Section 10 Appendix

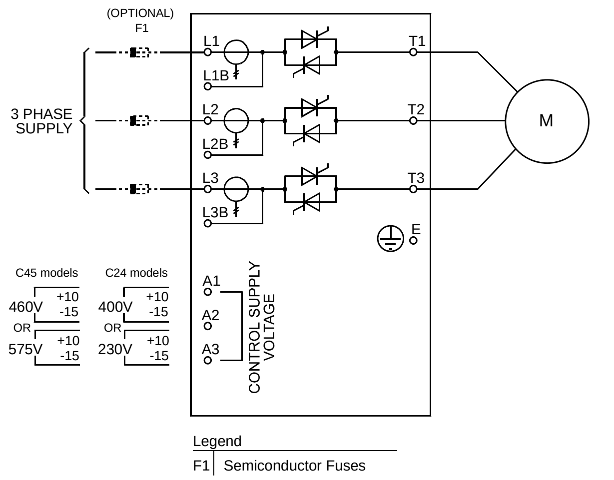
BASIC SETUP PROCEDURE

For simple applications IMS2 soft starters can be installed using the three simple steps outlined below. For applications with advanced control, protection or interface requirements a comprehensive review of this Users Manual is recommended.

1. Installation & Connection

WARNING - ELECTRICAL SHOCK HAZARD
The IMS2 contains dangerous voltages when connected to line voltage. Only a competent electrician should carry out the electrical installation. Improper installation of the motor or the IMS2 may cause equipment failure, serious injury or death. Follow this manual and National Electrical Codes (NEC®) and local safety codes.

1. Ensure the correct IMS2 model has been selected for the connected motor and application type.
2. Mount the IMS2 making sure to allow adequate clearance top and bottom for the free circulation of air through the starter. (Refer to section 4.3 Mounting Instructions for further detail.)
3. Connect the supply cables to starter input terminals L1, L2 & L3.
4. Connect the motor cables to starter output terminals T1, T2 & T3.
5. Connect a control supply to starter input terminals A1 & A2 or A2 & A3. (Refer to section 6.2 Control Supply for further detail).



2. Programming

Basic application requires only that the IMS2 be programmed with the connected motor's nameplate full load current (FLC). To program the IMS2 with the motor's FLC do the following:

1. Select Function 1. *Motor Full Load Current* by holding down the **<FUNCTION>** key and then press the **<UP>** key until the display shows "1".
2. Release the **<FUNCTION>** key to display the currently stored value of Function 1. *Motor Full Load Current*.
3. Use the **<UP>** and/or **<DOWN>** keys adjust the FLC setting to match the FLC of the connected motor.
4. Press the **<STORE>** key to store the new FLC setting.
5. Exit the programming mode by holding down the **<FUNCTION>** key, pressing the **<DOWN>** key until the display shows "0" and then release the **<FUNCTION>** key.

3. Operation

The IMS2 is now ready to control the motor. Motor operation can be controlled using the **<START>** and **<STOP>** keys on the IMS2 local control panel. Two other commonly used functions that may be useful for basic installations are Function 2. *Current Limit* and Function 5. *Stop Ramp Time*. These functions can be adjusted in the same manner as described above. (For a more detailed description of the programming procedure refer to section 7.1 Programming Procedure.)

Section 1 Caution Statements

This symbol is used throughout this manual to draw attention to topics of special importance to the installation and operation of the IMS2 soft starter.

Caution Statements cannot cover every potential cause of equipment damage but can highlight common causes of damage. It is therefore the installers responsibility to adhere to all instructions in this manual, to follow good electrical practice and to seek advice before operating this equipment in a manner other than as detailed in this manual.

- Ensure that the IMS2 is completely isolated from the power supply before attempting any work on the unit.
- Entry of metal swarf into the cabinet can cause equipment failure.
- Do not apply voltage to the control input terminals. These are active 12/24VDC inputs and must be controlled with potential free circuits.
- Ensure contacts/switches operating the control inputs are suitable for low voltage, low current switching ie, gold flash or similar.
- Ensure cables to the control inputs are segregated from AC power and control wiring.
- Do not connect Power Factor Correction capacitors to the output of the IMS2. If static power factor correction is employed, it must be connected to the supply side of the IMS2.
- Before installing the IMS2 without a line contactor ensure such connection meets local regulations and by-laws.
- If installing the IMS2 within a non-ventilated enclosure a bypass contactor must be utilised to prevent excessive heat build-up.
- If installing a by-pass contactor ensure phase connections are correctly made ie L1B-T1, L2B-T2, L3B-T3
- If installing a D.C.Braking contactor ensure that the phase connections are correctly made. i.e. T2 – T3.
- Removing control voltage resets the thermal model.

The examples and diagrams in this manual are included solely for illustrative purposes. Users are cautioned that the information contained in this manual is subject to change at any time and without prior notice. In no event will responsibility or liability be accepted for direct or indirect or consequential damages resulting from the use or application of this equipment.

WARNING - ELECTRICAL SHOCK HAZARD
The IMS2 contains dangerous voltages when connected to line voltage. Only a competent electrician should carry out the electrical installation. Improper installation of the motor or the IMS2 may cause equipment failure, serious injury or death. Follow this manual and National Electrical Codes (NEC®) and local safety codes.

GROUNDING AND BRANCH CIRCUIT PROTECTION
It is the responsibility of the user or person installing the IMS2 to provide proper grounding and branch circuit protection according to the National Electric Code (NEC®) and local codes.

Section 2 General Description

2.1 Overview

The IMS2 Series is a microcontroller based soft starter incorporating the latest technologies and has been designed to provide a complete range of the most advanced soft start, soft stop and motor protection features.

2.2 Feature List

Starting
- Constant current mode.
- Current ramp mode.
- Torque control.
- Kickstart.

Stopping
- Soft stop.
- Pump stop.
- Soft braking.
- D.C.Braking (F2 models only)

Protection
- Motor thermal model.
- Motor thermistor input.
- Phase imbalance.
- Phase sequence.
- Electronic shearpin.
- Undercurrent.
- Auxiliary trip input.
- Starter heatsink overtemperature.
- Excess start time.
- Supply frequency.
- Shorted SCR.
- Power circuit.
- Motor connection.
- RS485 failure.

Interface
- Remote control inputs (3 x fixed, 1 x programmable).
- Relay outputs (1 fixed, 3 x programmable).
- 4-20mA output (1 x programmable).
- RS485 link.

Human Interface
- Local push buttons. (Start, Stop, Reset, Local/Remote)
- Local programming buttons. (Function,Up,Down, Store)
- LED parameter display
- Phase indicator LEDs

Power connection.
- 3 Wire
- 6 Wire (F1 models only)
- Bypass connections to retain motor protection even when bypassed.
- 18 Amps to 1574 Amps (3 Wire)
  27 Amps to 2361 Amps (6 Wire)
- 200VAC to 525VAC (V5 models)
- 200VAC to 690VAC (V7 models)

Sundry features
- IP42 or IP54 (<253 Amps)
- IP00 (>302 Amps)
- Current read-out
- Motor temperature read-out
- Trip log (eight position).
- Multiple function sets.
- Restart Delay.
- Low current flag.
- High current flag.
- Motor overtemperature flag.
- Auto-reset.
- Auto-stop.
- Start counter.
- Function lock/Password protection.
- Store/Restore function settings.
- Emergency mode operation
- Thermal model override

2.3 Part Number Format

IMS2 □□□□ - □□ - □□□ - □□ - □□

Enclosure
E0 = IP00 / Nema 0
E4 = IP42 / Nema 1
E5 = IP54 / Nema 12

Functionality
F1 = Inside Delta (6 Wire) capable
F2 = D.C.Brake capable

Control Supply Voltage
C24 = 230 VAC & 400 VAC
C45 = 460 VAC & 575 VAC

Supply Voltage
V5 = 200 VAC ~ 525 VAC
V7 = 200 VAC ~ 690 VAC

Nominal Current Ratings (Amps @ AC53a 3-30:50-10)
eg. 0125 = 125A AC53a 3-10:50-10

Section 3 Specifications

3.1 Current Ratings

Continuous Operation (Not bypassed)

	3.0 x FLC		3.5 x FLC		4.0 x FLC		4.5 x FLC	
	AC53a 3-10:50-10 45°C <1000 metres		AC53a 3.5-15:50-10 45°C <1000 metres		AC53a 4-20:50-10 45°C <1000 metres		AC53a 4.5-30:50-10 45°C <1000 metres	
	3 Wire	6 Wire	3 Wire	6 Wire	3 Wire	6 Wire	3 Wire	6 Wire
IMS20018	18	27	16	25	14	22	12	19
IMS20034	34	51	32	48	28	42	24	36
IMS20041	41	62	39	58	34	51	28	42
IMS20047	47	71	44	66	39	58	33	50
IMS20067	67	101	60	90	52	79	46	69
IMS20088	88	132	78	116	68	102	59	88
IMS20096	96	144	85	127	74	111	64	96
IMS20125	125	188	112	168	97	146	84	125
IMS20141	141	212	122	183	107	161	94	141
IMS20202	202	303	177	266	155	233	135	202
IMS20238	238	357	211	317	185	277	160	241
IMS20253	253	379	218	327	191	286	167	251
IMS20302	302	453	275	413	239	358	205	308
IMS20405	405	608	376	564	324	486	274	412
IMS20513	513	769	481	722	411	616	342	513
IMS20585	585	878	558	837	474	711	392	587
IMS20628	628	942	595	893	508	762	424	636
IMS20775	775	1163	756	1134	637	956	521	782
IMS20897	897	1346	895	1342	749	1123	604	906
IMS21153	1153	1730	1049	1574	917	1376	791	1187
IMS21403	1403	2105	1302	1953	1135	1703	970	1454
IMS21574	1574	2361	1486	2229	1290	1936	1091	1637

AC53a Utilisation Category Format

78 A: AC-53a 3.5-15 : 50-10

- 10 – Starts Per Hour
- 50 – On-load Duty Cycle (%)
- 15 – Start Time (seconds)
- 3.5 – Start Current (multiple of FLC)
- 78 A – Starter Current Rating (Amps)

Starter Current Rating: The Full Load Current rating of soft starter given the parameters detailed in the remaining sections of the utilisation code.

Start Current: The maximum available start current given the parameters detailed in the remaining sections of the utilisation code.

Start Time: The maximum available start time given the parameters detailed in the remaining sections of the utilisation code.

On-load Duty Cycle: The maximum permissible percentage of each operating cycle that the soft starter can operate given the parameters detailed in the remaining sections of the utilisation code.

Starts Per Hour: The maximum available number of starts per hour given the parameters detailed in the remaining sections of the utilisation code.

Contact you local supplier for IMS2 ratings under operating conditions not covered by the above ratings charts.

Bypass Operation

	3.0 x FLC		3.5 x FLC		4.0 x FLC		4.5 x FLC	
	AC53b 3-10:350 45°C <1000 metres		AC53b 3.5-15:345 45°C <1000 metres		AC53b 4-20:340 45°C <1000 metres		AC53b 4.5-30:330 45°C <1000 metres	
	3 Wire	6 Wire	3 Wire	6 Wire	3 Wire	6 Wire	3 Wire	6 Wire
IMS20018	18	27	18	27	16	24	14	20
IMS20034	34	51	34	51	34	51	28	42
IMS20041	41	62	41	62	41	62	34	52
IMS20047	47	71	47	71	47	71	39	59
IMS20067	67	101	62	94	54	82	47	71
IMS20088	88	132	82	122	71	106	61	91
IMS20096	96	144	90	136	78	117	66	99
IMS20125	125	188	120	181	103	155	88	132
IMS20141	141	212	127	190	111	166	96	145
IMS20202	202	303	187	281	162	243	140	210
IMS20238	238	357	224	336	194	290	166	250
IMS20253	254	381	228	342	198	297	172	259
IMS20302	302	453	285	427	245	368	209	314
IMS20405	405	608	395	592	336	504	282	424
IMS20513	513	770	513	770	435	653	356	534
IMS20585	585	878	585	878	504	756	410	614
IMS20628	628	942	626	939	528	793	436	654
IMS20775	775	1163	775	1163	672	1009	542	813
IMS20897	897	1346	897	1346	798	1197	632	948
IMS21153	1153	1730	1153	1730	1006	1509	850	1276
IMS21403	1403	2105	1403	2105	1275	1912	1060	1591
IMS21574	1574	2361	1574	2361	1474	2212	1207	1811

AC53b Utilisation Category Format

90 A: AC-53b 3.5-15 : 345

Off Time (seconds)

Start Time (seconds)

Start Current (multiple of FLC)

Starter Current Rating (Amps)

Starter Current Rating: The Full Load Current rating of soft starter given the parameters detailed in the remaining sections of the utilisation code.

Start Current: The maximum available start current given the parameters detailed in the remaining sections of the utilisation code.

Start Time: The maximum available start time given the parameters detailed in the remaining sections of the utilisation code.

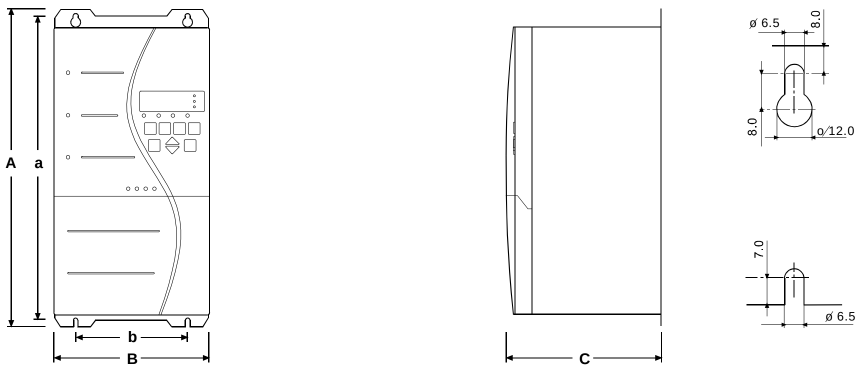
Off Time: The minimum allowable time between end of one start and the beginning of the next start given the parameters detailed in the remaining sections of the utilisation code.

Contact you local supplier for IMS2 ratings under operating conditions not covered by the above ratings charts.

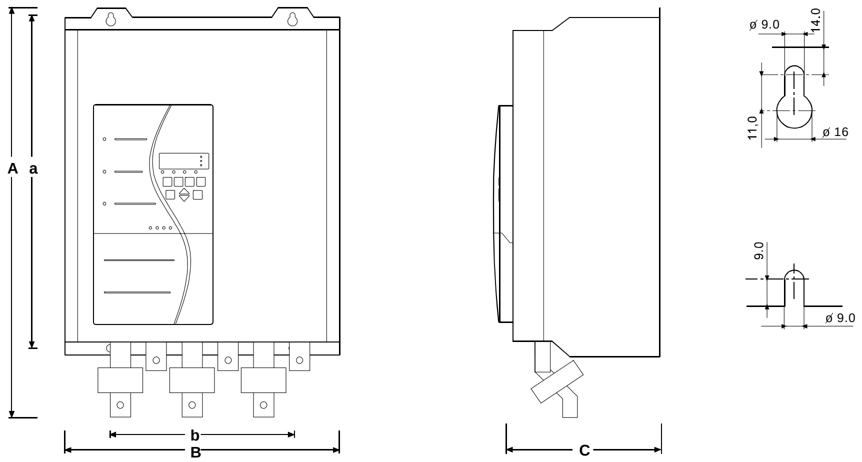
3.2 Dimensions & Weights

	A mm (inches)	B mm (inches)	C mm (inches)	a mm (inches)	b mm (inches)	Weight Kg (lbs)
	IP42/NEMA 1 or IP54/NEMA12					
IMS20018	380 (14.96)	185 (7.28)	180 (7.09)	365 (14.37)	130 (5.12)	6 (13.2)
IMS20034						
IMS20041						
IMS20047						
IMS20067	380 (14.96)	185 (7.28)	250 (9.84)	365 (14.37)	130 (14.37)	7 (15.4)
IMS20088						
IMS20096						
IMS20125						
IMS20141	425 (16.73)	270 (10.63)	275 (10.83)	410 (16.14)	200 (7.87)	17.5 (38.6)
IMS20202						
IMS20238						
IMS20253	425 (16.73)	390 (15.35)	275 (10.83)	410 (16.14)	300 (11.81)	23 (50.7)
	IP00					
IMS20302	545 (21.46)	430 (16.93)	294 (11.58)	522 (20.55)	320 (12.60)	42 (92.6)
IMS20405						
IMS20513						
IMS20585						
IMS20628						49 (108)
IMS20775						
IMS20897						
IMS21153	855 (33.27)	574 (22.60)	353 (13.90)	727 (27.83)	500 (19.68)	120 (242)
IMS21403						
IMS21574						

IMS20018~IMS20253



IMS20302~IMS21574



3.3 Semiconductor Fuses

Semiconductor fuses can be used with the IMS2 to reduce the potential of damage to SCRs from transient overload currents and for Type 2 coordination. Suitable Bussman semiconductor fuses are detailed below.

