Bardac drives

E-Series
AC Flux Vector Drive
Technical Manual

Part Number 4201-180 Revision L

IMPORTANT

This manual must be used in conjunction with the *E-Series AC Flux Vector Getting Started Manual - Part Number 4201-179*.

Read and understand the procedures described in both manuals before attempting to install or commission your drive.

If in doubt, before proceeding, please contact Bardac Drives at:

410-604-3400

Bardac Corporation
40 Log Canoe Circle, Stevensville, MD 21666 USA
Phone: (410) 604-3400 Fax: (410) 604-3500
www.bardac.com

IMPORTANT NOTES

SAFETY WARNINGS:

– It is the installer's responsibility to ensure the configuration and installation of the Elite Series meets the requirements of any site specific, local and national electrical regulations.

– The Elite Series operates from HIGH VOLTAGE, HIGH ENERGY ELECTRICAL SUPPLIES. Stored charge is present after switch off.

– Due to the high leakage currents inherent to AC drives, earth connection of both the motor and the Elite Series is essential before connection to the supply. The Elite Series must be permanently connected to the supply.

– For safety reasons, normal operation of the Elite Series requires front covers/doors to be in place and secured closed.

– Do not attempt to isolate the motor while the Elite Series is running.

– Some parameter settings may cause the Elite Series to start automatically after power failure.

– Motor overspeed operation may be limited by mechanical constraints.

RELIABILITY WARNINGS:

– Always screen control wiring.

– Ensure that the Elite Series is not mounted in an adverse environment.

ENVIRONMENTAL WARNINGS:

– Corrosive vapours or gases may interfere with the correct operation of electronic equipment. These compounds may include fumigants such as methyl bromide, or gases such as sulphur dioxide, hydrogen sulphide or chlorine derivatives.

  Please consult the manufacturer if there are any doubts about the environmental conditions this equipment may be operating in or subjected to.

– The IP/NEMA rating refers to dust and water ingress and not corrosive gases. PDL products are designed and manufactured to pollution degree 1 or 2 which do not cover corrosive vapours or gases.

– This equipment is intended for installation in a second (industrial) environment as defined by BS EN 61800-3. It is not intended to be used on a low voltage public network which supplies domestic premises. Radio frequency interference may result if used on such a network.

SERVICING WARNINGS:

– Service only by qualified personnel.

– Always isolate and allow to discharge before servicing.

– Never replace ceramic fuses with glass types.

– Always wear safety glasses when operating with the cover removed.

– The Elite Series contains static sensitive printed circuit boards. Use static safe procedures when handling these boards.

– Never work on live equipment alone.

– Observe all recommended practices.

NOTES:

– This manual and the screen list contained within this document relate to the Elite Series software version **4.4**.

– It is the responsibility of the end user/purchaser to ensure that operators understand how to use this equipment safely. Please read this manual thoroughly.

– The latest revision of this manual is available from our web-site **www.pdlelectronics.com**.

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SYMBOLS FOUND ON DRIVE

Caution, risk of electric shock *ISO 3864, No. B.3.6*

Caution (refer to accompanying documents) *ISO 3864, No. B.3.1*

3~ Three-phase alternating current *IEC 617-2, No. 02-02-06*

Direct Current *IEC 417, No. 5031*

Protective Earth (PE) Terminal *IEC 417 No. 5019*

Earth (ground) Terminal *IEC 417 No. 5017*

Induction motor, three phase, squirrel cage *IEC 617-2, No. 06-08-01*

REVISION HISTORY

Date:	Revision:	Description:
April 1997	D	Process control and fibre optic mode added.
Nov. 1997	E	Elite software version 2.0.
May 1998	F	Ultradrive specifications added.
March 1999	G	Add large Ultradrive specifications.
Dec. 2000	H	Update to software version 3.5. UL listings added. 500V ratings & open loop vector added.
Oct. 2001	I	New 500V ratings and parallel drive fault codes added.
April 2002	J	UL cable sizes added.
June 2003	K	Update to software version 4.1. Environmental warning added. Screens S12 and S13 added.
Nov. 2004	L	Updated. Incorporated Elite Getting Started manual.

1 INTRODUCTION TO THE ELITE SERIES AC MOTOR CONTROLLER

1.1 THE CONCEPT

The AC induction motor is the preferred choice of motive power for many industrial applications. With the development of electronic variable voltage variable frequency (VVVF) controllers, it became possible to control the speed of the induction motor. PDL Electronics has been at the forefront of development of VVVF controllers for the past 30 years.

However standard VVVF controllers can have certain performance limitations, specifically in applications where high torque is required at standstill and very low speeds, and in applications where extremely fast dynamic response is required. To address these limitations, PDL Electronics has developed the Elite Series of controllers. Advanced flux vector control techniques enables extended performance to be obtained from the AC induction motor, including full torque at standstill, and a speed response rivalling that of servomotors.

The Elite Series further evolves the hardware and software technology of previous ranges. The same Elite Series induction motor controller can be used without motor feedback for general industry applications, or with a shaft encoder (pulse tacho) driven by the motor to give the full performance associated with flux vector orientation control.

1.2 THE ELITE SERIES RANGE

The Elite Series has been developed from PDL's previous AC motor controller series, the Microdrive and Microvector. It inherits the Microdrive's simplicity and well proven electrical design. The Elite Series improves on the already highly flexible digital controls which have become the hallmark of the Microdrive and Microvector series.

The Elite Series currently spans the range from 0.75 kW to 1MW (1hp to 1200hp). All models are constructed to meet IP54/NEMA12, for protection against the ingress of dust and splashing water.

All Elite Series models have attained UL listing in the categories of Power Conversion Equipment and Power Conversion Equipment Certified for Canada.

1.3 THE BASIC PRINCIPLE OF FLUX VECTOR CONTROL

Field orientated flux vector control (or simply vector control) is a technique for controlling the torque developed by an AC induction motor. By independently controlling the magnitude of the air gap flux and the rotor current, and maintaining their orthogonality, it becomes possible to directly control the torque output of the motor. This is achieved by controlling the torque-producing and flux-producing components of the motor stator current. This is similar to controlling the armature and field currents in a separately excited DC motor. To achieve this level of control, the shaft speed and position must be sensed using a shaft encoder on the motor.

The Elite Series employs this technique in its Closed Loop Vector control mode. However if a shaft encoder is not used on the motor, Open Loop Mode control operation is available. This uses sophisticated monitoring and modelling techniques to estimate the rotor position.

1.4 CONFIGURATION OF CONTROLLER TYPE

When the Elite Series is set up for Closed Loop Vector control, it is set up as a torque controller. If further configured to "torque control" mode, it provides accurate output torque from the motor, in response to an external torque reference signal. This torque is available down to zero speed. This mode is most suited for use in torque control applications, e.g., power winder and rewinder systems. It can also be used in position control applications, with an external speed-position controller. A quadrature shaft encoder will be required on the motor, to provide rotor position feedback.

Closed Loop Vector control “speed control” mode is recommended for servomotor type applications, or anywhere that a speed controller with fast dynamic response or accurate speed holding is required. This mode is suitable for elevators or crane hoists, and other applications where full torque capability at zero speed are required. In this mode, the Elite Series can also be used in conjunction with an external position controller to do position control applications. A quadrature shaft encoder will be required on the motor, to provide rotor position and speed feedback.

Open Loop Mode control operating mode is for general purpose speed control applications, e.g., pumps, fans, conveyors, mixers etc. This mode gives equivalent or better performance to that of drives using previous VVVF technologies. In this mode, a quadrature shaft encoder on the motor is not necessary.

The V/Hz control operating mode is also suitable for general purpose speed control applications e.g. pumps, fans, conveyors, mixers etc. This mode gives equivalent or better performance to that of drives using previous VVVF technologies. When multiple motors are to be driven from the output of the Elite Series, the V/Hz control operating mode must be utilised.

The Elite Series will also function as an accurate sensor of torque, power and speed. The accuracy of this sensing is improved by using in Closed Loop Vector control operating mode. The outputs are available in analogue or digital format, or can be applied to internal comparators and limits.

1.5 CONTROL CONFIGURATION OPTIONS

The functions and formats of the six digital and two analogue inputs, and three digital and two analogue outputs, can be configured in a number of different ways.

Full details of the available screens and control functions are given in Section 8 of this manual.

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2 ELITE SERIES SPECIFICATIONS

2.1 ELITE SERIES SPECIFICATIONS

Input

Input frequency range	48 to 62Hz
Input current	< output current
Input displacement factor	> 0.99
Input current THD	< 40%
Power loss ride through	> 2 seconds at nominal voltage
Input voltage	(model dependant) refer to figures 2.1 to 2.4 for details. 3 phase earth neutral. Consult with factory for floating earth and corner earth supplies.

Output

Output voltage to motor	
Microdrive Elite Series	0 to V_{IN} -3V @ 100% load
Ultradrive Elite Series	0 to V_{IN} -15V @ 100% load
Current overload capability	150% for 30 secs (when hot) at 50°C at nominal rating 150% for 60 secs (when hot) at 40°C at nominal rating
Frequency range	
Closed Loop Mode	0 to ± 100Hz
Open Loop Mode	0 to ± 100Hz
V/Hz Mode	0 to ± 400Hz
Efficiency (full load, 50Hz)	> 97%
Suit motor rated kW	typically 50 to 150% of Elite Series nominal rating
Suit motor rated voltages	5 to 500Vac
Suit motor rated frequencies	10 to 400Hz
Modulation method	Space vector modulation
Modulation frequency	Up to 16kHz Whisper Wave or Narrow Band (model dependent)
Cable Length	Maximum cable length is typically 150m. This is dependent on Elite rating, cable type, switching frequency, and ambient temperature. For motor cable length exceeding 50m, please refer to PDL General Application Note "Output Choke Selection for the Elite Series" PDL Document 4216-053.

Environmental

Protection standard	**Refer to figures 2.1 to 2.4**
IP54/NEMA 12	Protected against dust and splashing water. Maximum pollution degree 2.
IP20/NEMA 1	Protected against accidental electrical contact. Maximum pollution degree 1.
Operating temperature	0°C to 50°C

For quadratic torque applications, the Elite Series may be up-rated when operated with a maximum ambient temperature of 40°C. Refer to figures 2.1 to 2.4.

Storage temperature	-25°C to +80°C
Relative humidity	< 90%, noncondensing
Altitude	1000m
Altitude derating (> 1000m)	-1% per 100m; 3000m max
Display unit protection	IP54/NEMA12, dust and splashing water protected

Electromagnetic Compatibility

IEC 61800-3 Ed 2. / EN 61800-3:1996 +A11:2000

Adjustable speed electrical power drive systems, part 3: EMC product standard including specific test methods.

BS EN55011:1998 / CISPR 11:1997

Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.

BS EN61000-4-2:1995. (*incorporating Amendment 1: 1999 issue 2*)

Testing and measurement techniques – Electrostatic discharge immunity.

BS EN61000-4-3:1998-11. Edition 1.1

Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity.

BS EN61000-4-4:1995-01

Testing and measurement techniques – Electrical fast transient/burst immunity.

BS IEC/EN61000-4-5:1995-03

Testing and measurement techniques – Surge Immunity.

IEC 61000-4-6:1993-04

Testing and measurement techniques – Immunity to conducted disturbances induced by radio-frequency fields.

Motor and Dynamic Brake Protection

Motor thermal model trip	PTC thermistor trip
Overload warning	Shear pin trip (configurable)
Dynamic brake resistor thermal model trip	
Torque limit and time-out (configurable)	
Speed limit and time-out (configurable)	

Elite Series Protection

Supply loss	Input phase loss	
Software thermal model	Heatsink overheat	
IGBT overload	Internal air overheat	
Output current limit	Output current trip	
DC bus voltage limiting	E002 to E046	Other Elites
Software	720Vdc	820Vdc
Hardware	750Vdc	850Vdc
Phase Fault	Ground fault	
Low DC bus voltage	Regeneration limit	
Hardware failure		

Specifications are subject to change without notice

Control

Control method	Closed Loop Mode, Open Loop Mode, V/Hz Mode
Analogue inputs	2 inputs, configurable as 0-10Vdc, ±10Vdc, 4-20mA or 0-20mA.
Digital inputs	6 inputs, configurable as active high/low, inch, speed or torque select, direction invert functions; front panel configurable to provide stop, start, reset.
Analogue outputs	2 outputs, configurable as 0-10Vdc, ±10Vdc, 4-20mA or 0-20mA, with multiple function selections for each.
Relay outputs	1 changeover, 2 normally open, rated 250Vac or 30Vdc, 2A non-inductive, with multiple function selections for each.
Display unit controls	2 lines x 16 characters liquid crystal display, start, stop-reset push-buttons. Increase, decrease, select push-buttons. Display unit can be removed and relocated up to 3m distance.

Power Quality

The Elite Series has been designed to operate in a Class 3 electromagnetic environment, as detailed by BS EN 6100-2-4:1995. This refers to an industrial environment where a large part of the electrical load is fed through converters, large motors are frequently started, loads vary rapidly, or welding machines are present.

For a 400V 50Hz or 480V 60Hz supply, this sets the following distortion limits:

Notch Depth:	40% maximum
Total Harmonic Distortion (THD):	10%
Notch Area:	250% degrees, at rated voltage and current

Failure to observe these limits may cause “soft charge” failure when power is applied to the drive.

In addition, repetitive overvoltage spikes (transients) must never exceed an instantaneous maximum voltage of 1.25 x the nominal phase peak voltage. Failure to observe this limit will apply excess stress on internal components and may cause premature failure.

For mains supplies with disturbances exceeding these limits, consult PDL Electronics for advice.

Output Current Rating of the Elite Series

The Elite Series output rating is determined by its current. The maximum motor size that can be run from each drive in the range is a funcition of this current, and of the motor rated voltage, the type of load, and the amibient temperature.

Each drive in the Elite range has two current ratings, depending on the type of load and the maximum expected ambient temperature.

Variable Torque Current Rating

This current rating, as detailed in figures 2.1 and 2.3, may be applied to any load where torque (and therefore motor current) increases with increasing motor speed. This includes centrifugal pumps and fans. The variable torque current rating is higher than the constant torque current rating because at low speed operation, current is also low and thermal cycle does not occur.

As can be seen from the tables, the variable torque ratings are approximately 20% higher than the constant torque ratings. This generally enables the next largest motor to be used, when compared with a constant torque load. Notice however that the variable torque ratings are valid for an ambient temperature not exceeding 40°C. For ambient temperatures greater than 40°C, derate the current rating by the amount shown in the figures, up to a maximum temperature of 50°C.

Constant Torque Current Rating

This current rating, as detailed in figures 2.2 and 2.4, is to be applied for any “constant torque” load. A constant torque load is defined as one where the motor load (and therefore the current drawn by the motor) remains essentially constant over the full speed range of the drive, such loads may include hoists, winches, conveyors, or any highly dynamic load which has regular and widely varying speed changes while operating. Any of the Elite range operating in closed loop vector mode must use this rating table. These types of load are the most severe on the drive, because significant thermal cycling of the drive’s power components will occur when operating at high torque at low speed.

Overload Rating

In general, the maximum overload current rating for each drive is 50% above the constant torque load rating, for a time of 60 seconds, at an ambient temperature of 40°C. This is a hardware limit, and cannot be varied. For ambient temperatures exceeding 40°C, the overload time must be reduced, (to 30s at 50°C), or the overload current must be reduced. Refer to figures 2.1 to 2.4 for the required overload current derating, as a function of ambient temperature.

Specifications are subject to change without notice

ELITE SERIES 400V VARIABLE TORQUE @ 40°C								
ENCLOSURE RATING	FRAME	ITEM	I [A]	MOTOR kW 400V	Overload I [A] 60 Seconds Maximum	Recommended Cable Size per Phase: (Note 6)		Fuses per Phase (A) (Note 7)
						AWG/kcmil	mm^2	
Nema 12 IEC IP54	1	E002	3.1	1.1	3.7	14 to 12	2.5 to 4	6
		E006	8.1	4	9.7	12 to 10	2.5 to 4	16
		E010	13.1	5.5	15.7	12 to 10	2.5 to 4	25
		E012	15	7.5	18.0	10 to 8	4 to 6	32
	2	E018	22.5	11	27	10 to 8	4 to 6	40
		E022	28	15	33	10 to 8	4 to 6	50
	3	E031	38	18.5	46	8 to 6	6 to 10	80
		E038	47	22	57	6 to 4	10 to 16	100
		E046	57	30	69	4 to 3	16 to 25	100
Nema 12 IEC IP54 Electronics Enclosure	4	UE060C54	75	37	90	3 to 1	16 to 36	150
		UE075C54	94	45	112	1 to 1/0	25 to 50	200
		UE090C54	112	55	135	1/0 to 3/0	25 to 50	200
		UE115C54	144	75	172	2/0 to 4/0	50 to 95	300
		UE140C54	175	90	210	4/0 to 250	70 to 120	300
Nema 12 IEC IP54 Electronics Enclosure	5	UE170C54	205	110	255	3/0 to 300	95 to 150	350
		UE205C54	250	132	307	250 to 400	120 to 240	350
		UE250C54	305	160	375	350 to 500	185 to 240	350
	6	UE305C54	370	200	457	2 by 500	2 by 240	2 by 350
		UE370C54	440	250	555	2 by 500	2 by 240	2 by 350
		UE440C54	540	315	660	2 by 500	2 by 240	2 by 350
		UE540C54	620	355	810	2 by 500	2 by 240	2 by 350
	7	UE620C54	700	400	930	3 by 500	3 by 240	3 by 350
		UE700C54	850	500	1050	3 by 500	3 by 240	3 by 350
	Parallel Ultradrive Elites (Note 4)	UE760C54	935	560	1140	4 by 500	4 by 240	4 by 350
		UE930C54	1070	630	1395	4 by 500	4 by 240	4 by 350
		UE1070C54	1210	710	1605	6 by 500	6 by 240	6 by 350
		UE1200C54	1470	710	1800	6 by 500	6 by 240	6 by 350

Note 1:	Supply Voltage (V_{in}) - 380Vac to 440Vac (-10% to +10%). Supply type - 3 phase earthed neutral.
Note 2:	Frame 4 is UL/cUL approved for 230 & 380 - 480Vac. 230V option must be specified at time of order. Frames 5 to 7 and Parallel drives are UL/cUL approved 380 - 500Vac. 230V options where available as a special will not be UL certified.
Note 3:	Motor kW ratings are based on typical 4 - pole ratings only. **Check your motor specification before selecting**.
Note 4:	Parallel Ultradrive Elites require the motor to be connected in "Inside Delta".
Note 5:	To maintain a 60 second overload above 40°C use a derating factor of 2.2 % per degree Celsius **for nominal and overload current to a maximum of 50°C**. Refer to diagram below.
Note 6:	Cable sizes are stated for copper cables. For compliance with UL/cUL, use copper cables only. Frame 1 minimum cable size is 10AWG (5.3mm^2) for UL/cUL compliance.
Note 7:	**Frames 1 & 2** input fuses must be of type gG (distribution) or gR/UR (semiconductor). **Frames 3 & 4** input fuses must be of type gR/UR (semiconductor). **Frames 5 to 7 and Parallel drives** have UL recognised type gR/UR (semiconductor) fuses fitted as standard. Fuses must be selected to protect circuits with a maximum 200kA prospective symmetrical short circuit capacity.

