.

Parameter settings are displayed by pressing the [MENU] key on the LCP keypad.



Use the [+] and [-] keys on the LCP keypad to scroll through parameters. The 300s parameter group is used to set control terminal values.

See the operator's manual for details on changing parameters and the functions available for each control terminal.

In addition, the input terminal must be receiving a signal. Confirm that the control and power sources are wired to the terminal. Then check the signal.

Signals can be checked in two ways. *Digital Input* can be selected for display by pressing [DISPLAY MODE] key as discussed previously, or a voltmeter may be used to check for voltage at the control terminal. See procedure details at *Input Terminal Test* in Section 5.

In summary, for proper drive functioning, the drive input control terminals must be:

1. wired properly
2. powered
3. programmed correctly for the intended function
4. receiving a signal

Control Terminal Functions

The following describes the functions of the control terminals. Many of these terminals have multiple functions determined by parameter settings. See Figure 1-2, *Control Terminals Electrical Diagram.*

Terminal No.	Function
01, 02, 03	Form C relay output. Maximum 240 VAC, 2 A. Minimum 24 VDC, 10 mA or 24 VAC, 100 mA. Can be used for indicating status and warnings. Physically located on power card.
04, 05	Form A relay output 30 VAC, 42.5 VDC. Can be used for indicating status and warnings.
12, 13	Voltage supply to digital inputs and external transducers. For the 24 VDC to be used for digital inputs, switch 4 on the control card must be closed (ON position). The maximum output current is 200 mA.
16 - 33	Programmable digital inputs for controlling the drive. R = 2 kohm. Less than 5 V = logic 0 (open). Greater than 10 V = logic 1 (closed).
20	Common for digital inputs.
39	Common for analog and digital outputs.
42, 45	Analog and digital outputs for indicating values such as frequency, reference, current and torque. The analog signal is 0 to 20 mA, or 4 to 20 mA at a maximum of 500 Ω. The digital signal is 24 VDC at a minimum of 600 Ω.
50	10 VDC, 17 mA maximum analog supply voltage for potentiometer or thermistor.
53, 54	0 to 10 VDC voltage input, R = 10 kΩ. Used for reference or feedback signals. A thermistor can be connected here.

Table 1-4. Control Terminals and Associated Parameter

Term	16	17	18	19	27	29	32	33	53	54	60	42	45	1-3	4-5
Para	300	301	302	303	304	305	306	307	308	311	314	319	321	323	326

Control terminals must be programmed. Each terminal has specific functions it is capable of performing and a numbered parameter associated with it. The setting selected in the parameter enables the function of the terminal. See the Operator's Manual for details.

Terminal No.	Function
55	Common for analog inputs. This common is isolated from the common of all other power supplies. If, for example, the drive's 24 VDC power supply is used to power an external transducer, which provides an analog input signal, terminal 55 must be wired to terminal 39.
60	Programmable 0 to 20 mA or 4 to 20 mA, analog current input, Resistance = approx. 200 Ω. Used for reference or feedback signals.
61	RS-485 common.
68, 69	RS-485 interface and serial communication.

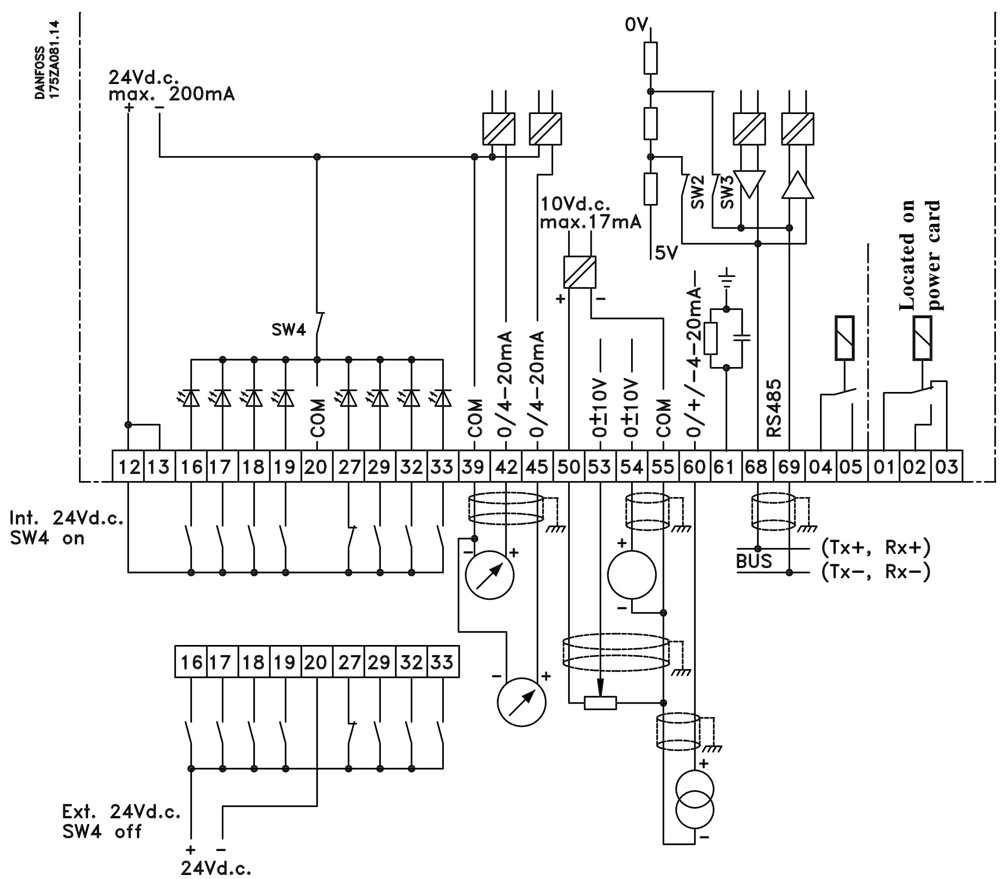
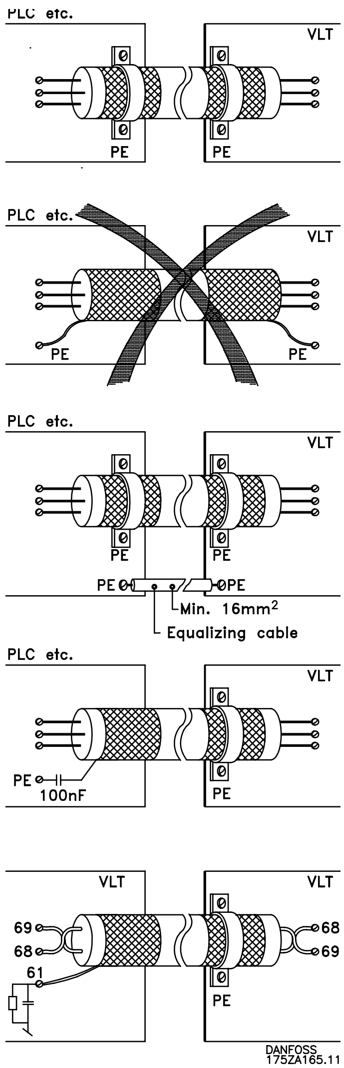


Figure 1-2. Control Terminals Electrical Diagram

Grounding Shielded Cables

It is recommended that shielded control cables be connected with cable clamps at both ends to the metal cabnet of the drive. Figure 1-3 shows ground cabling for optimal results.



Correct grounding

Control cables and cables for serial communication must be fitted with cable clamps at both ends to ensure the best possible electrical connection.

Incorrect grounding

Do not use twisted cable ends (pigtails) since these increase shield impedance at high frequencies.

Ground potential protection

When the ground potential between the drive and the PLC or other interface device is different, electrical noise may occur that can disturb the entire system. This can be resolved by fitting an equalizing cable next to the control cable. Minimum cable cross-section is 8 AWG.

50/60 Hz ground loops

When using very long control cables, 50/60 Hz ground loops may occur that can disturb the entire system. This can be resolved by connecting one end of the shield with a 100 nF capacitor and keeping the lead short.

Serial communication control cables

Low frequency noise currents between drives can be eliminated by connecting one end of the shielded cable to drive terminal 61. This terminal connects to ground through an internal RC link. It is recommended to use twisted-pair cables to reduce the differential mode interference between condutors.

Figure 1-3. Grounding Shielded Cables

SECTION 2
INTERNAL DRIVE OPERATION

GENERAL

This section is intended to provide an operational overview of the drive's main assemblies and circuitry. With this information, a repair technician should have a better understanding of the drive's operation and aid in the troubleshooting process.

The VLT series drives covered in this manual are very similar in design and construction. For the purpose of troubleshooting, two main differences exist. First, the control card and LCP for the VLT 5000 series differs from that of the other three series. Second, the power section is rated differently in a constant torque drive (VLT 5000) versus a variable torque drive. The power section of a 125 hp VLT 5000 series is similar to that of a 150 hp in the other three series, and so on. **To simplify the discussion, this section refers to the constant torque VLT 5000 drives, except where necessary to detail specific variations.**

DESCRIPTION OF OPERATION

An adjustable frequency drive is an electronic controller that supplies a regulated amount of AC power to a standard three phase induction motor in order to control the speed of the motor. By supplying variable frequency and voltage to the motor, the drive controls the motor speed, or maintains a constant speed as the load on the motor changes. The drive can also stop and start a motor without the mechanical stress associated with a line start.

In its basic form, the drive can be divided into four main sections: rectifier, intermediate circuit, inverter, and control and regulation (see Figure 2-1).

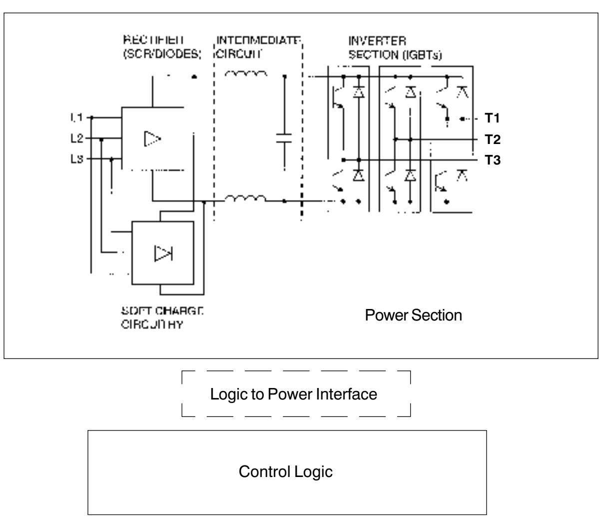


Figure 2-1. Control Card Logic

To provide an overview, the main drive components will be grouped into three categories consisting of the control logic section, logic to power interface, and power section. In the sequence of operation description, these three sections will be covered in greater detail while describing how power and control signals move throughout the drive.

Logic Section

The control card contains most of the logic section (see Figure 2-2). The primary logic element of the control card is a microprocessor, which supervises and controls all functions of drive operation. In addition, separate PROMs contain the parameters to provide the user with programmable options. These parameters are programmed to enable the drive to meet specific application requirements. This data is then stored in an EEPROM which provides security during power-down and also allows the flexibility to change the operational characteristics of the drive.

A custom integrated circuit generates a pulse width modulation (PWM) waveform which is then sent to the interface circuitry located on the power card.

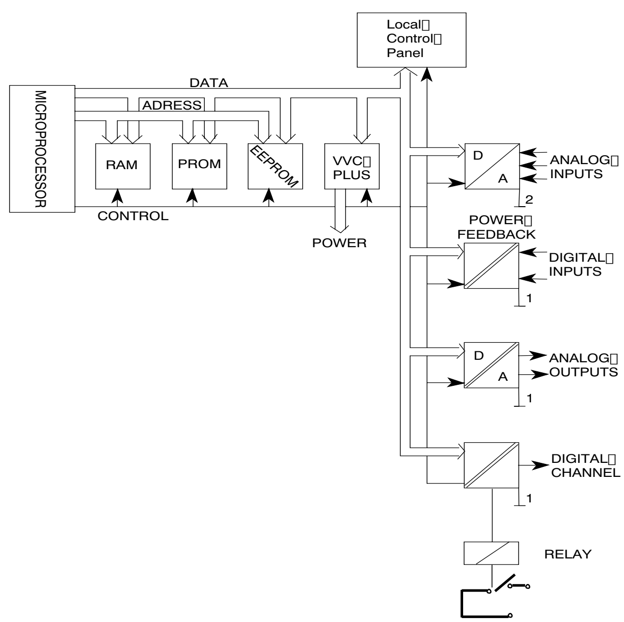


Figure 2-2. Logic Section

The PWM waveform is created using an improved control scheme called VVC^{plus}, a further development of the earlier VVC (Voltage Vector Control) system. VVC^{plus} provides a variable frequency and voltage to the motor which matches the requirements of the motor. The dynamic response of the system changes to meet the variable requirements of the load.

Another part of the logic section is the local control panel (LCP). This is a removable keypad/display mounted on the front of the drive. The keypad provides the interface between the drive's internal digital logic and the operator.

All the drive's programmable parameter settings can be uploaded into the EEPROM of the LCP. This function is useful for maintaining a back up drive profile and parameter set. It can also be used, through its download function, in programming other drives or to restore a program to a repaired unit. The LCP is removable during operation to prevent undesired program changes. With the addition of a remote mounting kit, the LCP can be mounted in a remote location of up to ten feet away.

Control terminals, with programmable functions, are provided for input commands such as run, stop, forward, reverse and speed reference. Additional output terminals are provided to supply signals to run peripheral devices or for monitoring and reporting status.

The control card logic is capable of communicating via serial link with outside devices such as personal computers or programmable logic controllers (PLC).

The control card also provides two voltage supplies for use from the control terminals. The 24 VDC is used for switching functions such as start, stop and forward/reverse. The 24 VDC supply is also capable of supplying 200ma of power, part of which may be used to power external encoders or other devices. A 10 VDC supply rated at 17ma is also available for use with speed reference circuitry.

The analog and digital output signals are powered through an internal drive supply. The three power supplies are isolated from one another to eliminate ground loop conditions in the control input circuitry.

A single pole low voltage relay on the control card activates external devices based on the status of the drive. The contacts of the control card relay are rated for 50 VAC at 1 Amp. However, in UL applications, the rating is limited to 30 VDC at 1 Amp.

The logic circuitry on the control card allow for the addition of option modules for synchronizing control, serial communications, additional relays, the cascade pump controller, or custom operating software.

Logic To Power Interface

The logic to power interface isolates the high voltage components of the power section from the low voltage signals of the logic section. The interface section consists of three separate circuit cards: the *interface* card, *power* card, and *gate driver* card.

The power card has been designed to accommodate the control circuitry for the next generation of VLT drives. For this reason, an interface card, located between the control and power cards in the current series of drives, provides translation between the two signal schemes. Most of the communication between the control logic and the rest of the drive passes through these two cards. Communication with the power card includes monitoring the DC bus voltage, line voltage, output current, along with control of inrush current and the gate drive firing signals.

Much of the fault processing for output short circuit and ground fault conditions is handled by the control card. The power and interface cards provide conditioning of these signals. Scaling of current feedback and voltage feedback is accomplished on the interface card before processing by the control card.

The power card contains a switch mode power supply (SMPS) which provides the unit with 24 VDC, +18 VDC, –18 VDC and 5 VDC operating voltage. The logic and interface circuitry is powered by the SMPS. The SMPS is supplied by the DC bus voltage. VLT 5000 Series drives can be purchased with an optional secondary SMPS which is powered from a customer supplied 24 VDC source. This secondary SMPS provides power to the logic circuitry with main input disconnected. It can keep units with communication options live on a network when the drive is not powered from the mains.

Circuitry for controlling the speed of the cooling fans is also provided on the power card.

Also located on the power card is a relay for monitoring the status of the drive. The relay is Form C, meaning it has one normally open contact and one normally closed contact on a single throw. The contacts of the relay are rated for a maximum load of 240 VAC at 2 Amps.

The gate drive signals from the control card to the output transistors (IGBTs) are isolated and buffered on the gate driver card. In units that have the dynamic brake option, the driver circuits for the brake transistors are also located on this card.

Power Section

The high voltage power section consists of AC input terminals, AC and DC bus bars, fusing, harnessing, AC output, and optional components. The power section (see Figure 2-3) also contains circuitry for the soft charge and SCR/Diode modules in the rectifier; the DC bus filter circuitry containing the DC coils, often referred to as the intermediate or DC bus circuit; and the output IGBT modules which make up the inverter section.

In conjunction with the SCR/Diode modules, the soft charge circuit limits the inrush current when power is first applied and the DC bus capacitors are charging. This is accomplished by the SCRs in the modules being held off while charging current passes through the soft charge resistors, thereby limiting the current. The DC bus circuitry smoothes the pulsating DC voltage created by the conversion from the AC supply.

The DC coil is a single unit with two coils wound on a common core. One coil resides in the positive side of the DC bus and the other in the negative. The coil aids in the reduction of line harmonics.

The DC bus capacitors are arranged into a capacitor bank along with bleeder and balancing circuitry. Due to the requirement for higher power capacity, some drives have two capacitor banks connected in parallel.

The inverter section is made up of six IGBTs, commonly referred to as switches. One switch is necessary for each half phase of the three-phase power, for a total of six. The six IGBTs are contained in a single module. Due to higher current handling requirements, some models contain two or three larger six-pack style modules. In these units, each switch (half phase) is made up of two or three IGBTs in parallel.

A Hall effect type current sensor is located on each phase of the output to measure motor current. This type of device is used instead of more common current transformer (CT) devices in order to reduce the amount of frequency and phase distortion that CTs introduce into the signal. With Hall sensors, the average, peak, and ground leakage currents can be monitored.

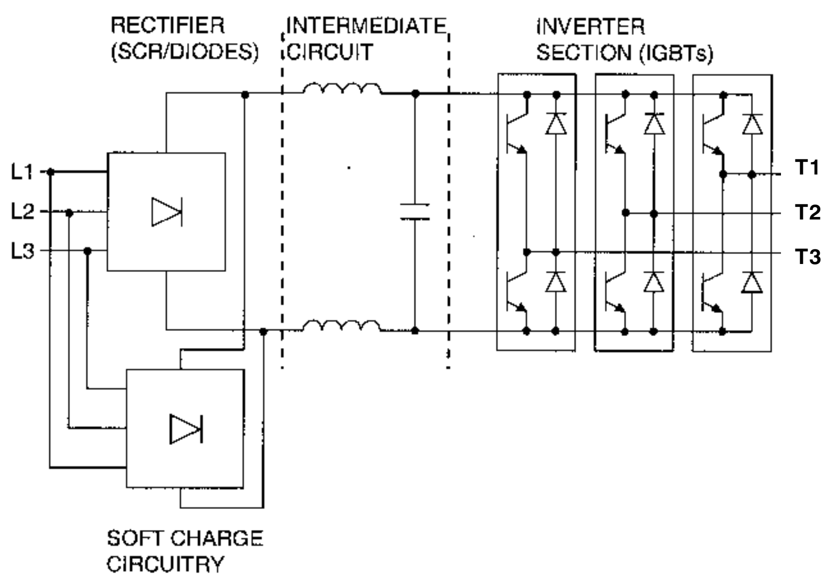


Figure 2-3. Typical Power Section

SEQUENCE OF OPERATION

Rectifier Section

When input power is first applied to the drive, it enters through the input terminals (L1, L2, L3) and on to the disconnect or/ and RFI option, depending on the unit's configuration (see Figure 2-4). If equipped with optional fuses, these fuses (FU1, FU2, FU3) limit damage caused by a short circuit in the power section. The SCRs, in the combined SCR/Diode modules, are not gated so current can travel to the rectifier on the soft charge card. In E1 drive models, the SCR and diode modules are separate. Additional fuses located on the soft charge card provide protection in the event of a short in the soft charge or fan circuits. Three phase power is also branched off and sent to the power card. It provides the power card with a reference of the main supply voltage and provides a supply voltage for the cooling fans.

During the charging process, the top diodes of the soft charge rectifier conduct and rectify during the positive half cycle. The diodes in the main rectifier conduct during the negative half cycle. The DC voltage is applied to the bus capacitors through the soft charge resistor. The purpose of charging the DC bus through this resistor is to limit the high inrush current that would otherwise be present.

Positive temperature coefficient (PTC) resistors located on the soft charge card are in series with the soft charge resistor. Frequent cycling of the input power or the DC bus charging over an extended time can cause the PTC resistors to heat up due to the current flow. Resistance of the PTC device increases with temperature, eventually adding enough resistance to the circuit to prevent significant current flow. This protects the soft charge resistor from damage along with any other components that could be damaged by continuous attempts to charge the DC bus.

The low voltage power supplies are activated when the DC bus reaches approximately 50 VDC less than the alarm voltage low for the DC bus (see ratings tables in the introductory section of this manual). The value for the low voltage alarm can be found in the ratings tables in the introductory section of this manual. After a short delay, an inrush enable signal is sent from the control card to the power card SCR gating circuit. The SCRs are automatically gated when forward biased, acting, as a result, similar to an uncontrolled rectifier.

When the DC bus capacitors are fully charged, the voltage on the DC bus will be equal to the peak voltage of the input AC line. Theoretically, this can be calculated by multiplying the AC line value by 1.414 (VAC x 1.414). However, since AC ripple voltage is present on the DC bus, the actual DC value will be closer to VAC x 1.38 under unloaded conditions and may drop to VAC x 1.32 while running under load. For example, a drive connected to a nominal 460 V line, while sitting idle, the DC bus voltage will be approximately 635 VDC.

As long as power is applied to the drive, this voltage is present in the intermediate circuit and the inverter circuit. It is also fed to the Switch Mode Power Supply (SMPS) on the power card and is used for generating all other low voltage supplies.

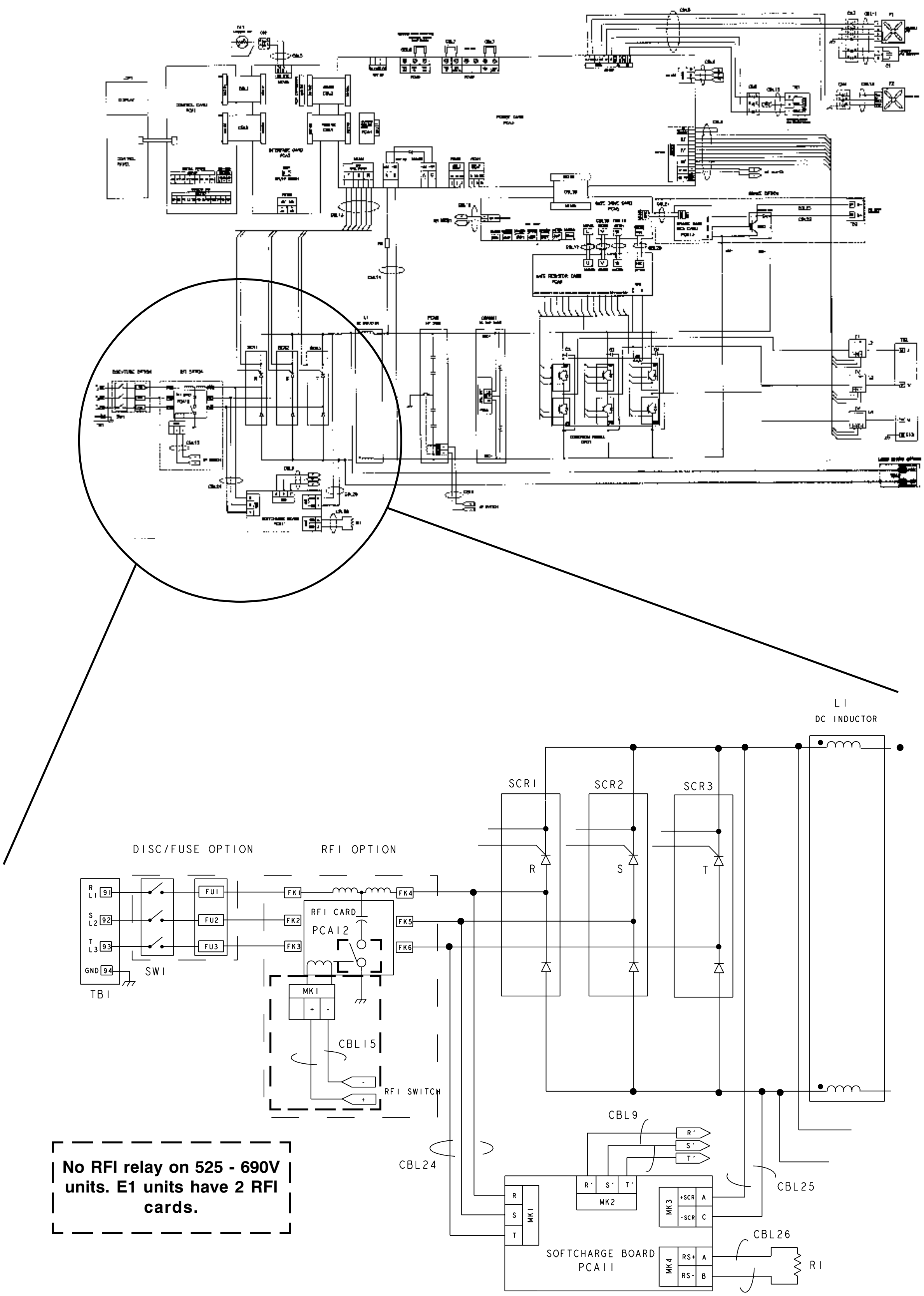


Figure 2-4. Rectifier Circuit

Intermediate Section

Following the rectifier section, voltage passes to the intermediate section. (see Figure 2-5). This rectified voltage is smoothed by an LC filter circuit consisting of the DC bus inductor and the DC bus capacitor bank.

The DC bus inductor provides series impedance to changing current. This aids the filtering process while reducing harmonic distortion to the input AC current waveform normally inherent in rectifier circuits.

The DC capacitor bank assembly consists of up to eight capacitors arranged in series/parallel configuration. Higher power units have two capacitor banks assemblies. Also contained within the assembly is the bleeder/balance circuitry. This circuitry maintains equal voltage drops across each capacitor and provides a current path for discharging the capacitors once power has been removed from the drive.

Also located in the intermediate section is the high frequency (HF) filter card. It contains a high frequency filter circuit to reduce naturally occurring currents in the HF range to prevent interference with other sensitive equipment in the area. The circuit, as with other RFI filter circuitry, can be sensitive to unbalanced phase-to-ground voltages in the three-phase AC input line. This can occasionally result in nuisance overvoltage alarms. For this reason, the HF filter card on 380 - 500 V range drives, contains a set of relay contacts in the ground connection of the filter capacitors. The relay is tied into the RFI/HF switch on the interface card, which can be manually switched off. This disconnects the ground references to all filters should unbalanced phase-to-ground voltages create nuisance overvoltage conditions.

For 525-600/690 V drives, there are no relay contacts that disconnect to ground.

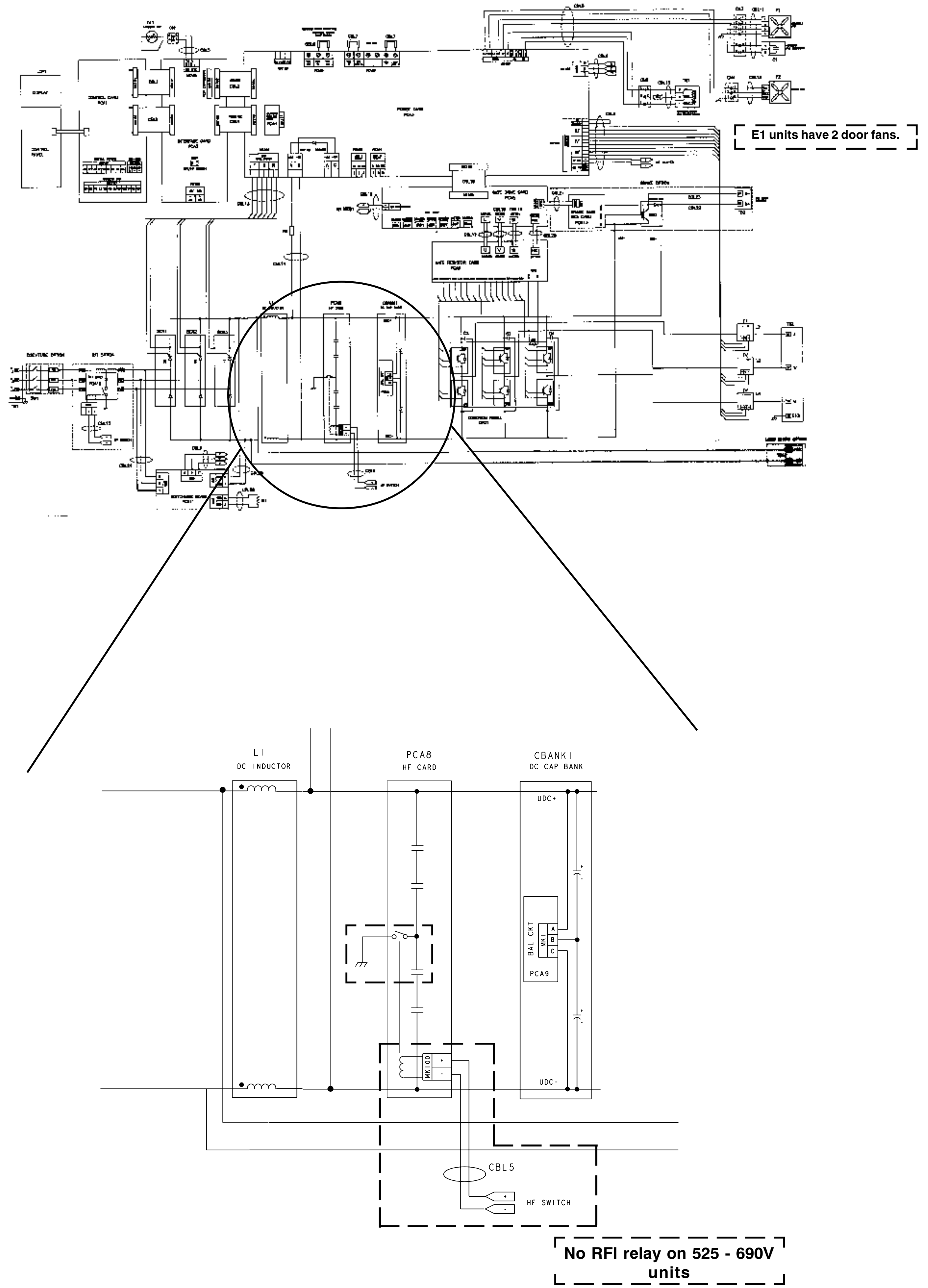


Figure 2-5. Intermediate Section

Inverter Section

In the inverter section (see Figure 2-7), gate signals are delivered from the control card, through the power card and gate drive card to the gates of the IGBTs. The series connection of each set of IGBTs is delivered to the output, first passing through the current sensors.

Once a run command and speed reference are present, the IGBTs begin switching to create the output waveform, as shown in Figure 2-6. Looking at the phase-to-phase voltage waveform with an oscilloscope, it can be seen that the Pulse Width Modulation (PWM) principal creates a series of pulses which vary in width. Basically, the pulses are narrower as zero crossing is neared and wider the farther from zero crossing. The width is controlled by the pulse duration of applied DC voltage. Though the voltage waveform is a consistant amplitude, the inductance within the motor windings will serve to average the voltage delivered and so, as the pulse width of the waveform varies, the average voltage seen by the motor varies as well. This then equates to the resultant current waveform which takes on the sine wave shape that we expect to see in an AC system. The frequency of the waveform is then determined by the rate at which the pulses occur. By employing a sophisticated control scheme, the drive is capable of delivering a current waveform that nearly replicates a true AC sine wave.

This waveform, as generated by the Danfoss VVC^{plus} PWM principle at the control card, provides optimal performance and minimal losses in the motor.

Hall effect current sensors monitor the output current and deliver proportional signals to the power card where they are buffered and delivered to the control card. These current signals are used by the control card logic to determine proper waveform compensations based on load conditions. They further serve to detect overcurrent conditions, including ground faults and phase-to-phase shorts on the output.

During normal operation, the power card and control card are monitoring various functions within the drive. The current sensors provide current feedback information. The DC bus voltage and AC line voltage are monitored as well as the voltage delivered to the motor. A thermal sensor mounted on the heatsink provides temperature feedback.

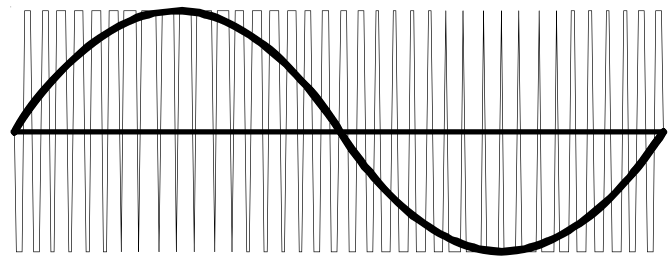


Figure 2-6. Output Voltage and Current Waveforms

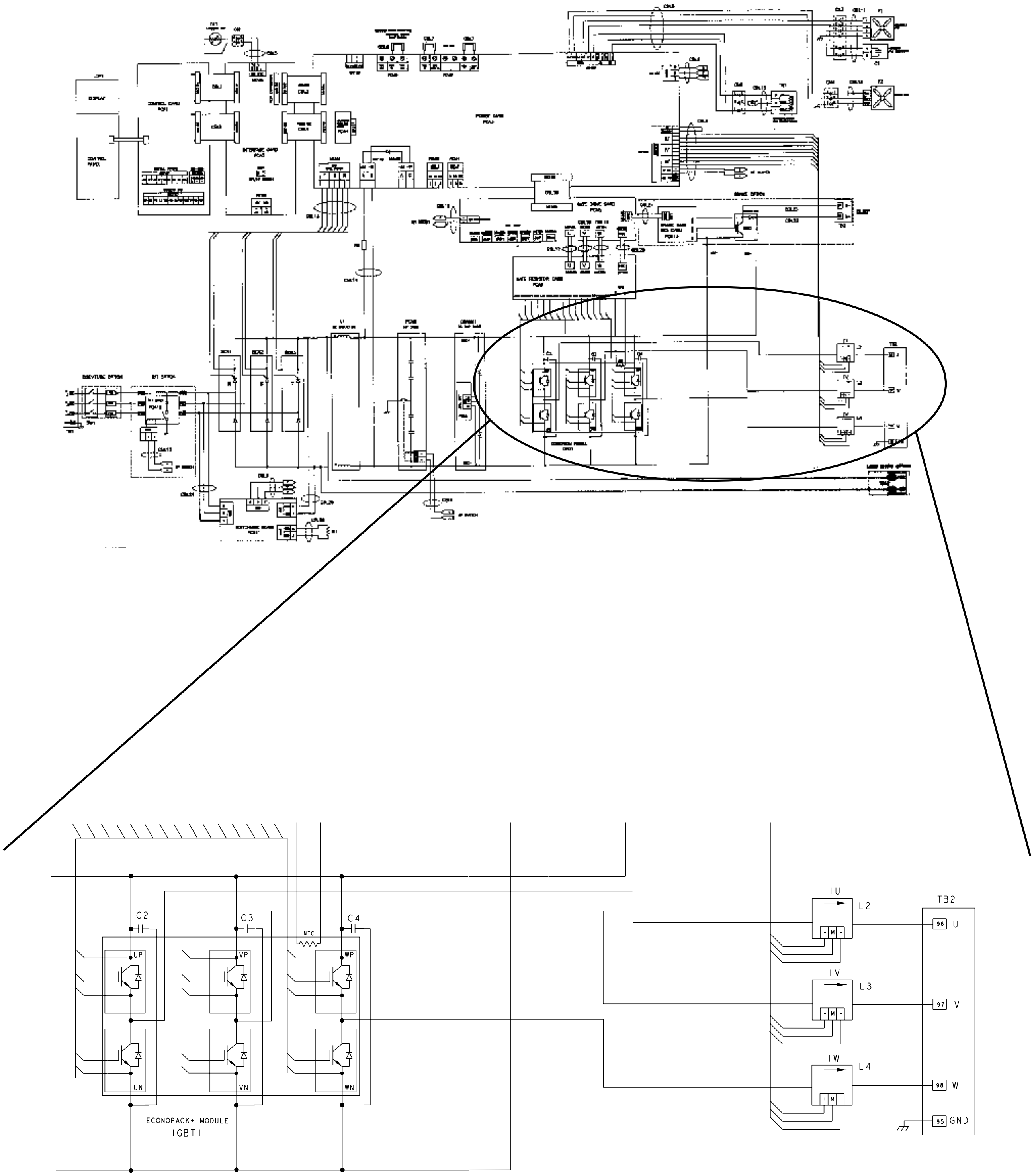


Figure 2-7. Inverter Section

Brake Option

For drives equipped with the dynamic brake option, a brake IGBT along with terminals 81(R-) and 82(R+) is included for connecting an external brake resistor.

The function of the brake IGBT (see Figure 2-8) is to limit the voltage in the intermediate circuit, whenever the maximum voltage limit is exceeded. It does this by switching the externally mounted resistor across the DC bus to remove excess DC voltage present on the bus capacitors. Excess DC bus voltage is generally a result of an overhauling load causing regenerative energy to be returned to the DC bus. This occurs, for example, when the load drives the motor causing the voltage to return to the DC bus circuit.

Placing the brake resistor externally has the advantages of selecting the resistor based on application need, dissipating the energy outside of the control panel, and protecting the drive from overheating if the brake resistor is overloaded.

The Brake IGBT gate signal originates on the control card and is delivered to the brake IGBT via the power card and gate drive card. Additionally, the power and control cards monitor the brake IGBT and brake resistor connection for short circuits and overloads.

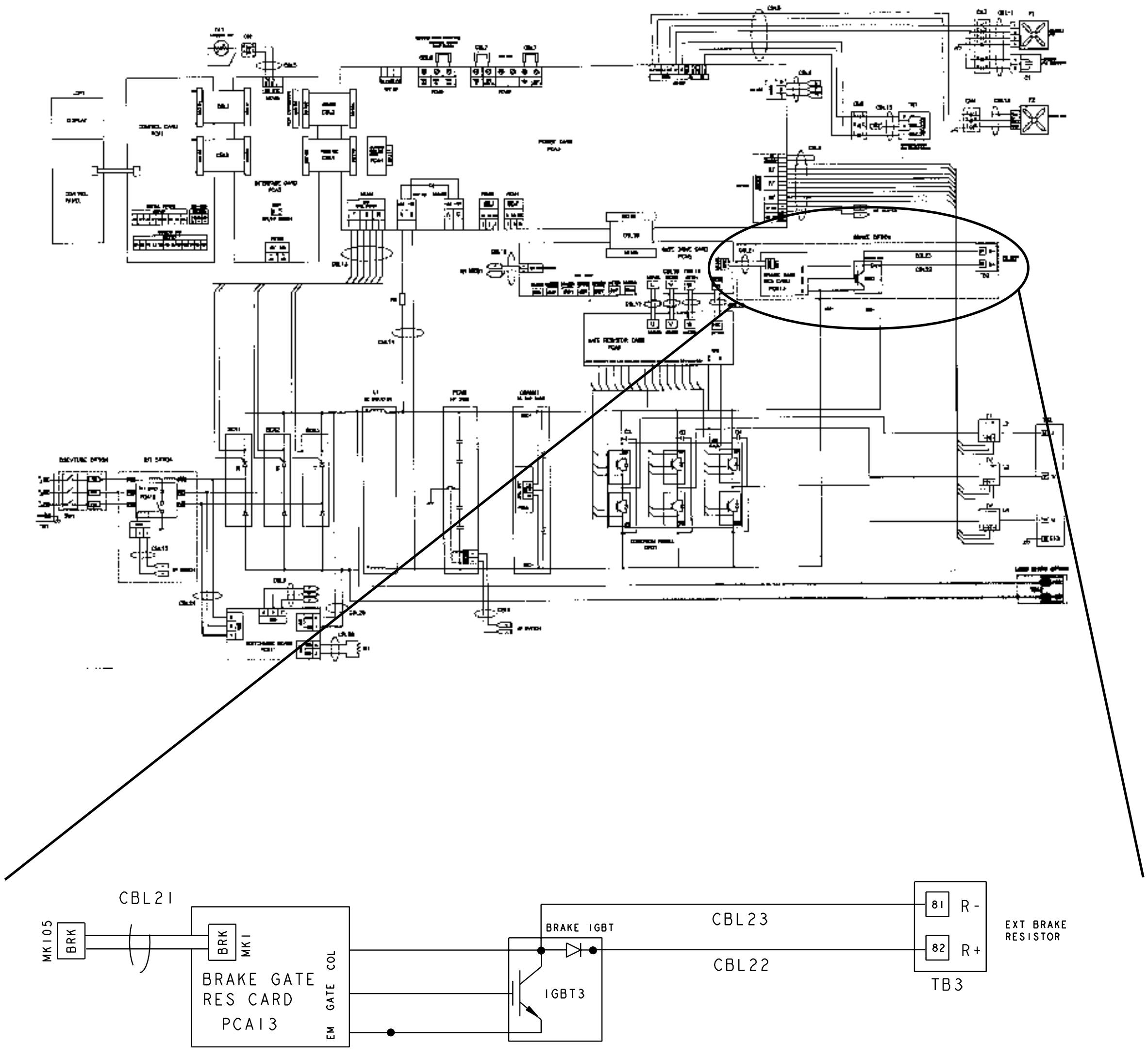


Figure 2-8. Brake Option

Cooling Fans

All drives in this size range are equipped with cooling fans to provide airflow along the heatsink. Units in NEMA 1 (IP21) and NEMA 12 (IP54) enclosures have, in addition, a fan mounted in the enclosure door to provide additional airflow to the rest of the unit. Units in chassis (IP00) enclosures have, in addition, a fan mounted to the top of the unit to provide additional cooling.

Some drives in this size range have a small 24 VDC fan mounted on the input plate. This fan is only mounted on E-frame size units equipped with both an RFI filter and mains fuses. The fan provides air flow around the main fuses. The fan operates anytime the drive is powered.

All fans are powered by the main line voltage which is stepped down by an autotransformer and then regulated to 200 or 230 VAC by circuitry provide on the power card. On/off and high/low speed control of the fans is provided to reduce overall acoustical noise and extend the life of the fans.

Regardless of the heatsink temperature, the fans are started shortly after main input power is applied to the drive. If the heatsink temperature is below 86°F (30°C), the fans will turn off after a short interval. At a heatsink temperature of greater than 113°F (45°C), the fans are switched on at low speed. This equates to approximately 200 VAC applied to the fans. At a heatsink temperature of more than 122°F (50°C), 230 VAC is applied to the fans to obtain full speed. When the heatsink temperature returns to less than 104°F (40°C), the fans return to low speed. Below 86°F (30°C)the fans switch off.

Since the internal ambient temperature is maintained by one or more 230 VAC fans, the transition between low and high speeds also occurs if the internal ambient rises, regardless of heatsink temperature. The internal ambient temperature sensor is located on the power card. If the internal temperature rises to greater than 95°F (35°C), the fans will switch to high speed, regardless of the heatsink temperature. If the internal ambient temperature returns to 86°F (30°C) and the heatsink temperature remains below 122°F (50°C), the fans will return to low speed.

The fans switch to low speed should a heatsink over temperature trip occur. In addition, regardless of any temperature, when the load current on the drive reaches 60% of its continuous rating the fans are switched on at low speed and then follow the temperatures as listed above.

Load Sharing

Units with the built-in load sharing option contain terminals 89 (+) DC and 88 (-) DC. Within the drive, these terminals connect to the DC bus in front of the DC link reactor and bus capacitors.

The use of the load sharing terminals can take on two different configurations.

In one method, the terminals are used to tie the DC bus circuits of multiple drives together. This allows for the possibility of one drive that is in a regenerative mode to share its excess bus voltage with another drive that is in the motoring mode. When applied correctly, this can reduce the need for external dynamic brake resistors while also saving energy. In theory, the number of drives that can be connected in this way is infinite, however, the drives must be of the same voltage rating. In addition, depending on the size and number of drives, it may be necessary to install DC reactors and DC fuses in the DC link connections and AC reactors on the mains. Attempting such a configuration requires specific considerations and should not be attempted without first consulting Danfoss Application Engineering.

In the second method, the drive is powered exclusively from a DC source. This is a bit more complicated. First, a DC source is required. Second, a means to soft charge the DC bus at power up is required. Last, a line voltage source is required to power the fans within the drive. Again such a configuration should not be attempted with out first consulting Danfoss Application Engineering.

Specific Card Connections

Connector FK102, terminals 104, 105 and 106 located on the power card, provide for the connection of an external temperature switch. The input could be used to monitor the temperature of an external brake resistor. Two input configurations are possible. A normally closed switch may be connected between terminals 104 and 106 or a normally open switch between terminals 104 and 105. Should the input change states, the drive would trip on an Alarm 29, Overtemperature. The input SCRs would also be disabled to prevent further energy from being supplied to the DC bus. If no such input is used, or the normally open configuration is selected, a jumper must be installed between terminals 104 and 106.

Connector FK103, terminals 100, 101, 102, and 103 located on the power card, provide for the connection of line voltage to allow powering the AC cooling fans from an external source. This is required when the drive is used in a load sharing application where no AC power is provided to the main input terminals. To make use of this provision, the jumpers would be removed from terminals 100 and 102, 101 and 103. The auxiliary line voltage power supply would be connected to terminals 100 and 101.

There are two FK100 terminals, one on the interface card and one on the power card.

The power card FK100, terminals 1, 2, and 3, provide access to auxiliary relay 1. This is a form C set of contacts, meaning one normally open and one normally closed contact on a single throw. The contacts are rated for a maximum of 240 VAC, 2 Amps and a minimum of 24VDC, 10mA or 24 VAC, 100mA. The relay can be programmed via parameter 323 to indicate drive status.

The interface card FK100, terminals 35 and 36, accept 24 VDC from an external source, if the drive is so equipped. This input provides control power to keep the control logic and any installed options powered up and communicating even with the main supply power removed from the drive. This is particularly useful for maintaining a bus communications network while some drives are not being powered by the mains.

Terminal positions on the power card labeled MK400, MK103, and FK101 are reserved for future use.

SECTION 3
TROUBLESHOOTING

TROUBLESHOOTING TIPS

Before attempting to repair a drive, here are some tips to follow to make the job easier and possibly prevent unnecessary damage to functional components.

1. Note all warnings concerning voltages present in the drive. Always verify the presence of AC input voltage and DC bus voltage before working on the unit. Some points in the drive are referenced to the negative DC bus and are at bus potential even though it may appear on diagrams to be a neutral reference.

   Remember that voltage may be present for as long as 40 minutes on E-frame size drives or 20 minutes on D-frame size drives after removing power from the unit.

2. Never apply power to a unit that is suspected of being faulty. Many faulty components within the drive can cause damage to other components when power is applied. Always perform the procedure for testing the unit after repair as described in Section 5, *Test Procedures*.

3. Never attempt to defeat any fault protection circuitry within the drive. That will result in unnecessary component damage and may cause personal injury.

4. Always use factory approved replacement parts. The drive has been designed to operate within certain specifications. Incorrect parts may affect tolerances and result in further damage to the unit.

5. Read the instruction and service manuals. A thorough understanding of the unit is the best approach. If ever in doubt, consult the factory or authorized repair center for assistance.

Exterior Fault Troubleshooting

There may be slight differences of servicing a drive that has been operational for some extended period of time compared to a new installation. With good troubleshooting techniques, however, it is not safe to make many assumptions. To assume a motor is wired properly because the drive has been in service for some time may overlook loose connections, improper programming, or added equipment, for example. It is best to develop a detailed approach, beginning with a physical inspection of the system. See Table 3-1, *Visual Inspection*, for items to examine.

Fault Symptom Troubleshooting

This troubleshooting section is divided into sections based on the symptom being experienced. To start Table 3-1 provides a visual inspection check list. Many times the root cause of the problem may be due to the way the drive has been installed or wired. The check list provides guidance through a variety of items to inspect during any drive service process.

Next, symptoms are approached as the technician most commonly discovers them: reading an unrecognized drive display, problems with motor operation, or a warning or alarm displayed by the drive. Remember, the drive processor monitors inputs and outputs as well as internal drive functions, so an alarm or warning does not necessary indicate a problem within the drive itself.

Each incident has further descriptions on how to troubleshoot that particular symptom. When necessary, further referrals are made to other parts of the manual for additional procedures. Section 4, *Drive and Motor Applications*, presents detailed discussions on areas of drive and system troubleshooting that an experienced repair technician should understand for effective analysis.

Finally, a list of tests called *After Repair Tests* is provided. These tests should always be performed when first starting a drive, when approaching a drive that is suspected of being faulty, or anytime following a repair to the drive.

3.0 Fault Symptoms
3.1 Display
3.1.1 No Display
3.1.2 Intermittent Display
3.1.3 Display Line 2 Flashing
3.1.4 WRONG Displayed
3.2 Motor
3.2.1 Motor Will Not Run
3.2.2 Incorrect Motor Operation
3.3 Warnings and Alarms
3.4 After Repair Tests

Visual Inspection

The table below lists a variety of conditions that should be inspected for visually as part of any initial troubleshooting procedure.

Table 3-1. Visual Inspection

Inspect For	Description
Auxiliary equipment	Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on input power side of drive or output side to motor. Examine operation and condition of these items as possible causes for operational faults. Check function and installation of pressure sensors or encoders (etc.) used for feedback to drive.
Cable routing	Avoid routing motor wiring, AC line wiring, and signal wiring in parallel. If parallel routing is unavoidable, try to maintain a separation of 6 - 8 inches (150 – 200 mm) between the cables or separate them with a grounded conductive partition. Avoid routing cables through free air.
Control wiring	Check for broken or damaged wires and connections. Check the voltage source of the signals. Though not always necessary depending on the installation conditions, the use of shielded cable or a twisted pair is recommended. Ensure the shield is terminated correctly. Refer to the section on grounding shielded cables in Section 1.
Drive cooling	Check operational status of all cooling fans. Check door filters on NEMA 12 (IP54) units. Check for blockage or constrained air passages. Verify bottom gland plate is installed.
Drive display	Warnings, alarms, drive status, fault history and many other important items are available through the display on the local control panel of drive.
Drive interior	Drive interior must be free of dirt, metal chips, moisture, and corrosion. Check for burnt or damaged power components or carbon deposits that were the result of a catastrophic component failure. Check for cracks or breaks in the housings of power semiconductors, or pieces of broken component housings loose inside the unit.
EMC considerations	Check for proper installation with regard to electromagnetic capability. Refer to the drive instruction manual and Section 4 of this manual for further details.
Environmental conditions	Under specific conditions these units can be operated within a maximum ambient of 50°C (122°F). Humidity levels must be less than 95% non-condensing. Check for harmful airborne contaminates such as sulfur based compounds.
Grounding	The drive requires a dedicated ground wire from its chassis to the building ground. It is also suggested that the motor be grounded to the drive chassis as well. The use of conduit or mounting of the drive to a metal surface is not considered a suitable ground. Check for good ground connections that are tight and free of oxidation.
Input power wiring	Check for loose connections. Check for proper fusing. Check for blown fuses.
Motor	Check nameplate ratings of motor. Ensure that motor ratings coincide with drives. Check that drive's motor parameters (102 – 106) are set according to motor ratings.
Output to motor wiring	Check for loose connections. Check for switching components in output circuit. Check for faulty contacts in switch gear.
Programming	Check that drive parameter settings are correct according to motor, application, and I/O configuration.
Proper clearance	These drives require top and bottom clearance adequate to ensure proper air flow for cooling in accordance with the drive size. Drives with exposed heat sinks out the back of the drive must be mounted on a flat solid surface.
Vibration	Though somewhat subjective look for an unusual amount of vibration that the drive may be subjected to. The drive should be mounted solidly or the use of shock mounts employed.

3.0 FAULT SYMPTOMS

3.1 DISPLAY

3.1.1 No Display

The LCP display provides two display indications. One by means of the backlit LCD alphanumeric display. The other is three LED indicators lights near the bottom of the LCP. If the green power on LED is illuminated but the backlit display is dark, this indicates that the LCP itself is defective and must be replaced.

● ALARM ● WARNING ● ON

Be certain, however, that the display is completely dark. Having a single character in the upper corner of the LCP or just a dot indicates that communications may have failed with the control card. This is typically seen when a serial bus communication option has been installed in the drive and is either not connected properly or is malfunctioning.

If neither indication is available, then the source of the problem may be elsewhere. Proceed to the No Display test in Section 5 to carry out further troubleshooting steps.

3.1.2 Intermittent Display

Cutting out or flashing of the entire display and power LED indicates that the power supply (SMPS) is shutting down as a result of being overloaded. This may be due to improper control wiring or a fault within the drive itself.

The first step is to rule out a problem in the control wiring. To do this, disconnect all control wiring by unplugging the control terminal blocks from the control card.

If the display stays lit, then the problem is in the control wiring (external to the drive). All control wiring should be checked for shorts or incorrect connections.

If the display continues to cut out, follow the procedure for No Display as though the display were not lit at all.

3.1.3 Display (Line 2) Flashing

This indicates that a local stop command has been given by pressing the stop key on the front of the LCP keypad. The drive cannot accept any further run command until the local stop is cleared. This is accomplished by pressing the [START] key. For the VLT 4000/6000/8000 the [HAND START] or [AUTO START] keys provide the same result.

⚠WARNING

Drive may start immediately. If drive is being operated in local control, or remote control with a maintained run signal, drive will start immediately.

3.1.4 WRONG or WRONG LCP Displayed

If the message WRONG or WRONG LCP appears, this is due to a faulty LCP or the use of an incorrect LCP, such as an LCP from a VLT 6000 series drive being connected to a VLT 5000 series unit.

Replace the LCP with a correct and functioning one.

3.2 MOTOR

3.2.1 Motor will not run

In the event that this symptom is detected, first verify that the unit is properly power up (display is lit) and that there are no warning or alarm messages displayed. The most common cause of this is either incorrect control logic or an incorrectly programmed drive. Such occurrences will result in one or more of the following status messages being displayed.

LCP Stop

The “Stop/Reset” key (VLT 5000) has been pressed. Line 2 of the display will also be flashing when this occurs.

Press the “Start” key.

Note: For VLT 4000/6000/8000, the status message “Stop” will be displayed. Pressing the “Hand Start” or “Auto Start” will correct this.

Standby

This indicates that there is no start signal at terminal 18.

Ensure that a start command is present at terminal 18. Refer to the Input Terminal Signal Test in Section 5.

Unit ready

Terminal 27 is low (no signal).

Ensure that terminal 27 is logic “1”. Refer to the Input Terminal Signal Test in Section 5.

Run OK

0 Hz

This indicates that a run command has been given to the drive but the reference (speed command) is zero or missing.

Check control wiring to ensure that the proper reference signal is present at the drive input terminals and that the unit is properly programmed to accept the signal provided. Refer to the Input Terminal Signal Test in Section 5.

Off 1 (2 or 3)

This indicates that bit #1 (or #2, or #3) in the control word is logic “0”. This will only occur when the drive is being controlled via the serial communication bus.

A correct control word must be transmitted to the drive over the communication bus to correct this.

STOP

(VLT 5000 only)

One of the digital input terminals 16, 17, 27, 29, 32, or 33 (parameters 300, 301, 304, 305, 306, or 307) is programmed for “Stop Inverse” and the corresponding terminal is low (logic “0”).

Ensure that the above parameters are programmed correctly and that any digital input programmed for “Stop Inverse” is high (logic “1”).

Display Indication That the Unit is Functioning, but No Output

Check that parameter 620 is not set to “Run With Inverter Disabled”.

If the unit is equipped with external 24VDC option, check that the main power is applied to the drive.

Note: In this case, the display will alternately flash Warning 8.

3.2.2 Incorrect Motor Operation

Occasionally, a fault can occur where the motor will continue to run, but not in the correct manner. The symptoms and causes may vary considerably. Many of the possible problems are listed below by symptom along with recommended procedures for determining their causes.

Wrong Speed/Unit Will Not Respond To Command

Possible incorrect reference (speed command).

Ensure that the unit is programmed correctly according to the reference signal being used, and that all reference limits are set correctly as well. Perform Input Terminal Signal Test in section 5 to check for faulty reference signals.

Motor Speed Unstable

Possible incorrect parameter settings, faulty current feedback circuit, loss of motor (output) phase.

Check settings of all motor parameters, including all motor compensation settings (Slip Compensation, Load Compensation, etc.) For Closed Loop operation, check PID settings. Perform Input Terminal Signal Test in section 5 to check for faulty reference signals. Perform Output Phase Imbalance Test in section 5 to check for loss of motor phase.

Motor Runs Rough

Possible over magnetization (incorrect motor settings), or an IGBT misfiring. Note: Motor may also stall when loaded or the drive may trip occasionally on Alarm 13.

Check setting of all motor parameters. Perform Output Phase Imbalance Test in section 5.

If output voltage is unbalanced, perform Gate Drive Signal Test in section 5.

Motor Draws High Current but Cannot Start

Possible open winding in motor or open connection to motor.

Perform Output Phase Imbalance Test in section 5 to ensure drive is providing correct output (see Motor Runs Rough above).

Check motor for open windings. Check all motor wiring connections.

Motor Will Not Brake

Possible fault in brake circuit. Possible incorrect setting in brake parameters. Ramp down time too short. Note: May be accompanied by an alarm or warning message.

Check all brake parameters and ramp down time (parameters 208, 400, 401, 402).