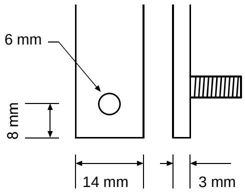
F Series Fuses	Supply Voltage ≤415VAC	Supply Voltage ≤525VAC	Supply Voltage ≤575VAC	Supply Voltage ≤695VAC	Starter I^2t
IMS20018	63AFE	63AFE	63AFE	63AFE	1,150
IMS20034	160AFEE	160AFEE	160AFEE	160AFEE	10,500
IMS20041	200FM	180FM	180FM	180FM	15,000
IMS20047	200FM	180FM	180FM	180FM	18,000
IMS20067	200FM	180FM	180FM	180FM	15,000
IMS20088	250FM	250FM	250FM	250FM	51,200
IMS20096	250FM	250FM	250FM	250FM	80,000
IMS20125	250FM	250FM	250FM	250FM	97,000
IMS20141	280FM	280FM	280FM	280FM	97,000
IMS20202	500FMM	450FMM	450FMM	450FMM	145,000
IMS20238	630FMM	630FMM	630FMM	630FMM	414,000
IMS20253	630FMM	630FMM	630FMM	630FMM	414,000
IMS20302	630FMM	500FMM	500FMM	500FMM	211,000
IMS20405	500FMM	500FMM	500FMM	500FMM	320,000
IMS20513	700FMM	700FMM	700FMM	700FMM	781,000
IMS20585	*500FMM	*500FMM	*500FMM	*500FMM	1,200,000
IMS20628	*500FMM	*500FMM	*500FMM	*500FMM	1,200,000
IMS20775	*700FMM	*700FMM	*700FMM	*700FMM	2,532,000
IMS20897	-	-	-	-	4,500,000
IMS21153	-	-	-	-	4,500,000
IMS21403	-	-	-	-	6,480,000
IMS21574	-	-	-	-	12,500,000

170M Fuses	Supply Voltage ≤415VAC	Supply Voltage ≤525VAC	Supply Voltage ≤575VAC	Supply Voltage ≤695VAC	Starter I^2t
IMS20018	170M1315	170M1314	170M1314	170M1314	1,150
IMS20034	170M1319	170M1317	170M1317	170M1317	10,500
IMS20041	170M1319	170M1318	170M1318	170M1318	15,000
IMS20047	170M1319	170M1318	170M1318	170M1318	18,000
IMS20067	170M1319	170M1318	170M1318	170M1318	15,000
IMS20088	170M3017	170M3017	170M3017	170M3017	51,200
IMS20096	170M1322	170M1321	170M1321	170M1321	80,000
IMS20125	170M1322	170M1322	170M1322	170M1322	97,000
IMS20141	170M1322	170M1322	170M1322	170M1322	97,000
IMS20202	170M6141	170M6141	170M6141	170M6141	145,000
IMS20238	170M3023	170M3023	170M3023	170M3023	414,000
IMS20253	170M3023	170M3023	170M3023	170M3023	414,000
IMS20302	170M5144	170M5144	170M5144	170M5144	211,000
IMS20405	170M6012	170M4016	170M6011	170M6011	320,000
IMS20513	170M6014	170M6014	170M4018	170M4018	781,000
IMS20585	170M5017	170M6015	170M6014	170M6014	1,200,000
IMS20628	170M6019	170M6018	170M6017	170M6017	1,200,000
IMS20775	170M6021	170M6020	170M6017	170M6017	2,532,000
IMS20897	170M6021	170M6020	170M6151	170M6151	4,500,000
IMS21153	170M6021	170M6020	170M6151	170M6151	4,500,000
IMS21403	170M6021	170M6021	*170M5018	*170M5018	6,480,000
IMS21574	170M6021	170M6021	*170M5018	*170M5018	12,500,000

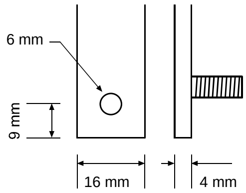
* Two parallel connected fuses required per phase

SPECIFICATIONS

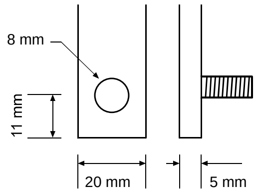
3.4 Power Terminations



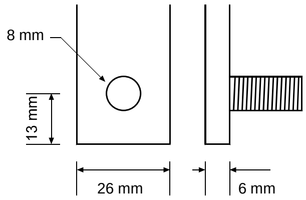
IMS20018~ IMS20047
(3.5 NM, 2.6 FT-LBS)



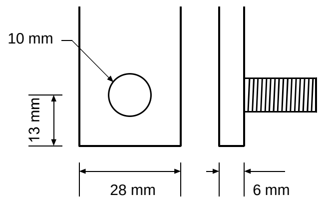
IMS20067~ IMS20125
(3.5 NM, 2.6 FT-LBS)



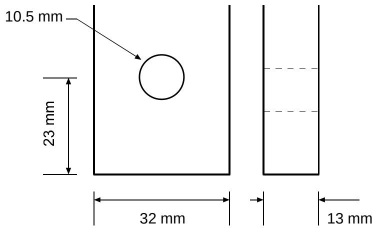
IMS20141
(8.5 NM, 6.3 FT-LBS)



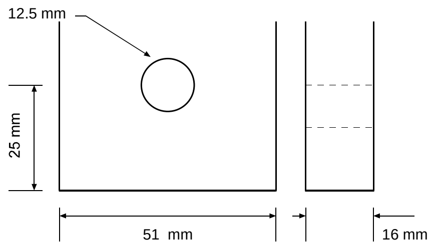
IMS20202~ IMS20238
(8.5 NM, 6.3 FT-LBS)



IMS20253
(17 NM, 12.5 FT-LBS)



IMS20302~ IMS20897



IMS21153~ IMS21574

3.5 General Technical Data

Supply	
Supply voltage IMS2xxxx-V5-xxx-xx-xx	3 x 200VAC ~ 525VAC (3 Wire Connection)
	3 x 200VAC ~ 440VAC (6 Wire Connection)
Supply voltage IMS2xxxx-V7-xxx-xx-xx	3 x 200VAC ~ 690VAC (6 Wire Connection)
	3 x 200VAC ~ 440VAC (6 Wire Connection)
Electronics Supply IMS2xxx-xx-C24-xx-xx	230VAC (+10%/-15%) or 400VAC (+10%/-15%)
Electronics Supply IMS2xxx-xx-C45-xx-xx	460VAC (+10%/-15%) or 575VAC (+10%/-15%)
Supply frequency (at start)	50Hz (± 2Hz) or 60Hz (±2Hz)
Supply frequency (during start)	> 45Hz (50Hz supply) or > 55Hz (60Hz supply)
Supply frequency (during run)	>48Hz (50Hz supply) or > 58Hz (60Hz supply)

Control Inputs	
Start (Terminals C23, C24)	Normally Open, Active 24VDC, 8mA approx.
Stop (Terminals C31, C32)	Normally Closed, Active 24VDC, 8mA approx.
Reset (Terminals C41, C42)	Normally Closed, Active 24VDC, 8mA approx.
Programmable Input A (Terminals C53, C54)	Normally Open, Active 24VDC, 8mA approx.

Outputs	
Run Output (Terminals 23, 24)	Normally Open, 5A @ 250VAC/360VA
	5A @ 30VDC resistive
Programmable Output A (Terminals 13, 14)	Normally Open, 5A @ 250VAC/360VA
	5A @ 30VDC resistive
Programmable Output B (Terminals 33, 34)	Normally Open, 5A @ 250VAC/360VA,
	5A @ 30VDC resistive
Programmable Output C (Terminals 41, 42, 44)	Changeover, 5A @ 250VAC/360VA
	5A @ 30VDC resistive
Analogue Output (Terminals B10, B11)	4-20mA

Sundry	
Enclosure Rating IMS2xxxx-xx-xxx-xx-E0	IP00 (Open Chassis)
Enclosure Rating IMS2xxxx-xx-xxx-xx-E4	IP42 (NEMA 1)
Enclosure Rating IMS2xxxx-xx-xxx-xx-E5	IP54 (NEMA 12)
Rated short-circuit current (with semi-conductor fuses)	100kA
Rated insulation voltage	690 V
Surges	2kV line to earth, 1kV line to line
Fast transients	2.0kV / 5.0 kHz
Rated impulse withstand voltage	2 kV
Form designation	Form 1
Electrostatic discharge	4kV contact discharge, 8 kV air discharge
Equipment class (EMC)	Class A[1]
Radio-frequency electromagnetic field	0.15 MHz - 80 MHz: 140dBµV
	80 MHz - 1 GHz: 10 V/m
Pollution degree	Pollution Degree 3
Operating Temperatures	-5°C / +60°C
Relative Humidity	5 – 95% (max non condensing)

[1] This product has been designed for class A equipment. Use of the product in domestic environments may cause radio interference, in which case the user may be required to employ additional mitigation methods.

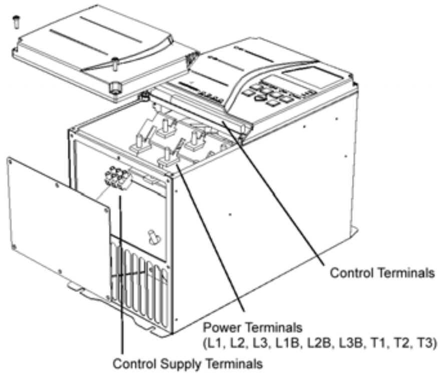
Standards Approvals	
CE	IEC 60947-4-2
UL[1]	UL508
C-UL[1]	CSA 22.2 No.14
C✓	AS/NZS 3947-4-2, CISPR-11

[1] Requires the use of semi-conductor fuses; is applicable for supply voltages up to 600V; excludes models IMS21153 TO IMS21574.

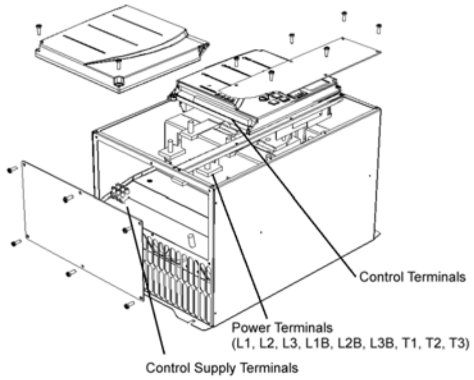
Section 4 Installation

4.1 General Layout Diagrams

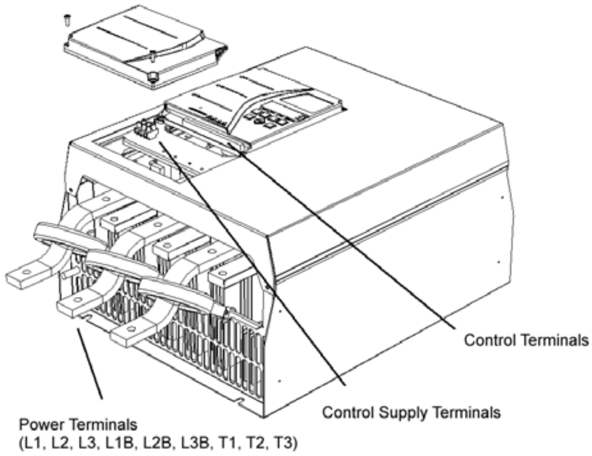
IMS20018 ~ 0125



IMS20141 ~ 0253

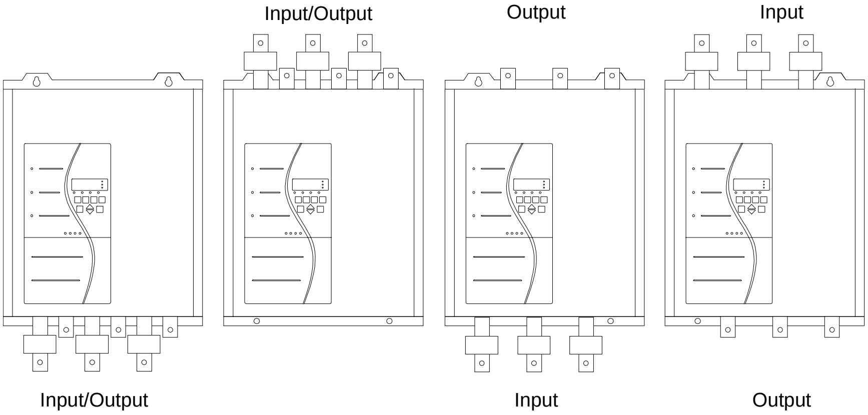


IMS20302 ~ 1574



4.2 Power Termination Configuration

The bus bars on models IMS20302 ~ 1574 can be adjusted to provide four different input/output power terminal configurations.



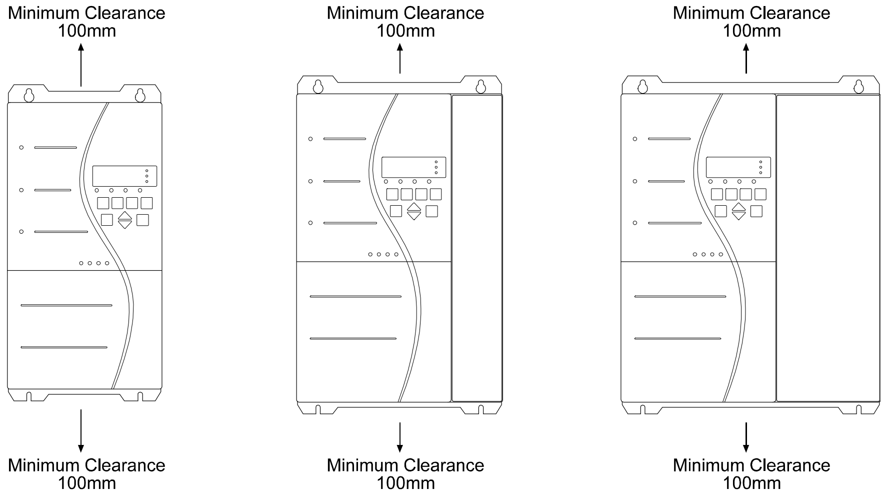
To adjust the bus bar configuration first remove the IMS2 covers and main control module. Next loosen and remove the bus bar fixing bolts. The bus bars can then be removed and reinstalled into the starter in the desired configuration. The fixing bolts should then be refitted and tightened to a torque of 8.5NM.

When re-orienting bus bars L1, L2, L3 the current transformers must also be relocated.

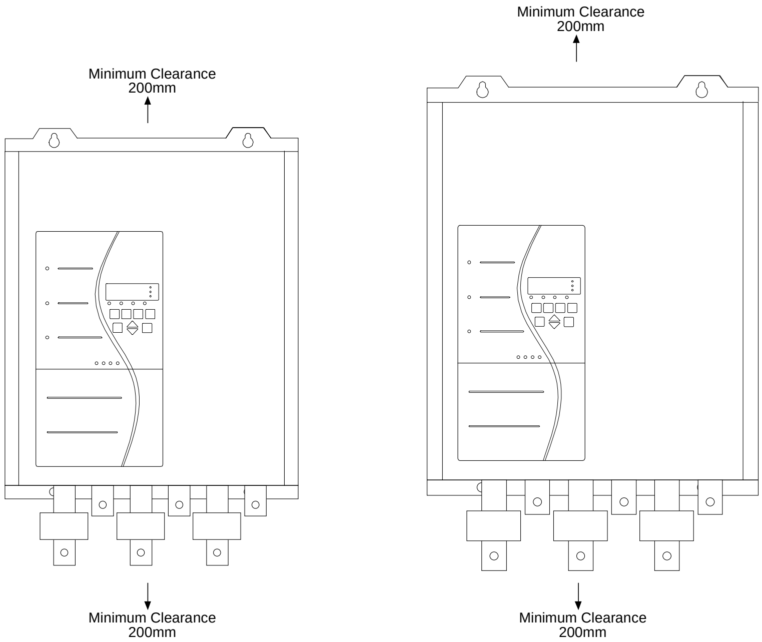
Care must be taken to ensure that foreign matter does not contaminate the jointing compound and become trapped between the bus bar and its mounting plate. If the paste does become contaminated, clean and replace with a jointing compound suitable for aluminium to aluminium, or aluminium to copper joints.

4.3 Mounting Instructions

Models IMS20018 ~ 0253 can be wall mounted or installed inside another enclosure. These models can be mounted side by side with no clearance but a 100mm allowance must be made top and bottom for air intake and exhaust.



Models IMS20302~ 1574 have an IP00 rating and must be mounted in another enclosure. These models can be mounted side by side with no clearance but a 200mm allowance must be made top and bottom for air intake and exhaust.



4.4 Ventilation

When installing IMS2 starters in an enclosure there must be sufficient air flow through the enclosure to limit heat rise within the enclosure. Temperature within the enclosure must be kept at, or below, the IMS2 maximum ambient temperature rating.

If installing an IMS2 within a totally sealed enclosure a bypass contactor must be employed to eliminate heat dissipation from the soft starter during run.

Soft starters dissipate approximately 4.5 watts per amp. The table below shows air flow requirements for selected motor currents. If other heat sources are installed in an enclosure along with the IMS2 an additional air flow allowance must be made for these items. Note that heat generation from semiconductor fuses, if used, can be eliminated by installing these within the bypass loop.