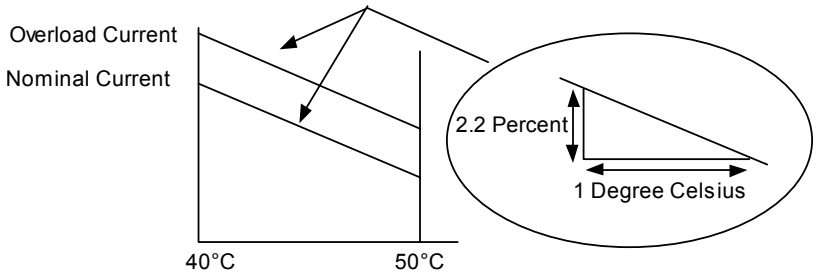

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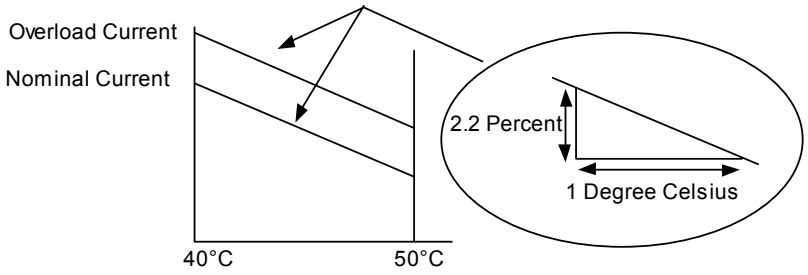
Figure 2.1: Elite Series 400V Variable Torque Ratings

ELITE SERIES 400V CONSTANT TORQUE @ 50°C								
ENCLOSURE RATING	FRAME	ITEM	I [A]	MOTOR kW 400V	Overload I [A] 30 Seconds Maximum (60 seconds @ 40°C)	Recommended Cable Size per Phase: (Note 7)		Fuses per Phase (A) (Note 8)
						AWG/kcmil	mm^2	
Nema 12 IEC IP54	1	E002	2.5	0.75	3.7	14 to 12	2.5 to 4	6
		E006	6.5	3	9.7	12 to 10	2.5 to 4	16
		E010	10.5	4	15.7	12 to 10	2.5 to 4	25
		E012	12	5.5	16.5	10 to 8	4 to 6	32
	2	E018	18	7.5	24	10 to 8	4 to 6	40
		E022	22.5	11	31.5	10 to 8	4 to 6	50
	3	E031	31	15	45	8 to 6	6 to 10	80
		E038	38	18.5	52.5	6 to 4	10 to 16	100
		E046	46	22	61.5	4 to 3	16 to 25	100
Nema 12 IEC IP54 Electronics Enclosure	4	UE060C54	60	30	90	3 to 1	16 to 36	150
		UE075C54	75	37	112	1 to 1/0	25 to 50	200
		UE090C54	90	45	135	1/0 to 3/0	25 to 50	200
		UE115C54	115	55	172	2/0 to 4/0	50 to 95	300
		UE140C54	140	75	210	4/0 to 250	70 to 120	300
Nema 12 IEC IP54 Electronics Enclosure	5	UE170C54	170	90	255	3/0 to 300	95 to 150	350
		UE205C54	205	110	307	250 to 400	120 to 240	350
		UE250C54	250	132	375	350 to 500	185 to 240	350
	6	UE305C54	305	160	457	2 by 500	2 by 240	2 by 350
		UE370C54	370	200	555	2 by 500	2 by 240	2 by 350
		UE440C54	440	250	660	2 by 500	2 by 240	2 by 350
		UE540C54	540	315	810	2 by 500	2 by 240	2 by 350
	7	UE620C54	620	355	930	3 by 500	3 by 240	3 by 350
		UE700C54	700	400	1050	3 by 500	3 by 240	3 by 350
	Parallel Ultradrive Elites (Note 4)	UE760C54	760	450	1140	4 by 500	4 by 240	4 by 350
		UE930C54	930	560	1395	4 by 500	4 by 240	4 by 350
		UE1070C54	1070	630	1605	6 by 500	6 by 240	6 by 350
		UE1200C54	1200	710	1800	6 by 500	6 by 240	6 by 350

Note 1:	Supply Voltage (V_{in}) - 380Vac to 440Vac (-10% to +10%). Supply type - 3 phase earthed neutral.
Note 2:	Frame 4 is UL/cUL approved for 230 & 380 - 480Vac. 230V option must be specified at time of order. Frames 5 to 7 and Parallel drives are UL/cUL approved 380 - 500Vac. 230V options where available as a special will not be UL certified.
Note 3:	Motor kW ratings are based on typical 4 - pole ratings only. **Check your motor specification before selecting**.
Note 4:	Parallel Ultradrive Elites require the motor to be connected in "Inside Delta".
Note 5:	By increasing the maximum **overload time to 60 seconds**, the table above can be used for Constant Torque current ratings at 40°C.
Note 6:	To maintain a 60 second overload above 40°C use a derating factor of 2.2 % per degree Celsius **for nominal and overload current to a maximum of 50°C**. Refer to diagram below.
Note 7:	Cable sizes are stated for copper cables. For compliance with UL/cUL, use copper cables only. Frame 1 minimum cable size is 10AWG (5.3mm2) for UL/cUL compliance.
Note 8:	**Frames 1 & 2** input fuses must be of type gG (distribution) or gR/UR (semiconductor). **Frames 3 & 4** input fuses must be of type gR/UR (semiconductor). **Frames 5 to 7 and Parallel drives** have UL recognised type gR/UR (semiconductor) fuses fitted as standard. Fuses must be selected to protect circuits with a maximum 200kA prospective symmetrical short circuit capacity.



4202-428 Rev B

Figure 2.2: Elite Series 400V Constant Torque Ratings

ELITE SERIES 500V VARIABLE TORQUE @ 104°F (40°C)									
ENCLOSURE RATING	FRAME	ITEM	I [A]	3 Phase Supply		Overload I [A] 60 Seconds Maximum	Recommended Cable Size per Phase: (Note 6)		Fuses per Phase (A) (Note 7)
				MOTOR HP 460V	MOTOR HP 230V		kcmil	mm^2	
Nema 12 IEC IP54	1	ME002D54	3.1	1.5	0.5	3.7	14 to 12	2.5 to 4	6
		ME006D54	7.6	5	2	9.0	12 to 10	2.5 to 4	16
		ME009D54	12	7.5	3	13.5	12 to 10	2.5 to 4	25
		ME011D54	14	10	3	16.0	10 to 8	4 to 6	32
	2	ME016D54	21	15	7.5	24	10 to 8	4 to 6	40
		ME021D54	27	20	10	31	10 to 8	4 to 6	50
	3	ME030D54	37.5	25	10	45	8 to 6	6 to 10	80
		ME035D54	45	30	15	52	6 to 4	10 to 16	100
		ME041D54	52	40	20	61	4 to 3	16 to 25	100
Nema 12 IEC IP54 Electronics Enclosure	4	UE060D54	75	50	25	90	3 to 1	16 to 36	150
		UE075D54	94	60	30	112	1 to 1/0	25 to 50	200
		UE090D54	112	75	40	135	1/0 to 3/0	25 to 50	200
		UE115D54	144	100	50	172	2/0 to 4/0	50 to 95	300
		UE140D54	175	125	60	210	4/0 to 250	70 to 120	300
Nema 12 IEC IP54 Electronics Enclosure	5	UE170D54	205	150	75	255	3/0 to 300	95 to 150	350
		UE205D54	250	200	100	307	250 to 400	120 to 240	350
		UE250D54	305	250	125	375	350 to 500	185 to 240	350
	6	UE305D54	370	300	150	457	2 by 500	2 by 240	2 by 350
		U0370D54	440	350	150	555	2 by 500	2 by 240	2 by 350
		UE440D54	540	450	200	660	2 by 500	2 by 240	2 by 350
		UE540D54	620	500	250	810	2 by 500	2 by 240	2 by 350
	7	UE620D54	700	600	300	930	3 by 500	3 by 240	3 by 350
		UE700D54	850	680	350	1050	3 by 500	3 by 240	3 by 350
	Parallel Ultradrive Elites	UE760D54	935	680	Not available as 230V	1140	4 by 500	4 by 240	4 by 350
		UE930D54	1070	845		1395	4 by 500	4 by 240	4 by 350
		UE1070D54	1210	952		1605	6 by 500	6 by 240	6 by 350
		UE1200D54	1470	1207		1800	6 by 500	6 by 240	6 by 350

Note 1:	Supply Voltage (V_{in}) - 440Vac to 500Vac (-10% to +10%). Supply type - 3 phase earthed neutral.
Note 2:	Frames 1 - 4 are UL/cUL approved for 230 & 380 - 480Vac. 230V option must be specified at time of order. Frames 5 to 7 and Parallel drives are UL/cUL approved 380 - 500Vac. 230V options where available as a special will not be UL certified.
Note 3:	HP ratings are based on typical 4 - pole ratings only. **Check your motor specification before selecting**.
Note 4:	Parallel Ultradrive Elites require the motor to be connected in "Inside Delta".
Note 5:	To maintain a 60 second overload above 104°F (40°C) use a derating factor of 2.2 % per degree Celsius for **nominal and overload current to 122°F (50°C)**. Refer to diagram below.
Note 6:	Cable sizes are stated for copper cables. For compliance with UL/cUL, use copper cables only. Frame 1 minimum cable size is 10AWG (5.3mm^2) for UL/cUL compliance.
Note 7:	**Frames 1 & 2** input fuses must be of type gG (distribution) or gR/UR (semiconductor). **Frames 3 & 4** input fuses must be of type gR/UR (semiconductor). **Frames 5 to 7 and Parallel drives** have UL-recognised type gR/UR (semiconductor) fuses fitted as standard. Fuses must be selected to protect circuits with a maximum 200kA prospective symmetrical short circuit capacity.

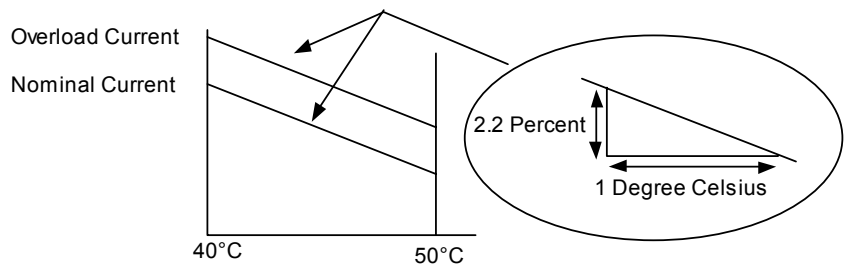


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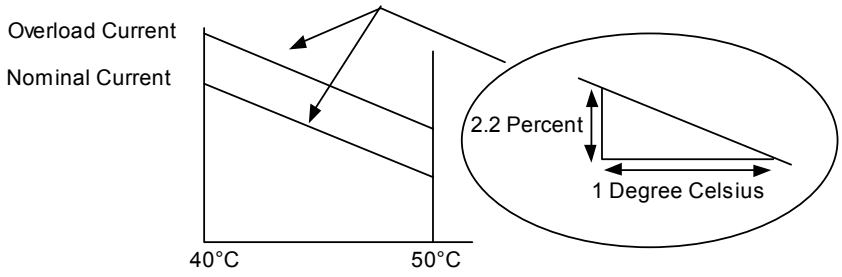
Figure 2.3: Elite Series 500V Variable Torque Ratings

ELITE SERIES 500V CONSTANT TORQUE @ 104°F (40°C)									
ENCLOSURE RATING	FRAME	ITEM	I [A]	3 Phase Supply		Overload I [A] 60 Seconds Maximum	Recommended Cable Size per Phase: (Note 7)		Fuses per Phase (A) (Note 8)
				MOTOR HP 460V	MOTOR HP 230V		AWG/kcmil	mm^2	
Nema 12 IEC IP54	1	ME002D54	2.5	1	0.5	3.7	14 to 12	2.5 to 4	6
		ME006D54	6	3	1.5	9	12 to 10	2.5 to 4	16
		ME009D54	9	5	2	13.5	12 to 10	2.5 to 4	25
		ME011D54	11	7.5	3	16.0	10 to 8	4 to 6	32
	2	ME016D54	16	10	5	24	10 to 8	4 to 6	40
		ME021D54	21	15	7.5	31.0	10 to 8	4 to 6	50
	3	ME030D54	30	20	10	45	8 to 6	6 to 10	80
		ME035D54	35	25	10	52	6 to 4	10 to 16	100
		ME041D54	41	30	15	61	4 to 3	16 to 25	100
Nema 12 IEC IP54 Electronics Enclosure	4	UE060D54	60	40	20	90	3 to 1	16 to 36	150
		UE075D54	75	50	25	112	1 to 1/0	25 to 50	200
		UE090D54	90	60	30	135	1/0 to 3/0	25 to 50	200
		UE115D54	115	75	40	172	2/0 to 4/0	50 to 95	300
		UE140D54	140	100	50	210	4/0 to 250	70 to 120	300
Nema 12 IEC IP54 Electronics Enclosure	5	UE170D54	170	125	60	255	3/0 to 300	95 to 150	350
		UE205D54	205	150	75	307	250 to 400	120 to 240	350
		UE250D54	250	200	100	375	350 to 500	185 to 240	350
	6	UE305D54	305	250	125	457	2 by 500	2 by 240	2 by 350
		UE370D54	370	300	150	555	2 by 500	2 by 240	2 by 350
		UE440D54	440	350	150	660	2 by 500	2 by 240	2 by 350
		UE540D54	540	450	200	810	2 by 500	2 by 240	2 by 350
	7	UE620D54	620	500	250	930	3 by 500	3 by 240	3 by 350
		UE700D54	700	600	300	1050	3 by 500	3 by 240	3 by 350
	Parallel Ultradrive Elites	UE760D54	760	600	Not available as 230V	1140	4 by 500	4 by 240	4 by 350
		UE930D54	930	680		1395	4 by 500	4 by 240	4 by 350
		UE1070D54	1070	845		1605	6 by 500	6 by 240	6 by 350
		UE1200D54	1200	952		1800	6 by 500	6 by 240	6 by 350

Note 1:	Supply Voltage (V_{in}) - 440Vac to 500Vac (-10% to +10%). Supply type - 3 phase earthed neutral.
Note 2:	Frames 1 - 4 are UL/cUL approved for 230 & 380 - 480Vac. 230V option must be specified at time of order. Frames 5 to 7 and Parallel drives are UL/cUL approved 380 - 500Vac. 230V options where available as a special will not be UL certified.
Note 3:	HP ratings are based on typical 4 - pole ratings only. **Check your motor specification before selecting**.
Note 4:	Parallel Ultradrive Elites require the motor to be connected in "Inside Delta".
Note 5:	By reducing the maximum **overload time to 30 seconds**, the table above can be used for Constant Torque current ratings at 122°F (50°C).
Note 6:	To maintain a 60 second overload above 104°F (40°C) use a derating factor of 2.2 % per degree Celsius **for nominal and overload current to a maximum of 122°F (50°C)**.
Note 7:	Cable sizes are stated for copper cables. For compliance with UL/cUL, use copper cables only. Frame 1 minimum cable size is 10AWG (5.3mm^2) for UL/cUL compliance.
Note 8:	**Frames 1 & 2** input fuses must be of type gG (distribution) or gR/UR (semiconductor). **Frames 3 & 4** input fuses must be of type gR/UR (semiconductor). **Frames 5 to 7 and Parallel drives** have UL recognised type gR/UR (semiconductor) fuses fitted as standard. Fuses must be selected to protect circuits with a maximum 200kA prospective symmetrical short circuit capacity.



4202-430 Rev B

Figure 2.4: Elite Series 500V Constant Torque Ratings

3 DESCRIPTIONS

3.1 DESCRIPTION OF THE ELITE SERIES HARDWARE

3.1.1 OVERVIEW

The Elite Series range is a family of advanced AC induction motor controllers, presented in seven frame styles. All models are available with IP54/NEMA12 ingress protection rating, suitable for installation in an environment where dust and splashing water may be present.

Ensure the correct model was specified for the intended environment. For detailed dimensional drawings, refer to Figures 3.1 to 3.3. An electrical overview is shown in Figure 3.4.

Full details of mounting are provided in Section 5.

3.1.2 POWER CONVERSION

Key electrical circuit elements of the Elite Series range are shown in Figures 3.5a to 3.5d.

AC power is fed to the Elite Series input via external input fuses. Here it is rectified to DC, filtered by chokes and capacitors and reconverted ("inverted") to AC current at the appropriate frequency, phase and voltage to supply the motor.

DC bus terminals are provided for connection of dynamic braking modules or direct supply from a DC source (external soft charge needed for DC supply).

