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## CAUTION STATEMENTS

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### Section 1

### Caution Statements

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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 installer's 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 24 VDC 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.
- Some electronic contactor coils are not suitable for direct switching with PCB mount relays. Consult the contactor manufacturer/supplier to see if this is advisable.
- 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 bypass contactor, ensure phase connections are correctly made, ie L1B-T1, L2B-T2, L3B-T3.
- Removing control voltage resets the thermal model.

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*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.*

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#### **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, the National Electrical Code (NEC<sup>®</sup>) 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 Electrical Code (NEC<sup>®</sup>) and local safety codes.

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**Section 2 General Description**

**2.1 Overview**

The IMS2 Series is a microcontroller based soft starter incorporating the latest technologies. It 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

**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
- Serial Interface 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 Serial Link

**Human Interface**

- Local Pushbuttons (Start, Stop, Reset, Local/Remote)
- Local Programming Buttons (Function, Up, Down, Store)
- LED Parameter Display
- Starter Status LEDs

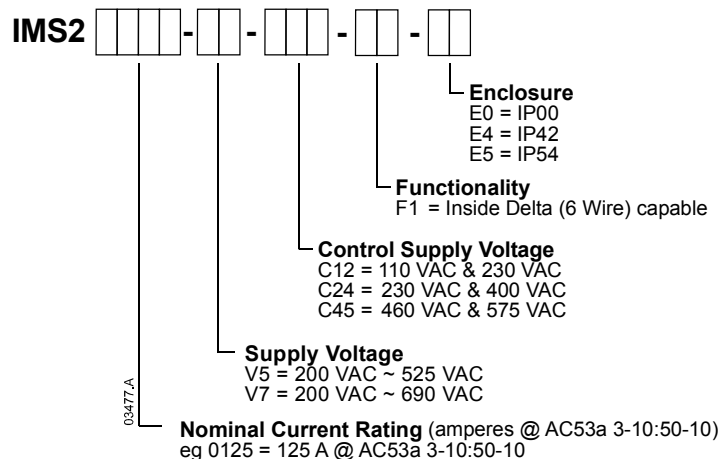
**Power connection**

- 3 Wire / 6 Wire
- Bypass connections to retain motor protection even when bypassed
- 18 A to 1574 A (3 Wire)
- 27 A to 2361 A (6 Wire)
- 200 VAC to 525 VAC (V5 models)
- 200 VAC to 690 VAC (V7 models)

**Sundry features**

- IP42 or IP54 (≤ 253 A)
- IP00 (≥ 302 A)
- Current Read-Out
- Motor Temperature Read-Out
- Trip Log (eight position)
- Multiple Function Sets
- Restart Delay
- High and Low Current Flags
- Motor Temperature 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**



# SPECIFICATIONS

## Section 3 Specifications

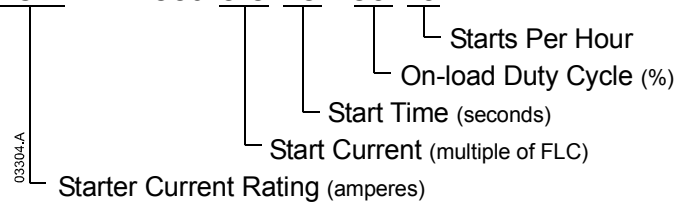
### 3.1 Current Ratings

#### 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**



**Starter Current Rating:** The full load current rating of the 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.

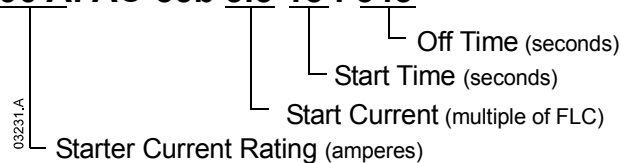
Contact your local supplier for IMS2 ratings under operating conditions not covered by the above ratings charts.

**Bypass Operation**

	<b>3.0 x FLC</b>		<b>3.5 x FLC</b>		<b>4.0 x FLC</b>		<b>4.5 x FLC</b>	
	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	253	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**



**Starter Current Rating:** The full load current rating of the 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 the end of one start and the beginning of the next start given the parameters detailed in the remaining sections of the utilisation code.

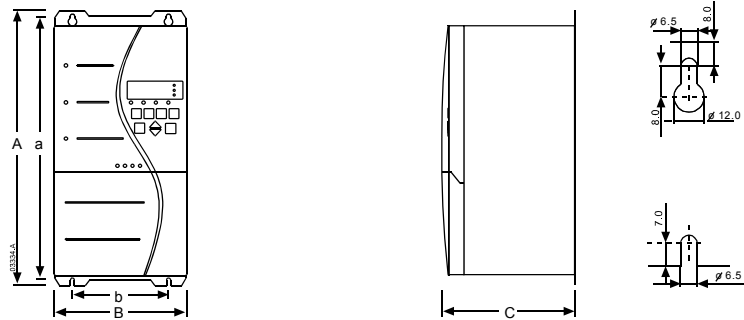
Contact your local supplier for IMS2 ratings under operating conditions not covered by the above ratings charts.

# SPECIFICATIONS

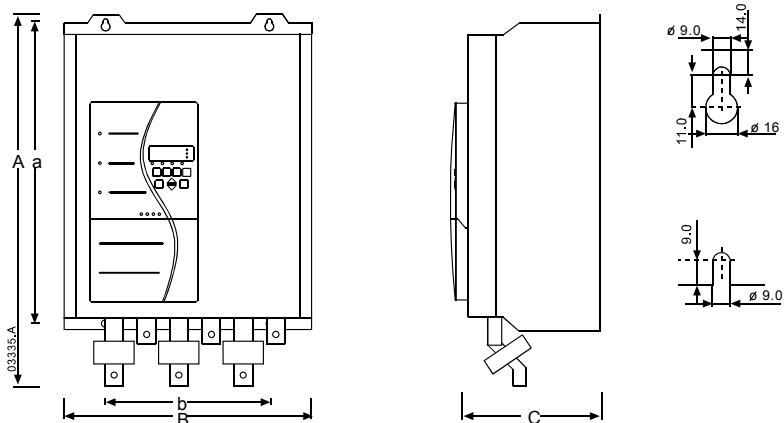
## 3.2 Dimensions and Weights

	<b>A</b>	<b>B</b>	<b>C</b>	<b>a</b>	<b>b</b>	<b>Weight</b>
	mm (inch)	mm (inch)	mm (inch)	mm (inch)	mm (inch)	kg (lb)
IP42 or IP54						
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)	10 (22)
IMS20088						
IMS20096						
IMS20125						
IMS20141	425 (16.73)	270 (10.63)	275 (10.83)	410 (16.14)	200 (7.87)	18 (39.6)
IMS20202						
IMS20238						
IMS20253	425 (16.73)	390 (15.35)	275 (10.83)	410 (16.14)	300 (11.81)	23 (50.6)
IP00						
IMS20302	690 (27.16)	430 (16.93)	294 (11.58)	522 (20.55)	320 (12.60)	38 (83.6)
IMS20405						50 (110)
IMS20513						
IMS20585						
IMS20628						
IMS20775						
IMS20897						53 (116.6)
IMS21153	855 (33.27)	574 (22.60)	353 (13.90)	727 (27.83)	500 (19.68)	121 (266.2)
IMS21403						
IMS21574						