Perform Brake Check in section 5.

3.3 WARNING AND ALARM MESSAGES

WARNING 1
10 VOLT LOW

The 10 VDC supply on terminal 50 of the control card is too low. Max capacity of terminal 50 is 17ma. The 10 VDC supply on terminal 50 is supplied from a 13 volt regulator that supplies option boards and the LCP.

This condition may be caused by overloading terminal 50 or a short circuit in the Speed Potentiometer or related wiring.

If the 10 VDC is missing or low the most common link would be the control card as the faulty part (after the external wiring was removed and verified). Also see the Analog Input Test (5.2.14.2) in Section 5.

WARNING/ALARM 2
LIVE ZERO ERROR

The current signal on terminal 60 is less than 50% of the value programmed in parameter 315, and parameters 317 and 318 have been programmed for the time out function to be active. It is possible to choose between a warning only or a warning and trip based on the selection of parameter 318. Manual reset is possible once the fault is corrected.

Faulty connection in control wiring, or faulty signal generating device (PLC, transducer, etc.).

Check connections of control wiring. Perform the Analog Input Test (5.2.14.2) in Section 5.

WARNING/ALARM 3
NO MOTOR

(Not applicable for the VLT 4000/6000/8000 series.)

The motor check function has been activated in parameter 122. During stop conditions the motor check is performed.

This warning will appear if the VLT fails to detect a motor.

Ensure connection between drive and motor.

WARNING/ALARM 4
AC LINE PHASE LOSS

This alarm is derived from reading the AC ripple on the DC Bus. It is intended to indicate a missing phase on the input AC main voltage.

One phase of the input AC line is missing or extremely low, or severe waveform distortion is present on the input line.

Measuring the voltage and current, and verifying the wave form of both the input AC line and the output to the motor may be the first step to restoring proper operation of the drive. Refer to section 5, Dynamic Test Procedures, Input Voltage Test, Input Phase Imbalance Test, Output Phase Imbalance Test.

See Mains Phase Loss Trips in Section 4 for more details.

WARNING 5
DC LINK VOLTAGE HIGH

The intermediate circuit voltage (DC) is above the upper warning limit. (See ratings tables in introduction section of this manual.) The drive is still operational.

Ramp Down time too short.

(Parameter 208 or 210 for VLT 5000, 207 for VLT 4000/6000/8000.)

WARNING 6
DC LINK VOLTAGE LOW

The intermediate circuit voltage (DC) is below the lower warning limit. (See ratings tables in introduction section of this manual.) The drive is still operational.

AC line voltage too low.

Check AC input line voltage.

WARNING/ALARM 7
DC LINK OVERVOLT

The intermediate circuit voltage (DC) is above the overvoltage limit. (See ratings tables in introduction section of this manual.) It may be necessary to use dynamic braking. As an alternative in the VLT 5000, the Over Voltage Control (OVC) scheme can be activated in parameter 400. For the VLT 4000/6000/8000, the OVC function is always active and the setting of parameters 400 and 410 have no effect on this alarm.

The voltage level detected will be displayed.

Manual reset is possible.

Warns for 5 sec.; trips after 25 sec.

Ramp Down time (Parameter 208 or 210 for VLT 5000, 207 for VLT 4000/6000/8000) significantly too short.

See Overvoltage Trips in Section 4 for more details.

WARNING/ALARM 8
DC LINK UNDERVOLT

The intermediate circuit voltage (DC) is below the under voltage limit. (See ratings tables in introduction section of this manual.) The unit will trip after a set period of time. On the VLT 5000 extended units with an external 24VDC supply, this message will be displayed as long as input power is removed, however, the unit will not trip.

The voltage level detected will be displayed. Manual reset is possible.

AC line voltage too low for too long time.

Check AC input line voltage.

See Input Voltage Test in Section 5.

WARNING/ALARM 9
INVERTER TIME

The unit has been operating with the output current having been in the intermittent range (between 100% and 150%) for too long. A warning will be displayed when the ETR counter reaches 98%. When the counter reaches 100%, the drive will trip. The unit can be programmed to display the ETR counter.

Improperly sized drive and/or motor. Improperly programmed drive.

Compare the output current (as displayed by the LCP) to the rated current of the drive and motor.

Ensure that the drive is programmed properly for the application. See section 4, Drive and Motor Applications for more information.

Manual reset is only possible after the counter has gone below 90%.

WARNING /ALARM 10
MOTOR TIME

The unit's ETR function has calculated an over temperature condition in the motor. This calculation is based on motor current, speed and the length of time these conditions exist, based on the settings of parameters 102 through 106. Based on the selection in parameter 128 the unit will display a warning or an alarm when the counter reaches 100%.

Overloaded motor (mechanical)

Verify parameters 102 - 106 are set correctly.

Check for mechanical overloading on motor shaft.

Manual reset is possible after the ETR counter has counted to zero.

WARNING/ALARM 11
MOTOR THERMISTOR

The motor thermistor function has been activated in parameter 128 and a thermistor is connected to either terminal 53 or 54 and programmed as such in parameter 308 or 311. Parameter 128 provides a choice of warning or alarm. Manual reset is possible.

This warning or trip occurs when the input to terminal 53 or 54 is more than 3K Ohms impedance between that terminal and terminal 50 or when the voltage to the selected terminal is less than 8 VDC. This could indicate an overheated motor. It is also possible that the connection has been broken.

Check for overheated motor (if Thermistor function is being used). Check for open connection by measuring voltage between corresponding terminal and terminal 55. A reading of less than 8 VDC indicates an open connection.

WARNING/ALARM 12
TORQUE LIMIT/CURRENT LIMIT

The torque requirement of the motor is higher than the value set in parameter 221 for the VLT 5000 or 215 for the VLT 4000/6000/8000 (in motor operation) or parameter 222 (regenerative operation). The warning will be present until the time programmed in parameter 409 for VLT 5000 or 412 for the VLT 4000/6000/8000 expires.

Manual reset is possible.

This normally indicates a mechanical overload on the motor, or incorrect setting of para. 221, 222, (or 215 for the VLT 4000/6000/8000) or incorrectly set ramp up time (para. 207 [206 - VLT 4000/6000/8000).

Check mechanical load on motor.

Ensure that para. 221, 222 [215] are set correctly.

Check ramp up settings.

See Drive and Motor Application in Section 4 for more information.

WARNING/ALARM 13
OVERCURRENT

The peak output current limit of the unit has exceeded the limit. After 1.5 seconds the unit will trip. (See ratings tables in introduction section of this manual.)

This fault may be caused by shock loading or fast accel ramps with high inertia loads. Incorrect settings of various group 1 parameters may also be the cause.

This fault results in a Trip Locked condition.

See Drive and Motor Application in Section 4 for more information.

ALARM 14
EARTH FAULT

The unit has sensed output leakage current sufficient enough to determine that there is a ground fault in the motor or motor wiring. This fault results in a Trip Locked condition. (See ratings tables in introduction section of this manual.)

Short circuit to ground in motor or motor wiring, or faulty current sensor.

Measure resistance to ground of motor leads with megohmmeter to check for earth faults.

Perform current sensor test (section 5).

See Internal Drive Problems in Section 5.

ALARM 15
SWITCH MODE FAULT

The internal plus and/or minus 18 VDC power supply voltage is not within the specified range.

This fault results in a Trip Locked condition.

This is normally due to a faulty Control Card.

Remove all I/O connectors from Control Card. If message remains, replace Control Card.

See Switch Mode Power Supply Test (5.2.2) in Section 5.

ALARM 16
CURR.SHORT CIRCUIT

This indicates that the instantaneous output current has exceeded the maximum level for that drive.

This fault results in a Trip Locked condition.

Refer to over current section in the application section.

This is due to a phase to phase short circuit in motor or motor wiring.

Check motor and cabling for shorts.

WARNING/ALARM 17
STD BUS TIMEOUT

Indicates the serial communication with the drive has failed and the time out function has been activated. The delay time programmed determines how long the warning will be present before a trip, provided “stop and trip” has been selected.

Manual reset is possible.

Loss of serial communication signal due to faulty wiring or communication equipment (PC, PLC, RS232/485 Adaptor, etc.)

Check connections on serial communication cable. Check operation of communication equipment.

WARNING/ALARM 18
HPFB BUS TIMEOUT

Indicates the communication between a high performance field bus option (such as DeviceNet) and the drive has failed and the time out function has been activated in parameter 804. The delay time programmed in parameter 803 determines how long the warning will be present before a trip, provided “stop and trip” has been selected in parameter 804. Manual reset is possible.

Faulty connection in communication wiring, or faulty control node (PLC) in communication network. Check connections on serial communication cable.

WARNING 20
EE ERROR CTRL CARD

Fault in the EEPROM on the control card. A fault exists in the ability of the VLT to read and write information to the control card EEPROM.

Failed EEPROM on Control Card.

The drive will operate normally and in most cases once the power is cycled the warning clears.

If the problem halts operation replacement of control card may be needed.

ALARM 21
AUTO MOTOR ADAPT OK

(Not applicable for the VLT 4000/6000/8000.)

Auto-optimization OK. The automatic motor tuning function (AMA) has been completed successfully. It is necessary to manually reset to resume normal operation.

AMA Function has been completed successfully.

No corrective action is needed. This alarm is displayed upon completion of AMA to indicate a requirement to reset the drive after performing AMA.

ALARM: 22
AUTO MOT ADAPT FAIL

Auto-optimization not OK. The automatic motor tuning function failed. The possible causes as shown in the display are listed below. The numbers in brackets will be logged as the value in parameter 617.

Check settings of p. 102 - 106, and restart AMA.

In case of non-standard motor, set p. 107 to “Enable R_S” and restart AMA.

[0] **CHECK P.103, 105**

AMA function was unable to be carried out due to incorrect settings or incorrect results of AMA tests.

Parameter 102, 103 or 105 has been set incorrectly. Correct the setting and restart AMA.

[1] **LOW P. 105**

AMA function was unable to be carried out due to incorrect settings or incorrect results of AMA tests.

The value entered in parameter 105 is too small for the drive. Enter correct the value.

Note: the motor nameplate current, and the value entered in parameter 105, must be greater than 35% of the nominal rating of the drive in order to carry out AMA.

ALARM: 22 (continued)
AUTO MOT ADAPT FAIL

[2] **ASYMMETRICAL IMPEDANCE**

AMA has detected asymmetrical impedance in the windings of the motor connected.

The motor may be defective. Check motor and motor connections.

[3] **MOTOR TOO BIG**

AMA function was unable to be carried out due to incorrect settings or incorrect results of AMA tests.

The motor is too large for AMA to be carried out or the setting in parameter 102 is incorrect. Ensure that the motor is sized correctly. Correct the setting and restart AMA.

[4] **MOTOR TOO SMALL**

AMA function was unable to be carried out due to incorrect settings or incorrect results of AMA tests.

The motor is too small for AMA to be carried out or the setting in parameter 102 is incorrect. Ensure that the motor is sized correctly. Correct the setting and restart AMA.

[5] **TIME OUT**

AMA has failed after attempting to tune for a period in excess of what should be normal.

It is possible that the signal data being returned is noisy.

It is possible to make several attempts under these conditions and eventually get the unit to pass.

[6] **INTERRUPTED BY USER**

The AMA function cannot be completed due to the application of a stop command by the user. Repeat AMA procedure.

[7] **INTERNAL FAULT**

A fault has occurred internal to the VLT.

Failed Control Card or noise interference. Repeat AMA procedure, if fault reoccurs, replace Control Card.

[8] **LIMIT VALUE FAULT**

The parameter values programmed for the motor are outside the typical characteristics of the drive's internal motor table.

This is due to the use of a non-standard motor.

Set p. 107 to "Enable R_S" and restart AMA. If this fault reoccurs, AMA cannot be performed on this particular motor.

[9] *MOTOR ROTATES*

The motor shaft rotated during the tuning process due to an overhauling load. Ensure the load is not capable of rotating the shaft, and restart AMA.

WARNING/ALARM 23
BRAKE TEST FAILED

(Not applicable for the VLT 4000/6000/8000.)

When a unit with braking is powered-up and a stop command is present, a brake test is performed automatically by the unit. If the result of this test indicates a fault condition in the brake circuit and parameter 404 is set to warning, a warning will be displayed. If *Trip* has been set in 404 an alarm will occur. The unit will be able to operate in this condition, however, the brake function will be inoperative.

Manual reset is possible.

Possible causes for this are: No brake resistor connected, or a faulty connection to the brake resistor, defective brake resistor or a defective brake IGBT, faulty brake firing circuit (Power Card).

Check all brake resistor connection, check resistor, perform Brake IGBT test (Static Test Section).

WARNING 25
BRAKE RESISTOR FAULT

(Not applicable for the VLT 4000/6000/8000.)

The brake resistor or the connection is short circuited. The unit will be able to operate in this condition, however, the brake function will be inoperative.

Manual reset is possible.

Ground fault in brake resistor circuit, shorted resistor cable, too low resistance in resistor.

Check all brake resistor connections for short circuits, check resistor value.

WARNING 26
BRK PWR WRN 100%

(Not applicable for the VLT 4000/6000/8000.)

Brake resistor power 100%. The monitoring function has been activated in parameter 403. The power transmitted to the brake resistor is monitored over a 120 second period. The power is based on the values entered in parameters 401 and 402. If the calculated power being dissipated exceeds 100% a warning will occur based on the choice in parameter 403. If warning is selected the warning will disappear when the dissipated power drops below 80%.

Manual reset is possible.

Overhauling motor load, load inertia too high, ramp down time incorrectly set.

Check ramp down time (para. 208) settings. Check for overhauling motor load. If load inertia is too high, load must be reduced or drive and resistor must be resized.

WARNING 27
BRAKE IGBT FAULT

(Not applicable for the VLT 4000/6000/8000.)

The brake transistor is shorted. As a result of the shorted transistor substantial power may be transmitted to the brake resistor.

Disconnect main input power to the VLT. Perform Brake IGBT Test (5.2.11) in Section 5.

ALARM 29
HEAT SINK OVER TEMP

The heatsink temperature has exceeded its limit. (See ratings tables in introduction section of this manual.) This fault results in a Trip Locked condition.

The drive will also trip when any of the following conditions occur:

> Ambient temperature is above 140°F (60°C) or below -4°F (-20°C).
>
> The drive is not on +24V backup and the power supply voltage is out of range. (Backup power is not monitored by the drive.)
>
> The enable/disable connector FK102 is not installed. This connector has a shorting wire and is used for the external brake resistor switch. It also disables the SCR front end.

Possible causes are: defective cooling fan, blocked heat sink or air flow path, defective thermal sensor, missing bottom gland plate.

Check fan operation. Check for airflow blockage. Check for proper clearance above and below drive (see Instruction Manual). Check fan filters (NEMA 12 units). Perform Heatsink Temperature Sensor Test (5.1.6) in Section 5. Install bottom gland plate.

ALARM 30
MISSING MOT. PHASE U

The unit has detected an open circuit in the U phase.

This fault may be manually reset.

Parameter 234 (VLT 5000 only) can disable the tripping or missing motor phase.

This can be due to a faulty connection between drive and motor, or a faulty motor.

Check motor wiring.

See Output Phase Imbalance Test (5.2.8) in Section 5.

ALARM 31
MISSING MOT. PHASE V

The unit has detected an open circuit in the V phase.

This fault may be manually reset.

Parameter 234 (VLT 5000 only) can disable the tripping or missing motor phase.

This can be due to a faulty connection between drive and motor, or a faulty motor.

Check motor wiring.

See Output Phase Imbalance Test (5.2.8) in Section 5.

ALARM 32
MISSING MOT. PHASE W

The unit has detected an open circuit in the W phase.

This fault may be manually reset.

Parameter 234 (VLT 5000 only) can disable the tripping or missing motor phase.

This can be due to a faulty connection between drive and motor, or a faulty motor.

Check motor wiring.

See Output Phase Imbalance Test (5.2.8) in Section 5.

WARNING/ALARM 34
PROFIBUS COMMUNICATION FAULT

The Profibus option is no longer communicating.

A trip can be manually reset.

In a warning state this may indicate the cable has been disconnected or the master (PLC) has stopped.

In an alarm state it may indicate the option card is disturbed by noise or possibly defective.

Check connections on serial communication cable. Check PLC.

WARNING 35
OUT OF FREQ. RANGE

(Not applicable for the VLT 4000/6000/8000.)

This warning will only be displayed when operating in Process Closed Loop and the output frequency of the drive is above or below the limits programmed in parameters 201 and 202. Parameter 455 can be programmed to disable this warning.

This warning could indicate a loss of feedback or an undesired condition in the regulation process.

Check connections in feedback circuit. Check process operation.

Note: Some applications may be designed to operate normally in this mode. No action is necessary in this case.

WARNING/ALARM 36
MAINS FAILURE

(Not applicable for the VLT 4000/6000/8000.)

The mains failure function has been activated in parameter 407. A choice of actions is available including whether or not to trip . A trip can be manually reset.

This is due to a loss of AC mains voltage.

Check AC mains voltage.

ALARM 37
INVERTER FAULT

Indicates an IGBT is defective.

This fault results in a Trip Locked condition.

NOTE: Do not reset and reattempt to start the drive without taking corrective action. Further damage may result.

Faulty IGBT.

Measure gate to emitter resistance on all IGBTs.

WARNING 39
CHECK Parameter 104, 106

AMA function has detected an error in calculating motor data.

The settings in parameter 102, 104 or 106 are possibly set incorrectly.

Check the setting and choose "Continue" or "Stop". If stop is selected AMA will have to be started over.

WARNING: 40
CHECK Parameter 103, 105

AMA function has detected an error in calculating motor data.

The settings in parameter 102, 103 or 105 are possibly set incorrectly.

Check the setting and choose "Continue" or "Stop". If stop is selected AMA will have to be started over.

WARNING 41
MOTOR TOO BIG

AMA function has detected an error in calculating motor data.

The motor is too large for the VLT or the setting of parameter 102 is incorrect.

Check the motor and setting and choose "Continue" or "Stop". If stop is selected AMA will have to be started over.

WARNING 42
MOTOR TOO SMALL

AMA function has detected an error in calculating motor data.

The motor is too small for the VLT or the setting of parameter 102 is incorrect.

Check the motor and setting and choose "Continue" or "Stop". If stop is selected AMA will have to be started over.

ALARM 43
BRAKE FAULT

(Not applicable for the VLT 4000/6000/8000.)

A test of the brake function has failed.

The possible causes as shown in the display are listed below. The numbers in brackets will be logged as the value in parameter 617.

These failures result in a Trip Locked condition.

Make corrections as needed.

[0] **BRAKE CHECK FAILED**

During power up the brake test failed to find a resistor connected, or the resistance between terminals 81, 82 is too high.

Verify that the brake resistor is properly connected to terminals 81, 82.

[1] **BRAKE RESISTOR FAULT**

During the brake test the VLT 5000 has found a short circuit at the brake terminals, or the resistance between terminals 81, 82 is too low.

Verify no shorts exist at the terminals and the brake resistor is the proper value for the VLT 5000.

[2] **BRAKE IGBT FAULT**

The brake transistor is shorted

As a result of the shorted transistor substantial power may be transmitted to the brake resistor.

Disconnect input power to the unit. Perform Brake IGBT Test (5.2.11) in Section 5).

It may be possible to run the drive with the brake resistor disconnected, however the braking function will be inoperative.

WARNING/ALARM 44
ENCODER FAULT

(Not applicable for the VLT 4000/6000/8000.)

This message active for VLT 5000 units programmed for Speed Closed Loop operation only. The measured feedback differs from the reference by more than 3 x slip RPM.

The encoder signal is interrupted from terminal 32 or 33.

Check the connections of encoder device.

ALARM 60
EXTERNAL FAULT

Parameter 304 has been programmed for *Safety Interlock* and a logic “0” is present at terminal 27.

Terminal 27 must have a logic “1” for the unit to operate.

This fault can be manually reset.

The following Warning/Alarms are only applicable to the VLT 4000/6000/8000 series drives.

WARNING: 62
FOUT>FHIGH

Output frequency high.

The output frequency is higher than the value programmed in parameter 224 *Warning: High frequency.*

This is a customer programmable indicator of operating conditions.

No corrective action needed.

WARNING/ALARM: 63
I MOTOR<I LOW

Output current low.

The output current is lower than the value programmed in parameter 221 *Warning: Low current*

Select the required function in parameter 409 function in case of no load.

WARNING: 64
I MOTOR>I HIGH

The output current is higher than the value programmed in parameter 222 *Warning: High current.*

This is a customer programmable indicator of operating conditions.

No corrective action needed.

WARNING: 65
FEEDBACK<FDB LOW

The resulting feedback value is lower than the value programmed in parameter 227 *Warning: Low feedback.*

This is a customer programmable indicator of operating conditions.

No corrective action needed.

WARNING: 66
FEEDBACK>FDB HIGH

The resulting feedback value is higher than the value programmed in parameter 228 *Warning: High feedback.*

This is a customer programmable indicator of operating conditions.

No corrective action needed.

WARNING: 67
REF.<REF LOW

Remote reference low.

The remote reference is lower than parameter 225 *Warning: Low reference.*

This is a customer programmable indicator of operating conditions.

No corrective action needed.

WARNING: 68
REF.>REF HIGH

The remote reference is higher than the value programmed in parameter 226 *Warning: High reference.*

This is a customer programmable indicator of operating conditions.

No corrective action needed.

WARNING: 69
TEMP.AUTO DERATE

Temperature auto derate. The heatsink temperature has exceeded the max value and the auto derating function (par. 411) is active. *Warning: Temp. auto derate.*

See Warning/Alarm 29

WARNING: 99
UNKNOWN ALARM

An unknown fault has occurred which the software is not able to handle.

This may be due to noise interference, or a faulty Control Card.

Cycle power and or reinitialize the VLT to clear the fault. Possible replacement of control card is needed.

3.4 AFTER REPAIR TESTS

Following any repair to a drive or testing of a drive suspected of being faulty, the following procedure must be followed to ensure that all circuitry in the drive is functioning properly before putting the unit into operation.

1. Perform visual inspection procedures as described in Table 3-1.

2. Perform static test procedures 5.1.1., 5.1.2 and 5.1.5 for D-frame size units or 5.1.3, 5.1.4 and 5.1.5 for E-frame size units to ensure drive is safe to start.

3. Disconnect motor leads from output terminals (U, V, W) of drive.

4. Apply AC power to drive.

5. Give drive a run command and slowly increase reference (speed command) to approximately 40 Hz.

6. Using an analog volt meter or a DVM capable of measuring true RMS, measure phase-to-phase output voltage on all three phases: U to V, U to W, V to W. All voltages must be balanced within 8 volts. If unbalanced voltage is measured, refer to Input Voltage Test (5.2.1.1).

7. Stop drive and remove input power. *Allow 40 minutes for DC capacitors to fully discharge for E-frame size drives or 20 minutes for D-frame size drives.*

8. Reconnect motor leads to drive output terminals (U, V, W).

9. Reapply power and restart drive. Adjust motor speed to a nominal level.

10. Using a clamp-on style ammeter, measure output current on each output phase. All currents should be balanced. If unbalanced current is measured, refer to Current Sensor Test (5.2.12).

SECTION 4
DRIVE AND MOTOR APPLICATIONS

Torque Limit, Current Limit, and Unstable Motor Operation

Excessive loading of the drive may result in warning or tripping on torque limit, over current, or inverter time. This is not a concern if the drive is properly sized for the application and intermittent load conditions cause anticipated operation in torque limit or an occasional trip. However, nuisance or unexplained occurrences may be the result of improperly setting specific parameters. The following parameters are important in matching the drive to the motor for optimum operation. These setting need careful attention, particularly for the selectable torque drives of the VLT 5000 series. For the VLT 4000/6000/8000 series, torque settings are constant.

Parameters 100 and 101 set the mode in which the drive will operate.

Parameters 102 through 107 match the drive to the motor and adapt to the motor characteristics.

Parameters 221 and 409 set the torque control features of the drive for the application.

Parameter 100, *Configuration*, sets the drive for open or closed loop operation or torque mode operation. In a closed loop configuration, a feedback signal controls the drive speed. The settings for the PID controller play a key role for stable operation in closed loop, as described in the operator's manual. In open loop, the drive calculates the torque requirement based on current measurements of the motor.

Parameter 101, *Torque Characteristics*, for the VLT 5000 series, sets the drive for constant or variable torque operation. It is imperative that the correct torque characteristic is selected, based on the application. If, for example, the load type is constant torque, such as a conveyor, and variable torque is selected, the drive may have great difficulty starting the load, if started at all. Consult the factory if uncertain about the torque characteristics of an application.

Parameters 102 through 106 configure the drive for the connected motor. These are motor power, voltage, frequency, current, and rated motor speed. Accurate setting of these parameters is very important. Enter the motor data required as listed on the motor nameplate. For effective and efficient load control, the drive relies on this information for calculating the output waveform in response to the changing demands of the application.

Parameter 107 activates the automatic motor adaptation (AMA) function. When AMA is performed, the drive measures the electrical characteristics of the motor and sets various drive parameters based on the findings. Two key parameter values set by this function are stator resistance and stator reactance, parameters 108 and 109. If unstable motor operation is experienced and AMA has not been performed, it should be done. AMA can only be performed on single motor applications within the programming range of the drive. Consult the instruction manual for more on this function.

Parameters 108 and 109, as stated, should be set by the AMA function, values supplied by the motor manufacturer, or left at the factory default values. Never adjust these parameters to random values even though it may seem to improve operation. Such adjustments can result in unpredictable operation under changing conditions.

Parameter 221, *Torque Limit*, sets the limit for drive torque. The factory setting is 160% for VLT 5000 series and 110% for VLT 4000/6000/8000 series and will vary with motor power setting. For example, a drive programmed to operate a smaller rated motor will yield a higher torque limit value than the same drive programmed to operate a larger size motor. It is important that this value not be set too low for the requirements of the application. In some cases, it may be desirable to have a torque limit set at a lesser value. This offers protection for the application in that the drive will limit the torque. It may, however, require higher torque at initial start up. Under these circumstances, nuisance tripping may occur.

Parameter 409, *Trip Delay Torque,* works in conjunction with torque limit in the VLT 5000 series. This parameter selects the length of time the drive operates in torque limit prior to a trip. The factory default value is off. This means that the drive will not trip on torque limit, but it does not mean it will never trip from an overload condition. Built into the drive is an internal inverter thermal protection circuit. This circuit monitors the output load on the inverter. If the load exceeds 100% of the continuous rating of the drive, a timer is activated. If the load remains excessive long enough, the drive will trip on inverter time. Adjustments cannot be made to alter this circuit. Improper parameter settings effecting load current can result in premature trips of this type. The timer can be displayed.

Overvoltage Trips

This trip occurs when the DC bus voltage reaches its DC bus alarm voltage high (see ratings tables in introductory section). Prior to the trip, the drive will display a high voltage warning. Most times an over voltage condition is due to fast deceleration ramps with respect to the inertia of the load. During deceleration of the load, inertia of the system acts to sustain the running speed. Once the motor frequency drops below the running speed, the load begins overhauling the motor. At this point the motor becomes a generator and starts returning energy to the drive. This is called regenerative energy. Regeneration occurs when the speed of the load is greater than the commanded speed. This return voltage is rectified by the diodes in the IGBT modules and raises the DC bus. If the amount of returned voltage is too high, the drive will trip.

There are a few ways to overcome this situation. One method is to reduce the deceleration rate so it takes longer for the drive to decelerate. A general rule of thumb is that the drive can only decelerate the load slightly faster than it would take for the load to naturally coast to a stop. A second method is to allow the overvoltage control circuit to take care of the deceleration ramp. When enabled in VLT 5000 parameter 400, the overvoltage control circuit regulates deceleration at a rate that maintains the DC bus voltage at an acceptable level. In VLT 4000/6000/8000 drives, auto ramping enables a similar function in parameter 208. One caution with overvoltage control is that it will not make corrections to unrealistic ramp rates. For example, if the deceleration ramp needs to be 100 seconds due to the inertia, and the ramp rate is set at 3 seconds, overvoltage control will initially engage and then disengage and allow the drive to trip. This is purposely done so the units operation is not misinterpreted. A third method in controlling regenerated energy is with a dynamic brake. With this system the optional brake electronics are built into the VLT 5000 drive with an external resistor bank mounted outside of the drive. The drive monitors the level of the DC bus. Should the level become too high, the drive switches the resistor across the DC bus and dissipates the unwanted energy into the resistor bank. This will actually increase the rate of deceleration.

Less often is the case that the overvoltage condition is caused by the load while it is running at speed. In this case the dynamic brake option can be used or the overvoltage control circuit. It works with the load in this way. As stated earlier, regeneration occurs when the speed of the load is greater than the commanded speed. Should the load become regenerative while the drive is running at a steady state speed, the overvoltage circuit will increase the frequency to match the speed of the load. The same restriction on the amount of influence applies. The drive will add about 10% to the base speed before a trip occurs. Otherwise, the speed could continue to rise to potentially unsafe levels.

In applications with very high inertia, such as a centrifuge, it is recommended to use a VLT 5000 Flux drive.

Mains Phase Loss Trips

The drive actually monitors phase loss by monitoring the amount of ripple voltage on the DC bus. Ripple voltage on the DC bus is a product of a phase loss. The main concern is that ripple voltage causes overheating in the DC bus capacitors and the DC coil. Left unchecked, the lifetime of the capacitors and DC coil would be drastically reduced.

When the input voltage becomes unbalanced or a phase disappears completely, the ripple voltage increases causing the drive to trip and issue an Alarm 4. In addition to missing phase voltage, increased bus ripple can be caused by a line disturbance or imbalance. Line disturbances may be caused by line notching, defective transformers or other loads that may be effecting the form factor of the AC waveform. Line imbalances which exceed 3% cause sufficient DC bus ripple to initiate a trip.

Output disturbances can have the same effect of increased ripple voltage on the DC bus. A missing or lower than normal output voltage on one phase can cause increased ripple on the DC bus. Should a mains imbalance trip occur, it is necessary to check both the input and output voltage of the drive.

Severe phase imbalance or phase loss can easily be detected with a volt meter. Line disturbances most likely need to be viewed on an oscilloscope. Conduct tests for input phase imbalance, input waveform, and output phase imbalance as described in Section 5.

Control Logic Problems

Problems with control logic can often be difficult to diagnose, since there is usually no associated fault indication. The typical complaint is simply that the drive does not respond to a given command. There are two basic commands that must be given to any drive in order to obtain an output. First, the drive must be told to run (start command). Second, the drive must be told how fast to run (reference or speed command).

The drives are designed to accept a variety of signals. First determine what types of signals the drive is receiving. There are eight digital inputs (terminals 16, 17, 18, 19, 20, 27, 29, 32, 33), three analog inputs (53, 54, 60), and the serial communication bus (68, 69). The presence of a correct reading will indicate that the desired signal has been detected by the microprocessor of the drive. See *Drive Inputs and Outputs* in Section 1.

Using the status information displayed by the drive is the best method of locating problems of this nature. By changing parameter 009 (VLT 5000) or parameter 007 (VLT 4000/6000/8000), line 2 of the display can be set to indicate the signals coming in. The presence of a correct reading indicates that the desired signal is detected by the microprocessor of the drive.

If there is not a correct indication, the next step is to determine whether the signal is present at the input terminals of the drive. This can be performed with a voltmeter or oscilloscope in accordance with the 5.2.14, Input Terminal Signal Test.

If the signal is present at the terminal, the control card is defective and must be replaced. If the signal is not present, the problem is external to the drive. The circuitry providing the signal along with its associated wiring must then be checked.

Programming Problems

Difficulty with drive operation can be a result of improper programming of the drive parameters. Three areas where programming errors may affect drive and motor operation are motor settings, references and limits, and I/O configuration. See *Drive Inputs and Outputs* in Section 1.

The drive must be setup correctly for the motor(s) connected to it. Parameters 102 – 106 must have data from the motor nameplate entered into the drive. This enables the drive processor to match the drive to power characteristics of the motor. The most common result of inaccurate motor data is the motor drawing higher than normal amounts of current to perform the task expected of it. In such cases, setting the correct values to these parameters and performing the automatic motor adaptation (AMA) function will usually solve the problem.

Any references or limits set incorrectly will result in less than acceptable drive performance. For instance, if maximum reference is set too low, the motor will be unable to reach full speed. These parameters must be set according to the requirements of the particular installation. References are set in the 200s parameter group.

Incorrectly set I/O configuration usually results in the drive not responding to the function as commanded. It must be remembered that for every control terminal input or output there are corresponding parameters settings. These determine how the drive responds to an input signal or the type of signal present at that output. Utilizing an I/O function must be thought of as a two step process. The desired I/O terminal must be wired properly, and the corresponding parameter must be set accordingly. Control terminals are programmed in the 300s parameter group.

Motor/Load Problems

Problems with the motor, motor wiring or mechanical load on the motor can develop in a number of ways. The motor or motor wiring can develop a phase-to-phase or phase-to-ground short resulting in an alarm indication. Checks must be made to determine whether the problem is in the motor wiring or the motor itself.

A motor with unbalanced, or non-symmetrical, impedances on all three phases can result in uneven or rough operation, or unbalanced output currents. Measurements should be made with a clamp-on style ammeter to determine whether the current is balanced on the three output phases. See 5.2.8, Output Phase Imbalance Test procedure.

An incorrect mechanical load will usually be indicated by a torque limit alarm or warning. Disconnecting the motor from the load, if possible, can determine if this is the case.

Quite often, the indications of motor problems are similar to those of a defect in the drive itself. To determine whether the problem is internal or external to the drive, disconnect the motor from the drive output terminals. Perform the output phase imbalance test procedure (5.2.8) on all three phases with an analog voltmeter. If the three voltage measurements are balanced, the drive is functioning correctly. The problem therefore is external to the drive.

If the voltage measurements are not balanced, the drive is malfunctioning. This typically means that one or more output IGBT is not switching on and off correctly. This can be a result of a defective IGBT or gate signal from the gate driver card. Perform the IGBT gate signal test (5.2.9).

INTERNAL DRIVE PROBLEMS

The vast majority of problems related to failed drive power components can be identified by performing a visual inspection and the static tests as described in the test section. There are, however, a number of possible problems that must be diagnosed in a different manner. The following discusses many of the most common of these problems.

Overtemperature Faults

In the event that an overtemperature indication is displayed, determine whether this condition actually exists within the drive or whether the thermal sensor is defective. Of course, this can easily be detected by feeling the outside of the unit, if the overtemperature condition is still present. If not, the temperature sensor must be checked. This can be done with the use of an ohmmeter in accordance with the thermal sensor test procedure.

Current Sensor Faults

When a current sensor fails, it is indicated sometimes by an overcurrent alarm that cannot be reset, even with the motor leads disconnected. Most often, however, the drive will experience frequent false earth fault trips. This is due to the DC offset failure mode of the sensors.

To explain this it is necessary to investigate the internal makeup of a Hall effect type current sensor. Included inside the device is an op-amp to amplify the signal to usable levels in the receiving circuitry. Like any op-amp, the output at zero input level (zero current flow being measured) should be zero volts, exactly half way between the plus and minus power supply voltages. A tolerance of +/- 15mv is acceptable. In a three phase system that is operating correctly, the sum of the three output currents should always be zero.

When the sensor becomes defective, the output voltage level varies by more than the 15mv allowed. The defective current sensor in that phase indicates current flow when there is none. This results in the sum of the three output currents being a value other than zero, an indication of leakage current flowing. If the deviation from zero (current amplitude) approaches a specific level, the drive assumes an earth fault and issues an alarm.

The simplest method of determining whether a current sensor is defective is to disconnect the motor from the drive, then observe the current in the display of the drive. With the motor disconnected, the current should, of course, be zero. A drive with a defective current sensor will indicate some current flow. Because the current sensors for the higher horsepower drives have less resolution, an indication of a fraction of an amp on a drive is tolerable. However, that value should be considerably less than one amp. Therefore, if the display shows more than one amp of current, there is a defective current sensor.

To determine which current sensor is defective, measure the voltage offset at zero current of each current sensor. See the current sensor test procedure (5.2.12).

Signal and Power Wiring Considerations for Drive Electromagnetic Compatibility

Following is an overview of general signal and power wiring considerations when addressing the Electromagnetic Compatibility (EMC) concerns for typical commercial and industrial equipment. Only certain high-frequency phenomena (RF emissions, RF immunity) are discussed. Low-frequency phenomena (harmonics, line voltage imbalance, notching) are not covered. Special installations or compliance to the European CE EMC directives will require strict adherence to relevant standards and is not presented here.

Effects of EMI

While Electromagnetic Interference (EMI) related disturbances to drive operation are uncommon, the following detrimental EMI effects may be seen:

Motor speed fluctuations

Serial communication transmission errors

Drive CPU exception faults

Unexplained drive trips

A disturbance to other nearby equipment is more common. Generally, other industrial control equipment has a high level of EMI immunity. However, non-industrial, commercial, and consumer equipment is often susceptible to lower levels of EMI. Detrimental effects to these systems may include the following:

Pressure/flow/temperature signal transmitter signal distortion or aberrant behavior

Radio and TV interference

Telephone interference

Computer network data loss

Digital control system faults

Sources of EMI

Modern adjustable frequency drives (see Figure 4-1) utilize Insulated-Gate Bipolar Transistors (IGBTs) to provide an efficient and cost effective means to create the Pulse Width Modulated (PWM) output waveform necessary for accurate motor control. These devices rapidly switch the fixed DC bus voltage creating a variable frequency, variable voltage PWM waveform. This high rate of voltage change [dV/dt] is the primary source of the drive generated EMI.

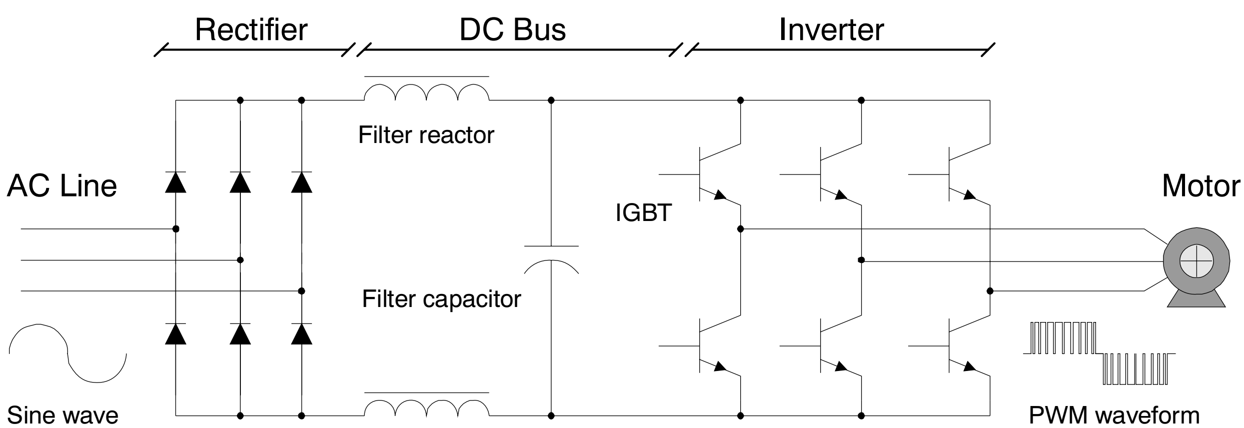


Figure 4-1. Adjustable Frequency Drive Functionality Diagram

The high rate of voltage change caused by the IGBT switching creates high frequency EMI.

EMI Propagation

Drive generated EMI is both conducted to the AC line and radiated to nearby conductors. See Figures 4-2 and 4-3 for illustrations.

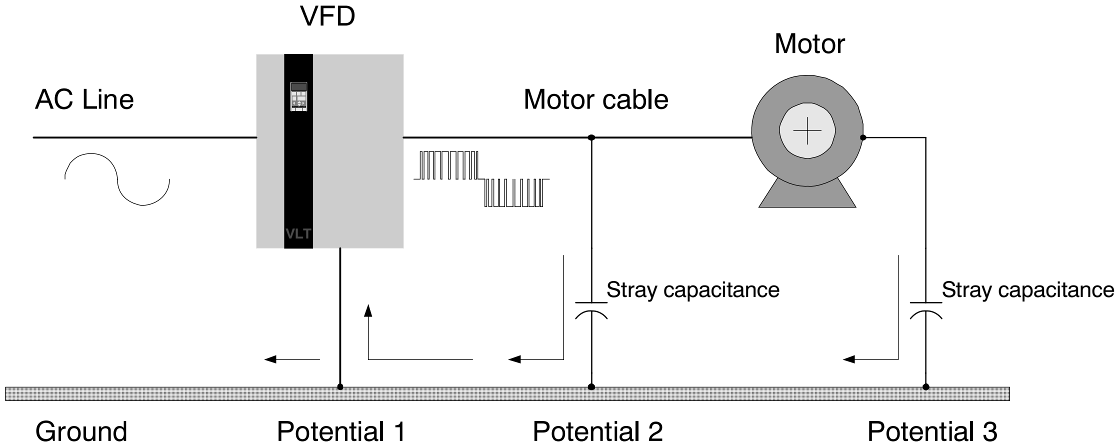


Figure 4-2. Ground Currents

Stray capacitance between the motor conductors, equipment ground, and other nearby conductors results in induced high frequency currents.

High ground circuit impedance at high frequencies results in an instantaneous voltage at points reputed to be at "ground potential." This voltage can appear throughout a system as a common mode signal that can interfere with control signals.

Theoretically, these currents will return to the drive's DC bus via the ground circuit and a High Frequency (HF) bypass network within the drive itself. However, imperfections in the drive grounding or the equipment ground system can cause some of the currents to travel out to the power network.

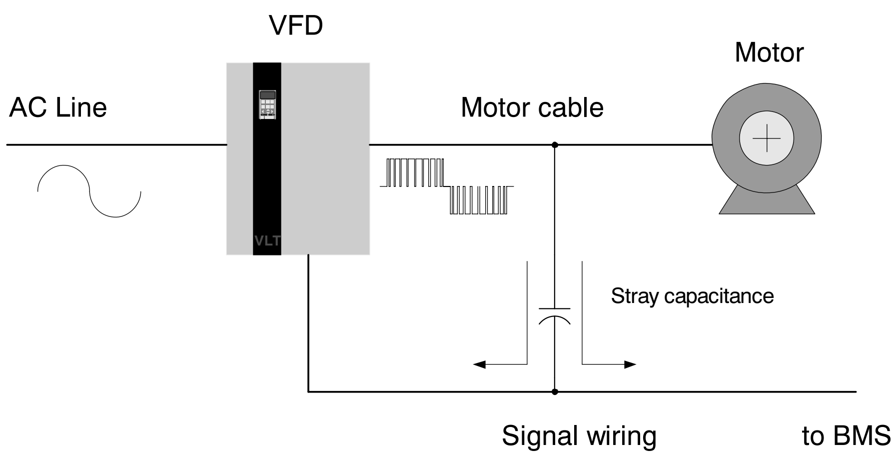


Figure 4-3. Signal Conductor Currents

Unprotected or poorly routed signal conductors located close to or in parallel to motor and AC line conductors are susceptible to EMI.

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Signal conductors are especially vulnerable when they are run parallel to the power conductors for any distance. EMI coupled into these conductors can affect either the drive or the interconnected control device. See Figure 4-4.

While these currents will tend to travel back to the drive, imperfections in the system will cause some current to flow in undesirable paths thus exposing other locations to the EMI.

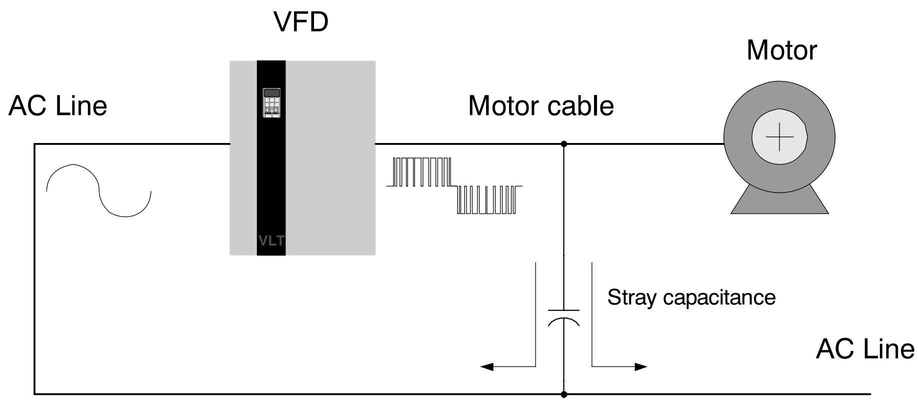


Figure 4-4. Alternate Signal Conductor Currents

HF currents can be coupled into the AC line supplying the drive when the AC line conductors are located close to the motor cables.

Preventative Measures

EMI related problems are more effectively alleviated during the design and installation phases rather then after the system is in service. Many of the steps listed here can be implemented at a relatively low cost when compared to the cost to later identify and fix the problem in the field.

Grounding. The drive and motor should be solidly grounded to the equipment frame. A good HF connection is necessary to allow the HF currents to return back to the drive rather than to travel thorough the power network. The ground connection will be ineffective if it has high impedance to HF currents, therefore it should be as short and direct as practical. Flat braided cable has lower HF impedance than round cable. Simply mounting the drive or motor onto a painted surface will not create an effective ground connection. In addition, running a separate ground conductor directly between the drive and the driven motor is recommended.

Cable routing. Avoid routing motor wiring, AC line wiring, and signal wiring in parallel. If parallel routing is unavoidable, try to maintain a separation of 6 - 8 inches between the cables or separate them with a grounded conductive partition. Avoid routing cables through free air.

Signal cable selection. Single conductor 600 volt rated wires provide the least protection from EMI. Twisted-pair and shielded twist-pair cables are available which are specifically designed to minimize the effects of EMI. While unshielded twisted-pair cables are often adequate, shielded twisted-pair cables provide another degree of protection. The signal cable's shield should be terminated in a manner that is appropriate for the connected equipment. Avoid terminating the shield through a pigtail connection as this increases the HF impedance and spoils the effectiveness of the shield. Refer to Section 1, *Grounding Shielded Cables.*

A simple alternative is to twist the existing single conductors to provide a balanced capacitive and inductive coupling thus canceling out differential-mode interference. While not as effective as true twisted-pair cable, it can be implemented in the field using the materials on hand.

Motor cable selection. The management of the motor conductors has the greatest influence on the EMI characteristics of the system. These conductors should receive the highest attention whenever EMI is a problem. Single conductor wires provide the least protection from EMI emissions. Often if these conductors are routed separately from the signal and AC line wiring then no further consideration is needed. If the conductors are routed close to other susceptible conductors, or if the system is suspected of causing EMI problems then alternate motor wiring methods should be considered.

Installing shielded power cable is the most effective means to alleviate EMI problems. The cable's shield forces the noise current to flow directly back to the drive before it gets back into the power network or takes other undesirable and unpredictable high frequency paths. Unlike most signal wiring, the shielding on the motor cable should be terminated at both ends.

If shielded motor cable is not available, then 3 phase conductors plus ground in a conduit will provide some degree of protection. This technique will not be as effective as shielded cable due to the unavoidable contact of the conduit with various points within the equipment.

Serial communications cable selection*.* There are various serial communication interfaces and protocols on the market. Each of these recommends one or more specific types of twisted-pair, shielded twisted-pair, or proprietary cables. Refer to the manufacturer's documentation when selecting these cables. Similar recommendations apply to serial communication cables as to other signal cables. Using twisted-pair cables and routing them away from power conductors is encouraged. While shielded cable provides additional EMI protection, the shield capacitance may reduce the maximum allowable cable length at high data rates.

Proper EMC Installation

Shown in Figure 4-5 is a correct installation with EMC considerations in mind. Although most installations will not follow all the recommended practices the closer an installation resembles this example the better immunity the network will have against EMI. Should EMI problems arise in an installation, refer to this example. Attempt to replicate this installation recommendation as closely as possible to alleviate such problems.

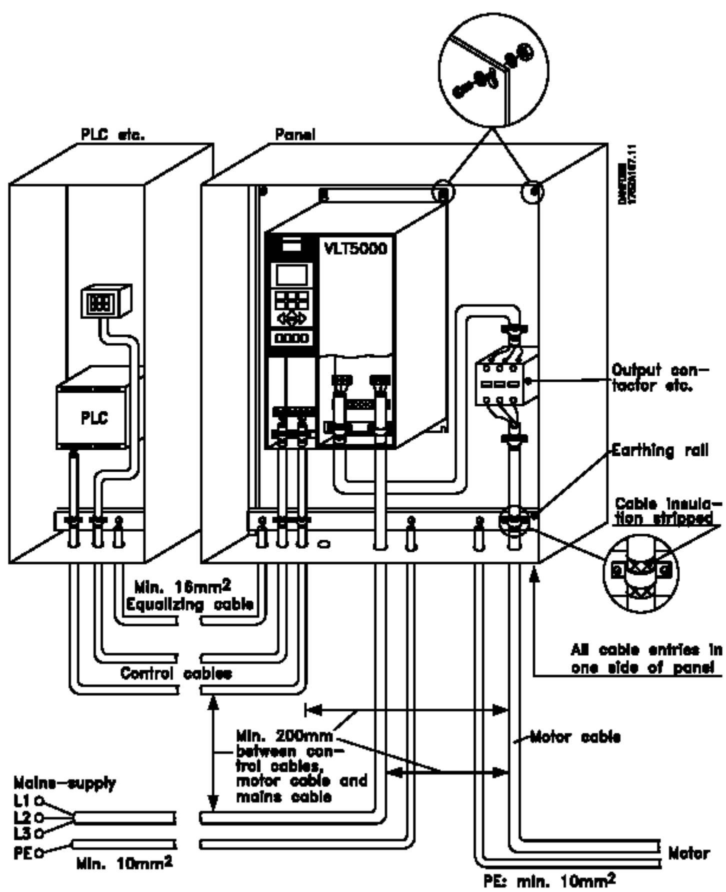


Figure 4-5. Proper EMC Installation

SECTION 5
TEST PROCEDURES

INTRODUCTION

⚠WARNING

Touching electrical parts of drive may be fatal even after equipment has been disconnected from AC power. Wait 20 minutes for D-frame sizes or 40 minutes for E-frame sizes after power has been removed before touching any internal components to ensure that capacitors have fully discharged.

This section contains detailed procedures for testing VLT drives. Previous sections of this manual provide symptoms, alarms and other conditions which require additional test procedures to further diagnose the drive. The results of these tests indicate the appropriate repair actions. Again, because the drive monitors input and output signals, motor conditions, AC and DC power and other functions, the source of fault conditions may exist outside of the drive itself. Testing described here will isolate many of these conditions as well. Sections 6 and 7, *Disassembly and Assembly Instructions*, describes detailed procedures for removing and replacing drive components, as required (D- or E-sized drives, respectively).

Drive testing is divided into 5.1 *Static Tests*, 5.2 *Dynamic Tests*, and 5.3 *Initial Start Up or After Repair Drive Tests*. Static tests are conducted without power applied to the drive. Most drive problems can be diagnosed simply with these tests. Static tests are performed with little or no disassembly. The purpose of static testing is to check for shorted power components. Perform these tests on any unit suspected of containing faulty power components prior to applying power.

⚠WARNING

For dynamic test procedures, main input power is required. All line powered devices and power supplies are energized at rated voltage. Use extreme caution when conducting tests on a powered drive. Contact with powered components could result in electrical shock and personal injury.

Dynamic tests are performed with power applied to the drive. Dynamic testing traces signal circuitry to isolate faulty components.

Both D-frame and E-frame size drives (see Introduction Section) are covered here. Differences in the procedures are noted, as required. However, the Soft Charge and Rectifier Circuit Test, Soft Charge Rectifier Test, and Fan Continuity Test sections are independent for D-frame and E-frame drives.

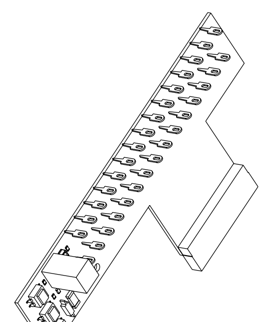
Replace any defective component and retest the drive with the new component before applying power to the drive as described in 5.3 *Initial Start Up or After Repair Drive Tests*.

TOOLS REQUIRED FOR TESTING

Digital volt/ohm meter capable of reading real RMS
Analog volt meter
Oscilloscope
Clamp-on style ammeter
Signal test board p/n 176F8437
Test cable p/n 176F8439

Signal Test Board

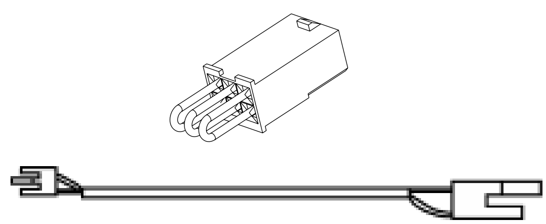
The signal test board can be used to test circuitry within the drive and provides easy access to test points. The test board plugs into connector MK104 on the interface card. Its use is described in the procedures where called out. See Section 8, *Signal Test Board*, for detailed pin descriptions.



Signal Test Board

Test Cable

The test cable bypasses the main DC bus and supplies DC voltage to the power card from the soft charge card. This provides voltage for testing the power card without the drive circuitry being powered. The SCR shorting plug ensures that the SCRs do not fire. The cable connects between the soft charge connector MK3 and the power card connector MK105.



Test Cable Connector and SCR Shorting Plug

5.0 TEST PROCEDURES

5.1 STATIC TEST PROCEDURES

All tests should be made with a meter capable of testing diodes. Use a digital volt/ohm meter (VOM) set on the diode scale or an analog ohmmeter set on Rx100 scale. Before making any checks disconnect all input, motor and brake resistor connections.

Figure 5-1. *Interface PCA and Power Card PCA Connector Identification* is provided as a reference for finding the appropriate connectors described in the test procedures in this section. Some connectors are optional and not on all drive configurations.

NOTE

For best troubleshooting results, it is recommended that static test procedures described in this section be performed in the order presented.

Diode Drop. A diode drop reading will vary depending on the model of ohmmeter. Whatever the ohmmeter displays as a typical forward bias diode is defined as a "diode drop" in these procedures. With a typical DVM, the voltage drop across most components will be around .300 to .500. The opposite reading is referred to as infinity and most DMVs will display the value OL for overload.

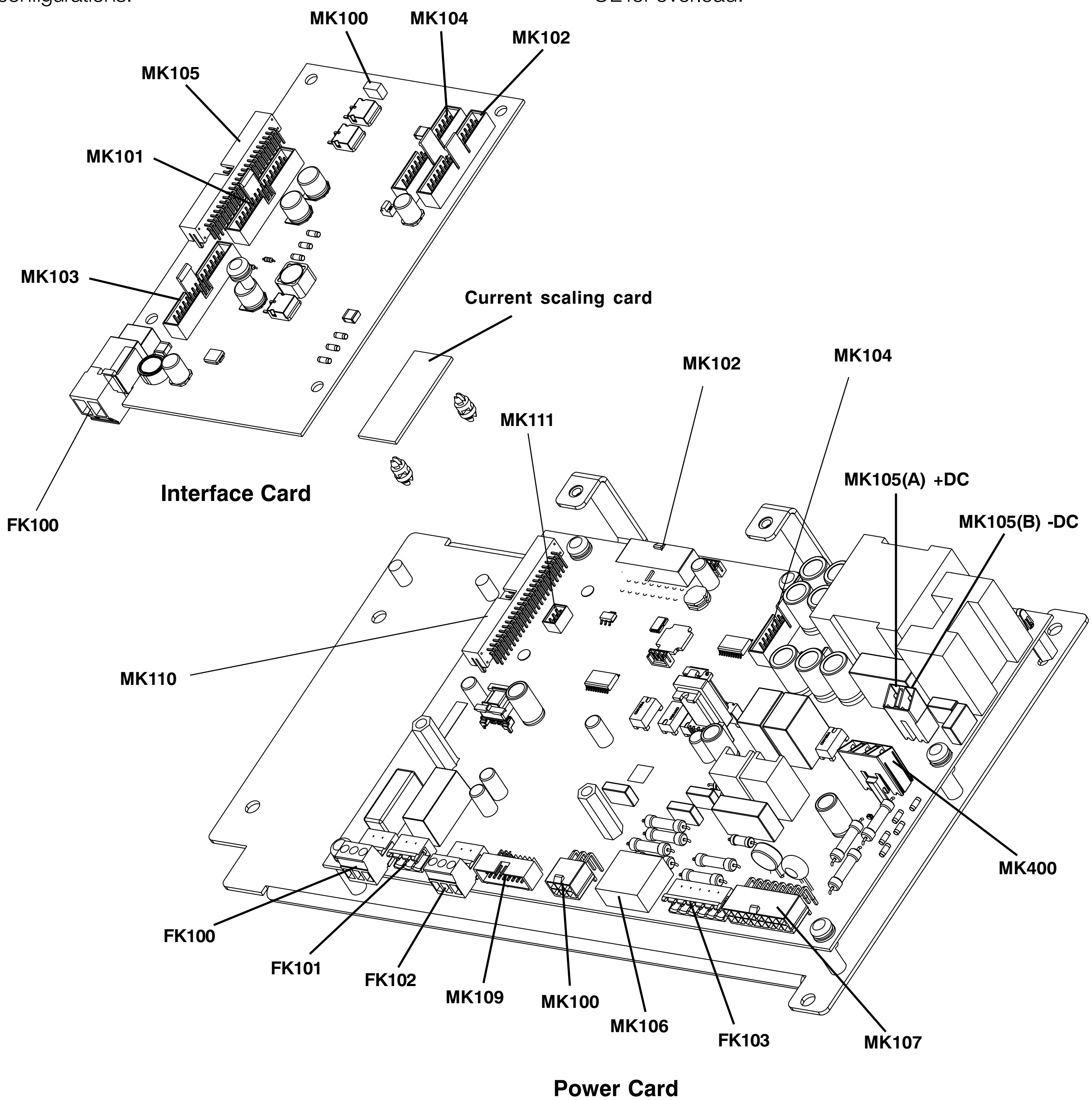


Figure 5-1. Interface PCA and Power PCA Connector Identification

5.1.1 Soft Charge and Rectifier Circuits Test: D-frame Size

Both the rectifier and soft charge circuits are tested simultaneously. The soft charge circuit is made up of the soft charge rectifier, fuses and the soft charge resistor. The rectifier circuit is made up of the SCR/Diode modules. The soft charge resistor limits the inrush current when power is applied to the drive. The soft charge circuit card also provides snubbing for the SCRs.