Motor Amps	Heat (watts)	Required Airflow			
		m^3/min		m^3/hour	
		5°C Rise	10°C Rise	5°C Rise	10°C Rise
10	45	0.5	0.2	30	15
20	90	0.9	0.5	54	27
30	135	1.4	0.7	84	42
40	180	1.8	0.9	108	54
50	225	2.3	1.1	138	69
75	338	3.4	1.7	204	102
100	450	4.5	2.3	270	135
125	563	5.6	2.8	336	168
150	675	6.8	3.4	408	204
175	788	7.9	3.9	474	237
200	900	9.0	4.5	540	270
250	1125	11.3	5.6	678	339
300	1350	13.5	6.8	810	405
350	1575	15.8	7.9	948	474
400	1800	18.0	9.0	1080	540
450	2025	20.3	10.1	1218	609
500	2250	22.5	11.3	1350	675
550	2475	24.8	12.4	1488	744
600	2700	27.0	13.5	1620	810

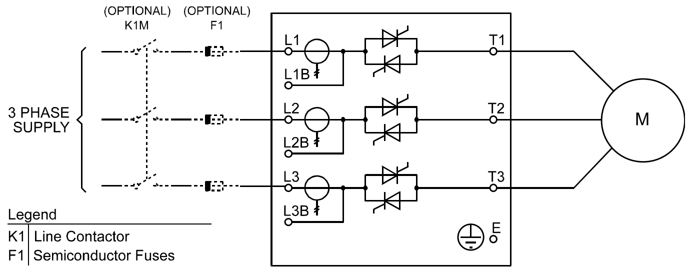
Section 5 Power Circuits

5.1 Overview

IMS2 starters can be wired with a number of different power circuits depending on application requirements.

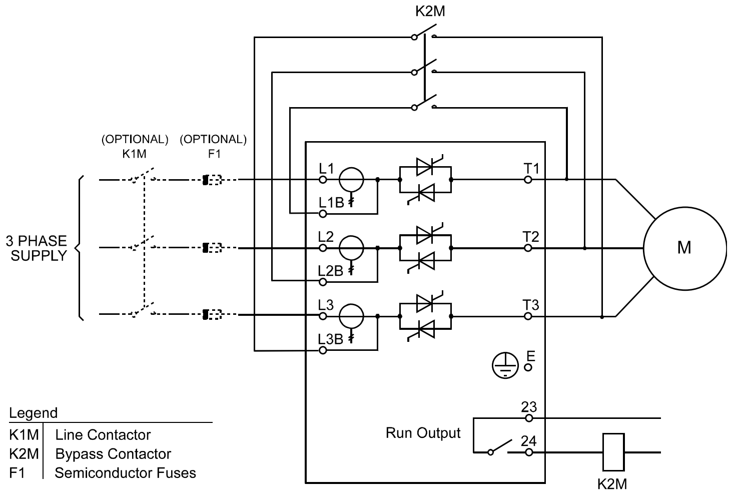
5.2 3 Wire Connection

This is the standard connection format. Supply voltage is connected to the starter input terminals L1, L2 & L3. The motor cables are connected to the soft starter output terminals T1, T2 & T3.



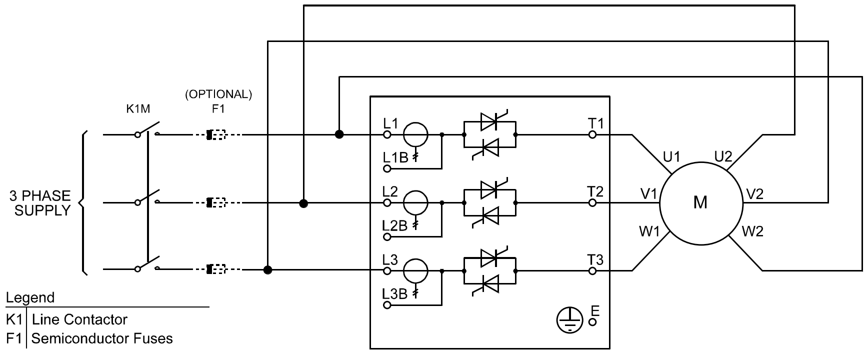
5.3 3 Wire Connection (Bypassed Operation)

IMS2 starters can be bypassed while the motor is running. Special terminals (L1B, L2B, L3B) are provided for connection of the bypass contactor. Use of these terminals enables the IMS2 to continue to provide all protection and current monitoring functions even when bypassed.
The IMS2 Run Output (Terminals 23 & 24) should be used to control operation of the bypass contactor. The bypass contactor can be AC1 rated for the motor full load current.

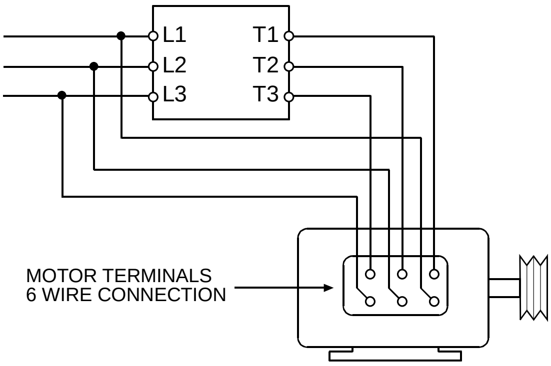


5.4 6 Wire Connection

IMS2xxxx-xx-xxx-**F1**-xx units are capable of 6 Wire (Inside Delta) connection as well as 3 Wire connection. When connected in this configuration the soft starter carries only phase current, this means the motor FLC current can be 50% greater than the soft starter's FLC current rating.



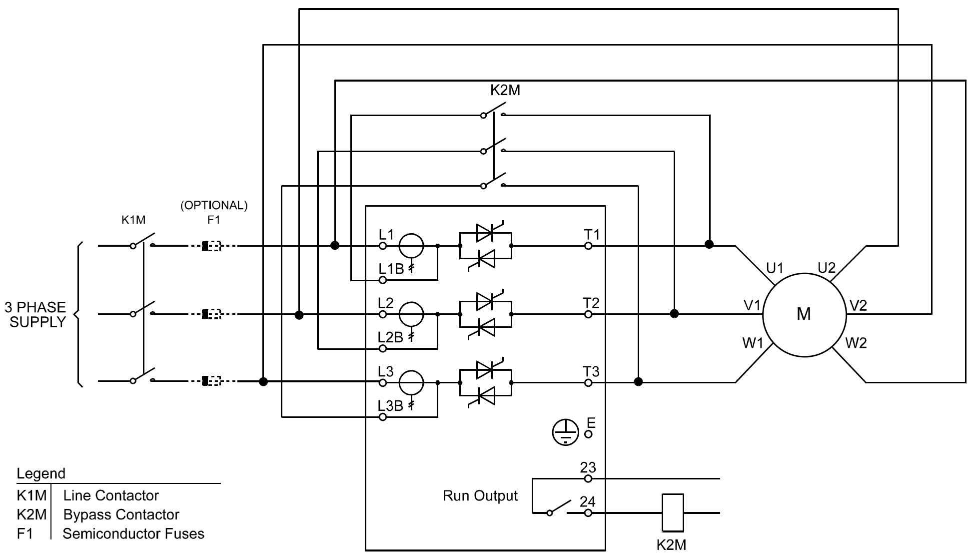
Connect the three OUTPUT terminals (T1, T2, T3) of the IMS2 to the motor windings ensuring that the connections are made to one end of each winding only. It is imperative to connect the output of the IMS2 to the same end of each winding and this is usually marked on the motor terminations.



The six terminations to the motor windings are usually arranged in two rows of three so that the links can be fitted across from the top three terminations to the lower terminations. In this case connect the IMS2 to the top terminations only. Connect the other three motor terminals to the input of the IMS2 in a manner that connects the end of each winding to a different phase from the input.
This is most easily achieved by replacing each delta link in the motor terminal box by one phase of the controller. For example if the delta links are fitted U1-V2,V1-W2,W1-U2
- Connect the incoming phases to L1,L2,L3 on the IMS2.
- Connect the IMS2 to the motor. T1-U1, T2-V1, T3-W1
- Connect the other motor terminals to the IMS2's input W2-L1, U2-L2, V2-L3

5.5 6 Wire Connection (Bypassed Operation)

IMS2xxxx-xx-xxx-**F1**-xx units are capable of 6 Wire (Inside Delta) connection and can be bypassed.

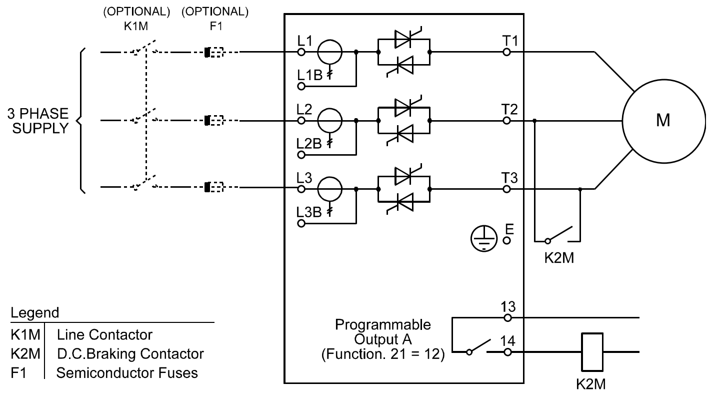


5.6 D.C.Braking

IMS2xxxx-xx-xxx-**F2**-xx units can be configured to provide a D.C.Brake function. To utilise the D.C.Brake function a contactor (AC1 rated for the motor FLC) must be wired to short output terminals T2 & T3 during the braking operation. This contactor must be controlled by Programmable Output A, and Programmable Output A must be set for D.C.Brake Contactor Control.

- Refer to Functions 14 & 15 for *D.C.Brake* parameter adjustments
- Refer to Function 21. *Relay Output A Functionality*

CAUTION:
The soft starter power modules will be damaged if the D.C.Brake contactor is closed when the D.C.Brake function is not operating, or if the D.C.Brake contactor is incorrectly wired between T1-T2 or T1-T3.



5.7 Power Factor Correction

If static power factor correction is employed, it must be connected to the supply side of the soft starter.

CAUTION:
Under no circumstance should power factor correction capacitors be connected between the soft starter and the motor. Connecting power factor correction capacitors to the output of the soft starter will result in damage to the soft starter.

5.8 Line contactors

The IMS2 is designed to operate with or without a line contactor. In many regions there is a statutory requirement that a line contactor be employed with electronic motor control equipment. From a safety point of view, this is the preferable option, however is not necessary for starter operation. An additional benefit gained by use of a line contactor is isolation of the starter SCR's in the off state, when they are most susceptible to damage from voltage transients.

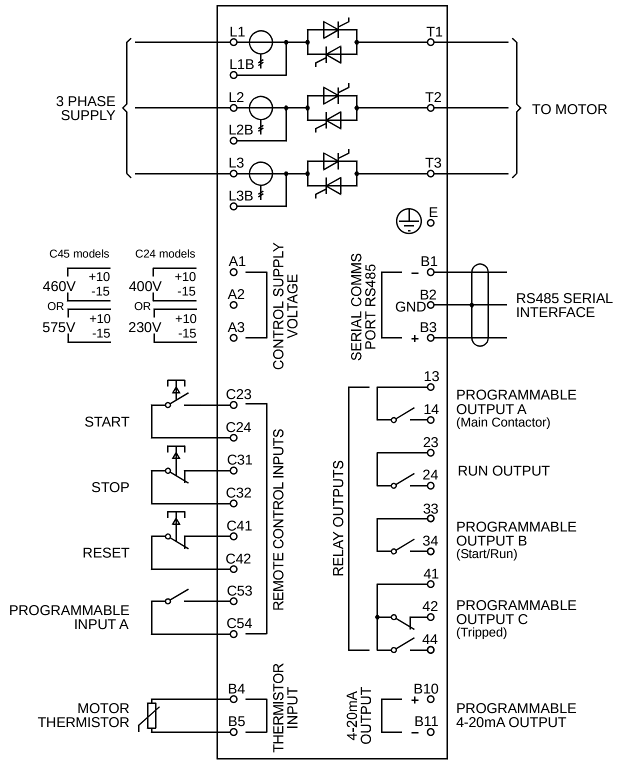
The IMS2 can directly control a line contactor via the Main Contactor Control output.

As an alternative to a line contactor, either a circuit breaker with a no volt release coil operated by the IMS2 trip output, or a motor operated circuit breaker can be considered. If a motor operated circuit breaker is used as a line contactor, the potential delay between the breaker being told to close and phase power being applied to the IMS2 could cause the IMS2 to trip on installation faults. Closing the motorized breaker directly and using the breaker's auxiliary contacts, or preferably a slave relay with gold flash contacts, to control the IMS2 can avoid this.

Line contactors must be selected such that their AC3 rating is equal to or greater than the full load current rating of the connected motor.

Section 6 Control Circuits

6.1 Electrical Schematic



6.2 Control Supply

Voltage must be connected to the IMS2 control voltage terminals. The required control voltage is dependent upon the IMS2 model ordered.

- IMS2xxxx-xx-**C24**-xx-xx models: 230VAC (A2-A3) or 400VAC (A1-A2)
- IMS2xxxx-xx-**C45**-xx-xx models: 460VAC (A1-A2) or 575VAC (A2-A3)

IMS2 Model	Maximum VA
IMS20018~IMS20047	11VA
IMS20067~IMS20125	18VA
IMS20141~IMS20238	24VA
IMS20253~IMS20897	41VA
IMS21153~IMS21574	56VA

For circumstances where the available control supply voltage is not suitable for direct connection to the IMS2 the following range of auto-transformers are available as accessories. These auto-transformers can be mounted within the IMS2 in models up to IMS20253 and should be connected between the line voltage and IMS2 control supply input.

Input Voltages For C24 IMS2 Models	Part Number			
	IMS20018 ~ IMS20047	IMS20067 ~ IMS20125	IMS20141 ~ IMS20238	IMS20253~ IMS21574
110 / 460 VAC	1PT11H	1PT17H	1PT23H	1PT55H
110 / 575 VAC	1PT11I	1PT17I	1PT23I	1PT55I

Input Voltages For C45 IMS2 Models	Part Number			
	IMS20018 ~ IMS20047	IMS20067 ~ IMS20125	IMS20141 ~ IMS20238	IMS20253~ IMS21574
110 / 230 VAC	1PT11M	1PT17M	1PT23M	1PT55M

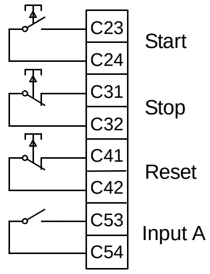
6.3 Control Wiring

IMS2 operation can be controlled using either the local push buttons, remote control inputs or the serial communications link. The **<LOCAL/REMOTE>** push button can be used to switch between local and remote control. Refer to Function 20. *Local/Remote Operation* for details.

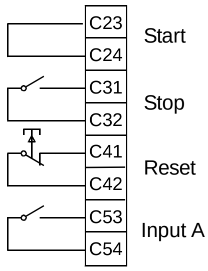
Remote Control Inputs

The IMS2 has four remote control inputs. Contacts used for controlling these inputs should be low voltage, low current rated (Gold flash or similar).

Remote push button control



Two wire control



CAUTION:

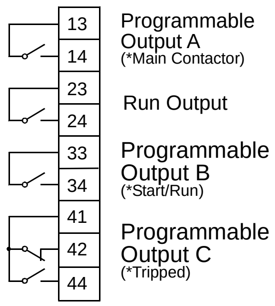
Do not apply voltage to the control inputs. The inputs are active 24VDC and must be controlled with potential free circuits.

Ensure contacts/switches operating the control inputs are suitable for low voltage, low current switching ie, gold flash or similar.

Ensure cables to the control inputs are segregated from AC power and control wiring.

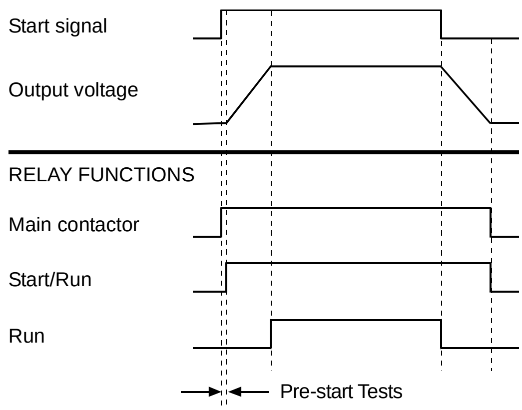
Relay Outputs

The IMS2 provides four relay outputs, one fixed and three programmable. Functionality of the programmable outputs is determined by the settings of Functions 21, 22 & 23.



Functionality Assignment
- Tripped
- Overcurrent trip
- Undercurrent trip
- Motor thermistor trip
- Starter overtemperature trip
- Phase imbalance trip
- Electronic shearpin trip
- Low current flag
- High current flag
- Motor overload flag
- Start/Run
- Main Contactor
- D.C.Brake Control (Output A Only)

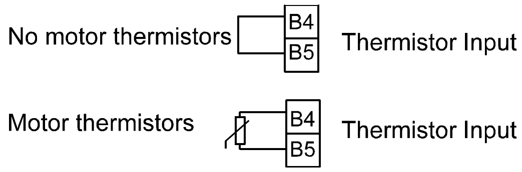
* = default functionality



Motor Thermistors

Motor thermistors (if installed in the motor) may be connected directly to the IMS2. A trip will occur when the resistance of the thermistor circuit exceeds approximately

2.8kΩ. The IMS2 can be reset once the thermistor circuit resistance falls below approximately 2.8kΩ



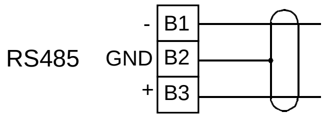
NOTE:
The thermistor circuit must be closed before the IMS2 will run.

The thermistor circuit should be run in screened cable and must be electrically isolated from earth and all other power and control circuits.