IMS20018 ~ IMS20253



IMS20302 ~ IMS21574



**3.3 Semiconductor Fuses**

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

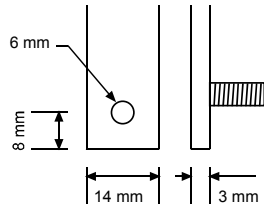
<b>F Series Fuses</b>	Supply Voltage ≤415 VAC	Supply Voltage ≤525 VAC	Supply Voltage ≤575 VAC	Supply Voltage ≤695 VAC	SCR $I_t^2$
MS20018	63AFE	63AFE	63AFE	63AFE	1,150
MS20034	160AFEE	160AFEE	160AFEE	160AFEE	10,500
MS20041	200FM	180FM	180FM	180FM	15,000
MS20047	200FM	180FM	180FM	180FM	18,000
MS20067	200FM	180FM	180FM	180FM	15,000
MS20088	250FM	250FM	250FM	250FM	51,200
MS20096	250FM	250FM	250FM	250FM	80,000
MS20125	250FM	250FM	250FM	250FM	97,000
MS20141	280FM	280FM	280FM	280FM	97,000
MS20202	500FMM	450FMM	450FMM	450FMM	245,000
MS20238	630FMM	630FMM	630FMM	630FMM	320,000
MS20253	630FMM	630FMM	630FMM	630FMM	320,000
MS20302	630FMM	500FMM	500FMM	500FMM	202,000
MS20405	500FMM	500FMM	500FMM	500FMM	320,000
MS20513	700FMM	700FMM	700FMM	700FMM	781,000
MS20585	*500FMM	*500FMM	*500FMM	*500FMM	1,200,000
MS20628	*500FMM	*500FMM	*500FMM	*500FMM	1,200,000
MS20775	*700FMM	*700FMM	*700FMM	*700FMM	2,532,000
MS20897	-	-	-	-	4,500,000
MS21153	-	-	-	-	4,500,000
MS21403	-	-	-	-	6,480,000
MS21574	-	-	-	-	12,500,000

<b>170M Fuses</b>	Supply Voltage ≤415 VAC	Supply Voltage ≤525 VAC	Supply Voltage ≤575 VAC	Supply Voltage ≤695 VAC	SCR $I_t^2$
MS20018	170M1315	170M1314	170M1314	170M1314	1,150
MS20034	170M1319	170M1317	170M1317	170M1317	10,500
MS20041	170M1319	170M1318	170M1318	170M1318	15,000
MS20047	170M1319	170M1318	170M1318	170M1318	18,000
MS20067	170M1319	170M1318	170M1318	170M1318	15,000
MS20088	170M3017	170M3017	170M3017	170M3017	51,200
MS20096	170M1322	170M1321	170M1321	170M1321	80,000
MS20125	170M1322	170M1322	170M1322	170M1322	97,000
MS20141	170M1322	170M1322	170M1322	170M1322	97,000
MS20202	170M6141	170M6141	170M6141	170M6141	245,000
MS20238	170M3023	170M3023	170M3023	170M3023	320,000
MS20253	170M3023	170M3023	170M3023	170M3023	320,000
MS20302	170M5144	170M5144	170M5144	170M5144	202,000
MS20405	170M6012	170M4016	170M6011	170M6011	320,000
MS20513	170M6014	170M6014	170M4018	170M4018	781,000
MS20585	170M5017	170M6015	170M6014	170M6014	1,200,000
MS20628	170M6019	170M6018	170M6017	170M6017	1,200,000
MS20775	170M6021	170M6020	170M6017	170M6017	2,532,000
MS20897	170M6021	170M6020	170M6151	170M6151	4,500,000
MS21153	170M6021	170M6020	170M6151	170M6151	4,500,000
MS21403	170M6021	170M6021	*170M5018	*170M5018	6,480,000
MS21574	170M6021	170M6021	*170M5018	*170M5018	12,500,000

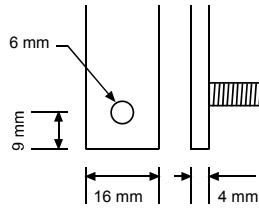
\* Two parallel connected fuses required per phase

# SPECIFICATIONS

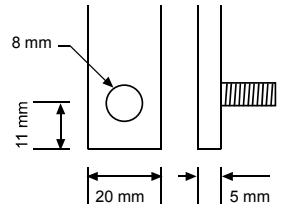
## 3.4 Power Terminations



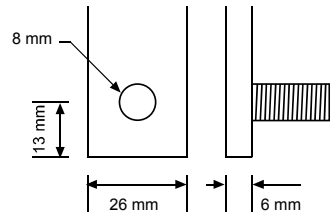
IMS20018 ~ IMS20047  
(3.5 Nm, 2.6 ft-lb)



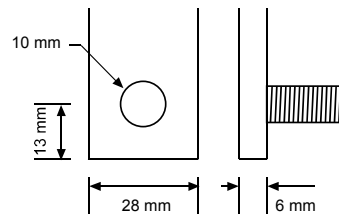
IMS20067 ~ IMS20125  
(3.5 Nm, 2.6 ft-lb)



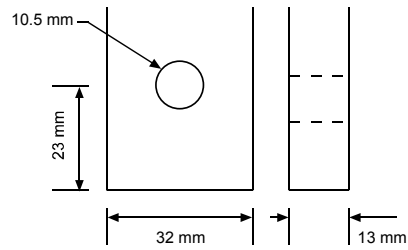
IMS20141  
(8.5 Nm, 6.3 ft-lb)



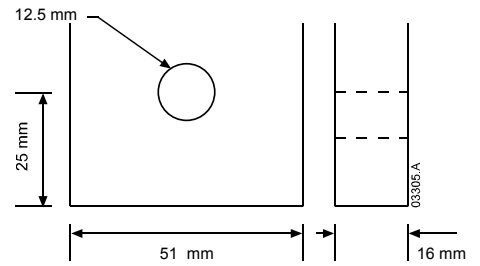
IMS20202 ~ IMS20238  
(8.5 Nm, 6.3 ft-lb)



IMS20253  
(17 Nm, 12.5 ft-lb)



IMS20302 ~ IMS20897



IMS21153 ~ IMS21574



**3.5 General Technical Data**

<b>Supply</b>	
Mains Supply Voltage IMS2xxxx-V5-xxx-xx-xx .....	3 x 200 VAC to 525 VAC (3 Wire Connection) 3 x 200 VAC to 440 VAC (6 Wire Connection)
Mains Supply Voltage IMS2xxxx-V7-xxx-xx-xx .....	3 x 200 VAC to 690 VAC (3 Wire Connection) 3 x 200 VAC to 440 VAC (6 Wire Connection)
Control Supply Voltage IMS2xxx-xx-C12-xx-xx .....	110 VAC (+ 10% / - 15%) or 230 VAC (+ 10% / - 15%)
Control Supply Voltage IMS2xxx-xx-C24-xx-xx .....	230 VAC (+ 10% / - 15%) or 400 VAC (+ 10% / - 15%)
Control Supply Voltage IMS2xxx-xx-C45-xx-xx .....	460 VAC (+ 10% / - 15%) or 575 VAC (+ 10% / - 15%)
Supply Frequency (at start) .....	50 Hz (± 2 Hz) or 60 Hz (± 2 Hz)
Supply Frequency (during start) .....	> 45 Hz (50 Hz supply) or > 55 Hz (60 Hz supply)
Supply Frequency (during run) .....	> 48 Hz (50 Hz supply) or > 58 Hz (60 Hz supply)

<b>Control Inputs</b>	
Start (Terminals C23, C24) .....	Active 24 VDC, 8 mA approx
Stop (Terminals C31, C32) .....	Active 24 VDC, 8 mA approx
Reset (Terminals C41, C42) .....	Active 24 VDC, 8 mA approx
Programmable Input A (Terminals C53, C54) .....	Active 24 VDC, 8 mA approx

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

<b>Sundry</b>	
Enclosure Rating IMS2xxxx-xx-xxx-xx-E0 .....	IP00 (Open Chassis)
Enclosure Rating IMS2xxxx-xx-xxx-xx-E4 .....	IP42
Enclosure Rating IMS2xxxx-xx-xxx-xx-E5 .....	IP54
Rated Short-Circuit Current (with semiconductor fuses) .....	100 kA
Rated Insulation Voltage .....	690 V
Surges .....	2 kV line to earth, 1 kV line to line
Fast Transients .....	2 kV / 5 kHz
Form Designation .....	Form 1
Electrostatic Discharge .....	4 kV contact discharge, 8 kV air discharge
Equipment Class (EMC) .....	Class A <sup>1</sup>
Radio-Frequency Electromagnetic Field .....	0.15 MHz – 80 MHz: 140 dBµV 8 MHz – 1 GHz: 10 V/m
Pollution Degree .....	Pollution Degree 3
Operating Temperatures .....	- 5 °C / + 60 °C
Relative Humidity .....	5 – 95% (max non condensing)

<sup>1</sup> 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.