It is important to pay close attention to the polarity of the meter leads to ensure identification of a faulty component should an incorrect reading appear.

Prior to making the test, it is necessary to ensure the soft charge fuses, F1, F2, and F3, located on the soft charge card, are good.

Figure 5-2 shows the soft charge card and the location of the fuses. It is for reference only. It is not necessary to remove the card to perform the tests.

5.1.1.1 Soft Charge Fuse Test

Use a digital ohmmeter to test continuity on rectifier fuses F1, F2, and F3 at connector MK106 on the power card.

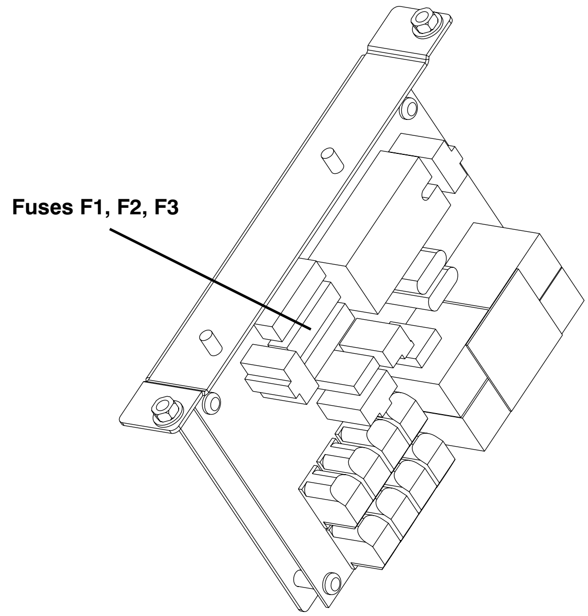


Figure 5-2. Soft Charge Card Fuses

NOTE

If unit has fused disconnect option, make test connections L1, L2, and L3 to output (drive) side of disconnect. Do not unplug connector.

1. Measure fuse F1 from mains input L1 (R) to MK106 pin 10 on power card.

2. Measure fuse F2 from mains input L2 (S) to MK106 pin 8 on power card.

3. Measure fuse F3 from mains input L3 (T) to MK106 pin 6 on power card.

A measurement of 0 ohms indicates good continuity. Replace any open fuse (infinite resistance).

To replace a soft charge fuse, follow the soft charge disassembly instructions in Section 6.

5.1.1.2 Main Rectifier Circuit Test Part I

1. Connect positive (+) meter lead to positive (+) DC bus connector MK105 (A) on power card.

2. Connect negative (–) meter lead to terminals L1, L2, and L3 in turn.

Each reading should show infinity. The meter will start at a low value and slowly climb towards infinity due to capacitance within the drive being charged by the meter.

Incorrect Reading
With the Part I test connection, the SCRs in the SCR/Diode modules are reverse biased so they are blocking current flow. If a short circuit exists, it would be possible that either the SCRs or the diodes in the soft charge rectifier are shorted. To isolate between SCRs or the soft charge rectifier, perform the Soft Charge Rectifier Test.

5.1.1.3 Main Rectifier Circuit Test Part II

1. Reverse meter leads by connecting negative (–) meter lead to positive (+) DC bus connector MK105 (A) on power card.

2. Connect positive (+) meter lead to L1, L2, and L3 in turn. Each reading should show a diode drop.

Incorrect Reading
With the Part II test connection, even though the SCRs in the SCR/Diode modules are forward biased by the meter, current will not flow through the SCRs without providing a signal to their gates. The upper diodes in the soft charge rectifier are forward biased so the meter reads the voltage drop across those diodes.

If an open reading were present, it would indicate the upper diodes in the soft charge rectifier are open. It could also indicate that one or more of the soft charge fuses are open. It could further indicate that the soft charge resistor is open. To isolate between the three possibilities, perform the Soft Charge Fuse Test and Soft Charge Rectifier Test.

A short circuit reading indicates either one or more of the upper soft charge rectifier diodes are shorted or the SCRs are shorted in the SCR/Diode module. To isolate between SCRs or the soft charge rectifier, perform the Soft Charge Rectifier Test.

5.1.1.4 Main Rectifier Circuit Test Part III

1. Connect positive (+) meter lead to negative (-) DC bus connector MK105 (B) on power card.

2. Connect negative (–) meter lead to terminals L1, L2 and L3 in turn. Each reading should show a diode drop.

Incorrect Reading
With the Part III test connection, the diodes in the SCR/Diode modules are forward biased as well as the lower diodes in the soft charge rectifier. The meter reads the diode drops. If a short circuit exists it would be possible that either the diodes in the SCR/Diode modules or the lower diodes in the soft charge rectifier are shorted. To isolate between SCRs or the soft charge rectifier, perform the Soft Charge Rectifier Test.

Although an open reading is possible, it is unlikely since that indicates that both the diodes in the SCR/diode modules and the lower diodes in the soft charge rectifier are open. Should that occur, replace both diodes.

5.1.1.5 Main Rectifier Circuit Test Part IV

1. Reverse meter leads by connecting negative (–) meter lead to negative (-) DC bus connector MK105 (B) on power card.

2. Connect positive (+) meter lead to L1, L2 and L3 in turn. Each reading should show infinity.

Each reading should show infinity. The meter will start at a low value and slowly climb toward infinity due to capacitance within the drive being charged by the meter.

Incorrect Reading
With the Part IV test connection, the diodes in the SCR/Diode modules are reversed biased as well as the lower diodes in the soft charge rectifier. If a short circuit exists it would be possible that either the diodes in the SCR/Diode modules or the lower diodes in the soft charge rectifier are shorted. To isolate between SCRs or the soft charge rectifier, perform the Soft Charge Rectifier Test, 5.1.2.

5.1.2 Soft Charge Rectifier Test: D-frame Size

Testing the soft charge rectifier requires access to the soft charge card connectors. It requires removing the control card and power card mounting plate. Refer to removal instructions for soft charge card in Section 6.

Do not remove the soft charge card completely or unplug any connectors not called out. Doing so will break the continuity path of these measurements and may result in a false interpretation of a failure.

1. Extract soft charge card far enough to access connectors.

2. Disconnect DC cable at connector MK3.

Since the rectifier test requires the soft charge resistor to be in the circuit, verify the resistor is good before proceeding.

3. Measure resistance between pins A and B of connector MK4 on soft charge card. It should read 27 ohms (±10%) for 380 - 500V drives and 68 ohms (±10%) for 525 - 690V. A reading outside this range indicates a defective soft charge resistor. Replace resistor in accordance with disassembly procedures in Section 6. Continue tests.

Should the resistor be defective and a replacement not readily available, the remainder of the tests can be carried out by disconnecting the cable at connector MK4 on the soft charge card and placing a temporary jumper across pins A and B. This provides a path for continuity for the remaining tests. Ensure any temporary jumpers are removed at the conclusion of the tests.

For the following tests, set the meter to diode check or Rx100 scale.

4. Connect negative (-) meter lead to positive (+) MK3 (A) (DC output to DC bus), and connect positive (+) meter lead to MK1 terminals R, S, and T in turn. Each reading should show a diode drop.

An incorrect reading here indicates the soft charge rectifier is shorted. The rectifier is not serviced as a component. Replace the entire soft charge card in accordance with the disassembly procedures in Section 6.

5. Reverse meter leads with positive (+) meter lead to positive (+) MK3 (A). Connect negative (-) lead to MK1 terminals R, S, and T in turn. Each reading should show open.

6. Connect positive (+) meter lead to negative (-) MK3 (C). Connect negative (-) meter lead to MK1 terminals R, S, and T in turn. Each reading should show a diode drop.

An incorrect reading here indicates the soft charge rectifier is shorted. The rectifier is not serviced as a component. Replace the entire soft charge card in accordance with the disassembly procedures in Section 6.

7. Reverse meter leads with negative (-) meter lead to negative (-) MK3 (C). Connect positive (+) meter lead to MK1 terminals R, S, and T in turn. Each reading should show open.

If all tests indicate correctly while isolating between the SCR/Diode modules and the soft charge card, the SCR/Diode modules are suspect. Before reconnecting the cable at MK3, return to the Main Rectifier tests and repeat those tests. Put the power card temporarily back in place to retest the main rectifier. Replace any defective assemblies in accordance with the disassembly procedures in Section 6.

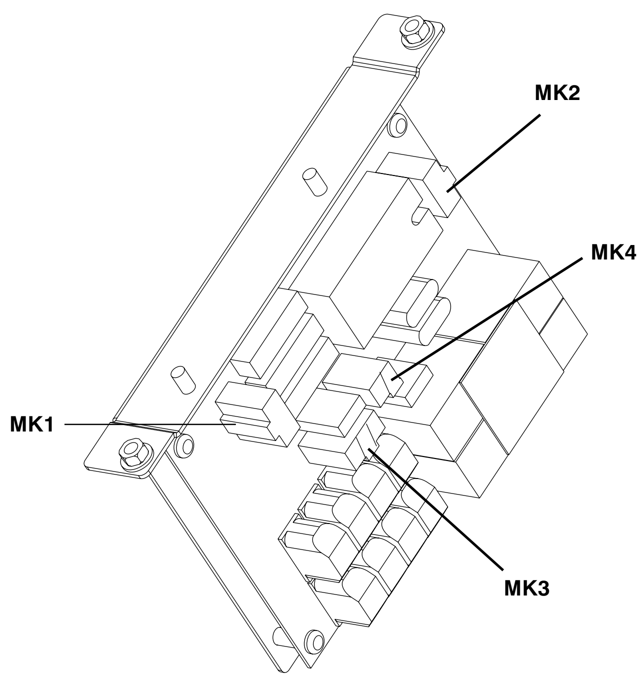


Figure 5-3. Soft Charge Card Connectors

5.1.3 Soft Charge and Rectifier Circuits Test: E-frame Sizes

For E-frame size drives, the rectifier and soft charge circuits are tested separately. The soft charge circuit is made up of the soft charge rectifier, fuses and the soft charge resistor. The rectifier circuit is made up of the SCR and diode modules. The soft charge resistor limits the inrush current when power is applied to the drive. The soft charge circuit card also provides snubbing for the SCRs.

It is important to pay close attention to the polarity of the meter leads to ensure identification of a faulty component should an incorrect reading appear.

Prior to making the test, it is necessary to ensure the soft charge fuses, F1, F2, and F3, located on the soft charge card, are good. An open fuse could indicate a problem in the soft charge curcuit. Continue test procedures.

Figure 5-4 shows the soft charge card and the location of the fuses. It is for reference only. It is not necessary to remove the card to perform the tests.

Disconnect MK3 from the soft charge card and leave disconected until completion of soft charge and rectifier tests.

5.1.3.1 Soft Charge Fuse Test

Use a digital ohmmeter to test continuity on rectifier fuses F1, F2, and F3 on the soft chanrge card.

1. Measure F1 across fuse. Open reading indicates open (blown) fuse.

2. Measure F2 across fuse. Open reading indicates open (blown) fuse.

3. Measure F3 across fuse. Open reading indicates open (blown) fuse.

A measurement of 0 ohms indicates good continuity. Replace any open fuse (infinite resistance).

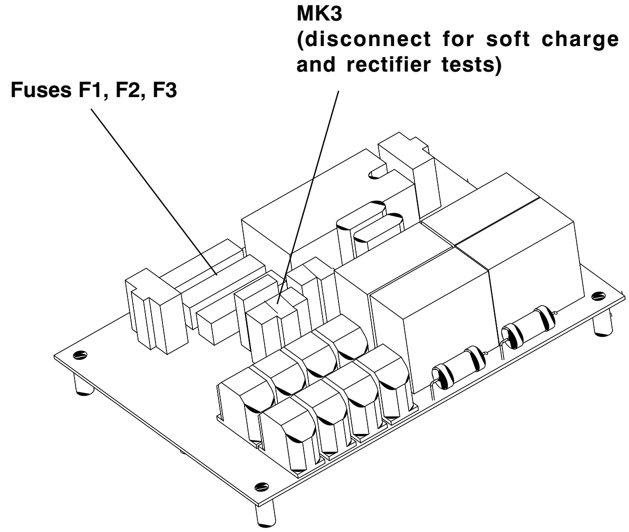


Figure 5-4. Soft Charge Card Fuse Location

5.1.3.2 Main Rectifier Circuit Test E-frames Part I

1. Connect positive (+) meter lead to positive (+) DC bus connector MK105 (A) on power card.

2. Connect negative (–) meter lead to terminals L1, L2, and L3 in turn. If a disconnect option is used, measure on top side of fuses.

Each reading should show infinity. The meter will start at a low value and slowly climb towards infinity due to capacitance within the drive being charged by the meter.

Incorrect Reading
With the Part I test connection, the SCR modules are blocking current flow. A short indicates a shorted SCR module.

5.1.3.3 Main Rectifier Circuit Test E-frames Part II

1. Reverse meter leads by connecting negative (–) meter lead to positive (+) DC bus connector MK105 (A) on power card.

2. Connect positive (+) meter lead to L1, L2, and L3 in turn. Each reading should show open.

Incorrect Reading
With the Part II test connection, the SCR modules are blocking current flow. A short indicates a shorted SCR module.

5.1.3.4 Main Rectifier Circuit Test E-frames Part III

1. Connect positive (+) meter lead to negative (-) DC bus connector MK105 (B) on power card.

2. Connect negative (–) meter lead to terminals L1, L2 and L3 in turn. Each reading should show a diode drop.

Incorrect Reading
With the Part III test connection, the diodes in the main rectifier diode modules are forward biased. The meter reads the diode drops. If a short circuit or an open circuit exists, the diode module is damaged.

5.1.3.5 Main Rectifier Circuit Test E-frames Part IV

1. Reverse meter leads by connecting negative (–) meter lead to negative (-) DC bus connector MK105 (B) on power card.

2. Connect positive (+) meter lead to L1, L2 and L3 in turn. Each reading should show infinity.

Each reading should show infinity. The meter will start at a low value and slowly climb toward infinity due to capacitance within the drive being charged by the meter.

Incorrect Reading
With the Part IV test connection, the diodes in the main diode modules are reversed biased. If a short circuit exists, the diode module is damaged.

Continue to Soft Charge Rectifier Tests: E-frames, 5.1.4.

5.1.4 Soft Charge Rectifier Test: E-frame Size

The DC cable at connector MK3 remains disconnected for this procedure.

Since the rectifier test requires the soft charge resistor to be in the circuit, verify the resistor is good before proceeding.

1. Measure resistance between pins A and B of connector MK4 on soft charge card. It should read 27 ohms (±10%) for 380-500 V drives or 68 ohms (±10%) for 525-690 V drives. A reading outside this range indicates a defective soft charge resistor. Replace resistor in accordance with disassembly procedures in Section 7. Continue tests.

Should the resistor be defective and a replacement not readily available, the remainder of the tests can be carried out by disconnecting the cable at connector MK4 on the soft charge card and placing a temporary jumper across pins A and B. This provides a path for continuity for the remaining tests. Ensure any temporary jumpers are removed at the conclusion of the tests.

For the following tests, set the meter to diode check or Rx100 scale.

2. Connect negative (-) meter lead to positive (+) MK3 (A) (DC output to DC bus), and connect positive (+) meter lead to MK1 terminals R, S, and T in turn. Each reading should show a diode drop.

3. Reverse meter leads with positive (+) meter lead to positive (+) MK3 (A). Connect negative (-) lead to MK1 terminals R, S, and T in turn. Each reading should show open.

4. Connect positive (+) meter lead to negative (-) MK3 (C). Connect negative (-) meter lead to MK1 terminals R, S, and T in turn. Each reading should show a diode drop.

5. Reverse meter leads with negative (-) meter lead to negative (-) MK3 (C). Connect positive (+) meter lead to MK1 terminals R, S, and T in turn. Each reading should show open.

An incorrect reading here indicates the soft charge rectifier is faulty. The rectifier is not serviced as a component. Replace the entire soft charge card in accordance with the disassembly procedures in Section 7.

Reconnect MK3 on shoft charge card after these tests.

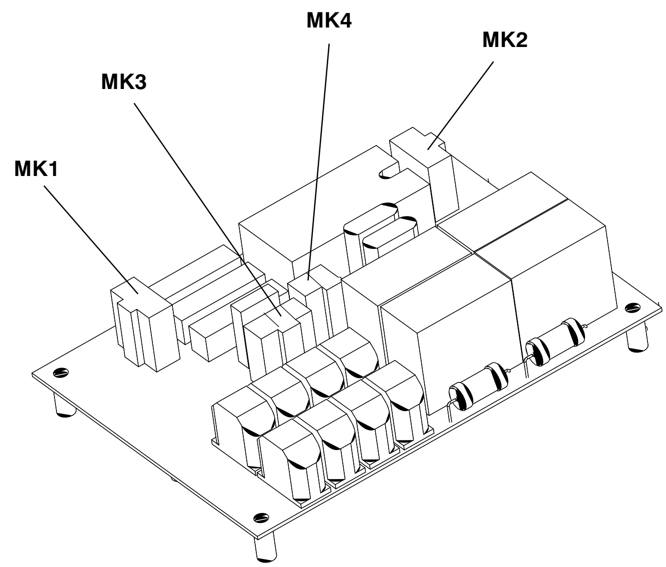


Figure 5-5. Soft Charge Card Connectors

5.1.5 Inverter Section Tests

The inverter section is primarily made up of the IGBTs used for switching the DC bus voltage to create the output to the motor. IGBTs are grouped into modules comprised of six IGBTs. Depending on the size of the unit, either one, two, or three IGBT modules are present. The drive also has 3 snubber capacitors on each IGBT module.

⚠CAUTION

Disconnect motor leads when testing inverter section. With leads connected, a short circuit in one phase will read in all phases, making isolation difficult.

Before starting tests, ensure that meter is set to diode scale. If removed previously, reinstall the soft charge card, interface and power cards. Do not disconnect the cable to connector MK105 on the power card since the path for continuity would be broken.

5.1.5.1 Inverter Test Part I

1. Connect positive (+) meter lead to (+) positive DC bus connector MK105 (A) on power card.

2. Connect negative (–) meter lead to terminals U, V, and W in turn.

Each reading should show infinity. The meter will start at a low value and slowly climb toward infinity due to capacitance within the drive being charged by the meter.

5.1.5.2 Inverter Test Part II

1. Reverse the meter leads by connecting negative (–) meter lead to positive (+) DC bus connector MK105 (A) on power card.

2. Connect positive (+) meter lead to U, V, and W in turn. Each reading should show a diode drop.

Incorrect Reading

An incorrect reading in any inverter test indicates a failed IGBT module. Replace the IGBT module in accordance with the disassembly instructions in Section 6 or 7. It is further recommended for units with two IGBT modules that both modules be replaced even if the second module tests correctly.

5.1.5.3 Inverter Test Part III

1. Connect positive (+) meter lead to the negative (-) DC bus connector MK105 (B) on power card.

2. Connect negative (–) meter lead to terminals U, V, and W in turn. Each reading should show a diode drop.

5.1.5.4 Inverter Test Part IV

1. Reverse the meter leads by connecting negative (–) meter lead to negative (-) DC bus connector MK105 (B) on power card.

2. Connect positive (+) meter lead to U, V, and W in turn.

Each reading should show infinity. The meter will start at a low value and slowly climb toward infinity due to capacitance within the drive being charged by the meter.

Incorrect Reading

An incorrect reading in any inverter test indicates a failed IGBT module. Replace the IGBT module in accordance with the disassembly instructions in Section 6 or 7. It is further recommended for units with two IGBT modules that both modules be replaced even if the second module tests correctly.

Indications of a failure in this circuit

IGBT failures may be caused by the drive being exposed to repeated short circuits or ground faults, or by extended drive operation outside of its normal operating parameters. Following an IGBT failure, it is important to verify the gate drive signals are present and of the correct waveform. See the dynamic test section on checking IGBT gate drive signals.

5.1.5.5 Gate Resistor Test

Mounted to each IGBT module is an IGBT gate resistor board containing, among other components, the gate resistors for the IGBT transistors. Based on the nature of the failure, a defective IGBT can produce good readings from the previous tests. In nearly all cases, the failure of an IGBT will result in the failure of the gate resistors.

Located on the gate drive card near each of the gate signal leads is a 3 pin test connector. These are labeled MK 250, 350, 450, 550, 650, 750, and, if the drive is equipped with a brake option, 850.

For the sake of clarity, refer to the 3 pins as one, two, and three, reading left to right. Pins 1 and 2 of each connector are in parallel with the gate drive signal sent to the IGBTs. Pin 1 is the signal and Pin 2 is common.

1. With ohm meter, measure pins 1 and 2 of each test connector. Reading should indicate 7.8K ohms for units with single IGBT module, 3.9K ohms for units with dual IGBT modules, and 2.6K ohms for units with three IGBT modules.

Incorrect Reading

An incorrect reading indicates that either the gate signal wires are not connected from the gate drive card to the gate resistor board or the gate resistors are defective. Connect gate signal wires, or if the resistors are defective, the entire IGBT module assembly requires replacement. Replace the IGBT module in accordance with the disassembly procedures in Section 6 or 7.

5.1.6 Brake IGBT Test

This test can only be carried out on units equipped with a dynamic brake option. If a brake resistor is connected to terminals 81 and 82, disconnect it before proceding. Use an ohm meter set on diode check or Rx100 scale.

5.1.6.1 Brake IGBT Test Part I

1. Connect positive (+) meter lead to brake resistor terminal R+ (82).

2. Connect negative (-) meter lead to brake resistor terminal R- (81).

The reading should indicate infinity. The meter may start out at a value and climb toward infinity as capacitance is charged within the drive.

5.1.6.2 Brake IGBT Test Part II

1. Connect positive (+) meter lead to brake resistor terminal R- (81).

2. Connect negative (-) meter lead to brake resistor terminal R+ (82).

The reading should indicate a diode drop.

5.1.6.3 Brake IGBT Test Part III

1. Connect positive (+) meter lead to brake resistor terminal R- (81).

2. Connect negative (-) meter lead to negative (-) DC bus connector MK105 (B) on the power card.

The reading should indicate infinity. The meter may start out at a value and climb toward infinity as capacitance is charged within the drive.

Incorrect Reading

An incorrect reading on any of the above tests indicates that the brake IGBT is defective. Replace the brake IGBT in accordance with the disassembly procedures in Section 6 or 7.

The failure of any IGBT may also lead to a failure of the gate drive circuit supplying that device. Following the replacement of an IGBT, always ensure the gate drive signals are tested in accordance with the procedures in the dynamic test section.

5.1.7 Intermediate Section Tests

The intermediate section of the drive is made up of the DC bus capacitors, the DC coils, and the balance circuit for the capacitors.

1. Test for short circuits with ohmmeter set on Rx100 scale or, for a digital meter, select diode.

2. Measure across positive (+) DC terminal (A) and negative (–) DC terminal (B) on connector MK105 on power card. Observe meter polarity.

3. Meter will start out with low ohms and then move towards infinity as meter charges capacitors.

4. Reverse meter leads on connector MK105 on power card.

5. Meter will peg at zero while capacitors are discharged by meter. Meter then begins moving slowly toward two diode drops as meter charges capacitors in reverse direction. Although test does not ensure capacitors are fully functional, it ensures no short circuits exist in intermediate circuit.

Incorrect Reading

A short circuit could be caused by a short in the soft charge, rectifier, or inverter section. Be sure that the test for these circuits have already been performed successfully. A failure in one of these sections could be read in the intermediate section since they are all across the DC bus.

If a short circuit is present, and the unit is equipped with a brake, perform the brake IGBT test next.

The only other likely cause would be a defective capacitor within the capacitor bank.

There is not an effective test of the capacitor bank when it is fully assembled. Although unlikely that a failure within the capacitor bank would not be indicated by a physically damaged capacitor, if suspect, the entire capacitor bank must be replaced. Replace the capacitor bank in accordance with the disassembly procedures in Section 6 or 7.

5.1.8 Heatsink Temperature Sensor Test

The temperature sensor is an NTC (negative temperature coefficient) device. As a result, high resistance means low temperature. As temperature decreases, resistance increases. The power card reads the resistance of the NTC sensor to regulate fan speed and to monitor for over temperature conditions.

1. Use ohmmeter set to read ohms.

2. Unplug connector MK100 on interface card and measure across cable leads.

The full range of the sensor is 787 ohms to 10K ohms where 10K ohms equals 25°C and 787 ohms equals 95°C. The higher the temperature, the lower the resistance.

5.1.9 Fan Continuity Tests: D-frame Size

Make all continuity checks using an ohmmeter set to Rx1 scale. Digital or analog ohmmeter can be used.

To aid in making the measurements, unplug the connector CN2 from its mate. CN2 terminals correspond to the terminal numbers labeled on the transformer.

5.1.9.1 Checking Continuity of Connections

For the following tests, read the plug end of connector CN2 that is not connected to the transformer.

1. Measure from L3 (T) to CN2 terminal 1. A reading of <1ohm should be indicated.

2. Measure from L2 (S) to CN2 terminal 3. A reading of <1 ohm should be indicated.

3. Measure from CN2 terminal 2 to terminal 12 of power card connector MK107. A reading of <1 ohm should be indicated.

Incorrect Reading
An incorrect reading would indicate a faulty cable connection. Replace the cable assembly.

5.1.9.2.1 Ohm Test of Transformer (380 - 500V)

For the following tests, read the plug end of connector CN2 that is connected to the transformer.

1. Measure between CN2 terminals 1 and 3. Approximately 15 ohms should be read.

2. Measure between CN2 terminals 1 and 2. Approximately 12 ohms should be read.

3. Measure between CN2 terminals 2 and 3. Approximately 4 ohms should be read.

Incorrect Reading
An incorrect reading would indicate a defective fan transformer. Replace the fan transformer.

When finished, be sure to reconnect CN2.

5.1.9.2.2 Ohm Test of Transformer (525 - 690V)

For the following tests, read the plug end of connector CN2 that is connected to the transformer.

1. Measure between CN2 terminals 1 and 3. Approximately 20 ohms should be read.

2. Measure between CN2 terminals 1 and 2. Approximately 8 ohms should be read.

3. Measure between CN2 terminals 2 and 3. Approximately 12 ohms should be read.

Incorrect Reading
An incorrect reading would indicate a defective fan transformer. Replace the fan transformer.

When finished, be sure to reconnect CN2.

5.1.9.3 Ohm Test of Fans

1. Measure between terminals 11 and 13 of power card connector MK107. A reading of 20 ohms should be indicated.

2. Disconnect spade connectors from door fan and repeat measurement. A reading of 21 ohms should be indicated.

3. Read terminals of door fan with wires disconnected. A reading of 400 ohms should be indicated.

4. Reconnect wires to door fan.

Incorrect Reading
An incorrect reading of one or both of the fans indicates a defective fan. Replace the defective fan.

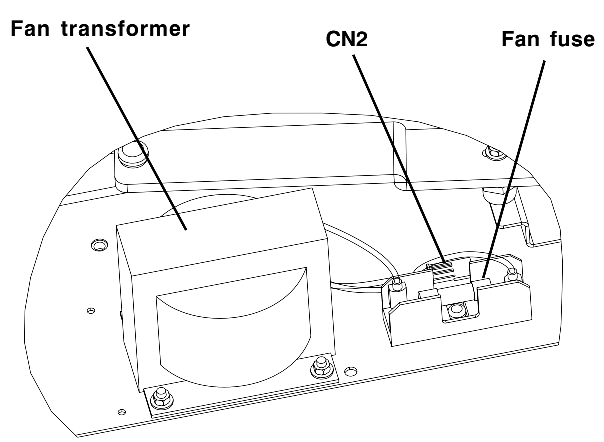


Figure 5-6. Fan Transformer and Fuse Location

5.1.10 Fan Continuity Tests: E-frame Sizes

Make all continuity checks using an ohmmeter set to Rx1 scale. A digital or analog ohmmeter can be used. Some instability may result when measuring resistance of a transformer with a multimeter. This can be reduced by turning off the auto-ranging function and setting the measurement manually.

To aid in making the measurements, unplug MK107 from the power card.

5.1.10.1 Checking Continuity of Connections

For the following tests, read connector MK107 on the power card.

1. Measure from L3 (T) to MK107 terminal 8. Reading of <1ohm should be indicated.

2. Measure from L2 (S) to MK107 terminal 1. Reading of <1 ohm should be indicated.

Incorrect Reading
An incorrect reading would indicate a faulty cable connection. Replace the cable assembly.

Fan Fuse Test

1. Test fan fuses on power card mounting plate by checking continuity across fuse.

An open fuse could indicate additional faults. Replace fuse and continue fan checks.

5.1.10.2 Ohm Test of Transformer

For the following tests, read the plug end of the wire connected to MK107 on the power card.

1. Measure between MK107 terminals 1 and 8. Should read approx value A in Table 5-1.

2. Measure between MK107 terminals 8 and 12. Should read approx value B in Table 5-1.

3. Measure between MK107 terminals 1 and 12. Should read approx value C in Table 5-1.

Table 5-1. Fan Transformer Resistance

AC Voltage	Drive	Resistance (in Ohms)			Heatsink Fan	Fan Inductor
		A	B	C	D	
380-500	5352, 4452, 6402, 8452	15	12	4	21	no
380-500	5452, 4502, 6502, 8502	4	3	1	4	yes
380-500	5502, 4602, 6552, 8602	4	3	1	4	yes
380-500	5552, 4652, 6602, 8652	4	3	1	4	yes
525-690	5402, 4502, 6502, 8502	20	8	12	21	no
525-690	5502, 4602, 6602, 8602	7.4	3.6	3.2	4	yes
525-690	5602, 4652, 6652, 8652	7.4	3.6	3.2	4	yes

Incorrect Reading
An incorrect reading would indicate a defective fan transformer. Replace the fan transformer.

When finished reconnect MK107.

5.1.10.3 Ohm Test of Fans

1. Measure between terminals 3 and 5 of power card connector MK107. Should read approx value D in Table 5-1.

Incorrect Reading
For fans without an inductor, replace the fan. For drives with a fan and inductor, isolate the fault between the fan and the inductor as follows.

a. Disconnect CN3 and measure resistance between pins 1 and 2 on fan side of conector. Reading should be approx 4 ohms. If incorrect, replace fan.

b. Disconnect CN4 and CN5. Measure resistance across inductor. Reading should be less than 1 ohm. If incorrect, replace inductor.

2. Measure between terminals 11 and 13 of power card connector MK107. For units with one top mounted fan, a reading of 400 ohms is expected. For units with two door mounted fans, a reading of 200 ohms is expected.

Incorrect Reading
For units with one top mounted fan, replace the fan. For units with two door mounted fans, isolate the faulty fan as follows.

a. Disconnect wiring from fan terminals.

b. Read across fan terminals on each fan. A reading of 400 ohms is expected. Replace any defective fans.

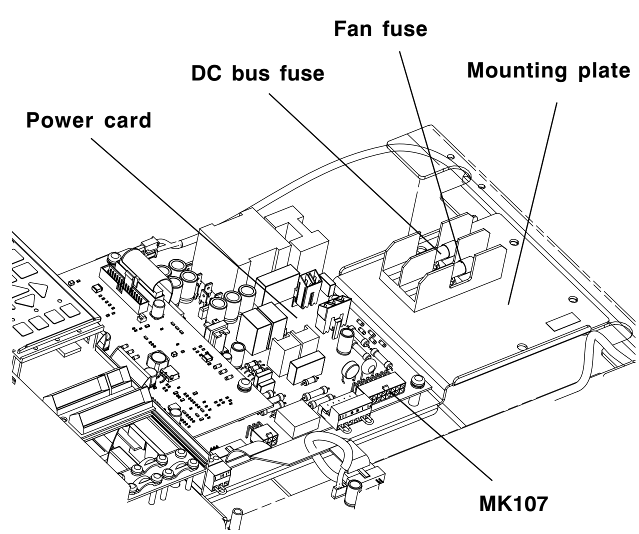


Figure 5-7. Fan and DC Bus Fuse Locations

5.2 DYNAMIC TEST PROCEDURES

Refer to terminal locations in Figure 5-8 for performing dynamic test procedures.

NOTE

Test procedures in this section are numbered for reference only. Tests do not need to be performed in this order. Perform tests only as necessary.

⚠DANGER

Never disconnect input cabling to drive with power applied due to danger of severe injury or death.

⚠WARNING

Take all necessary safety precautions for system start up prior to applying power to drive.

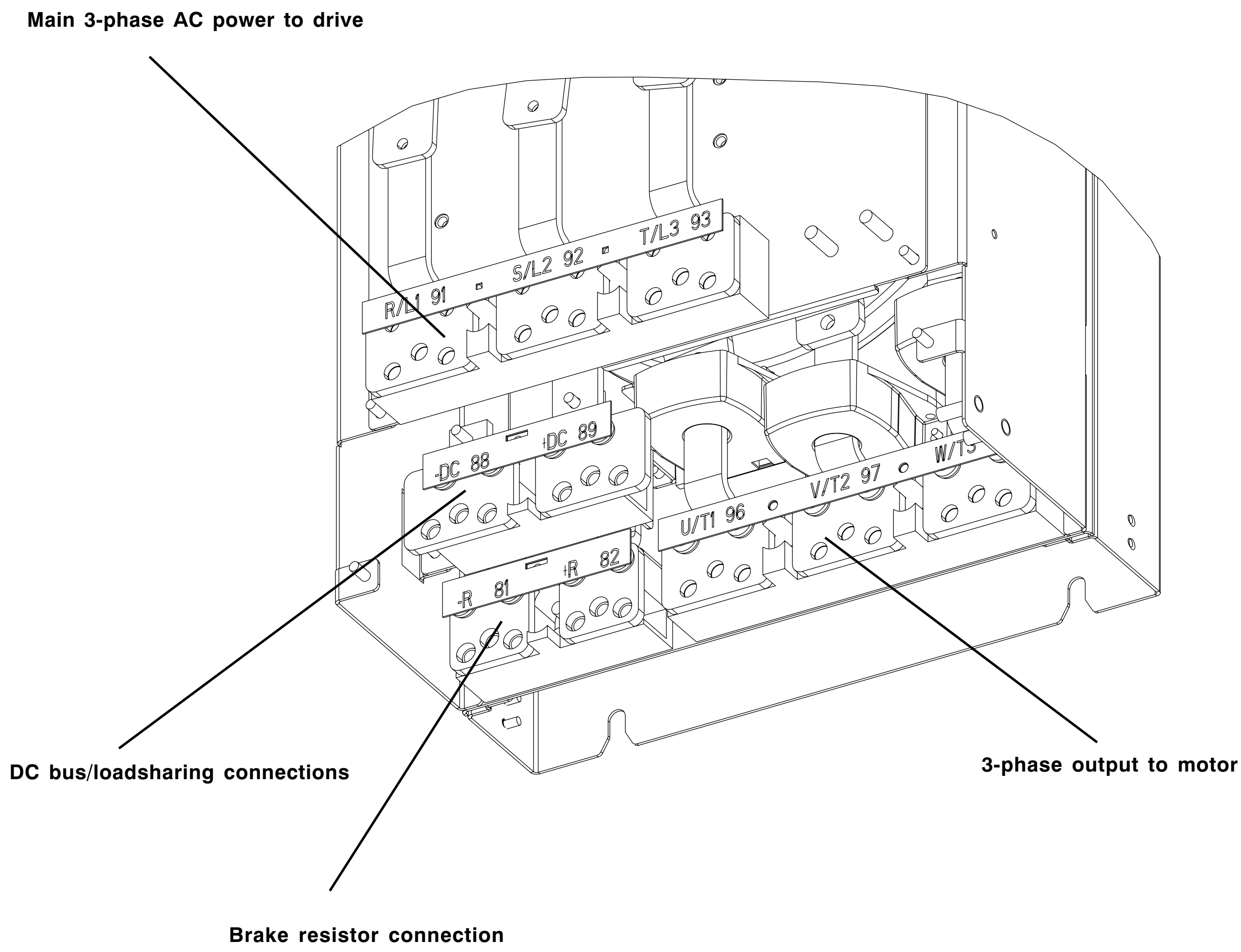


Figure 5-8. Drive Power Terminals (D-size Frames)

5.2.1 No Display Test

A drive with no display can be the result of several causes. Verify first that there is no display whatsoever. A single character in the display or a dot in the upper corner of the display indicates a communication error and is typically caused by an option card not properly installed. Under this condition the green power-on LED is illuminated.

If the LCD display is completely dark and the green power-on LED is not lit, proceed with the following tests.

First test for proper input voltage.

5.2.1.1 Input Voltage Test

1. Apply power to drive.

2. Use DVM to measure input line voltage between drive input terminals in turn:

   L1 to L2

   L1 to L3

   L2 to L3

For 380 - 480 V drives, all measurements must be within the range of 342 to 528 VAC (or 342 to 550 VAC for VLT 5000). Readings of less than 342 VAC indicate problems with the input AC line voltage. For 525 - 690 V drives, all measurements must be within the range of 446 to 759 VAC (or 446 to 660 VAC for VLT 6000). Readings of less than 446 VAC indicate problems with the input AC line voltage.

In addition to the actual voltage reading, the balance of the voltage between the phases is also important. The drive can operate within specifications as long as the phase imbalance is not more than 3%.

Danfoss calculates line imbalance per an IEC specification.

Imbalance = 0.67 X (Vmax – Vmin) / Vavg

For example, if three phase readings were taken and the results were 500 VAC, 478.5 VAC, and 478.5 VAC; then 500 VAC is Vmax, 478.5 VAC is Vmin, and 485.7 VAC is Vavg, resulting in an imbalance of 3%.

Although the drive can operate at higher line imbalances, the lifetime of components, such as DC bus capacitors, will be shortened.

Incorrect Reading

An incorrect reading here requires that the main supply be investigated further. Typical items to check would be:

Open (blown) input fuses or tripped circuit breakers

Open disconnects or line side contactors

Problems with the power distribution system

⚠CAUTION

Open (blown) input fuses or tripped circuit breakers usually indicate a more serious problem. Prior to replacing fuses or resetting breakers, perform static tests described in section 5.1.

If the Input Voltage Test was successful check for voltage to the control card.

5.2.1.2 Basic Control Card Voltage Test

1. Use voltmeter to measure 24 VDC control voltage at terminal 12 with respect to terminal 20. Meter should read between 21 and 27 VDC.

If an external 24 VDC supply is used for control voltage, it would be likely for switch 4 on the control card to be open. This opens the common connection to terminal 20. If this is the case, measure terminal 12 with respect to terminal 39.

An incorrect reading here could indicate the supply is being loaded down by a fault in the customer connections. Unplug the terminal strip and repeat the test. If this test is successful then continue. Remember to check out the customer connections. If still unsuccessful proceed to the Switch Mode Power Supply (SMPS) test.

2. Measure 10 V DC control voltage at terminal 50 with respect to terminal 55. Meter should read between 9.2 and 11.2 VDC.

An incorrect reading here could indicate the supply is being loaded down by a fault in the customer connections. Unplug the terminal strip and repeat the test. If this test is successful than continue. Remember to check out the customer connections. If still unsuccessful proceed to the SMPS test.

A correct reading of both control card voltages would indicate the LCP or the control card is defective. Replace the LCP with a known good one. If the problem persists replace the control card in accordance with the disassembly procedures in Section 6 or 7.

5.2.2 Switch Mode Power Supply (SMPS) Test

The SMPS derives its power from the DC bus. The first indication that the DC bus is charged is the DC bus charge indicator being lit. This LED however can be lit at a voltage still to low to enable the power supplies.

First test for the presence of the DC bus.

1. Using a voltmeter, read DC bus voltage at power card connector MK105 (A) with respect to MK105 (B). Meter should indicate approximately 1.38 x AC input voltage to drive.

2. If voltage is correct proceed to set 3. If voltage is present but out of range, proceed to DC Under Voltage test. If voltage is at zero, proceed to Zero DC Bus Voltage test.

3. Test remaining power supplies. Insert signal test board into interface card connector MK104

4. Connect negative (-) meter lead to terminal 4 (common) of signal board. With positive (+) meter lead check the following terminals on signal board.

Terminal	*Supply*	*Voltage Range*
11	+18V	16.5 to 19.5 VDC
12	-18V	-16.5 to -19.5 VDC
23	+24V	23 to 25 VDC
24	+5V	4.75 to 5.25 VDC

In addition, the signal test board contains three LED indicators that indicate the presence of voltage as follows:

Red LED +/- 18VDC supplies present

Yellow LED +24VDC supply present

Green LED +5VDC supply present

The lack of any one of these power supplies indicates the low voltage supplies on the power card are defective. This assumes of course that the proper DC bus voltage was read at power card connector MK105 (A) and (B). Replace the power card in accordance with the disassembly procedures in Section 6 or 7.

5.2.3 Zero DC Bus Voltage Test

If no voltage is present at power card connector MK105 (A) and (B), check the condition of the DC power supply fuse. For D-size frames, the DC power supply fuse is located beneath the power card. For E-size frames, the fuse is located on the power card mounting plate next to the power card. It can be tested without disassembling the unit.

1. Remove power to drive and ensure DC bus is fully discharged by measuring voltage at power card connector MK105 (A) with respect to MK105 (B).

⚠CAUTION

If DC power supply fuse is open (blown), it is not possible to detect the presence of bus voltage at these terminals. If uncertain, wait 20 minutes for D-frame sizes or 40 minutes for E-frames sizes to allow DC bus to fully discharge.

2. With ohmmeter set on diode scale or Rx100, measure from power card connector MK105 (A) to any bus bars coming from DC inductor. Bus bars are visible at lower edge and beneath power card mounting bracket. Depending on bus bar read, look for a diode drop or complete short. In either case this indicates a fuse is in the circuit providing a path for continuity. An open reading indicates open fuse.

If the fuse is open, it indicates a failure of the power supplies on the power card. The power card and fuse require replacement. If the fuse checks good, there may be a problem with the soft charge circuitry. Proceed to the static checks of the soft charge and rectifier circuits earlier in this section.

5.2.4 DC Under Voltage Test

The initial charge of the DC bus is accomplished by the soft charge circuit. If the DC bus voltage is below normal it would indicate that either the line voltage is out of tolerance or the soft charge circuit is restricting the DC bus from charging. Conduct the input voltage test (5.2.1.1) to ensure the line voltage is correct.

If excessive input power cycling has occurred, the PTC resistors on the soft charge card may be restricting the bus from charging. If this is the case, expect to read a DC bus voltage in the area of 50 VDC.

1. Check DC bus voltage by reading power card connector MK105 (A) with respect to MK105 (B). If verified, remove power from drive and allow it to cool for approximately 20 minutes.

2. Reapply power to drive after 20 minutes and recheck DC bus voltage. If voltage remains, a short circuit may exist within the intermediate circuit preventing it from charging. Proceed to static checks (5.1) earlier in this section.

5.2.5 Input Phase Imbalance Test

Theoretically, the current drawn on all three input phases should be equal. Some imbalance may be seen, however, due to variations in the phase to phase input voltage and, to some degree, single phase loads within the drive itself.

A current measurement of each phase will reveal the balanced condition of the line. To obtain an accurate reading, it will be necessary for the drive to run at its rated load or not less than 40% load.

1. Perform input voltage test prior to checking current in accordance with procedure. Voltage imbalances will automatically result in a corresponding current imbalance.

2. Apply power to drive and place it in run.

3. Using a clamp-on amp meter (analog preferred), read current on each of three input lines at L1(R), L2(S), and L3(T).

Typically, the current should not vary from phase to phase by more than 5%. Should a greater current variation exist, it would indicate a possible problem with the main supply to the drive or a problem within the drive itself.

One way to determine if the mains supply is at fault is to swap two of the incoming phases. This assumes that two phases read one current while the third is more than 5% different. If all three phases are different from one another, it would be difficult to determine which leads to swap.

4. Remove power to drive.

5. Swap phase that appears to be incorrect with one of other two phases.

6. Reapply power to drive and place it in run.

7. Repeat current measurements.

If the phase imbalance moves with swapping the leads, then the main supply is suspect. Otherwise, it may indicate a problem with the gating of the SCR. This may be due to a defective SCR or in the gate signals from the power card to the module, including the possibility of the wire harness from the power card to the SCR gates. Further tests on the proper gating of the SCRs requires an oscilloscope equipped with current probes. Proceed to testing the input waveform and input SCR in accordance with their procedures.

5.2.6 Input Waveform Test

Testing the current waveform on the input of the drive can assist in troubleshooting mains phase loss conditions or suspected problems with the SCR/Diode modules. Phase loss caused by the AC supply can be easily detected. In addition, the rectifier section is controlled by SCR/Diode modules. Should one of the SCR/Diode modules become defective or the gate signal to the SCR lost, the drive will respond the same as loss of one of the phases.

The following measurements require an oscilloscope with voltage and current probes.

Under normal operating conditions, the waveform of a single phase of input AC voltage to the drive appears as in Figure 5-9.

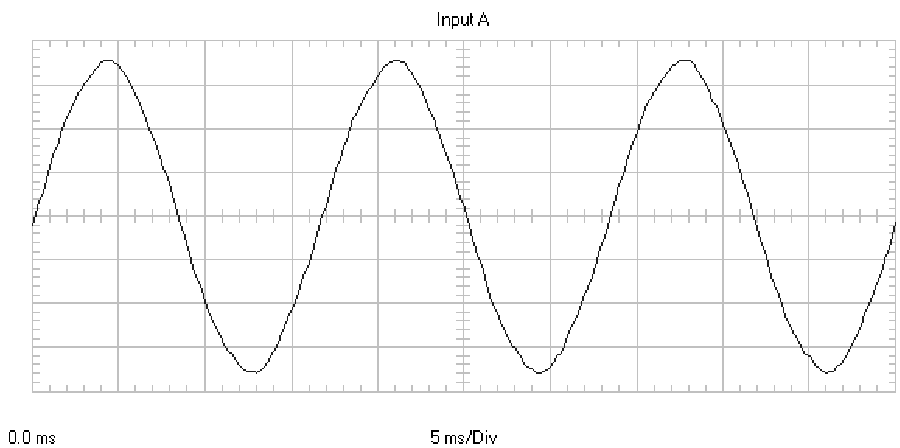


Figure 5-9. Normal AC Input Voltage Waveform

The waveform shown in Figure 5-10 represents the input current waveform for the same phase as Figure 5-9 while the drive is running at 40% load. The two positive and two negative jumps are typical of any 6 diode bridge. It is the same for drives with SCR/Diode modules.

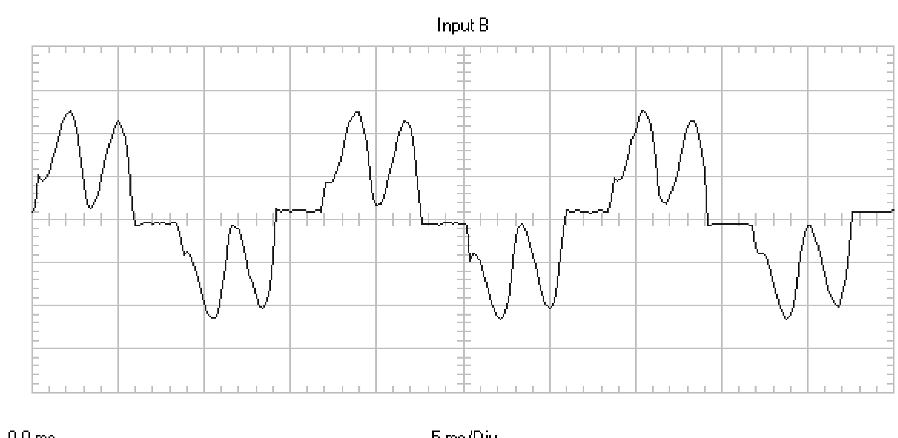


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Figure 5-10. AC Input Current Waveform with Diode Bridge

With a phase loss, the current waveform of the remaining phases would take on the appearance shown in Figure 5-11.

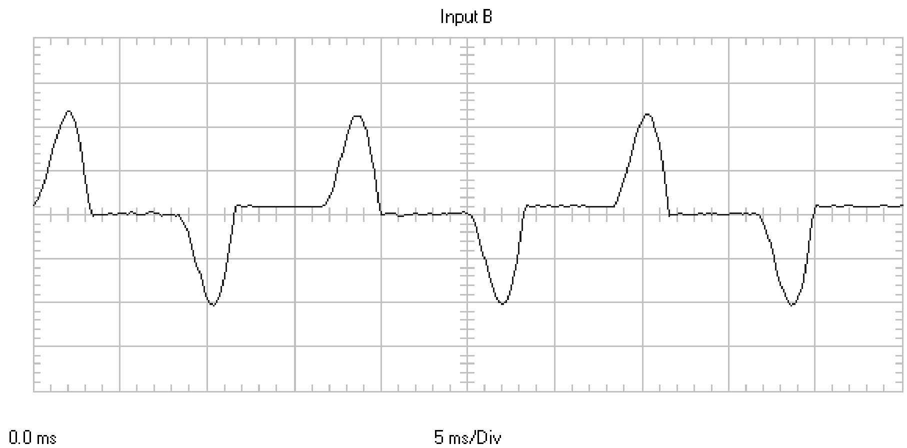

Figure 5-11. Input Current Waveform with Phase Loss

Always verify the condition of the input voltage waveform before forming a conclusion. The current waveform will follow the voltage waveform. If the voltage waveform is incorrect proceed to investigate the reason for the AC supply problem. If the voltage waveform on all three phases is correct but the current waveform is not then the input rectifier circuit in the drive is suspect. Perform the static soft charge and rectifier tests and also the dynamic SCR/Diode module test.

5.2.7 Input SCR Test

The SCR can be disabled by the drive for various reasons. Check the following before making more complicated tests.

The SCRs can be disabled as a result of an input, or lack of input, at power card connector FK102, the external brake temperature switch. Unless used as an input, a jumper must be placed between terminals 104 and 106 of FK102

The SCRs are gated in sequence with the main supply. Verify that the voltage reference signal is correct as follows.

1. Using a volt meter, measure phase to phase AC line voltage at Terminals R, S, and T of power card connector MK106.

2. Measurements should correspond with measurements called out in the Input Voltage Test (5.2.1.1).

An incorrect reading at MK106 with a correct input voltage may indicate a problem in the soft charge card or the connecting cable.

If the above tests reveal no abnormalities, it is further possible that the inrush signal has not been enabled by the control card. Using the signal test card, verify the inrush signal is present and the SCR disable signal is at the correct voltage level as follows.

3. Insert signal test board into interface card connector MK104.

4. Check SCR disable signal.

5. Using a volt meter, connect negative (-) meter lead to terminal 4 (common) of test board.

6. Connect positive (+) meter lead to terminal 19 of signal board.

A reading of 0 VDC indicates the SCRs have been disabled. A reading of 0.6 to 0.8 VDC indicates the SCRs are active and should be gated.

With a reading of 0 VDC and proper line power applied to the drive, it would be likely that the input at power card terminal FK102 has caused the SCRs to be disabled. Given the connection at FK102 has been verified the control card would be suspect. Check the inrush signal as follows.

7. Connect positive (+) meter lead to terminal 7 of signal board.

A reading of 0 VDC indicates the inrush signal is active and the SCRs are being gated. A reading of 5 VDC indicates the inrush signal is inactive and the SCRs are not gated.

With a reading of 5 VDC and proper line power applied to the drive, it would be likely that the control card is defective.

The inrush signal is also deactivated by the control card anytime an over temperature condition exists but that should be indicated by an Alarm 29 and a different group of troubleshooting procedures would be in order.

If the control card is suspect, replace it in accordance with the disassembly procedures in Section 6 or 7.

Should the above tests check correctly, proceed to testing the SCR gate signals.

To view the gate signals an oscilloscope and a current probe are required.

8. Run drive while under some degree of load. At least a 30% load may be required to consistently see gate signals produced since SCRs are only gated when DC bus falls below peak of line.

9. Connect current probe, in turn, to each (+) positive SCR gate wire (white leads) marked R, S, and T at power card connector MK100.

The waveform should appear as in Figure 5-12.

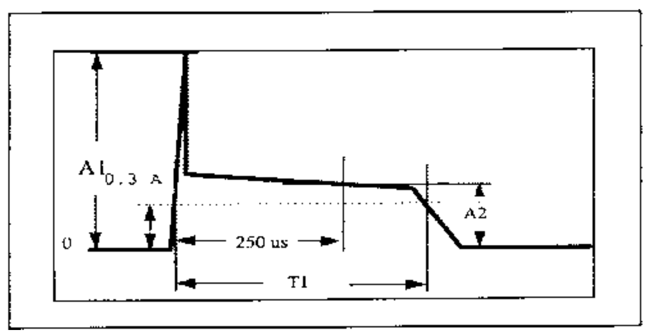

Figure 5-12. SCR Gate Signal

The current pulse should have a waveform as shown.

A1 > 1.1 A

A2 > 0.40 A

T1> 300 µs

Given all the other tests above were successful, a missing gate signal indicates the power card is defective. Replace the power card in accordance with the disassembly procedures in Section 6 or 7.

A distorted signal may be due to a defective gate on that particular SCR that is loading down the supply. Replace the SCR module which corresponds to the incorrect gate signal reading.

5.2.8 Output Phase Imbalance Test

Checking the balance of the drive output voltage and current measures the electrical functioning between the drive and the motor. In testing the phase-to-phase output, both voltage and current are monitored. It is recommended that static tests on the inverter section of the drive be conducted prior to this procedure.

If the voltage is balanced but the current is not, this indicates the motor is drawing an uneven load. This could be the result of a defective motor, a poor connection in the wiring between the drive and the motor, or, if applicable, a defective motor overload.

If the output current is unbalanced as well as the voltage, the drive is not gating the output properly. This could be the result of a defective power card, gate drive, connections between the gate drive card and IGBTs, or the output circuitry of the drive improperly connected.

NOTE

Use an analog volt meter for monitoring output voltage. Digital volt meters are sensitive to waveform and switching frequencies and commonly return erroneous readings.

The initial test can be made with the motor connected and running its load. If suspect readings are recorded then the motor leads may have to be disconnected to further isolate the problem.

1. Using a volt meter, measure AC output voltage at drive motor terminals 96 (U), 97 (V), and 98 (W). Measure phase to phase checking U to V, then U to W, and then V to W.

All three readings should be within 8 VAC of each other. The actual value of the voltage depends on the speed the drive is running at. The volts/hertz ratio is relatively linear (except in VT mode) so at 60Hz the voltage should be approximately equal to the line voltage applied. At 30 Hz it is about half of that and so on for any other speed selected. The exact voltage reading is less important than balance between phases.

2. Next monitor three output phases at drive motor terminals 96 (U), 97 (V), and 98 (W) with clamp on ammeter. Analog device is preferred. To achieve accurate reading, run drive above 40Hz (as this is normally the frequency limitation of such meters.)

The output current should be balanced from phase to phase and no phase should be more than 2 to 3% different from another. If the above tests are successful, the drive is operating normally.

3. If a greater imbalance exists than described above, disconnect motor leads and repeat voltage balance test.

Since the current will follow the voltage, it is necessary to isolate between a load problem and a drive problem. Should a voltage imbalance in the output be detected with the motor disconnected, it is necessary to test the gate drive circuits for proper firing. Proceed to the gate drive signals test (5.2.9).

If the voltage was balanced but the current imbalanced when the motor was connected, then the load is suspect. There could be a faulty connection between the drive and motor or a defect in the motor itself. Look for bad connections at any junctions of the output wires including connections made to contactors and over loads. Also, check for burned or open contacts in such devices.

5.2.9 IGBT Gate Drive Signals Test

This procedure tests the gate drive signals at the output of the gate driver card just prior to them being delivered to the IGBT's.

A simple test to check for the presence of the gate signals can be performed with a DVM, however to actually check the waveforms an oscilloscope is required.

⚠CAUTION

Disable DC bus when performing this test with Test Cable p/n 176F8437. Failure to do so could result in damage to drive if probe is inadvertently connected to wrong pins. Additionally, AC mains bus bars are in close proximity to these test points. Exercise caution when working close to high voltage components.

Prior to beginning the tests, ensure that power is removed from the unit and that the DC Bus capacitors have been discharged.

Check for the presence of DC bus voltage by measuring power card connector MK105 (A) with respect to MK105 (B). The voltage should be zero (0) before proceeding.