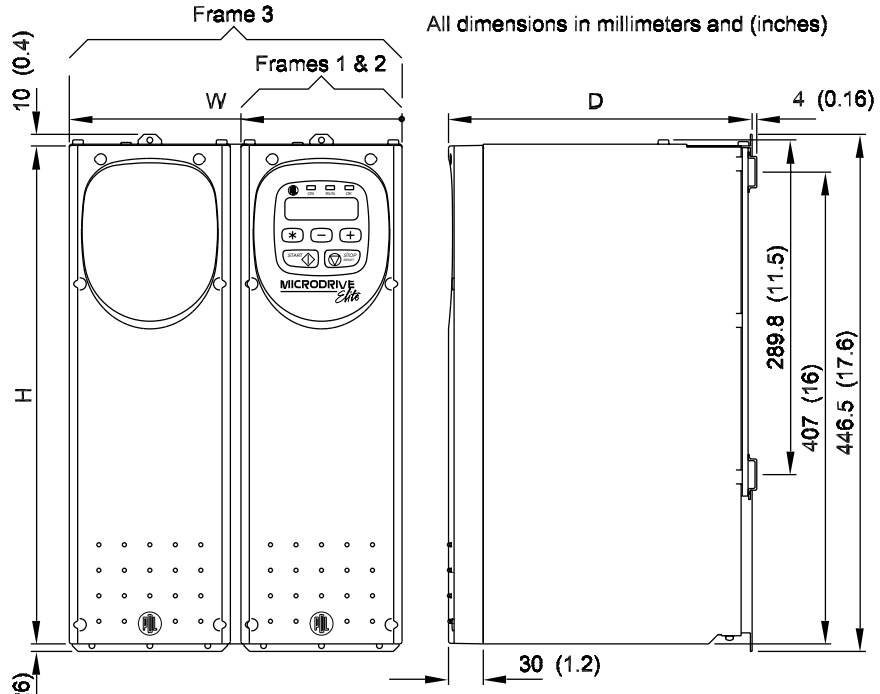
3.1.3 CONTROL BOARD

The control processor (control board) is supplied from the DC bus via a DC to DC converter. In this way the control system uses the DC bus to provide brief energy storage to achieve significant immunity to small mains supply interruptions or variations. Provision is made for energising of the control board from an external power supply.

A Display Unit (3 LEDs, 16 x 2 character alphanumeric display, 3 keys, and START and STOP-RESET push-buttons) provides the primary user interface to the Elite Series. Detail follows in Section 3.1.4. The Elite Series can be configured from this Display Unit. Alternatively custom configuration can be achieved by use of the external PDL Vysta® for Windows software package, on a PC running Microsoft Windows.

The push-buttons can be configured to be inactive, or to provide stand-alone START/STOP-RESET control.

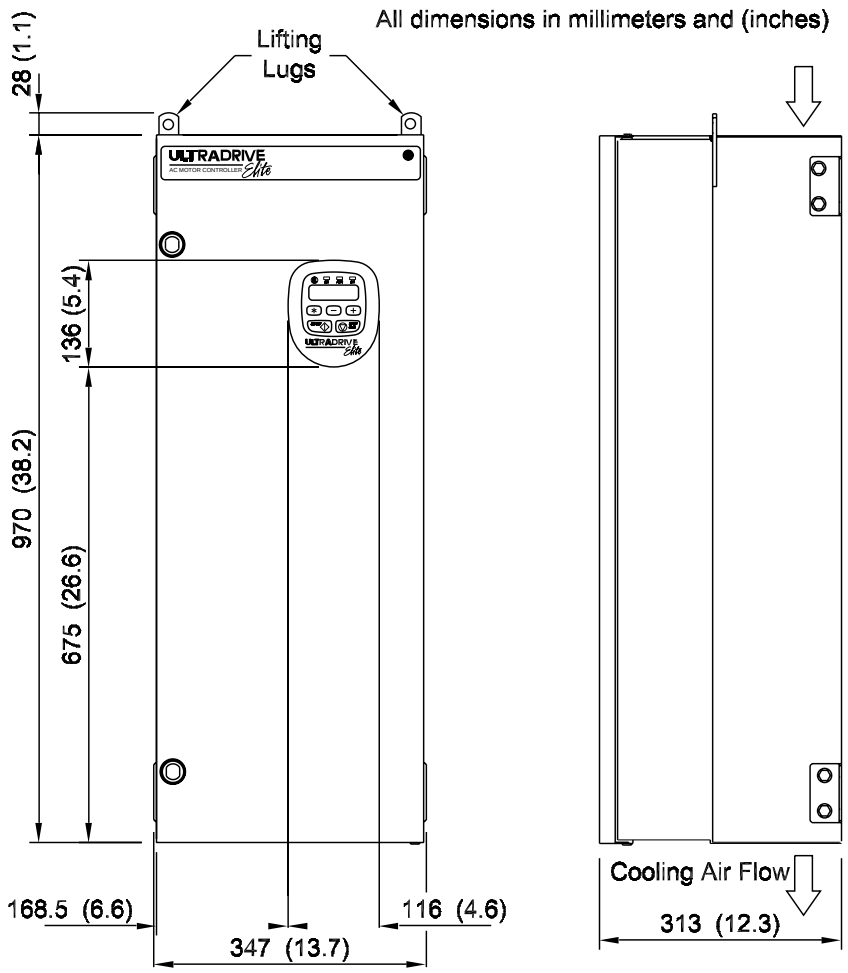
Analogue and digital inputs and outputs are provided as detailed in Section 3.1.5.



	MODEL		H	W	D	Net Weight
	400V	500V	mm (inches)	mm (inches)	mm (inches)	Kg (lbs)
FRAME 1	E002	ME002D54	430 (17)	139 (5.5)	262 (10.3)	10 (22)
	E006	ME006D54				
	E010	ME009D54				
	E012	ME011D54				
FRAME 2	E018	ME016D54	430 (17)	139 (5.5)	262 (10.3)	14 (31)
	E022	ME021D54				
FRAME 3	E031	ME030D54	430 (17)	279 (11)	262 (10.3)	27 (60)
	E038	ME035D54				
	E046	ME041D54				

4808-013 Rev M

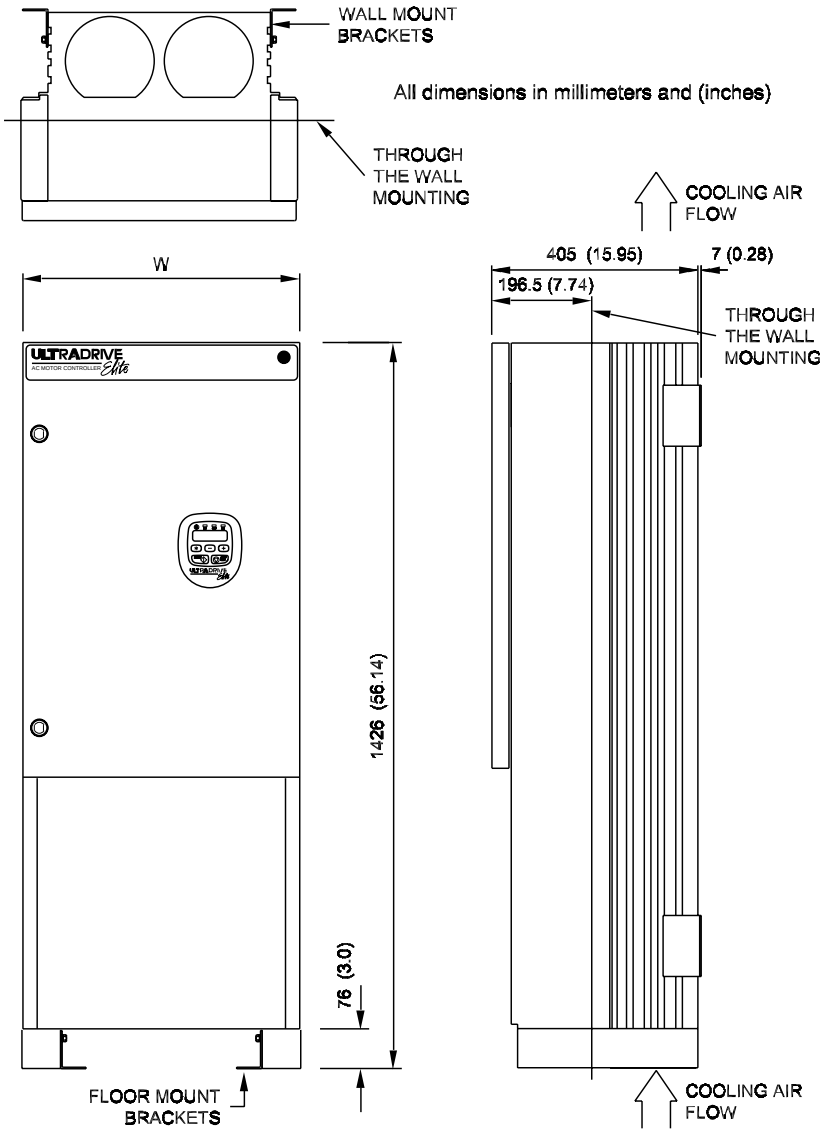
Figure 3.1: Microdrive Elite Series Dimensions



	MODEL		Net Weight Kg (lbs)
	400V	500V	
FRAME 4	UE060C54	UE060D54	73.5 (162.04)
	UE075C54	UE075D54	73.5 (162.04)
	UE090C54	UE090D54	77.5 (170.86)
	UE115C54	UE115D54	80.5 (177.47)
	UE140C54	UE140D54	80.5 (177.47)

4808-090 Rev I

Figure 3.2: Ultradrive Elite Frame 4 Dimensions



	MODEL		W	Net Weight
	400V	500V	mm (inches)	Kg (lbs)
FRAME 5	UE170C54	UE170D54	545 (21.5)	160 (353)
	UE205C54	UE205D54		
	UE250C54	UE250D54		175 (386)
FRAME 6	UE305C54	UE305D54	965 (38)	320 (705)
	UE370C54	UE370D54		
	UE440C54	UE440D54		350 (772)
	UE540C54	UE540D54		
FRAME 7	UE620C54	UE620D54	1385 (54.6)	566 (1248)
	UE700C54	UE700D54		

4808-099 Rev G

Figure 3.3: Ultradrive Elite Frames 5 to 7 Dimensions

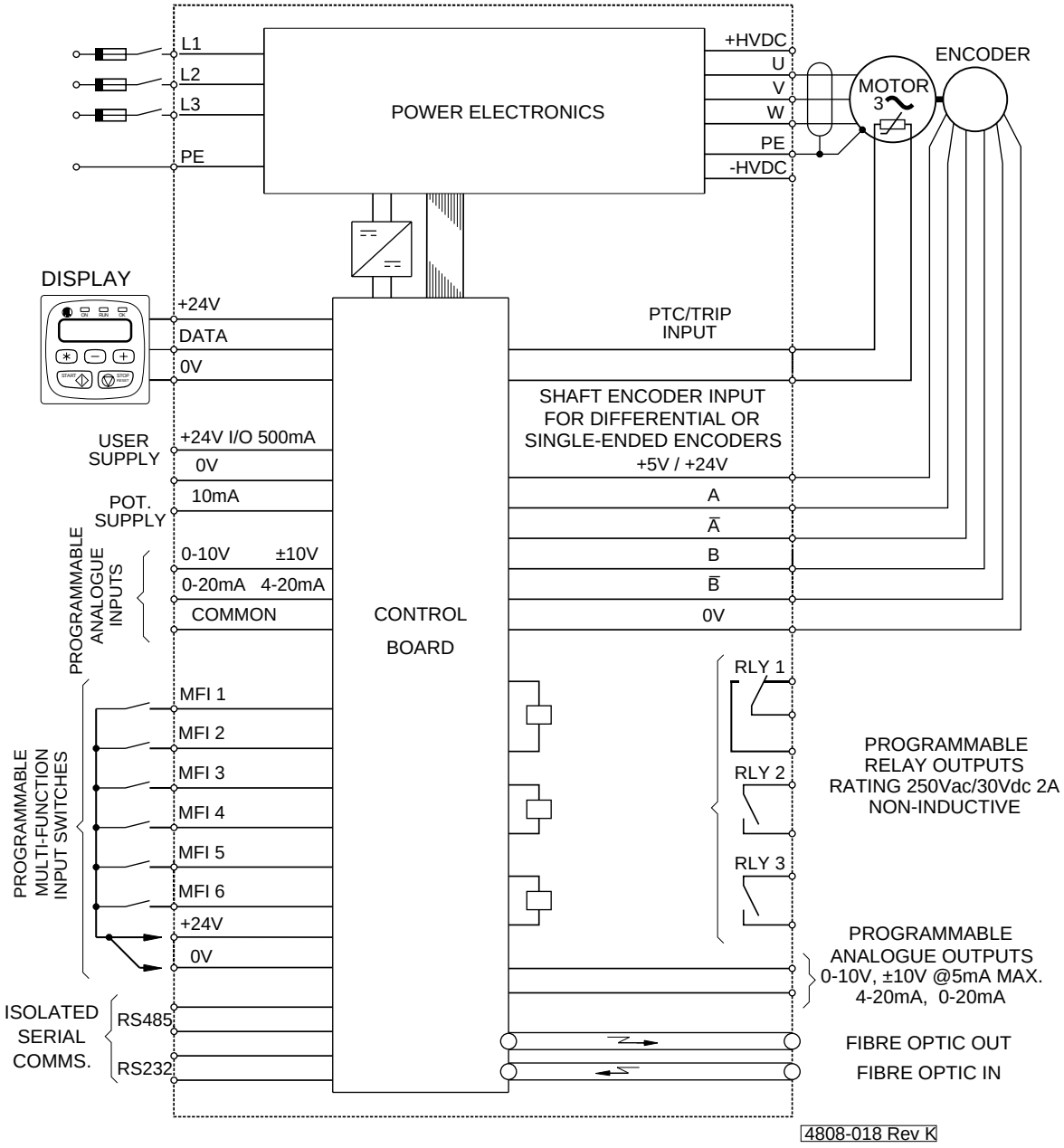


Figure 3.4: Elite Series Electrical Overview

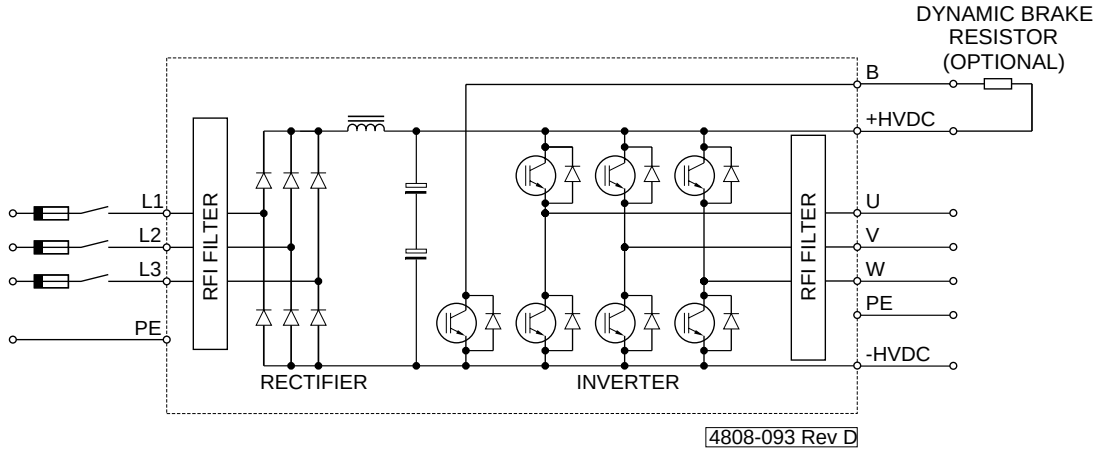


Figure 3.5a: Power Electronics - Microdrive Elite Frames 1 & 2

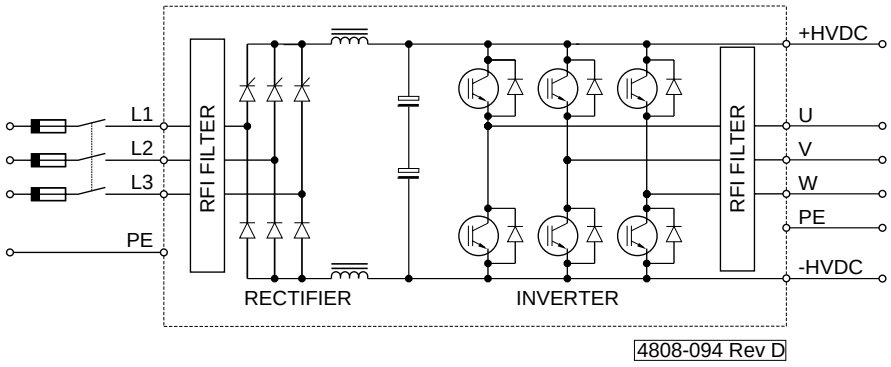


Figure 3.5b: Power Electronics - Microdrive Elite Frame 3

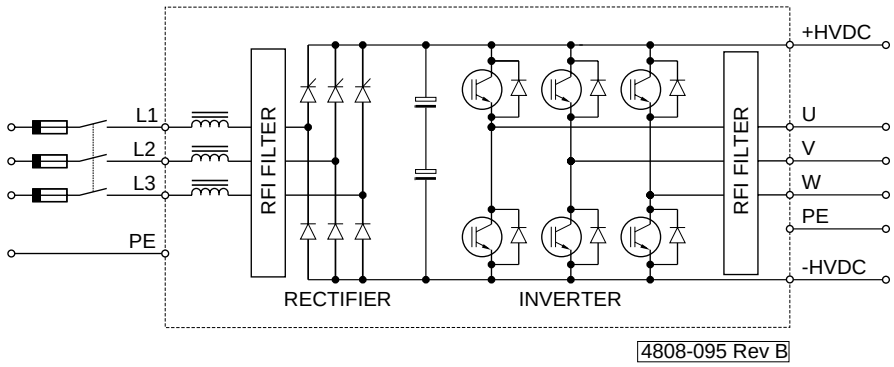


Figure 3.5c: Power Electronics - Ultradrive Elite Frame 4

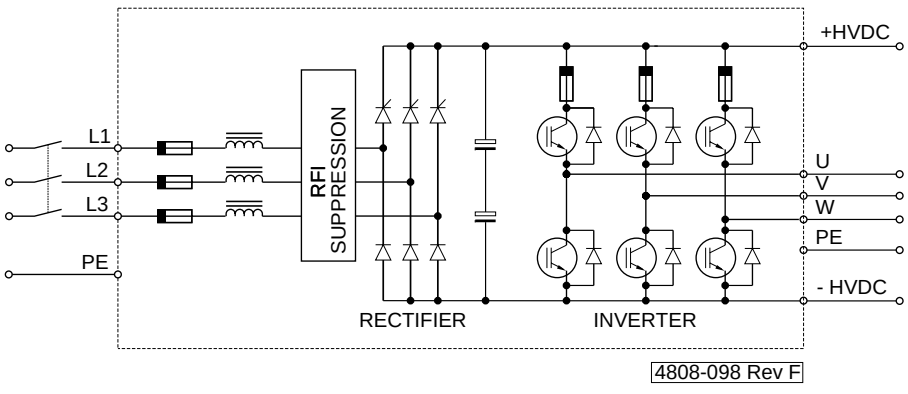


Figure 3.5d: Power Electronics - Ultradrive Elite Frames 5 to 7

3.1.4 CONTROL INPUTS AND OUTPUTS

Figure 3.6 provides the complete electrical specification of all Elite Series control inputs and outputs. Each input and output is individually described below. Further information (including specific examples of connection) is presented in the detailed descriptions of the relevant control screens.