<b>Standards Approvals</b>	
CE .....	IEC 60947-4-2
UL and C-UL .....	UL 508 <sup>2</sup>
C✓ .....	IEC 60947-4-2

<sup>2</sup> Includes models IMS20018 ~ IMS20897 for mains supply voltages up to 600 VAC when protected by semiconductor fuses.

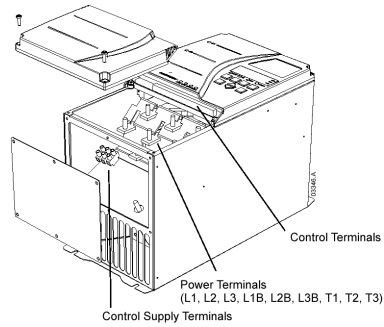
# INSTALLATION

## Section 4

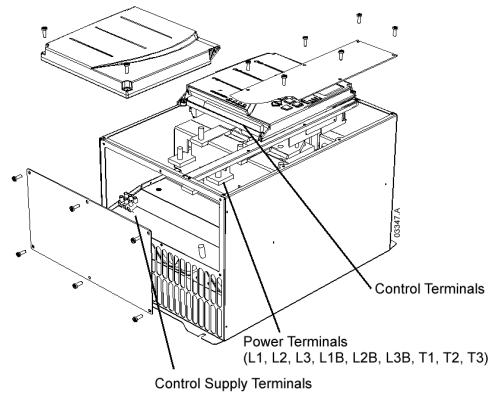
## Installation

### 4.1 General Layout Diagrams

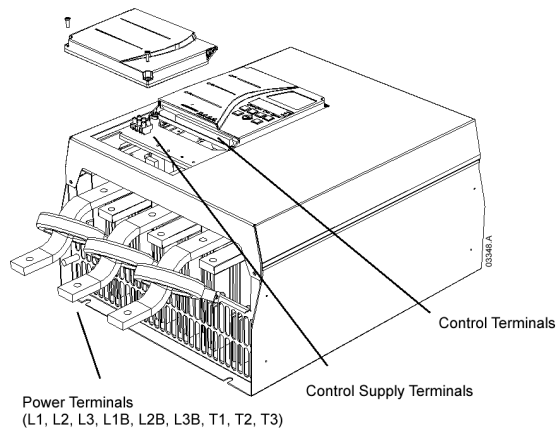
IMS20018 ~ 0125



IMS20141 ~ 0253

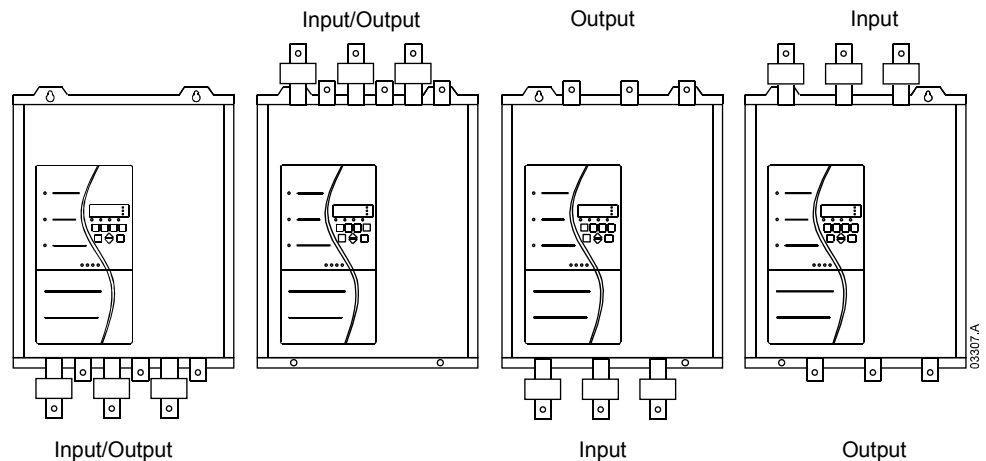


IMS20302 ~ 1574



### 4.2 Power Termination Configuration

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



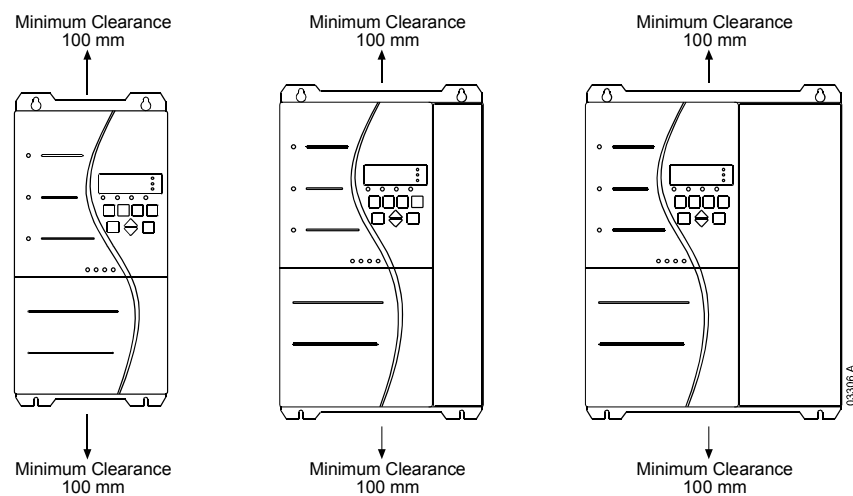
To adjust the bus bar configuration, first remove the IMS2 covers and main control module. Next loosen and remove the bus bar fixing bolts. The bus bars can now be removed and reinstalled into the starter in the desired configuration. The fixing bolts should then be refitted and tightened to a torque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

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

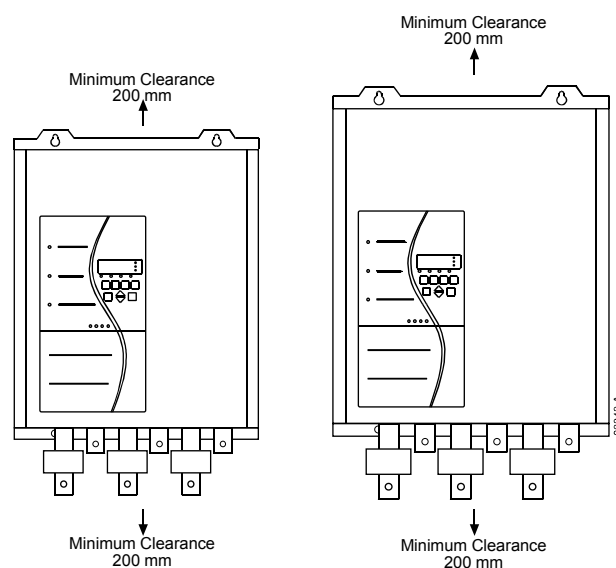
Care must be taken to ensure that foreign matter does not contaminate the jointing compound and become trapped between the bus bar and its mounting plate. If the paste does become contaminated, clean and replace with a jointing compound suitable for aluminium to aluminium, or aluminium to copper joints.

## 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 100 mm 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 200 mm allowance must be made top and bottom for air intake and exhaust.



# INSTALLATION

## 4.4 Ventilation

When installing IMS2 starters in an enclosure there must be sufficient airflow through the enclosure to limit heat rise. 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 motor ampere. The table below shows airflow requirements for selected motor currents. If other heat sources are installed in an enclosure along with the IMS2 an additional airflow allowance must be made for these items. Note that heat generation from semiconductor fuses (if used) is eliminated by installing these within the bypass loop.