1. For D-frame size units, follow procedure in Section 6 for soft charge card removal and disengage soft charge card far enough to disconnect cable plugged into MK3.
2. Disconnect cable from MK3 connector on soft charge card and connect one end of test cable into MK3.
3. For D-frame size units, reinstall soft charge card.
4. Disconnect connectors MK100 and MK105 on power card.
5. Connect free end of Test Cable into MK105.
6. Connect SCR gate shorting plug (included with test cable 176F8437) into cable that was removed from MK100.

Located on the gate drive card near each gate signal lead is a 3 pin test connector. These are labeled MK250, MK350, MK450, MK550, MK650, MK750, and, if the drive is equipped with a brake option, MK850.

For the sake of clarity, refer to the 3 pins as one, two, and three, reading left to right. Pins 1 and 2 of each connector are in parallel with the gate drive signal sent to the IGBTs. Pin 1 is the signal and pin 2 is common.

7. Reconnect AC power to drive.
8. In stop mode, apply power to drive.
9. Measure pins 1 and 2 of each test connector. Each reading should be approximately –9 VDC, indicating all IGBTs are tuned off.
10. Apply run command to drive and 30 Hz reference.

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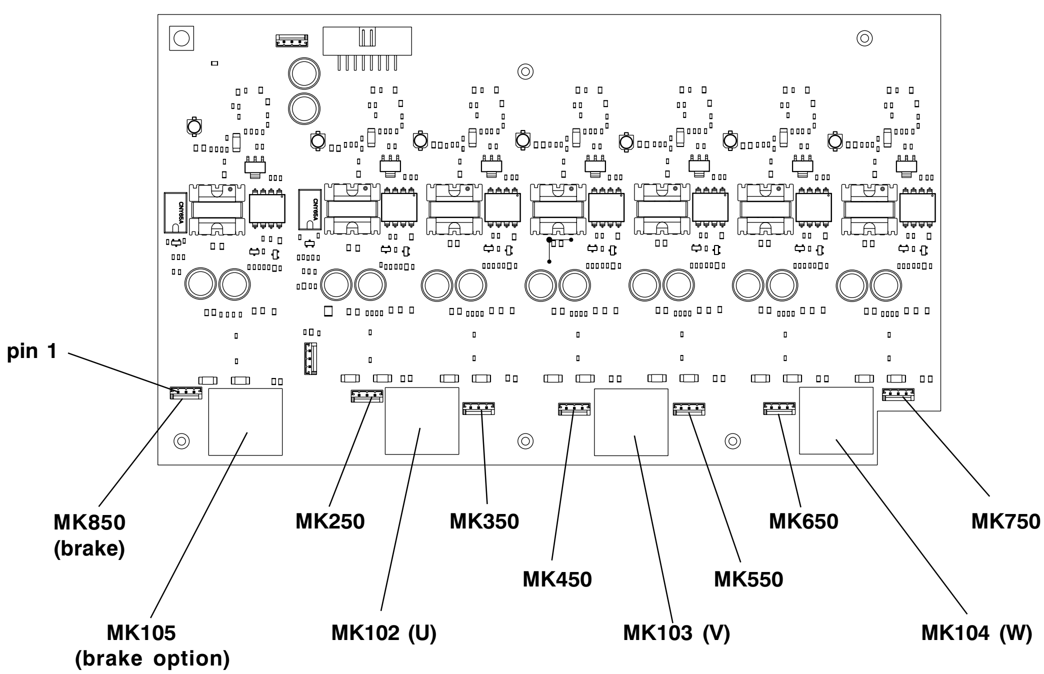
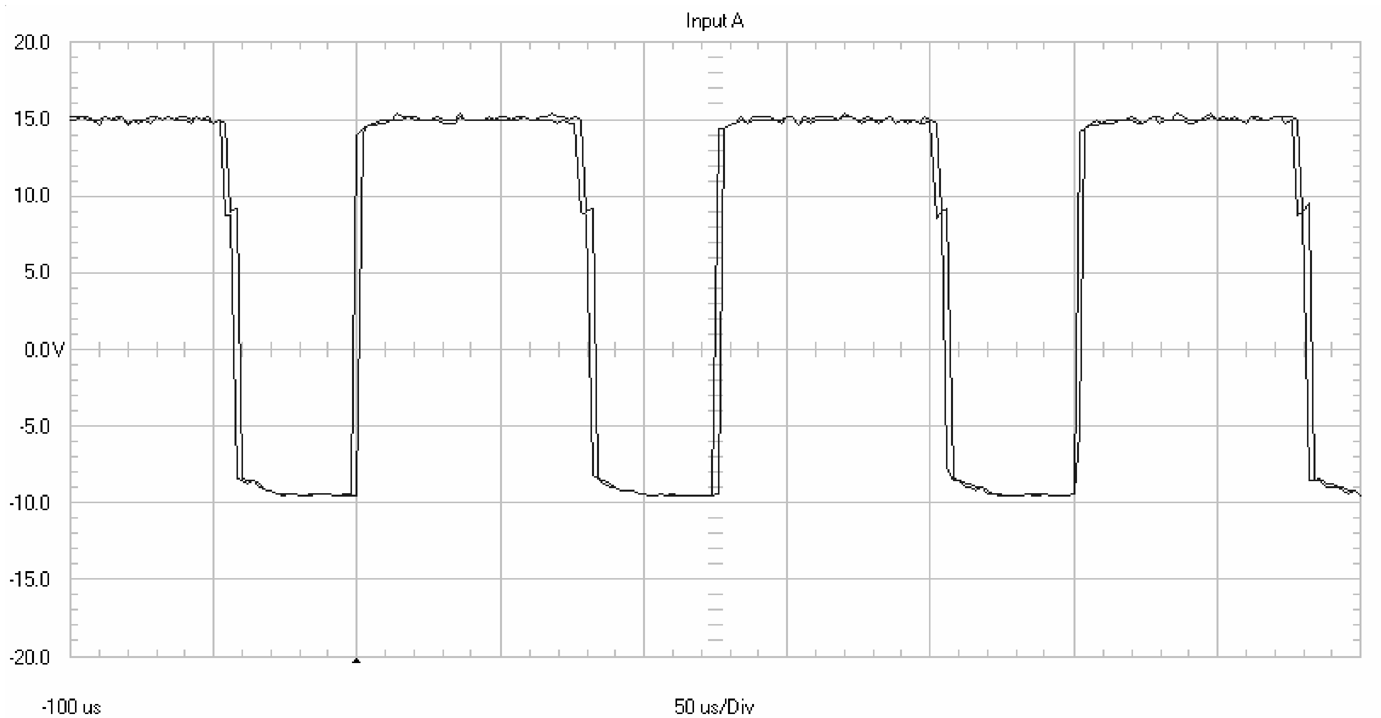


Figure 5-13. Gate Drive Card Test Connectors

11. If using a DVM, measure pins 1 and 2 of each connector. Waveform to IGBTs is a square wave that goes positive to 14 VDC and negative to -9 VDC. Average voltage read by DVM should be 2.2 to 2.5 VDC.

When using an oscilloscope, the readings should appear as in Figure 5-14.



IGBT Gate Signal measured on the Gate Drive Card: 5 volts per division vertical scale, 50 microseconds per division time scale. Unit running at 30 Hz.

Figure 5-14. Gate Signal Waveform from Gate Drive Card

An incorrect reading of a gate signal indicates the gate drive card is defective or the signal has been lost prior to it arriving at the gate card. The gate signals can then be checked with the signal test board to verify their presence from the control card to the power card as follows.

12. Insert signal test board into interface card connector MK104.

13. With scope probe ground connected to terminal 4 (common) of signal board, measure six gate signals at signal board terminals 25 through 30.

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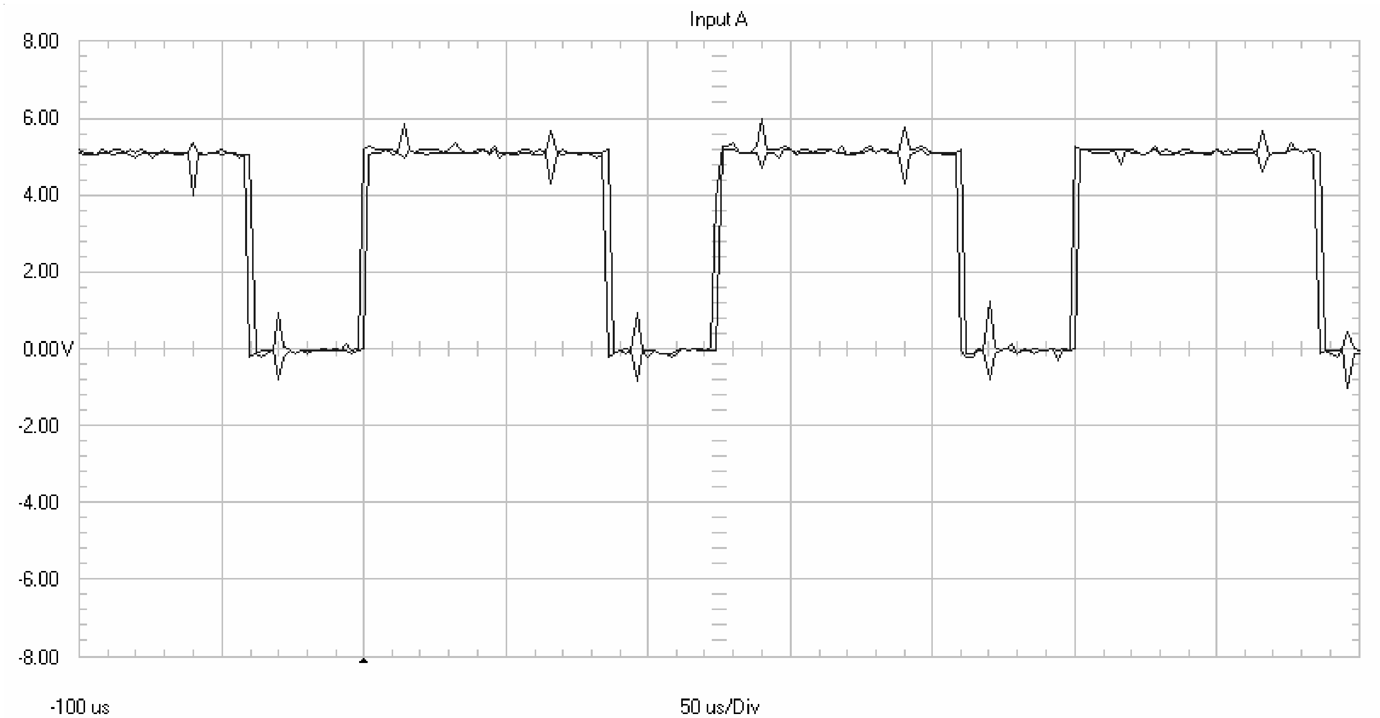
14. Place drive in run at 30 Hz.

The waveform should appear as in Figure 5-15.



IGBT Gate Signal measured with the Signal Test Board: 2 volts per division vertical scale, 50 microseconds per division time scale. Unit running at 30 Hertz

Figure 5-15. Gate Signal Waveform from Signal Test Board

15. Using a DVM, again check these same signal board terminals. DVM should read 2.2 to 2.5 VDC.

An incorrect reading of a gate signal indicates either the power card is defective or the signal has been lost prior to arriving at the power card. There is no test to verify the signals directly out of the control card. The power card would be suspected if a single gate signal is incorrect. The control card would be suspect if all six signals are incorrect. Replace the corresponding card in accordance with the disassembly procedures in Section 6 or 7.

5.2.10 IGBT Switching Test

Using the test cable 176F8439 while the drive is powered and the DC bus is disabled, a simple test can be made to determine if the IGBTs are actually turning on.

Before proceeding, verify that the DC bus is in fact disabled.

1. Disconnect cable from connector MK105 on power card. With a volt meter, measure between white lead of cable disconnected from MK105 and output terminals U, V, and W in turn. Switch between AC and DC scales. Voltage should read nearly zero.

2. Measure between black lead of same cable and the output terminals U, V, and W in turn. Voltage should read nearly zero.

With DC bus disabled, proceed using a DVM set on diode scale.

1. With drive in a stop mode, connect positive (+) meter lead to black lead of MK105 cable disconnected from power card.

2. In turn connect negative (-) meter lead to drive output terminals U, V, and W. Meter should indicate a diode drop.

3. Leaving positive meter lead connected to cable MK105, run drive at 30 Hz.

4. In turn, again connect negative (-) meter lead to drive output terminals U, V, and W. Meter should indicate effectively a short circuit or around a 0.035 diode drop which indicates lower IGBTs are turned on and shorting meter to negative bus.

NOTE

Some voltage leakage within unit may cause meter to indicate a small negative voltage drop.

5. Repeat test for positive (+) or upper IGBTs.

6. With drive in a stop mode, connect negative (-) meter lead to white lead of MK105 cable disconnected from power card.

7. In turn, connect positive (+) meter lead to drive output terminals U, V, and W. Meter should indicate a diode drop.

8. Leaving negative meter lead connected to cable MK105, run drive at 30 Hz.

9. In turn, again connect positive (+) meter lead to drive output terminals U, V, and W. Meter should indicate effectively a short circuit or around a 0.035 diode drop which indicates upper IGBTs are turned on and shorting meter to positive bus.

NOTE

Some voltage leakage within unit may cause meter to indicate a small negative voltage drop.

Incorrect Reading

An incorrect reading indicates some of the IGBTs are not turning on. Replace the IGBT module in accordance with the disassembly instructions in Section 6 or 7.

5.2.11 Brake IGBT Test

Use the signal test board to test the operation of the dynamic brake IGBT and gate drive circuitry. The following procedure can be used to force the brake circuit to activate for testing.

1. Connect signal test board to connector MK104 on control card.

2. Set voltage test switch labeled Over V to ON position.

3. Turn potentiometer on test board until brake circuit activates. This causes brake IGBT to turn on and off at approximately 1.2 KHz. Duty cycle (pulse width) increases as potentiometer is increased.

4. Measure with oscilloscope or DVM at terminal 13. Terminal 13 represents gate signal to brake IGBT. This should be 4.04 VDC when brake is OFF and drop to zero when brake is ON.

5. Measure with oscilloscope or DVM at terminal 14. Terminal 14 is a logic level (5V) signal representing voltage across brake IGBT. This should measure 5.1 VDC when brake is OFF and drop to zero when brake is ON.

Incorrect Reading

If the signal on terminal 13 is not correct, first check that the drive is correctly programmed for dynamic braking (parameters 400 - 404). If the programming is correct, replace the control card in accordance with procedures in Section 6 or 7.

If the signal on terminal 13 is correct but the signal on terminal 14 is not, the brake IGBT gate signal must be checked to determine whether the fault lies in the IGBT or the gate driver card. See Gate Drive Signal Tests (5.2.9).

5.2.12 Current Sensors Test

The current sensors are Hall effect devices that send a signal proportional to the actual output current waveform to the power card. The current scaling card, attached to the power card, scales the signals from the current sensors to the proper level for monitoring and processing motor control data. A defective current sensor can cause erroneous ground faults and over current trips. In such instances, the fault will usually only occur at higher loads. If the incorrect current scaling card is installed, the current signals will be improperly scaled. This could cause erroneous over current trips. If the current scaling card is not installed, the drive will trip.

A couple of simple checks can be made to determine the status of the sensors.

1. Apply power to drive.

2. Ensure that motor check, pre-magnetizing, DC hold, DC brake, or other parameter setups are disabled that create a holding torque while at zero speed. Current displayed will exceed 1 to 2 amps if such parameters are not disabled.

3. Run drive with a zero speed reference. Note output current reading in display. Display should indicate approximately 1 to 2 amps.

If the current is greater than 1 to 2 amps and a current producing parameter is not active, the test will need to be made again with the motor leads disconnected.

4. Remove power from drive. Monitor DC bus voltage at power card connector MK105 (A) and (B) to ensure bus is fully discharged.

5. Remove output motor leads from terminals U, V, and W.

6. Apply power to drive.

7. Run drive with a zero speed reference. Note output current reading in display. Display should indicate less than 1 amp.

If an incorrect reading was obtained from the above tests, further tests of the current feedback signals are required using the signal test board.

Testing current feedback with the signal test board.

8. Remove power to drive. Ensure DC bus is fully discharged.

9. Install signal test board into interface card connector MK104.

10. Using a DVM, measure resistance between terminals 1 and 4, 2 and 4, and 3 and 4 of signal test board. Resistance should be the same for all three readings. Table 5-2 shows approximate resistance readings based on drive power and voltage rating. Note that values listed are values at the current scaling card. When measuring with signal test board, actual reading may be higher due to meter lead resistance. Absence of resistance indicates a missing scaling card.

11. Reapply power to drive.

12. Using a DVM, connect negative (-) meter lead to terminal 4 (common) of signal test board.

13. Run drive with a zero speed reference.

14. In turn measure AC voltage at terminals 1, 2, and 3 of signal test board. These terminals correspond with current sensor outputs U, V, and W, respectively. Expect a reading near zero volts but no greater than 15mv.

If the control card parameters are setup to provide holding torque while at zero speed, the current displayed will be greater than expected. To make this test disable such parameters.

The current sensor feedback signal at this point in the circuit will read approximately 400mv at 100% drive load so any reading above 15mv while the drive is at zero speed has a negative effect on the way the drive interprets the feedback signal.

A reading of greater than 15mv suggests that the corresponding current sensor be replaced. See the disassembly instructions in Section 6 or 7.

Table 5-2. Scaling Card Resistance Values

Voltage (VAC)	Drive Model Number	Resistance (Ohms)
380-500	5122, 4152, 6152, 8152	4.5
380-500	5152, 4202, 6172, 8202	3.8
380-500	5202, 4252, 6222, 8252	3.1
380-500	5252, 4302, 6272, 8302	2.6
380-500	5302, 4352, 6352, 8352	5.1
380-500	5352, 4452, 6402, 8452	4.2
380-500	5452, 4502, 6502, 8502	2.6
380-500	5502, 4602, 6552, 8602	2.6
380-500	5552, 4652, 6602, 8652	2.6
525-600/690	5042, 8052	5.9
525-600/690	5052, 8062	5.9
525-600/690	5062, 8072	5.9
525-600/690	5072, 4102, 6102, 8102	5.9
525-600/690	5102, 4122, 6122, 8122	5.9
525-600/690	5122, 4152, 6152, 8152	5.9
525-600/690	5152, 4202, 6172, 8202	4.5
525-600/690	5202, 4252, 6222, 8252	3.1
525-600/690	5252, 4302, 6272, 8302	3.1
525-600/690	5302, 4352, 6352, 8352	2.6
525-600/690	5352, 4402, 6402, 8402	5.1
525-600/690	5402, 4502, 6502, 8502	4.5
525-600/690	5502, 4602, 6602, 8602	3.8
525-600/690	5602, 4652, 6652, 8652	2.6

5.2.13 Fan Tests

The fan control circuit is made up of the fan transformer and the control circuitry located on the power card along with control signals for ON, OFF, and speed control from the control card. Since the fans do not necessarily run at all times, see the description of cooling fans operation under sequence of operation in Section 2.

5.2.13.1 Supply Voltage

Supply voltage for the fans is from the soft charge card to power card connector MK106. First verify the supply voltage is present as follows.

1. With a voltmeter, measure AC phase to phase voltage at R, S, and T of power card connector MK106. It should equal main supply voltage applied to drive.

2. If voltage is not present, ensure proper line voltage is applied to drive. Conduct Input Voltage test (5.2.1.1).

3. If line voltage is present at input of drive but not at MK106 of power card, conduct static test of soft charge fuses (5.1.1).

4. If voltage is present at MK106, check voltage at fan transformer read from connector CN2 located near transformer. With a volt meter, read AC voltage at CN2 pins 1 and 3. Voltage should correspond to main AC line voltage applied to drive.

5. If voltage is not present, ensure jumpers are in place at power card connector FK103. Otherwise connect an external source of power to terminal FK103 for fan supply voltage.

If the jumpers are in place or an auxiliary supply is connected and powered but no voltage is present at the fan transformer connector CN2, the power card is likely defective. Replace the power card in accordance with the disassembly instructions in Section 6 or 7.

5.2.13.2 Transformer Output

If the appropriate voltage is present at CN2 pins 1 and 3, next check the output of the transformer. Prior to making this test, ensure the fan transformer fuse is good.

1. With a volt meter, measure AC voltage from CN2 terminal 1 to terminal 2. Voltage should equal 66% of main AC supply voltage (48% for drives 525-600/690 VAC) applied to drive (or that of auxiliary supply). If voltage is incorrect, replace fan transformer.

2. If voltage is correct, check fan voltage being supplied to fans themselves. Voltage can be read at power card connector MK107 pins 8 and 11 with respect to pin 1. Voltage at pins 8 and 11 correspond to fan's commanded speed: 200 VAC for low speed and 230 VAC for high speed.

If the correct voltage is available but the fan is not running, that fan is defective. If no voltage is available, verify that the fans should be running. If so, the power card is defective. Replace the fan or power card in accordance with the disassembly instructions in Section 6 or 7.

5.2.13.3 Fan Control Circuit

To verify that the fan control circuit is receiving appropriate commands from the control card, the signal test board can be used to verify those signals.

1. Remove power from drive and allow DC bus to fully discharge.

2. Install signal test board into interface connector MK104.

3. Reapply power to drive.

4. Connect negative (-) meter lead of a voltmeter to signal board terminal 4 (common).

5. With positive (+) meter lead check signal at terminal 6 of signal board. Meter should read zero (0) volts with fans commanded to run, 5 VDC if control card commands fans off.

6. Verify cooling fans sequence of operation to ensure they should be running. In addition, signal board contains a fan test switch. When switched on fans should start and run at high speed.

The signals at terminals 5 and 10 of the signal board determine fan speed. See Section 8 for more on those signals. In addition, if a heat sink overtemperature trip has occurred, the fans will automatically be switched to high speed.

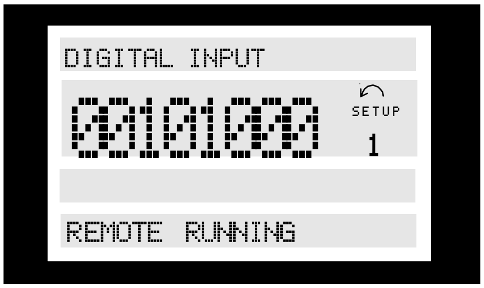
Given the fact that the fans should be running, if the signal at terminal 6 is correct and the fan test switch activates the fan, the control card is defective. Otherwise the power card is defective. Replace the appropriate assembly in accordance with the disassembly instructions in Section 6 or 7.

5.2.14 Input Terminal Signal Tests

The presence of signals on either the digital or analog input terminals of the drive can be verified on the drive display. Digital or analog input status can be selected in the display using the [DISPLAY MODE] key and the [+] and [-] keys on the keypad.

5.2.14.1 Digital inputs

With digital inputs displayed, control terminals 16-33 are shown left to right, with a 1 indicating the presence of a signal.



If the desired signal is not present in the display, the problem may be either in the external control wiring to the drive or a faulty control card. To determine the fault location, use a volt meter to test for voltage at the control terminals.

Verify the control voltage power supply is correct as follows.

1. With a voltmeter measure voltage at control card terminal 12 and 13 with respect to terminal 20. Meter should read between 21 and 27 VDC.

If the 24 V supply voltage is not present, conduct the Control Card Test (5.2.15) earlier in this section.

If the 24 V is present proceed with checking the individual inputs as follows.

2. Connect (-) negative meter lead to reference terminal 20.

3. Connect (+) positive meter lead to terminals 16, 17, 18, 19, 27, 29, 32, and 33 in turn.

Presence of a signal at the desired terminal should correspond to the digital input display reading. A reading of 24 VDC indicates the presence of a signal. A reading of 0 VDC indicates no signal is present.

5.2.14.2 Analog inputs

The value of signals on analog input terminals 53, 54, and 60 can also be displayed.

The voltage on terminals 53 and 54, or the current in milliamps for terminal 60 is shown in line 2 of the display.

If the desired signal is not present in the display, the problem may be either in the external control wiring to the drive or a faulty control card. To determine the fault location, use a volt meter to test for a signal at the control terminals.

Verify the reference voltage power supply is correct as follows.

1. With a voltmeter measure voltage at control card terminal 50 with respect to terminal 55. Meter should read between 9.2 and 11.2 VDC.

If the 10 V supply voltage is not present, conduct the Control Card Voltage Test earlier in this section.

If the 10 volts is present proceed with checking the individual inputs as follows.

2. Connect (-) negative meter lead to reference terminal 55.

3. Connect (+) positive meter lead to desired terminal 53, 54 or 60.

For analog input terminals 53 and 54, a DC voltage between 0 and +10 VDC should be read to match the analog signal being sent to the drive.

For analog input terminal 60, a reading of 0.9 to 4.8 VDC corresponds to a 4 to 20ma signal.

Note that a (-) minus sign preceding any reading above indicates a reversed polarity. In this case, reverse the wiring to the analog terminals.

5.2.15 Control Card Test

The control card tests checks the operation of the analog and digital inputs, the analog/digital relay outputs and the +10 V control voltage.

1. Cycle power to drive.
2. Access parameter 620, *Operating Mode*, and select control card test.
3. Remove power to drive.
4. Wire control terminals as shown in Figure 5-13.
5. Reapply power to drive.
6. Press OK key on drive keypad.
7. Control card test will be carried out automatically. Display will indicate a pass or fail mode. If a failure is indicated, replace control card in accordance with procedures in Section 6.
8. If tests pass successfully, press OK key and parameter 620 automatically returns to normal operation.

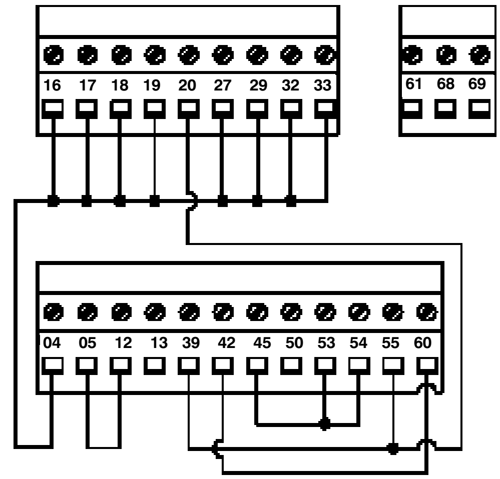


Figure 5-16. Control Card Test Connections

5.3 INITIAL START UP OR AFTER REPAIR DRIVE TESTS

Following any repair to a drive or testing of a drive suspected of being faulty, the following procedure must be followed to ensure that all circuitry in the drive is functioning properly before putting the unit into operation.

1. Perform visual inspection procedures as described in Table 3-1.

2. Perform static test procedures 5.1.1., 5.1.2 and 5.1.5 for D-frame size units or 5.1.3, 5.1.4 and 5.1.5 for E-frame size units to ensure drive is safe to start.

3. Disconnect motor leads from output terminals (U, V, W) of drive.

4. Apply AC power to drive.

5. Give drive a run command and slowly increase reference (speed command) to approximately 40 Hz.

6. Using an analog volt meter or a DVM capable of measuring true RMS, measure phase-to-phase output voltage on all three phases: U to V, U to W, V to W. All voltages must be balanced within 8 volts. If unbalanced voltage is measured, refer to Input Voltage Test (5.2.1.1).

7. Stop drive and remove input power. *Allow 40 minutes for DC capacitors to fully discharge for E-frame size drives or 20 minutes for D-frame size drives.*

8. Reconnect motor leads to drive output terminals (U, V, W).

9. Reapply power and restart drive. Adjust motor speed to a nominal level.

10. Using a clamp-on style ammeter, measure output current on each output phase. All currents should be balanced. If unbalanced current is measured, refer to Current Sensor Test (5.2.12).

SECTION 6
D-FRAME SIZES DISASSEMBLY AND ASSEMBLY INSTRUCTIONS

⚠DANGER

Drives contain dangerous voltages when connected to line voltage. No disassembly should be attempted with power applied. Remove power to drive and wait at least 20 minutes to let drive capacitors fully discharge. Only a competent technician should carry out service.

ELECTROSTATIC DISCHARGE (ESD)

Many electronic components within the adjustable frequency drive are sensitive to static electricity. Voltages so low that they cannot be felt, seen or heard can reduce the life, affect performance, or completely destroy sensitive electronic components.

⚠CAUTION

Use proper electrostatic discharge (ESD) procedures when servicing drive to prevent damage to sensitive components.

NOTE

Frame size is used throughout this manual where ever procedures or components differ between drives based upon the unit's physical size. Refer to tables in the Introduction Section to determine frame size definitions. See Section 7 for E-frame sizes disassembly and assembly instructions.

6.0 INSTRUCTIONS

6.1 Control Card Cassette

1. Remove control wiring by unplugging control terminals (see Figure 6-1).
2. Remove grounding clamps by removing two screws holding each in place. Save screws for reassembly.
3. For NEMA 12 configurations, disconnect cable between LCP and control card.
4. Unplug the two ribbon cables from side of control card.
5. Loosen two captive screws to free cassette (T20 Torx).
6. Slide cassette down and free from mounting tabs.
7. Remove and replace control card in accordance with instructions included with replacement card.

Reinstall in reverse order of this procedure. Ensure that two ribbon cables are not crossed. Tighten control card mounting screws to 8 in-lb (1 Nm).

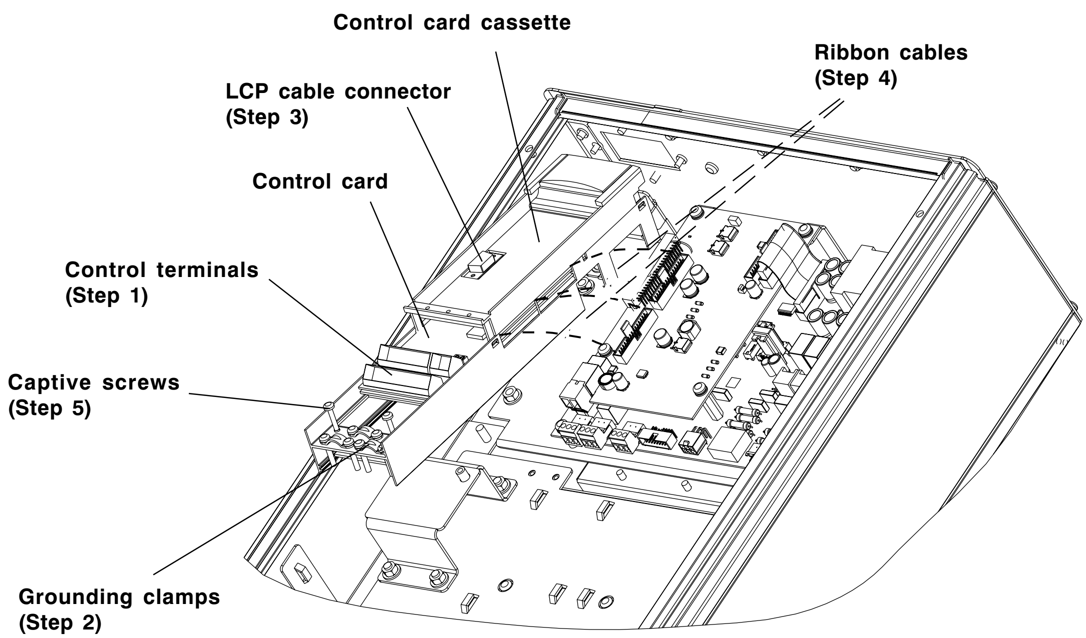


Figure 6-1. Control Card Cassette

6.2 Interface Card

1. Disconnect cables from connectors on interface card MK100, MK102 and MK105. Disconnect cables from connectors MK101 and MK103 only if replacing interface card.

2. Remove interface card by remove 4 mounting screws (T25 Torx) from standoffs.

Reinstall in reverse order of this procedure. Tighten T25 screws and interface card standoffs to 20 in-lbs (2.25 Nm). Card will initialize in service mode. Follow instructions to enter data required.

6.3 Power Card

1. Remove interface card in accordance with procedure.

2. Disconnect cables from connectors on power card MK100, MK102, MK104, MK105, MK106, MK107, MK109, MK110, and FK100.

3. Remove 2 interface card standoffs (8mm).

4. Remove power card by removing 5 mounting screws (T25 Torx) from standoffs.

5. Remove current scaling card from power card by pushing in retaining clips on standoffs. KEEP THIS SCALING CARD TO REINSTALL ON ANY REPLACEMENT POWER CARD. Scaling card controls signals operating with this specific VLT drive. Scaling card is not part of replacement power card.

Reinstall in reverse order of this procedure. Tighten mounting screws and interface card standoffs to 20 in-lbs (2.25 Nm).

6.4 Control Card/Power Card Mounting Plate

1. Remove control card cassette and interface card in accordance with procedures.

2. Remove 4 mounting nuts (10mm).

3. Disconnect all cabling from power card.

4. Remove optional wiring connections, as necessary, to free mounting plate.

5. Lift plate free from chassis.

Reinstall in reverse order of this procedure. Torque T25 mounting screws to 20 in-lbs (2.25 Nm).

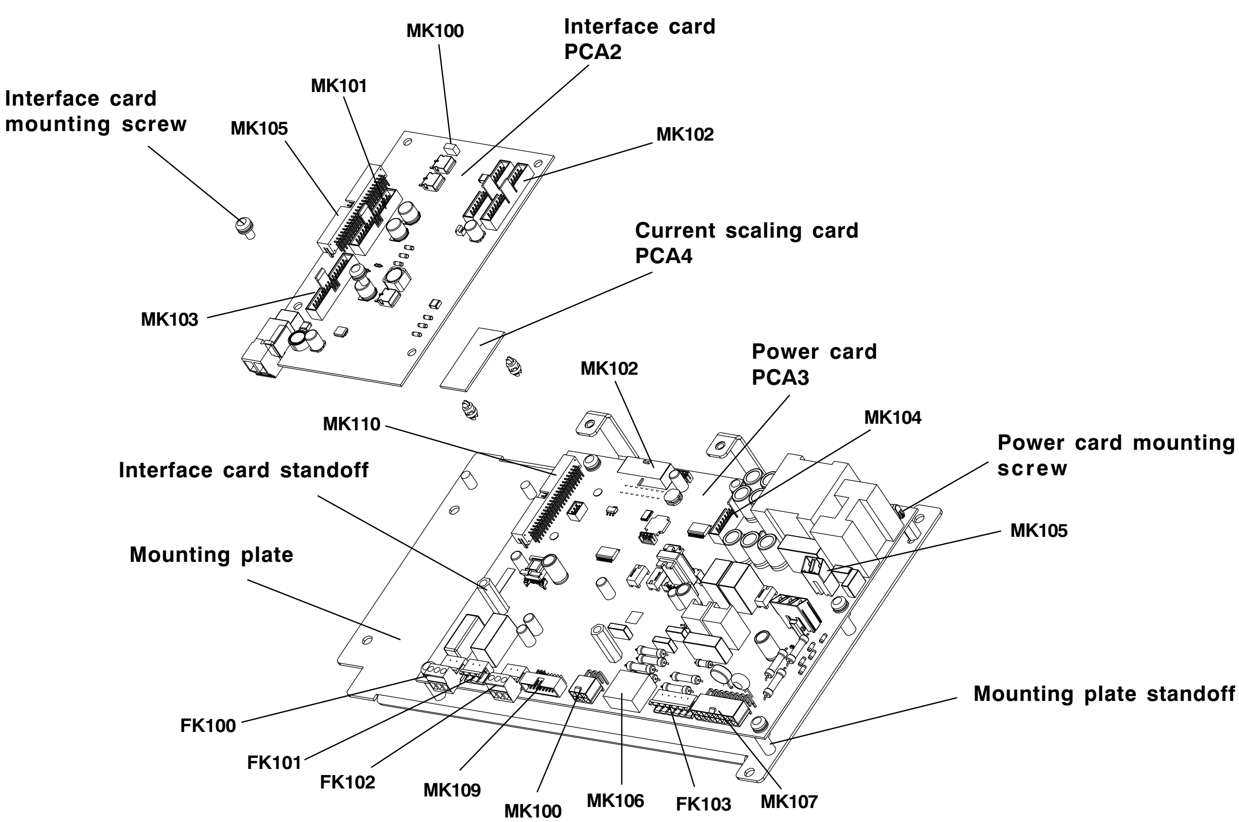


Figure 6-2. Interface Card, Power Card, and Mounting Plate

6.5 Gate Drive Card

1. Disconnect cables from connectors on gate drive card MK102, MK103, MK104, MK106, and, if unit has extended brake option, MK105, and, for 380-500 V units with an RFI filter, MK101.

2. Remove gate driver card by removing 6 mounting screws (T25 Torx) from standoffs.

Reinstall in reverse order of this procedure. Tighten mounting screws to 20 in-lbs (2.25 Nm).

6.6 Soft Charge Card

1. Remove control card/power card mounting plate in accordance with procedure.

2. Remove 2 retaining nuts from soft charge card assembly (10mm).

3. Slide assembly part way out to access cable connectors on card.

4. Disconnect MK1, MK2, MK3, and MK4.

5. Remove soft charge card assembly.

Reinstall by aligning soft charge card with fastening clips on the side of the chassis. Reattach connectors. Slide into place and tighten mounting screws to 35 in-lbs (4 Nm).

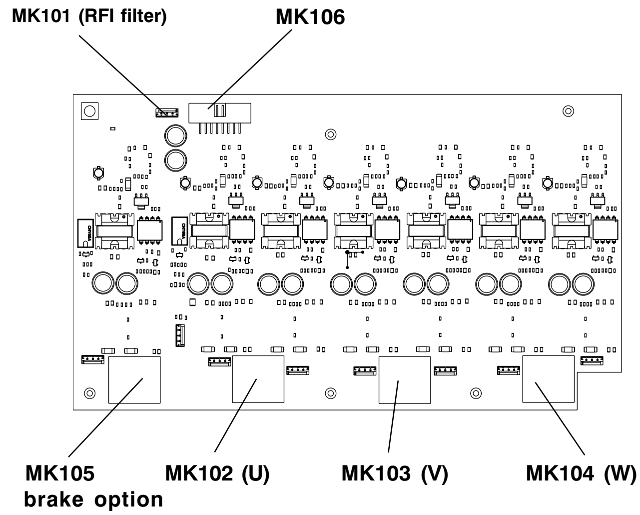


Figure 6-3. Gate Drive Card

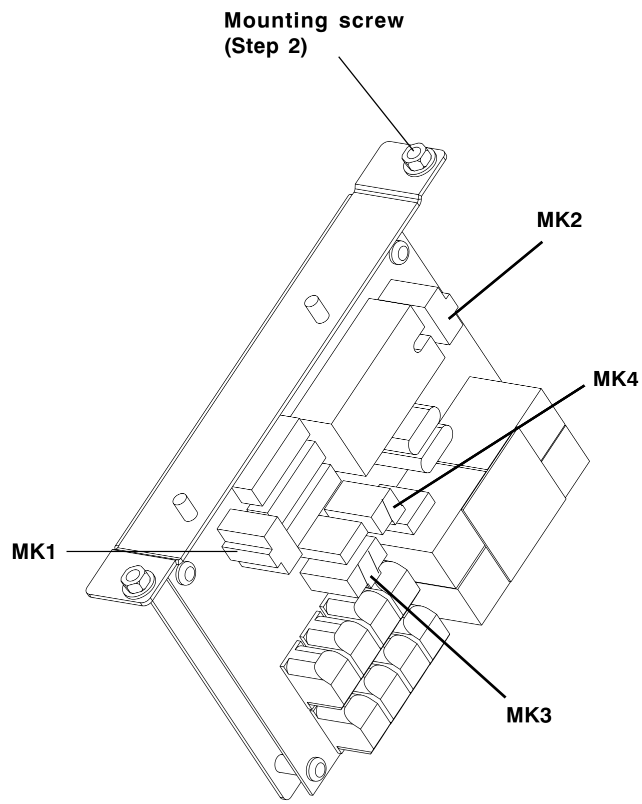


Figure 6-4. Soft Charge Card Assy

6.7 Capacitor Bank(s)

NOTE

D2 size units have 2 capacitor bank assemblies mounted one above the other. Separate disassembly instructions are given for upper and lower capacitor banks. For D1 units with one capacitor bank assembly only, disassemble in accordance with instructions for single capacitor bank units 6.7.3.

6.7.1 Upper Capacitor Bank D2 Units

1. Remove control card cassette in accordance with instructions.
2. Capacitor bank connection to DC bus bars can be seen recessed in the gap between upper and lower cap banks. Remove left most 2 nuts (10mm) from DC bus bars. A minimum 4 in. (100mm) extension is required.
3. Remove 4 retaining nuts (10 mm) from cap bank cover plate and remove cover plate.
4. Note that weight of cap bank is approx. 20 lbs. (9 kg). Remove cap bank by pulling free from mounting studs.

Reinstall in reverse order of this procedure. Tighten mounting screws to 35 in-lbs (4 Nm).

6.7.2 Lower Capacitor Bank D2 Units

1. Capacitor bank connection to DC bus bars can be seen recessed in the gap between upper and lower cap banks. Remove right most 2 cap bank retaining nuts (10mm) from DC bus bars. A minimum 4 in. (100mm) extension is required.
2. Disconnect MK102, MK103, MK104, and MK106 from gate drive card. Also remove MK105, for units with brake, and MK101 for units with RFI filter. Note that IGBT gate drive card can remain attached to cap bank cover plate.
3. Remove 4 retaining nuts (10mm) from cap bank cover plate and remove plate.
4. Note that weight of cap bank is approx. 20 lbs. (9 kg). Remove cap bank by pulling free from mounting studs.

Reinstall in reverse order of this procedure. Tighten mounting screws to 35 in-lbs (4 Nm).

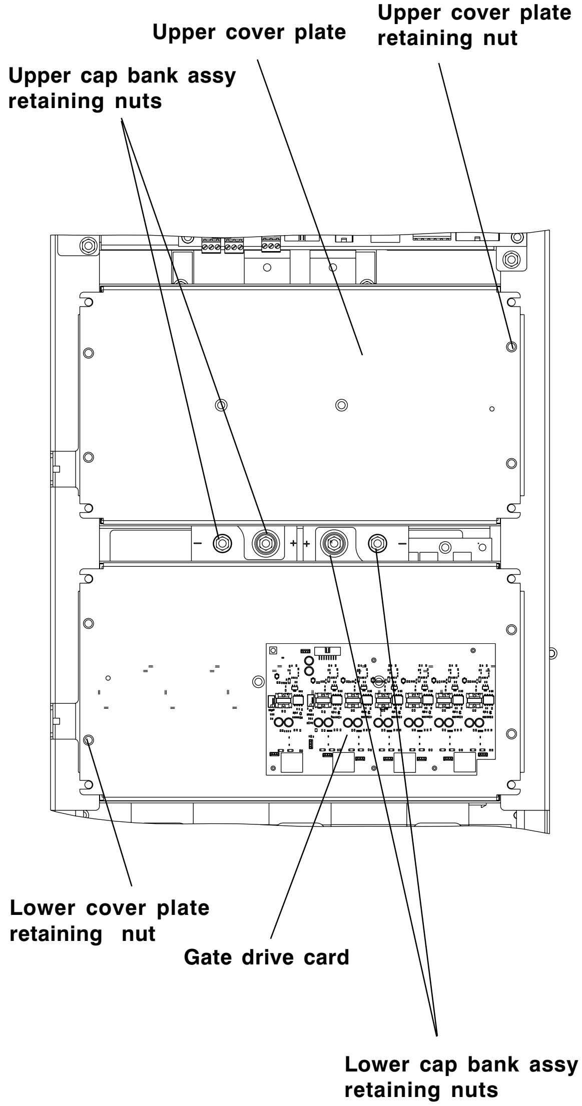


Figure 6-5. D2 Upper and Lower Capacitor Bank Assemblies

6.7.3 Single Capacitor Bank D1 Units

1. Remove control card cassette in accordance with instructions.

2. Remove 2 capacitor bank retaining nuts (10mm) from DC bus bars. A minimum 4 in. (100mm) extension is required.

3. Disconnect MK102, MK103, MK104, and MK106 from gate drive card. Also remove MK105, for units with extended brake, and MK101 for units with RFI filter. Note that IGBT gate drive card can remain attached to cap bank cover plate.

4. Remove 4 retaining nuts (10mm) from cap bank cover plate and remove plate.

5. Note that weight of cap bank is approx. 20 lbs. (9 kg). Remove cap bank by pulling free from mounting studs.

Reinstall in reverse order of this procedure. Tighten mounting screws to 35 in-lbs (4 Nm).

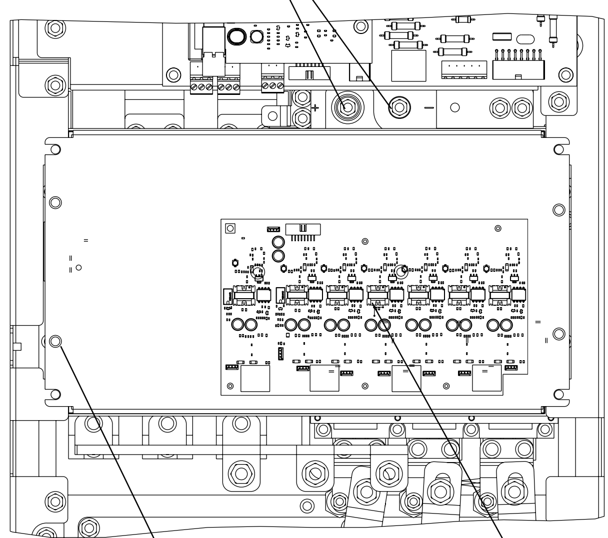


Figure 6-6. D1 Single Capacitor Bank Assembly

6.8 Soft Charge (SC) Resistors D2 Units

1. Remove capacitor bank assembly in accordance with procedure.

NOTE
On D2 units, only upper cap bank assembly is removed.

2. MK4 connector on soft charge card must be disconnected. Disengage soft charge card far enough to access MK4 (see Figure 6-4) in accordance with steps 1-3 in soft charge card disassembly procedure.

3. Note that soft charge resistor is located under bus bars and held in place by 2 retaining nuts. Bus bars do not need to be removed. Loosen right most retaining nut (8mm).

4. Remove left most 8mm retaining nut.

5. Lift left side of SC resistor and remove resistor by sliding to left and out from under bus bars.

Reinstall in reverse order of this procedure. Tighten 8mm mounting nuts to 20 in-lbs (2.25 Nm). Tighten 10mm mounting nuts to 35 in-lbs (4 Nm).

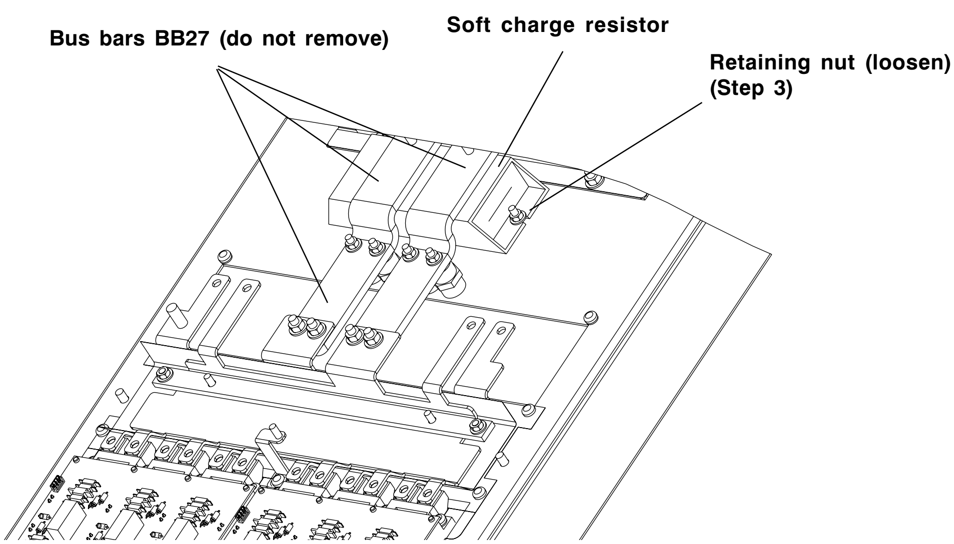


Figure 6-7. D2 Soft Charge Resistor

6.9 Soft Charge (SC) Resistors D1 Units

1. Remove capacitor bank per instruction.

2. Remove input terminal mounting plate per instructions.

3. Note the color coding for each of three wires attached to terminal 1 for each SCR/Diode module. Ensure that correct wire is attached to applicable stud upon reassembling. Remove wiring from studs. Remove retaining screw (T25) from terminal 1 of each of 3 SCR/Diode modules and remove bus bar.

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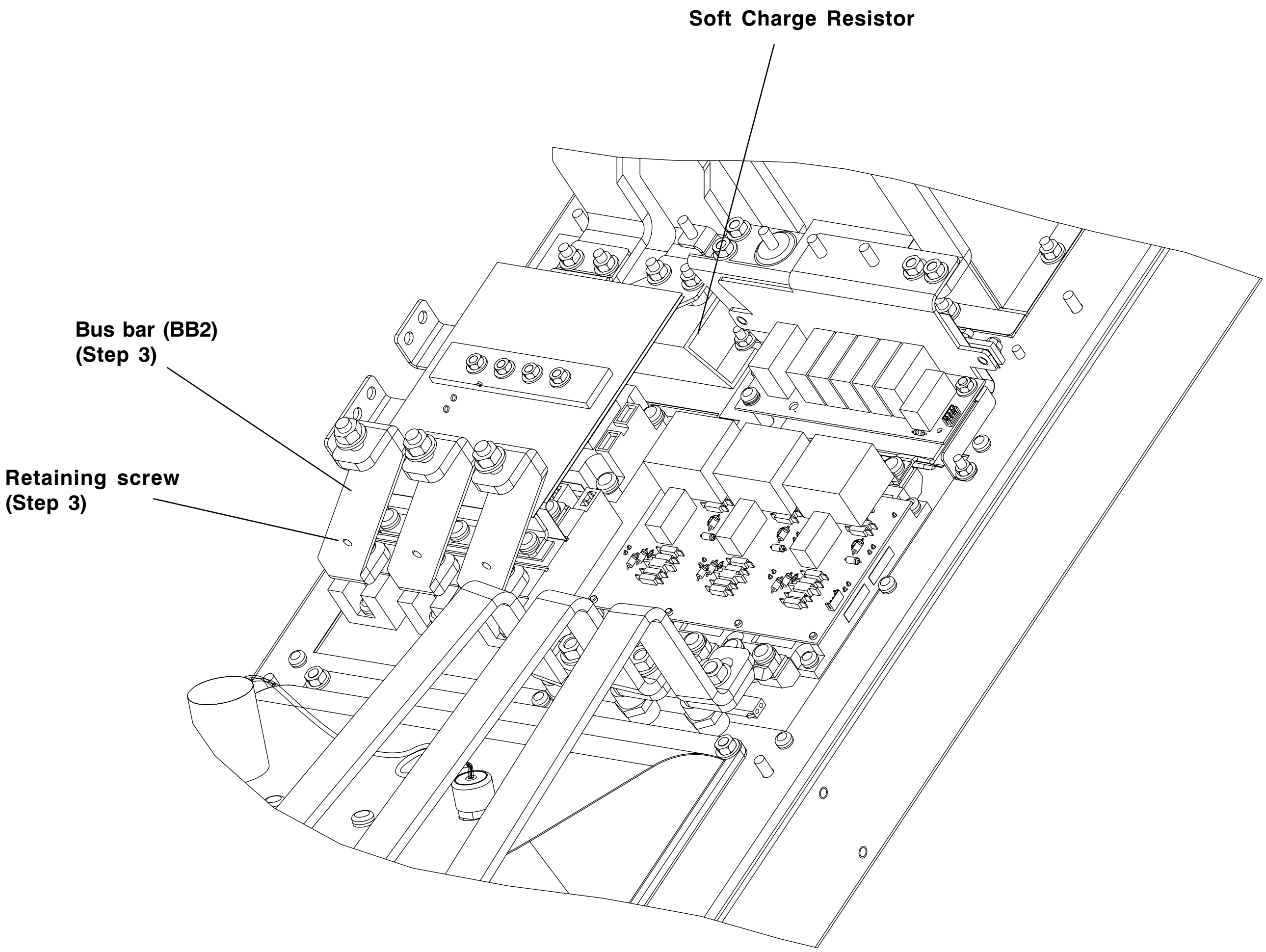

Figure 6-8. D1 Soft Charge Resistor (1 of 3)

4. Remove six retaining screws (T25) from SCR/ Diode modules, terminals 2 and 3 in each module.

5. Remove four (10mm) retaining nuts from DC inductor input bus bars and four retaining nuts (not shown) from side mounted bus bars. (Side mounted bus bars are only present on units with load sharing.) Remove DC input bus assembly.

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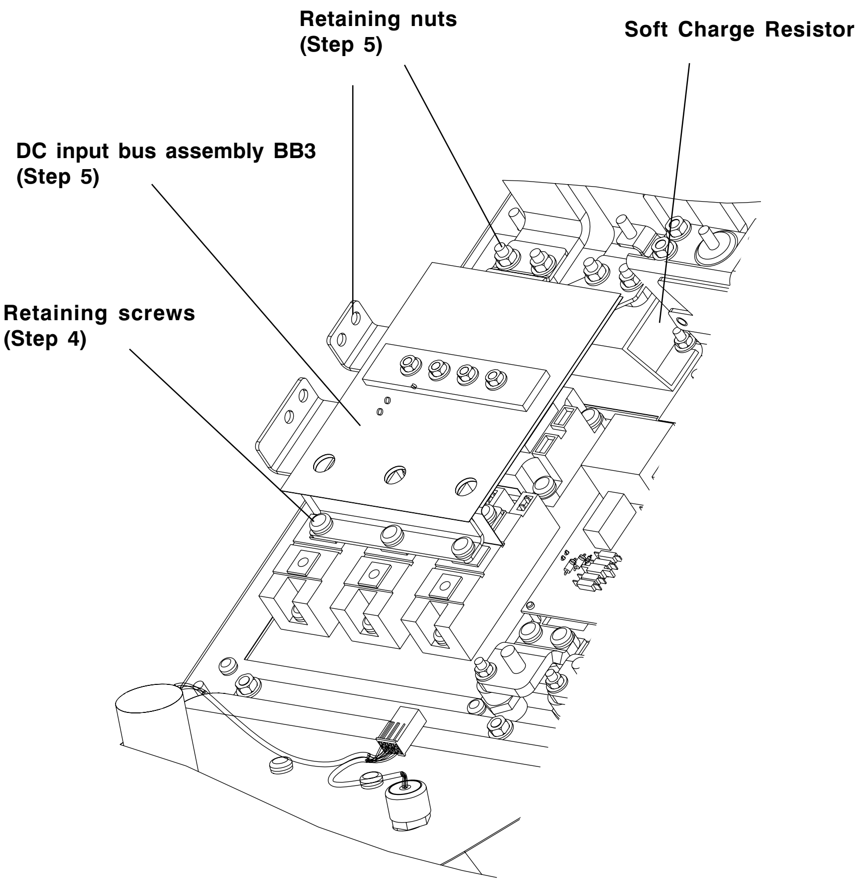

Figure 6-8. D1 Soft Charge Resistor (2 of 3)

6. Remove soft charge resistor by removing two mounting screws.

Reassembly

1. Clean heatsink surface with mild solvent or alcohol solution.

2. Reassemble remaining parts in reverse order of their removal. Tighten T25 and 8mm mounting screws to 20 in-lbs (2.25 Nm) and T30 and 10 mm to 35 in-lbs (4 Nm).

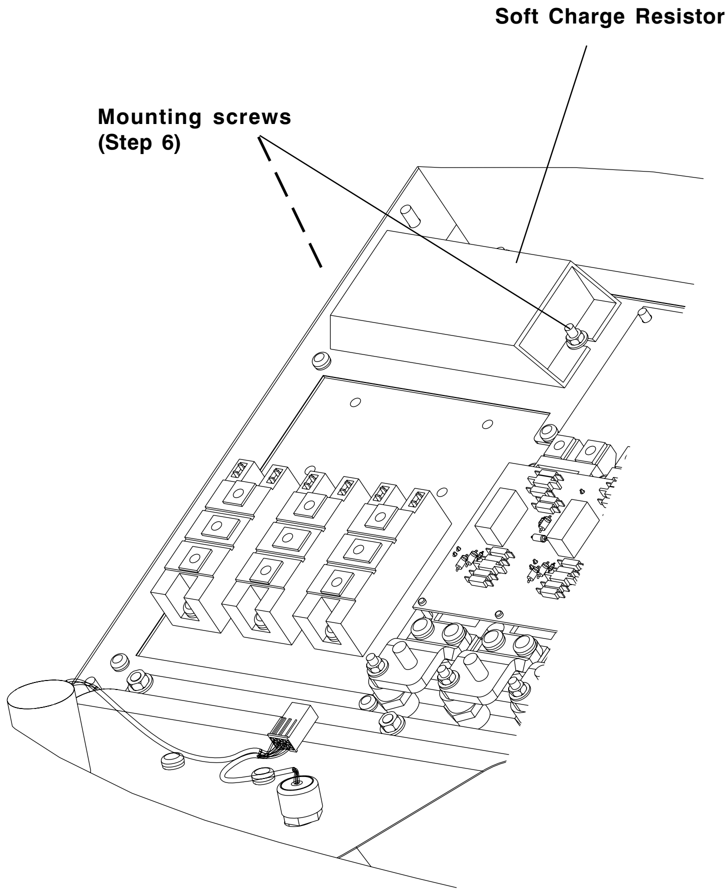

Figure 6-8. D1 Soft Charge Resistor (3 of 3)

6.10 Input Terminal Mounting Plate Assy

1. Disconnect input power wiring from L1, L2, L3, and ground connection.

2. Remove upper most bus bar retaining nuts (13mm) from AC power input bus bars L1, L2, and L3.

3. Disconnect fan autotransformer cable at in-line connector.

4. Remove 4 or 5 (10mm) retaining nuts (varies with size) from mounting plate.

⚠CAUTION

Input terminal mounting plate weighs approx. 15 - 60 lbs (7 - 27 kg), depending on mounted options.