Terminals T1 to T7 - Configurable Relay Outputs

These are low power relay contacts offering operation at signal or 250Vac levels (referenced to the protective earth - PE). Selection of their function is made through screen group O. Avoid settings which cause the relays to switch excessively as this will reduce their life expectancy. The software places a 250ms minimum pulse width to prevent relay chatter.

Terminals T8, T9 - Dynamic Brake Control

If a dynamic brake is to be installed in conjunction with the Elite Series, it can be controlled from these terminals. For drives up to and including Frame 3, these terminals will be internally connected to the inbuilt dynamic brake transistor. Dynamic brake resistor thermal protection can be configured from screen group D.

Terminal T10 to T12 - Display Unit

The connections to the Display Unit are made via these terminals. The Display Unit may be removed from its position within the drive and be mounted remotely, The maximum allowable length of wiring is 3 metres.

Terminals T13 to T18 - Multi-function Inputs

The function of these inputs can be programmed from the keyboard, from screen group I. Alternatively they can be customised via the PDL Vysta® for Windows software running on a personal computer.

Their operating format may be set for active high or active low. These inputs are factory preset for active high operation (that is, they are internally connected to bias low). Sampling rate:4ms

Terminal T19 - External trip/Motor PTC

This is a digital input committed to causing a protective trip should the resistance between this terminal and the selected common exceed 2.1kOhms. This is characterised for a set of standard motor PTC thermistors. The operating mode of the input can be changed between active high and active low. Opening this circuit will always trip the Elite Series, removing power from the motor. Open this circuit in the event of a “loss of control” situation. Sampling rate: 4ms

Terminals T20, T21 - Input Switch 0V & +24Vdc Connections

These terminals provide a return point for the seven digital inputs connected to terminals T13 to T19. If active high is selected, the common points of the switches connect to Terminal T21. If active low is selected, the common points of the switches connect to Terminal T20.

Terminal T22 - Analogue Output 0V Connection

This 0V is a suitable return point for the two analogue outputs connected to Terminals T23, T24. This ground is internally linked to the other control grounds with the exception of T40.

Terminals T23, T24 - Configurable Analogue Outputs

These two analogue outputs may have their formats and sources configured. Formats can be 0 to 10Vdc, -10 to +10Vdc; 5mA max or 0 to 20mA or 4 to 20mA. Configuration is done from screen group O. Accuracy: ± 2%; Resolution: 8 bits.

Terminal T25 - Analogue Input 0V Connection

This 0V connection is a suitable return point for the two analogue outputs connected to Terminals T26, T27. This ground is internally linked to the other control grounds with the exception of T40.

Terminals T26, T27 - Analogue Inputs

These inputs are configurable as to their function, also their formats and scaling may be set. Formats can be 0 to 10Vdc, -10 to +10Vdc, 0 to 20mA or 4 to 20mA. Configuration is done from screen group I. Accuracy: ± 2%; Resolution: 10 bits.

Terminals T28, T29 - Potentiometer Supply

A 10mA constant current source provides up to 10Vdc for a 1k Ohm potentiometer.

Terminals T30 - +5Vdc

This terminal is provided for the encoder power supply. Maximum load is 100mA.

Terminals T31 to T34 - Incremental Quadrature Encoder Inputs

The Elite Series is designed to accept input from a standard quadrature encoder designed to operate from +5Vdc to 24Vdc and having single ended open collector outputs, push-pull open collector outputs, or differential logic driver outputs. This encoder is only required if operating in Closed Loop Vector control mode. The encoder type and pulses per revolution may be configured from screen group N.

Terminal T35 - Encoder 0V

This terminal is provided for the encoder power supply 0V return. This ground is internally linked to the other control grounds with the exception of T40.

Terminals T36, T37 - User 24Vdc In/out, 0V

These are provided for powering of user controls, encoder power supply or for back feeding a backup power supply to energise the control board in the event of mains failure. This output is fuse protected.

Max. output current capability:	500mA
Min. input current capacity of backup supply:	1A.
Backup supply voltage:	24Vdc ±10%

Terminals T38 to T42 - RS232 / RS485 Connections

These terminals are provided for serial communications connections, for control, monitoring or configuration from a PC or other remote host. These terminals are optically isolated from the Elite Series potential.

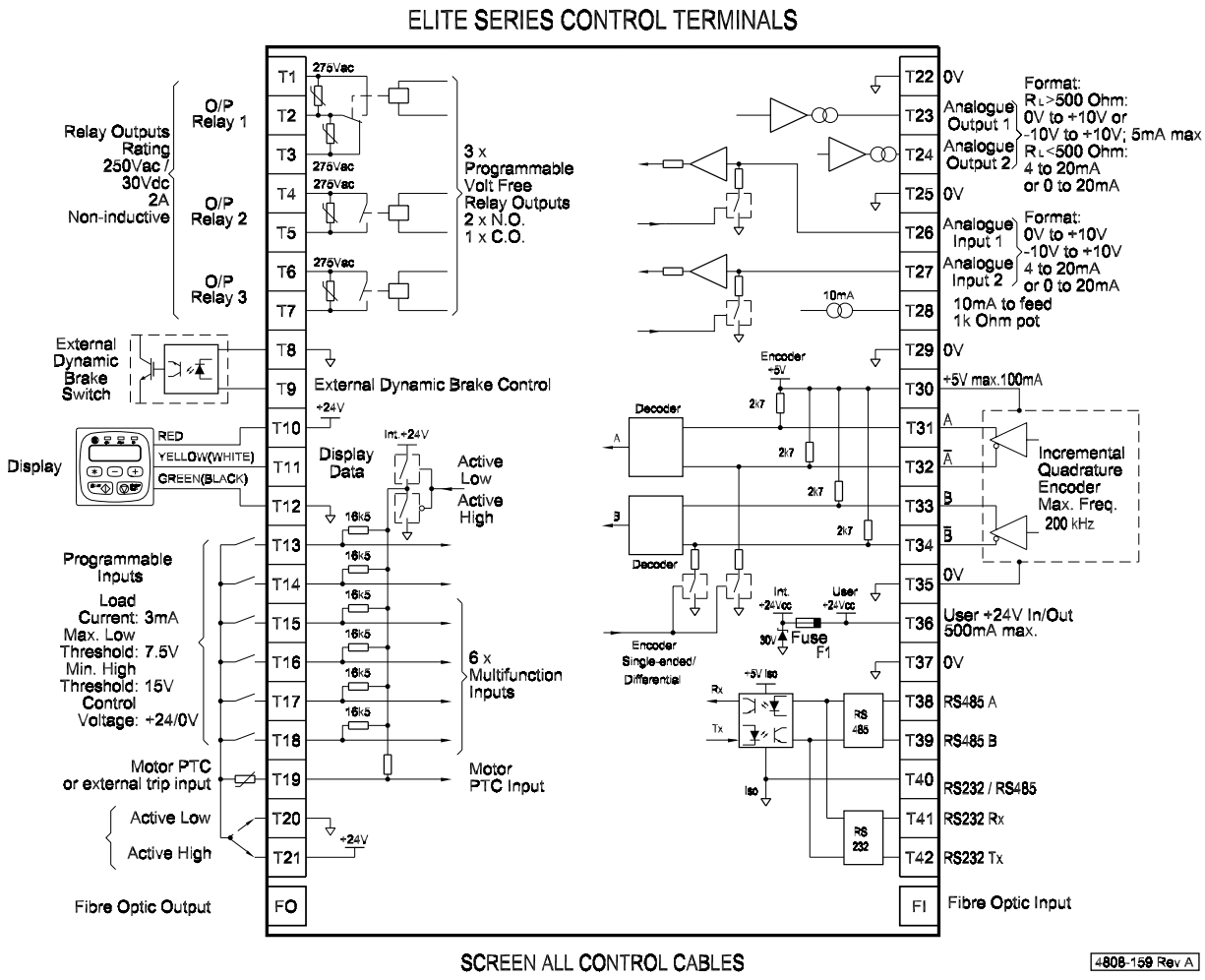


Figure 3.6: Elite Series Control Terminals

IMPORTANT NOTES REGARDING RELIABILITY OF CONTROL CIRCUITS

Screening

Screening - it is essential that all control inputs and analogue outputs are screened. There are no exceptions if you expect reliability!

Cable Separation

Do not run control signals together with power input or output cables to the motor - space at least 300mm away, and cross at right angles.

Relay Signals

Output relay signals do need to be screened. If power switching, do not include output relay signals in the same screened cable with control signals. Do not overload relays.

Switch Inputs

Switch (multifunction) Input circuits are designed for 24Vdc operation. Do not apply any other voltage.

Earthing of Control 0V

To comply with the requirement of a Class 1 earthing system, the Elite Series control 0V must be linked to earth at some point. Connection of multiple earth points may cause earth loops and should be avoided. An earth link is provided, and must be removed if not required. Removal will allow the 0V point to float up to ±50Vdc (30Vac) from chassis earth.

3.2 DESCRIPTION OF THE ELITE SERIES CONTROL SYSTEM

3.2.1 STRUCTURE OF THE INPUTS AND OUTPUTS

The following descriptions refer to figure 3.7.

Analogue Inputs

Two analogue inputs are provided. The format and scaling of these inputs are configurable from the front panel.

The format of each is configurable by screens I6a, I6d, without links, to be 0 to 10Vdc, -10 to +10Vdc, 0 to 20mA or 4 to 20mA.

Analogue Processing - Screen I6g may be used to introduce a zero baud to the analogue signal. This is used to ease setting of absolute zero values. Scaling determines the percentage (of motor speed or torque) demanded by the minimum and maximum settings. This is done by screens I6b, I6c, I6e, and I6f.

Outputs

Potentiometer Supply - A 11mA constant current source provides 10V to a 1kOhm potentiometer.

Relay Outputs - Each of three relay outputs may be controlled from a large number of sources using screens O2a, O2c, O2e. Each may be individually inverted. RLY1 is of changeover configuration, RLY2 and RLY3 have normally open contacts.

Analogue Outputs - Each of the two analogue outputs can have its source, format and scaling configured from the display unit. Each analogue output can have its format configured, with a choice of 0 to 10Vdc (unipolar), -10 to +10Vdc (bipolar), 0 to 20mA or 4 to 20mA using screens O1a to O1h.

Comparator

Comparator - Two software comparators allow relay outputs to respond to analogue levels. The comparators may be individually selected to any analogue output source. Individual ON and OFF levels may be set. A window function may also be selected. Configuration is by screens C1 to C6.

Switch Inputs - Multi-Function Inputs

Switch Inputs - Six switch inputs are provided. These inputs set digital levels and are collectively known as Multi-function Inputs (MFI).

The multi-function inputs are factory set from the Display Unit to bias low for active high switching, which is considered to be a "fail-safe" mode. Alternatively the inputs may be set for active low switching using screen I7b.

The six multi-function inputs perform control functions according to the input mode selected on screen I7a. When certain modes are selected the function of some (or all) of the inputs may be individually programmed to act as one of a wide range of possible controls, by use of screens I7c to I7h.

The switch inputs are processed together with keyboard controls (and set point references - multi-references) to provide a number of internal digital controls as well as the control of two analogue reference signals (motorised potentiometer and multi-reference).

3.2.2 STRUCTURE OF THE MOTOR CONTROL SYSTEM

Referring to Figure 3.8, **unless the Elite Series is operating in V/Hz mode**, the structure of the Elite Series control system may be considered as a torque controller, (the flux vector control system), the input of which selects either a speed referencing or torque referencing processor. This torque controller may be operated with a shaft encoder mounted on the motor for the best response and low speed operation. Alternatively it may be used without an encoder (Open Loop Mode control mode) for less critical applications.

The Flux Vector (Torque) Controller

Unlike conventional AC motor speed controllers, the Elite Series is primarily a torque control system. The flux vector control method requires complete knowledge of motor parameters, together with feedback of the rotor shaft speed. A high resolution encoder fixed to the motor shaft directly feeds back accurate indication of motor speed. This is scaled according to the pulse per revolution rating of the encoder (typically 2000 ppr) and the motor rated speed. The encoder additionally feeds back speed to the speed control loop, and overspeed protection override.

To ensure accurate operation, all the motor and shaft encoder parameters must be entered using the N screen group. Also vector loop tuning parameters (the X screens) must also be entered. The X screens can most easily be set up by using the autotuning facilities available (screen X2).

Open Loop mode operation is also available, where a motor shaft encoder is not used. A reduction in performance may be expected when running in this mode. Torque control is not available when operating in Open loop Mode.

The source of the torque demand reference is selected according to the desired (speed or torque) operating mode. The torque reference is subject to overspeed limits set on screens L2 and L3, and minimum and maximum torque limits set on screens L4 and L5.

Additionally a special torque limit (L8 MAX REGEN) is provided which controls the maximum level of regenerated power.

Torque Reference Processing

The torque set point may be selected from eight possible torque references. Additionally a second alternative reference selection may be made. The chosen torque set point may optionally be inverted. Minimum and maximum torque limits are provided. An optional torque filter completes the processing. The torque set point is then routed to the flux vector controller source selector.

Speed Reference Processing

The speed set point may be selected from eight possible sources. Additionally a second alternative reference selection may be made. The chosen speed reference may optionally be inverted. At this point the speed set point may be overridden by fixed speed demands such as inch references.

Minimum and maximum speed limits are provided followed by Skip speeds (set by screens L10 to L12) to allow the user to avoid mechanical resonances. The speed set point is then processed by the acceleration, deceleration and speed filter controls according to various rate (R) screen settings.

As the flux vector controller is a torque control system, the speed control signal cannot be applied directly to the vector controller. Instead it must be applied to a speed feedback loop, the output of which is a torque demand. Thus, the speed set point is finally applied to a PID speed controller. The set point is compared to the actual speed, fed back from the shaft speed encoder. The resulting torque command signal is routed to the flux vector controller source selector.

Process Control

The inclusion of a full three term PID regulator allows the Elite Series to perform process control (e.g. constant pressure pumping etc.). External auto/manual selection is also available to assist during start-up conditions. Refer to Figure 3.9.