Motor Current (A)	Heat (W)	Required Airflow			
		m <sup>3</sup> /minute		m <sup>3</sup> /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

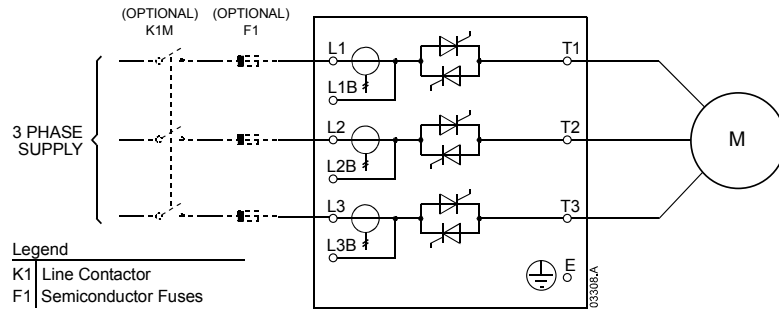
Section 5 Power Circuits

5.1 Overview

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

5.2 3 Wire Connection

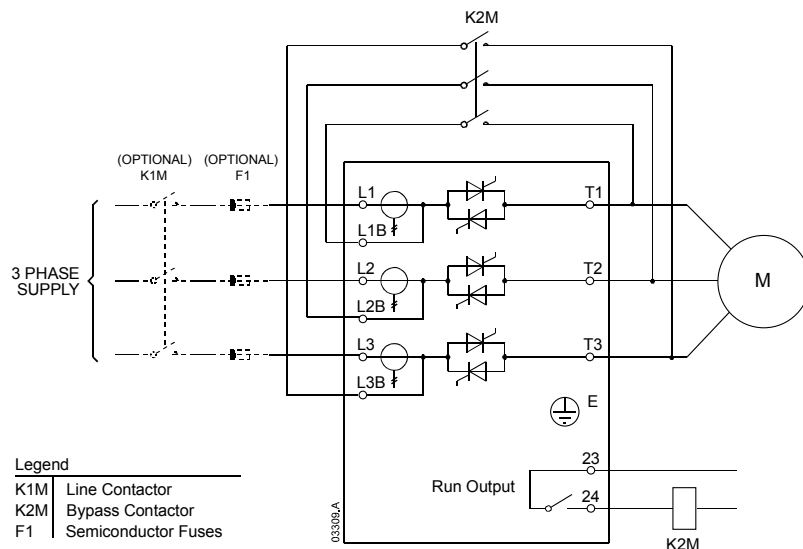
This is the standard connection format. Mains supply voltage is connected to the starter input terminals L1, L2, L3. The motor cables are connected to the soft starter output terminals T1, T2, T3.



5.3 3 Wire Connection (Bypass Operation)

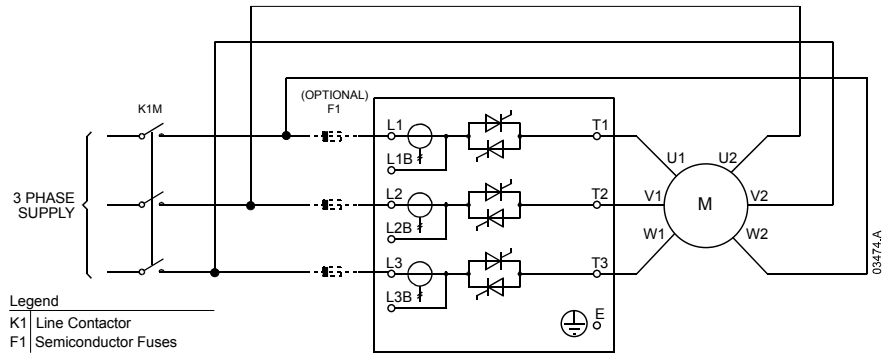
IMS2 starters can be bypassed while the motor is running. Special terminals (L1B, L2B, L3B) are provided for connection of the bypass contactor. Use of these terminals enables the IMS2 to continue to provide all protection and current monitoring functions even when bypassed.

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**

IMS2 starters 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.



A motor usually has two rows of three terminals in the motor termination box.

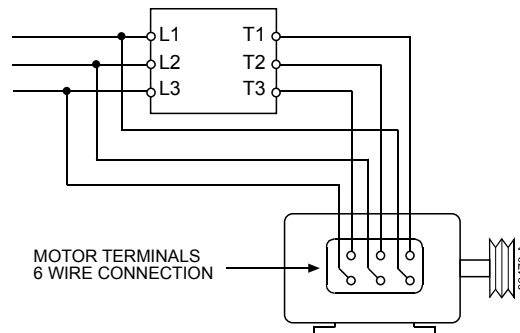
If the motor windings are connected in delta, there will be three links fitted. Each link is connected from a terminal in the top row to one in the bottom row.

If the motor windings are connected in star, there will be one link fitted. This link is connected to all three terminals in one row.

For 6 Wire connection, remove all links from the motor termination box. Connect the three output terminals of the IMS2 (T1, T2, T3) to one end of each motor winding. Connect the opposite end of each motor winding to a different phase on the input of the IMS2.

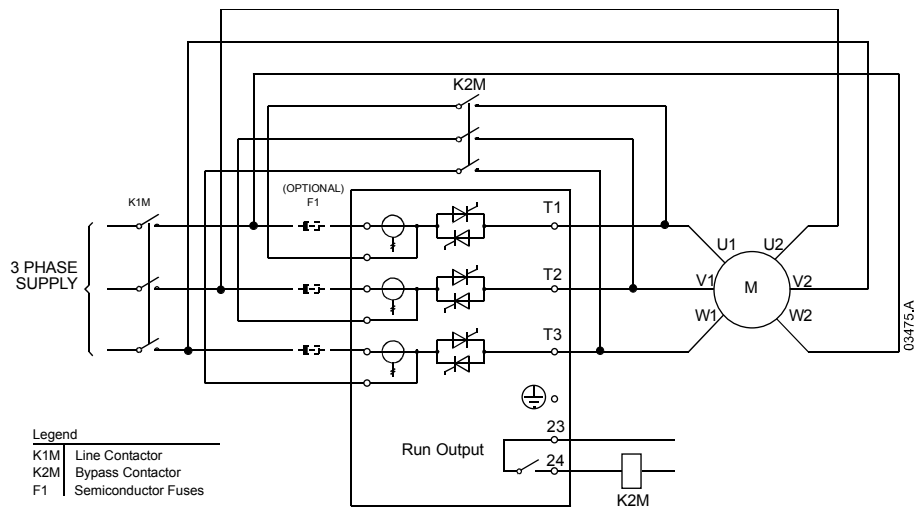
For example:

- Remove the links from the motor termination box.
- Connect the incoming phases to L1, L2, L3 on the IMS2.
- Connect each IMS2 output phase to one end of an individual motor winding: T1-U1, T2-V1, T3-W1.
- Connect the other end of each individual motor winding to a different phase on the input of the IMS2: U2-L2, V2-L3, W2-L1.



### 5.5 6 Wire Connection (Bypass Operation)

IMS2 starters are capable of 6 Wire (Inside Delta) connection and can be bypassed.



### 5.6 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.

### 5.7 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 it is not necessary for starter operation. An additional benefit gained by use of a line contactor is isolation of the starter SCRs in the off state, when they are most susceptible to damage from voltage transients.

The IMS2 can directly control a line contactor by assigning one of the relay outputs to Main Contactor control.