If no motor thermistors are connected to the IMS2 thermistor input there must be a link across the thermistor input terminals B4 & B5 or Function 34. *Motor Thermistor* must be set to 1 (Off).

6.4 RS485 Serial Communication

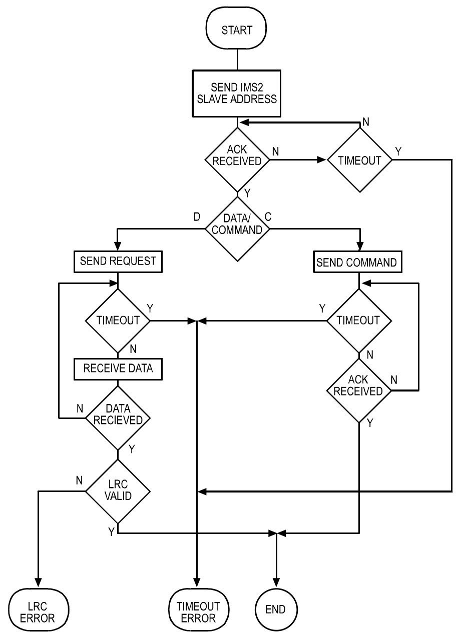
The IMS2 has a non-isolated RS485 serial communication link.



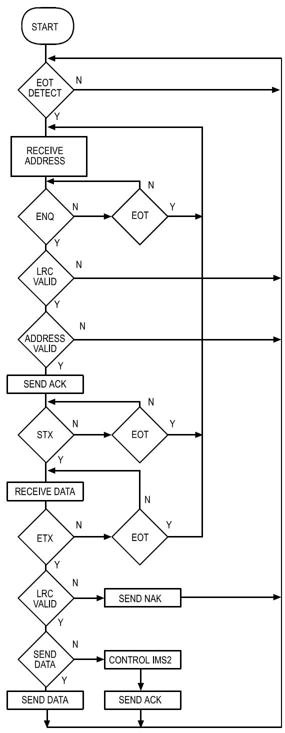
NOTE:
Power cabling should be kept at least 300mm away from communications cabling. Where this cannot be avoided magnetic shielding should be provided to reduce induced common mode voltages.

Data transmitted to and from the IMS2 must be in 8 bit ASCII, no parity, 1 stop bit.
Baud rate is set by Function. 61 *RS485 Baud Rate*.
The IMS2 can be programmed to trip if the RS485 link fails by setting Function 60. *RS485 Timeout.*
The starter address is assigned using Function 62. RS485 *Satellite Address*.
The flow charts below show typical form of communication between an IMS2 and host controller.

Host controller to IMS2



IMS2 to host controller



The following code sequences are used in the communications between the host and the IMS2 (network).

Address slave unit.

ASCII	EOT	[nn]	LRC	ENQ
or	04h	[n1]h [n2]h	[LRC1]h [LRC2]h	05h

Slave response.

ASCII	ACK
or	06h

NOTE:
If no IMS2 starter is configured to the specific slave address, no response will be received by the host. The host software timeout should be set to a minimum of 250 ms.

NOTE:
Slave address must be two digit, addresses less than 10 must have a leading zero (0).

Master command to slave.

ASCII	STX	[command]	LRC	ETX
or	02h	[c1]h [c2]h [c3]h	[LRC1]h [LRC2]h	03h

[command] = 3 byte ASCII command (or request) selected from the tables below.
LRC = Longitudinal Redundancy Check.

Slave response if Command and LRC correct

ASCII	ACK
or	06h

Slave response if Command and LRC incorrect

ASCII	NAK
or	15h

Slave response of Read request correct and LRC correct.

ASCII	STX	[data]	LRC	ETX
or	02h	[d3]h [d2]h [d1]h [d0]h	[LRC1]h [LRC2]h	03h

Slave response if Read request or LRC invalid.

ASCII	NAK
or	15h

Each command, status or data request is a 3 byte string as detailed below. Invalid command/request strings cause the IMS2 to respond with a NAK (15h).

Command	ASCII	Comment
Start	B10	Initiates a start.
Stop	B12	Initiates a stop
Reset	B14	Resets a trip state
Coast to stop	B16	Initiates an immediate removal of voltage from the motor. Any soft stop or D.C.Brake settings are ignored.

Status Read	ASCII	Comment
Status	C10	Requests the configuration status of the IMS2.
Status_1	C12	Requests the operational status of the IMS2.
Trip	C14	Requests the trip status of the IMS2.
Version	C16	RS485 protocol version number.
Trip Code	C18	255 = No trip

Status Read	ASCII	Comment
		0 = Shorted SCR 1 = Excess start time trip 2 = Motor Thermal model trip 3 = Motor thermistor 4 = Phase imbalance trip 5 = Supply frequency trip 6 = Phase sequence trip 7 = Electronic shearpin trip 8 = Power circuit fault 9 = Undercurrent trip 10 = Starter heatsink overtemperature 11 = Invalid motor connection 12 = Auxiliary trip

Data Read	ASCII	Comment
Current	D10	Requests motor current. The data is 4 byte decimal ASCII. Minimum value 0000, Maximum value 9999 Amps.
Temperature	D12	Requests the calculated value of the motor thermal model as a % of Motor Thermal Capacity. The data is 4 byte decimal ASCII. Minimium value 0000%. Trip point 0105%.

Each command string sent to and from the IMS2 includes a check sum. The form used is the Longitudinal Redundancy Check (LRC) in ASCII hex. This is an 8-bit binary number represented and transmitted as two ASCII hexadecimal characters.
To calculate LRC:
1. Sum all ASCII bytes
2. Mod 256
3. 2's complement
4. ASCII convert

For example Command String (Start);

ASCII	STX	B	1	0
or	02h	42h	31h	30h

ASCII	Hex	Binary	
STX	02h	0000 0010	
B	42h	0100 0010	
1	31h	0011 0001	
0	30h	0011 0000	
	A5h	1010 0101	SUM (1)
	A5h	1010 0101	MOD 256 (2)
	5Ah	0101 1010	1's COMPLEMENT
	01h	0101 1011	+ 1 =
	5Bh	0101 1011	2's COMPLEMENT (3)

ASCII	5	B	ASCII CONVERT (4)
or	35h	42h	LRC CHECKSUM

The complete command string becomes

ASCII	STX	B	1	0	5	B	ETX
or	02h	42h	31h	30h	35h	42h	03h

To verify a received message containing an LRC;
1. Convert the last two bytes of message from ASCII to binary.
2. Left shift 2nd to last byte 4 bits.
3. Add this result to the last byte to get the binary LRC.
4. Add up all the bytes of the message, except the last two.
5. Add the binary LRC.
6. The least significant byte should be zero.

For example:

ASCII	STX	B	1	0	5	B	ETX
or	02h	42h	31h	30h	35h	42h	03h

1. 35h (ASCII hex) = 5H = 00000101
   42h (ASCII hex) = Bh = 00001011
   Note: 03h is the EXT character (end of transmission) and is not part of the message.
2. 00000101 = 01010000
3. 01010000 + 00001011 = 01011011
4. 02h + 42h + 31h + 30h = A5h
5. A5h + 5Bh = 100h
6. The least significant byte is zero so the message and LRC match.

Response or status bytes are sent from the IMS2 as an ASCII string.

STX [d1]h [d2]h [d3]h [d4]h LRC1 LRC2 ETX

d1 = 30h
d2 = 30h
d3 = 30h plus upper nibble of status byte right shifted by four binary places.
d4 = 30h plus lower nibble of status byte.

For example status byte = 1Fh, response is
STX 30h 30h 31h 3Fh LRC1 LRC2 ETX

Status bits (positive logic 1 = true)

Status Bit	Function	Comment
Status.7	50 Hz	Only one of either Status.7 or Status.6 can be at logic 1 when the IMS2 is operating.
Status.6	60 Hz	
Status.5	-	Unallocated
Status.4	Soft stop	
Status.3	Positive phase rotation	Will be at logic 0 when there is a negative phase rotation.
Status.2	-	Unallocated
Status.1	-	Unallocated
Status.0	-	Unallocated

Status_1 bits (negative logic 0 = true)

Status Bit	Function	Comment
NOT Status_1.7	-	
NOT Status_1.6	-	
NOT Status_1.5	-	
NOT Status_1.4	Restart Delay	
NOT Status_1.3	Overload	Motor is operating in an overload condition.
NOT Status_1.2	Run	
NOT Status_1.1	Output On	
NOT Status_1.0	Power On	

Trip bits (negative logic 0 = true). The table below shows the complement of these bits to give positive logic (1 = true).

Status Bit	Function
NOT Trip.7	Phase Loss
NOT Trip.6	Undercurrent
NOT Trip.5	Phase Rotation
NOT Trip.4	Overcurrent
NOT Trip.3	Over Temperature
NOT Trip.2	Installation
NOT Trip.1	Instantaneous Overload
NOT Trip.0	Thermistor

Section 7 Programming

7.1 Programming Procedure

Step 1. Enter the program mode and select the function number to be viewed or adjusted.

1. Press and hold the **<FUNCTION>** key.
2. Using the **<UP>** and **<DOWN>** keys select the required function number. (Function numbers are left justified and blink).
3. When the required function number is dispalyed, release the **<FUNCTION>** key. The display changes to show the function set point currently stored in memory. (Function values are right justified and do not blink)

Step 2. Alter the function set point.

1. Review the current function set point and, if necessary, use the **<UP>** or **<DOWN>** keys to adjust the setting. (Pressing the **<FUNCTION>** key will restore the original setting).

Step 3. Store the new function set point.

1. Press the **<STORE>** key to store the displayed setting into memory.
2. Verify the new set point has been correctly stored by pressing and then releasing the **<FUNCTION>** key. The LED display should now show the new set point.

Step 4. Exit programming mode.

1. Once all function settings have been made, exit the programming mode by using the **<FUNCTION>** and **<DOWN>** keys to select function number 0 (RUN MODE).

7.2 Function List

No.	Function	Factory Defaults	User Set 1	User Set 2
	Primary Motor Settings			
1	Motor full load current	-		
2	Current limit	350		
3	Initial start current	350		
4	Start ramp time	1		
5	Stop ramp time	0		
6	Motor start time constant	10		
7	Phase imbalance sensitivity	5		
8	Undercurrent protection	20		
9	Electronic shearpin protection	400		
	Start/Stop Formats			
10	Torque control	0		
11	Kickstart	0		
12	Soft stop mode	0		
13	Auto-stop run time	0		
14	D.C.Brake - Brake Time	0		
15	D.C.Brake - Brake Torque	30		
	Starter Functionality			
20	Local/Remote operation	0		
21	Relay output A functionality	11		
22	Relay output B functionality	10		
23	Relay output C functionality	0		
24	Input A functionality	0		
	Protection Settings			
30	Excess start time	20		
31	Phase sequence	0		
32	Restart delay	1		
33	Phase imbalance	0		
34	Motor thermistor	0		
35	Starter overtemperature	0		
36	Auxiliary trip mode	0		
	Set Points			
40	Low current flag	50		
41	High current flag	105		
42	Motor temperature flag	80		
43	Field calibration	100		
	Analogue Output			
50	4-20mA output functionality	0		
51	4-20mA output range - max	100		
52	4-20mA output range - min	0		
	Serial Communications			
60	RS485 timeout	0		
61	RS485 baud rate	4		
62	RS485 satellite address	20		
	Auto Reset			
70	Auto-reset - configuration	0		
71	Auto-reset - number of resets	1		
72	Auto-reset - group A & B delay	5		
73	Auto-reset - group C delay	5		

No.	Function	Factory Defaults	User Set 1	User Set 2
	Secondary Motor Settings			
80	Motor full load current	-		
81	Current limit	350		
82	Initial start current	350		
83	Start ramp time	1		
84	Stop ramp time	0		
85	Motor start time constant	10		
86	Phase imbalance sensitivity	5		
87	Undercurrent protection	20		
88	Electronic shearpin protection	400		
	Protection Delays			
90	Phase imbalance trip delay	3		
91	Undercurrent trip delay	5		
92	Electronic shearpin delay	0		
93	Out of frequency trip delay	0		
94	Auxiliary trip delay	0		
	Read Only Data			
100	Model Number	-		
101	Start counter (1000's)	-		
102	Start counter (1's)	-		
103	Trip Log	-		
	Restricted Functions			
110	Access code	0		
111	Update access code	0		
112	Function lock	0		
113	Restore function settings	0		
114	Emergency mode format	0		
115	Emergency mode trip relay	0		
116	Thermal model override	-		
117	Thermal model override count	-		

Application Detail	
IMS2 model	
IMS2 serial number	
IMS2 connection format (tick)	▯ 3 Wire ▯ 6 Wire ▯ Bypassed
Motor amps	Amps
Motor kW	kW
Driven machine	
Start current (%FLC)	% FLC
Start time (seconds)	secs
Starts per hour	
Ambient temperature (^{o}C)	^{o}C
Application Reference	

If requesting assistance during commissioning or troubleshooting please complete the above table and make it available for your IMS2 supplier.

7.2 Function Descriptions

1. Motor Full Load Current [Primary Motor Settings]

Range: **Model Dependant (Amps)**

Default Setting: **Model Dependant (Amps)**

Description

Sets the IMS2 for the connected motor's full load current.

Adjustment

Set to the Full Load Current (amps) rating shown on the motor nameplate.

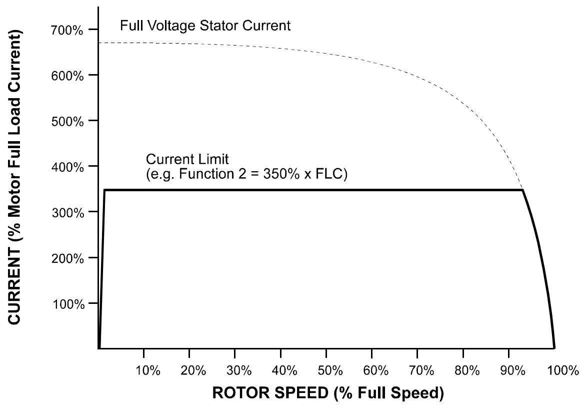
2. Current Limit [Primary Motor Settings]

Range: **100 – 550 % FLC**

Default Setting: **350% FLC**

Description

Sets the current limit for the Constant Current start mode.



Adjustment

The required setting for the Current Limit function is installation dependant and should be set such that:

- The motor is supplied with sufficient start current to enable it to produce torque adequate to easily accelerate the connected load.
- Desired starting performance is obtained.
- IMS2 ratings are not exceeded.

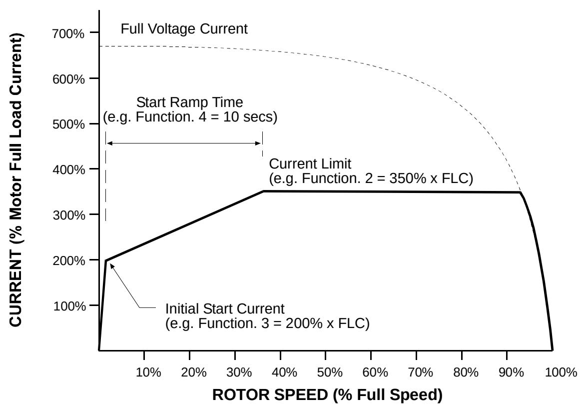
3. Initial Start Current [Primary Motor Settings]

Range: **100 – 550 % FLC**

Default Setting: **350% FLC**

Description

Sets the initial start current level for the Current Ramp start mode.



Adjustment

Function 3 *Initial Start Current* and Function 4 *Start Ramp Time* are used together to activate and control the Current Ramp start mode.

If the Current Ramp start mode is required, set the *Initial Start Current* so that the motor begins to accelerate immediately a start is initiated. If Current Ramp start mode is not required, set the *Initial Start Current* equal to the Current Limit.

Current Ramp start mode should be considered in preference to Constant Current start mode in applications where:

- Required start torque can vary from start to start. For example conveyors may start loaded or unloaded. In this case set Function 3 *Initial Start Current* to a level that will start motor in the light load condition and Function 2 *Current Limit* to a level that will start the motor in the high load condition.
- Starting time of an easily broken away load needs to be extended, for example pumps.
- A generator set supply is limited and a slower application of load will allow greater time for the generator set to respond.

4. Start Ramp Time [Primary Motor Settings]

Range
1 – 30 Seconds

Default Setting
1 Second

Description

Sets the ramp time for the Current Ramp start mode.

Adjustment

Set the *Start Ramp Time* to optimise start performance.

5. Stop Ramp Time [Primary Motor Settings]

Range
0 – 100 Seconds

Default Setting
0 Second (Off)

Description

Sets the soft stop ramp time for soft stopping of the motor.

Adjustment

Set the *Stop Ramp Time* to produce the desired motor stopping performance.

Two soft stop modes are provided by the IMS2. Use Function 12. *Soft Stop Mode* to select the desired mode.

If utilising the Soft Stop function and a line contactor, the contactor must not be opened until the end of the stop ramp time. The IMS2 programmable outputs A,B or C can be set for control of the line contactor. Refer Functions 21, 22, 23 for programmable output assignment details.

6. Motor Start Time Constant [Primary Motor Settings]

Range
0 – 120 Seconds

Default Setting
10 Seconds

NOTE:
A setting of 0 seconds disables the IMS2 motor thermal model. Use this setting only if another form of motor protection is used.

Description

Sets the motor thermal capacity used by the IMS2 motor thermal model.