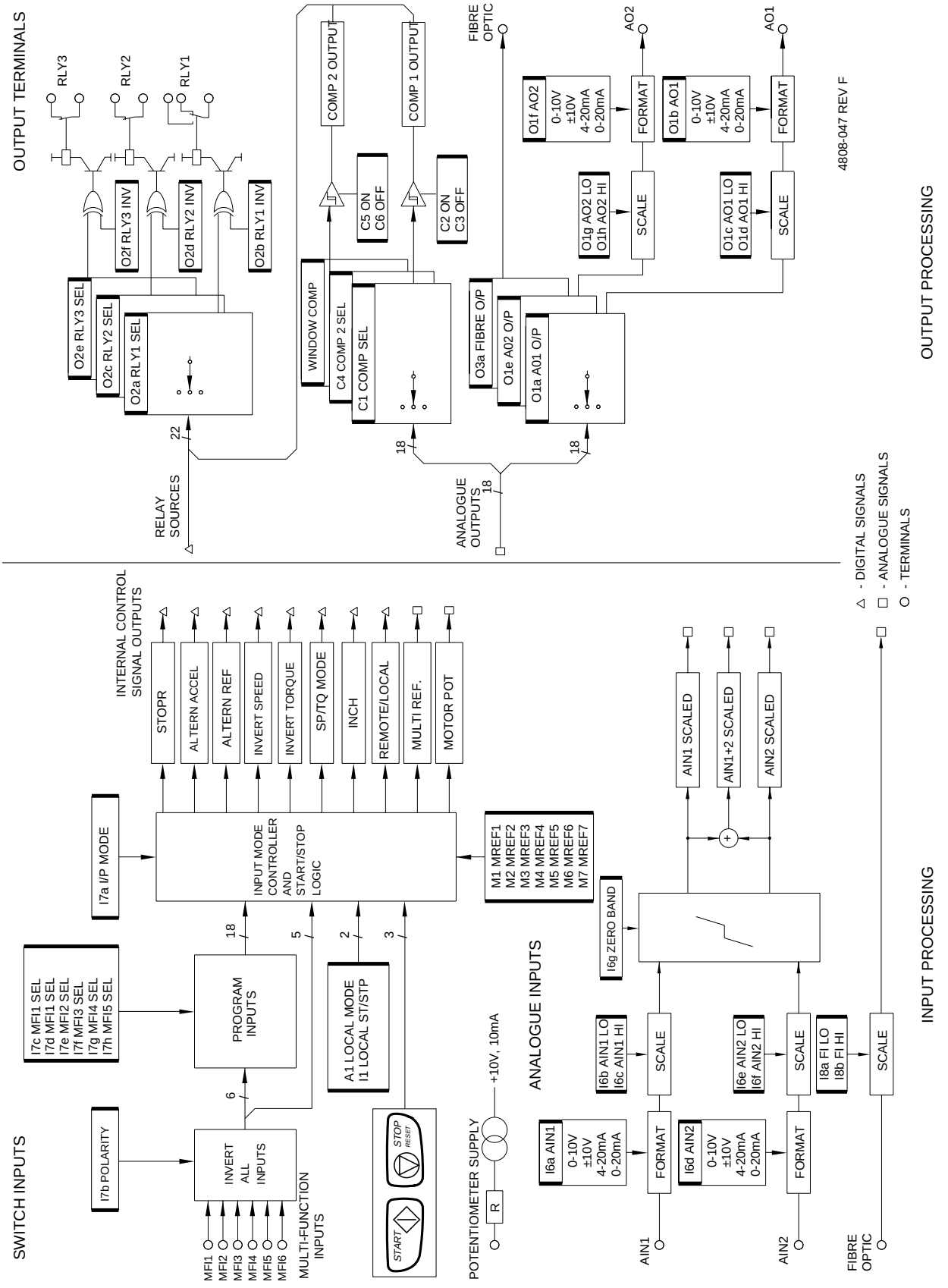


Figure 3.7: Structure of the Elite Series Input/Output Processing System

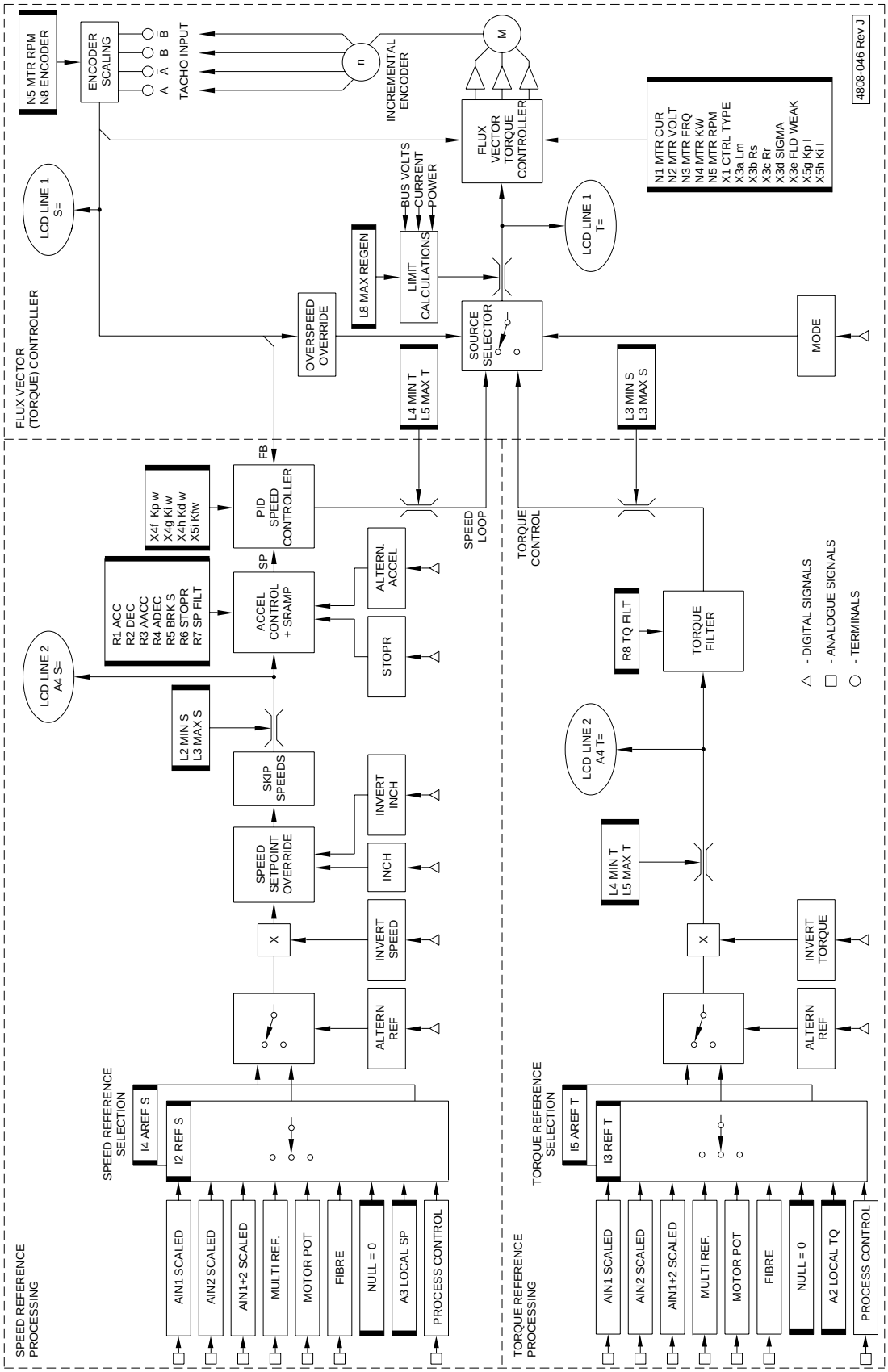


Figure 3.8: Structure of the Elite Series Motor Control System

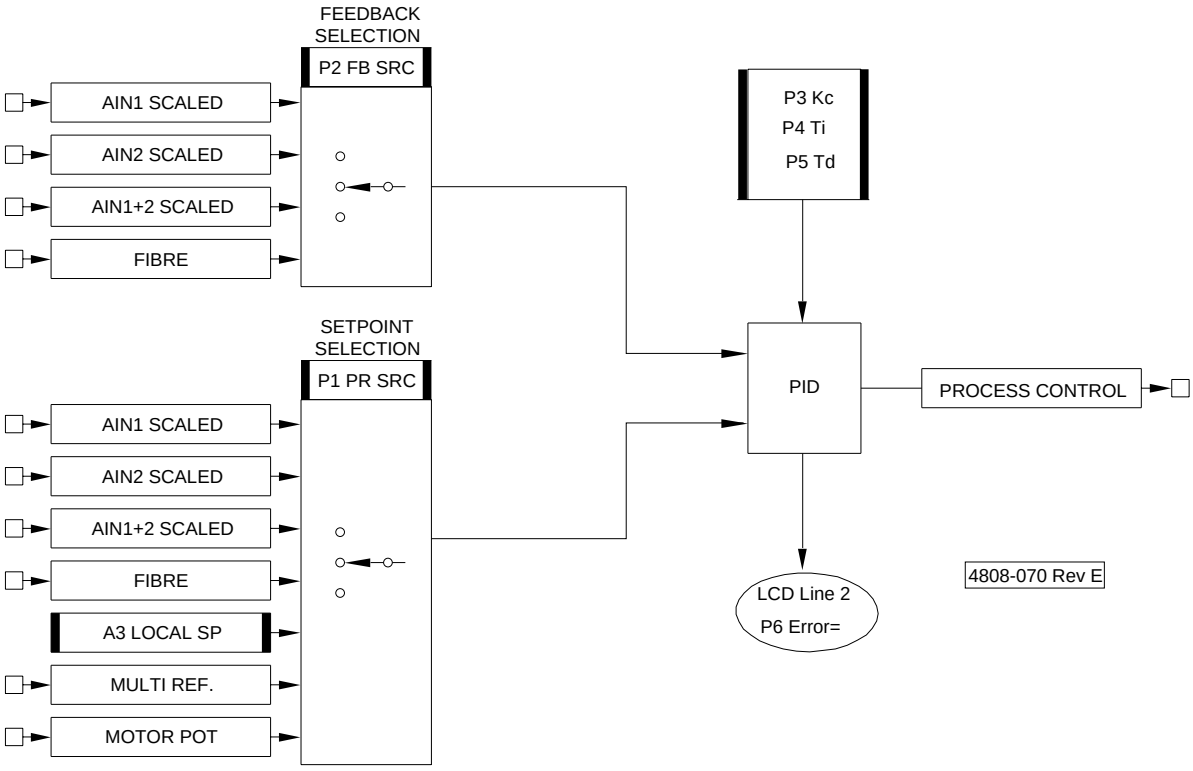


Figure 3.9: Process Control

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4 APPLICATION RECOMMENDATIONS

4.1 THE MOTOR

4.1.1 SIZING THE MOTOR AND ELITE SERIES

The Elite Series is suitable for controlling all standard three phase induction motors. In sizing the Elite Series, the torque requirements of the load must first be assessed. Under flux vector control conventional induction motors are able to provide at least 200% of rated torque (often 250%). Choose a motor capable of supplying the required torque and a Elite Series capable of supplying the motor's current requirements.

In applications requiring high peak torques, the Elite Series is required to supply current approximately in proportion to the torque. The Elite Series should be chosen according to its short term overload limit of **150%** (30 seconds).

Note: Figure 4.1 is presented as a guide only. Refer to Figures 2.1 and 2.2 for the 400V ratings and Figures 2.3 and 2.4 for the 500V ratings.

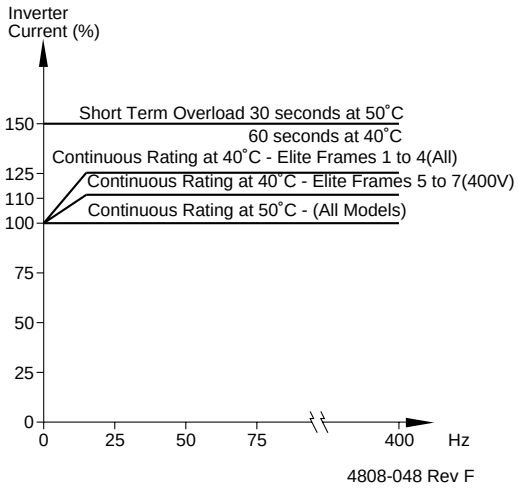

Figure 4.1: Elite Series Thermal Overload Characteristics

In applications operating continuous loads or providing significant torque at low speeds, the motor must be chosen on a basis of continuous dissipation. It may be necessary to oversize, or force cool the motor for applications operating with significant torque at low speeds (Figure 4.2). In such applications the Elite Series should be chosen according to its continuous rating.

For pump and fan applications having a quadratic torque requirement where a high overload margin is not usually required, the Elite Series may be re-rated according to Figures 2.1 and 2.3, if the Elite Series is to be operated in an environment of an ambient temperature not exceeding 40°C.

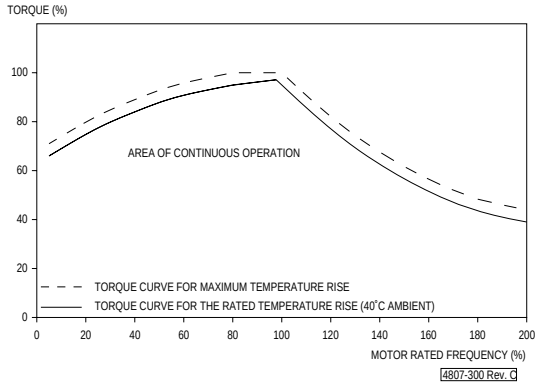

Figure 4.2: Typical Motor Thermal Derating

4.1.2 OPERATION ABOVE MOTOR RATED SPEED

The Elite Series can be operated above motor rated speed in V/Hz and closed loop mode only, however the torque that is able to be generated declines (1/f) as there is insufficient voltage to provide correct stator flux. The torque response also reduces significantly in this mode of operation for the same reasons.

Check that the motor is suitable for operation above rated speed. Consult the motor manufacturer.

A popular solution to achieve a wider speed range is to reconfigure the motor for lower voltage operation (e.g. connect a 400Vac star motor as a 230Vac delta , or specially wind the motor). Full performance is achieved at increased speeds (until the supply voltage is reached), at the penalty of increased motor current.

4.1.3 OPERATION OF MORE THAN ONE MOTOR

When running the Elite Series in Open or Closed Loop mode, operation of more than one motor from the Elite Series is generally impractical. In certain applications utilising identical motors with identical loads (e.g. load sharing or mechanically locked) connection of more than one motor may be possible.

When running the Elite Series in V/Hz Mode, it is possible to run more than one motor in parallel off one Elite Series. If running parallel motors, the rating of the Elite Series should exceed the sum of the individual motor currents. Each motor will require individual thermal protection. Performance will be reduced.

4.1.4 THERMAL PROTECTION OF THE MOTOR

The Elite Series maintains a thermal model of the motor as its primary means of detecting overload and providing protection. Nevertheless the use of a temperature protecting PTC embedded in the motor windings provides ultimate protection and is recommended. The thermal model will not be effective if the Elite Series is running more than one motor.

4.1.5 LARGE FRAME-SIZE MOTOR CONSIDERATIONS

Large frame-size motors (typically greater than 315 frame) have additional installation requirements when used with AC motor controllers. These motors may exhibit rotor voltage build-up due to parasitic capacitance. Unless protective measures are taken, this voltage may discharge through the anti-friction bearings possibly leading to degradation of the bearing via electrical discharge machining (EDM).

The preferred solution is to fit insulated bearings (or an insulated bearing housing) with a rotor earthing brush. Careful selection of the rotor earthing brush is required, as this brush must provide a low impedance earth for high frequency pulses. Rotor shaft earthing brushes are now commercially available to suit this low voltage, low current application. These brush systems are designed for long life with minimal maintenance. Contact PDL Electronics Ltd or its agent for further information on suitable earthing brushes. An alternative solution is available from PDL Electronics in the form of PDL's EDM Filter. The EDM filters out the common mode voltage applied to the motor. Contact PDL Electronics or its agent for further information on the EDM Filter.

4.2 THE ENCODER

4.2.1 CHOICE OF ENCODER

If the Elite Series is to be used in Closed Loop Vector control mode, a shaft encoder will need to be connected to the motor. A specification for a suitable encoder for a 50 or 60Hz motor is:

Encoder Type:

Incremental, quadrature (bi-phase), differential or single-ended output. Push-pull output preferred to maximise range.

Recommended ppr:

1000 to 2000 ppr per motor pole pair, for directly driven encoder.

Minimum ppr:

500 ppr per motor pole pair (4 pole motor = 1000 ppr).

Supply requirement:

5Vdc, 100mA maximum.

The shaft encoder should be fitted directly to the motor (using a flexible coupling) or indirectly via a toothed (zero slip) belt drive or similar. There must be zero slip or backlash, and high shaft loads or loose couplings must be avoided.

The encoder MUST be connected using shielded twisted cable. The shield should be earthed at the Elite Series end only, to avoid the possibility of earth loops. The maximum cable length is inversely proportional to the required maximum pulse rate. A push-pull output encoder gives a better range than a single ended open collector type, and is recommended for cable runs exceeding 30 metres. If using an open collector type of encoder, when wired with typical shielded cable with capacitance of 200pF/metre, the product of cable length (metres) x max. frequency (kHz) should not exceed 1500.

A differential output encoder has a high common-mode noise rejection capability, thus is **recommended** for electrically noisy environments. The encoder inputs to the Elite Series will also accept input pulses from an encoder operating off a supply up to 24Vdc.

4.2.2 CONNECTION OF THE ENCODER

The encoder orientation shown in the drawings in this manual (i.e., the connection of the A and B outputs) assumes the encoder is to be connected directly to the non-drive end (non-shaft end) of the motor and that motor wiring orientation is normal (motor terminals U1, V1 and W1 are connected to Elite Series terminals U, V, W, respectively). In this case, an increasing count (Screen Z9) should correspond to rotation in the positive direction (motor shaft rotates clockwise when the motor is viewed from the drive end), in response to a positive speed reference.

If the encoder direction is inverted (e.g., by mounting at the drive end or using an inverting belt coupling), A and B, or for a differential encoder, A and A signals should be swapped. Refer Figure 5.13.

4.3 SWITCHING

4.3.1 POWER SWITCHING

Generally it is better practice to leave electronic equipment (including the Elite Series) permanently connected to the mains supply. Switching the mains on and off to control the Elite Series is bad practice and should be avoided (use the control terminals). Mains switching must not occur more often than once every five minutes to avoid overheating the charging circuits.

4.3.2 MOTOR SWITCHING

Because the Elite Series acts as a variable frequency (including DC) current source :-

WARNING: Motor isolation **MUST NOT BE OPENED** while the Elite Series is running.

Although the Elite Series will not be damaged, standard industrial switchgear (AC1 or AC3) is not designed to operate at or near DC conditions, and there is great danger of damage or fire due to arcing under these conditions.

4.4 TORQUE AND SPEED CONTROL MODES

4.4.1 TORQUE CONTROL MODE

Unlike conventional AC motor speed controllers, the Elite Series is primarily a torque controlling device. When used in Closed Loop Vector torque mode, a reference torque demand signal sets the output torque level which the Elite Series will try to achieve from the motor. This level may be positive or negative and is quite independent of the motor speed (within speed limits). Web control systems which require constant tension applied to the web, regardless of speed, are a typical torque control application.

While in torque mode, speed limits are used to limit overspeed such as may occur from temporary loss of load (e.g. a web break in the above example). The speed reference signal is disregarded while in torque control mode.

To run in torque control mode, it is necessary to employ Closed Loop Vector control mode and use a shaft encoder on the motor.

4.4.2 SPEED CONTROL MODE

In Open Loop or Closed Loop vector mode PID settings are used to adjust the response of the speed control loop. Apart from this, speed control is implemented and settings made in a similar way to conventional AC drives.

A reference speed control signal sets the output speed which the Elite Series will try to achieve at the motor. The direction may be positive or negative, and is independent of load torque (within torque limits).

While in speed control mode, torque limits are used to limit over- torque such as may occur due to process changes or fault conditions.

For best performance in speed control mode, employ Closed Loop Vector control mode and use a shaft encoder on the motor. This gives improved speed regulation, faster dynamic response, and full torque capability at zero speed.

If such high performance is not required, Open Loop Mode or V/Hz control mode may be employed. In these modes a shaft encoder on the motor is not necessary.

4.4.3 SWITCHING BETWEEN TORQUE AND SPEED CONTROL MODES

When switched, transition from torque control mode to speed control mode and the inverse, is achieved without discontinuity (i.e. smoothly). **Torque Control mode may only be selected** when the Elite Series is used in Closed Loop Vector control mode.

4.5 DYNAMIC BRAKING

Regeneration is achieved through the motor being driven by the load (e.g. lowering crane hoists or rapid deceleration of high inertia loads). While being driven, the motor acts as a generator and energy is transferred back into the DC bus capacitors of the Elite Series. In its standard form the Elite Series can only dissipate this energy as losses and so can only provide limited braking of 5-10%.

Where higher levels of braking are needed, an additional dynamic brake module must be fitted. Dynamic brakes are controlled power switches which are used to dump energy from the DC bus into resistive loads. Generally such brakes and resistors must be sized to suit the requirements of the application according to considerations of both peak and continuous power dissipation requirements. Refer to the supplier for more information regarding specific dynamic brake modules, or to the dynamic brake manual if already supplied.

The Elite Series frame 1 to 2 models have a dynamic brake transistor built into the unit. Simply connect the appropriately sized resistor between the positive DC bus terminal "+" and the dynamic brake resistor terminal "B".