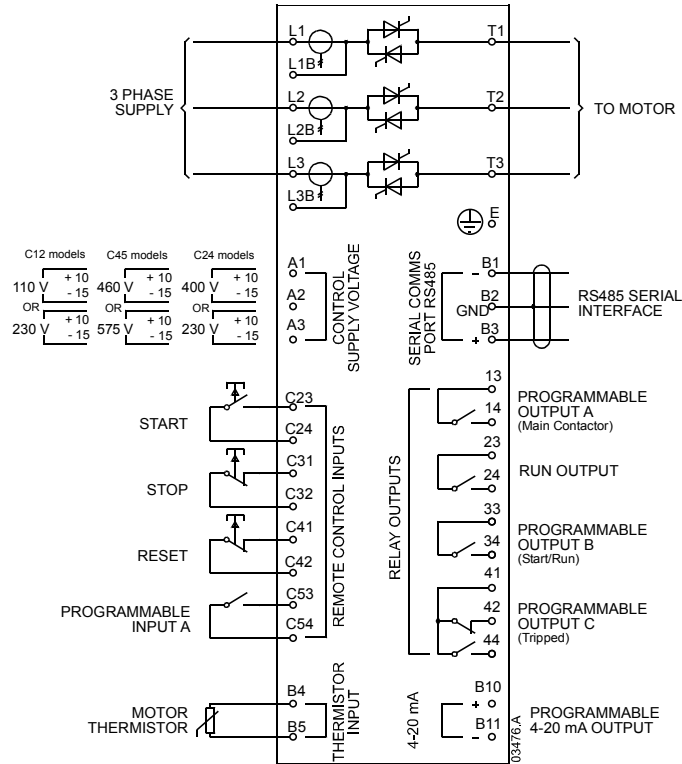
As an alternative to a line contactor, either a circuit breaker with a no volt release coil operated by the IMS2 trip output, or a motor operated circuit breaker can be considered. If a motor operated circuit breaker is used as a line contactor, the potential delay between the breaker being told to close and phase power being applied to the IMS2 could cause the IMS2 to trip on Power Circuit fault. Closing the motorised 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.

# CONTROL CIRCUITS

## 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.

- IMS2xxx-xx-**C12**-xx-xx models: 110 VAC (A1-A2) or 230 VAC (A2-A3)
- IMS2xxx-xx-**C24**-xx-xx models: 230 VAC (A2-A3) or 400 VAC (A1-A2)
- IMS2xxx-xx-**C45**-xx-xx models: 460 VAC (A1-A2) or 575 VAC (A2-A3)

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

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 ~ IMS20238	IMS20253 ~ IMS21574
110 / 460 VAC	995-00821-00	995-00823-00	995-00824-00
110 / 575 VAC	995-00825-00	995-00827-00	995-00828-00

Input Voltages For C45 IMS2 Models	Part Number		
	IMS20018 ~ IMS20047	IMS20067 ~ IMS20238	IMS20253 ~ IMS21574
110 / 230 VAC	995-00829-00	995-00831-00	995-00832-00



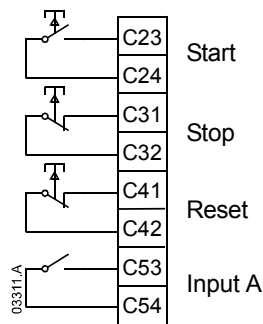
### 6.3 Control Wiring

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

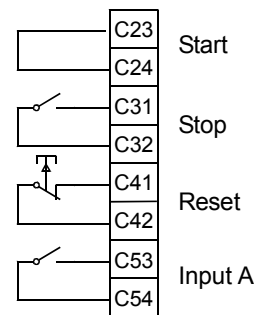
#### Remote Control Inputs

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 pushbutton control



Two wire control



#### CAUTION

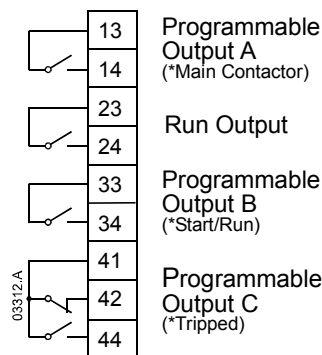
Do not apply voltage to the control inputs. The inputs are active 24 VDC and must be controlled with potential free circuits.

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

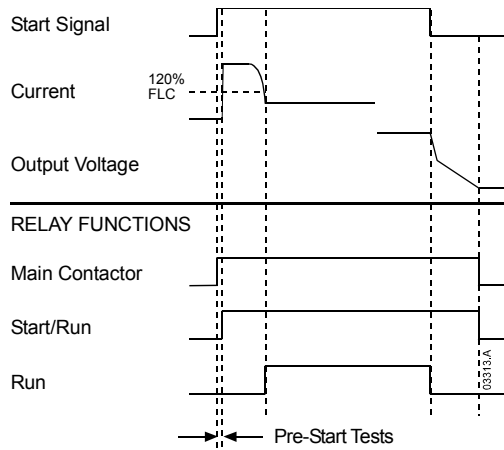
The IMS2 provides four relay outputs, one fixed and three programmable. Functionality of the programmable outputs is determined by the settings of Functions 21, 22 and 23.



#### Functionality Assignment

- Tripped
- Overcurrent Trip
- Undercurrent Trip
- Motor Thermistor Trip
- Heatsink Overtemperature Trip
- Phase Imbalance Trip
- Electronic Shearpin Trip
- Low Current Flag
- High Current Flag
- Motor Temperature Flag
- Start/Run
- Main Contactor
- Auxiliary Trip
- Off

\* = default functionality

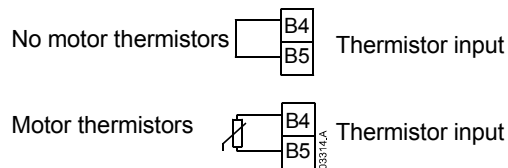


**CAUTION**

Some electronic contactor coils are not suitable for direct switching with PCB mount relays. Consult the contactor manufacturer/supplier to see if this is advisable.

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



**NOTE**

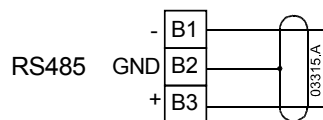
The thermistor circuit must be closed before the IMS2 will run.

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 and 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.



The serial link can be used to:

- Control IMS2 operation
- Query IMS2 status and operating data
- Read (download) function values from the IMS2
- Write (upload) function values to the IMS2

Three serial protocols are available: AP ASCII, Modbus RTU and Modbus ASCII. Select the relevant protocol using Function 63 *Serial Protocol*.



**NOTE**

Power cabling should be kept at least 300 mm away from communications cabling. Where this separation is not possible, magnetic shielding should be provided to reduce induced common mode voltages.

The IMS2 can be programmed to trip if the RS485 serial link fails. This is done by setting Function 60 *Serial Time Out*.

Baud rate is set by Function 61 *Serial Baud Rate*.

The starter address is assigned using Function 62 *Serial Satellite Address*.



**NOTE**

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



**NOTE**

The IMS2 may take up to 250 ms to respond. The host software timeout should be set accordingly.



**NOTE**

The satellite address and baud rate may also be altered through the serial interface. Behaviour of the serial interface will not be affected by such function value changes until the current serial programming mode session is terminated by the master. The serial master application must ensure that altering these function values does not cause communication problems.

**6.5 AP ASCII Protocol**

The details of the message fragments used in communicating with the IMS2 are shown in the table below. The message fragments may be assembled into complete messages as described in the sections that follow.



**NOTE**

Data transmitted to and from the IMS2 must be in 8 bit ASCII, no parity, 1 stop bit.

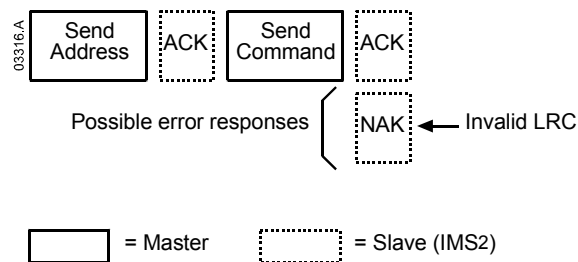
Message Fragment Type	ASCII Character String or (Hexadecimal Character String)
Send Address	EOT [nn] [lrc] ENQ or (04h [nn] [lrc] 05h)
Send Command	STX [ccc] [lrc] ETX or (02h [ccc] [lrc] 03h)
Send Request	
Read Function Values	
Write Function Values	
Receive Data	STX [dddd] [lrc] ETX or (02h [dddd] [lrc] 03h)
Receive Status	STX [ssss] [lrc] ETX or (02h [ssss] [lrc] 03h)
Function Number	DC1 [pppp] [lrc] ETX or (011h [pppp] [lrc] 03h)
Function Value	DC2 [vvvv] [lrc] ETX or (012h [vvvv] [lrc] 03h)
ACK (acknowledge)	ACK or (06h)
NAK (negative acknowledge)	NAK or (15h)
ERR (error)	BEL or (07h)

## CONTROL CIRCUITS

- nn = two byte ASCII number representing the soft starter address where each decimal digit is represented by n.
- lrc = two byte longitudinal redundancy check in hexadecimal.
- ccc = three byte ASCII command number where each character is represented by c.
- dddd = four byte ASCII number representing the current or temperature data where each decimal digit is represented by d.
- ssss = four byte ASCII number. The first two bytes are ASCII zero. The last two bytes represent the nibbles of a single byte of status data in hexadecimal.
- pppp = four byte ASCII number representing the function number where each decimal digit is represented by p.
- vvvv = four byte ASCII number representing the function value where each decimal digit is represented by v.