5. Remove entire assembly from mounting studs.

Reinstall in reverse order of this procedure. Tighten mounting nuts to 35 in-lbs (4Nm).

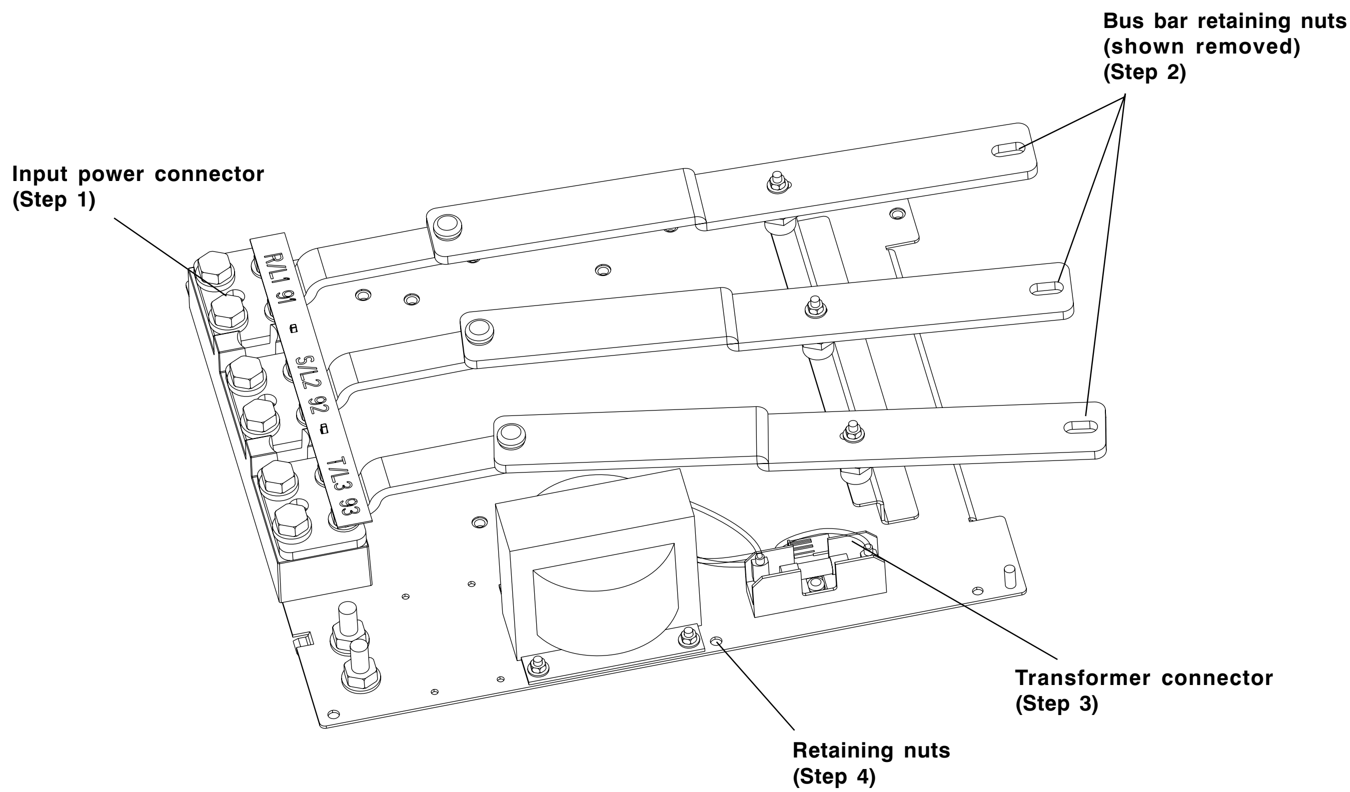

Figure 6-9. Input Terminal Mounting Plate Assy

6.11 SCR/Diode Module D2 Units

1. Remove lower DC capacitor bank per instruction.

2. Remove input terminal plate per instructions.

3. Remove retaining nuts (8mm) from SCR input bus bars.

4. Note the color coding for each of three wires attached to retaining studs. Ensure that correct wire is attached to applicable stud upon reassembling. Remove wiring from studs.

5. Remove screw (T30) from terminal 1 of each SCR/Diode module by accessing screw through access hole in SCR/Diode input bus bar. Remove SCR input bus bars.

6. Remove each IGBT output bus bar by removing nut (13mm) from stud. Also remove retaining screw (T40) at other end of IGBT output bus bars (not shown).

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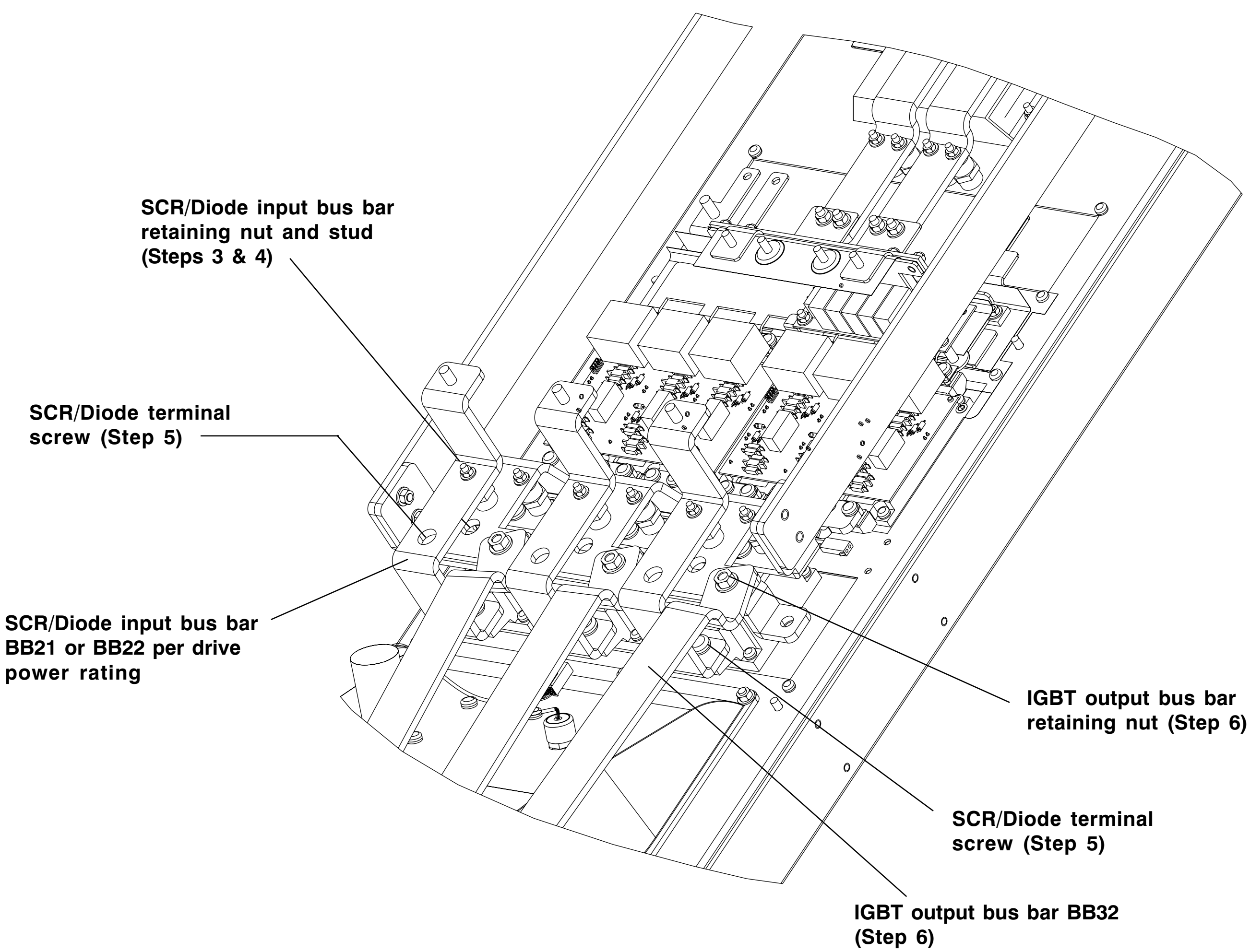

Figure 6-10. D2 SCR/Diode Module (1 of 4)

7. Remove twelve (T30) screws from output (lower) side of IGBT modules.

8. Remove retaining nut (8mm) from each intermediate IGBT output bus bar. Remove intermediate IGBT bus bars.

9. Remove 4 nuts (10mm), two on either side, connecting rectifier DC bus bars to main DC bus bars. These are located to either side of SCR/ Diode modules.

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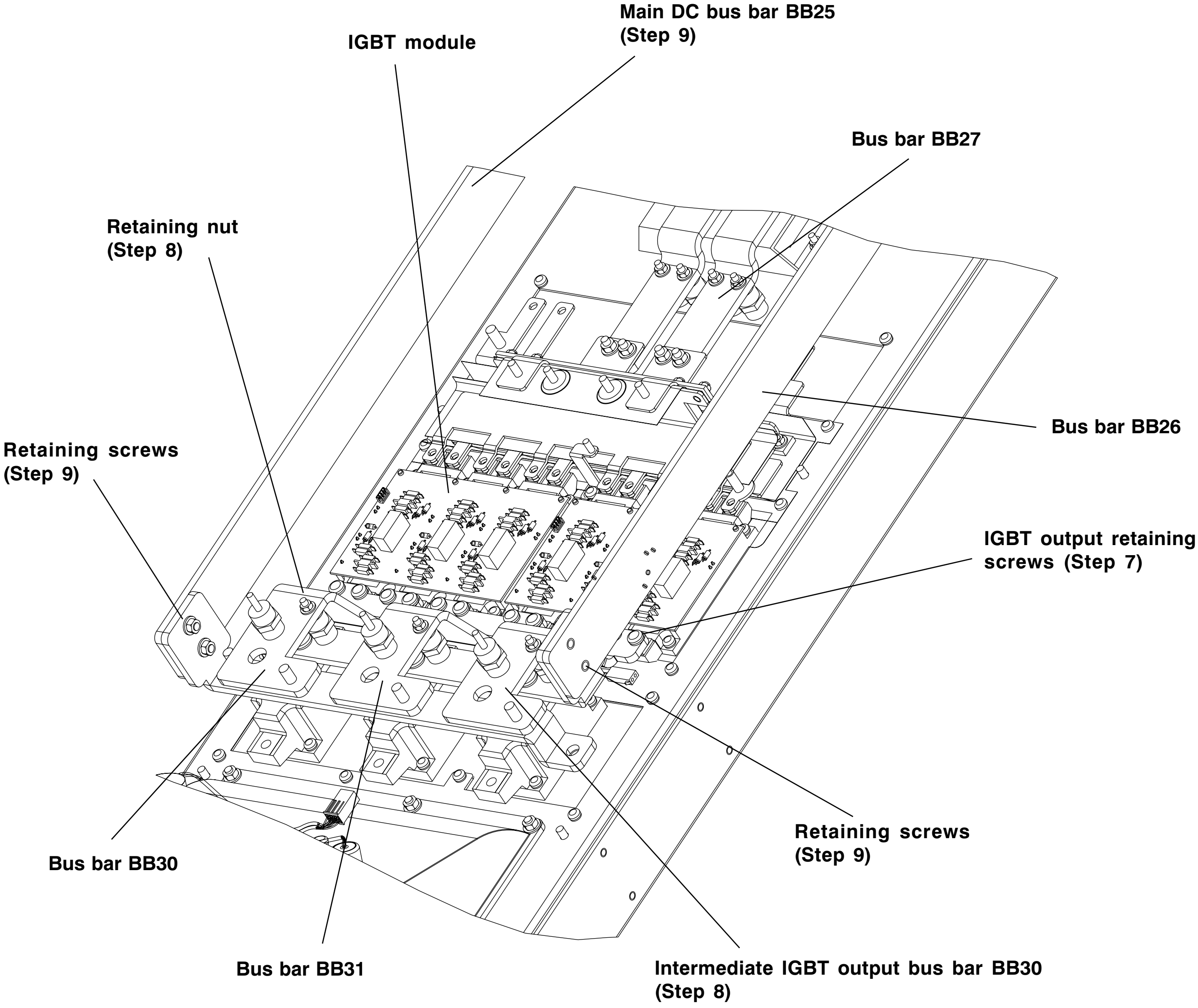

Figure 6-10. D2 SCR/Diode Module (2 of 4)

10. Remove rectifier DC bus bars by removing 3 screws (T25) connecting each rectifier DC bus bar to standoffs on SCR/Diode modules.

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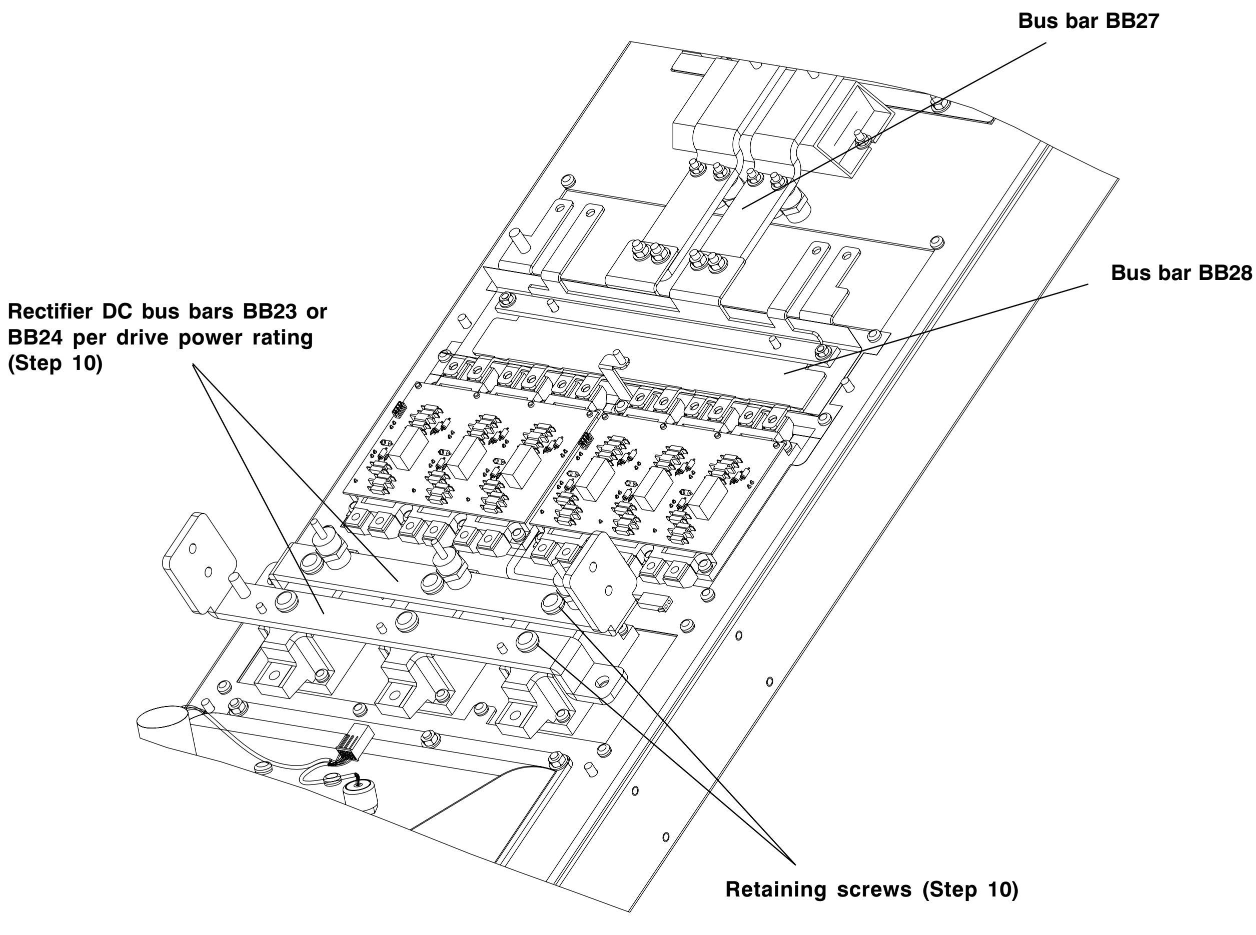

Figure 6-10. D2 SCR/Diode Module (3 of 4)

Note

Note which gate leads are attached to each module to ensure that leads are reconnected to correct modules upon reassembly.

11. Remove SCR gate lead connectors from modules.

12. Remove two SCR/Diode module retaining screws on each module (T30) and remove SCR/Diode modules.

REASSEMBLY

1. To replace SCR/Diode modules, follow instructions included with replacement module.

2. Reassemble in reverse order. Tighten remaining T25 and 8mm screws to 20 in-lbs (2.25 Nm) and T30 to 35 in-lbs (4 Nm).

3. Be sure to cross tighten replacement unit per instructions with spare part.

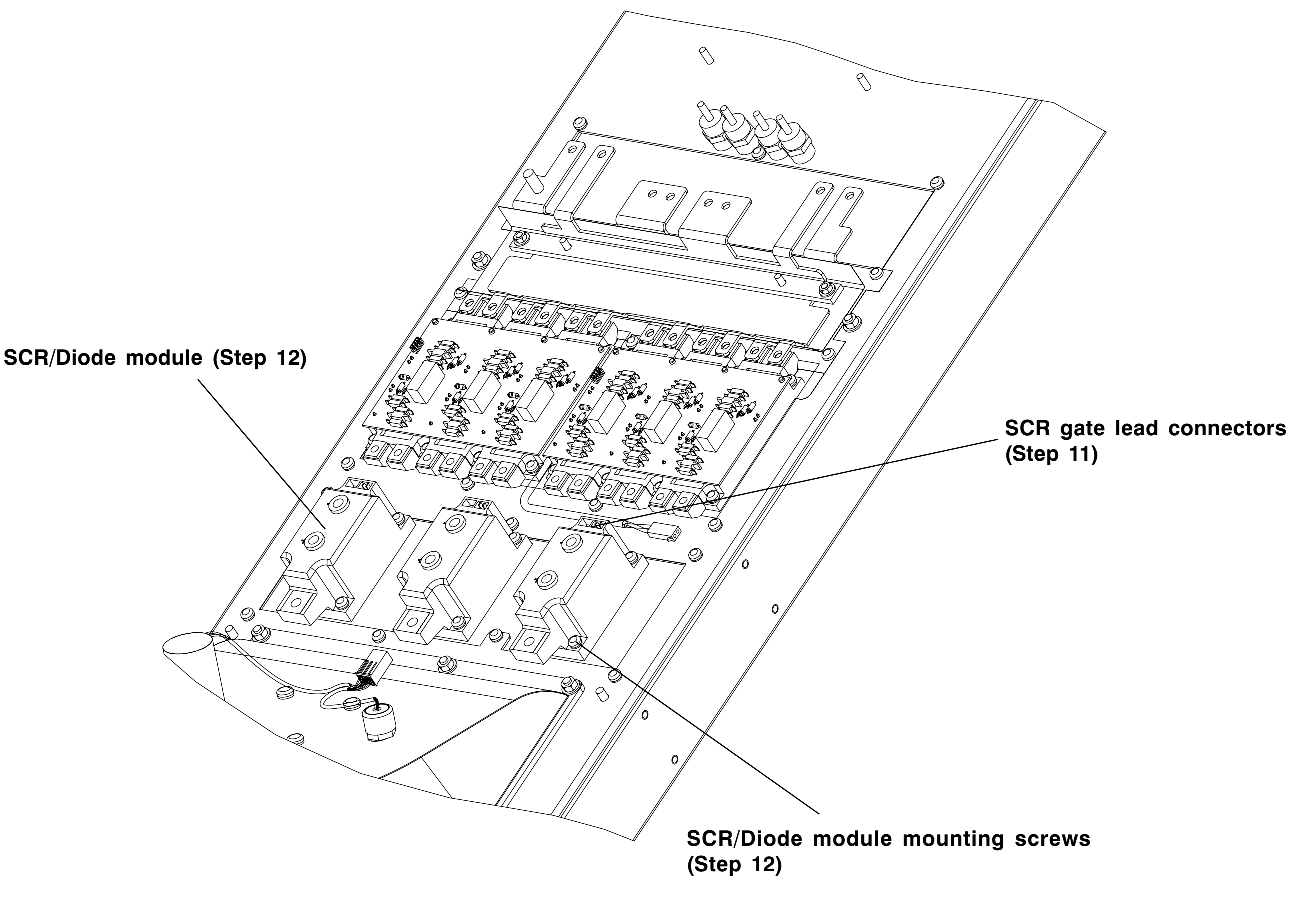

Figure 6-10. D2 SCR/Diode Module (4 of 4)

6.12 SCR/Diode Module D1 Units

1. Remove capacitor bank per instruction.

2. Remove input terminal mounting plate per instructions.

3. Remove retaining screw (T25) from terminal 1 of each SCR/Diode module.

4. Remove 8mm retaining nut from bus bar holding bracket and remove bus bar.

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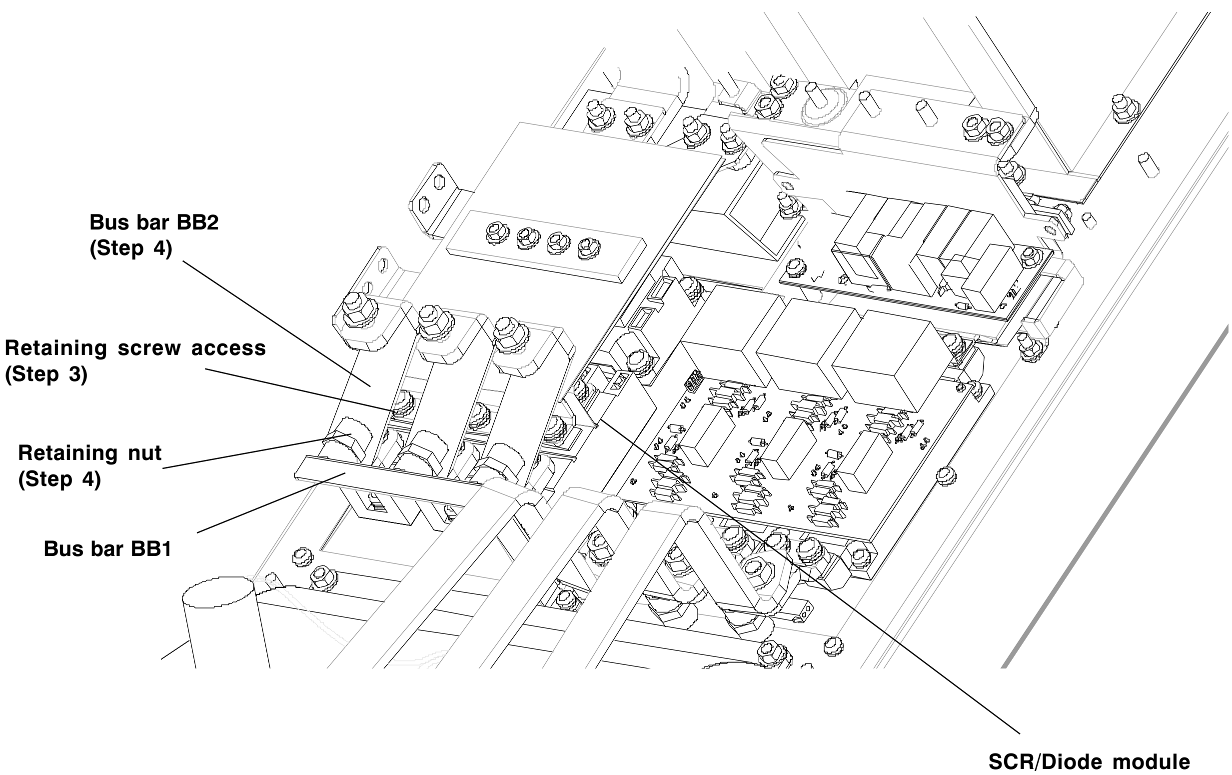

Figure 6-11. D1 SCR/Diode Module (1 of 3)

5. Remove six retaining screws (T25) from SCR/ Diode modules, terminals 2 and 3 in each module.

6. Remove four (10mm) retaining nuts from DC inductor input bus bars and four retaining nuts (not shown) from side mounted bus bars. (Side mounted bus bars are only present on units with load sharing.) Remove DC input bus assembly.

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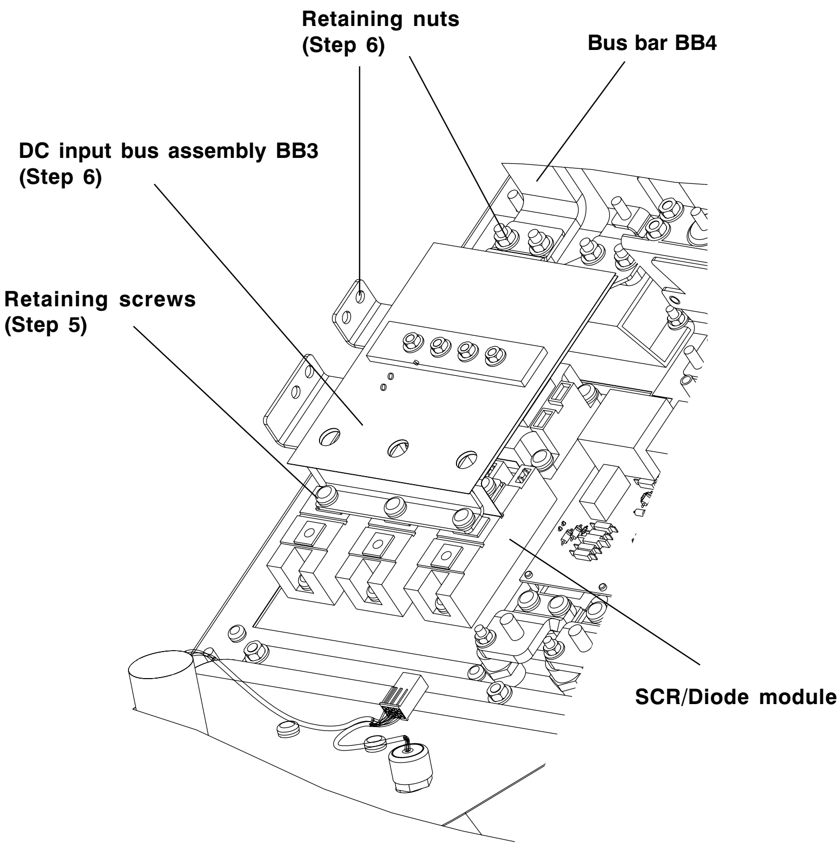

Figure 6-11. D1 SCR/Diode Module (2 of 3)

7. Note which gate leads attach to which module for reasembly. Remove SCR/Diode gate lead connectors from modules (not shown).

8. If unit is equipped with brake option, remove two bus bars attaching brake IGBT module to IGBT bus assy. Remove SCR/Diode mounting screws.

REASSEMBLY

1. To replace SCR/Diode modules, follow instructions included with replacement module.

2. Reinstall module and mounting screws. Tighten remaining T25 and 8mm screws to 20 in-lbs (2.25 Nm) and T30 and 10 mm to 35 in-lbs (4 Nm).

3. Reassemble remaining parts in reverse order of their removal.

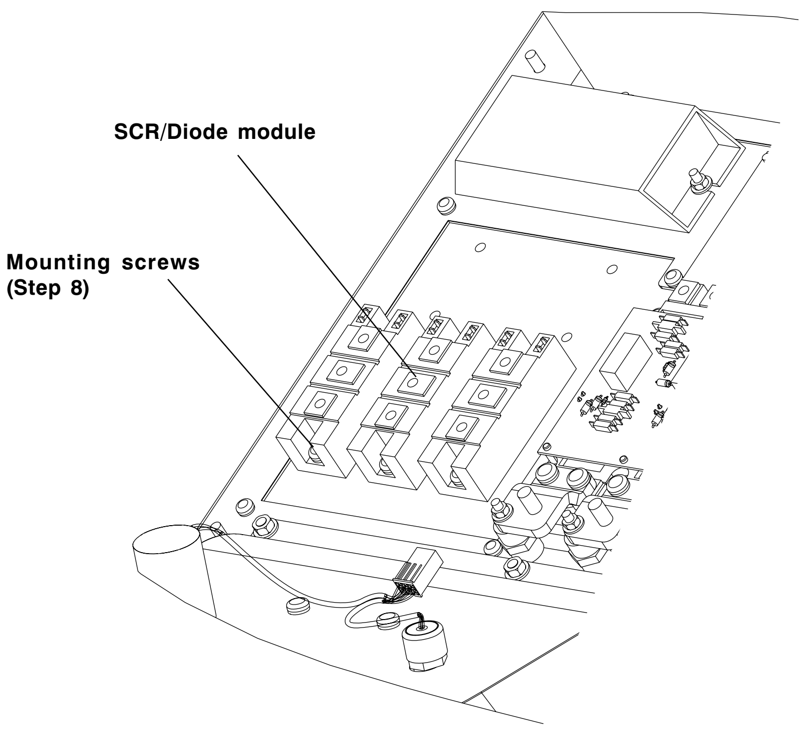

Figure 6-11. D1 SCR/Diode Module (3 of 3)

6.13 Current Sensor

1. Remove motor cabling, as required.

2. Remove input terminal mounting plate assembly per instructions.

3. Remove terminals U, V, and W by removing 3 mounting screws. Terminal slides out from under current sensor.

4. Disconnect current sensor cable from current sensor.

5. Note which cables attach to which sensor for reasembly. Remove 2 (8mm) retaining nuts from stud on chassis baseplate and remove sensor.

Reinstall in reverse order of this procedure. Tighten 8mm mounting nuts to 20 in-lbs (2.25 Nm).

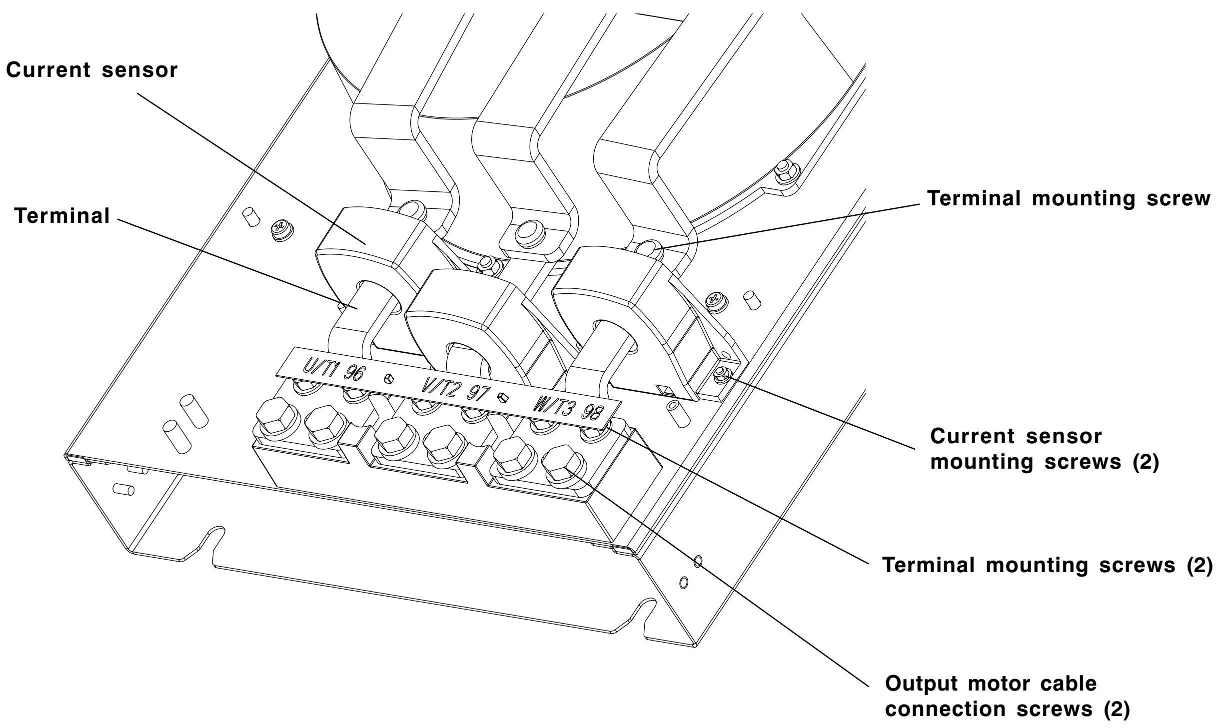

Figure 6-12. Current Sensors

6.14 Fan Assembly

1. Remove input terminal mounting plate assembly per instructions.

2. Remove 3 IGBT output bus bars by removing 6 retaining nuts (8mm), one from each end, of IGBT output bus bars. Remove bus bars.

NOTE
Omit steps 3 and 4 for D2 units.

3. Use 4 in. (100mm) minimum extension and remove terminal 1 of SCR/Diode module.

4. Note the color coding for each of three wires attached to retaining studs. Ensure that correct wire is attached to applicable stud upon reassembling. Remove AC power lead to intermediate SCR input bus bar by removing nut (8mm) and remove bus bar.

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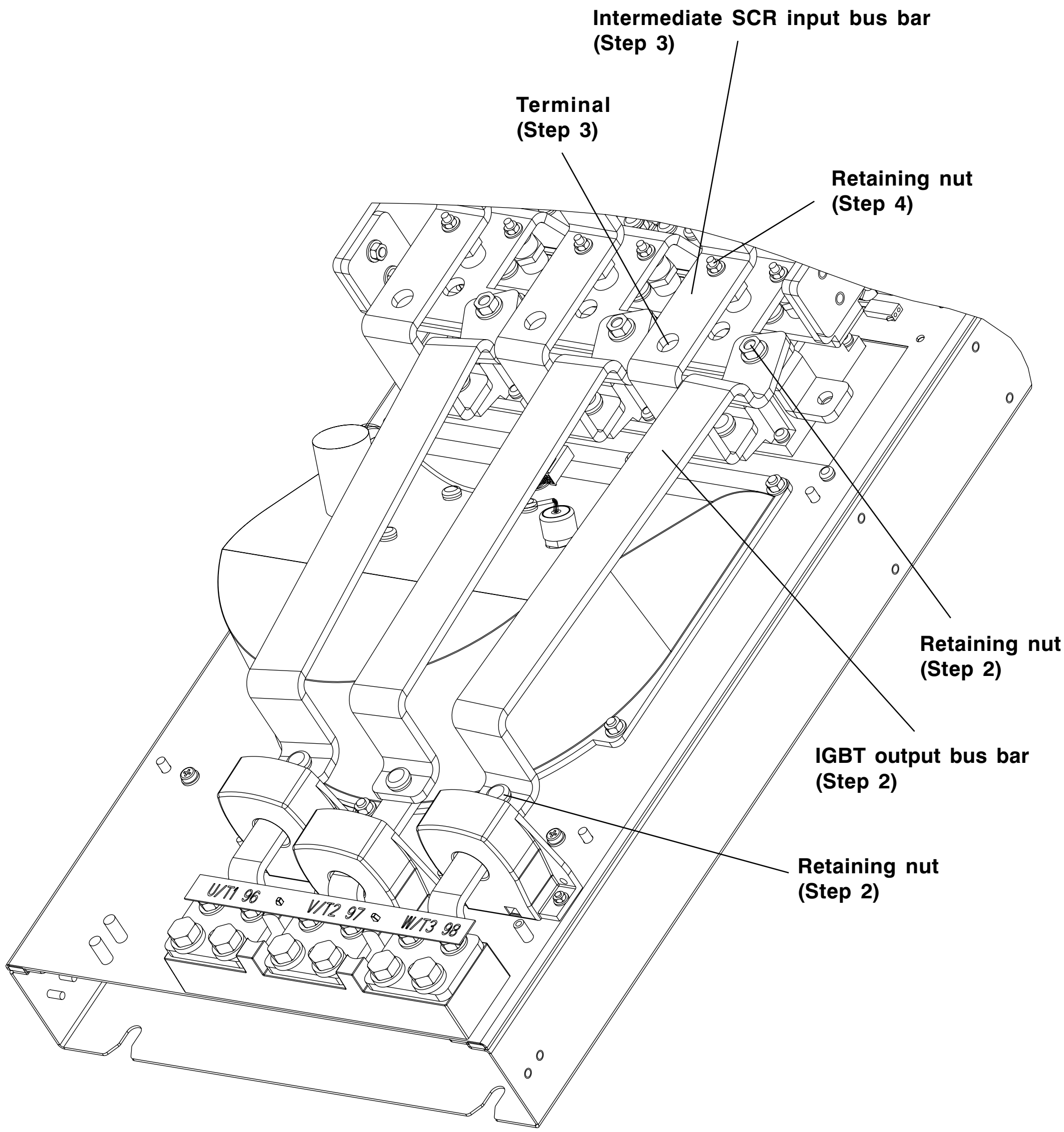

Figure 6-13. Fan Assembly (1 of 2)

5. Disconnect in-line molex connector.

6. Remove fan assy by removing 6 (8mm) retaining nuts from stud. Note that fan assy weighs approx. 18 lbs (8 kg).

Reinstall in reverse order of this procedure. Tighten mounting nuts to 20 in-lbs (2.25 Nm).

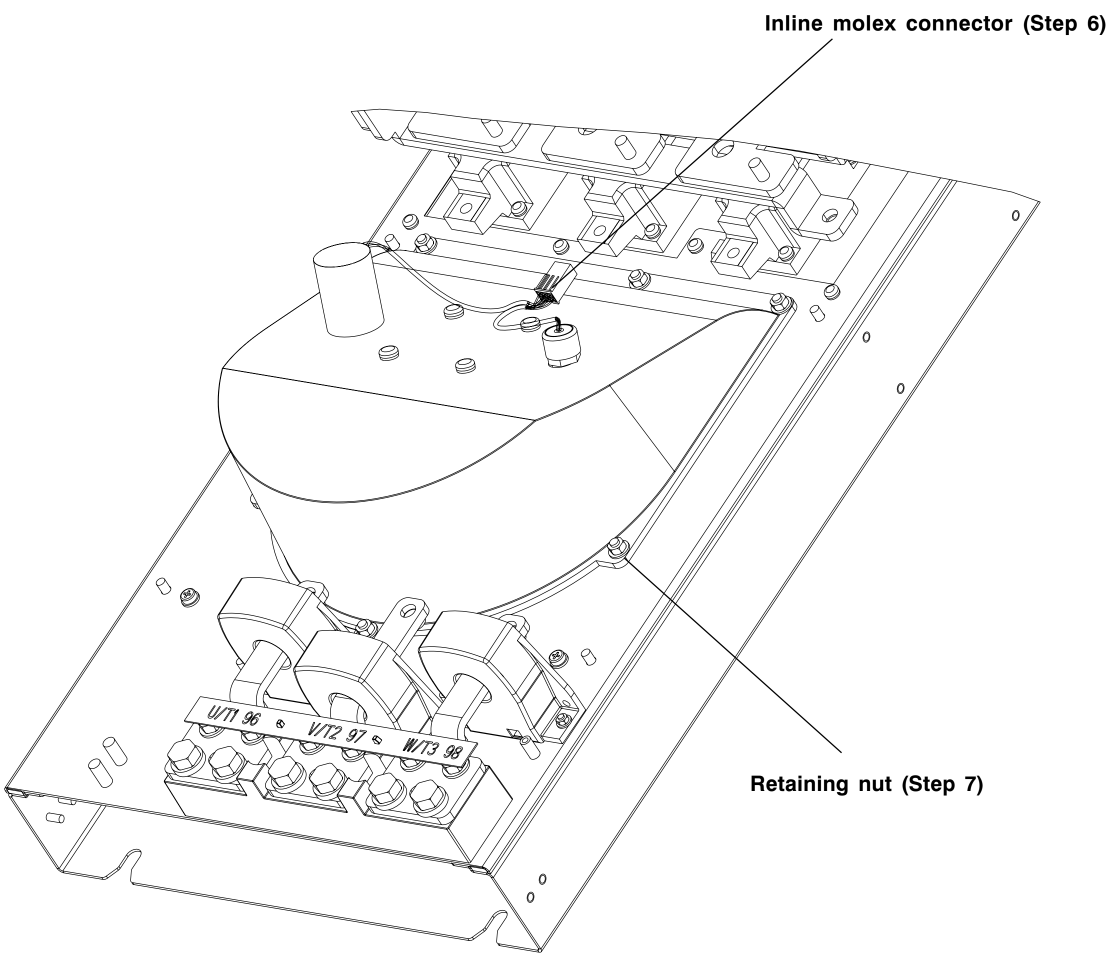

Figure 6-13. Fan Assembly (2 of 2)

6.15 AC Input Terminals

1. Remove AC input power cabling, as required.

2. Remove R/L1, S/L2, T/L3 terminals by removing 3 retaining screws.

Reinstall in reverse order of this procedure. Tighten mounting nuts per specifications in the unit's instruction manual.

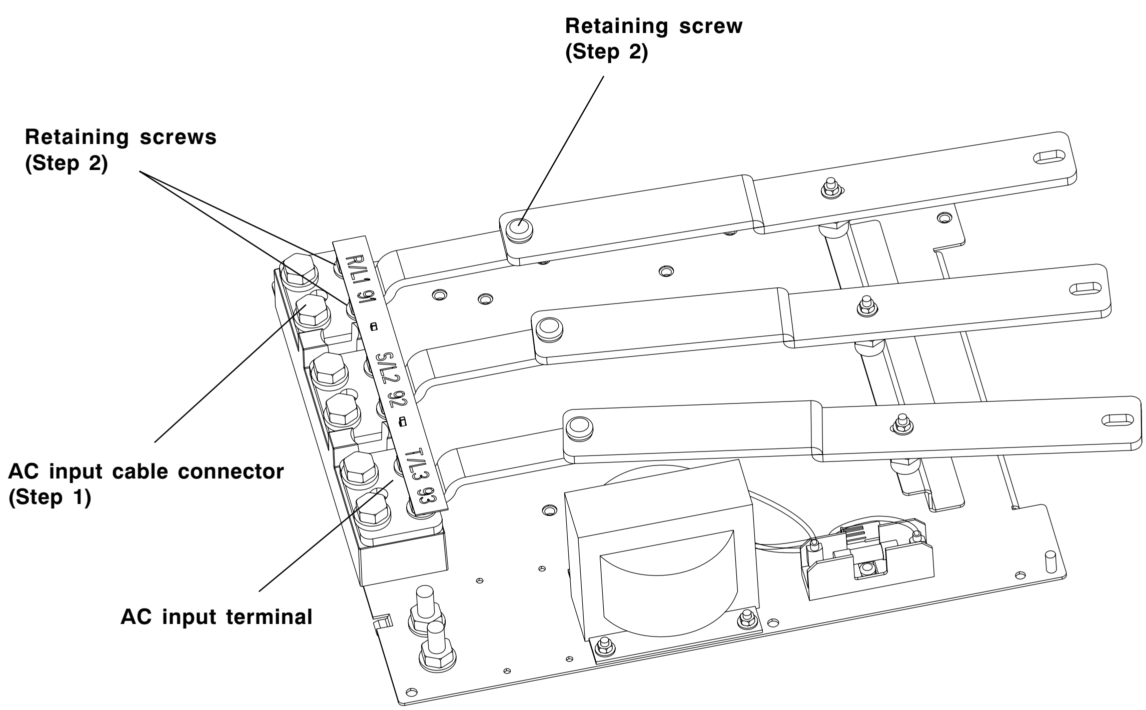

Figure 6-14. AC Input Terminals

6.16 IGBT Modules D2 Units

1. Remove capacitor banks per instructions.

2. Note IGBT gate signal cables connected between gate drive card connectors MK102 (U), MK103 (V), and MK104 (W) and IGBTs. These will need to be reconnected in same locations during reassembly. Units with brake option will have brake cabling from MK105 in addition. Disconnect cables at connectors on IGBT modules.

3. Remove retaining nuts (8mm) from SCR input bus bars.

4. Note the color coding for each of three wires attached to retaining studs. Ensure that correct wire is attached to applicable stud upon reassembling. Remove wiring from studs.

5. Remove screw (T25) from terminal 1 of each SCR/Diode module by accessing screw through access hole in SCR/Diode input bus bar. Remove SCR input bus bars.

6. Remove each IGBT output bus bar by removing nut (10mm) from stud. Also remove retaining screw (T30) at other end of IGBT output bus bars (not shown).

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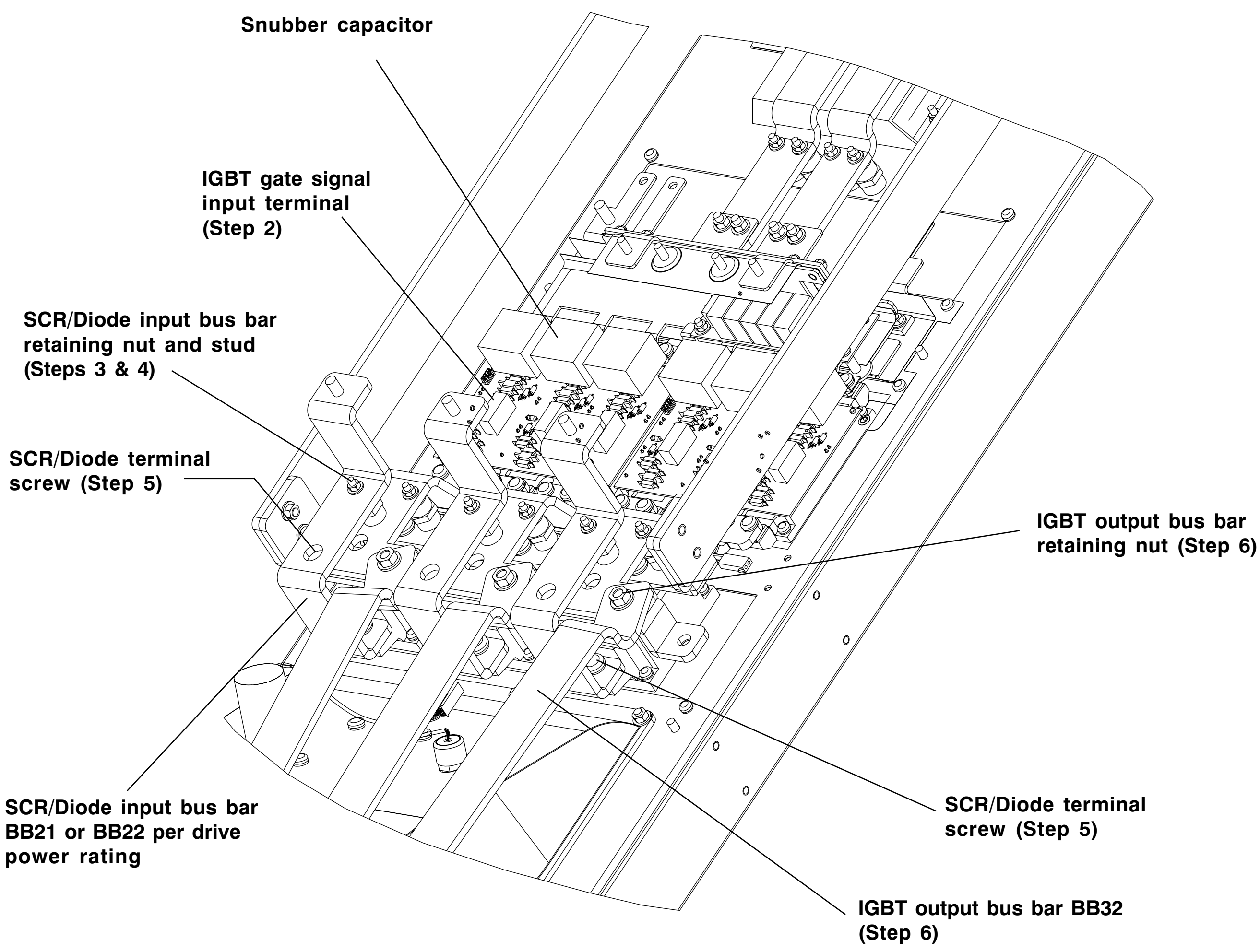

Figure 6-15. D2 IGBT Modules (1 of 3)

7. Remove 4 (10mm) retaining nuts at top of IGBT bus bar assy.

8. Remove 12 retaining screws (6 on each module) on upper portion of IGBT modules. These screws also attach the snubber capacitors to the IGBT modules (see Figure 6-15, 1 of 3 for snubber capacitor location). Remove the snubber capacitors.

9. Remove 10mm retaining nut from IGBT bus bar assy.

10. Remove IGBT bus bar assy.

11. At bottom end of IGBT module, remove 12 retaining screws (4 each for U, V, and W intermediate IGBT output bus bars).

12. Remove retaining nut (8mm) from 3 intermediate IGBT output bus bars. Remove intermediate IGBT output bus bars.

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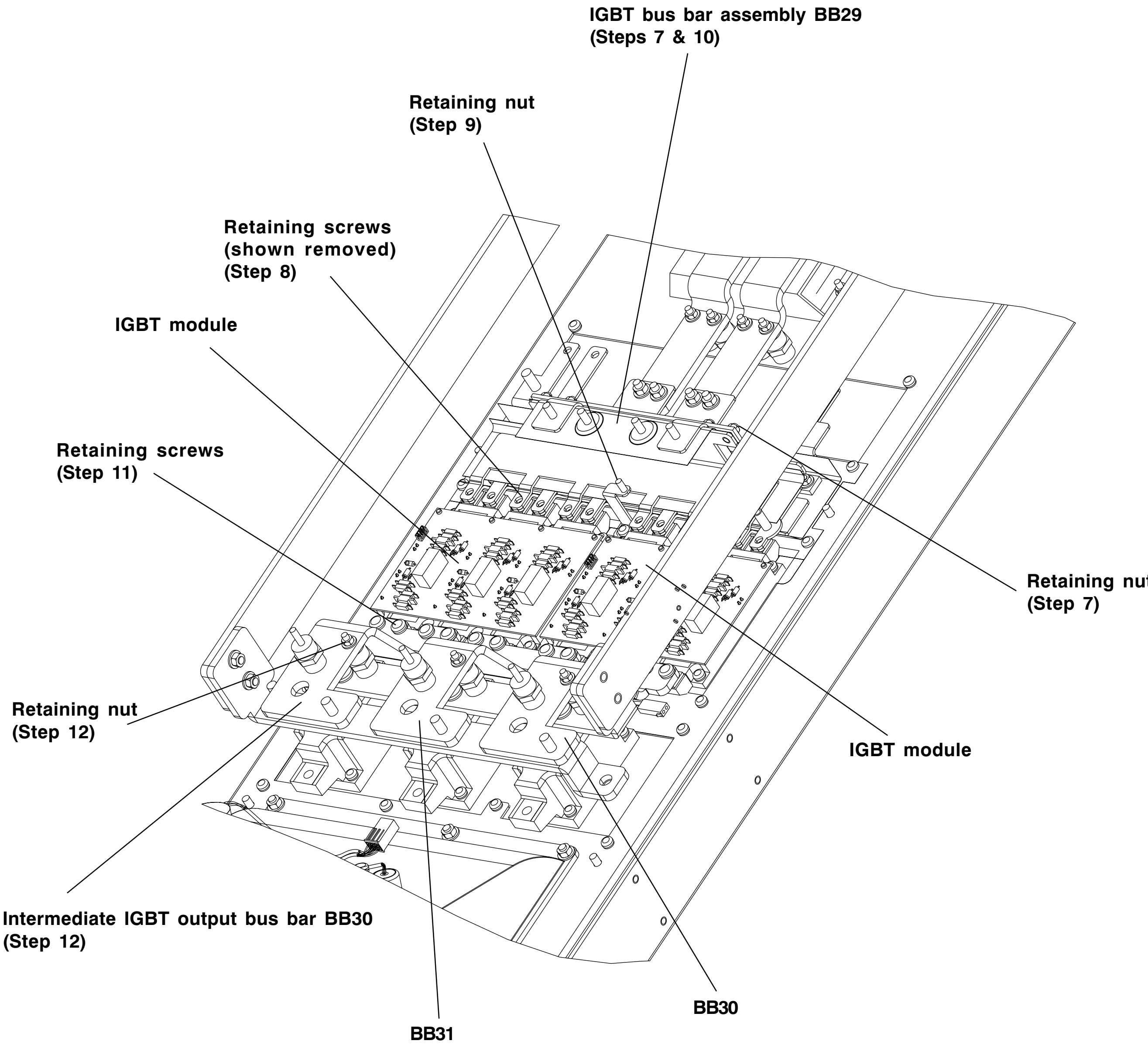

Figure 6-15. D2 IGBT Modules (2 of 3)

13. Remove 2 IGBT modules by removing 16 retaining screws (8 per module) and slide modules free from under bus bars.

14. Clean heatsink surface with mild solvent or alcohol solution.

REASSEMBLY

1. Replace IGBT module in accordance with instructions provided with replacement unit.

2. Reassemble remaining parts in reverse order of their removal.

3. Reinstall module and mounting screws. Tighten remaining T25 and 8mm screws to 20 in-lbs (2.25 Nm) and T30 and 10 mm to 35 in-lbs (4 Nm).

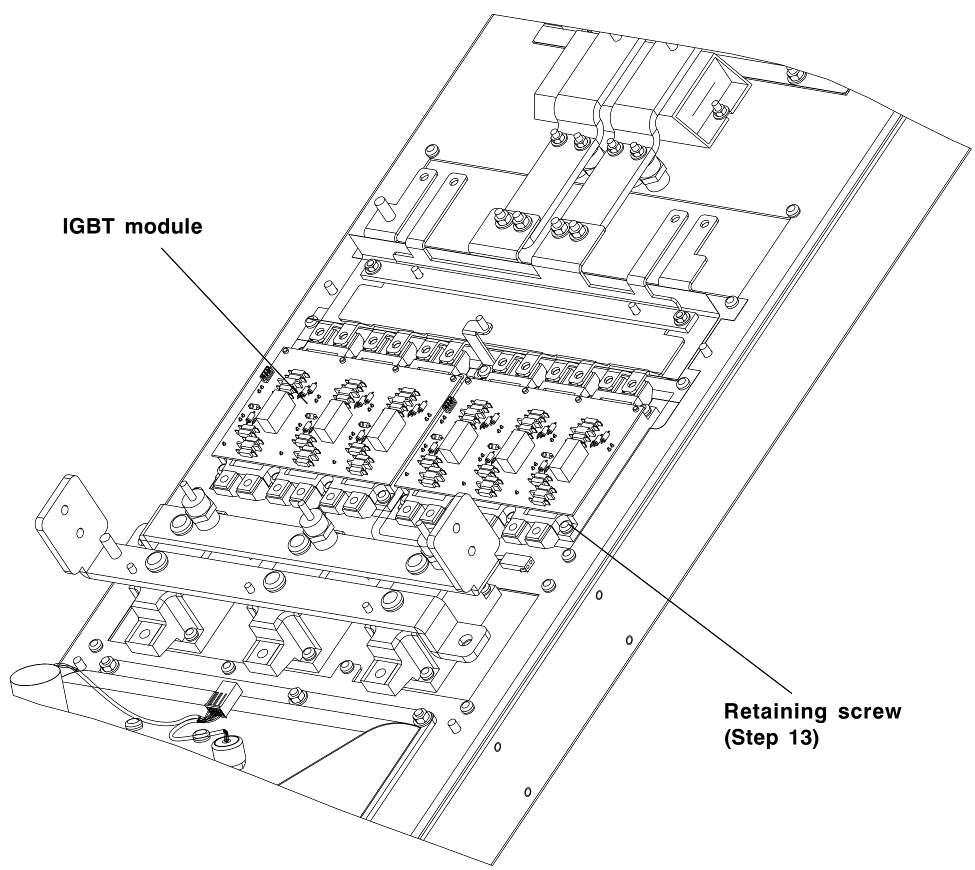

Figure 6-15. D2 IGBT Modules (3 of 3)

6.17 IGBT Modules D1 Units

1. Remove control card cassette per instructions.

2. Remove input terminal mounting plate per instructions.

3. Note IGBT gate signal cables connected between gate drive card connectors MK102 (U), MK103 (V), and MK104 (W) and IGBT module connectors. These will need to be reconnected in same locations during reassembly. Units with brake option will have brake cabling from MK105 in addition. Remove capacitor bank per instructions.

4. Disconnect gate drive cables at connectors on IGBT modules.

5. Disconnect cable connected to connector MK100 on high frequency card.

6. Remove high frequency card by removing 2 retaining screws and 1 retaining nut.

6A. For units with brake option, DC input bus assembly must be removed to access and remove bus bars between IGBT bus bar assembly (see step 10 in Figure 6-15 2 of 3) and brake IGBT. Remove DC input bus bar assembly per steps 3 - 5 of SCR/Diode Module Removal (D1 units).