Adjustment

Set the Motor Start Time Constant according to the motor's thermal capacity.

A motor's thermal capacity is expressed as the maximum time (seconds) a motor can maintain locked rotor current conditions from cold, and is often referred to as

Maximum Locked Rotor Time or Maximum DOL Start Time. This information is available from the motor data sheet or direct from the motor supplier.

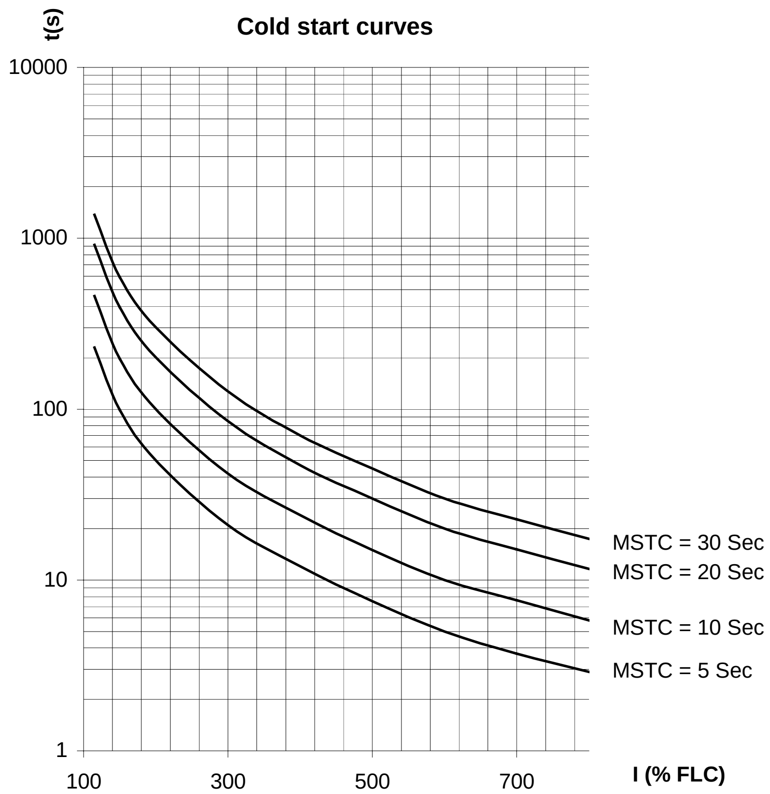
NOTE:
The IMS2 motor thermal model assumes a locked rotor current of 600%. If the connected motor's locked rotor current differs from this, greater accuracy can be achieved by using a normalised MSTC figure. A normalised MSTC figure can be calculated as follows:

$$\text{MSTC} = \left(\frac{\%\text{LRC}}{600}\right)^2 \text{X Max Start Time}$$

NOTE:
Setting Function 6 *Motor Start Time Constant* according to the motor's actual thermal capacity allows safe use of the motor's full overload capability both to start the load and ride through overload conditions. Additionally, a more conservative approach can be taken by setting a reduced MSTC for easy to start loads that will not experience transient operating overloads as a part of normal operation.

Using a reduced MSTC figure has the advantage of maximising motor life. The life of a motor is strongly influenced by its maximum winding temperature, with a 'rule of thumb' stating that the expected life span of a motor is halved for every ten degree rise in temperature. The temperature rise is dependent on the motor losses and the motor cooling. The highest stress on the motor is during start, and can be minimised by restricting the duration and frequency of starts. A reduced MSTC setting (Function 6) will also cause the IMS2 protection to operate before the motor is thermally stressed.

A suitable reduced MSTC figure can be established by observing the modelled motor temperature as shown on the IMS2 LED display, and adjusting the MSTC parameter such that after a normal start which has been preceded by a period of running at maximum load, the calculated motor temperature is approaching 90%.



7. Phase Imbalance Sensitivity [Primary Motor Settings]

Range	Default Setting
1 – 10	**5**

1 = Highest sensitivity (lowest imbalance)
I
5 = Average sensitivity
I
10 = Lowest sensitivity (highest imbalance)

Description

Sets the sensitivity of the phase imbalance protection.

Adjustment

The factory setting is suitable for most applications however the sensitivity can be adjusted to accommodate site specific tolerances.

8. Undercurrent Protection [Primary Motor Settings]

Range	Default Setting
15% – 100% FLC	**20% FLC**

Description

Sets the trip point for the IMS2 undercurrent protection as a percentage of motor full load current.

Adjustment

Set to a level below the motors normal working range and above the motor's magnetising (no load) current.

To disable the undercurrent protection make a setting less than the magnetising current of the motor, typically 25% - 35% of rated Full Load Current.

NOTE:
Undercurrent protection is only operative during 'run'.

9. Electronic Shearpin Protection [Primary Motor Settings]

Range	Default Setting
80% – 550% FLC	**400% FLC**

Description

Sets the trip point for the IMS2 electronic shearpin protection as a percentage of motor full load current.

Adjustment

Set as required

NOTE:
Electronic shearpin protection is operative only during 'run'.

10. Torque Control [Start/Stop Formats]

Range	Default Setting
0 - 1	**0 (Off)**

0 = Off
1 = On

Description

Enables or disables the torque control function.

Adjustment

Torque control provides a more linear acceleration than achieved by use of the Current Limit or Current Ramp start modes alone.

11. Kickstart [Start/Stop Formats]

Range	Default Setting
0 - 1	**0 (Off)**

0 = Off
1 = On

Description

Activates the Kickstart function.

Adjustment

Kickstart provides extra torque at the beginning of a start. This can be useful for accelerating loads that require high breakaway torque but then accelerate easily.

NOTE:
Kickstart subjects the motor/load to near DOL torque conditions by applying full voltage for 5 cycles at the beginning of a start. Ensure the motor and load can handle this torque before applying this feature.

12. Soft Stop Mode [Start/Stop Formats]

Range	Default Setting
0 - 1	**0 (Standard soft stop)**

0 = Standard soft stop
1 = Pump control

Description

Sets the active soft stop mode.

Adjustment

The standard soft stop mode automatically monitors motor deceleration and will provide optimum control for most applications. Pump control may however offer superior performance in some applications and can be of particular benefit in some pumping applications.

13. Auto-Stop – Run Time [Start/Stop Formats]

Range	Default Setting
0 – 255 units	**0 (Off)**

1 unit = 6 minutes

Description

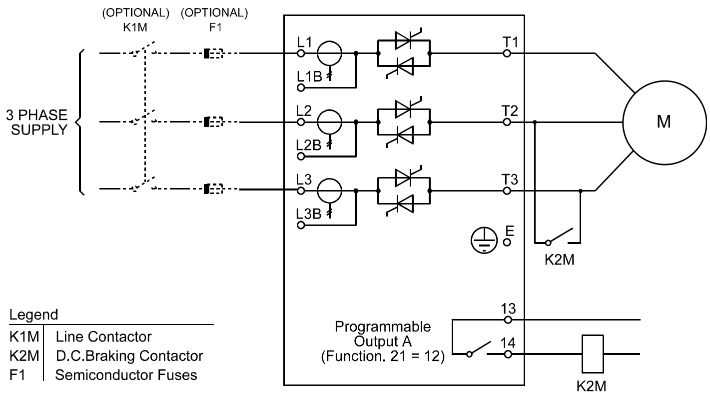
Sets the run time for the Auto-stop function.

Adjustment

Where a fixed run time is required the Auto-stop function can be activated by setting a run time of up to 25 hours, 30 minutes (6 minutes x 255). If this function is set to a time other than 0 the IMS2 will automatically stop after the prescribed time.

IMS2xxx-xx-xxx-F2-xx models provide a D.C.Brake function. The D.C.Brake function requires that a contactor with an AC1 rating greater than the FLC of the connected motor be wired between the output terminals T2 & T3 as shown in the electrical schematic below. The following functions must also be adjusted to activate the D.C.Brake function.

- **Function 14. *D.C.Brake - Brake time***
- **Function 15. *D.C.Brake - Brake torque***
- **Function 21. *Relay output A functionality***



CAUTION:
Incorrectly connecting the D.C.Brake contactor between T1-T2 or T1-T3 will damage the IMS2 power modules.

CAUTION:
Closing the D.C.Brake contactor when the D.C.Brake function is not operating will cause damage to the IMS2 power modules. Ensure that the D.C.Brake contactor is controlled by Relay Output A, and that Function 21. *Relay Output A Functionality* is set for D.C.Braking Contactor Control.

14. D.C.Brake - Brake Time **[Start/Stop Formats]**

Range	Default Setting
0 – 10 seconds	**0 seconds (Off)**

Description
Sets the time period for the D.C.Brake function. (F2 models only)

Adjustment
Set to optimise braking performance. A setting of 0 seconds turns the D.C.Brake function Off.
During operation of the D.C.Brake function the IMS2 display shows the letters 'br' as shown below.

NOTE:
The soft stop and D.C.Brake functions cannot be used together. When Function 14. *D.C.Brake - Brake Time* is adjusted to be greater than 0 seconds, Functions 5 & 84 *Stop Ramp Time* are automatically set to 0 seconds.

15. D.C.Brake - Brake Torque **[Start/Stop Formats]**

Range	Default Setting
30 - 100% Braking Torque	**30%**

Description
Sets the braking level as a % of maximum braking torque. (F2 models only)

Adjustment
Set as required.

NOTE:
Greater braking torque is available for very high inertia loads by use of the 'Soft Braking' technique described in section 8.5 Soft Braking.

20. Local/Remote Operation [Starter Functionality]

Range **0 - 3**

Default Setting **0 (Local/Remote button enabled)**

0 = IMS2 Local/Remote push button always enabled.
1 = IMS2 Local/Remote push button disabled while motor running.
2 = Local control only. (IMS2 push buttons enabled, remote inputs disabled)
3 = Remote control only. (IMS2 push buttons disabled, remote inputs enabled)

Description

Enables and disables the local push buttons and remote control inputs. Also determines when and if the Local/Remote push button can be used to switch between local and remote control.

Adjustment

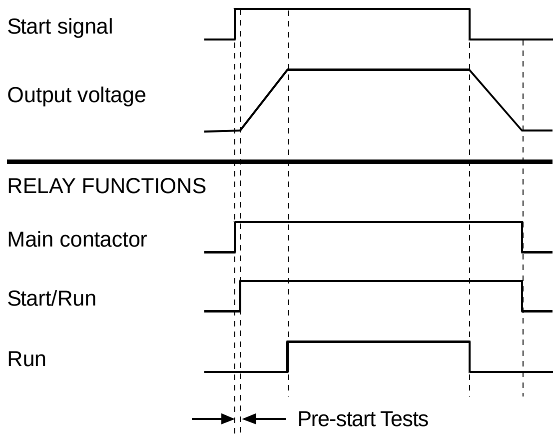
Set as required

21. Relay Output A Functionality [Starter Functionality]

Range **0 -13**

Default Setting **11 (Main Contactor)**

0 = Tripped
1 = Overcurrent trip
2 = Undercurrent trip
3 = Motor thermistor trip
4 = Starter overtemperature trip
5 = Phase imbalance trip
6 = Electronic shearpin trip
7 = Low current flag
8 = High current flag
9 = Motor overload flag
10 = Start/Run
11 = Main contactor.
12 = D.C.Brake Contactor Control
13 = Off



Description

Assigns the functionality of programmable relay output A.

Adjustment

Set as required

22. Relay Output B Functionality [Starter Functionality]

Range **0 - 11**

Default Setting **10 (Start Run)**

Description

Assigns the functionality of programmable relay output B.

Adjustment

Refer Function 21 *Relay Output A Functionality* for adjustment detail.

23. Relay Output C Functionality [Starter Functionality]

Range **0 - 11**

Default Setting **0 (Tripped)**

Description

Assigns the functionality of programmable relay output C.

Adjustment

Refer Function 21 *Relay Output A Functionality* for adjustment detail.

---

24. Input A Functionality [Starter Functionality]

Range
0 - 3

Default Setting
0 (Parameter Set Selection)

0 = Parameter Set Selection
1 = Auxiliary Trip (Normally Open)
2 = Auxiliary Trip (Normally Closed)
3 = Emergency Mode Operation

Description

Determines the functionality of Programmable Input A.

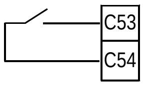
Adjustment

Programmable Input A can be used to activate the following IMS2 features:

0. Parameter Set Selection

The IMS2 can be programmed with two separate sets of motor and starting data. The primary parameter set is programmed using functions 1 ~ 9. The secondary parameter set is programmed using functions 80 ~ 88.

To activate the secondary parameter set Function 24. *Input A. Functionality* must be set to 0 (Secondary Parameter Set) and there must be a closed circuit across programmable input A when a start is called for.



Programmable Input A
(Function 24. Input A Functionality = 0)

---

1. Auxiliary Trip (Open Closed)

The IMS2 can be tripped by a remote circuit connected to programmable input A when Function 24. *Input A Functionality* is set to 1 (Auxiliary Trip N.O.). A closed circuit across Programmable Input A trips the IMS2.

Functionality of the auxiliary trip feature can be adjusted using Function 94. *Auxiliary Trip Delay* and Function 36. *Auxiliary Trip Mode*.

---

2. Auxiliary Trip (Normally Closed)

The IMS2 can be tripped by a remote circuit connected to programmable input A when Function 24. *Input A Functionality* is set to 2 (Auxiliary Trip N.C.). An open circuit across Programmable Input A trips the IMS2.

Functionality of the auxiliary trip feature can be adjusted using Function 94. *Auxiliary Trip Delay* and Function 36. *Auxiliary Trip Mode*.

---

3. Emergency Mode Operation

The IMS2 can be commanded to run in an 'emergency mode' where specified protection functions are ignored.

Emergency mode operation is possible when Function 24. *Input A. Functionality* is set = 3 (Emergency Mode Operation) and is activated by closing a circuit across programmable input A. This causes the IMS2 to start the motor, if not already running, and continue operation ignoring the trip conditions specified in Function 114 *Emergency Mode - Format*.

Opening the circuit across programmable Input A ends the emergency mode operation and returns control to the normal IMS2 control circuits.

Functionality of the trip relay during 'emergency mode' operation is determined by Function 115. *Emergency Mode - Trip Relay Operation*.

---

30. Excess Start Time [Protection Settings]

Range	Default Setting
0 – 255 Seconds	**20 Seconds**

Description

Sets the maximum time allowed for the motor to start.

Adjustment

Set for a period slightly longer than required for a normal healthy start. The IMS2 will trip if the start extends beyond the programmed limit thereby providing indication that the load has stalled or start torque requirements have increased since commissioning of the starter.

NOTE:
Ensure the excess start time setting is within the IMS2 rated capability. This ensures the IMS2 is also protected from overloads caused by stalled motors.

31. Phase Sequence [Protection Settings]

Range	Default Setting
0 - 2	**0 (Off)**

0 = Off (forward and reverse rotation accepted)
1 = Forward rotation only (reverse rotation prohibited)
2 = Reverse rotation only (forward rotation prohibited)

Description

Sets the valid phase sequences for the IMS2 phase sequence protection. The IMS2 examines the incoming three phases and trips if phase rotation does not match the allowable rotations specified by Function 31.

Adjustment

Set as required

32. Restart Delay [Protection Settings]

Range	Default Setting
0 – 254 units	**1 (10 Seconds)**

1 unit = 10 seconds

Description

Sets the minimum time between the end of a stop and the beginning of the next start.

Adjustment

Set as required.

During the restart delay period the LEDs to the right of the IMS2 LED display will flash indicating the motor cannot yet be restarted.

NOTE:
A setting of 0 units adjusts the IMS2 for the minimum Reset Delay period, which is 1 second.

33. Phase Imbalance [Protection Settings]

Range	Default Setting
0 - 1	**0 (On)**

0 = On
1 = Off

Description

Enables or disables the phase imbalance protection.

Adjustment

Set as required.

34. Motor Thermistor [Protection Settings]

Range: **0 - 1**
Default Setting: **0 (On)**

0 = On
1 = Off

Description
Enables or disables the thermistor protection feature.

Adjustment
Set as required.

35. Starter Overtemperature [Protection Settings]

Range: **0 - 1**
Default Setting: **0 (On)**

0 = On
1 = Off

Description
Enables or disables the IMS2 heatsink overtemperature protection.

Adjustment
Set as required.

CAUTION:
Defeating the IMS2 overtemperature protection may compromise starter life and should only be done in the case of emergency.

36. Auxiliary Trip Mode [Protection Settings]

Range: **0 - 2**
Default Setting: **0 (Active At All Times)**

0 = Active at all times
1 = Active during starting, run and stopping (Disabled while stopped)
2 = Active during run only

Description
Determines when the IMS2 monitors the auxiliary trip input.

Adjustment
Refer Function 24. *Input A Functionality* for further detail.

40. Low Current Flag [Set Points]

Range: **1 – 100% FLC**
Default Setting: **50% FLC**

Description
Sets the current level (% FLC) at which the low current flag operates

Adjustment
The low current flag can be assigned to the Programmable Relay Outputs A, B or C for indication of a motor current lower than the programmed value.

41. High Current Flag [Set Points]

Range: **50 – 550% FLC**
Default Setting: **105% FLC**

Description
Sets the current level (% FLC) at which the high current flag operates.

Adjustment

The high current flag can be assigned to the Programmable Relay Outputs A, B or C for indication of a motor current in excess of the programmed value.