### Commands

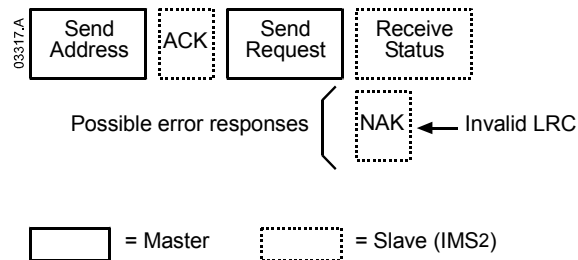
Commands can be sent to the IMS2 using the following format:



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 settings are ignored.
Forced comms trip	B18	Causes a communications trip at the IMS2. Displayed as trip code 'H'

### Status Retrieval

Starter status can be retrieved from the IMS2 using the following format:



Request	ASCII	Receive Status (ssss)
Version	C16	Serial protocol version number.
Trip Code	C18	Requests the trip status of the IMS2. 255 = No Trip 0 = Shorted SCR 1 = Excess Start Time 2 = Motor Thermal Model 3 = Motor Thermistor 4 = Phase Imbalance 5 = Supply Frequency 6 = Phase Sequence

		7 = Electronic Shearpin 8 = Power Circuit Fault 9 = Undercurrent 10 = Heatsink Overtemperature (F) 11 = Invalid Motor Connection (P) 12 = Auxiliary Input (J) 13 = Out of Range FLC (L) 14 = Incorrect Main Control Module (Y) 15 = RS485 Comms Fault (C) 16 = Forced Comms Trip (H) 17 = CPU Error (U)
Product Version	C20	<b>Bit No.</b> <b>Description</b>
		0 - 2        Function list version
		3 - 7        Starter type (2 = IMS2)
Starter Status	C22	<b>Bit No.</b> <b>Description</b>
		0 - 3        0 = Not used 1 = Waiting 2 = Starting (incl. Pre-start tests) 3 = Running 4 = Stopping 5 = Restart Delay 6 = Tripped 7 = Programming Mode
		4            1 = Positive phase sequence detected
		5            1 = Current exceeds the FLC
		6            0 = Uninitialised 1 = Initialised <i>nb: bit 4 is not valid unless bit 6 = 1</i>
		7            0 = Comms Connection Status OK 1 = Comms Connection Fault

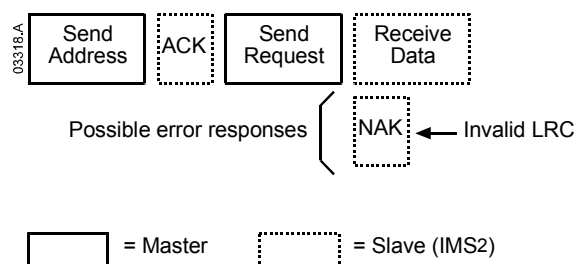


**NOTE**

The IMS2 command set has changed. The current version is backwards compatible with older functions. Refer to previous User Manuals, if required.

**Data Retrieval**

Data can be retrieved from the IMS2 using the following format:

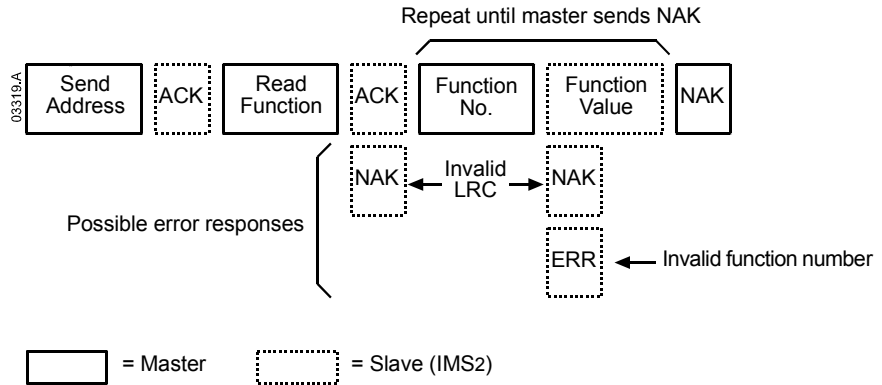


Request	ASCII	Receive Data (dddd)
Current	D10	Requests motor current. The data is 4 byte decimal ASCII. Minimum value 0000 A, maximum value 9999 A.
Temperature	D12	Requests the calculated value of the motor thermal model as a % of Motor Thermal Capacity. The data is 4 byte decimal ASCII. Minimum value 0000%. Trip point 0105%.

# CONTROL CIRCUITS

## Read Function Values from the IMS2

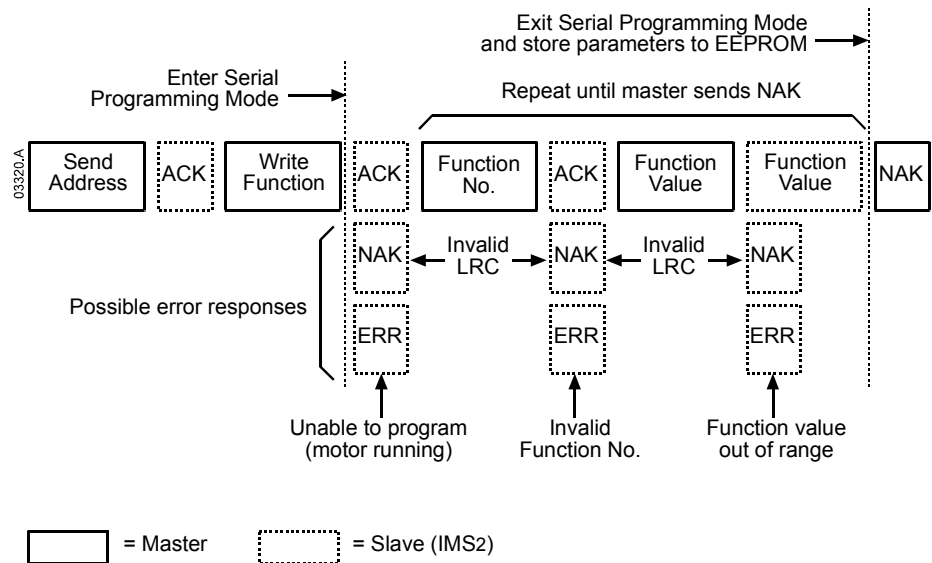
Function values may be read (downloaded) from the IMS2 at any time using the following format:



Read Function	ASCII	Comment
Download Functions	P10	Readies IMS2 to download function values.

## Write Function Values to the IMS2

Function values may be written (uploaded) to the IMS2 only when it is in the off state, ie not starting, running, stopping or tripped. Use the following format to write function values:



Write Function	ASCII	Comment
Upload Functions	P12	Readies IMS2 to upload function values.

When the IMS2 receives a Write Function command it enters serial programming mode. When in the serial programming mode the IMS2 local pushbuttons and remote inputs are inoperative, the serial start command is unavailable and the IMS2 numeric display flashes the letters 'SP'.

When the Write Function command is terminated by the master or with an error or timeout, the Functions are written to the EEPROM and the IMS2 exits serial programming mode.