6B. For units with brake option, remove bus bars between IGBT bus bar assembly (see step 10 in Figure 6-15 2 of 3) and brake IGBT by removing two T25 retaining screws on brake IGBT (not shown) and two 8mm retaining nuts on IGBT bus bar assembly (not shown).

7. Remove 3 IGBT output bus bars by removing nut (10mm) from stud. Also remove retaining screw (T30) at other end of IGBT output bus bars (not shown).

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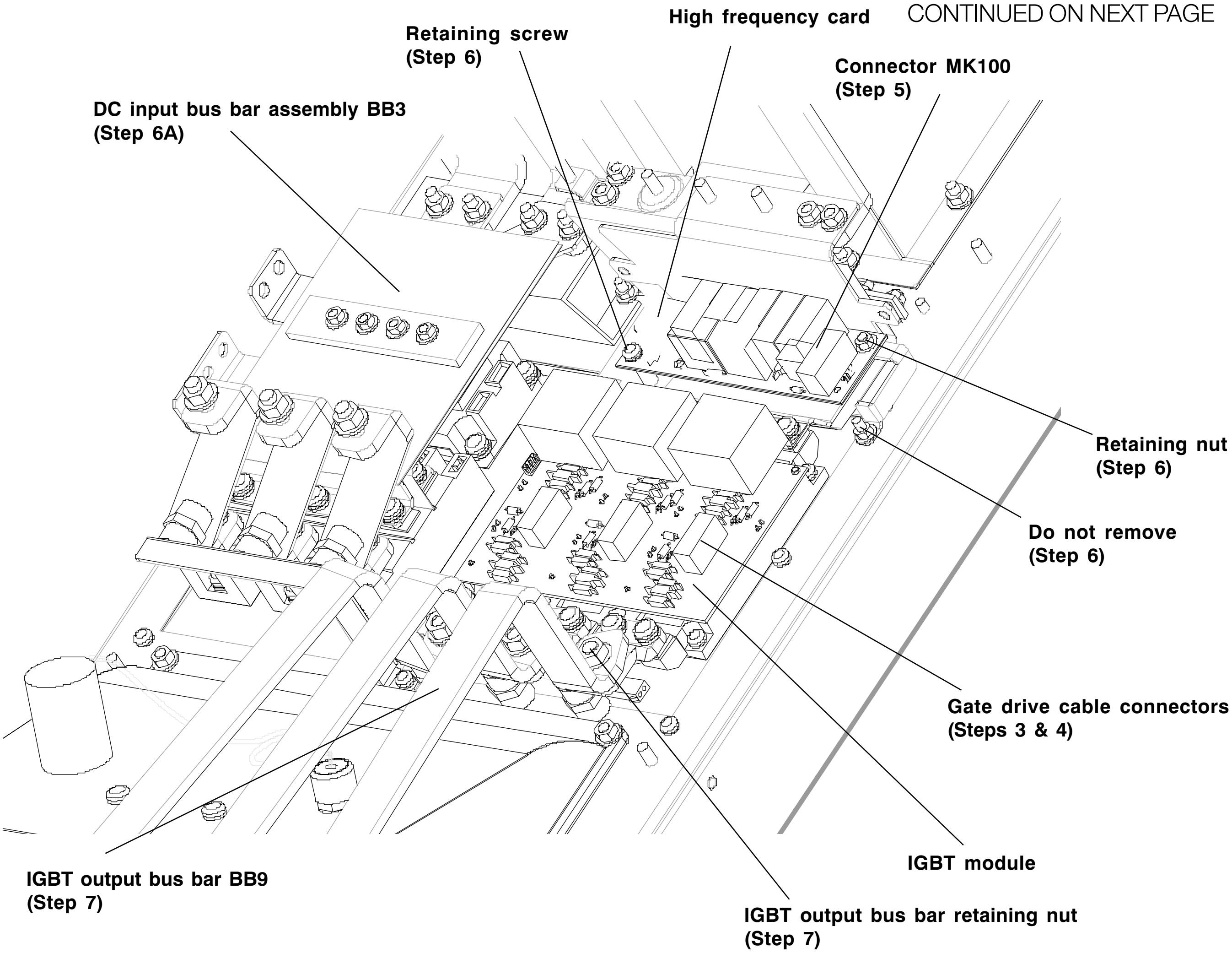

Figure 6-16. D1 IGBT Module (1 of 2)

8. Remove 4 (10mm) retaining nuts at top of IGBT bus bar assy.

9. Remove 6 retaining screws on upper portion of IGBT modules. These screws also attach the snubber capacitors to the IGBT modules. Remove 3 snubber capacitors.

10. Remove IGBT bus bar assy.

11. At bottom end of IGBT module, remove 6 retaining screws (2 each for U, V, and W intermediate IGBT output bus bars).

12. Remove retaining nut (8mm) from 3 intermediate IGBT output bus bars. Remove intermediate IGBT output bus bars.

13. Remove IGBT module.

14. Clean heatsink surface with mild solvent or alcohol solution.

REASSEMBLY

1. Replace IGBT module in accordance with instrucions enclosed with replacement module.

2. Tighten remaining T25 and 8mm screws to 20 in-lbs (2.25 Nm) and T30 and 10 mm to 35 in-lbs (4 Nm).

3. Reassemble drive in reverse order of disassembly and tighten attaching hardware in accordance with torque tables.

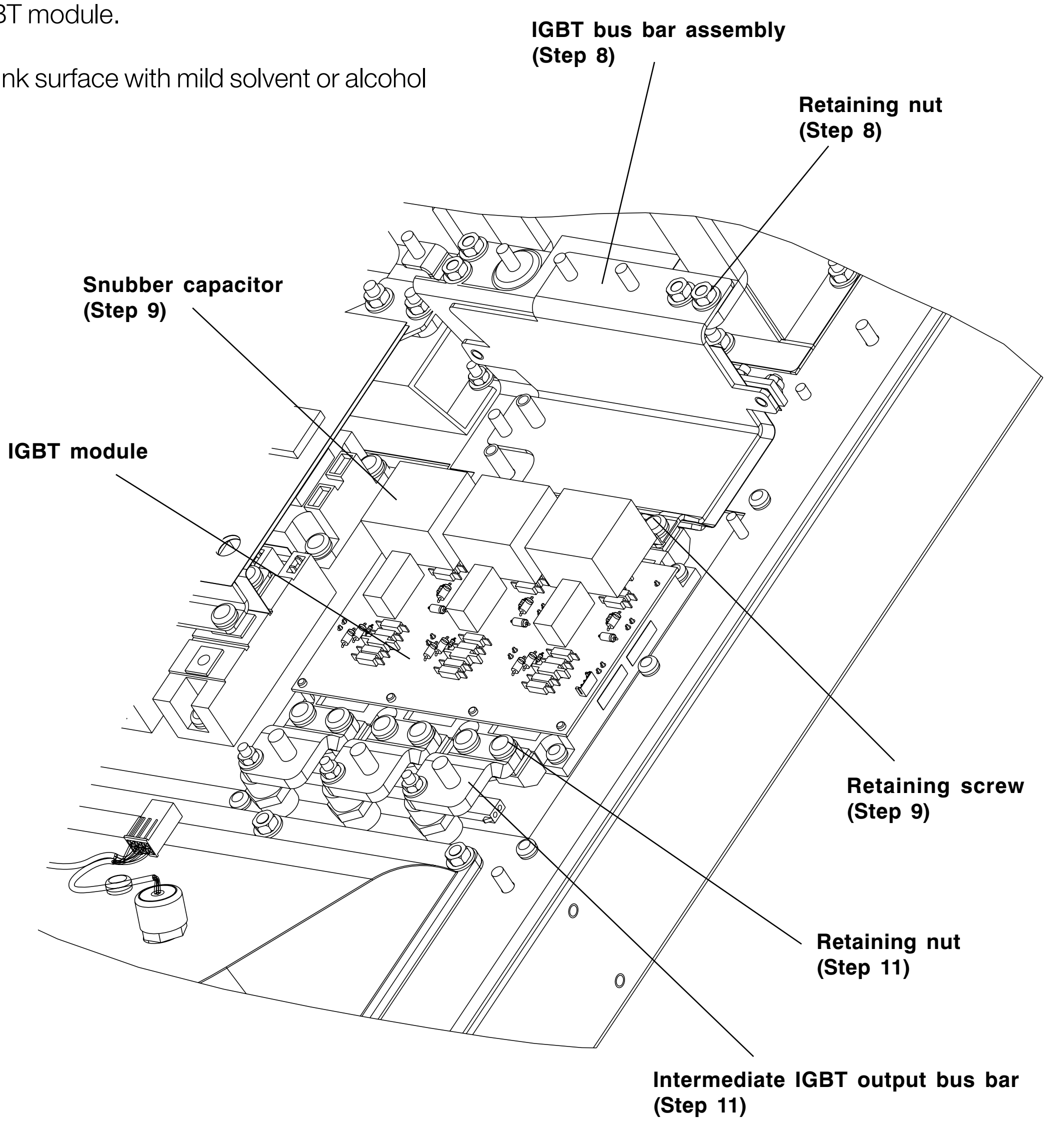

Figure 6-16. D1 IGBT Module (2 of 2)

SECTION 7
E-FRAME SIZES DISASSEMBLY AND ASSEMBLY INSTRUCTIONS

⚠DANGER

Drives contain dangerous voltages when connected to line voltage. No disassembly should be attempted with power applied. Remove power to drive and wait at least 40 minutes to let drive capacitors fully discharge. Only a competent technician should carry out service.

ELECTROSTATIC DISCHARGE (ESD)

Many electronic components within the adjustable frequency drive are sensitive to static electricity. Voltages so low that they cannot be felt, seen or heard can reduce the life, affect performance, or completely destroy sensitive electronic components.

⚠CAUTION

Use proper electrostatic discharge (ESD) procedures when servicing drive to prevent damage to sensitive components.

NOTE

Frame size is used throughout this manual where ever procedures or components differ between drives based upon the unit's physical size. Refer to tables in the Introduction Section to determine E1 frame size definitions.

7.0 INSTRUCTIONS

7.1 Control Card Cassette

1. Remove control wiring by unplugging control terminals.

2. Remove grounding clamps by removing two screws holding each in place. Save screws for reassembly.

3. Disconnect cable between LCP and control card.

4. Unplug two ribbon cables from side of control card.

5. Loosen two captive screws to free cassette (T20).

6. Slide cassette free from mounting tabs.

7. Remove and replace control card in accordance with instructions included with replacement card.

Reinstall in reverse order of this procedure. Ensure that two ribbon cables are not crossed. Tighten control card mounting screws to 10 in-lbs (1 Nm).

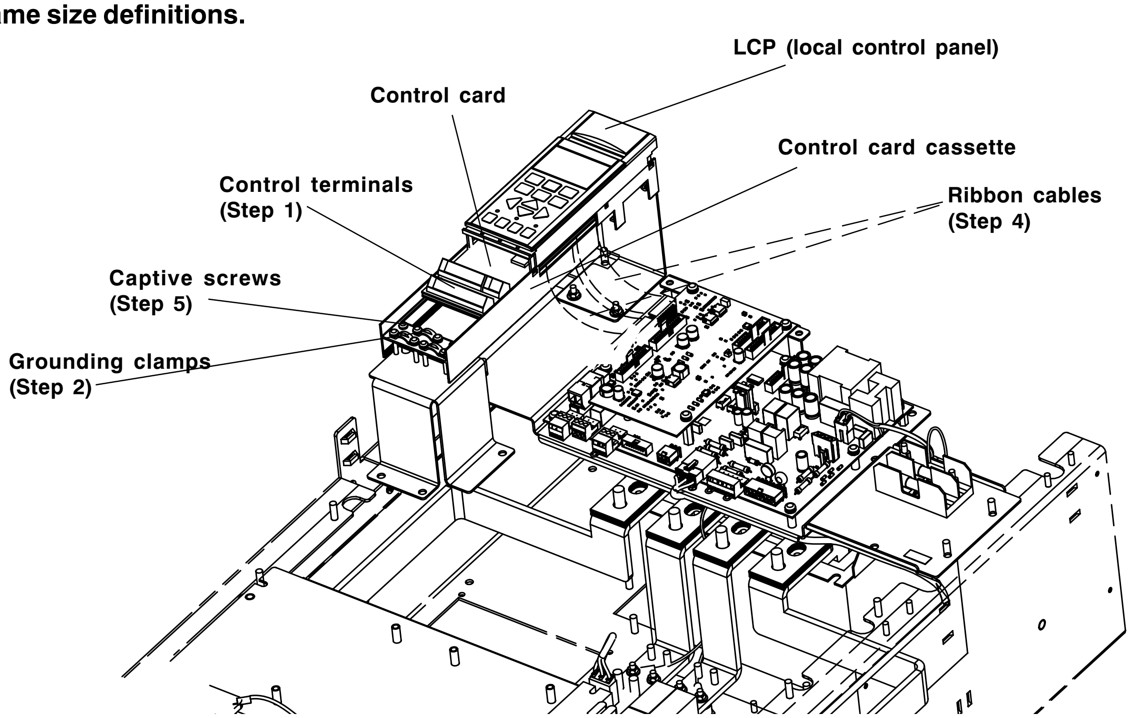

Figure 7-1. Control Card Cassette

7.2 Interface Card

1. Disconnect cables from connectors on interface card MK100, MK102 and MK105. If replacing interface card, disconnect cables from connectors MK101 and MK103

2. Remove interface card by remove 4 mounting screws (T25) from standoffs.

Reinstall in reverse order of this procedure. Tighten T25 screws and interface card standoffs to 20 in-lbs (2.25 Nm). Card will initialize in service mode. Follow instructions enclosed with the spare interface card to enter data required.

7.3 Power Card

1. Remove interface card in accordance with procedure.

2. Disconnect cables from connectors on power card MK100, MK102, MK104, MK105, MK106, MK107, MK109, MK110, and FK100.

3. Remove 2 interface card standoffs (8mm).

4. Remove power card by removing 4 mounting screws (T25) and one locking stud from standoff.

5. Disconnect ground lug from ground connector.

6. Remove current scaling card from power card by pushing in retaining clips on standoffs. KEEP THIS SCALING CARD TO REINSTALL ON ANY REPLACEMENT POWER CARD. Scaling card controls signals operating with this specific VLT drive. Scaling card is not part of replacement power card.

Reinstall in reverse order of this procedure. Tighten mounting screws and interface card standoffs to 20 in-lbs (2.25 Nm).

7.4 Control Card/Power Card Mounting Plate

1. Remove control card cassette and interface card in accordance with procedures.

2. Disconnect all cabling from power card.

3. Remove 4 mounting nuts (10mm).

4. Remove wiring from 2 fuse blocks on mounting plate.

5. Remove optional wiring connections, as necessary, to free mounting plate.

6. Lift plate free from chassis.

Reinstall in reverse order of this procedure. Torque 10mm mounting nuts to 35 in-lbs (4.0 Nm).

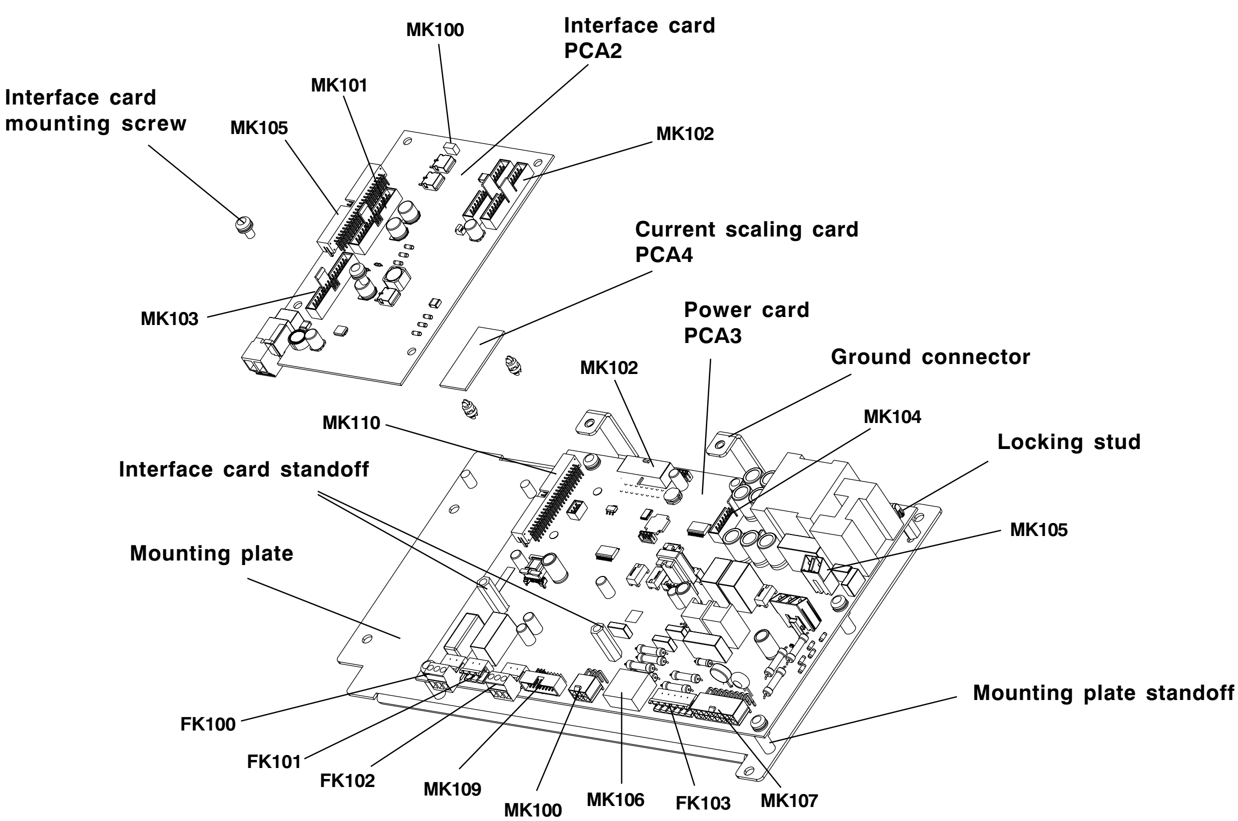

Figure 7-2. Interface Card, Power Card, and Mounting Plate

7.5 Gate Drive Card

1. Disconnect cables from connectors on gate drive card MK102, MK103, MK104, MK106, and, if unit has brake option, MK105, and, for 380-500 V units with an RFI filter, MK101.

2. Remove gate driver card by removing 6 mounting screws (T25 Torx) from standoffs.

Reinstall in reverse order of this procedure. Tighten mounting screws to 20 in-lbs (2.25 Nm).

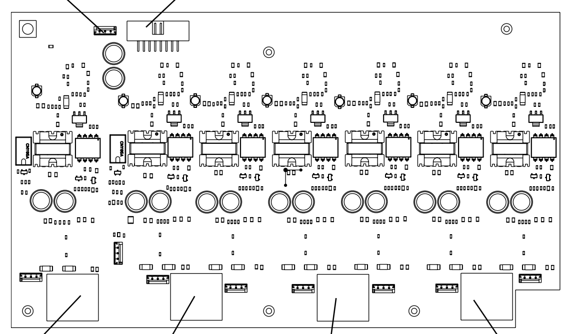

Figure 7-3. Gate Drive Card

7.6 Soft Charge Card

1. Disconnect MK1, MK2, MK3, and MK4.

2. Remove 4 mounting screws (T25) from standoffs.

3. Remove soft charge card. Note insulation sheet below soft charge card. Remove and keep insulation with card for reinstallation.

Reinstall by mounting insulation onto standoffs. Mount soft charge card and tighten mounting screws to 20 in-lbs (2.3 Nm).

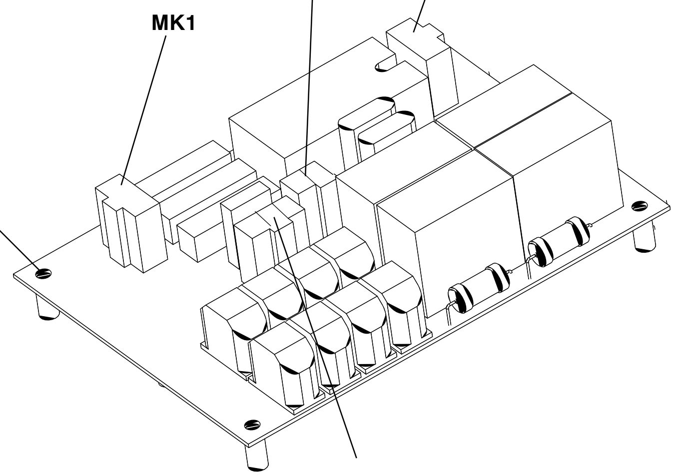

Figure 7-4. Soft Charge Card Assy

7.7 Capacitor Banks

7.7.1 Upper Capacitor Bank

1. Remove control card cassette and gate drive card in accordance with instructions.

2. Capacitor bank connection to DC bus bars can be seen recessed in gap between upper and lower capacitor banks. Minimum 6 inch (150 mm) extension required. Remove 6 electrical connection nuts (8 mm) for upper capacitor bank from DC bus bars.

3. Remove control card cassette mounting bracket by remove 3 nuts (10 mm).

4. Remove 4 retaining nuts (10 mm) from capacitor bank and remove air dam.

5. Note that the weight of capacitor bank is approximately 20 pounds (9 kg). Remove capacitor bank by pulling free from mounting studs.

Reinstall in reverse order of this procedure. Tighten electrical connection nuts (8 mm) to 20 in-lbs (2.3 Nm) and mechanical connection nuts (10 mm) to 35 in-lbs (4.0 Nm).

7.7.2 Lower Capacitor Bank

1. Remove soft charge card in accordance with procedures.

2. Capacitor bank connection to DC bus bars can be seen recessed in gap between upper and lower capacitor banks. Minimum 6 inch (150 mm) extension is required. Remove 6 electrical connection nuts (8 mm) for lower capacitor bank from DC bus bars.

3. Remove 4 retaining nuts (10 mm) from capacitor bank.

4. Note that the weight of the capacitor bank is approximately 20 pounds (9 kg). Remove capacitor bank by pulling free from mounting studs.

Reinstall in reverse order of this procedure. Tighten electrical connection nuts (8 mm) to 20 in-lbs (2.3 Nm) and mechanical connection nuts (10 mm) to 35 in-lbs (4.0 Nm).

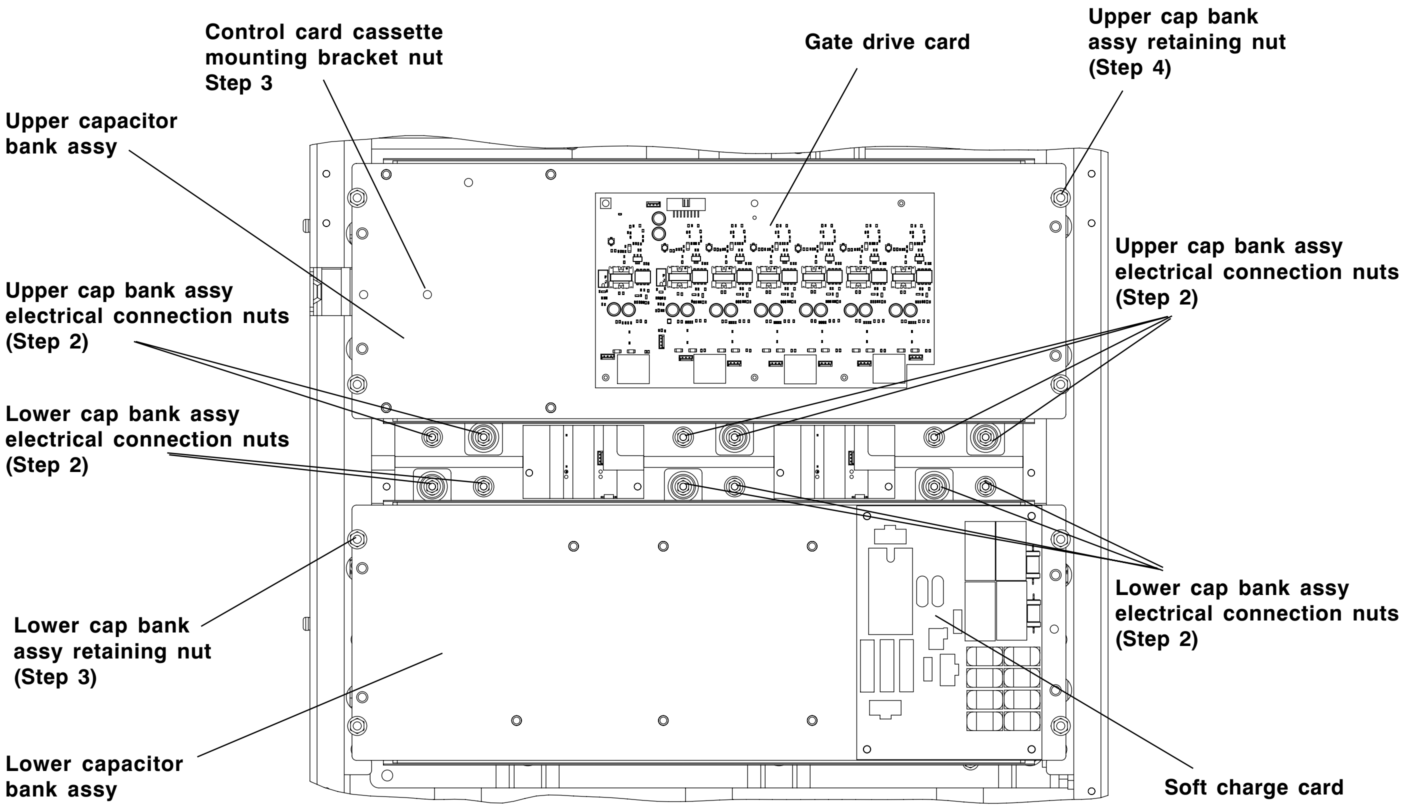

Figure 7-5. Upper and Lower Capacitor Bank Assemblies

7.8 Input Terminal Mounting Plate Assy Option

The drive has component options that mount to the input mounting plate. This results in differing unit configurations. These options include input terminal blocks, input disconnect, RFI filter, input fuses, and an additional cooling fan. These options may need to be removed from the mounting plate assembly to reduce the weight of the assembly for ease of removal.

1. Disconnect input power wiring from terminals L1, L2, L3, and ground connector.

2. Remove upper most bus bar retaining nut (17 mm) from each of three terminals.

3. If a disconnect (not shown) is mounted, remove disconnect from terminal plate assembly to reduce weight of terminal plate as follows.

   a. Loosen connection nut (17 mm) between fuse and disconnect.

   b. Remove 4 mounting screws (T40) from disconnect.

   c. Note that weight of disconnect can be up to 35 pounds (16 kg). Slide disconnect down to clear fuses and remove.

4. If cooling fan is mounted, disconnect fan cable.

5. If RFI filter is mounted, disconnect RFI cable.

6. Note that weight of terminal plate without disconnect can be up to 44 pounds (20 kg). To remove terminal plate, remove 8 retaining nuts (10 mm) from terminal plate and lift entire assembly from mounting studs.

Reinstall in reverse order of this procedure. Tighten 10 mm mounting nuts to 35 in-lbs (4.0 Nm), 17 mm connection nuts to 170 in-lbs (19.2 Nm) and T40 mounting screws to 85 in-lbs (9.6 Nm).

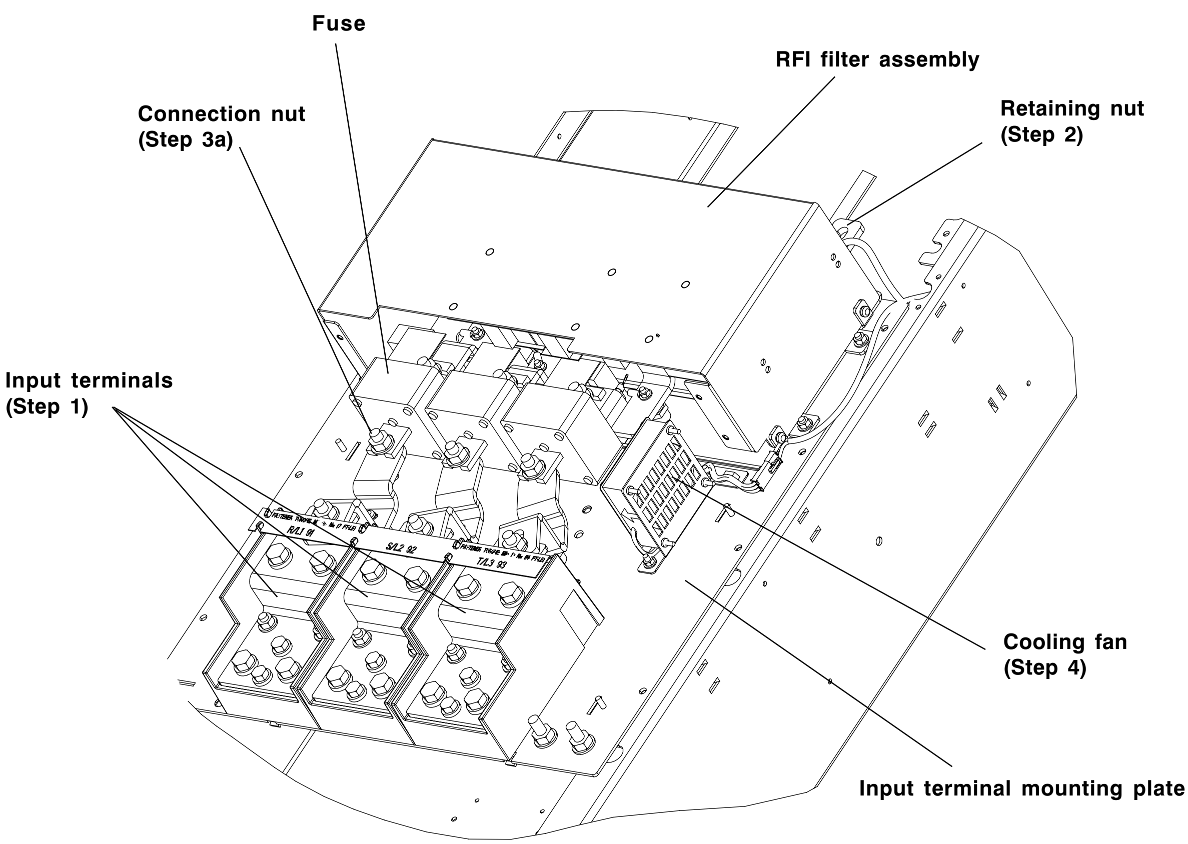

Figure 7-6. Input Terminal Mounting Plate Assy (with RFI option)

7.9 Soft Charge Resistor

1. Remove input terminal plate assembly in accordance with procedure.

2. Disconnect MK4 connector on soft charge card.

3. Loosen top retaining nut (8 mm) on soft charge resistor.

4. Remove bottom retaining nut (8 mm) on soft charge resistor.

5. Lift bottom of soft charge resistor and remove resistor by sliding down.

Reinstall in reverse order of this procedure. Tighten 8 mm retaining nuts to 20 in-lbs (2.3 Nm).

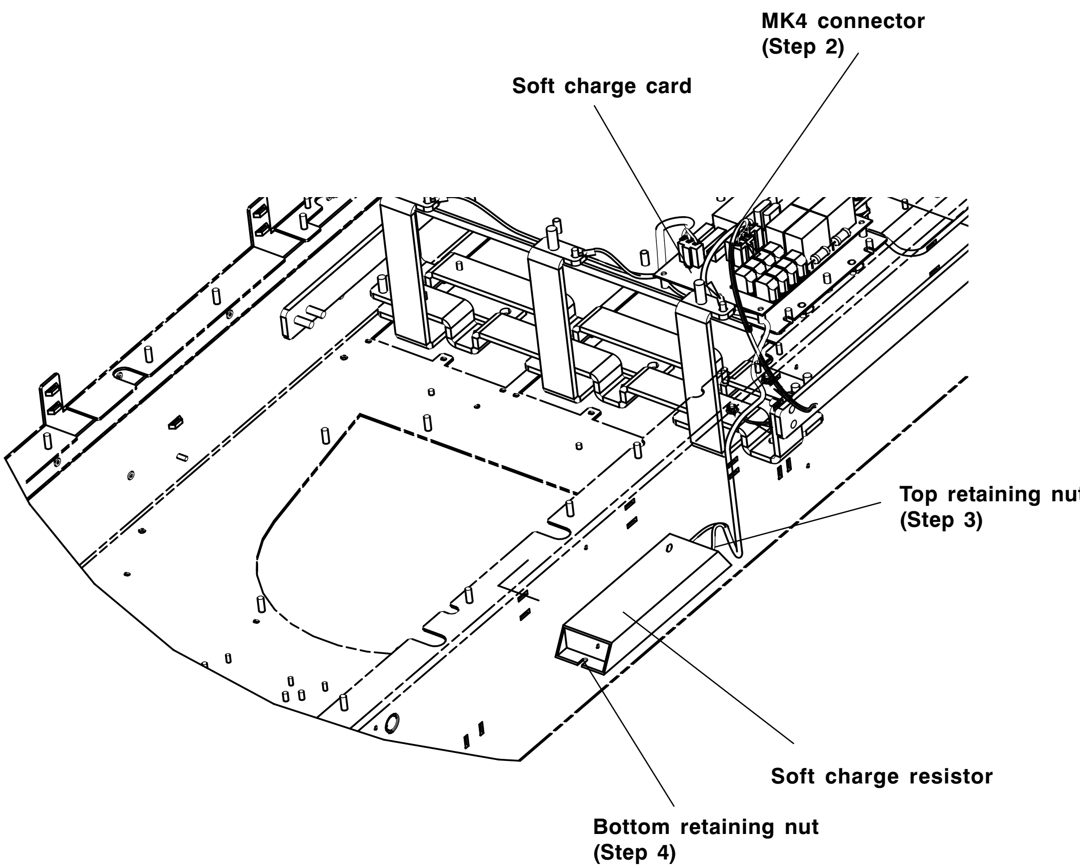

Figure 7-7. Soft Charge Resistor

7.10 SCR and Diode Modules

1. Remove lower DC capacitor bank in accordance with procedure.

2. Remove input terminal plate in accordance with procedure.

3. Remove wire retaining nut (10 mm) from each of 3 SCR input bus bars (BB41).

4. Note color coding for each of 3 wires attached to retaining studs. Ensure that correct wire is attached to applicable stud upon reassembly. Remove wiring from studs.

5. Remove wire retaining nut (8 mm) from SCR output bus bars (BB42). One from (+) DC bus bar and one from (–) DC bus bar.

6. Note color coding for each wire attached to retaining studs. Ensure that correct wire is attached to applicable stud upon reassembly. Remove wiring from studs.

7. Remove 4 retaining nuts (13 mm) on side of bus bars, 2 on each bus bar.

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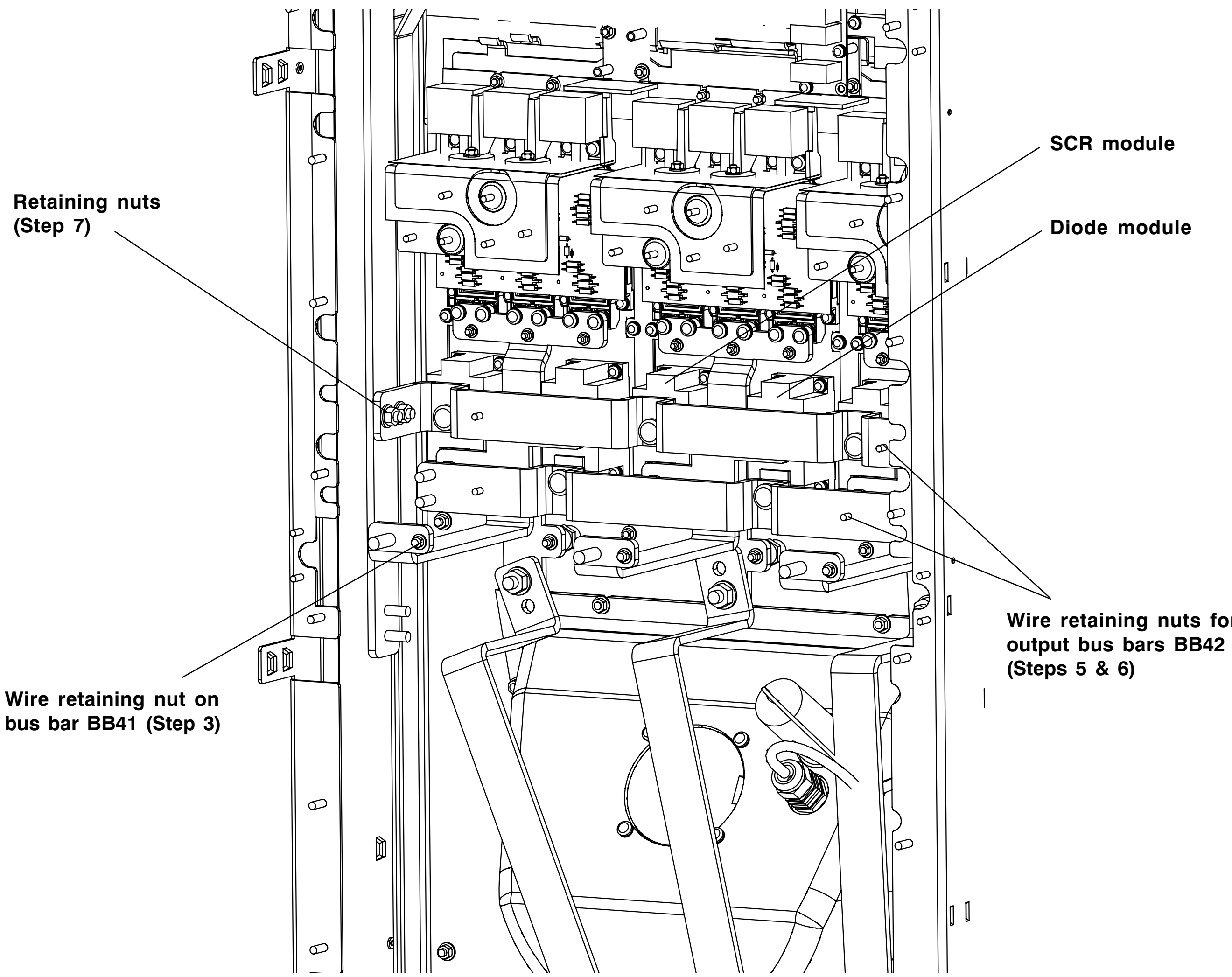

Figure 7-8. SCR and Diode Modules (1 of 3)

8. If unit is not equipped with load sharing option, proceed to step 9. If unit is equipped with load sharing, load share minus (-) bus bar must be removed as follows.

   a. Remove 2 retaining nuts (13 mm) connecting load share bus bar to the SCR output bus bar.

   b. Remove retaining nut (17 mm) connecting load share bus bar to load share terminal on opposite end of bus bar (not shown).

   c. Remove load share bus bar.

9. Remove both positive (+) and negative (-) SCR output bus bars by removing 6 connection screws (T50). There are 3 screws per bus bar.

10. Remove three SCR and Diode input bus bars by removing 6 connection screws (T50). There are 2 screws per bus bar.

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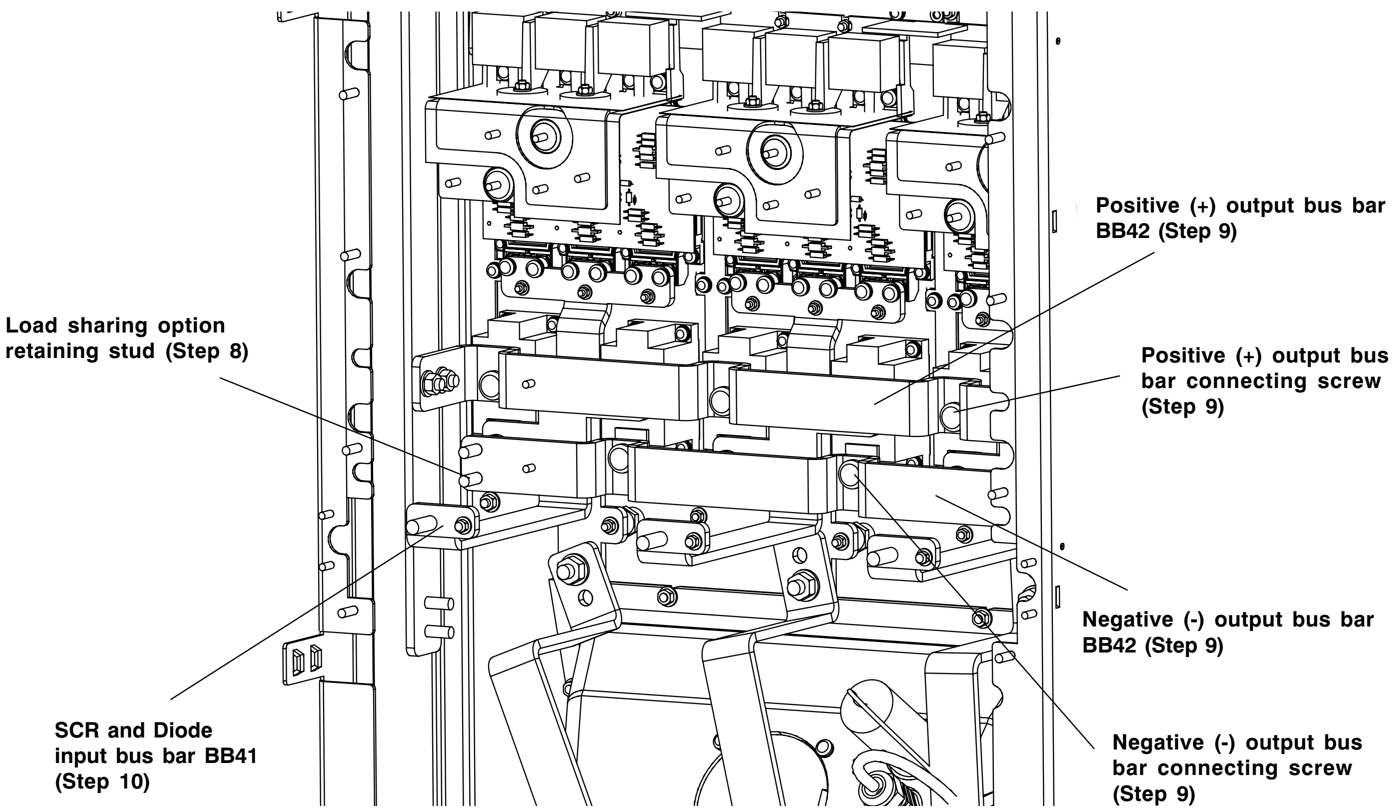

Figure 7-8. SCR and Diode Modules (2 of 3)

11. Note which gate lead connects to each SCR module. Ensure that correct wire is attached to applicable SCR upon reassembly. Remove wiring from each SCR modules. Connector is keyed for proper reinstallation. DO NOT force connection.

12. Remove SCR or diode module by removing 4 retaining screws (T25) from each module.

REASSEMBLY

CAUTION

Equipment Damage!

Do not reverse SCR and diode modules during installation. Reversing SCR and diode modules can result in equipment damage.

Note

For each AC input phase there is one SCR module and one diode module. The SCR is on the left, diode on the right (as seen facing upright unit). There are three pair. Only the SCR module has a connection pin for the gate signals.

1. Replace SCR and diode modules in accordance with instructions included with replacement modules.

2. Reassemble in reverse order.

Attaching Hardware	Tightening Torque
T50	Per spare part instruction
T25	Per spare part instruction
17 mm	170 in-lbs (19.2 Nm)
13 mm	85 in-lbs (9.6 Nm)
10 mm	35 in-lbs (4.0Nm)
8 mm	20 in-lbs (2.25 Nm)

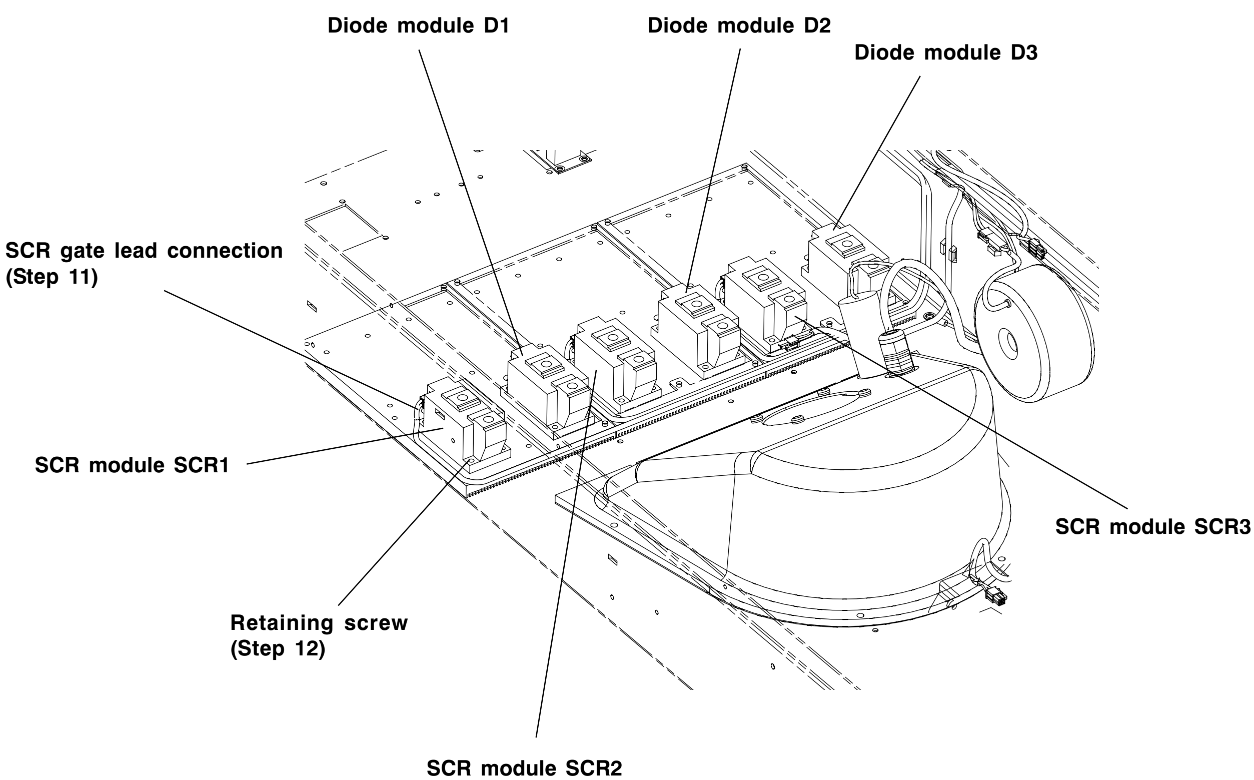

Figure 7-8. SCR and Diode Modules (3 of 3)

7.11 Current Sensor

1. Remove input terminal plate in accordance with procedure.

2. Remove retaining nut (17 mm) connecting current sensor bus bar to motor terminal bus bar.

3. Remove retaining nut (17 mm) or T50 screw, depending on unit type, connecting current sensor bus bar to IGBT over fan bus bar.

4. Note which cable is attached to current sensor. Ensure that correct cable is attached upon reassembly. Unplug cable from current sensor being removed.

5. Remove the 2 retaining nuts (size varies with model) from stud on baseplate and remove sensor.

Reinstall in reverse order of this procedure. Tighten 17 mm retaining nuts or T50 screw to 170 in-lbs (19.2 Nm).

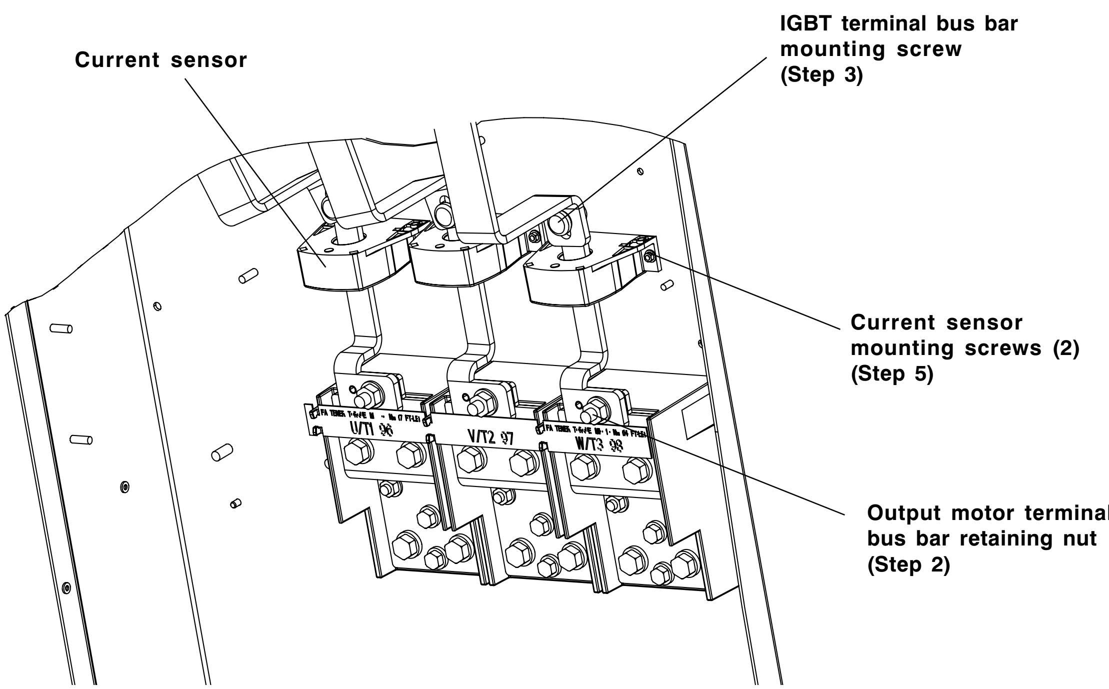

Figure 7-9. Current Sensors

7.12 Fan Assembly

1. Remove input terminal plate in accordance with procedure.

2. Remove retaining nut (17 mm) or T50 Torx screw, depending on unit type, connecting each of 3 IGBT over-fan bus bars to 3 current sensor bus bars.

3. Remove retaining nut (17 mm) connecting each of three IGBT over-fan bus bars to three IGBT output bus bars.

4. Disconnect in-line Molex connector in fan wiring. Cut tie wrap to free wiring from frame.

5. Remove fan assembly by removing 6 retaining nuts (10 mm). Note that fan assembly weights approximately 25 pounds (11 kg).

Reinstall in reverse order of this procedure. Tighten 10 mm retaining nuts to 35 in-lbs (4.0 Nm) and 17 mm connecting nuts or T50 screw to 170 in-lbs (19.2 Nm).

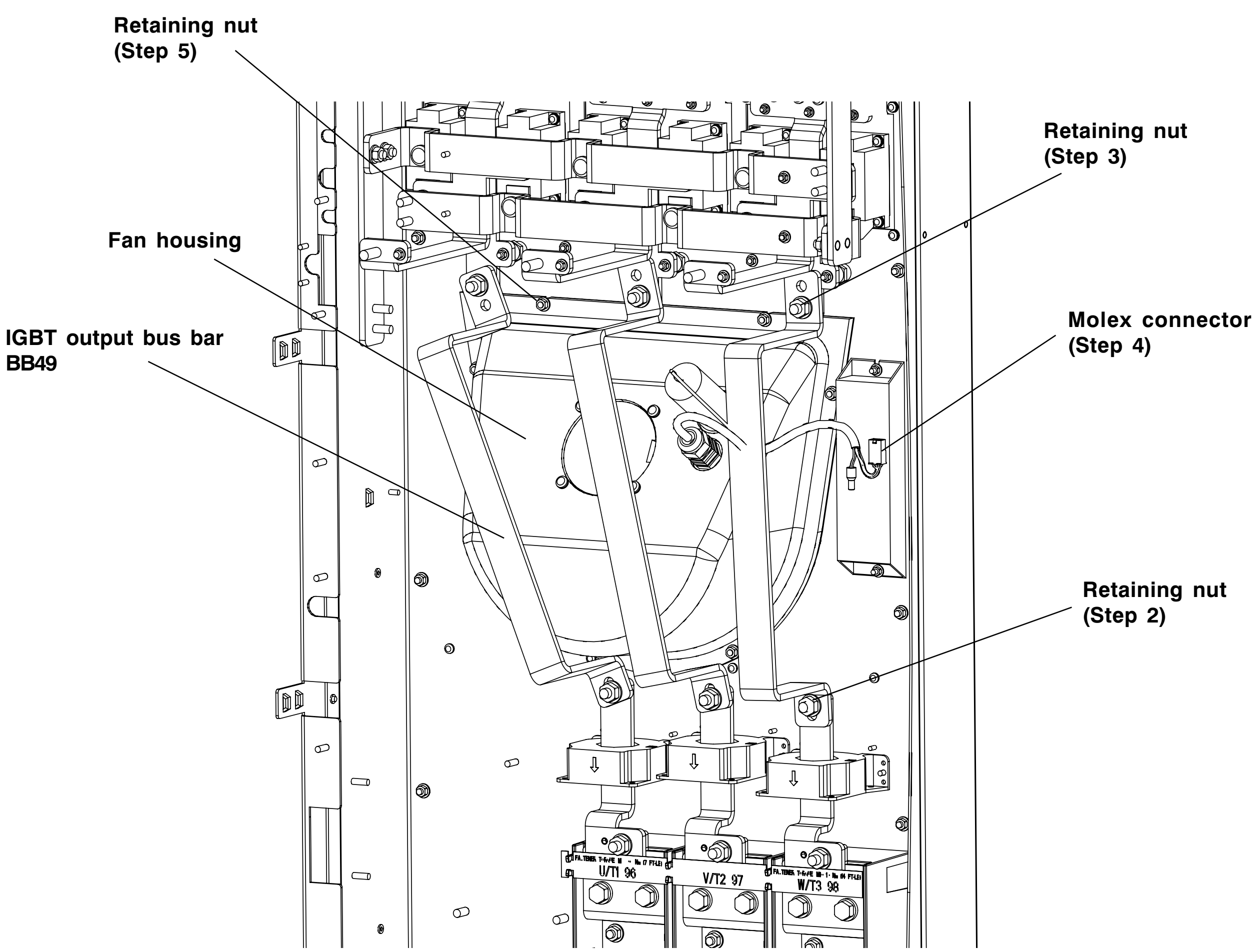

Figure 7-10. Fan Assembly

7.13 AC Input, Motor, Load Sharing or Regen Terminals

1. Remove external wiring from terminals as required.

2. Remove retaining nut (17 mm) connecting terminal bus bar to other bus bar assemblies.

3. Remove 2 retaining nuts (13 mm) attaching terminal bus bar to terminal block insulation. Slide terminal bus bar out.

4. If terminal block is attached to input terminal plate (not shown), remove retaining screw (T40) attaching terminal block insulation, otherwise go to step 5.

5. If terminal block is not attached to the input terminal plate, remove retaining nut (13 mm) attaching terminal block insulation.

Reinstall in reverse order of this procedure. Tighten 17 mm connecting nuts to 170 in-lbs (19.2 Nm) and 13 mm or T40 Torx screw to 85 in-lbs (9.6 Nm).

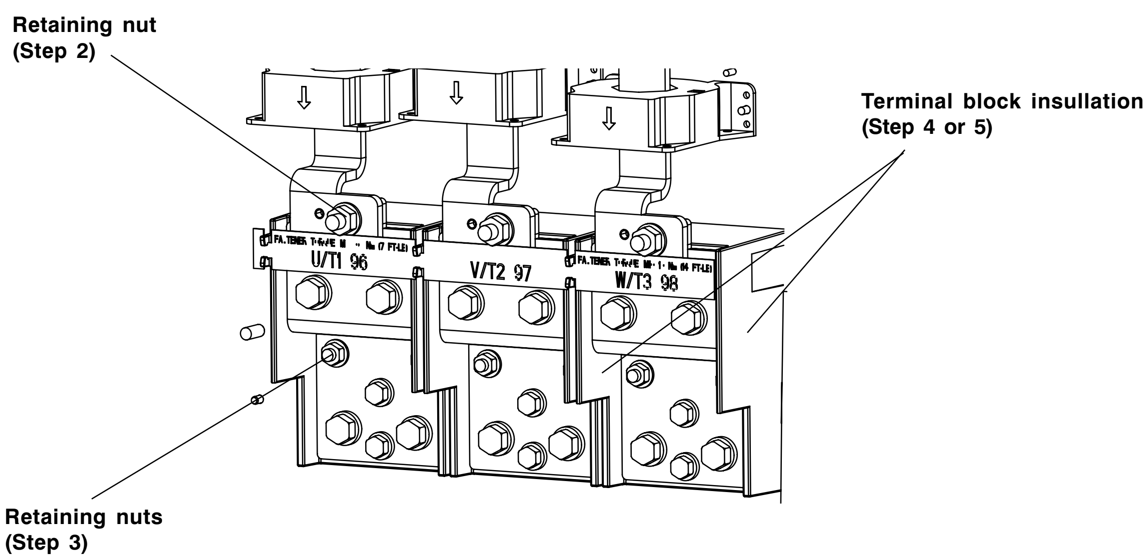

Figure 7-11. Terminal Blocks

7.14 IGBT Modules

1. Remove both DC capacitor banks in accordance with procedure.

2. Remove Input Terminal Plate in accordance with procedure.

3. Remove wire retaining nut (10 mm) from each of 3 SCR input bus bars.

4. Note color coding for each of 3 wires attached to retaining studs. Ensure that correct wire is attached to applicable stud upon reassembly. Remove wiring from studs.