42. Motor Temperature Flag [Set Points]

Range: **0 – 105% Motor Temperature**
Default Setting: **80%**

Description

Sets the temperature (%) at which the motor overtemperature flag operates.

Adjustment

The motor overtemperature flag can be assigned to the Programmable Relay Outputs A, B or C for indication of a motor temperature (as calculated by the Motor Thermal Model) in excess of the programmed value.

A trip condition occurs when motor temperature reaches 105%.

43. Field Calibration [Set Points]

Range: **85% - 115%**
Default Setting: **100%**

Description

Adds a gain to the IMS2 current monitoring circuits. The IMS2 is factory calibrated with an accuracy of ± 5%. The field calibration function can be used to match the IMS2 current readout with an external current metering device.

Adjustment

Use the following formula to calculate the setting required.

$$\text{Field Calibration (Function 43)} = \frac{\text{Current shown on IMS2 display}}{\text{Current measured by external device}}$$

$$\text{e.g.} \quad 102\% = \frac{66\text{ Amps}}{65\text{ Amps}}$$

NOTE:
All current based functions are affected by this adjustment..

50. 4-20mA Output Functionality [Analogue Output]

Range: **0 - 1**
Default Setting: **0 (Current)**

0 = Current (% FLC)
1 = Motor Temperature (% Maximum Temperature – trip point 105%)

Description

Sets the functionality of the analogue output.

Adjustment

Set as required.

Performance of the 4-20mA signal can be set using the following functions:
Function 51. *Analogue Output Range – Max*
Function 52. *Analogue Output Range - Min*

51. 4-20mA Output Range - Max [Analogue Output]

Range: **0 – 255%**
Default Setting: **100 %**

Description
Determines the value represented by a 20mA signal from the analogue output.

Adjustment
Set as required.

52. 4-20mA Output Range - Min [Analogue Output]

Range	Default Setting
0 – 255%	**0 %**

Description
Determines the value represented by a 4mA signal from the analogue output.

Adjustment
Set as required.

60. RS485 Timeout [Serial Communications]

Range	Default Setting
0 – 100 Seconds	**0 seconds (Off)**

Description
Sets the maximum allowable period of RS485 serial inactivity.

Adjustment
Set as required

NOTE:
A setting of 0 seconds disables the RS485 – Timeout Protection and enables the IMS2 to continuing operating even if the RS485 link becomes inactive.

61. RS485 Baud Rate [Serial Communications]

Range	Default Setting
1 - 5	**4 (9600 baud)**

1 = 1200 baud
2 = 2400 baud
3 = 4800 baud
4 = 9600 baud
5 = 19200 baud

Description
Sets the baud rate for RS485 serial activity.

Adjustment
Set as required

62. RS485 Satellite Address [Serial Communications]

Range	Default Setting
1 - 99	**20**

Description
Assigns the IMS2 an address for RS485 serial communication.

Adjustment
Set as required

70. Auto-Reset - Configuration [Auto Reset]

Range	Default Setting
0 - 3	**0 (Off)**

0 = Off
1 = Reset Group A trips
2 = Reset Group A & B trips
3 = Reset Group A, B & C trips

Description

Determines which trips will be automatically reset.

Adjustment

A setting of other than 0 causes the IMS2 to automatically reset, and after a delay if the start signal is still present, attempt to start the motor. The Auto-reset function can be programmed to reset faults according to the table below:

Trip Group	Trip Conditions
A	Phase imbalance, Phase loss
B	Undercurrent, Electronic shearpin, Auxiliary trip
C	Overcurrent, Motor thermistor, Starter overtemperature

Operation of the Auto-reset function is controlled according to the following function settings:

Function 70. *Auto-reset – Configuration*
Function 71. *Auto-reset – Number of resets*
Function 72. *Auto-reset – Group A & B Delay*
Function 73. *Auto-reset – Group C Delay*

CAUTION:
Operation of the auto-reset function will reset a trip state and if the start signal is still present, allow the motor to restart. Ensure that personal safety is not endangered by such operation and that all relevant safety measures and/or regulations are complied with before utilising this function.

71. Auto-Reset – Number Of Resets [Auto Reset]

Range	Default Setting
1 - 5	**1**

Description

Sets maximum number of reset attempts for the Auto-reset function.

Adjustment

The Auto-reset counter increases by one after each trip, up to the maximum number of resets set in Function 71. *Auto-Reset – Number Of Resets*. The fault is then latched and a manual reset is required.

The Auto-reset counter decreases by one, to a minimum of zero, after each successful start/stop cycle.

Refer Function 70 *Auto-Reset – Configuration* for further detail.

72. Auto-Reset – Group A & B Delay [Auto Reset]

Range	Default Setting
5 – 999 seconds	**5 seconds**

Description

Sets the delay for resetting of Group A & B trips.

Adjustment

Refer Function 70 *Auto-Reset – Configuration* for further detail.

73. Auto-Reset – Group C Delay [Auto Reset]

Range	Default Setting
5 – 60 minutes	**5 minutes**

Description

Sets the delay for resetting of Group C trips.

Adjustment

Refer Function 70 *Auto-Reset – Configuration* for further detail.

IMS2 soft starters can be programmed with two separate sets of motor data. The primary motor settings are adjusted using Functions 1 ~ 9. The secondary motor settings are adjusted using Functions 80 ~ 88. Refer to Function 24. *Input A Functionality* for detail on enabling the secondary parameter set.

80. Motor Full Load Current [Secondary Motor Settings]

Range	Default Setting
Model Dependant (Amps)	**Model Dependant (Amps)**

Description

Sets the IMS2 for the connected motor's full load current.

Adjustment

Refer Function 1 for further detail.

---

81. Current Limit [Secondary Motor Settings]

Range	Default Setting
100 – 550 % FLC	**350% FLC**

Description

Sets the current limit for the Constant Current start mode.

Adjustment

Refer Function 2 for further detail.

---

82. Initial Start Current [Secondary Motor Settings]

Range	Default Setting
100 – 550 % FLC	**350% FLC**

Description

Sets the initial start current level for the Current Ramp start mode.

Adjustment

Refer Function 3 for further detail.

---

83. Start Ramp Time [Secondary Motor Settings]

Range	Default Setting
1 – 30 Seconds	**1 Second**

Description

Sets the ramp time for the Current Ramp start mode.

Adjustment

Refer Function 4 for further detail.

---

84. Stop Ramp Time [Secondary Motor Settings]

Range
0 – 100 Seconds

Default Setting
0 Second (Off)

Description

Sets the soft stop ramp time for soft stopping of the motor.

Adjustment

Refer Function 5 for further detail.

---

85. Motor Start Time Constant [Secondary Motor Settings]

Range
0 – 120 Seconds

Default Setting
10 Seconds

NOTE:
A setting of 0 seconds disables the IMS2 motor thermal model. Use this setting only if another form of motor protection is used.

Description

Sets the motor thermal capacity used by the IMS2 motor thermal model.

Adjustment

Refer Function 6 for further detail.

---

86. Phase Imbalance Protection [Secondary Motor Settings]

Range
1 – 10

Default Setting
5

1 = Highest sensitivity
|
5 = Normal sensitivity
|
10 = Lowest sensitivity

Description

Sets the sensitivity of the Phase Imbalance Protection circuitry.

Adjustment

Refer Function 7 for further detail.

---

87. Undercurrent Protection [Secondary Motor Settings]

Range
15% – 100% FLC

Default Setting
20% FLC

Description

Sets the trip point for the IMS2 undercurrent protection as a percentage of motor full load current.

Adjustment

Refer Function 8 for further detail.

---

88. Electronic Shearpin Protection [Secondary Motor Settings]

Range
80% – 550% FLC

Default Setting
400% FLC

Description

Sets the trip point for the IMS2 electronic shearpin protection as a percentage of motor full load current.

Adjustment

Refer Function 9 for further detail.

90. Phase Imbalance Trip Delay [Protection Delays]

Range **3 – 254 Seconds** Default Setting **3 Seconds**

Description
Sets the delay period between detection of a phase imbalance greater than allowed by the setting made in Function 7 & 86. *Phase Imbalance Sensitivity* and a trip condition.

Adjustment
Set as required.

91. Undercurrent Trip Delay [Protection Delays]

Range **0 – 60 Seconds** Default Setting **5 Seconds**

Description
Sets the delay period between detection of a current lower than set in Function 8 & 87. *Undercurrent Protection* and a trip condition.

Adjustment
Set as required.

92. Electronic Shearpin Delay [Protection Delays]

Range **0 – 60 seconds** Default Setting **0 Seconds**

Description
Sets a delay period between application of full voltage to the motor and enablement of the Electronic Shearpin protection.

Adjustment
Set as required.

93. Out Of Frequency Trip Delay [Protection Delays]

Range **0 - 60 seconds** Default Setting **0 Seconds**

Description
Sets the delay period between detection of a low supply frequency while the motor is running (<48Hz for 50Hz supplies, <58Hz for 60Hz supplies) and a trip condition.

Adjustment
Set to allow continued motor operation during extreme but temporary under frequency conditions that endanger motor life.

NOTE:
If the supply frequency drops below 45Hz (50Hz supplies) or 55Hz (60Hz supplies) the IMS2 will trip immediately irrespective of the delay setting.

94. Auxiliary Trip Delay [Protection Delays]

Range **0 – 240 Seconds** Default Setting **0 Seconds**

Description
Sets a delay period between activation of the auxiliary trip input and a trip condition.

Adjustment

Refer Function 24. *Input A Functionality* for future detail.

100. Model Number [Read Only Data]

Range	Default Setting
1 - 22	**Model Dependant**

Description

A diagnostic parameter used to identify the power assembly type.

101. Start Counter (1000's) [Read Only Data]

Range	Default Setting
1(,000) – 999(,000)	**n/a**

Description

Displays the number of successful starts.

Must be read in conjunction with Function 102 for total start count.

102. Start Counter (1's) [Read Only Data]

Range	Default Setting
0 - 999	**n/a**

Description

Displays the number of successful starts.

Must be read in conjunction with Function 101 for total start count. (Note that it is normal for the IMS2 to have recorded a limited number of starts during the factory testing process).

103. Trip Log [Read Only Data]

Range	Default Setting
n/a	**n/a**

Description

Displays the IMS2 Trip Log.

Adjustment

Use the **<UP>** and **<DOWN>** keys to scroll through the trip log.

Refer to Section 9, Trouble Shooting Procedure for a description of the trip log and fault conditions.

110. Access Code [Restricted Functions]

Range	Default Setting
0 - 999	**0**

Description

Entering the correct access code does two things

1. Temporarily changes the function lock to Read/Write irrespective of the state specified by Function 112 *Function Lock*. This allows function settings to be adjusted during the current programming session. On exit of the current programming session function settings are again protected according to Function 112. *Function Lock.*
2. Provides access to parameters 111 - 117.

Adjustment

Enter access code. The default access code is 0. Contact your supplier if the access code is lost or forgotten.

111. Update Access Code [Restricted Functions]

Range: **0 - 999**
Default Setting: **0**

Description
Changes the current access code.

Adjustment
Set as required, remembering to make note of the new access code.

112. Function Lock [Restricted Functions]

Range: **0 - 1**
Default Setting: **0 (Read / Write)**

0 = Read/Write
1 = Read Only

Description
Allows protection of all function settings. Note that when this function has been changed from 0 (Read/Write) to 1 (Read Only) the new setting takes effect only when program mode is exited.

Adjustment
Set as required.

113. Restore Function Settings [Restricted Functions]

Range: **50, 60, 70**
Default Setting: **0**

50 = Load default settings
60 = Archive current function settings
70 = Load archived function settings

Description
Allows function adjustments be returned to the factory defaults. Additionally users can archive their own function settings, for example the commissioning settings, and then restore these at a later date.

Adjustment
Restore or store function settings as required.

114. Emergency Mode - Format [Restricted Functions]

Range: **0 - 4**
Default Setting: **0 (Off)**

0 = Off
1 = Trip Group A
2 = Trip Group A & B
3 = Trip Group A, B & C
4 = All trips

Description
Sets which trip conditions are ignored during Emergency Mode operation. Refer to Function 24 *Input A Functionality* for a description of Emergency Mode operation.

Adjustment
Sets as required.

Trip Group	Trip Conditions
A	Phase imbalance, Phase loss
B	Undercurrent, Electronic Shearpin, Auxiliary Trip

C	Overcurrent, Motor thermistor, Starter overtempearture

115. Emergency Mode – Trip Relay Operation [Restricted Functions]

Range
0 - 1

Default Setting
0 (Trips not indicated)

0 = Trips not indicated
1 = Trips indicated

Description

Sets whether or not output relays assigned to the trip function (Refer Function 21, 22 & 23) change state in the event of a detected fault condition when the IMS2 is operating in Emergency Mode.

Refer to Function 24 *Input A Functionality* for a description of Emergency Mode operation.

Adjustment

Set as required.

116. Thermal Model – Override [Restricted Functions]

Range
0 – 150%

Default Setting
n/a

Description

Allows the motor thermal model to be manually adjusted.

CAUTION:
Adjustment of the motor thermal model may compromise motor life and should only be done in the case of emergency.

Adjustment

In emergency situations the motor thermal model can be manually decreased to allow a restart of the motor. Adjust as required.

117. Thermal Model – Override Count [Restricted Functions]

Range
0 - 255

Default Setting
n/a

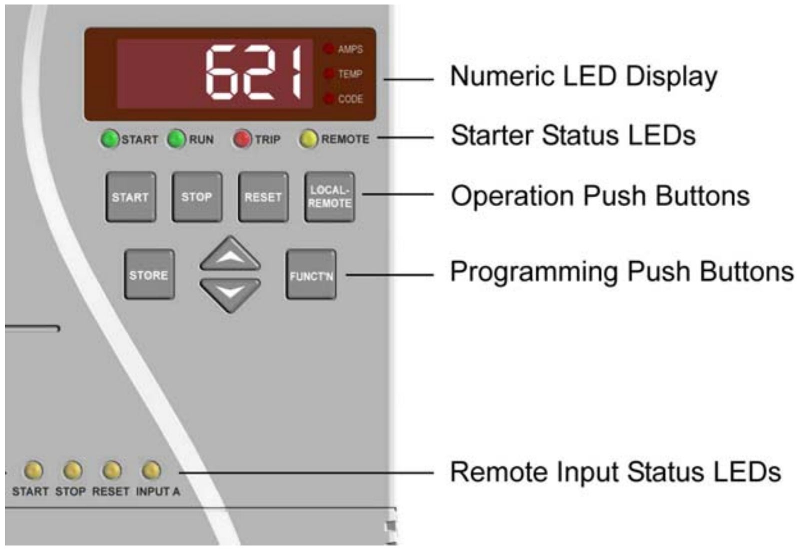
Description

Displays the number of times the motor thermal model has been manually adjusted.

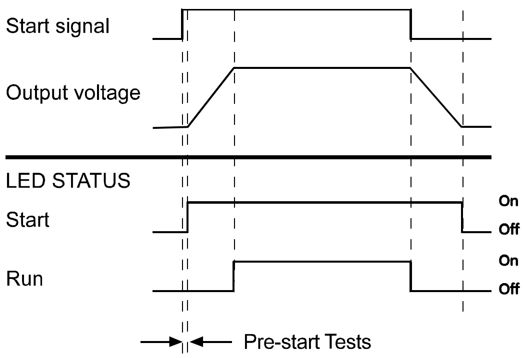
7.4 Operation

Once installed, wired and programmed according to the instructions earlier in this manual the IMS2 can be operated.

Local control panel.



1. *Numeric LED Display:* The information being displayed is indicated by the LEDs to the right of the display. During operation either motor current (Amps) or the calculated motor temperature (%) can be displayed. Use the **<UP>** or **<DOWN>** keys select what information is displayed. In the event of a trip state the relevant trip code will be shown.
   If motor current exceeds the maximum current able to be shown on the numeric display, the display will show dashes. ---
2. *Starter Status LEDs:*
   Start: Voltage is being applied to the motor terminals.
   Run: Full voltage is being applied to the motor terminals.
   Trip: The IMS2 has tripped.
   Remote: The IMS2 is in remote control mode.



3. *Operational Push Buttons:* These push buttons can be used to control IMS2 operation when in local control mode. The **<LOCAL/REMOTE>** push button can be used to switch between local and remote control.

NOTE:
When control power is applied to the IMS2 it may be in either local or remote control mode according to the mode it was in when control power was removed. The factory default is local control.

NOTE:
Function 20. *Local/Remote Operation* can be used to limit operation to either local or remote mode operation. If the **<LOCAL/REMOTE>** push button is used in an attempt to switch to a prohibited mode the numeric display will show 'OFF'.

NOTE:
Simultaneously pressing the **<STOP>** and **<RESET>** push buttons causes the IMS2 to immediately remove voltage from the motor, resulting in a coast to stop. Any soft stop or D.C.brake settings are ignored.

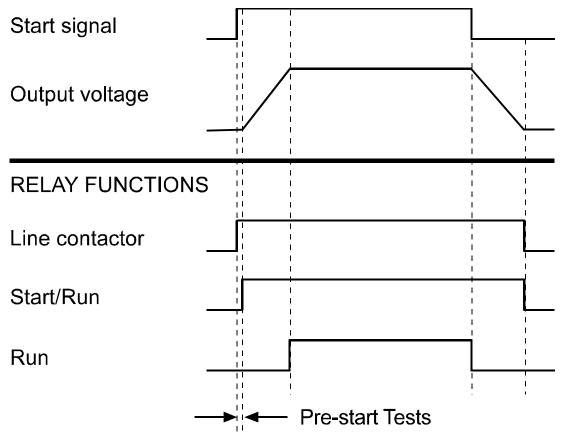
4. *Programming Buttons:* Refer to section 7.1.
5. *Remote Control Inputs Status:* These LEDs indicate the state of the circuits across the IMS2 remote control inputs.