### NOTE

Serial programming mode will time out in 500 ms if there has been no serial activity.



**NOTE**

The following functions may not be adjusted:  
 Function 100, 101, 102, 103, 110, 111, 112, 113 and 117.  
 If values for these functions are uploaded to the IMS2 there will be no effect and an error will be generated.

**Calculating the checksum (LRC)**

Each command string sent to and from the IMS2 includes a checksum. 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	0000 0001	+ 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:

Convert last two bytes of message from ASCII to binary.

Left shift 2<sup>nd</sup> to last byte 4 bits.

Add to last byte to get binary LRC.

Remove last two bytes from message.

Add remaining bytes of message.

Add binary LRC.

Round to one byte.

The result should be zero.

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	46h	LRC1	LRC2	ETX
-----	-----	-----	-----	-----	------	------	-----

## CONTROL CIRCUITS

### 6.6 Modbus Protocols

Protocol options are available for Modbus RTU and Modbus ASCII.

The relevant protocol is selected using Function 63 *Serial Protocol*.

Modbus Parity is set by Function 64 *Modbus Parity*.

All the functionality of the IMS2 serial protocol (see previous section) is implemented in the Modbus RTU and ASCII protocols using the Modbus register structure as follows.



**NOTE**

1. Command, Starter Status, Trip Code, Current, Temperature, Product type/version, RS485 Protocol version, and Function Upload (write) must be sent individually, ie one data word request at a time (single read/write).
2. The Modbus ASCII protocol is restricted to transferring one function download at a time (single read).
3. The Modbus RTU protocol is restricted to transferring a maximum of six function downloads at a time (multiple read).

Refer to the Modbus standard at <http://www.Modbus.org> for protocol details.

Register Address	Register	Type	Description	
40002	Command	Single Write	1 = Start 2 = Stop 3 = Reset 4 = Quick Stop 5 = Forced Comms Trip	
40003	Starter Status	Single Read	<b>Bit No.</b>	<b>Description</b>
			0 - 3	0 = Not used 1 = Waiting 2 = Starting (incl. Pre-start tests) 3 = Running 4 = Stopping 5 = Restart delay 6 = Tripped 7 = Programming Mode
			4	1 = Positive phase sequence detected
			5	1 = Current exceeds the FLC
			6	0 = Uninitialised 1 = Initialised <i>nb: bit 4 is not valid unless bit 6 = 1</i>
7	0 = Comms connection status OK 1 = Comms connection fault			
40004	Trip Code	Single Read	255 = No Trip 0 = Shorted SCR 1 = Excess Start Time 2 = Motor Thermal Model 3 = Motor Thermistor 4 = Phase Imbalance 5 = Supply Frequency 6 = Phase Sequence 7 = Electronic Shearpin 8 = Power Circuit Fault	





## CONTROL CIRCUITS

Write Function to the Soft Starter:

*Write to Function 12 Soft Stop Mode, set = 1 (Pump Control)*

Note: Returns error if out of range

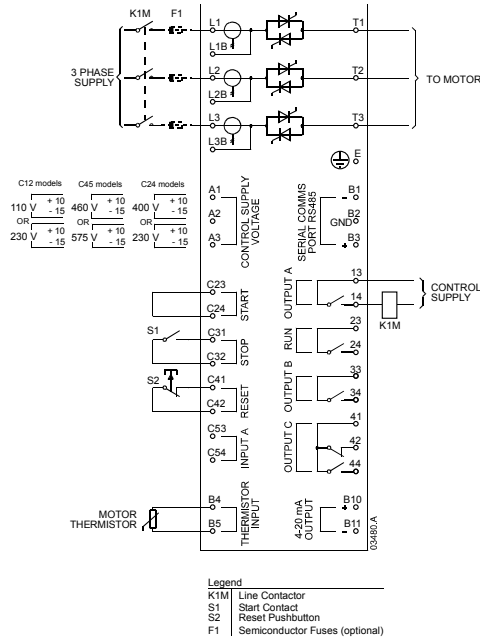
Slave Address	Function Code	Register Address	Data	Checksum
20	06	40020	1	(LRC or CRC)

### 6.7 IMS2 Programmable Functions

No.	Function	No.	Function
	<b>Primary Motor Settings</b>		<b>Auto-Reset</b>
1	Motor Full Load Current	70	Auto-Reset – Configuration
2	Current Limit	71	Auto-Reset – Number of Resets
3	Initial Start Current	72	Auto-Reset – Group A & B Delay
4	Start Ramp Time	73	Auto-Reset – Group C Delay
5	Stop Ramp Time		<b>Secondary Motor Settings</b>
6	Motor Start Time Constant	80	Motor Full Load Current
7	Phase Imbalance Sensitivity	81	Current Limit
8	Undercurrent Protection	82	Initial Start Current
9	Electronic Shearpin Protection	83	Start Ramp Time
	<b>Start/Stop Formats</b>	84	Stop Ramp Time
10	Torque Control	85	Motor Start Time Constant
11	Kickstart	86	Phase Imbalance Sensitivity
12	Soft Stop Mode	87	Undercurrent Protection
13	Auto-Stop – Run Time	88	Electronic Shearpin Protection
	<b>Starter Functionality</b>		<b>Protection Delays</b>
20	Local/Remote Operation	90	Phase Imbalance Trip Delay
21	Relay Output A Functionality	91	Undercurrent Trip Delay
22	Relay Output B Functionality	92	Electronic Shearpin Delay
23	Relay Output C Functionality	93	Out Of Frequency Trip Delay
24	Input A Functionality	94	Auxiliary Trip Delay
	<b>Protection Settings</b>		<b>Read Only Data</b>
30	Excess Start Time	100	Model Number
31	Phase Sequence	101	Start Counter (1000's)
32	Restart Delay	102	Start Counter (1's)
33	Phase Imbalance	103	Trip Log
34	Motor Thermistor		<b>Restricted Functions</b>
35	Heatsink Overtemperature	110	Access Code
36	Auxiliary Trip Mode	111	Update Access Code
	<b>Set Points</b>	112	Function Lock
40	Low Current Flag	113	Restore Function Settings
41	High Current Flag	114	Emergency Mode – Format
42	Motor Temperature Flag	115	Emergency Mode – Trip Relay
43	Field Calibration	116	Thermal Model – Override
	<b>Analogue Output</b>	117	Thermal Model – Override Count
50	4-20 mA Output Functionality		
51	4-20 mA Output Range – Max		
52	4-20 mA Output Range – Min		
	<b>Serial Communications</b>		
60	Serial Timeout		
61	Serial Baud Rate		
62	Serial Satellite Address		
63	Serial Protocol		
64	Modbus Parity		

Section 7 Application Examples

7.1 Installation with Line Contactor



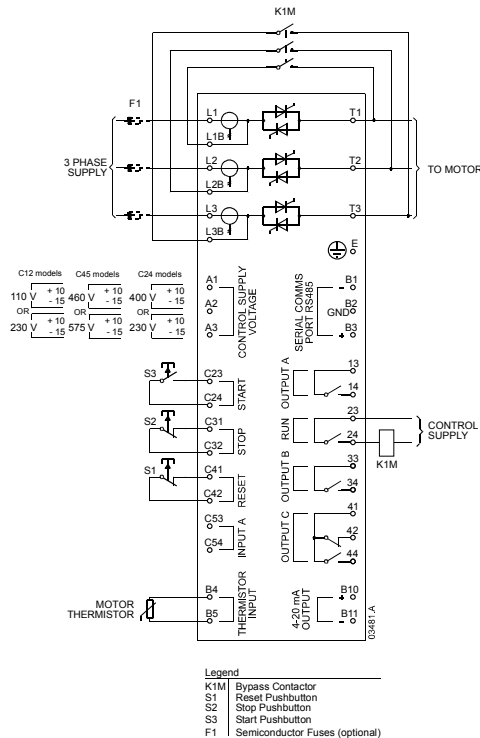
**Description:**

The IMS2 is installed 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).