5. Remove wire retaining nut (8 mm) from SCR output bus bars. One from (+) DC bus bar and one from (–) DC bus bar.

6. Note color coding for each wire attached to retaining studs. Ensure that correct wire is attached to applicable stud upon reassembly. Remove wiring from studs.

7. Remove 4 retaining nuts (13 mm) on side of bus bars, 2 on each bus bar.

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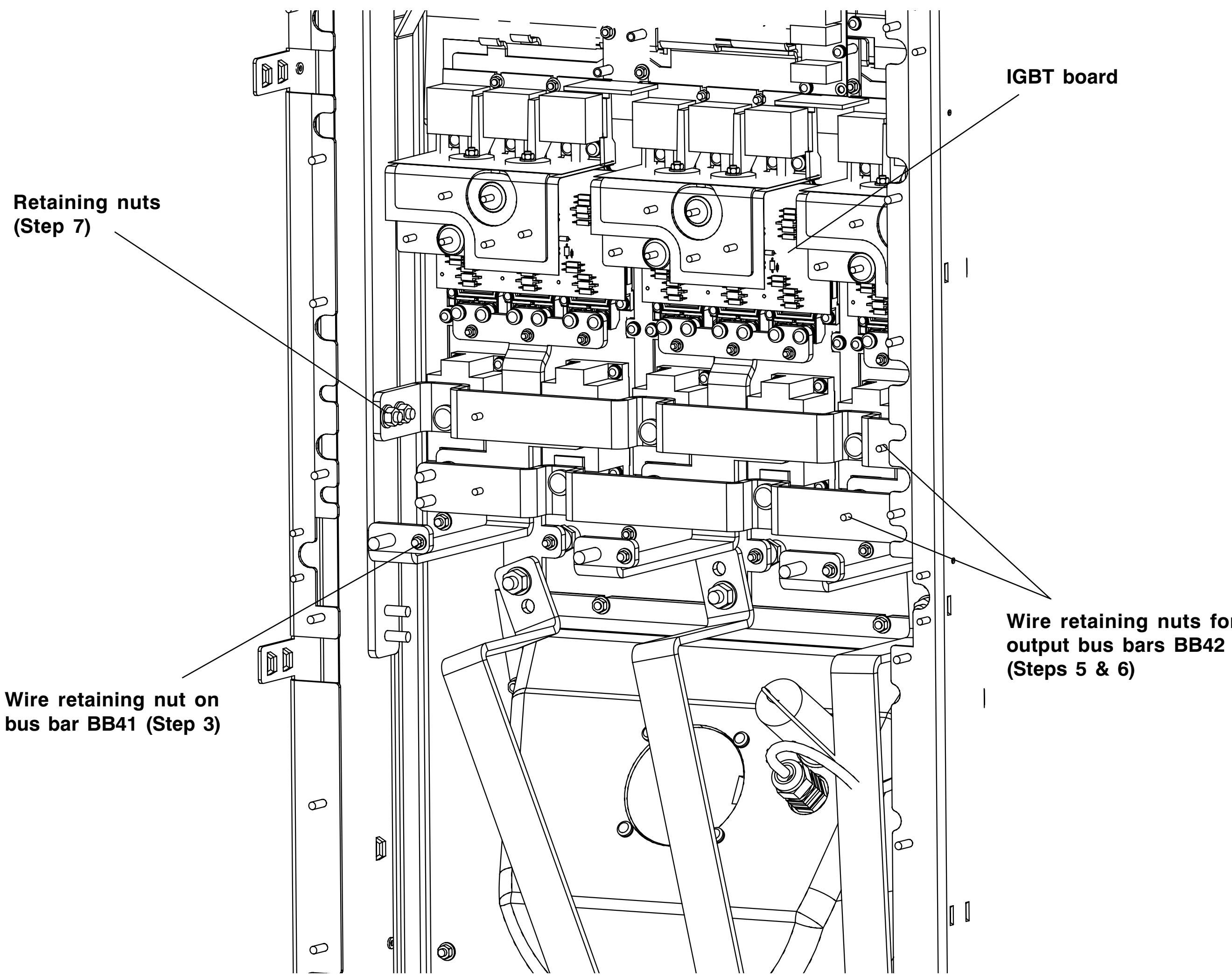

Figure 7-12. IGBT Modules (1 of 4)

8. If unit is not equipped with load sharing option, proceed to step 9. If unit is equipped with load sharing, load share minus (-) bus bar must be removed as follows.

   a. Remove 2 retaining nuts (13 mm) connecting load share bus bar to the SCR output bus bar.

   b. Remove retaining nut (17 mm) connecting load share bus bar to load share terminal on opposite end of bus bar (not shown).

   c. Remove load share bus bar.

9. Remove both positive (+) and negative (-) SCR output bus bars by removing 6 connection screws (T50). There are 3 screws per bus bar.

10. Remove three SCR and Diode input bus bars by removing 6 connection screws (T50). There are 2 screws per bus bar.

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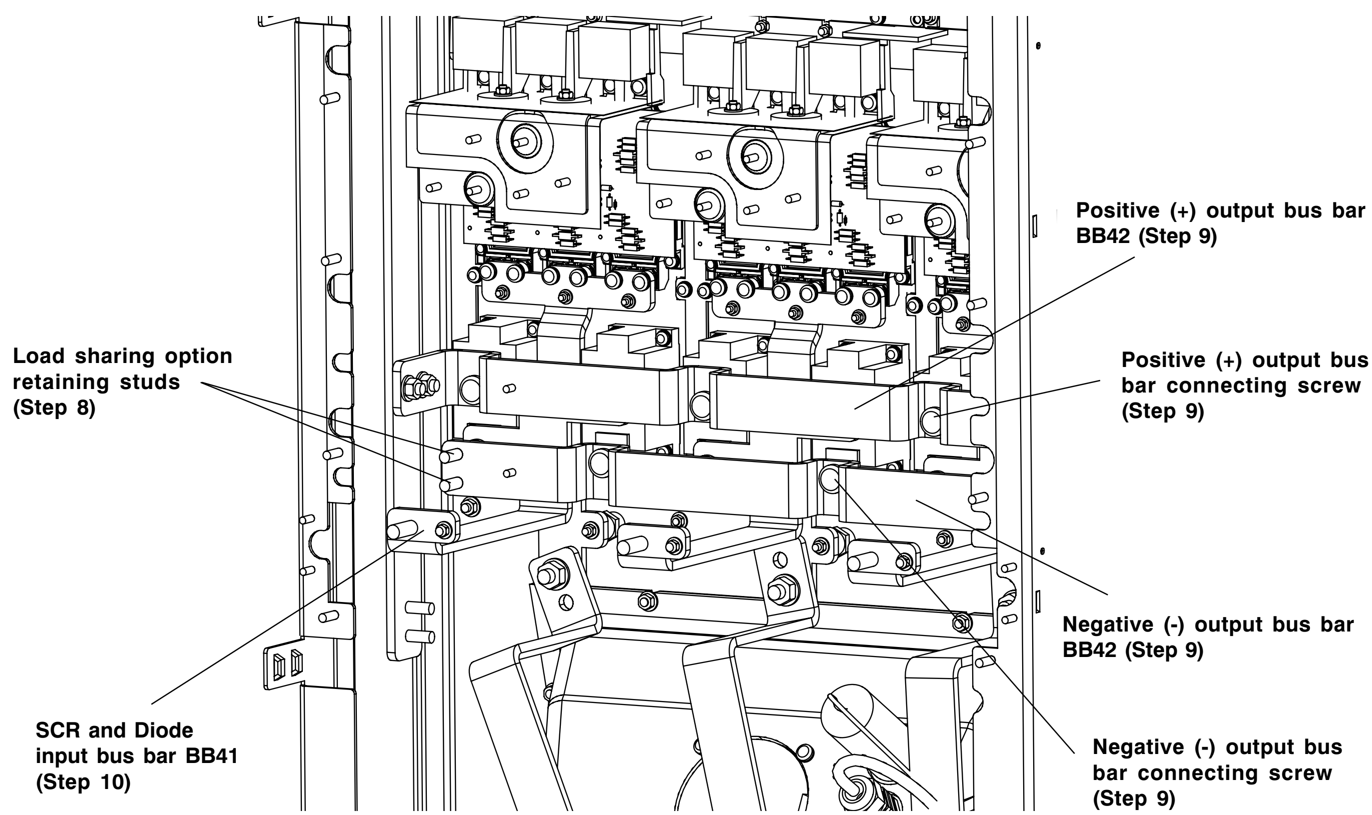

Figure 7-12. IGBT Modules (2 of 4)

11. Remove 6 retaining screws (T30) connecting each IGBT module output to IGBT output bus bars.

12. Remove retaining nut (17 mm) connecting IGBT output bus bar to IGBT over-fan bus bar. Note that there is one for each of three phases.

13. Remove retaining nut (17 mm) or T50 Torx screw, depending on unit type, connecting IGBT over-fan bus bar to current sensor bus bar.

14. Remove 3 retaining nuts (17 mm) at top and one retaining nut (8 mm) at bottom attaching IGBT output bus bar to standoffs. Remove IGBT output bus bar.

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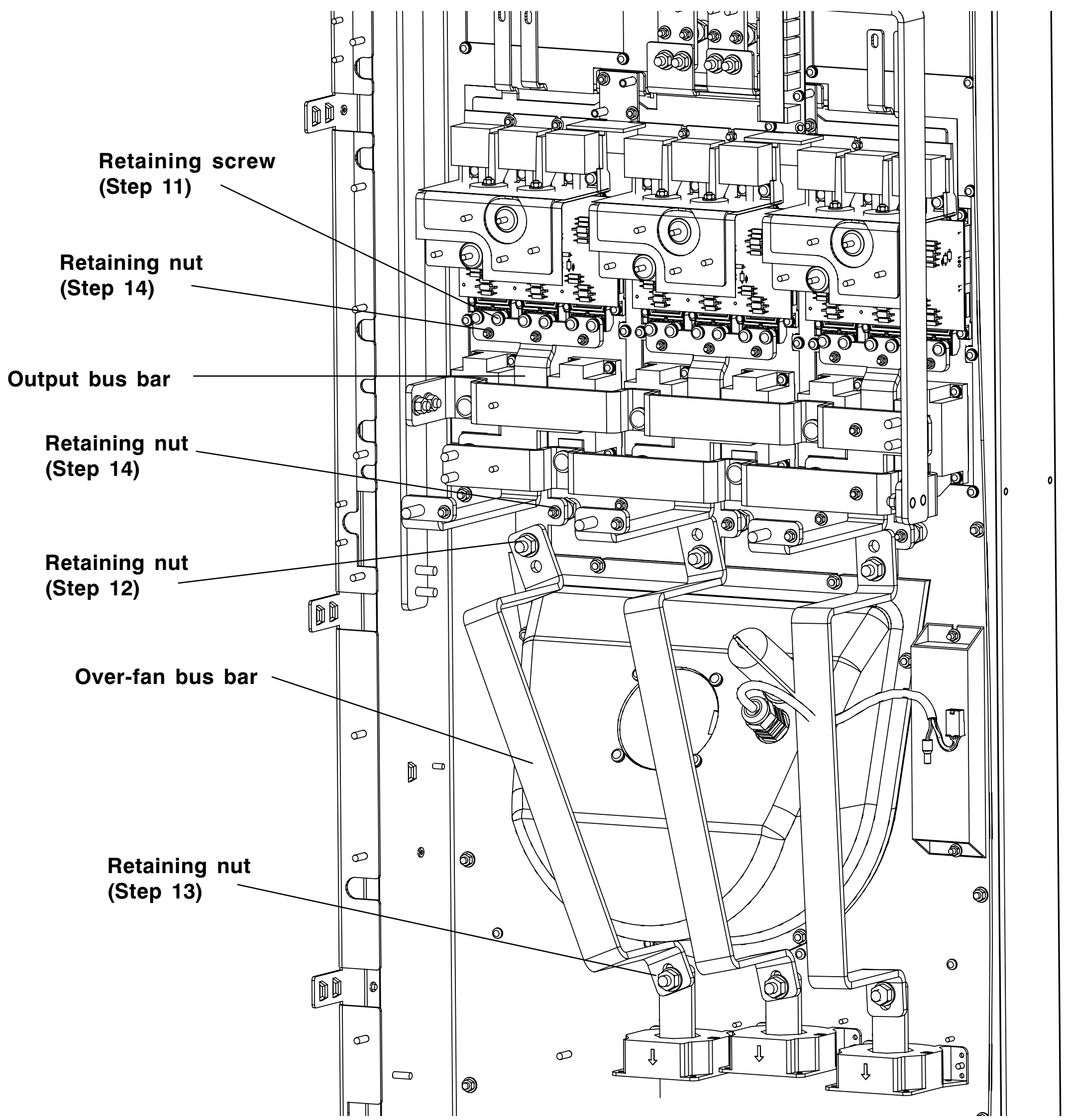


Figure 7-12. IGBT Modules (3 of 4)

15. Remove 18 retaining screws (T30) on IGBT input terminals. Note snubber capacitors come off when screws are removed. There are 6 screws for each IGBT module.

16. Remove 2 retaining nuts (8 mm) connecting each IGBT-Cap bus bar assemblies to IGBT-Ind bus bar assembly and remove the IGBT-Cap bus bar assembly. There are three IGBT-Cap bus bar assemblies.

17. Remove retaining nut (8 mm) from high frequency board.

18. Remove 2 retaining screws (T25) from high frequency board.

19. Disconnect wire assembly from high frequency board and remove board.

20. If unit has Brake IGBTs, remove the 4 retaining screws (T30) connecting IGBT-Ind bus bar assembly to Brake IGBT. Note that there are 2 screws per Brake IGBT module.

21. Remove 4 retaining nuts (13 mm) connecting IGBT-Ind bus bar assembly to two DC bus bars from inductor. Remove IGBT-Ind bus bar assembly.

22. Remove 8 retaining screws (T25) mounting each IGBT module.

REASSEMBLY

1. Replace IGBT modules in accordance with instructions included with replacement modules.

2. Reassemble in reverse order.

Attaching Hardware	Tightening Torque
8 mm / T25	20 in-lbs (2.25 Nm)
10 mm / T30	35 in-lbs (4.0Nm)
13 mm	85 in-lbs (9.6 Nm)
17 mm / T50	170 in-lbs (19.2 Nm)

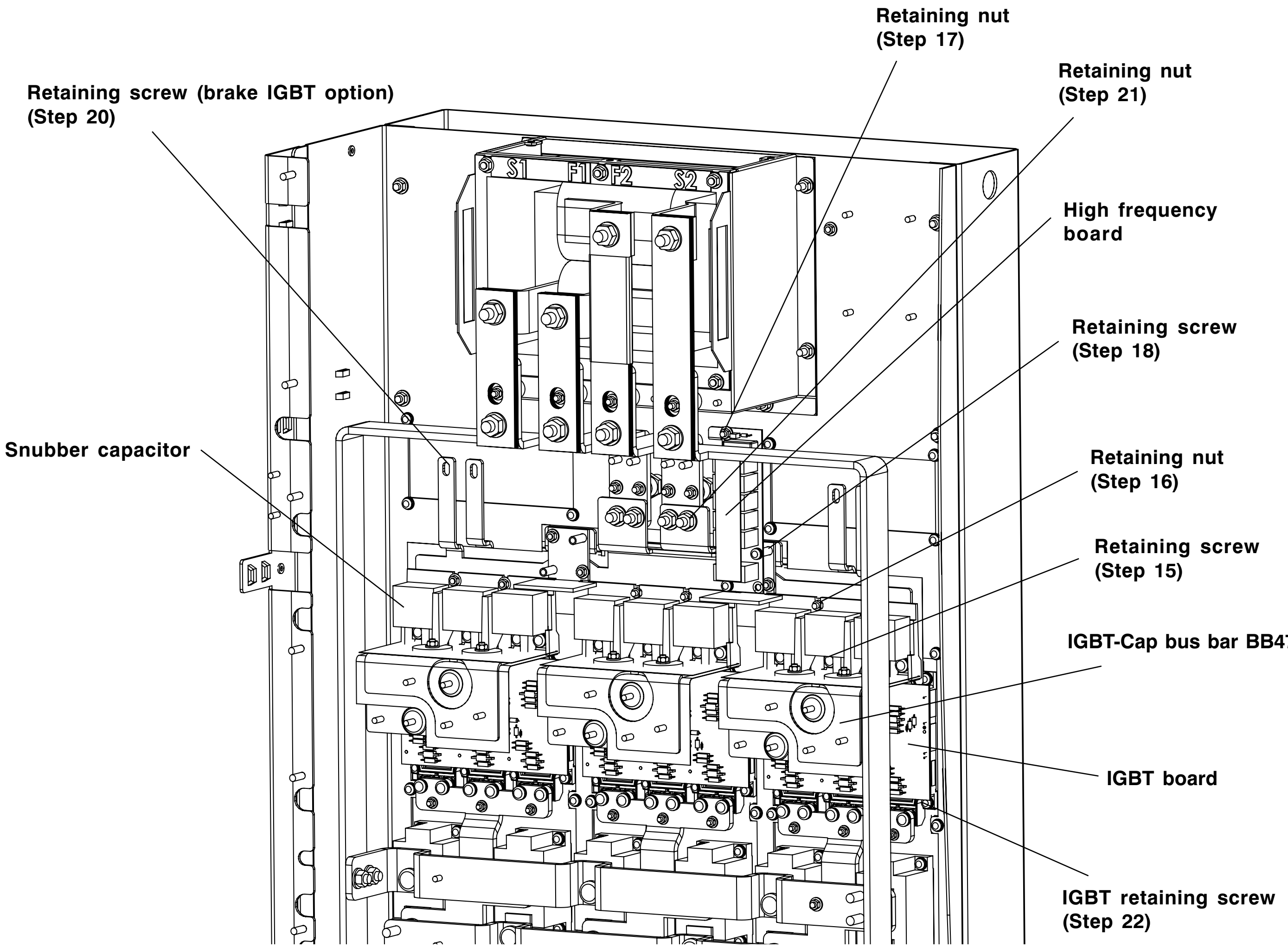


Figure 7-12. IGBT Modules (4 of 4)

SECTION 8
SPECIAL TEST EQUIPMENT

TEST EQUIPMENT

Test tools have been developed to aid in troubleshooting these products. It is highly recommended for repair and servicing this equipment that these tools be available to the technician. Without them some troubleshooting procedures described in this manual cannot be carried out. Although some test points can be found inside the drive to probe for similar signals, the test tools provide a safe and sure point for making necessary measurements. Test equipment described in this section is available from Danfoss.

⚠WARNING

Use of test cable allows powering the drive without charging DC bus capacitors. Main input power is required and all line powered devices and power supplies are energized at rated voltage. Use extreme caution when conducting tests on a powered drive. Contact with powered components could result in electrical shock and personal injury.

Test Cable and SCR Shorting Plug (p/n 176F8439)

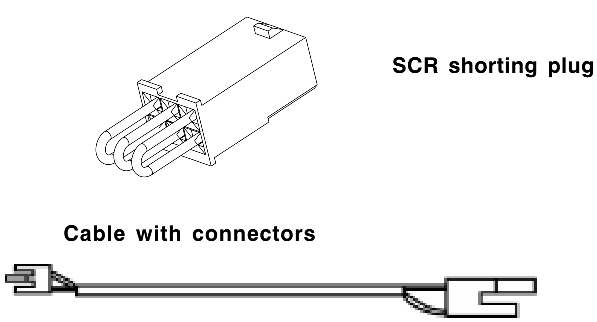


Figure 8-1. Test Cable and SCR Shorting Plug

This tool provides the ability to power up the Switch Mode Power Supplies (SMPS) and activate all the control functions of the drive without having the DC bus charged. It provides protection for troubleshooting gate drive signals and other important control signals within the drive than having the DC bus disabled.

The cable is connected between the soft charge card and the power card. The SCR shorting plug shorts the gates of the SCRs to ensure they do not fire and add a charge to the DC bus.

Test cables provided after September, 2005, are usable on all drives described in this manual. Test cables prior to that date are shorter and apply only for D-frame size units.

To install the cable, first ensure the drive is powered down and the DC bus is fully discharged.

1. For D-frame size units, follow procedure in Section 6 for soft charge card removal and disengage soft charge card far enough to disconnect cable plugged into MK3.
2. For all frame sizes, disconnect cable from MK3 connector on soft charge card and connect one end of test cable into MK3.
3. For D-frame size units, reinstall soft charge card.
4. For all frame sizes, disconnect connectors MK100 and MK105 on power card.
5. For all frame sizes, connect free end of test cable into MK105.
6. For all frame sizes, connect SCR gate shorting plug (included with test cable 176F8437) into cable that was removed from MK100.

When reapplying main input power to the drive, the soft charge rectifier provides DC power to the power card. Testing with the use of the gate signal board and the signal test board can now be carried out without the presence of DC bus voltage.

Signal Test Board (p/n 176F8437)

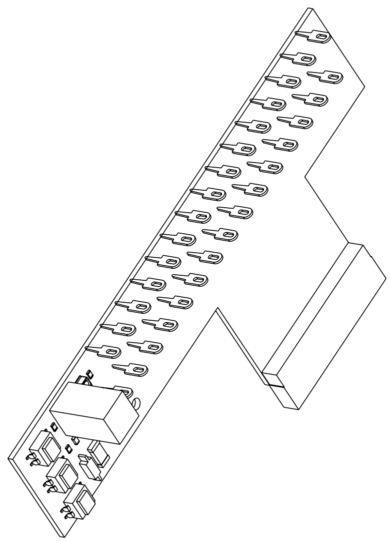


Figure 8-2. Signal Test Board

The Signal Test Board provides access to a variety of signals that can be helpful in troubleshooting the drive.

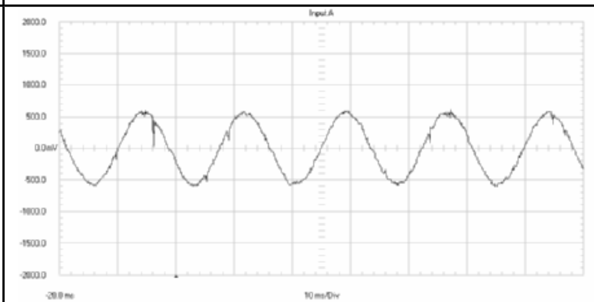
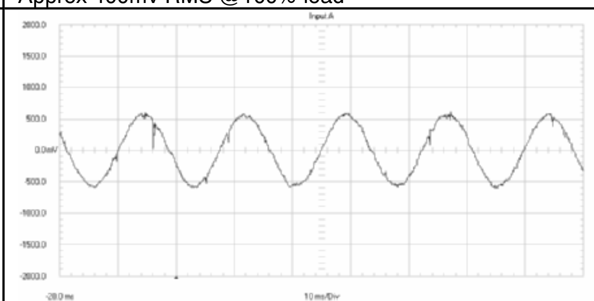
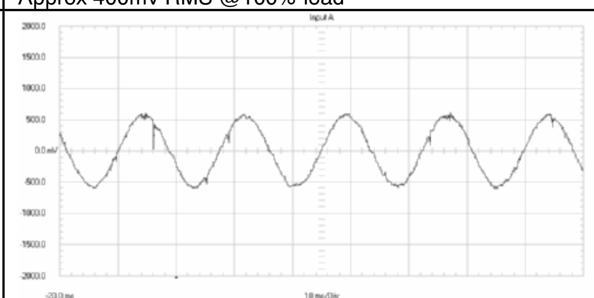
The signal test board is plugged into interface card connector MK104. Points on the signal test board can be monitored with or without the DC bus disabled. In some cases the drive will need the DC bus enabled and operating a load to verify some test signals.

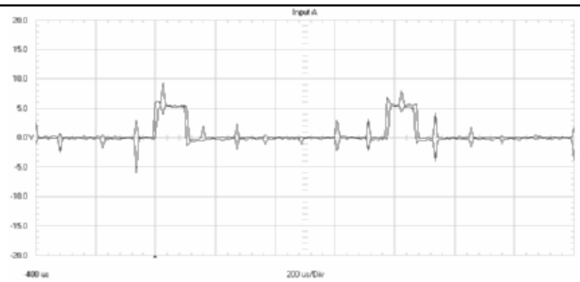
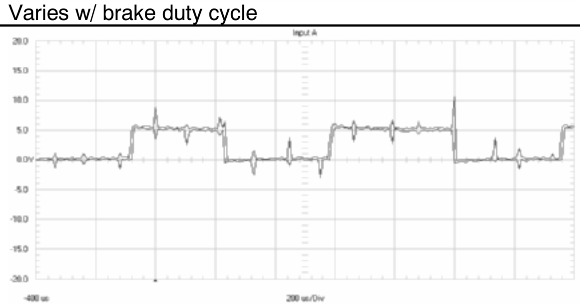
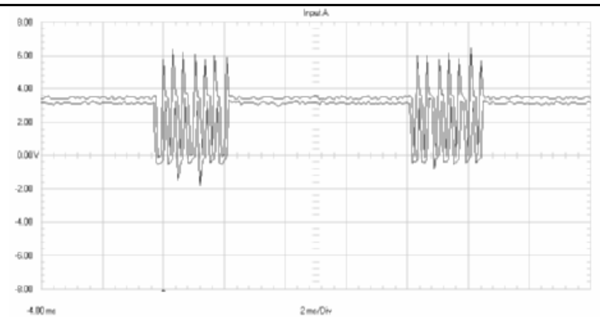
Following is a description of the signals available on the signal test board. Section 5 of this manual describes when these tests would be called for and what the signal should be at that given test point.

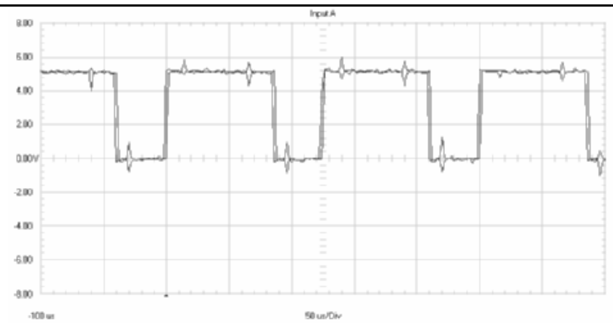
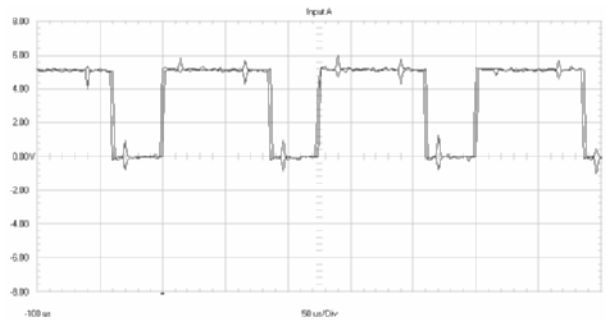
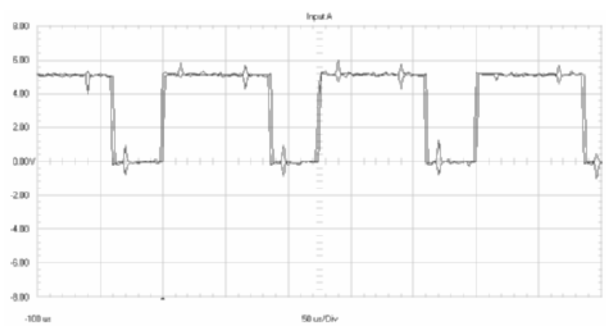
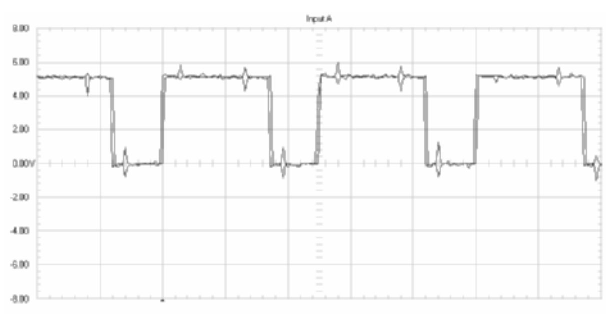
Signal Test Board Pin Outs: Description and Voltage Levels

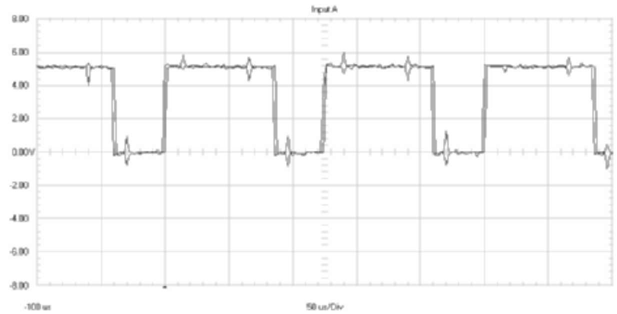
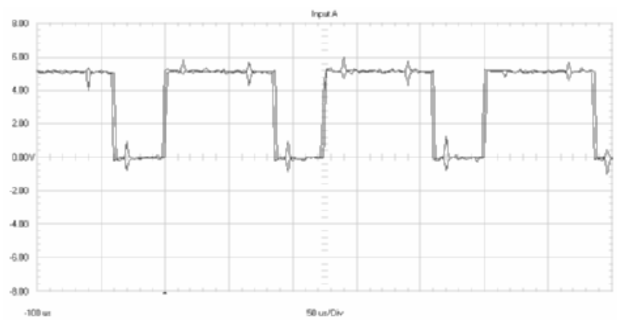
The tables on the following pages list the pins located on the signal test board. For each pin, its function, description, and voltage levels are provided. Details on performing tests using the test fixture are provided in Section 5 of this manual. Other than power supply measurements, most of the signals being measured are made up of waveforms.

Although in some cases a digital voltmeter can be used to verify the presence of such signals, it cannot be relied upon to verify that the waveform is correct. An oscilloscope is the instrument prefered. However, when similar signals are being measured at multiple points, a digital voltmeter can be used with some degree of confidence. By comparing several signals to each other, such as gate drive signals, and obtaining similar readings, it can be concluded each of the waveforms match one another and are therefore correct. Values are provided for using a digital volt meter for testing as well.

Pin No.	Schematic Acronym	Function	Description	Reading Using a Digital Volt Meter
1	IU1	Current sensed, U phase, not conditioned	 Approx 400mv RMS @100% load	.937 VACpeak @ 165% of CT current rating. AC waveform @ output frequency of the drive.
2	IV1	Current sensed, V phase, not conditioned	 Approx 400mv RMS @100% load	.937 VACpeak @ 165% of CT current rating. AC waveform @ output frequency of the drive.
3	IW1	Current sensed, W phase, not conditioned	 Approx 400mv RMS @100% load	.937 VACpeak @ 165% of CT current rating. AC waveform @ output frequency of the drive.
4	COMMON	Logic common	This common is for all signals.	
5	AMBT	Ambient temp.	Used to control FAN high and low fan speeds.	1VDC approximately equal to 25C
6	FANO	Control Card signal	Signal from Control Card to turn fans on and off.	0VDC – ON command 5VDC – OFF command
7	INRUSH	Control Card signal	Signal from Control Card to start gating SCR front end	5VDC – SCRs disabled 0VDC – SCRs enabled
8	RL1	Control Card signal	Signal from Control Card to provide status of Relay 01	5VDC – Relay active 0VDC – inactive
9	EXT24V	Signal to Control Card	Signal indicating a backup power supply is active.	5VDC – backup present 0VDC – no backup
10	TEMP_HS	Analog signal inversely proportional to HS temp	Will read ~ 3.3 volts if the heat sink NTC is disconnected. As HS temperature goes up the voltage goes down.	Formula, VDC = 2.82 – 0.035 * (T – 30), where T is the temperature in degrees Celsius.
11	VPOS	+18 VDC regulated supply +16.5 to 19.5 VDC	Red LED indicates voltage is present between VPOS and VNEG terminals.	+18 VDC regulated supply +16.5 to 19.5 VDC
12	VNEG	-18 VDC regulated supply -16.5 to 19.5 VDC	Red LED indicates voltage is present between VPOS and VNEG terminals.	-18 VDC regulated supply -16.5 to 19.5 VDC

Pin No.	Schematic Acronym	Function	Description	Reading Using a Digital Volt Meter
13	DBGATE	Brake IGBT gate pulse train. (Signal to brake IGBT.)	 Varies w/ brake duty cycle	Voltage drops to zero when brake is turned off. Voltage increases to 4.04 VDC as brake duty cycle reaches max.
14	BRT_ON	Brake IGBT 5V logic level signal. (Indicates voltage across brake IGBT.)	 Varies w/ brake duty cycle	5.10 VDC level with the brake turned off. Voltage decreases to zero as brake duty cycle reaches max.
15	OTFLT	Temperature / Voltage out of range	Monitors Brake resistor, Heatsink temp, Ambient temp, power supplies voltages.	5VDC – No fault 0VDC – Fault
16	FAN_TST	Control signal for fans	Indicates Fan Test switch is activated to force the fans on high	+5VDC – disabled 0VDC – fans on high
17	FAN_ON	Pulse train to gate SCR's for fan voltage control. In sync with line freq.	 7 trigger pulses at 3Khz	5VDC - fans off ~4.3VDC – fans on
18	HI_LOW	Control signal from Power Card	Signal to switch fan speeds between high and low	+5VDC = fans on high, Otherwise 0VDC.
19	SCR_DIS	Control signal for SCR front end	Indicates SCR front end is enabled or disabled.	0.6 to 0.8 VDC – SCRs enabled 0VDC – SCR disabled
20	INV_DIS	Control signal from Power Card	Disables IGBT gate voltages	5VDC – inverter disabled 0VDC – inverter enabled
21	RFI_RL2	Control signal for RFI	Ground signal to enable RFI HF capacitors	24VDC – no RFI 0VDC – RFI enabled
22	UINVEX	Bus Voltage scaled down	Signal proportional to UDC	380- 500 V 1VDC = 262 VDC 525 – 690 V 1VDC = 373 VDC OV switch must be off.
23	VDD	+24 VDC power supply	Yellow LED indicates voltage is present.	+24 VDC regulated supply +23 to 25 VDC
24	VCC	+5.0 VDC regulated supply. +4.75-5.25 VDC	Green LED indicates voltage is present.	+5.0 VDC regulated supply +4.75 to 5.25 VDC

Pin No.	Schematic Acronym	Function	Description	Reading Using a Digital Volt Meter
25	GUP_T	IGBT gate signal, buffered, U phase, positive. Signal originates on Control Card.	 2v/div 100us/div Run@10Hz	2.2 - 2.5 VDC Equal on all phases TP25-TP30
26	GUN_T	IGBT gate signal, buffered, U phase, negative. Signal originates on Control Card.	 2v/div 100us/div Run@10Hz	2.2 - 2.5 VDC Equal on all phases TP25-TP30
27	GVP_T	IGBT gate signal, buffered, V phase, positive. Signal originates on Control Card.	 2v/div 100us/div Run@10Hz	2.2 - 2.5 VDC Equal on all phases TP25-TP30
28	GVN_T	IGBT gate signal, buffered, V phase, negative. Signal originates on Control Card.	 2v/div 100us/div Run@10Hz	2.2 - 2.5 VDC Equal on all phases TP25-TP30

Pin No.	Schematic Acronym	Function	Description	Reading Using a Digital Volt Meter
29	GWP_T	IGBT gate signal, buffered, W phase, positive. Signal originates on Control Card.	 2v/div 100us/div Run@10Hz	2.2 - 2.5 VDC Equal on all phases TP25-TP30
30	GWN_T	IGBT gate signal, buffered, W phase, negative. Signal originates on Control Card.	 2v/div 100us/div Run@10Hz	2.2 - 2.5 VDC Equal on all phases TP25-TP30

 VLT is a registered Danfoss trademark

General Notes:

IGBT spare part kits for D1 and D2 380-500 VAC units include the IGBT modules required to replace all modules in the drive, along with the gate cables. For all other units, the IGBT spare part kits have just one IGBT module, and gate cables must be ordered separately.

The IGBT mounting procedure has changed from thermal grease application to use of thermal mounting pads. Replacement parts now come with thermal pads. Thermal grease is permitted for existing spare parts in inventory.

For 600/690 VAC units, use only the wire harness dated after 18 April 2005. For 380-500 VAC drives, either the new or older wire harness may be used. The date of the spare is shown on the spare part kit.

When ordering spare parts for conformal coated drives, choose the appropriate conformal coated version of the control card and power card. All other spare parts are suitable for conformal coated drives and can be used in either coated or non-conformal coated drives.

Bus bars used in some units are aluminum. Spare part bus bars are always plated copper. Plated copper bus bars are useable for all units.

Common Spares for All Models

Block diagram Designator	Spare part Number	Spare part name (40 characters)	Comments
		Spares Common to All Drive Sizes and Voltages	
PCA1	176F1400	SPARE,PCA,CONTROL,VLT5000P	Control PCA - VLT 5000 Process
PCA1	176F1452	SPARE,CTRL CARD ASSY,PROC,CONF	Control PCA - VLT 5000 Process. Conformal coated
PCA1	176F1405	SPARE,PCA,CTRL CARD,VLT6000	Control PCA - VLT 6000 HVAC
PCA1	176F1453	SPARE,CTRL CARD,AQUA/HVAC,CONF	Control PCA - VLT 6000 HVAC. Conformal coated
PCA1	176F5591	SPARE,PCA,CONTROL,VLT4000V	Control PCA - VLT 4000
PCA1	176F5592	SPARE,PCA,CONTROL,VLT4000V,COAT	Control PCA - VLT 4000. Conformal coated
PCA1	175Z3595	SPARE,CONTROL,FLUX UNIT W/SOFTWARE,C1	Control PCA - VLT 5000 Flux. Conformal coated
PCA1	176F5580	SPARE,PCA,CONTROL,8000A	Control PCA - VLT 8000 Aqua
PCA1	176F5581	SPARE,CONTROL CARD,VLT8000A,COATED	Control PCA - VLT 8000 Aqua. Conformal coated
LCP1	175Z0401	SPARE,LOCAL CONTROL PANEL,PROC	LCP - Process
LCP1	175Z7804	SPARE,LOCAL CONTROL PANEL,HVAC	LCP - HVAC, Aqua, 4000
PCA1 MK100	613X6358	SPARE,CC CONNECTOR,12 POS	Controll card 12 position terminal block connector
PCA1 MK105	613X6360	SPARE,CC CONNECTOR,3 POS	Controll card 3 position terminal block connector
PCA1 MK101	613X6359	SPARE,CC CONNECTOR,9 POS	Controll card 9 position terminal block connector
PCA1	175Z1158	SPARE,CRADLE,LCP	LCP cradle
PCA1	175Z1064	SPARE.CONTROL CARD CASSETTE	Control card cassette

Spare Parts List D-frame Sizes

Block diagram Designator	Spare part Number	Spare part name (40 characters)	Comments	Requirements Per Drive 380-500 VAC (380-460 VAC, 380-480 VAC)					Requirements Per Drive 525-690 VAC (525-600 VAC)										
				VLT5122	VLT5152	VLT5202	VLT5252	VLT5302	VLT5042	VLT5052	VLT5062	VLT5072	VLT5102	VLT5122	VLT5152	VLT5202	VLT5252	VLT5302	VLT5352
				VLT5122F	VLT5152F	VLT5202F	VLT5252F	VLT5302F											
				VLT4152	VLT4202	VLT4252	VLT4302	VLT4352				VLT4102	VLT4122	VLT4152	VLT4202	VLT4252	VLT4302	VLT4352	VLT4402
				VLT6152	VLT6172	VLT6222	VLT6272	VLT6352				VLT6102	VLT6122	VLT6152	VLT6172	VLT6222	VLT6272	VLT6352	VLT6402
				VLT8152	VLT8202	VLT8252	VLT8302	VLT8352	VLT8052	VLT8062	VLT8072	VLT8102	VLT8122	VLT8152	VLT8202	VLT8252	VLT8302	VLT8352	VLT8402
		PCAs																	
PCA 2	176F8300	Spare,BCC INTERFACE PCA, VLT5122	Interface Card: between Control Card and Power Card	1															
PCA 2	176F8301	Spare,BCC INTERFACE PCA, VLT5152	Interface Card: between Control Card and Power Card		1														
PCA 2	176F8302	Spare,BCC INTERFACE PCA, VLT5202	Interface Card: between Control Card and Power Card			1													
PCA 2	176F8303	Spare,BCC INTERFACE PCA, VLT5252	Interface Card: between Control Card and Power Card				1												
PCA 2	176F8304	Spare,BCC INTERFACE PCA, VLT5302	Interface Card: between Control Card and Power Card					1											
PCA 2	176F8511	Spare,BCC Interface PCA,VLT5042T7	Interface Card: between Control Card and Power Card						1										
PCA 2	176F8512	Spare,BCC Interface PCA,VLT5052T7	Interface Card: between Control Card and Power Card							1									
PCA 2	176F8513	Spare,BCC Interface PCA,VLT5062T7	Interface Card: between Control Card and Power Card								1								
PCA 2	176F8514	Spare,BCC Interface PCA,VLT5072T6/7	Interface Card: between Control Card and Power Card									1							
PCA 2	176F8515	Spare,BCC Interface PCA,VLT5102T6/7	Interface Card: between Control Card and Power Card										1						
PCA 2	176F8516	Spare,BCC Interface PCA,VLT5122T6/7	Interface Card: between Control Card and Power Card											1					
PCA 2	176F8517	Spare,BCC Interface PCA,VLT5152T6/7	Interface Card: between Control Card and Power Card												1				
PCA 2	176F8518	Spare,BCC Interface PCA,VLT5202T6/7	Interface Card: between Control Card and Power Card													1			
PCA 2	176F8519	Spare,BCC Interface PCA,VLT5252T6/7	Interface Card: between Control Card and Power Card														1		
PCA 2	176F8520	Spare,BCC Interface PCA,VLT5302T6/7	Interface Card: between Control Card and Power Card															1	
PCA 2	176F8521	Spare,BCC Interface PCA,VLT5352T6/7	Interface Card: between Control Card and Power Card																1
PCA 3	176F8313	Spare,POWER PCA,CC,VLT5122-5302	Power PCA does not include the I-Scaling PCA	1	1	1	1	1											
PCA 3	176F8411	Spare,POWER PCA,VLT5122-5302	Power PCA does not include the I-Scaling PCA. Not Coated	1	1	1	1	1											
PCA 3	176F8524	Spare,Power PCA,CC,VLT5122-5352T6/7	Power Card, does not include the I-Scaling Card						1	1	1	1	1	1	1	1	1	1	1
PCA 4	176F8308	Spare,I-Scaling PCA, 4.54 Ohm	Current Scaling PCA. Installs on Power PCA. 5122T5 and 5152T6/7	1											1				
PCA 4	176F8309	Spare,I-Scaling PCA,3.79 Ohm	Current Scaling PCA. Installs on Power PCA. 5152T5		1														
PCA 4	176F8310	Spare,I-Scaling PCA, 3.10 Ohm	Current Scaling PCA. Installs on Power PCA. 5202T5 and 5202-5252T6/7			1										1	1		
PCA 4	176F8311	Spare,I-Scaling PCA, 2.56 Ohm	Current Scaling PCA. Installs on Power PCA. 5252T5 and 5302T6/7				1											1	
PCA 4	176F8312	Spare,I-Scaling PCA, 5.10 Ohm	Current Scaling PCA. Installs on Power PCA. 5302T5 and 5352T6/7					1											1
PCA 4	176F8525	Spare,I-Scaling PCA,5.85 Ohm	Current Scaling PCA. Installs on Power PCA. 5042-5122T6/7						1	1	1	1	1	1					
PCA 5	176F8305	Spare.Gate Drive PCA,CC,D Frame	Gate Drive PCA, conformal coated. 5122-5302T5 and 5122-5352T6/7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PCA 8	176F8307	Spare, HF PCA, VLT5122-5302	High Frequency PCA	1	1	1	1	1											
PCA 8	176F8523	Spare,HF PCA,VLT5122-5352T6/7	High Frequency PCA						1	1	1	1	1	1	1	1	1	1	1
PCA11	176F8306	Spare,SOFTCHARGE PCA,CC,VLT5122-5302	Softcharge PCA. Includes metal mounting bracket	1	1	1	1	1											
PCA11	176F8522	Spare,Softcharge PCA,CC,VLT5122-5302T6/7	Softcharge PCA, Includes metal mounting bracket						1	1	1	1	1	1	1	1	1	1	1
PCA9, 10	176F8510	Spare, Balance PCA,VLT5122-5302T4/5	Capacitor Bank balance card, included in capacitor bank spare part	1	1	1	2	2											
PCA9, 10	176F8526	Spare,Balance PCA,VLT5122-5352T6/7	Capacitor Bank balance card, included in capacitor bank spare part						1	1	1	1	1	1	1	2	2	2	2
		Semiconductors																	
IGBT1, PCA 6	176F8451	SPARE, IGBT KIT, VLT5122T4/5	Includes: IGBT, gate PCA, fasteners, gate cables, and thermal pad	1															
IGBT1, PCA 6	176F8452	SPARE, IGBT KIT, VLT5152T4/5	Includes: IGBT, gate PCA, fasteners, gate cables, and thermal pad		1														
IGBT1,2 PCA 6, 7	176F8453	SPARE, IGBT KIT, VLT5202-5252T4/5	Includes: Two IGBTs, gate PCAs, fasteners, gate cables, and thermal pad			1	1												
IGBT1,2 PCA 6, 7	176F8454	SPARE, IGBT KIT, VLT5305T4/5	Includes: Two IGBTs, gate PCAs, fasteners, gate cables, and thermal pad					1											
IGBT1,2 PCA 6, 7	176F8527	Spare,IGBT Kit,300A,1700V	Includes: IGBT, gate PCA, fasteners, and themal pad. Note quantity required						1	1	1	1	1	1		2	2		
IGBT1,2 PCA 6, 7	176F8528	Spare,IGBT Kit,450A,1700V	Includes: IGBT, gate PCA, fasteners, and themal pad. Note quantity required												1			2	2
IGBT3,4 PCA 13, 14	176F8316	SPARE,IGBT Kit,BRK,VLT5122-VLT5302	Includes: IGBT, gate PCA, fasteners, and themal pad. Note quantity required	1	1	2	2	2	1	1	1	1	1	1	1	2	2	2	2
SCR1,2,3	176F8317	SPARE,SCR/DI KIT,160A, 1600V	Includes:SCRs, fasteners, and thermal pad. Note quantity required	3	3														
SCR1,2,3	176F8318	SPARE,SCR/DI KIT,175A, 1600V	Includes:SCRs, fasteners, and thermal pad. Note quantity required			3													
SCR1,2,3	176F8319	SPARE,SCR/DI KIT,250A, 1600V	Includes:SCRs, fasteners, and thermal pad. Note quantity required				3												
SCR1,2,3	176F8320	SPARE,SCR/DI KIT,330A, 1600V	Includes:SCRs, fasteners, and thermal pad. Note quantity required					3											
SCR1,2,3	176F8529	Spare SCR/Di Kit, 160 Amp, 2200V	Includes: SCR module, fasteners, and thermal pad. Note quantity required						3	3	3	3	3	3	3	3			
SCR1,2,3	176F8530	Spare SCR/Di Kit, 280 Amp, 2200V	Includes: SCR module, fasteners, and thermal pad. Note quantity required														3	3	3
		Resistors																	
TH1	176F8321	SPARE,Thermistor ASSY,D Frame	Heat sink thermistor. Includes cable assembly.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
R1+CBL26	176F8322	SPARE,Softcharg Res ASSY,27 Ohm,110W	Soft charge resistor assembly. Includes cable assembly.	1	1	1	1	1											
R1+CBL26	176F8531	SPARE,Softcharg Res ASSY,68 Ohm,110W	Soft charge resistor assemby. Includes cable assembly						1	1	1	1	1	1	1	1	1	1	1
		Capacitors																	
C2,3,4,5,6,7	176F8323	SPARE,CAP,IGBT Snubber,1000V,1.5uF	IGBT snubber caps mounted on the IGBT modules. Note quantity required.	3	3	6	6	6											
C2,3,4,5,6,7	176F8534	SPARE,CAP,IGBT Snubber,1250V,1uF	IGBT snubber caps mounted on the IGBT modules. Note quantity required.						3	3	3	3	3	3	3	6	6	6	6
CBANK1 or 2 +PCA9 and 10	176F8324	SPARE,CAP BANK,450V,4CAP	Capacitor bank. Note quantity required. Replaces 410 VDC capacitors where applicable. Includes Balance Card	1			2	1 (upper)											
CBANK1 or 2 +PCA9 and 10	176F8325	SPARE,CAP BANK,450V,6CAP	Capacitor bank. Note quantity required. Replaces 410 VDC capacitors where applicable. Includes Balance Card		1	1		1 (lower)											
CBANK1 or 2 +PCA9 and 10	176F8532	Spare,Cap Bank,4 cap,T6/7	Capacitor bank, includes the Balance Card. Note quantity required.						1	1	1	1	1	1		2	2	1 (upper)	
CBANK1 or 2 +PCA9 and 10	176F8533	Spare,Cap Bank,6 cap,T6/7	Capacitor bank, includes the Balance Card. Note quantity required.												1			1 (lower)	2
		Fans																	
F1+C1+CBL11	176F8329	SPARE, HS FAN ASSY,D Frame	Heat sink fan assembly. Includes fan, fan box, capacitor, gasket, cables	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
F2	176F8330	SPARE,DOOR FAN KIT,D Frame	Door fan kit. Includes fan, grills, support, fasteners	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54
	176F8331	SPARE,DOOR VENT KIT,D Frame	Door fan vent kit. Includes grill, support, fasterners	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54
	176F8332	SPARE,DOOR FAN FILTER,PKG 10,D Frame	Door fan filters. Package of 10.	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54
F2	176F8333	SPARE,DOOR/TOP FAN, D Frame	Door or top fan. Includes fan only	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

VLT is a registered Danfoss trademark

Spare Parts List D-frame Sizes

Block diagram Designator	Spare part Number	Spare part name (40 characters)	Comments	Requirements Per Drive 380-500 VAC (380-460 VAC, 380-480 VAC)					Requirements Per Drive 525-690 VAC (525-600 VAC)										
				VLT5122	VLT5152	VLT5202	VLT5252	VLT5302	VLT5042	VLT5052	VLT5062	VLT5072	VLT5102	VLT5122	VLT5152	VLT5202	VLT5252	VLT5302	VLT5352
				VLT5122F	VLT5152F	VLT5202F	VLT5252F	VLT5302F											
				VLT4152	VLT4202	VLT4252	VLT4302	VLT4352				VLT4102	VLT4122	VLT4152	VLT4202	VLT4252	VLT4302	VLT4352	VLT4402
				VLT6152	VLT6172	VLT6222	VLT6272	VLT6352				VLT6102	VLT6122	VLT6152	VLT6172	VLT6222	VLT6272	VLT6352	VLT6402
				VLT8152	VLT8202	VLT8252	VLT8302	VLT8352	VLT8052	VLT8062	VLT8072	VLT8102	VLT8122	VLT8152	VLT8202	VLT8252	VLT8302	VLT8352	VLT8402
		Fuses																	
FU1,2,3	176F8334	SPARE,FUSE,SEMI,350Amp	Mains fuse. Package of 1	3	3								3	3	3				
FU1,2,3	176F8335	SPARE,FUSE,SEMI,630Amp	Mains fuse. Package of 1			3	3	3											
FU1,2,3	176F8540	SPARE,Fuse,Semi,550Amp	Mains fuse. Package of 1													3	3	3	3
FU1,2,3	176F8539	SPARE,Fuse,Semi,200Amp	Mains fuse. Package of 1						3	3	3	3							
FU4,5	176F8440	SPARE, FUSE, PWR PCA AND FAN, 4A,PKG3,D Frame	Power PCA and fan fuse. Package of 3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PCA11	176F8336	SPARE,FUSE,SOFTCHG,20A,PKG3,D Frame	Softcharge fuse. Package of 3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Inductors and current sensors																	
L1	176F8337	SPARE,BUS INDUCTOR,VLT5122	DC link inductor. 5122T5	1															
L1	176F8338	SPARE,BUS INDUCTOR,VLT5152	DC link inductor. 5152T5		1														
L1	176F8339	SPARE,Bus Inductor,136uH	DC link inductor. 5202T5 and 5302T6/7			1												1	
L1	176F8340	SPARE,Bus Inductor,109uH	DC link inductor. 5252T5 and 5352T6/7				1												1
L1	176F8341	SPARE,BUS INDUCTOR,VLT5302	DC link inductor. 5302T5					1											
L1	176F8536	Spare,Bus Inductor,350uH	DC link inductor. 5042-5122T6/7						1	1	1	1	1	1					
L1	176F8537	Spare,Bus Inductor,250uH	DC link inductor. 5152T6/7												1				
L1	176F8538	Spare,Bus Inductor,195uH	DC link inductor. 5202-5252T6/7													1	1		
L2,3,4	176F8342	SPARE,I-SENSOR,300 Amp	Motor current sensor, 300 amp. 5122-5252T5 and 5042-5252T6/7	3	3	3	3		3	3	3	3	3	3	3	3	3	3	
L2,3,4	176F8343	SPARE,I-SENSOR,500 Amp	Motor current sensor, 500 amp. 5302T5 and 5352T6/7					3											3
TR1	176F8344	SPARE,FAN TRANSFORMER ASSY,500V	Fan transfomer. T4/5 drives. Includes cables and plug	1	1	1	1	1											
TR1	176F8535	SPARE,Fan Transformer ASSY,690V,400VA	Fan transfomer. T6/7 drives. Includes cables and plug						1	1	1	1	1	1	1	1	1	1	1
		Disconnects																	
SW1	176F8345	SPARE,DISCONNECT SW,200A,600V,D1 Frane	Disconnect switch. 5122-5152T5 and 5042-5152T6/7	1	1				1	1	1	1	1	1	1				
	176F8346	SPARE,DISCONNECT HANDLE,ROD,D1 Frame	Disconnect switch handle for 200 Amp disconnect	1	1				1	1	1	1	1	1	1				
SW1	176F8347	SPARE,DISCONNECT SW,400A,600V,D2 Frame	Disconnect switch			1	1	1								1	1	1	1
	176F8348	SPARE,DISCONNECT HANDLE,ROD,D2 Frame	Disconnect switch/handle connection rod for 400 Amp disconnect			1	1	1								1	1	1	1
		Cables																	
CBL 1,2	176F8362	SPARE,CABLE,CONTROL PCA, 30PIN,VLT5122-5303	Cables between control card and interface card	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CBL 3	176F8360	SPARE,CABLE,INTF PCA, 30PIN,VLT5122-5302	Cable between interface card and power card	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CBL 4	176F8361	SPARE,CABLE,INTF PCA, 44PIN,VLT5122-5302	Cable between interface card and power card	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CBL 5	176F8349	SPARE,CABLE,I-SENSE,D2 Frame	Wire harness from power card to current sensors			1	1	1								1	1	1	1
CBL 5	176F8541	SPARE,Cable,I-Sense,D1 Frame	Wire harness from power card to current sensors	1	1				1	1	1	1	1	1	1				
CBL 8	176F8359	SPARE,CABLE,HS FAN,D2 Frame	Wire harness from power card to fan transformer			1	1	1								1	1	1	1
CBL 8	176F8542	SPARE,Cable,HS Fan,D1 Frame	Wire harness from power card to fan transformer	1	1				1	1	1	1	1	1	1				
CBL9	176F8354	SPARE,CABLE,SOFTCHG RST PRIME,D Frame	AC voltage from softcharge to power card	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CBL12	176F8358	SPARE,CABLE,DOOR FAN,D Frame	Wire harness to door/top fan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CBL13	176F8357	SPARE,CABLE,SCR,D2 Frame	Wire harness from power card to SCR			1	1	1								1	1	1	1
CBL13	176F8544	SPARE,Cable,SCR,D1 Frame	Wire harness from power card to SCR	1	1				1	1	1	1	1	1	1				
CBL14	176F8356	SPARE,CABLE,UDC LINK,D Frame	Voltage from DC Bus to power card	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CBL16	176F8350	SPARE,CABLE,GATE DRIVE,D2 Frame	Ribbon cable from power card to gate drive card			1	1	1								1	1	1	1
CBL16	176F8363	SPARE,CABLE,GATE DRIVE,D1 Frame	Ribbon cable from power card to gate drive card	1	1				1	1	1	1	1	1	1				
CBL17, 18, 19	176F8351	SPARE,CABLE,IBGT GATE,D2 Frame	Wire harness from gate drive card to IGBT gate resistor card. One per phase			3	3	3								3	3	3	3
CBL17, 18, 19	176F8364	SPARE,CABLE,GATE RES,D1 Frame	Wire harness from gate drive card to IGBT gate resistor card. One per phase	3	3				3	3	3	3	3	3	3				
CBL20	176F8352	SPARE,CABLE,IBGT TEMP,VLT5122-5302		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CBL21	176F8365	SPARE,CABLE,BRAKE IGBT,D1 Frame	Wire harness from gate drive card to brake IGBT gate resistor.	1	1				1	1	1	1	1	1	1				
CBL21	176F8368	SPARE,CABLE,BRAKE IGBT,D2 Frame	Wire harness from gate drive card to brake IGBT gate resistor.			1	1	1								1	1	1	1
CBL22	176F8366	SPARE,CABLE,BRAKE POWER PLUS,D1 Frame	Cable from brake IGBT to brake terminal	1	1				1	1	1	1	1	1	1				
CBL22	176F8369	SPARE,CABLE,BRAKE POWER PLUS,D2 Frame	Cable from brake IGBT to brake terminal			1	1	1								1	1	1	1
CBL23	176F8367	SPARE,CABLE,BRAKE POWER MINUS,D1 Frame	Cable from brake IGBT to brake terminal	1	1				1	1	1	1	1	1	1				
CBL23	176F8370	SPARE,CABLE,BRAKE POWER MINUS,D2 Frame	Cable from brake IGBT to brake terminal			1	1	1								1	1	1	1
CBL 24	176F8353	SPARE,CABLE,SOFTCHG RST,D2 Frame	AC voltage from softcharge to power card			1	1	1								1	1	1	1
CBL 24	176F8543	SPARE,Cable,Softchg RST,D1 Frame	Wire harness from input power to softcharge assembly	1	1				1	1	1	1	1	1	1				
CBL25	176F8355	SPARE,CABLE,SOFTCHG DC LINK,D Frame	Wire harness from softcharge to DC bus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Terminals, Labels, Insulators																	
TB1,2	176F8371	SPARE,TERMINAL INSUL,MAINS,MOTOR,VLT5122-5302	Mains and motor terminals insulation block. Includes fasteners	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
TB3,4	176F8372	SPARE,TERMINAL INSUL, BRK,LD SHR,VLT5122-5303	Load share terminals insulation block. Includes fasteners	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
TB1,2,3,4	176F8373	SPARE,LABEL SET,TERMINAL BLK,VLT5122-5302	Mains, motor, load share, and brake terminal block label set.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TB1,2 (BB10)	176F8374	SPARE,BB,TERMINAL,MAINS,MOTOR,VLT5122-5152	Mains and motor terminals. Includes fasteners	6	6				6	6	6	6	6	6	6				
TB1,2 (BB33)	176F8375	SPARE,BB,TERMINAL,MAINS,MOTOR,VLT5202-5302	Mains and motor terminals. Includes fasteners			6	6	6								6	6	6	6
TB3 (BB13)	176F8395	SPARE,BB,TERMINAL,LS,BK,VLT5122-5302	Brake terminals. Includes fasteners	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
TB4 (BB16)	176F8395	SPARE,BB,TERMINAL,LS,BK,VLT5122-5302	Load share terminals	2	2				2	2	2	2	2	2	2				
TB4 (BB38)	176F8399	SPARE,BB,TERMINAL,LS,LT,VLT5202-5302	Load share terminal - left. Includes fasteners			1	1	1								1	1	1	1
TB4 (BB37)	176F8404	SPARE,BB,TERMINAL,LS,RT,VLT5202-5302	Load share terminal - right. Includes fasteners			1	1	1								1	1	1	1
PCA3	176F8470	SPARE, INSUL, MYLAR, IF BOARD, VLT5122-5302	Mylar insulator for Interface PCA manufactured prior to week 33, 2004	1	1	1	1	1											
	176F3330	SPARE, Insul, Mylar, IGBT,Bus,D2 Frame	Mylar insulator under IGBT input bus bar assemblies			1	1	1								1	1	1	1
	176F8545	SPARE,Insul, Mylar, IGBT, Bus, D1 Frame	Mylar insulator under IGBT input bus bar assemblies	1	1				1	1	1	1	1	1	1				
	176F8546	SPARE,Insul,between mains fuse,T6/7	Insulator between mains fuses.													1	1	1	1
	176F8547	SPARE,Insul,IGBT snubber cap support	Mounts between IGBT and snubber capacitor. One per IGBT module	1	1	2	2	2	1	1	1	1	1	1	1	2	2	2	2