ELITE SERIES	DB RESISTOR MINIMUM (Ohms)	DB RESISTOR POWER RATING (MIN-kW)
E002	500	1.1
ME002D	500	1.4
E006	180	3
ME006D	180	3.8
E010	130	4
ME009D	130	5.3
E012	100	5.3
ME011D	100	6.7
E018	50	10.6
ME016D	50	13.5
E022	50	10.6
ME021D	50	13.5

Figure 4.3: Dynamic Brake Resistor Ratings (Typical)

For application advice on resistor sizing and cabling requirements please request assistance from PDL Electronics or its agent.

Dynamic Brake Resistor Wiring

Due to the high voltage switching and the currents involved, special wiring practices must be observed when connecting the dynamic brake resistor.

For the dynamic brake resistor connection a multicore cable with screen is recommended. Alternatively, two separate cables securely tied together at 200mm intervals without gaps between the cables may be used. This minimises the cable inductance. Keep the cable length to a minimum to reduce overall cable inductance.

The resistor bank MUST be of non-inductive construction.

Do observe normal wiring practices of separating control and power cables.

The dynamic brake resistor cable must have sufficient dielectric strength to withstand 1000 Vdc (conductor to conductor rating for multicore cables).

On the Elite Series, set screen D1 (DB Time Constant) to the time it would take to reach 64% of the resistor's final temperature if continuously energised.

Set screen D2 (DB Duty) to the average percentage of time that the resistor may be operated for.

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5 UNPACKING, INSTALLATION AND CONNECTION

5.1 UNPACKING

5.1.1 UNPACKING THE ELITE SERIES

Ensure that all of the items listed below are supplied, and that there is no visible damage.

Item 1: Elite Series motor controller

Item 2: 1 x Manual Pack containing the following:
1 x Elite Series Technical Manual - 4201-180
1 x Warning Label - 4101-403
1 x Form - Help Us To Improve - 4801-449

Item 3: Included with frames 1 to 3 only.
1 x Plastic Bag conaining the following:
Frames 1 & 2: 2 x Terminal Connectors - 3 pin
6 x White Blanking Plugs
2 x Rubber Grommets
Frame 3: 2 x Terminal Connectors - 3 pin
12 x White Blanking Plugs
4 x Rubber Grommets

If the Elite Series motor controller appears to be damaged, file a report with your carrier.

If any documentation is not present, contact your local PDL Electronics supplier or distributor.

5.1.2 DISPOSAL OF PACKAGING

All packaging materials made from cardboard and/or wood are able to be recycled at your local recycling centre.

5.2 MANUFACTURER'S RECOMMENDATIONS

Failure to adhere to the manufacturer's recommendations for installation, environmental conditions and electrical specifications may result in damage to the Elite Series (and/or external equipment) and may void the warranty.

5.3 INSTALLATION

5.3.1 INSTALLATION ENVIRONMENT

The ambient temperature of the installation location must not exceed 50°C (122°F). However the cleaner and cooler the environment, the longer the lifetime that can be expected from the unit. An ambient temperature below 40°C (104°F) is preferable, for longer component lifetime, and also to enable the Elite Series to have it's output current re-rated according to Figures 2.1 and 2.3 for motor speeds exceeding 25Hz. This is useful for pump and fan applications with quadratic torque requirements.

The internal components of the Elite Series IP54/NEAM 12 models are sealed from the cooling air and therefore are protected against an environment contaminated to pollution degree 2 (damp or dusty air).

Each Elite Series motor controller must have cooling air available and will contribute to heating the environment in which it is mounted. Details are given in Figure 5.1 from which the total cooling load should be calculated. Any air conditioning or ventilation system used in the plant room must be capable of handling this load, plus that caused by any other dissipative devices in the same room, while keeping the ambient air temperature below 40°C to 50°C (104°F to 122°F). The air delivery system must be able to handle the total calculated air flow, with allowance made for system back pressure.

Corrosive vapours or gases may interfere with the correct operation of Electronic equipment. These compounds may include fumigants such as methyl bromide, or gases such as sulphur dioxide, hydrogen sulphide or chlorine derivatives.

Consult PDL Electronics if there an any doubts about the environmental conditions this equipment may be operating in or subjected to.

As with all electronic equipment, the cleaner, cooler and more vibration free the environment, the longer and more trouble free will be the life of the Elite.

Not adhering to the above conditions will result in the warranty being void.

5.3.2 MOUNTING METHODS - MICRODRIVE ELITE SERIES

The Microdrive Elite Series range is designed for wall or switchboard mounting.

Allowable mounting methods are:

- Standard mounting - vertical, back to wall, with gland plate at bottom. Steel DIN rail mounting at top, screw fixing at bottom. Refer Figure 5.2a.
- Inverted mounting, with gland plate at top. Steel DIN rail mounting at centre, screw fixing at top. Refer Figure 5.2b.
- Vertical mounting, side to wall. Use extra mounting brackets.
- Horizontal mounting. Steel DIN rail mounting at centre, screw fixing at sides. Refer Figure 5.2c.

Allow 300mm of free air space vertically top and bottom to provide adequate ventilation. Avoid mounting inline above other units to prevent accumulated air heating.

5.3.3 MOUNTING METHODS - ULTRADRIVE ELITE FRAME 4

The Ultradrive Elite Series frame 4 is designed for wall or switchboard mounting (vertical upright). Do not invert. Refer Figure 5.3.

The mounting must be:

- Vertical, back to wall, with gland at bottom.
- 4 x M8 high tensile bolts must be used for fixing to wall. Note that eyelets are provided to allow prefixing of the mounting bolts before fitting of the Elite Series.
- Wall/switchboard gear plate must be designed for the weight of the Elite Series and power cables.

Allow 300mm of free air space above and below for adequate ventilation.

5.3.4 MOUNTING METHODS - ULTRADRIVE ELITE FRAMES 5 TO 7

The Ultradrive Elite Series frames 5 to 7 are designed for floor mounting only (vertical upright). Secure using the wall supports for earthquake protection. Allow 300mm of free air space above for adequate ventilation. Refer Figure 5.4.

FRAME SIZE	MODEL		DISSIPATION AT MAX CT LOAD	DISSIPATION AT MAX VT LOAD	COOLING AIR FLOW RATE
	400V	500V	(W)	(W)	(cubic m/hr)
F1	E002	ME002D	55	68	100-120
	E006	ME006D	140	165	100-120
	E010	ME009D	220	250	100-120
	E012	ME011D	250	290	100-120
F2	E018	ME016D	330	385	100-120
	E022	ME021D	465	560	100-120
F3	E031	ME030D	640	775	200-240
	E038	ME035D	780	925	200-240
	E046	ME041D	950	1080	200-240
F4	UE060C	UE060D	1100	1375	380-420
	UE075C	UE075D	1300	1630	380-420
	UE090C	UE090D	1600	2000	380-420
	UE115C	UE115D	2000	2500	380-420
	UE140C	UE140D	2500	3125	380-420
F5	UE170C	UE170D	2600	3250	800-1000
	UE205C	UE205D	3150	3850	800-1000
	UE250C	UE250D	3700	4500	800-1000
F6	UE305C	UE305D	4500	5450	1800-2000
	UE370C	UE370D	5000	6000	1800-2000
	UE440C	UE440D	6500	8000	1800-2000
	UE540C	UE540D	7800	9000	1800-2000
F7	UE620C	UE620D	9000	10200	2500-2700
	UE700C	UE700D	10200	12400	2500-2700
2 x F6	UE760C	UE760D	13000	16000	3600-4000
	UE930C	UE930D	15600	18000	3600-4000
2 x F7	UE1070C	UE1070D	18000	20400	5000-5400
	UE1200C	UE1200D	20400	25000	5000-5400

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Figure 5.1: Full Load Dissipation and Cooling Air Flow Rates

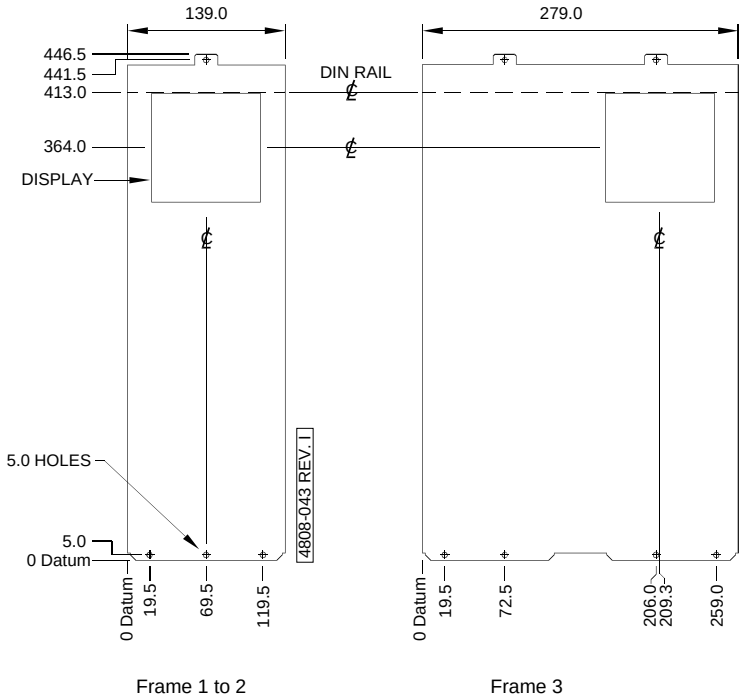


Figure 5.2a: Standard Mounting Details for Microdrive Elite Series

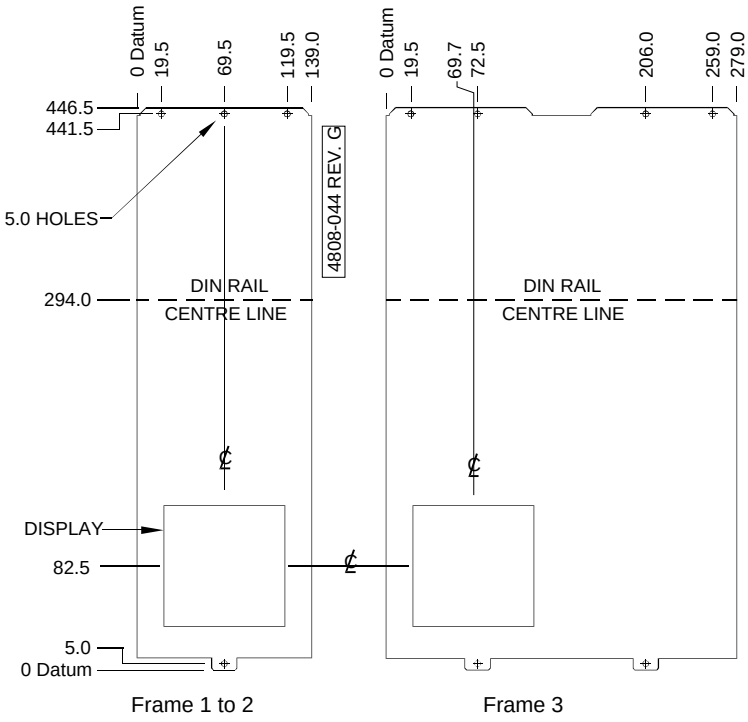


Figure 5.2b: Inverted Mounting Details for Microdrive Elite Series

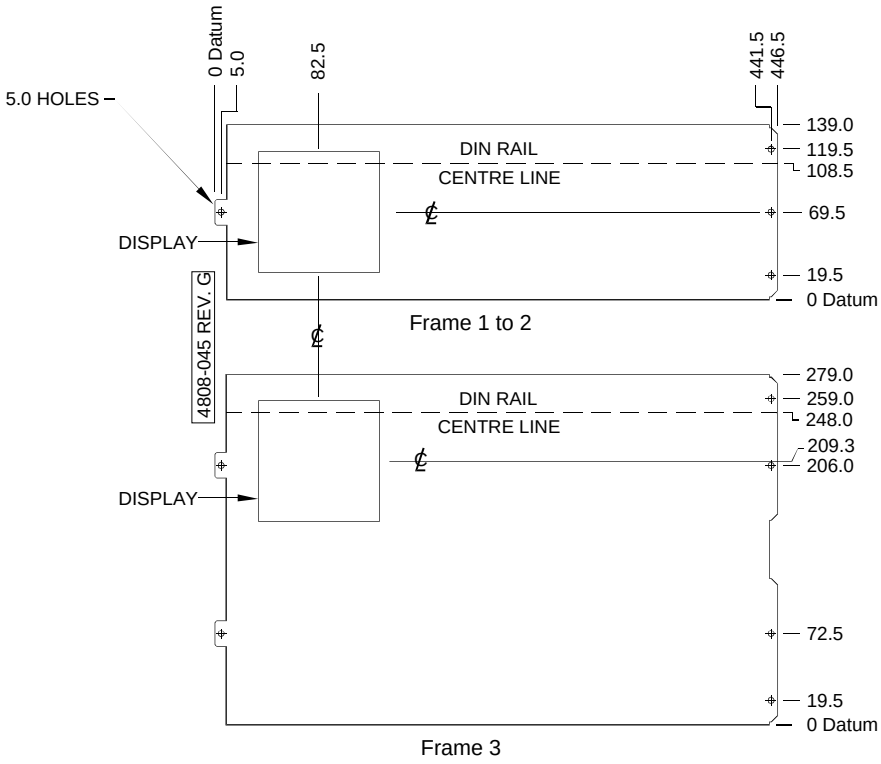


Figure 5.2c: Horizontal Mounting Details for Microdrive Elite Series

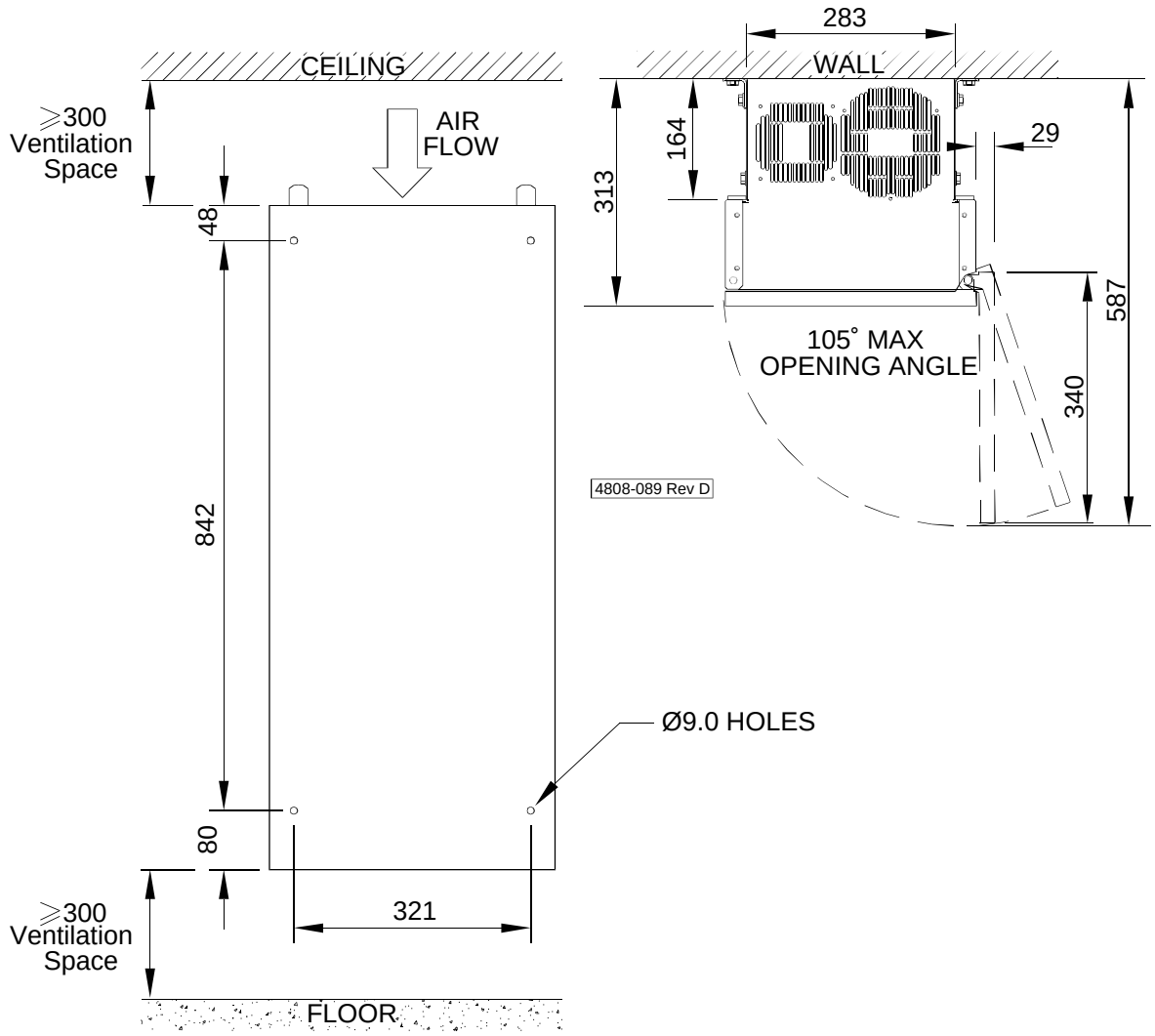
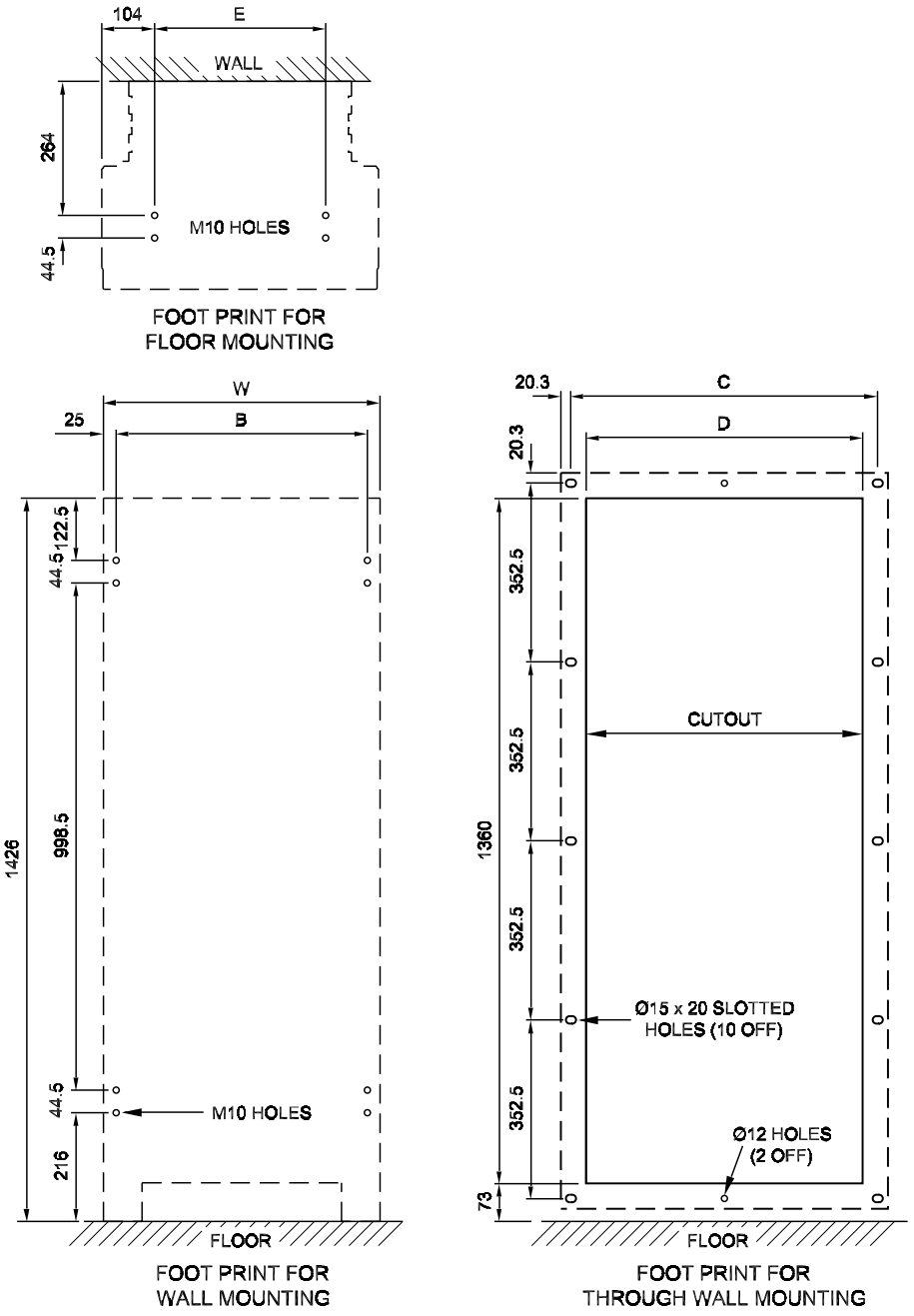