7.2 Installation with Bypass Contactor



**Description:**

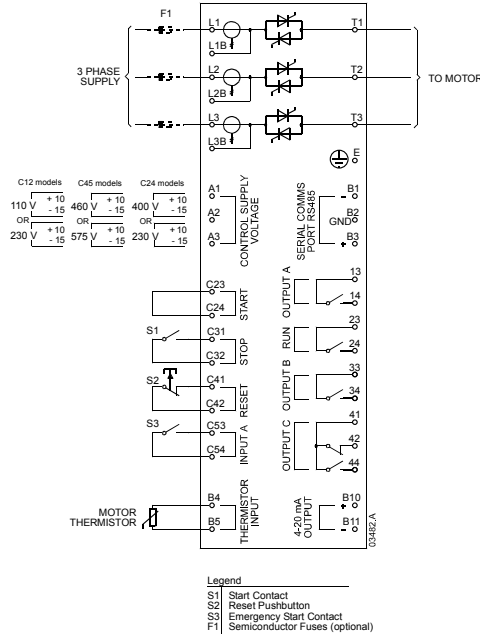
The IMS2 is installed with a bypass contactor (AC1 rated). The bypass contactor is controlled by the IMS2 RUN OUTPUT (terminals 23, 24).

**Function Settings:**

- No special settings required.

# APPLICATION EXAMPLES

## 7.3 Emergency Mode Operation



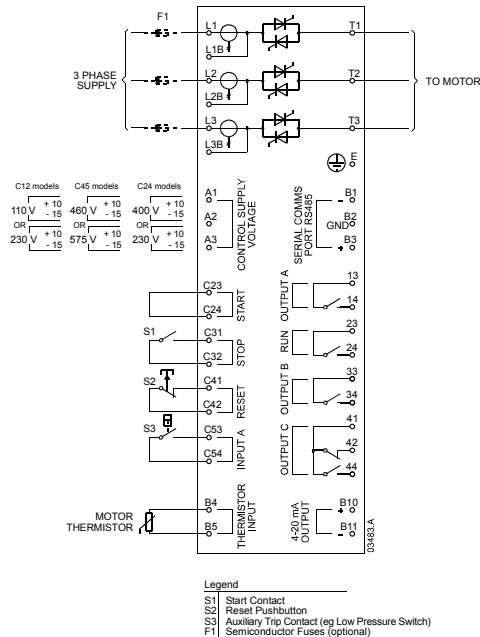
### Description:

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 certain trip conditions during the emergency run period (the user can define which classes of trip are ignored).

### 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 Operation* = as desired (determines if the trip relay operates when a fault is detected during emergency mode operation).

## 7.4 Auxiliary Trip Circuit



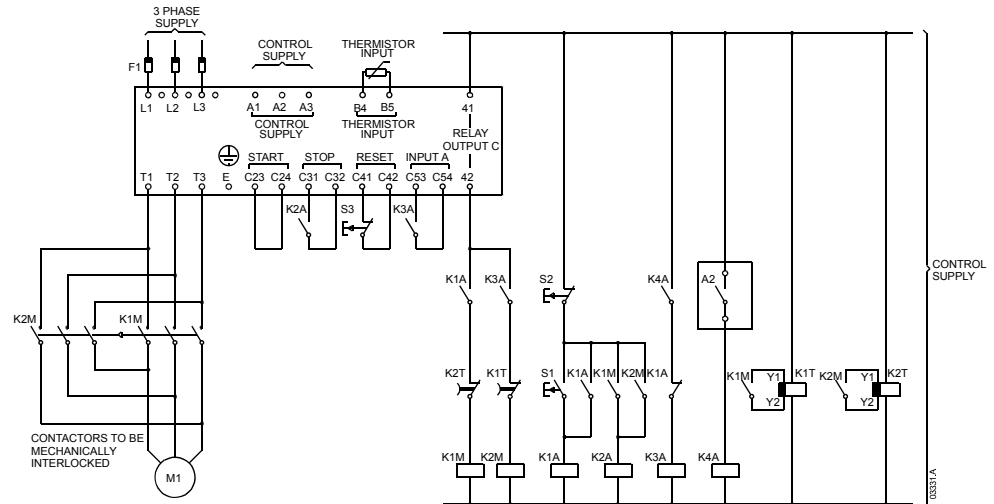
### Description:

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* = 6 (limits operation of the Auxiliary Trip function to 120 seconds after the start command, 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).

7.5 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 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 to 9 (sets starting performance characteristics).
- Functions 80 to 88 (sets braking performance characteristics).

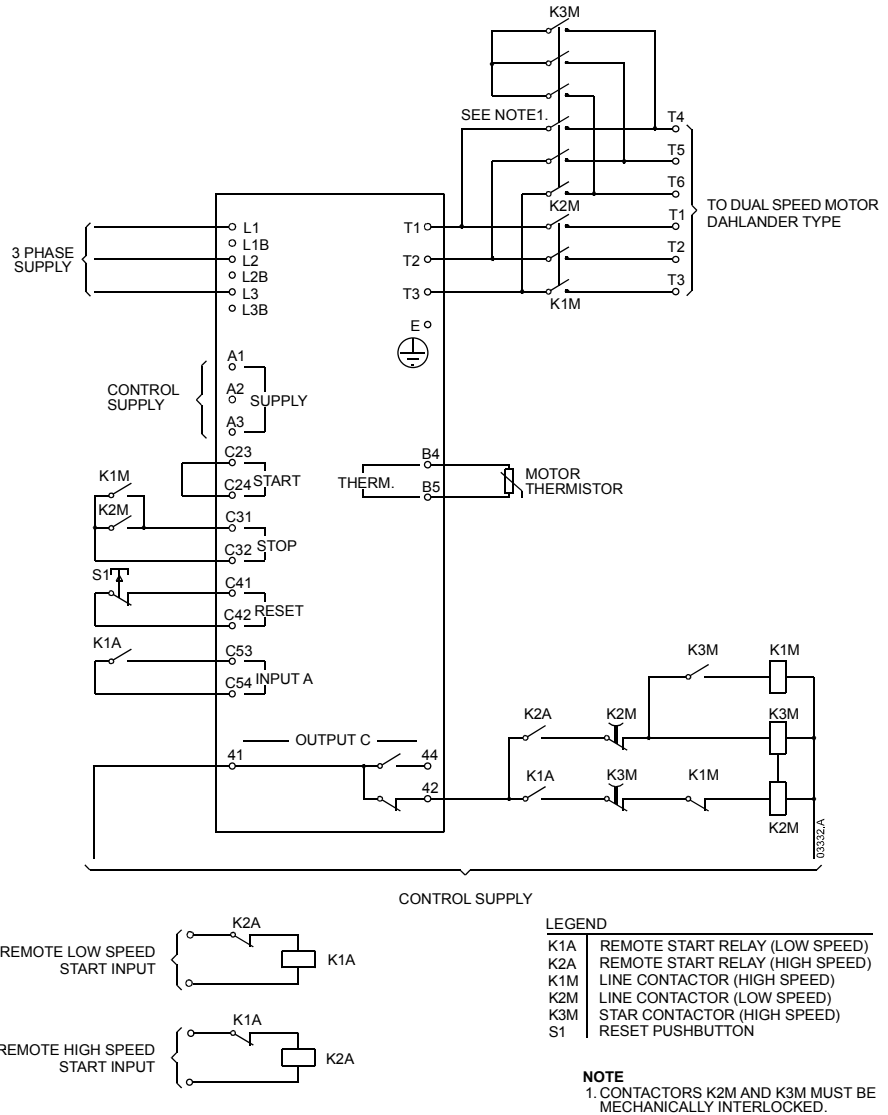


**NOTE**

If the IMS2 soft starter trips on a code 5 Supply Frequency Trip when the braking contactor K2M opens, increase the setting of Function 93 *Out of Frequency Trip Delay*.

# APPLICATION EXAMPLES

## 7.6 Two Speed Motor



### 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 (Functions 1 to 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 (Functions 80 to 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).