Spare Parts List D-frame Sizes

Block diagram	Spare part	Spare part name	Comments	Requirements Per Drive					Requirements Per Drive										
				380-500 VAC (380-460 VAC, 380-480 VAC)					525-690 VAC (525-600 VAC)										
				VLT5122	VLT5152	VLT5202	VLT5252	VLT5302	VLT5042	VLT5052	VLT5062	VLT5072	VLT5102	VLT5122	VLT5152	VLT5202	VLT5252	VLT5302	VLT5352
				VLT5122F	VLT5152F	VLT5202F	VLT5252F	VLT5302F											
				VLT4152	VLT4202	VLT4252	VLT4302	VLT4352				VLT4102	VLT4122	VLT4152	VLT4202	VLT4252	VLT4302	VLT4352	VLT4402
				VLT6152	VLT6172	VLT6222	VLT6272	VLT6352				VLT6102	VLT6122	VLT6152	VLT6172	VLT6222	VLT6272	VLT6352	VLT6402
Designator	Number	(40 characters)		VLT8152	VLT8202	VLT8252	VLT8302	VLT8352	VLT8052	VLT8062	VLT8072	VLT8102	VLT8122	VLT8152	VLT8202	VLT8252	VLT8302	VLT8352	VLT8402
		Bus Bars																	
BB1	176F8548	SPARE,BRKT,SCR BB Support,D1 Frame	SCR input bus bar support	1	1				1	1	1	1	1	1	1				
BB2	176F8380	SPARE,BB,SCR,R\S\T,VLT5122-5152	Connects input plate bus bars to SCR input. One per phase	3	3				3	3	3	3	3	3	3				
BB3	176F8379	SPARE,BB ASSY,SCR,VLT5122-5152	Connects to SCR outputs. Sandwich assembly.	1	1				1	1	1	1	1	1	1				
BB4	176F8381	SPARE,BB,SCR,MINUS,VLT5122-5152	Connects DC coil inputs to SCR output bus bar assembly. One plus, one minus.	2	2				2	2	2	2	2	2	2				
BB5	176F8549	SPARE,BB,DC Link,Plus,D1 Frame	Connects DC Plus coil output to IGBT input bus bar assembly	1	1				1	1	1	1	1	1	1				
BB6	176F8391	SPARE,BB,DC LINK,PLUS,VLT5122-5152	Connects DC Minus coil output to IGBT input bus bar assembly	1	1				1	1	1	1	1	1	1				
BB7	176F8376	SPARE,BB ASSY, IGBT,VLT5122-5152	Connects capacitor bank and IGBT inputs. Sandwich assembly.	1	1				1	1	1	1	1	1	1				
BB8	176F8390	SPARE,BB,IGBT,U\V\W,VLT5122-5152	Connects IGBT output to long bus bar over the fan. One per phase.	3	3				3	3	3	3	3	3	3				
BB9	176F8392	SPARE,BB,MOTOR 2,VLT5122-5152	Long output bus bar over the fan. One per phase.	3	3				3	3	3	3	3	3	3				
BB11	176F8398	SPARE,BB,BRAKE,MINUS,VLT5122-5152	Connects DC Minus to brake IGBT	1	1				1	1	1	1	1	1	1				
BB12	176F8397	SPARE,BB,BRAKE,PLUS,VLT5122-5152	Connects DC Plus to brake IGBT	1	1				1	1	1	1	1	1	1				
BB14	176F8400	SPARE,BB,LS,MINUS,VLT5122-5152	Connects Minus Load Share terminal to SCR output bus bar assembly.	1	1				1	1	1	1	1	1	1				
BB15	176F8401	SPARE,BB,LS,PLUS,VLT5122-5152	Connects Plus Load Share terminal to SCR output bus bar assembly.	1	1				1	1	1	1	1	1	1				
	176F8407	SPARE,BB,DISC,VLT5122-5152	Located on input plate	3	3				3	3	3	3	3	3	3				
	176F8405	SPARE,BB,SCR,INPUT 2,VLT5122-5152	Located on input plate	3	3				3	3	3	3	3	3	3				
BB21	176F8394	SPARE,BB,SCR,INPUT,VLT5202-5302	Connects input plate bus bars to SCR input. One per phase			3										3			
BB22	176F8387	SPARE,BB,SCR,PLUS,1,VLT5252-5302	Connects input plate bus bars to SCR input. One per phase				3	3									3	3	3
BB23	176F8393	SPARE,BB,SCR,DC,VLT5202	Connects to SCR outputs.			2										2			
BB24	176F8385	SPARE,BB,SCR,MINUS,1,VLT5202-5302	Connects to SCR outputs.				2	2									2	2	2
BB25	176F8386	SPARE,BB,SCR,MINUS,2,VLT5202-5302	Connects to DC coils plus input (left side of drive)			1	1	1								1	1	1	1
BB26	176F8388	SPARE,BB,SCR,PLUS,2,VLT5202-5302	Connects to DC coils minus input (right side of drive)			1	1	1								1	1	1	1
BB27	176F8382	SPARE,BB,DC LINK,MINUSVLT5202-5302	Connects DC coil output to IGBT input bus bar assembly.			2	2	2								2	2	2	2
BB28	176F8377	SPARE,BB ASSY,IGBT-IND,VLT5202-5302	Lower IGBT input bus bar sandwich assembly.			1	1	1								1	1	1	1
BB29	176F8378	SPARE,BB ASSY,IGBT-CAP,VLT5202-5302	Upper IGBT input bus bar sandwich assembly. Connects capacitor bank to IGBT			1	1	1								1	1	1	1
BB30	176F8383	SPARE,BB,MOTOR,U/W,VLT5202-5302	Connects to IGBT output. For phase U or W			2	2	2								2	2	2	2
BB31	176F8384	SPARE,BB,MOTOR,V,VLT5202-5302	Connects to IGBT output. For phase V (middle phase)			1	1	1								1	1	1	1
BB32	176F8389	SPARE,BB,I-SENSOR,VLT5202-5302	Long output bus bar over the fan. One per phase.			3	3	3								3	3	3	3
BB34	176F8396	SPARE,BB,BRAKE,VLT5202-5302	Connects the two brake IGBT together			1	1	1								1	1	1	1
BB35	176F8403	SPARE,BB,LS,PLUS,VLT5202-5302	Connects SCR bus bar to Plus load share terminal			1	1	1								1	1	1	1
BB36	176F8402	SPARE,BB,LS,MINUS,VLT5202-5302	Connects SCR bus bar to Minus load share terminal			1	1	1								1	1	1	1
	176F8408	SPARE,BB,DISC,R,S,VLT5202-5302	Located on input plate			2	2	2								2	2	2	2
	176F8409	SPARE,BB,DISC,T,VLT5202-5302	Located on input plate			1	1	1								1	1	1	1
	176F8406	SPARE,BB,SCR,T,1,VLT5202-5302	Located on input plate			3	3	3								3	3	3	3
	176F8410	SPARE,BB STAND OFF,PKG10,VLT5202-5302	Bus bar mounting standoff. Package of 10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
		Enclosure Fabrications																	
	176F8429	SPARE, FAB, IP20 COVER,TOP KIT,VLT5122-5302		IP00	IP00	IP00	IP00	IP00	IP00	IP00	IP00	IP00	IP00	IP00	IP00	IP00	IP00	IP00	IP00
	176F8418	SPARE,FAB,ENCL BOT,IP21,VLT5122-5303		IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21
	176F8419	SPARE,FAB,ENCL BOT,IP54,VLT5122-5303		IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54
	176F8416	SPARE,FAB,ENCL TOP KIT,IP21,VLT5122-5302		IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21	IP21
	176F8417	SPARE,FAB,ENCL TOP KIT,IP54,VLT5122-5302		IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54	IP54
	176F8420	SPARE,FAB,GLANDPLATE,VLT5122-5302		IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54
	176F8413	SPARE,FAB,CHASSIS,LT SIDE,VLT5122-5152		1	1				1	1	1	1	1	1	1				
	176F8412	SPARE,FAB,CHASSIS,RT SIDE,VLT5122-5152		1	1				1	1	1	1	1	1	1				
	176F8427	SPARE,FAB,IP00 COVER,SIDE,VLT5122-5152		IP00	IP00				IP00	IP00	IP00	IP00	IP00	IP00	IP00				
	176F8425	SPARE,FAB,IP00 DR,BOT,VLT5122-5152		IP00	IP00				IP00	IP00	IP00	IP00	IP00	IP00	IP00				
	176F8423	SPARE,FAB,IP00 DR,TOP,VLT5122-5152		IP00	IP00				IP00	IP00	IP00	IP00	IP00	IP00	IP00				
	176F8415	SPARE,FAB,CHASSIS,LT SIDE,VLT5202-5302				1	1	1								1	1	1	1
	176F8414	SPARE,FAB,CHASSIS,RT SIDE,VLT5202-5302				1	1	1								1	1	1	1
	176F8428	SPARE,FAB,IP00 COVER,SIDE,VLT5202-5302				IP00	IP00	IP00								IP00	IP00	IP00	IP00
	176F8424	SPARE,FAB,IP00 DR,TOP,VLT5202-5302				IP00	IP00	IP00								IP00	IP00	IP00	IP00
	176F8426	SPARE,FAB,IP00DR,BOT,VLT5202-5302				IP00	IP00	IP00								IP00	IP00	IP00	IP00
	176F8430	SPARE,CABLE CLAMP,60MM,VLT5122-5302	Power cable clamp	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54
	176F8431	SPARE,EARTH BONDING PLATE	Power cable clamp bonding plate	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54	IP21/54
		Service Tools																	
	176F8437	SPARE,TOOL,PWR PCA SIG BOARD,VLT5122-5302	Power PCA signal test board																
	176F8439	SPARE,TOOL,PWR PCA PWR CABLES,VLT5122-5302	Power PCA test cables																

Spare Parts List E-frame Sizes

Block diagram Designator	Spare part Number	Spare part name (40 characters)	Comments	Requirements Per Drive 380-500 VAC				Requirements Per Drive 525-690 VAC		
				VLT5352	VLT5452	VLT5502	VLT5552	VLT5402	VLT5502	VLT5602
				VLT5352F	VLT5452F	VLT5502F	---	---	---	---
				VLT4452	VLT4502	VLT4602	VLT4652	VLT4502	VLT4602	VLT4652
				VLT6402	VLT6502	VLT6552	VLT6602	VLT6502	VLT6602	VLT6652
				VLT8452	VLT8502	VLT8602	VLT8652	VLT8502	VLT8602	VLT8652
		PCAs								
PCA 2	176F8551	Spare,Interface PCA,CC,5352T5	Interface Card: between Control Card and Power Card, conformal coated	1	---	---	---	---	---	---
PCA 2	176F8552	Spare,Interface PCA,CC,5452T5	Interface Card: between Control Card and Power Card, conformal coated	---	1	---	---	---	---	---
PCA 2	176F8553	Spare,Interface PCA,CC,5502T5	Interface Card: between Control Card and Power Card, conformal coated	---	---	1	---	---	---	---
PCA 2	176F8611	Spare,Interface PCA,CC,5552T5	Interface Card: between Control Card and Power Card, conformal coated	---	---	---	1	---	---	---
PCA 2	176F8462	Spare,Interface,PCA,CC,5402T7	Interface Card: between Control Card and Power Card, conformal coated	---	---	---	---	1	---	---
PCA 2	176F8464	Spare,Interface,PCA,CC,5502T7	Interface Card: between Control Card and Power Card, conformal coated	---	---	---	---	---	1	---
PCA 2	176F8465	Spare,Interface,PCA,CC,5602T7	Interface Card: between Control Card and Power Card, conformal coated	---	---	---	---	---	---	1
PCA 3	176F8313	Spare,Power PCA,CC,VLT5122-5302	Power Card, does not include I-Scaling Card, conformal coated	1	1	1	1	---	---	---
PCA 3	176F8524	Spare,Power PCA,CC,VLT5122-5352T6/7	Power Card, does not include I-Scaling Card, conformal coated	---	---	---	---	1	1	1
PCA 4	176F8554	Spare,I-Scaling PCA,4.21 Ohm	Current Scaling Card, 5353T5	1	---	---	---	---	---	---
PCA 4	176F8311	Spare,I-Scaling PCA,2.56 Ohm	Current Scaling Card, 5452-5502T5, 5602T7	---	1	1	1	---	---	1
PCA 4	176F8308	Spare,I-Scaling PCA,4.54 Ohm	Current Scaling Card, 5402T7	---	---	---	---	1	---	---
PCA 4	176F8309	Spare,I-Scaling PCA,3.79 Ohm	Current Scaling Card, 5502T7	---	---	---	---	---	1	---
PCA 5	176F8305	Spare,Gate Drive PCA,CC,D Frame	Gate Drive Card, conformal coated,	1	1	1	1	1	1	1
PCA 9	176F8307	Spare,HF PCA,VLT5122-5302T4/5	High Frequency Card	1	1	1	1	---	---	---
PCA 9	176F8523	Spare,HF PCA,VLT5122-5352T6/7	High Frequency Card	---	---	---	---	1	1	1
PCA12	176F8555	Spare,Softcharge PCA,CC,T5,E1 Frame	Softcharge Card, conformal coated	1	1	1	1	---	---	---
PCA12	176F8466	Spare,Softcharge PCA,CC,T7,E1 Frame	Softcharge Card, conformal coated	---	---	---	---	1	1	1
PCA10,11	176F8510	Spare, Balance PCA,VLT5122-5302T4/5	Capacitor Bank balance card, included in capacitor bank spare part	2	2	2	2	---	---	---
PCA10,11	176F8526	Spare,Balance PCA,VLT5122-5352T6/7	Capacitor Bank balance card, included in capacitor bank spare part	---	---	---	---	2	2	2
		Semiconductors								
IGBT1,2,3 PCA 6,7,8	176F8556	Spare, IGBT Kit,300A,1200V,E1 Frame	IGBT, gate PCA, fasteners, and thermal pad (1 per phase)	3	---	---	---	---	---	---
IGBT1,2,3 PCA 6,7,8	176F8557	Spare, IGBT Kit,450A,1200V,E1 Frame	IGBT, gate PCA, fasteners, and thermal pad (1 per phase)	---	3	3	3	---	---	---
IGBT1,2,3 PCA 6,7,8	176F8432	Spare,IGBT Kit,300A,1700V,E1 Frame	IGBT, gate PCA, fasteners, and thermal pad (1 per phase)	---	---	---	---	3	---	---
IGBT1,2,3 PCA 6,7,8	176F8433	Spare,IGBT Kit,450A,1700V,E1 Frame	IGBT, gate PCA, fasteners, and thermal pad (1 per phase)	---	---	---	---	---	3	3
IGBT4,5 PCA13,14	176F8316	Spare,IGBT Kit,BRK,VLT5122-VLT5302	IGBT, gate PCA, fasteners, and thermal pad (2 per drive)	2	2	2	2	2	2	2
SCR1,2,3	176F8558	Spare,SCR Kit,500A,1600V,E1 Frame	SCRs, fasteners, and thermal pad. Note: does not include Diode. (1 per phase)	3	3	3	3	---	---	---
D1,2,3	176F8559	Spare,Diode Kit,600A,1600V,E1 Frame	Diode, fasteners, and thermal pad. Note, does not include SCR. (1 per phase)	3	3	3	3	---	---	---
SCR1,2,3	176F8434	Spare,SCR Kit,430A,2200V,E1 Frame	SCRs, fasteners, and thermal pad. Note: does not include Diode. (1 per phase)	---	---	---	---	3	3	3
D1,2,3	176F8435	Spare,Diode Kit,540A,2200V,E1 Frame	Diode, fasteners, and thermal pad. Note, does not include SCR. (1 per phase)	---	---	---	---	3	3	3
		Resistors								
TH1	176F8321	SpareThermistor ASSY,D Frame	Heat sink thermistor, includes cable assembly	1	1	1	1	1	1	1
R1	176F8560	Spare,Softcharg Res ASSY,27 Ohm,155W	Soft charge resistor, includes cable assembly	1	1	1	1	---	---	---
R1	176F8467	Spare,Softcharg Res ASSY,68 Ohm,155W	Soft charge resistor, includes cable assembly	---	---	---	---	1	1	1
		Capacitors								
C2,3,4,5,6,7,8,9,10	176F8323	Spare,CAP,IGBT Snubber,1000V,1.5uF	IGBT snubber caps, mount on IGBT Modules (3 per IGBT module)	9	9	9	9	---	---	---
C2,3,4,5,6,7,8,9,10	176F8534	Spare,CAP,IGBT Snubber,1250V,1uF	IGBT snubber caps, mount on IGBT Modules (3 per IGBT module)	---	---	---	---	9	9	9
CBANK1 or 2 +PCA10 and 11	176F8561	Spare,CAP Bank,6Cap,T5	Capacitor bank, includes Balance PCA	2	1	---	---	---	---	---
CBANK1 or 2 +PCA10 and 11	176F8562	Spare,CAP Bank,8Cap,T5	Capacitor bank, includes Balance PCA	---	1	2	2	---	---	---
CBANK1 or 2 +PCA10 and 11	176F8468	Spare,CAP Bank,8Cap,T7	Capacitor bank, includes Balance PCA	---	---	---	---	2	2	2
		Fans								
F1+C1	176F8578	Spare, HS Fan Assy,5352T5	Heat sink fan assembly. Includes fan, fan box, capacitor, gasket, cables (1 per drive)	1	---	---	---	1	---	---
F1+C1	176F8579	Spare,HS Fan Assy,5452-5502	Heat sink fan assembly. Includes fan, fan box, capacitor, gasket, cables (1 per drive)	---	1	1	1	---	1	1
F2, F3	176F8330	Spare,Door Fan Kit,D Frame	Door fan kit. Includes fan, grills, support, fasteners (2 per drive)	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54
	176F8331	Spare,Door Vent Kit,D Frame	Door fan vent kit. Includes grill, support, fasterners (2 per drive)	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54
	176F8332	Spare,Door Fan Filter,PKG 10,D Frame	Door fan filters. Package of 10.	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54
	176F8333	Spare,Door/Top Fan,D Frame	Door fan, fan only (2 per drive)	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54	IP21/IP54
	176F8333	Spare,Door/Top Fan,D Frame	Top fan, fan only (1 per drive)	IP00	IP00	IP00	IP00	IP00	IP00	IP00
F4	176F8612	Spare,Fuse Fan,Input Plate,E Frame	Input fuse fan for units with RFI Filter and Mains Fuse	1	1	1	1	---	---	---

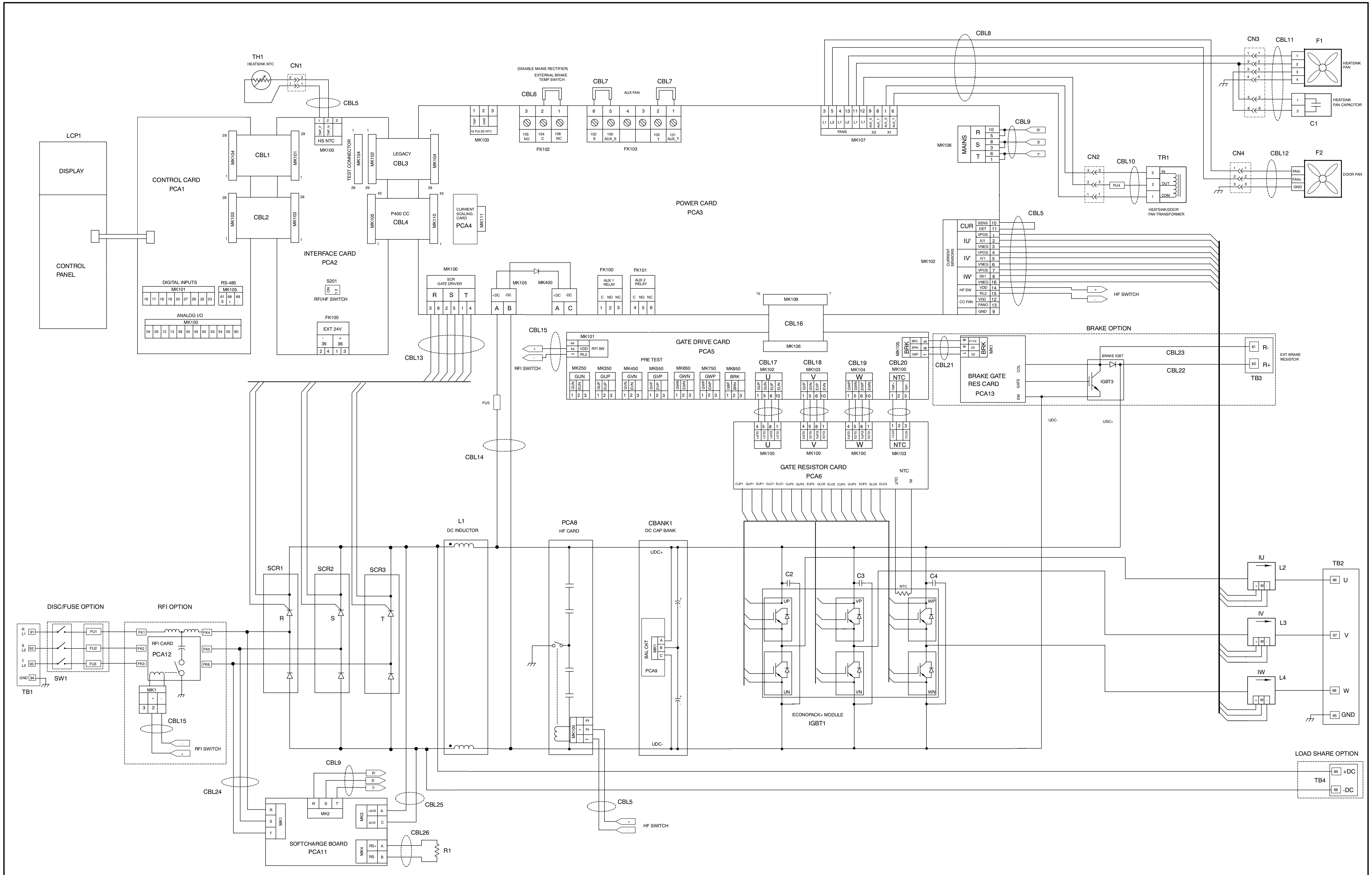
Spare Parts List E-frame Sizes

Block diagram	Spare part	Spare part name	Comments	Requirements Per Drive				Requirements Per Drive		
				380-500 VAC				525-690 VAC		
				VLT5352	VLT5452	VLT5502	VLT5552	VLT5402	VLT5502	VLT5602
				VLT5352F	VLT5452F	VLT5502F	---	---	---	---
				VLT4452	VLT4502	VLT4602	VLT4652	VLT4502	VLT4602	VLT4652
				VLT6402	VLT6502	VLT6552	VLT6602	VLT6502	VLT6602	VLT6652
Designator	Number			VLT8452	VLT8502	VLT8602	VLT8652	VLT8502	VLT8602	VLT8652
		Fuses								
FU1,2,3	176F8591	Spare,Fuse,Semi,700Amp	Mains fuse. Package of 1	3	---	---	---	3	3	---
FU1,2,3	176F8592	Spare,Fuse,Semi,900Amp	Mains fuse. Package of 1	---	3	3	3	---	---	3
FU4	176F8440	Spare,Fuse,PPCA,Fan,4A,PKG3,D Frame	Fan Fuse, 4 amp. Package of 3	1	---	---	---	1	---	---
FU4	176F8609	Spare,Fuse,Fan,15A,PKG3,5452-5502	Fan Fuse, 15 amp. Package of 3	---	1	1	1	---	1	1
FU5	176F8440	Spare,Fuse,PPCA,Fan,4A,PKG3,D Frame	DC Bus Fuse, 4 amp. Package of 3	1	1	1	1	1	1	1
PCA12	176F8336	Spare,Fuse,Softchg,20A,PKG3,D Frame	Softcharge fuse. Package of 3	1 PKG	1 PKG	1 PKG	1 PKG	1 PKG	1 PKG	1 PKG
		Inductors and current sensors								
L1	176F8564	Spare,Bus Inductor,62uH	DC link inductor, (1 per drive) includes flexible bus bars	1	---	---	---	---	---	---
L1	176F8565	Spare,Bus Inductor,51uH	DC link inductor, (1 per drive) includes flexible bus bars	---	1	1	1	---	---	---
L1	176F8469	Spare,Bus Inductor,73uH	DC link inductor, (1 per drive) includes flexible bus bars	---	---	---	---	1	1	1
L2,3,4	176F8343	Spare,I-Sensor,500Amp	Motor current sensor, (1 per phase)	3	---	---	---	3	3	---
L2,3,4	176F8563	Spare,I-Sensor,1000A	Motor current sensor, (1 per phase)	---	3	3	3	---	---	3
TR1	176F8566	Spare,Fan Transformer Assy,5352T5	Fan transformer, 5352 T5 units	1	---	---	---	---	---	---
TR1	176F8567	Spare,Fan Transformer ASSY,1500VA	Fan transfomer, 5452-5502 T5 units	---	1	1	1	---	---	---
L5	176F8577	Spare,HS Fan Inductor Assy,E1 Frame	Fan inductor, 5452-5502 T5, 5502-5602 T7	---	1	1	1	---	1	1
TR1	176F8535	Spare,Fan Transformer ASSY,690V,400VA	Fan Transformer, 5402 T7 units	---	---	---	---	1	---	---
TR1	176F8471	Spare,Fan Transformer Assy,E1,T7	Fan Transformer, 5502-5602 T7	---	---	---	---	---	1	1
		Disconnects								
SW1	176F8593	SPARE,Disc SW,600A,600V,E1 Frame	Disconnect switch, VLT 5352	1	---	---	---	1	1	1
SW1	176F8594	SPARE,Disc SW,800A,600V,E1 Frame	Disconnect switch, VLT 5452-5502	---	1	1	1	---	---	---
	176F8348	SPARE,Disconnect Handle,Rod,D2 Frame	Disconnect switch handle amd connecting rod	1	1	1	1	1	1	1
		Cables								
CBL 1,2	176F8362	SPARE,Cable,Control PCA, 30pin,	Cables between control card and interface card	2	2	2	2	2	2	2
CBL 3	176F8360	SPARE,Cable,Intf PCA, 30pin,VLT5122-5302	Cable between interface card and power card	1	1	1	1	1	1	1
CBL 4	176F8361	SPARE,Cable,Intf PCA, 44pin,VLT5122-5302	Cable between interface card and power card	1	1	1	1	1	1	1
CBL 5	176F8568	SPARE,Cable,I-Sense,5352T5	Wire harness from power card to current sensors	1	---	---	---	1	1	---
CBL 5	176F8569	SPARE,Cable,I-Sense,5452-5502	Wire harness from power card to current sensors	---	1	1	1	---	---	1
CBL 9	176F8570	SPARE,Cable,Softchg RST Prime,E1 Frame	AC voltage from softcharge to power card	1	1	1	1	1	1	1
CBL12	176F8571	SPARE,Cable,Fan,5352T5,IP00	Wire harness for all the AC fans on IP00 units (1 per drive)	IP00	---	---	---	IP00	---	---
CBL12	176F8572	SPARE,Cable,Fan,5352T5,IP21/IP54	Wire harness for all the AC fans on IP21/IP54 units (1 per drive)	IP21/IP54	---	---	---	IP21/IP54	---	---
CBL12	176F8573	SPARE,Cable,Fan,5452-5502,IP00	Wire harness for all the AC fans on IP00 units (1 per drive)	---	IP00	IP00	IP00	---	IP00	IP00
CBL12	176F8574	SPARE,Cable,Fan,5452-5502,IP21/IP54	Wire harness for all the AC fans on IP21/IP54 units (1 per drive)	---	IP21/IP54	IP21/IP54	IP21/IP54	---	IP21/IP54	IP21/IP54
CBL13	176F8575	SPARE,Cable,SCR,E1 Frame	Wire harness from power card to SCR	1	1	1	1	1	1	1
CBL14	176F8576	SPARE,Cable,Powercard DClink,E1 Frame	Voltage from DC Bus to power card	1	1	1	1	1	1	1
CBL15	176F8580	SPARE,Cable,RFI Switch,E1 Frame	Wire from gate drive card to RFI filter for RFI switch control	1	1	1	1	1	1	1
CBL16	176F8581	SPARE,Cable,Gate Drive,16pin,E1 Frame	Ribbon cable from power card to gate drive card	1	1	1	1	1	1	1
CBL17, 18, 19	176F8582	SPARE,Cable,IGBT Gate,E1 Frame	Wire harness from gate drive card to IGBT gate resistor card. One per phase	3	3	3	3	3	3	3
CBL21	176F8583	SPARE,Cable,Brake IGBT,E1 Frame	Wire harness from gate drive card to brake IGBT gate resistor.	1	1	1	1	1	1	1
CBL24	176F8584	SPARE,Cable,Softchg RST,E1 Frame	Wire harness from input power to softcharge assembly	1	1	1	1	1	1	1
CBL25	176F8585	SPARE,Cable,Softchg DC Link,E1 Frame	Wire harness from softcharge to DC bus	1	1	1	1	1	1	1
	176F8586	SPARE,Cable,LCP,E1 Frame	Cable from control card to LCP (1 per drive)	1	1	1	1	1	1	1
CBL26	176F8613	Spare,Cable,Fuse Fan,E Frame	Cable from power card to fan fuse (1 per drive if RFI Filter and Mains Fuse)	1	1	1	1	1	1	1

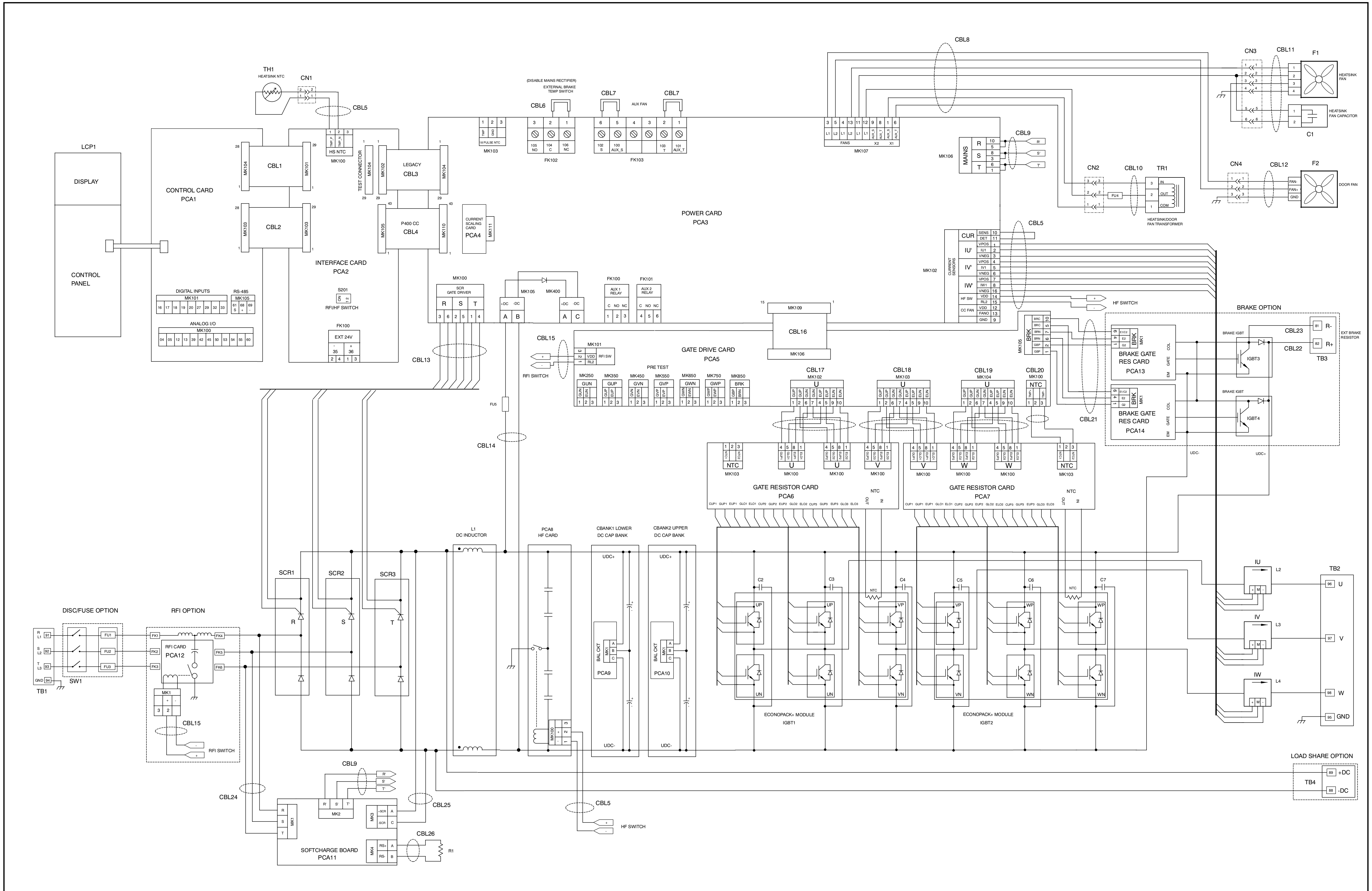
Spare Parts List E-frame Sizes

Block diagram Designator	Spare part Number	Spare part name	Comments	Requirements Per Drive 380-500 VAC				Requirements Per Drive 525-690 VAC		
				VLT5352 VLT5352F VLT4452 VLT6402 VLT8452	VLT5452 VLT5452F VLT4502 VLT6502 VLT8502	VLT5502 VLT5502F VLT4602 VLT6552 VLT8602	VLT5552 --- VLT4652 VLT6602 VLT8652	VLT5402 --- VLT4502 VLT6502 VLT8502	VLT5502 --- VLT4602 VLT6602 VLT8602	VLT5602 --- VLT4652 VLT6652 VLT8652
		Terminals, Labels, Insulators								
TB1	176F8587	Spare,BB,Terminal Block,E1 Frame	Mains terminal stepped bus bar, NOT disconnect, (1 per phase)	3	3	3	3	3	3	3
TB2	176F8587	Spare,BB,Terminal Block,E1 Frame	Motor terminal stepped bus bar (1 per phase)	3	3	3	3	3	3	3
TB3	176F8399	Spare,BB,LS,VLT5202-5302	Brake terminal - left. Includes fasteners	1	1	1	1	1	1	1
TB3	176F8404	Spare,BB,Load Share,2,VLT5202-5302	Brake terminal - right. Includes fasteners	1	1	1	1	1	1	1
TB4	176F8587	Spare,BB,Terminal Block,E1 Frame	Load Sharing terminal stepped bus bar (2 per drive)	2	2	2	2	2	2	2
TB1	176F8588	Spare,Insul,Terminal Block,E1 Frame	Mains terminal insulation block, NOT disconnect (1 per phase)	3	3	3	3	3	3	3
TB2	176F8588	Spare,Insul,Terminal Block,E1 Frame	Motor terminal insulation block (1 per phase)	3	3	3	3	3	3	3
TB3	176F8372	Spare,Term Insul,BRK,LD SHR,VLT5122-5303	Brake terminals insulation block (1 per drive)	1	1	1	1	1	1	1
TB4	176F8588	Spare,Insul,Terminal Block,E1 Frame	Load Share terminal insulation block (2 per drive)	2	2	2	2	2	2	2
	176F8589	Spare,Label Set,Terminal,E1 Frame	Mains, motor, load share, and brake terminal block label set.	1	1	1	1	1	1	1
	176F8590	Spare,Insul,IGBT-Chassis,E1 Frame	Insulator under IGBT input bus bar assemblies	1	1	1	1	1	1	1
		Bus Bars								
BB 41	176F8595	Spare,BB,SCR/Di Input,E1 Frame	From input plate to SCR and Diode (1 per phase)	3	3	3	3	3	3	3
BB 42	176F8596	Spare,BB,SCR/Di Output,E1 Frame	Attaches to the SCR and Diode on the DC side (1 plus, 1 minus)	2	2	2	2	2	2	2
BB 43	176F8597	Spare,BB,DC Bus Plus,Before Coil,E1	DC Plus to DC Coils (1 per drive)	1	1	1	1	1	1	1
BB 44	176F8598	Spare,BB,DC Bus Minus,Before Coil,E1	DC Minus to DC Coils (1 per drive)	1	1	1	1	1	1	1
BB 45	176F8599	Spare,BB,DC Bus,After Coil,E1 Frame	From DC Coil output to IGBT sandwitch (1 plus, 1 minus)	2	2	2	2	2	2	2
BB 46	176F8600	Spare,BB Assy,IGBT-Ind,E1 Frame	DC Bus Sandwich. Connects to the IGBT inputs (1 per drive)	1	1	1	1	1	1	1
BB 47	176F8601	Spare,BB Assy,IGBT-Cap,E1 Frame	Connects the Capacitor Bank to the IGBT inputs (1 per phase)	3	3	3	3	3	3	3
BB 48	176F8602	Spare,BB,IGBT Output,E1 Frame	From IGBT output between SCR and Diode (1 per phase)	3	3	3	3	3	3	3
BB 49	176F8603	Spare,BB,Over Fan Box,E1 Frame	Output over the fan box (1 per phase)	3	3	3	3	3	3	3
BB 50	176F8604	Spare,BB,Current Sensor 5352,E1	Goes through the current sensors (1 per phase)	3	---	---	---	3	3	---
BB 50	176F8605	Spare,BB,Current Sensor 5452-5502,E1	Goes through the current sensors (1 per phase)	---	3	3	3	---	---	3
	176F8606	Spare,BB,Brake Assy,E1 Frame	Collection of brake bus bars. Does not include terminal bus bars	1	1	1	1	1	1	1
	176F8607	Spare,BB,Load Share Plus,E1 Frame	Load Sharing Plus bus bar (1 per drive)	1	1	1	1	1	1	1
	176F8608	Spare,BB,Load Share Minus,E1 Frame	Load Sharing Minus bus bar (1 per drive)	1	1	1	1	1	1	1
	176F8410	SPARE,BB STAND OFF,PKG10,VLT5202-5302	Bus bar mounting standoff. Package of 10							
	176F8610	SPARE,IGBT Output Standoff,PKG9,E Frame	IGBT output bus bar mounting standoff. Package of 9 (9 per drive)							
		Enclosure Fabrications								
	176F8430	Spare,Cable Clamp,60mm								
		Service Tools								
	176F8437	SPARE,TOOL,PWR PCA SIG BOARD,VLT5122-5302	Power PCA signal test board							
	176F8439	SPARE,TOOL,PWR PCA PWR CABLES,VLT5122-5302	Power PCA test cables							

D1 380-500 VAC



D2 380-500 VAC



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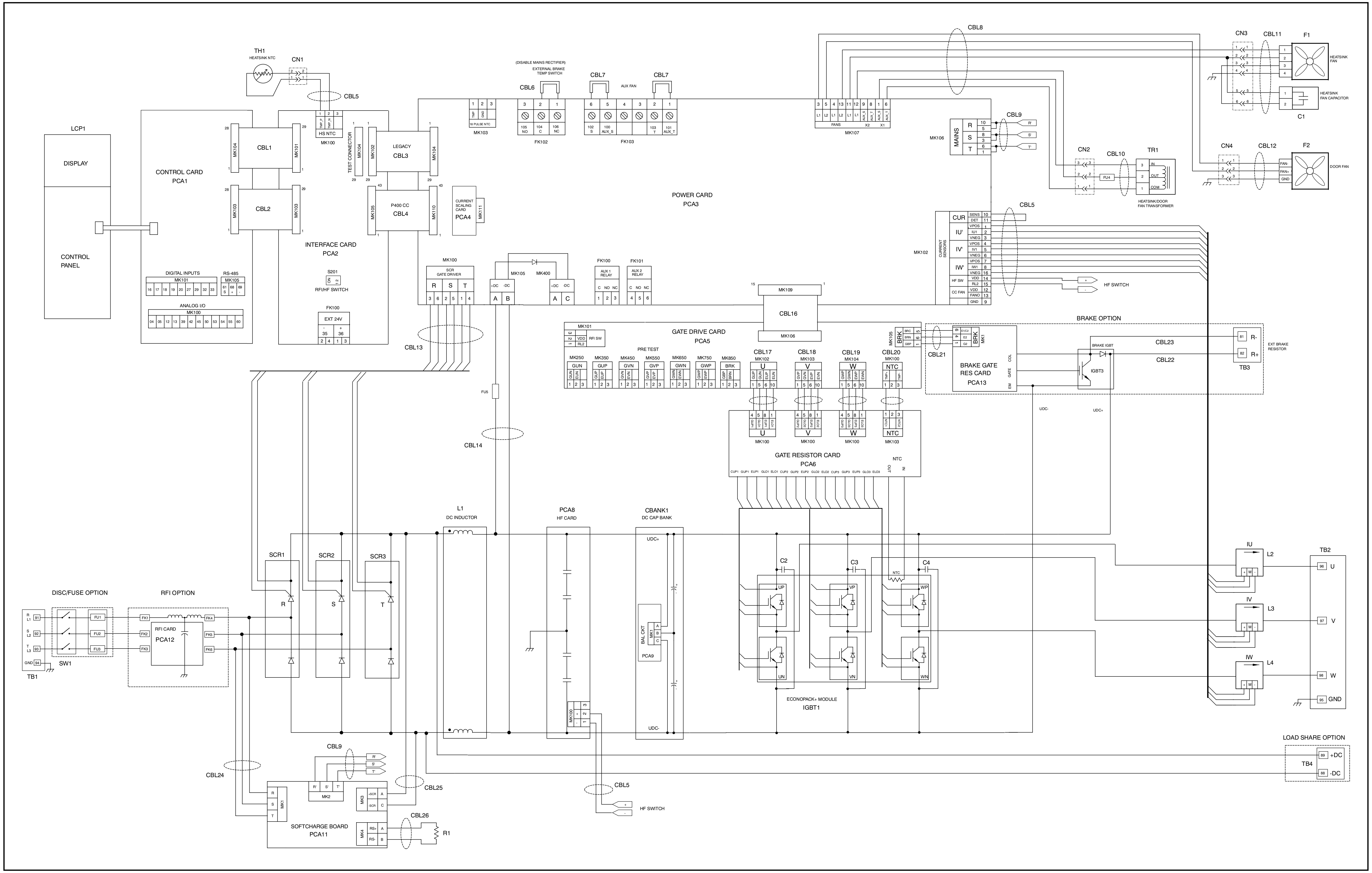
D1 525-600/690 VAC



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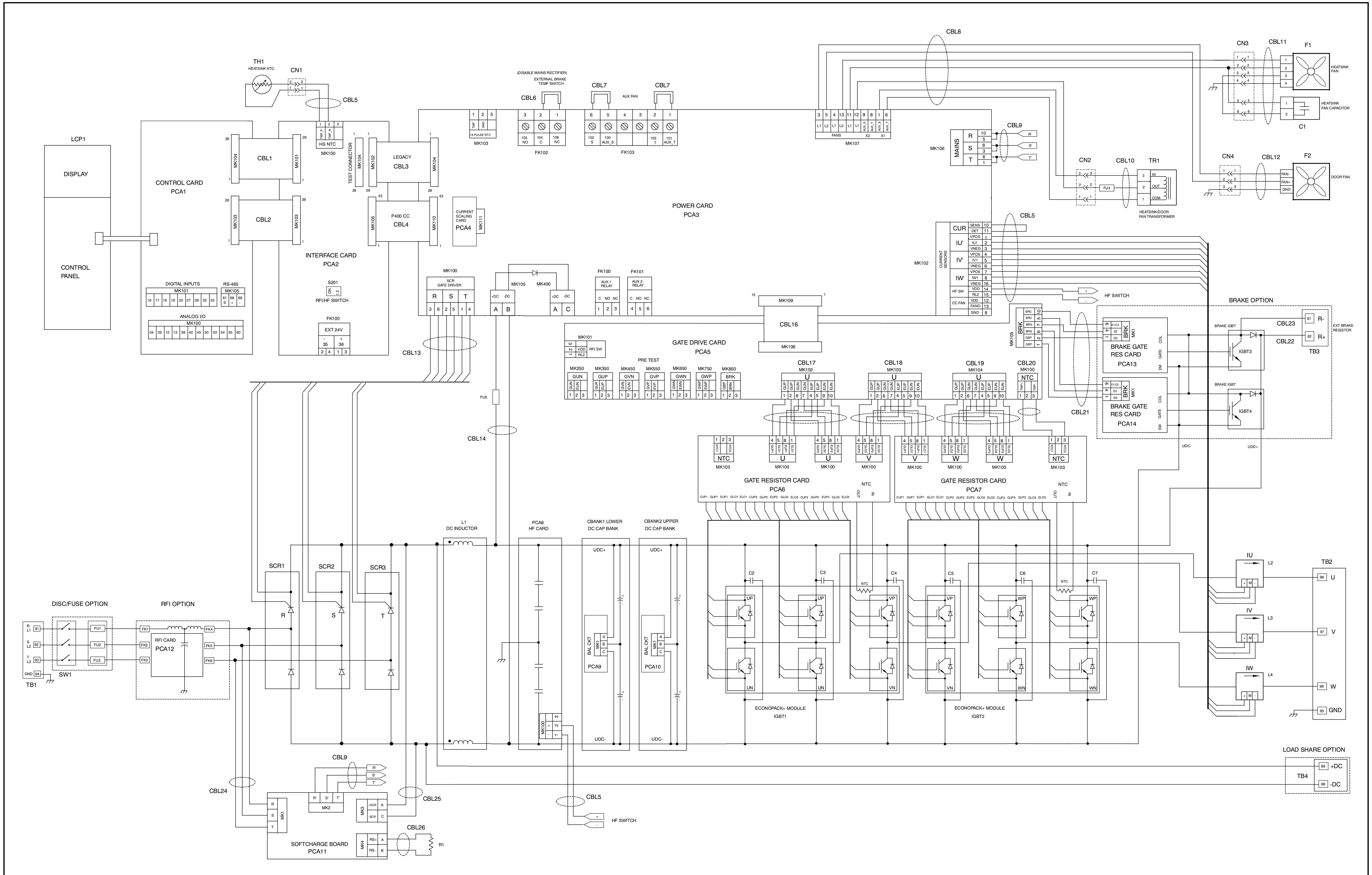

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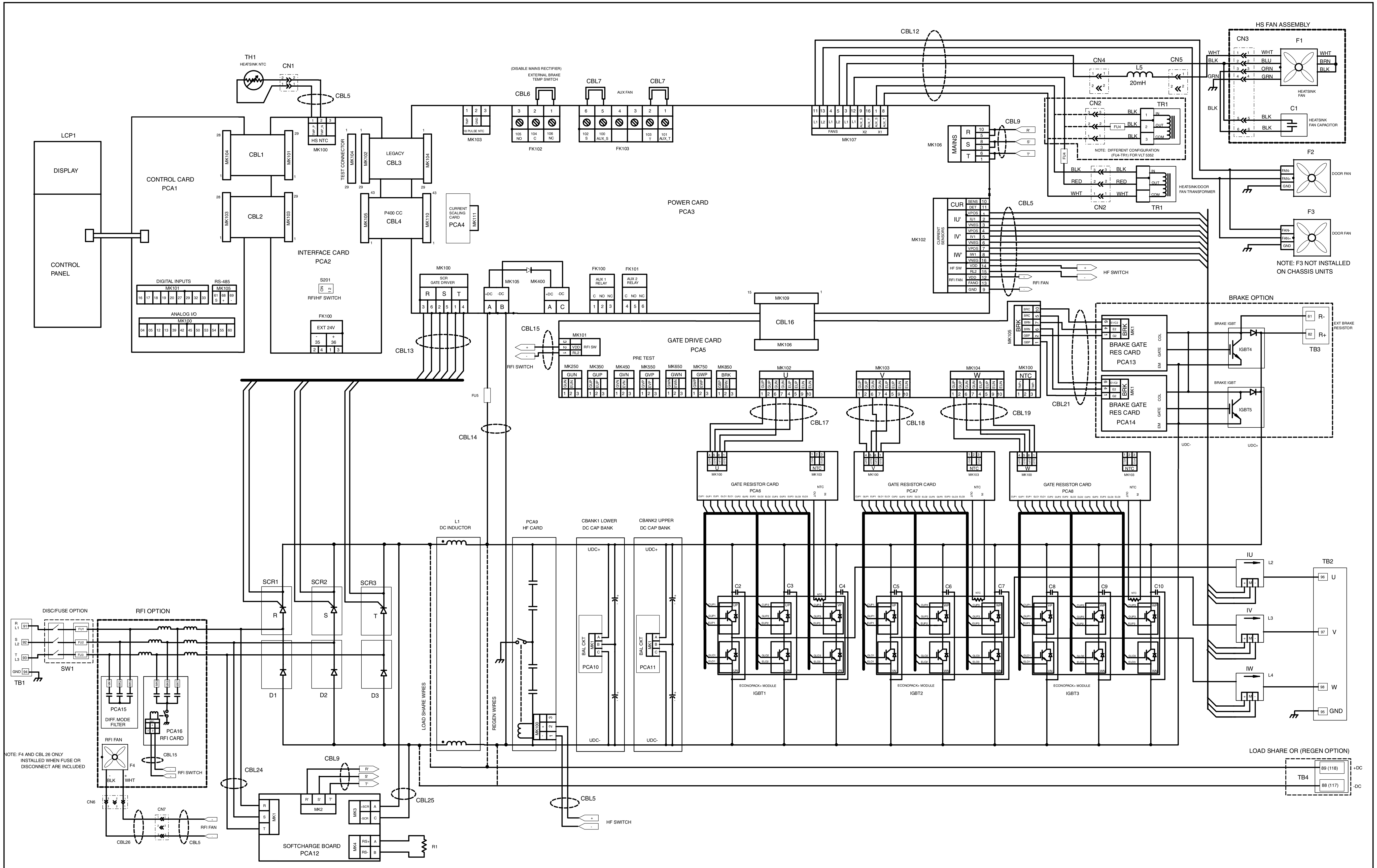
E1 380-500 VAC



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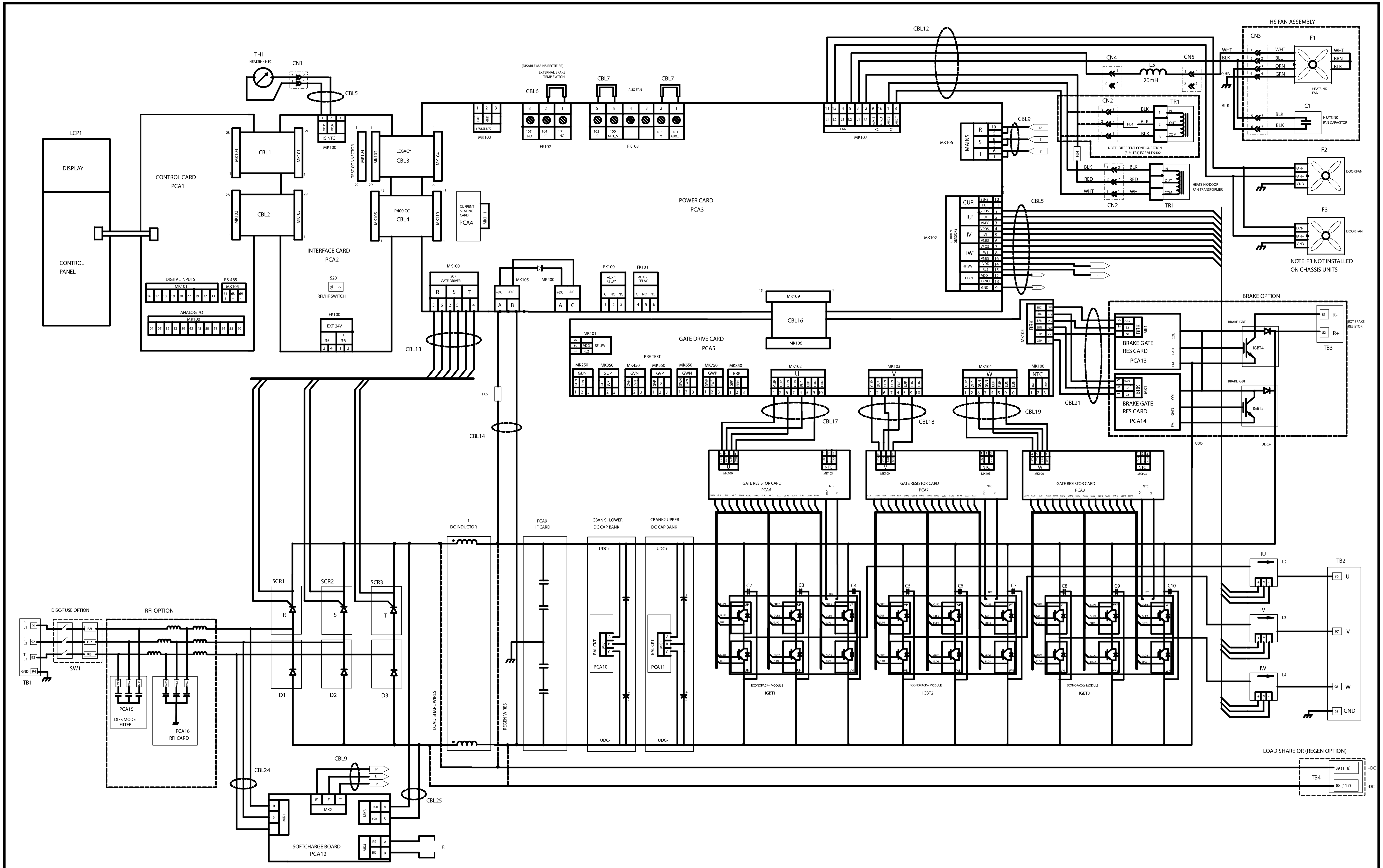

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