NOTE:
All LEDs and the Numeric display are illuminated for approximately 1 second to test their operation when control power is first applied .

Remote control.
IMS2 operation can be controlled via the remote control inputs when the soft starter is in remote mode. Use the **<LOCAL/REMOTE>** push button to switch between local and remote modes. Refer to section 6.3 *Control Wiring* for further detail.

Restart delay.
Function 32. *Restart Delay* sets the delay period between the end of a stop and the beginning of the next start. During the restart delay period the LEDs to the right of the numeric display will flash indicating that a restart cannot yet be attempted.

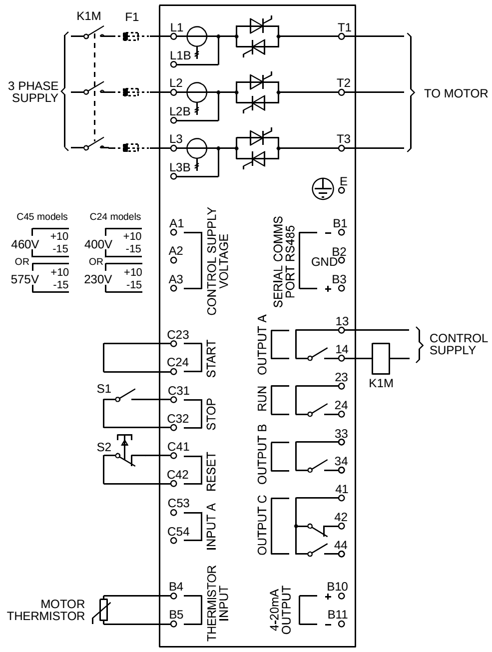
Pre-start tests.
Before applying voltage to the motor when a start is initiated, the IMS2 first performs a series of tests to check the motor connection and supply conditions.



Secondary motor settings.
IMS2 starters can be programmed with two motor parameter sets. The primary motor parameters are set using functions 1~9. The secondary motor parameters are set using functions 80~88.
Programmable Input A can be used to select between the two parameter sets. Refer to Function 24 *Input A Functionality* for further detail.

Section 8 Application Examples

8.1 Installation With Line Contactor

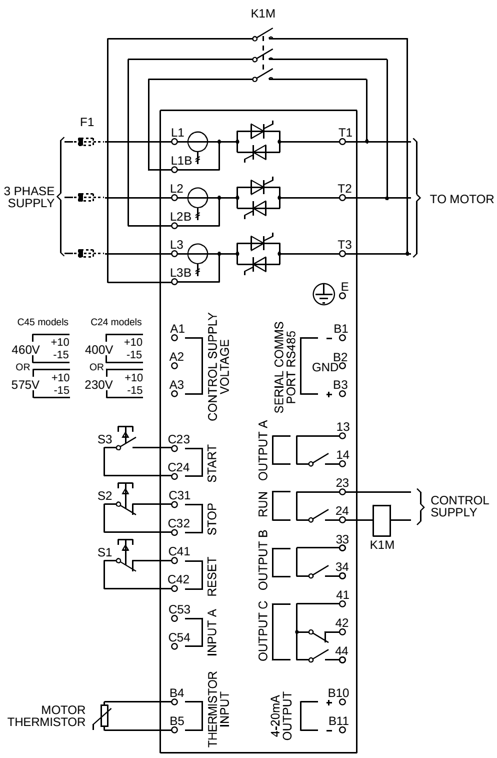


Legend	
K1M	Line Contactor
S1	Start Contact
S2	Reset Pushbutton
F1	Semiconductor Fuses (optional)

Description:
The IMS2 is applied with a line contactor (AC3 rated). The line contactor is controlled by the IMS2 Main Contactor output, which by default is assigned to RELAY OUTPUT A (terminals 13, 14). The control supply must be sourced from before the contactor.

Function Settings:
- Function 21. *Relay Output A Functionality* = 11 (Assigns the Main Contactor function to Relay Output A)

8.2 Installation With Bypass Contactor

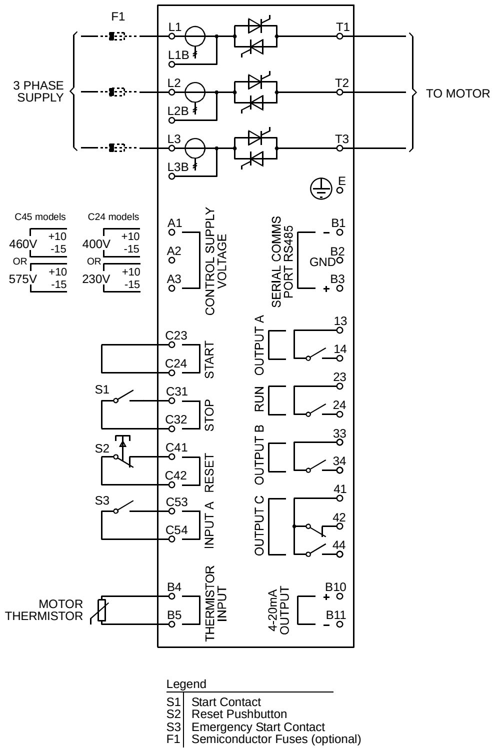


Legend	
K1M	Bypass Contactor
S1	Reset Pushbutton
S2	Stop Pushbutton
S3	Start Pushbutton
F1	Semiconductor Fuses (optional)

Description:
The IMS2 is applied with a bypass contactor (AC1 rated). The bypass contactor is controlled by the IMS2 RUN OUTPUT (terminals 23, 24).

Function Settings:
- no special settings required.

8.3 Emergency Mode Operation



Description:

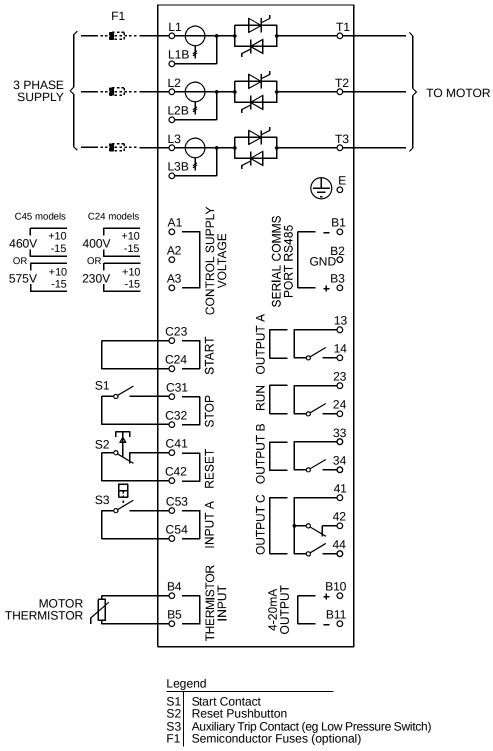
In normal operation the IMS2 is controlled via a remote two wire signal.

For emergency operation, an additional remote two wire circuit has been connected to INPUT A. Closing this circuit causes the IMS2 to run the motor and ignore any user defined trip conditions that may be detected during the emergency run period.

Function Settings:

- Function 24. *Input A Functionality* = 3 (Assigns Input A to the *Emergency Mode Operation* function)
- Function 114. *Emergency Mode Format* = as desired (Sets which trip types are ignored during emergency mode operation)
- Function 115. *Emergency Mode - Trip Relay Format* = as desired (Determines if the trip relay operates when a fault is detected during emergency mode operation)

8.4 Auxiliary Trip Circuit



Description:

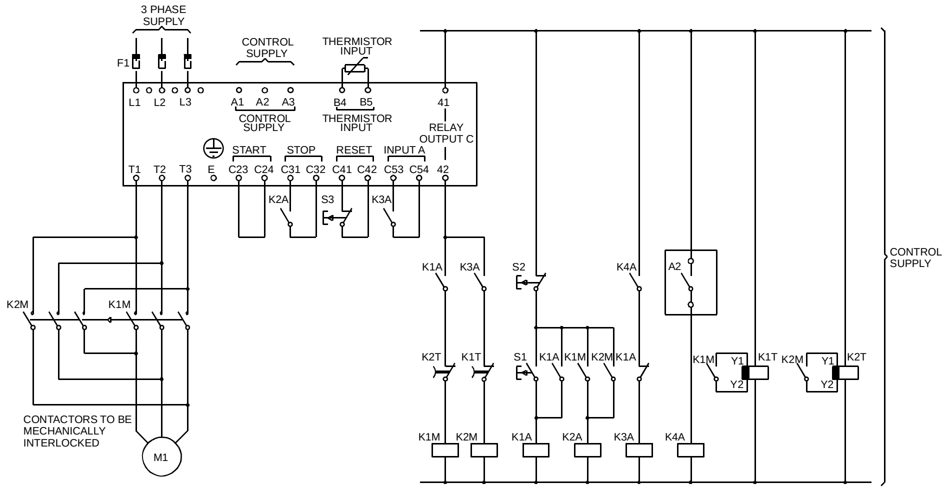
The IMS2 is controlled via a simple remote two wire signal.

An external trip circuit (in this case a low pressure alarm switch for a pumping system) has been connected to INPUT A. Operation of the external trip circuit causes the IMS2 to trip the motor, close the trip output, display the relevant trip code and record the event in the trip log.

Function Settings:

- Function 24. *Input A Functionality* = 1 (Assigns Input A to the Auxiliary Trip (N.O.) function)
- Function 36. *Auxiliary Trip Mode* = 2 (Limits operation of the Auxiliary Trip Function to when the motor is running so that pressure has time to build up in the piping before the low pressure alarm becomes active).
- Function 94. *Auxiliary Trip Delay* = as desired (Can be used to provide a further delay for pressure to build up before the low pressure alarm becomes active).

8.5 Soft Braking



LEGEND

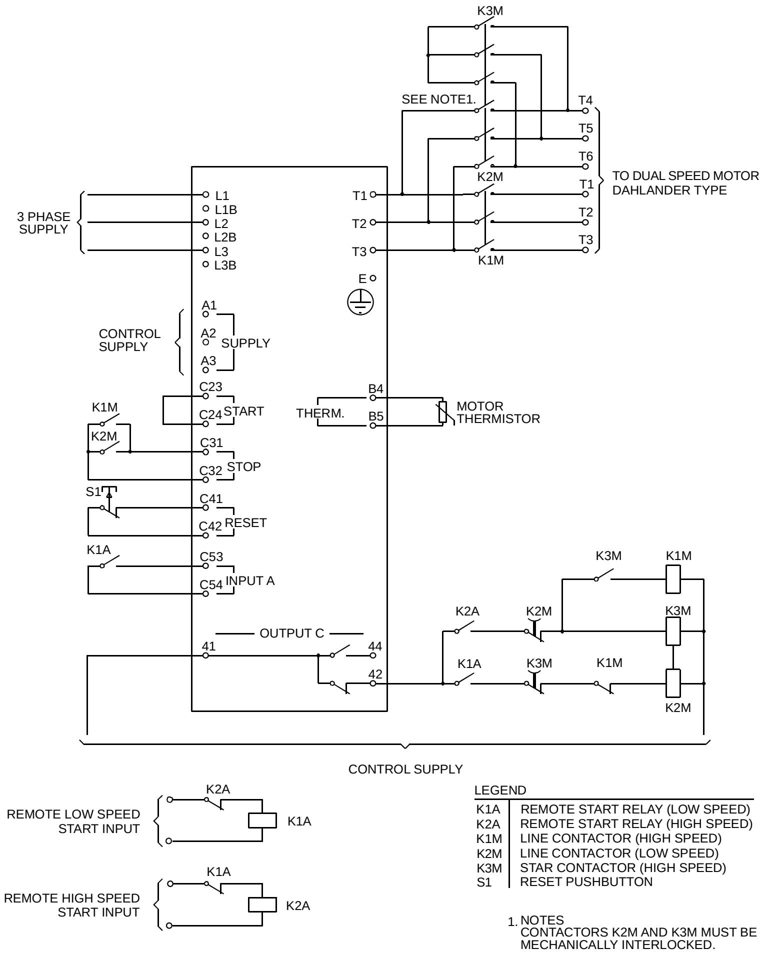
A2	SHAFT ROTATION SENSOR	K1M	LINE CONTACTOR (RUN)
F1	SEMI-CONDUCTOR FUSES (OPTIONAL)	K2M	LINE CONTACTOR (BRAKE)
K1A	RUN RELAY	K1T	RUN DELAY TIMER
K2A	START RELAY	K2T	BRAKE DELAY TIMER
K3A	BRAKE RELAY	S1	START PUSHBUTTON
K4A	ROTATION SENSING RELAY	S2	STOP PUSHBUTTON
		S3	RESET PUSHBUTTON

Description:
For high inertia loads that require more braking torque than is available from the D.C.Brake feature, the IMS2 can be configured for 'Soft Braking'.
In this application the IMS2 is employed with forward run and braking contactors.
On receipt of a start signal (pushbutton S1) the IMS2 closes the forward run contactor (K1M) and controls the motor according to the programmed Primary Motor Settings.
On receipt of a stop signal (pushbutton S2) the IMS2 opens the forward run contactor (K1M) and closes the braking contactor (K2M) after a delay of approximately 2-3 seconds (K1T). K3A is also closed to activate the Secondary Motor Settings which should be user programmed for the desired stopping performance characteristics.
When motor speed approaches zero the shaft rotation sensor (A2) stops the soft starter and opens the braking contactor (K2M).

Function Settings:

- Function 23. *Relay Output C Functionality* = 0 (Assigns the Trip function to Relay Output C)
- Function 24. Input A Functionality = 0 (Assigns Input A to the Parameter Set Selection function)
- Functions 1~9 (Sets starting performance characteristics)
- Functions 80~88 (Sets braking performance characteristics)

8.6 Two Speed Motors



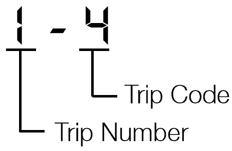
Description:
The IMS2 can be configured for control of dual speed Dahlander type motors.
In this application the IMS2 is employed with a High Speed contactor (K1M), Low Speed contactor (K2M) and a Star contactor (K3M).
On receipt of a High Speed start signal the High Speed contactor (K1M) and Star contactor (K3M) are closed. The IMS2 then controls the motor according to the Primary Motor Parameter set. (Function Numbers 1~9)
On receipt of a Low Speed start signal the Low Speed contactor (K2M) is closed. The relay contact across Input A is also closed causing the IMS2 to control the motor according to the Secondary Parameter set (Function Numbers 80~88).
.

Function Settings:
- Function 23. *Relay Output C Functionality* = 0 (Assigns the Trip function to Relay Output C)
- Function 24. Input A Functionality = 0 (Assigns Input A to the Parameter Set Selection function)

Section 9 Trouble Shooting

9.1 Trip Codes

When the IMS2 enters the trip state the cause of the trip is indicated on the LED display panel.