Figure 5.3: Ultradrive Elite Frame 4 Mounting Details



	MODEL		W (mm)	B (mm)	C (mm)	D (mm)	E (mm)
	400V	500V					
FRAME 5	UE170C54	UE170D54	545	495	605	555	337
	UE205C54	UE205D54					
	UE250C54	UE250D54					
FRAME 6	UE305C54	UE305D54	965	915	1025	975	757
	UE370C54	UE370D54					
	UE440C54	UE440D54					
	UE540C54	UE540D54					
FRAME 7	UE620C54	UE620D54	1385	1335	1445	1395	1177
	UE700C54	UE700D54					

4808-100 Rev E

Figure 5.4: Ultradrive Elite Frames 5 to 7 Mounting Details

5.4 CONNECTING THE ELITE SERIES

5.4.1 POWER WIRING CONNECTIONS

Figure 5.5 provides a summary of the required power connections. Note the following requirements:

1 The Elite Series is designed for operation from a three phase earthed neutral supply. Input fuses are required. Details of the recommended fuse size are given in Figures 2.1 to 2.4. In all cases, observe all site, local and national wiring and safety regulations. Harmonic and EMC suppression techniques used means that the Elite Series is designed only for connection to an industrial power supply, supplied by a dedicated distribution transformer. The Elite Series is not suitable for direct connection to a low-voltage public mains network which is shared with other premises.

2 Due to the high leakage currents inherent to AC drives, earth connection of both the motor and the Elite Series is essential before connecting to the supply. The Elite Series must be permanently connected to the supply.

3 Power factor capacitors are not required on the Elite Series input, and must not be connected to the Elite Series output.

4 An off load isolation switch or contactor may be fitted to the Elite Series output. **Never** attempt to operate this switch under load. **Never** open a contactor on the output while the Elite Series is running as the Elite Series operates as a current source. Opening the output while running could cause extensive damage or fire in the switchgear.

5 The Microdrive Elite Series and Ultradrive Elite frame 4 are fitted with electromagnetic interference (EMI) filtering as standard.
External supply side filters are **not required** for the Ultradrive Elite frames 5 to 7.
Shielded mains supply cables are not required to meet EMC requirements, however these may be used to reduce the possibility of interference to very sensitive equipment. As an alternative, 3 phases and an earth lead can be run together in a tight loom to reduce any magnetic and electric fields. Enclosing the cable loom in metallic trunking can also reduce interference problems. Do not run mains wiring in close proximity to motor output cables or control cables. Further information is available from PDL Electronics Applications Department.

6 The Elite Series protects the motor with an electronic overload, so an external overload relay is not necessary. Where multiple motors are attached, separate overload protection must be applied to each motor. The Elite Series or the motor must be isolated before operating on the motor terminals.

7 The Elite Series output switching waveform can give rise to high (capacitive) earth leakage currents. A direct, permanent earth connection between the motor and the Elite series drive is essential before connection to the supply.

8 Screened EMC cable should be used between the Elite series output and the motor to reduce the chances of radio frequency interference (RFI) problems. Suitable EMC cables are SIEMENS PROTOLEX - EMV, OLEX VAROLEX- flex, and TRIANGLE AM cables. A 360° EMC clamp should be used to secure the cable screen to the cable gland plate. Parallel connection of EMC cables for higher operating currents is possible provided the cables are equal length and each cable uses all of the three output phases.
Where screened EMC cable is impractical individual cables for each phase can be used but these must be run parallel and close proximity to each other. Binding these cables together with tape and/or cable ties will minimize stray magnetic and electric fields as well as RFI. Enclosing these cables inside steel conduit or ducting can further reduce the possibility of interference. Do not run motor output cables in close proximity to mains wiring or control cabling. Further information is available from PDL Electronics Applications Engineers.

9 For applications where regeneration is likely to occur, a dynamic brake resistor or module may be required. The resistor must be positioned where the expected heat generated by it will not ignite or damage its surroundings.

10 The location and order of the power terminals varies from model to model. Refer to the terminals labels before connection. Figure 5.11 provides recommended tightening torques for the power terminals.

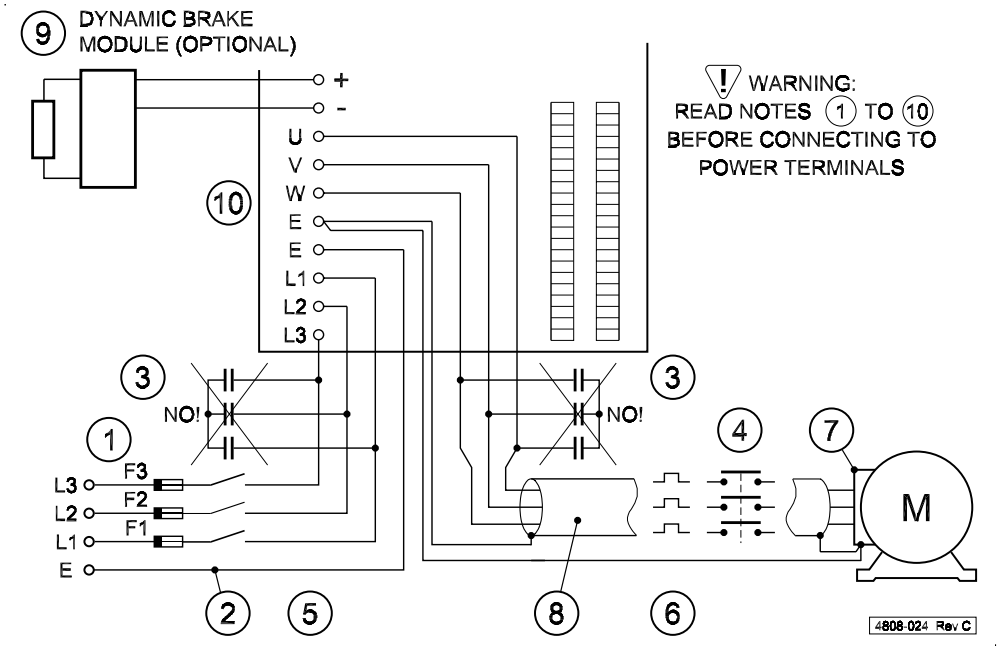


Figure 5.5: Elite Series Power Connection

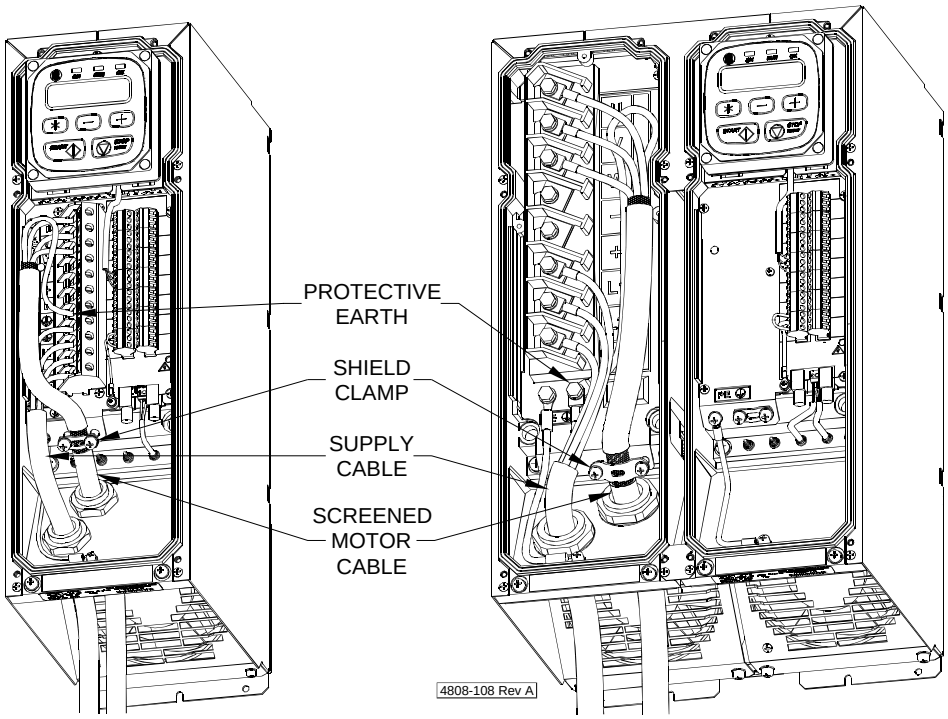


Figure 5.6: Microdrive Elite Frames 1 to 3 Screened Motor Cable Configuration

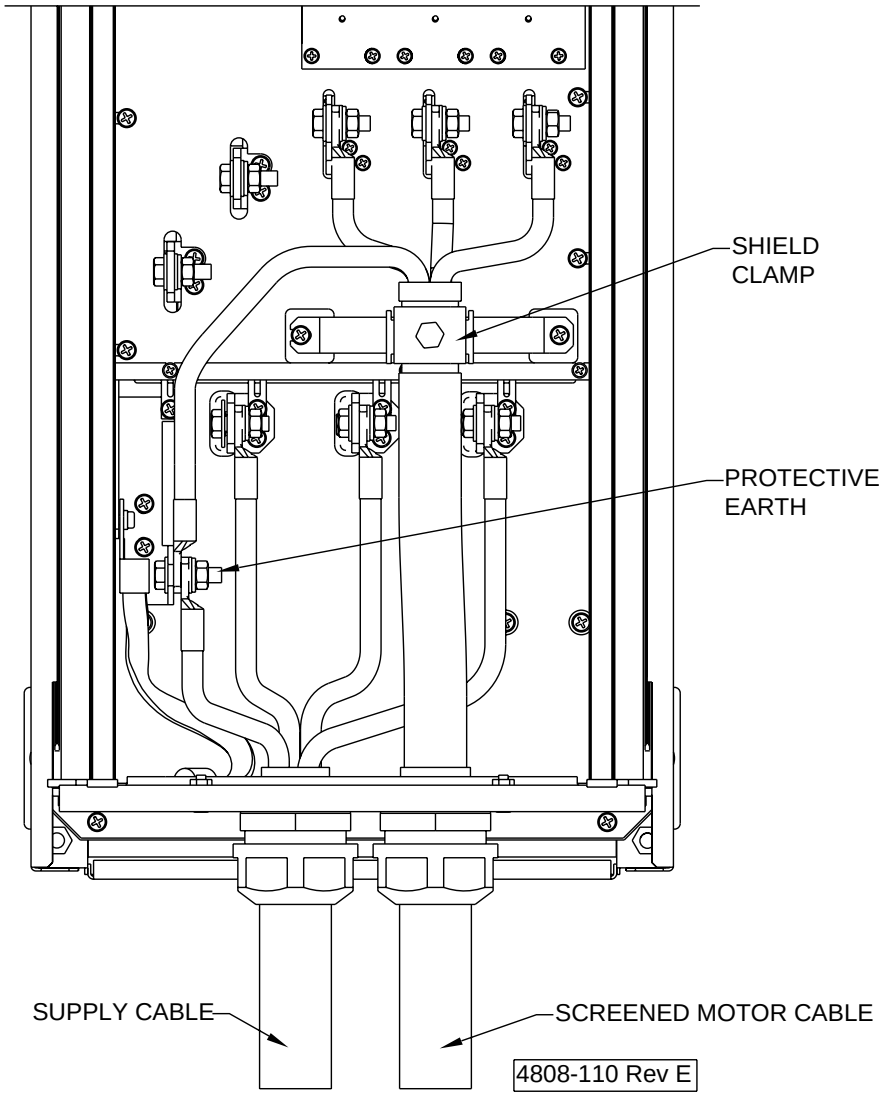


Figure 5.7: Microdrive Elite Frame 4 Screened Motor Cable Configuration

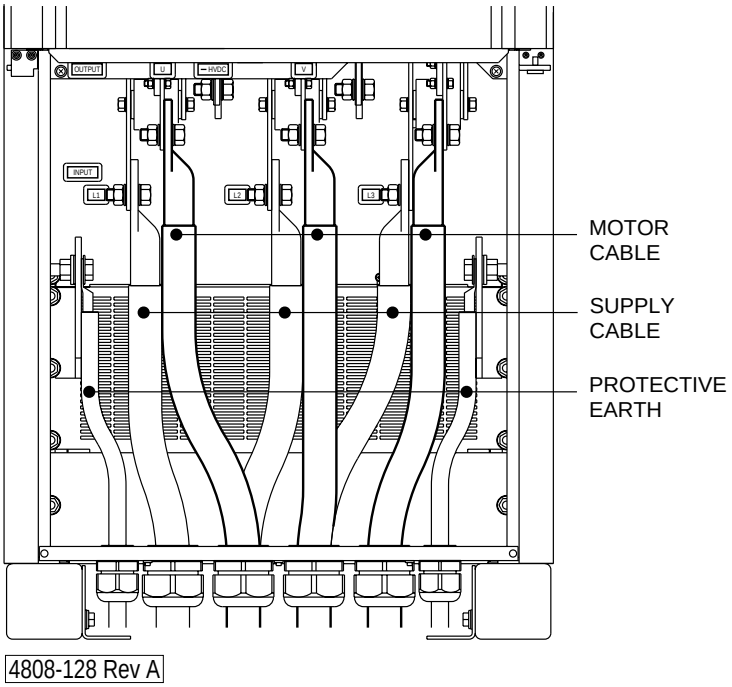


Figure 5.8: Microdrive Elite Frame 5 Screened Motor Cable Configuration

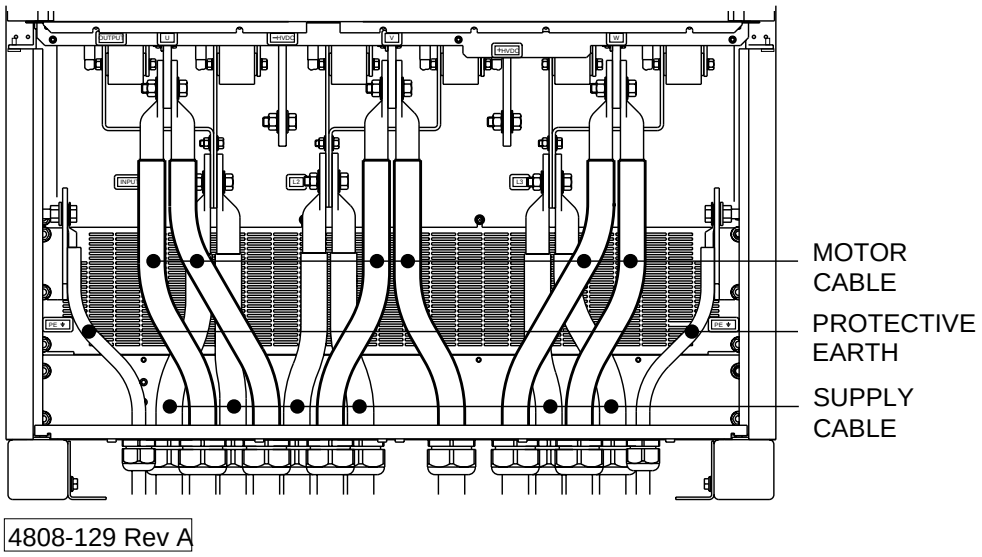


Figure 5.9: Microdrive Elite Frame 6 Screened Motor Cable Configuration

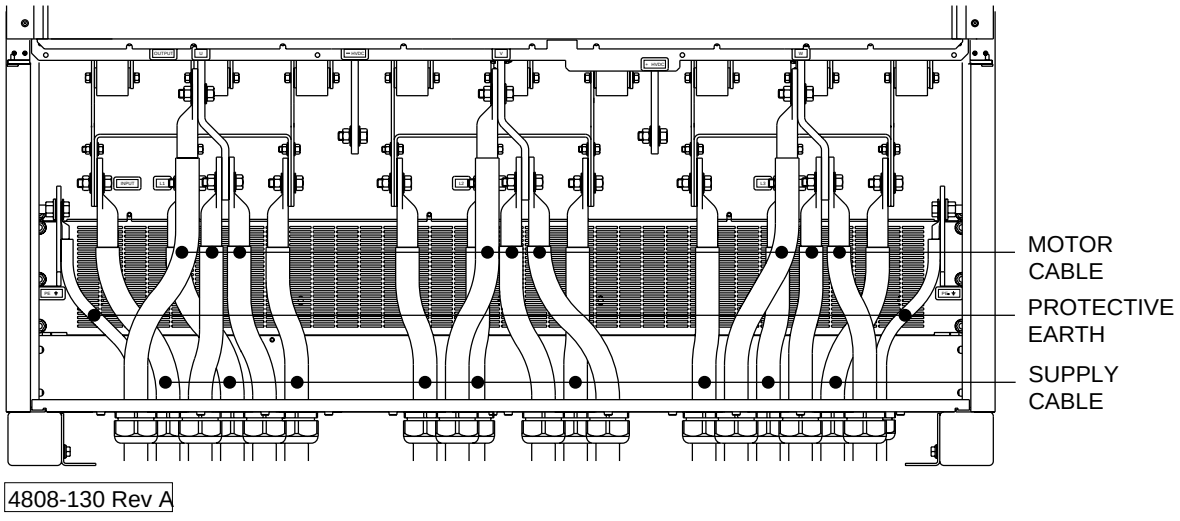


Figure 5.10: Microdrive Elite Frame 7 Screened Motor Cable Configuration

MODEL	Torque N.m (lbs.ins)
Frames 1 & 2	1.7 - 2.3 (15 - 20)
Frame 3	10.2 - 12.4 (90 - 110)
Frame 4	M8 22 - 29 (195 - 257) M10 43 - 56 (381 - 496)
Frames 5 to 7	43 - 56 (381 - 496)

Figure 5.11: Power Terminal Tightening Torques

The Elite Series, frame sizes 5 to 7, are fitted with UL approved DC cooling fans. These fans are powered from a DC power supply. The AC supply to the fan transformer must be matched to the incoming supply voltage.