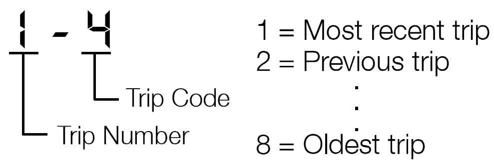
Code	Description
0	**Shorted SCR** The IMS2 has detected a shorted SCR(s). 1. Determine the affected phase using the 3 phase indicators LEDs located on the left hand side of the IMS2 cover. Damaged SCRs are indicated by an extinguished phase indicator LED (all phase indicator LEDs should be illuminated when input voltage is present but the motor is not running). SCR damage can be verified using the Power Circuit Test described in the Test & Measurement chapter of this section. 2. Replace the damaged SCR. 3. Reset the trip condition by removing and reapplying control voltage to the IMS2.
1	**Excess start time trip** Motor start time has exceeded the limit set in Function 30. *Excess Start Time Protection.* 1. Ensure the load is not jammed. 2. Ensure the starting load has not increased. 3. Verify that the start current is as expected using the Start Performance Test described in the Test & Measurement chapter of this section.
2	**Motor thermal model trip** The motor has been overloaded and the motor's thermal limit, as calculated by the IMS2 motor thermal model, has been reached. 1. Remove the cause of the overload and let the motor cool before restarting. **NOTE:** If the motor needs to be immediately restarted in an emergency situation and motor life can be risked, the IMS2 Motor Thermal Model can be lowered to allow an immediate restart using *Function 116. Thermal Model - Override*.
3	**Motor thermistor trip** The motor thermistors have indicated an overtemperature situation. 1. Identify and correct the cause of the motor overheating. 2. If no thermistors are connected to the IMS2, ensure there is a closed circuit across the motor thermistor input (terminals B4 & B5) or that the Motor Thermistor Protection is turned Off by setting Function 34. *Motor Thermistors* = 1.
4	**Phase imbalance trip** An imbalance in the phase currents has exceeded the limits set in Function 7. *Phase Imbalance Sensitivity*. 1. Monitor the supply voltage 2. Check the motor circuit

Code	Description
5	**Supply frequency trip** Supply frequency has varied outside the IMS2's specified range. 1. Correct the cause of the frequency variations. 2. Check the three phase supply to the IMS2. Loss of all three phases is seen by the IMS2 as a 0Hz situation and may be the cause of a supply frequency trip. 3. If the frequency variation is causing the trip is only temporary and occurs while the motor is running Function 93. *Out Of Frequency Trip Delay* can be used to 'ride through' the out of frequency situation. Note that running a motor at less than its designed frequency increases motor heating and should only be allowed for short periods.
6	**Phase sequence trip** The IMS2 has detected a phase sequence that has been prohibited by the setting made in Function 31. *Phase Sequence Protection*. 1. Change the incoming phase sequence.
7	**Electronic shearpin trip** The IMS2 has measured a current equal to the limit set in Function 9. *Electronic Shearpin Protection*. 1. Identify and correct the cause of the instantaneous overcurrent event.
8	**Power circuit fault** The IMS2 has detected a fault in the power circuit. 1. Ensure that the motor is correctly connected to the IMS2 and verify the circuit. 2. Check that voltage is correctly applied to all three IMS2 input terminals (L1, L2 & L3).
9	**Undercurrent trip** The IMS2 has measured a run current lower than the limit set in Function 8. *Undercurrent Protection*. 1. Identify and correct the cause of the undercurrent event.
J	**Auxiliary trip** Input A has been assigned to the Auxiliary Trip function (refer Function 24. *Input A Functionality*) and the IMS2 has detected an invalid circuit across programmable input A. 1. Determine and correct the cause of the invalid circuit on Input A.
F	**Heatsink overtemperature trip** The IMS2 heatsink temperature sensor has indicated and excess heatsink temperature. 1. Verify that the IMS2 has sufficient ventilation. 2. Verify that cooling air is able to freely circulate through the IMS2. 3. Verify that the IMS2 cooling fans (if fitted) are working.
P	**Invalid motor connection** The IMS2 cannot detect a valid motor circuit. 1. Ensure the motor is connected to the IMS2 in a valid configuration. Refer to Section 5 Power Circuits for further detail.
C	**RS485 communication fault** The RS485 link connected to the IMS2 has been inactive for a period of time greater than set in Function 60. *RS485 – Timeout Protection*. 1. Restore the RS485 link.
E	**EEPROM read/write failure** The IMS2 has failed to read or write to the internal EEPROM. Reset the IMS2. If the problem persists contact your supplier.

Code	Description
L	**Out of range FLC** The IMS2 has detected that the motor is connected in the 3 Wire configuration and that Function 1. *Motor FLC* or Function 80 *Motor FLC* (secondary motor settings) has been set in excess of the IMS2's maximum capability for this connection format. 1. Reduce the motor FLC setting and then reset the IMS2. Note that the IMS2 cannot be reset until the FLC setting has been corrected. 2. Alternatively, remove control voltage from the IMS2 and reconnect the motor in 6 Wire configuration.
y	**Incorrect main control module.** The IMS2 is fitted with an incompatible main control module. 1. Fit a suitable main control module.
u	**CPU error** Reset the IMS2. If the problem persists contact your supplier.

9.2 Trip Log

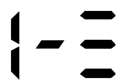
The IMS2 includes a Trip Log that records the last eight trip events. Each trip is numbered. Trip number 1 is the most recent trip with trip number 8 being the oldest.



The trip log can be viewed by selecting Function 103. *Trip Log* and using the **<UP>** and **<DOWN>** keys to scroll through the trip log.

NOTE:
The IMS2 records trips in the trip log immediately after they are detected, this requires control voltage to be present after the trip. Trips caused by or involving a loss of control voltage may not be recorded.

A 'marker' can be inserted into the trip log to identify trips that have occurred after placement of the 'marker'. To insert a 'marker' enter the programming mode and move to Function 103. *Trip Log*. Then simultaneously depress the **<UP>** and **<DOWN>** and **<STORE>** keys. The marker is added as the most recent trip and is displayed as three horizontal lines as shown below.



NOTE:
Trip makers must be separated by at least one trip and cannot be placed consecutively..

9.3 General Faults

Symptom	Cause
IMS2 will not operate.	**Local push buttons not active.** The IMS2 may be in remote control mode. (Refer to Function 20. *Local/Remote Operation*) **Remote control inputs not active.** The IMS2 may be in local control mode. (Refer to Function 54. *Local/Remote Operation*) **Faulty start signal.** Verify any circuits connected to the

Symptom	Cause
	IMS2 remote control inputs. The state of the remote circuits is indicated by the IMS2 remote control input LEDs. The LEDs are illuminated when there is a closed circuit. For there to be a successful start there must be a closed circuit across the start, stop and reset circuits. **No, or incorrect control voltage.** Ensure the correct control voltage is applied to the inputs A1, A2, A3.
IMS2 will not operate.	**Restart delay active.** The IMS2 cannot be started during the restart delay period. The period of the restart delay is set using Function 32. *Restart Delay*. **Auto-reset function active.** If there has been a trip and the auto-reset function is active the fault must be manually reset before a manual restart can be attempted. (Refer to Functions 70, 71, 72 & 73 *Auto-reset*) **IMS2 in programming mode.** The IMS2 will not run while in programming mode.
Uncontrolled start.	**Power factor correction capacitors connected to the IMS2 output.** Remove any power factor correction from the output of the soft starter. Connection of power factor correction capacitors to the output of a soft starter can result in damage to the SCRs so they should be checked by using the SCR test described in section 9.4 Tests and Measurements. **Damaged SCRS.** Verify soft starter operation using the SCR test described in section 9.4 Tests and Measurements. **Damaged firing circuit.** Verify the IMS2 SCR firing circuit using the Power Circuit Test described in section 9.4 Tests and Measurements.
IMS2 dispaly shows a 'h'	**The START button on the local control panel is stuck**. Release the button to restore normal operation.
The motor will not accelerate to full speed.	**Start current too low**. Check the load is not jammed. Increase start current using Function 2. *Current Limit*.
Erratic motor operation and tripping.	**SCRs not latching.** SCRs require a minimum current flow to 'latch' on. In situations where very small motors are being controlled by large soft starters the current drawn may be insufficient to latch on the SCRs. Increase motor size or reduce soft start size.
Soft stop ends before the programmed ramp time.	**Motor will not stall.** The IMS2 has significantly reduced the voltage applied to the motor without detecting a reduction in motor speed. This indicates that with present motor loading further control of the voltage will be ineffectual, hence the soft stop function has halted.
Function setting cannot be made or are not recorded.	**Incorrect programming procedure**. Function settings must be stored using the **<STORE>** button. Refer to section 7.1 *Programming Procedure* for further detail. **Function settings are locked**. Ensure that Function 112. *Function Lock* is set for Read/Write.
IMS2 will not enter the programming mode.	**The IMS2 is running.** The IMS2 must be stopped before programming mode can be accessed. **No, or incorrect control voltage.** Ensure the correct control voltage is applied to the inputs A1, A2, A3.

9.4 Tests & Measurements

Test	Procedure
Control input test	This test verifies circuits connected to the IMS2 remote control inputs. (Start, Stop, Reset & Input A) 1. Measure the voltage across each input. With the remote circuit closed there should be 0VDC measured. If 24VDC is measured the switch/control is incorrectly connected or faulty.
Run performance test.	This test verifies correct operation of the IMS2 during run. 1. Measure the voltage drop across each phase of the IMS2 (L1–T1, L2–T2, L3–T3). The voltage drop will be less than approximately 2 VAC when the IMS2 is operating correctly.
Power circuit test.	This test verifies the IMS2 power circuit including the SCR, firing loom and control modue. 1. Remove the incoming supply from the IMS2 (L1, L2, L3 and control supply). 2. Remove the motor cables from the output terminals of the IMS2 (T1, T2 & T3). 3. Use a 500 VDC insulation tester to measure the resistance between the input and output of each phase of the IMS2 (L1-T1, L2-T2, L3-T3). Note that low voltage ohm meters or multi-meters are not adequate for this measurement. 4. The measured resistance should be close to 33kΩ and approximately equal on all three phases. 5. If a resistance of less than about 10kΩ is measured across the SCR, the SCR should be replaced. 6. If a resistance greater than about 60kΩ is measured across the SCR there could be a fault with the IMS2 control module or firing loom.
Start performance test.	This test verifies correct operation of the IMS2 during start. 1. Determine the expected start current by multiplying the settings made in Function 1. *Motor Full Load Current* and Function 2. *Current Limit*. 2. Start the motor and measure the actual start current. 3. If the expected start current and the actual start current are the same, the IMS2 is performing correctly.

Section 10 Appendix

10.1 Soft Start Technology

Soft starter products fall into four distinct categories and can be characterized as follows:

1. Start Torque Controllers

Start Torque Controllers control just one phase of three phase motors. Controlling just one phase provides a level of control over motor starting torque, but does little to reduce the starting current. Current equal to almost DOL levels flows in the motor winding not controlled by the starter. This level of current is maintained for a longer period than that experienced during a DOL start, thereby potentially causing excessive motor heating.

Start torque controllers should not be used in applications requiring a reduction in start current, have a very high starting frequency, or for starting high inertia loads.

2. Open loop voltage controllers

Open loop voltage controllers follow a user defined time referenced voltage pattern and receive no feedback from the motor. They offer the electrical and mechanical benefits normally associated with soft start and may control either two or all three phases to the motor.

Start performance is controlled by the user through adjustments such as Initial Voltage and Start Ramp Time. Many open loop voltage controllers also offer a Current Limiting adjustment however this functionality is generally achieved by maintaining a constant reduced voltage throughout the starting period. Control over motor deceleration is also often provided through the soft stop feature which ramps down voltage during a stop thus extending motor deceleration time.

Two-phase open loop controllers provide a reduced starting current in all three phases, however the current is not balanced. Although an improvement on the single controlled phase controllers they generally provide limited start time adjustability and should be used only on light load applications to avoid motor over-heating.

3. Closed loop voltage controllers

Closed loop voltage controllers are an enhancement of the open loop systems described above. They receive feedback of the motor current and use this to halt the voltage ramp when the user set start current limit is reached. The current feedback is also used to provide basic protection functions such as motor overload, phase imbalance, electronic shearpin etc.

Closed loop voltage controllers can be used as complete motor starting systems.

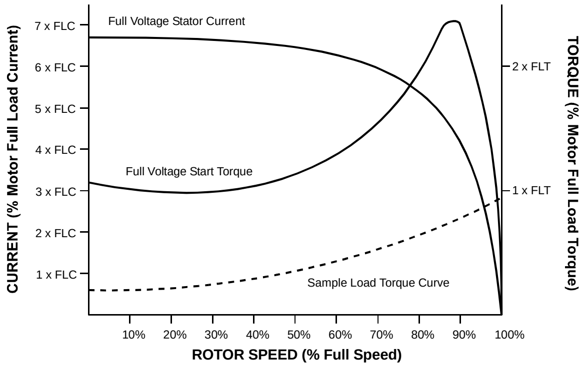
4. Closed loop current controllers

Closed loop current controllers are the most advanced form of soft start technology. Closed loop current controllers use current rather than voltage as the primary reference. This direct control of the current provides more precise control of motor starting performance as well as simplifying adjustment and programming of the soft starter. Many of the parameter settings required by the closed loop voltage system are made automatically by current based systems.

IMS2 soft starters covered in this manual are closed loop current controllers.

10.2 Reduced Voltage Starting

When started under full voltage conditions an a.c.induction motor will initially draw Locked Rotor Current (LRC) and produce Locked Rotor Torque (LRT). During motor acceleration the current will fall, while torque will first increase to break down torque and then fall to full speed levels. Motor design determines the magnitude and shape of both the current and torque curves.



Starting performance of motors with similar full speed characteristics can vary dramatically. Locked rotor currents can range from 500% to in excess of 900% of motor FLC. Similarly, locked rotor torque figures can range from as low as 70% to as much as 230% of motor Full Load Torque (FLT). These performance characteristics are determined by the design of the motor and set the limits of what can be achieved by the application of a reduced voltage starter.

For applications in which the minimisation of start current and maximisation of starting torque is essential, it is important to ensure that a motor with low Locked Rotor Current and high Locked Rotor Torque is used.

Under reduced voltage starting conditions a motor's torque output is reduced by the square of the current reduction as shown in the formula below.

$$T_{ST} = LRT \times \left(\frac{I_{ST}}{LRC} \right)^2$$

T_{ST} = Start Torque
I_{ST} = Start Current
LRC = Motor Locked Rotor Current
LRT = Motor Locked Rotor Torque

When applying a reduced voltage starter, the start current can be reduced only to the point where the resulting start torque still exceeds the torque required by the load. If the torque output from the motor falls below the torque required by the load at any point during motor starting acceleration will cease and the motor/load will not reach full speed.

10.3 Star Delta Starters

Although the star/delta starter is the most common form of reduced voltage starting its full benefits can only be realized in very lightly loaded applications.

During start, the motor is initially connected in star and the current and torque are reduced to one third that available under direct on line starting conditions. After a user-defined period of time, the motor is disconnected from supply and then reconnected in delta.

For a star/delta starter to be effective, the motor must be capable of producing sufficient torque to accelerate the load to full speed whilst connected in star. A transition from star to delta at much less than full speed will result in a current and torque step to levels approximating that under DOL starting.

In addition to the step in current and torque, severe transients also occur during the transition form star to delta. The magnitude of these transients is dependant upon the phase angle and level of voltage generated by the motor during the transition from star to delta. At times this generated voltage will be equal to and 180^o out of phase with the supply voltage, thus giving rise to a current transient of twice locked rotor current and torque transient of four time locked rotor torque.

10.4 Auto-transformer Starters

Auto-transformer starters make use of an auto-transformer to reduce the voltage applied to the motor during start. They generally offer a choice of voltage tapings to allow a variation of motor starting current and torque within particular limits. This ability to select the voltage tapping most suited to the application provides an increased opportunity for the motor to reach full speed before transition to full voltage, thereby minimising the step in current and torque during transition.

However it should be noted that as the number of voltage tapings is limited, precise control over starting performance is not achievable.

Unlike the star/delta a ‘Korndorfer’ connected auto-transformer starter is a ‘closed transition’ starter and therefore there are no current and torque transients during the transition from reduced to full voltage.

The constant reduced voltage nature of the auto-transformer results in a reduced torque at all motor speed. For high inertia loads, starting times may be extended beyond safe/acceptable levels and for loads that present a variable start torque characteristic, optimum performance cannot be achieved.

Auto-transformer starters are usually rated for infrequent starting duties, typically 3 starts per hour. Auto-transformer starters rated for frequent or extended start conditions can be large and expensive.

10.5 Primary Resistance Starters

Primary resistance starters employ either a ‘fixed metal’ or ‘liquid electrolyte’ resistance to reduce the voltage applied to a motor during start. They provide an effective means of reducing motor starting current and torque and perform extremely well when the resistors are selected correctly.

To accurately size the resistors many motor, load and operating parameters must be known at design stage. Such information is often difficult to obtain and hence, the resistors are often selected on a ‘rule of thumb’ basis, thus compromising start performance and long term reliability.

The value of the resistors changes as they heat up during start. To ensure the start performance remains consistent and improve long term reliability, restart delay timers are often installed.

Due to the high heat dissipation of the resistors, primary resistance starters are not suited to starting very high inertia loads.

10.6 Soft Starters

Electronic soft starting is the most advanced form of reduced voltage starting. The technology offers superior control over starting current and torque. Additionally the more advanced soft start systems also provide advanced protection and interface functions.

The main starting and stopping advantages offered include:

- Smooth application of voltage and current without and steps or transients.
- Users are provided total control over the starting current and starting torque through simple programming adjustments.
- Frequent start capability without performance variations.
- Optimum start performance for every start even in applications where load varies between starts.
- Soft stop control for applications such as pumps and conveyors
- Braking for reducing decelerations times.

10.7 Typical Start Current Requirements

	300%	350%	400%	450%
Agitator			●	
Atomiser			●	
Bottle Washer	●			
Centrifuge				●
Chipper				●
Compressor - Recip (loaded)				●
Compressor - Recip (unloaded)			●	
Compressor - Screw (loaded)			●	
Compressor - Screw (unloaded)		●		
Conveyor - Belt				●
Conveyor - Roller		●		
Conveyor - Screw			●	
Crusher - Cone		●		
Crusher - Jaw				●
Crusher - Rotary		●		
Crusher - Vertical Impact		●		
Debarker		●		
Dryer				●
Dust Collector		●		
Edger		●		
Fan - Axial (Damped)		●		
Fan - Axial (Un-damped)				●
Fan - Centrifugal (Damped)		●		
Fan - Centrifugal (Un-damped)				●

	300%	350%	400%	450%
Fan - High Pressure				●
Grinder		●		
Hydraulic Power Pack		●		
Mill				●
Mill - Ball				●
Mill - Hammer				●
Mill - Roller				●
Mixer				●
Palletiser				●
Planer		●		
Press		●		
Pump - Bore	●			
Pump - Centrifugal		●		
Pump - Positive Displacement			●	
Pump - Slurry				●
Re-pulper				●
Rotary Table			●	
Sander			●	
Saw - Bandsaw				●
Saw - Circular		●		
Separator				●
Shredder				●
Slicer	●			
Tumbler			●	

The above table is intended as a guide only. Individual machine and motor characteristics will determine the actual start current requirements. Refer to Section 10.2 *Reduced Voltage Starting* for further detail.