Mismatching the fan power supply and line voltage can lead to inefficient cooling, or fan damage.

To achieve full IP54 and UL Type 12 ingress protection rating, it is important to pass all external wiring through the gland plate supplied. Glands must be correctly fitted to the cables and the gland plate screws tightened to the recommended torque. Also once connections are made, ensure that the terminal cover is fitted correctly and all screws and locks tightened to the recommended torque.

5.4.2 MOTOR ROTATION

Use of "+" and "-"

"+" speed is used to describe speed in the forward direction.

According to IEC34-7, the motor rotates clockwise when:

- Viewed from the shaft end.
- Terminals U1, V1 and W1 or U2, V2 and W2 are connected to the Elite Series output phases U, V, W respectively.
- The Elite Series is operating with "+" speed.

"-" is used to describe speed in the reverse direction of the motor.

5.4.3 DISPLAY MOUNTING

The display unit may be rotated in 90° increments, to suit the mounting orientation of the Microdrive Elite Series. The display unit may also be mounted remotely from the drive, to a maximum of 3 meters.

The Display unit has an IP54/NEAM 12 protection rating (front and sides only) when mounted against a hard flat surface. To maintain this protection rating the protective screw caps must be fitted.

5.4.4 CONTROL WIRING CONNECTIONS

Control Wiring Recommendations

Bring the control wiring into the enclosure through the gland plate, and install glands to maintain IP54/NEAM 12 integrity. Loom control wiring and power wiring separately, at least 300mm apart and crossing only at right angles. Control cables must be screened to ensure correct operation. Connect the screen only to the ground at the Elite Series to prevent ground loops.

Note that the control inputs and output are highly configurable, so the desired configuration should be planned and designed before attempting connections.

Connection Recommendations Are:

Maximum Tightening Torque: 0.5 Nm (4.5 lb-in)

Maximum Cable Size: 1.5 mm² appliance wire (26 - 14 AWG Cu)

Maximum Number Of Cables per Terminal: Two

Cable Stripping Length: 7 mm (0.28 in)

The default configuration of the digital inputs is active high. I.e. the common of all multi-function input switches should be connected to +24Vdc (terminal T21).

The External Trip / PTC input must be connected to +24Vdc (terminal T21) (when set for active high) for the Elite Series to start and run a motor.

Communications connections can be made to the RS232 or RS485 ports.

5.4.5 EARTHING OF CONTROL 0V

To comply with the requirements of a Class 1 earthing system, the Elite Series control 0V must be linked to earth at some point. Connection of multiple earth points may cause earth loops and should be avoided. An earth link is provided between terminal T20 and and the terminal surround plate and must be removed if not required. Removal will allow the 0V point to float up to ±50Vdc (30Vac) from chassis earth.

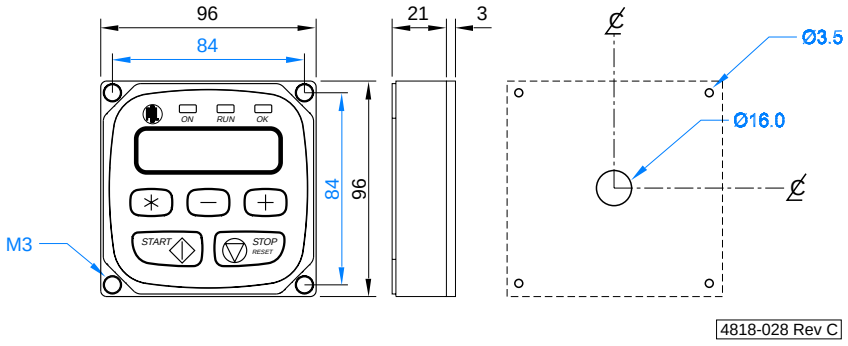


Figure 5.12: Remote Display Dimensions and Cutout Pattern

5.4.6 SHAFT ENCODER SELECTION AND MOUNTING

If using the Elite Series in Closed Loop Vector Control Mode a shaft encoder is required on the motor. Figure 5.13 details encoder connections. The encoder orientation shown in the drawings in this manual (i.e. the connection of the A and B outputs) assumes the encoder is to be connected directly to the non-drive end (non-shaft end) of the motor and that motor wiring orientation is normal (motor terminals U1, V1 and W1 are connected to the Elite Series terminals U, V, W respectively). In this case, an increasing count (screen Z9) should correspond to rotation in the positive direction (motor shaft rotates clockwise when the motor is viewed from the drive end), in response to a positive speed reference.

Choice of Encoder

If the Elite Series is to be used in Closed Loop Vector control mode, a shaft encoder will need to be connected to the motor. A specification for a suitable encoder for a 50 or 60Hz motor is:

Encoder Type:

Incremental, quadrature (bi-phase), differential or single-ended output. Push-pull output preferred to maximise range.

Recommended ppr:

1000 to 2000 ppr per motor pole pair, for directly driven encoder.

Minimum ppr:

500 ppr per motor pole pair (4 pole motor = 1000 ppr).

Supply Requirement:

5Vdc, 100mA maximum.

Alternative Specification:

Type:

Single ended push-pull - will cause a reduction in noise immunity.

Or:

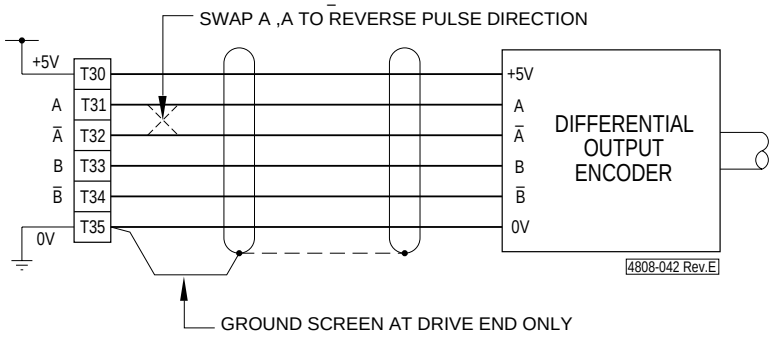
Single ended open collector - pulses will be distorted by long cables. For this type of encoder the product of cable length (meters) x maximum frequency (kHz) should not exceed 1500. Absolute maximum cable length is 30 m.

Fitting of Encoder:

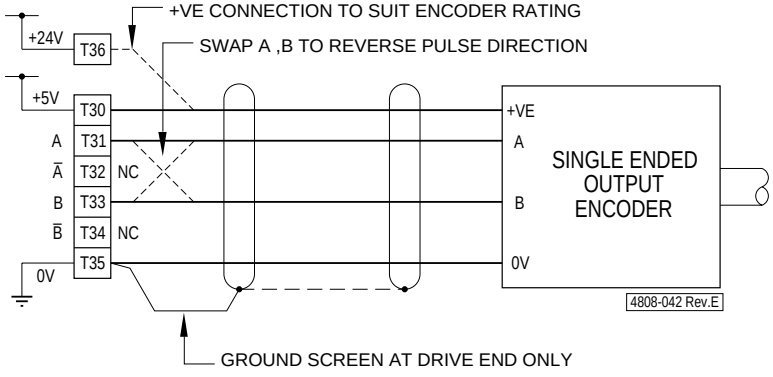
The shaft encoder should be fitted directly to the motor (using a flexible coupling) or indirectly via a toothed (zero slip) belt drive or similar. There must be zero slip or backlash, and high shaft loadings or loose couplings must be avoided.

The encoder MUST be connected using shielded twisted cable. The shield should be earthed at the Elite Series end only, to avoid the possibility of earth loops. The maximum cable length is inversely proportional to the required maximum pulse rate. A push-pull output encoder gives a better range than a single ended open collector type, and is recommended for cable runs exceeding 30 meters. If using an open collector type of encoder, when wired with typical shielded cable with capacitance of 200pF/meter, the product of cable length (meters) x maximum frequency (kHz) should not exceed 1500. Figure 5.13 shows connection details.

A differential output encoder has a high common-mode noise rejection capability, thus is recommended for electrically noisy environments. The encoder inputs to the Elite Series will also accept input pulses from an encoder operating off a supply up to 24Vdc.



(a) DIFFERENTIAL ENCODER



(b) SINGLE-ENDED ENCODER

Figure 5.13: Shaft Encoder Connection Details

5.4.7 FIBRE OPTIC CONNECTIONS

The fibre optic cable used can be any low cost plastic fibre with 1mm core diameter. The maximum recommended cable length is 50m at 50°C ambient. Note that if the fibre optic cable is located near power cables, the local ambient temperature may exceed 50°C. Signal attentuation increases with temperature thereby decreasing the maximum cable length for reliable communication.

Connection is made by cutting a suitable length using a knife (recommended) or side cutters, inserting through a rubber control cable grommet into the fibre optic port and screwing tight the connector. There is no need to strip back the sleeving of the fibre optic cable.

5.4.8 RUBBER CONTROL CABLE GROMMETS

Several rubber control cable grommets are provided within the gland plate area of the Microdrive Elite Series range for glanding control cables, fibre optic cables and encoder cables. Cut the tip to the desired diameter for proper sealing around the cable.

5.5 EXTERNAL POWERING OF THE CONTROL BOARD

The Elite Series Control Board can be externally energised, by connection of an external +24Vdc (nominal) 1A supply to control terminals T36, T37. Refer to Figure 5.14 for connection details.

5.6 GLAND PLATE AND FRONT COVER RECOMMENDED SCREW TORQUES

To ensure that the Elite Series is protected against ingress of dust and splashing water, cable glands must be used and the gland plate and front cover must be tightened to the recommended torque. Refer Figure 5.15.

5.7 DYNAMIC BRAKE DETAILS

The possible need for dynamic braking is discussed in Section 4.5 of this manual. If a dynamic brake is required, the brake resistor must be mounted in a position where the expected heat generated by it will not ignite or damage its surroundings.

5.8 ANCILLARY EQUIPMENT

The Ultradrive Elite frames 5 to 7 has mounting points for small items of ancillary equipment. Do not drill additional holes in the Elite metalwork as swarf (metal filings etc) may short internal components leading to irreparable damage and danger to personnel.

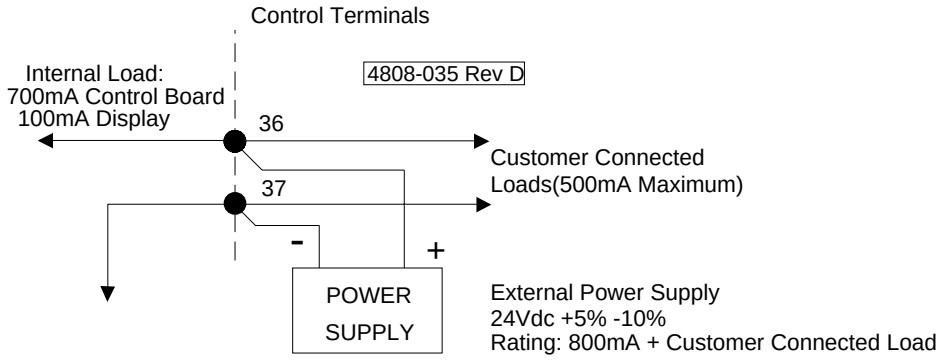


Figure 5.14: External Powering of Control Board

MODEL	SCREWS	TORQUE N.m (lbf.in)
Frames 1 to 3	Gland Plate Screws (M5) Front Cover Screws (6/32 UNC)	3.25 - 3.75 (28 - 33) 1.0 - 1.5 (9 - 13)
Frame 4 & 5	Gland Plate Screws (M5)	3.25 - 3.75 (28 - 33)
Frame 6 & 7	Gland Plate Screws (M6)	8.5 - 9.5 (75 - 84)

Figure 5.15: Recommended Gland Plate and Front Cover Tightening Torques

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6 OPERATION OF THE DISPLAY UNIT

6.1 DISPLAY UNIT DESCRIPTION

6.1.1 THE DISPLAY UNIT AND KEYS

The Display Unit (as shown in Figure 6.1) of the Elite Series may be removed from the front of the unit, and refitted in any orientation, or mounted remotely from the unit (up to three metres away). The display unit has an IP54/NEAM12 protection rating (front and sides only) when mounted against a hard flat surface, thus is protected against ingress of dust and moisture.

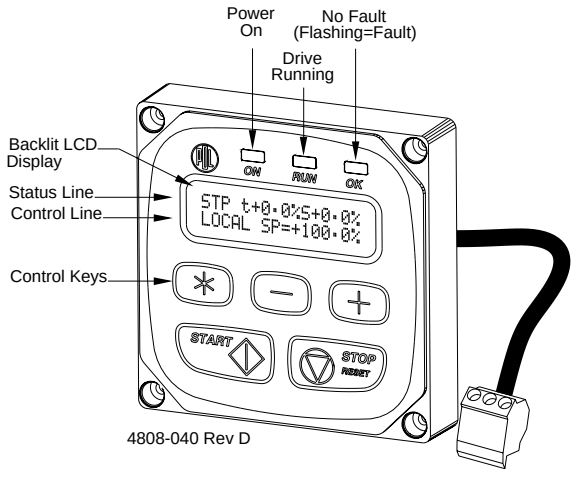

Figure 6.1: The Display Unit

The LED Indicators

ON Indicates mains power is supplied to the Elite Series Display.

RUN Indicates the Elite Series is running (driving a motor).

OK Steady: Indicates that the Elite Series is operating normally.

OK Flashing: Indicates that the Elite Series has tripped on fault protection.

The Liquid Crystal Display (LCD)

The Elite Series has a sixteen character by two line (16x2) LCD.

The lines each have different functions:

- The STATUS LINE is always present and shows the Elite Series status, overload status, the output current or torque and the output speed.
- The CONTROL LINE of the display is used to view and/or adjust the many parameters of the Elite Series. Indicates screen number, screen description and parameter for adjustment.

The Display Unit Control Keys

The "+" and "–" keys enable scrolling between screen groups and subscreens.
The "∗" key is used to unfold a screen group if required.
By holding down the "∗" key and using the "+" or "–" keys, individual modes or parameters can be adjusted, if allowed.

The Start and Stop-Reset Push-Buttons

These push-buttons may be configured to enable starting and stopping of the motor from the display unit if required, and also to reset the Elite Series in the event of a fault trip.

Alternatively, the START push-button can be configured to be in parallel with an external START switch, and the STOP-RESET push-button in series with an external STOP-RESET switch.

Details on configuring these push-buttons are given in Section 8 (via screen I1) and Sections 9 and 10 of this manual.

6.1.2 DISPLAY UNIT CONTROLLABILITY

The degree of control and monitoring available from this display will be as set up at the time of commissioning.

Each screen will have a pre-configured attribute, controlling whether it is hidden, read only, or read-write. The attribute will apply only when the Elite Series is in Operation Mode (refer Section 6.3). When in Commissioning Mode, all screens will be read-write. Before control adjustment is available from the Display Unit when in Operation Mode, the respective screen must have its attribute set to read-write.

6.1.3 PARAMETER CONVENTIONS

Use of %

Where possible, all adjustments are normalized to the motor parameters - i.e. they are given as a percentage of a motor rating.

The motor ratings themselves are entered in engineering units (volts, amps, etc.).

Use of "+" and "-"

"+" Is used to describe speed or torque in the forward direction of the motor.

"-" Is used to describe speed or torque in the reverse direction of the motor.

According to IEC34-7, the motor rotates forward (clockwise) when:

- viewed from the drive (shaft) end.
- and terminals U1, V1, and W1 or U2, V2 and W2 are connected to RodMax phases U, V, W respectively.
- and the Elite Series is operating with "+" speed.

6.1.4 SECURITY PROTECTION

For reasons of security, the Elite Series must be in **commissioning mode** (screen Z) before certain adjustments can be made. Some adjustments also cannot be made unless the Elite Series is in a OFF state (this is for safety reasons).

If **commissioning mode** is enabled, any user can adjust all settings and configurations. To enable this mode, scroll to Screen Z, and enter the correct password. Further details are given in Section 6.3.2 and Section 8 (screen Z).

6.1.5 CUSTOMISATION OF CONFIGURATION

The Elite Series Control Board processor has a number of logic and processing blocks integrated into the firmware. These can be configured **using PDL VYSTA® for Windows** to enhance the existing default configuration, or for configuring a completely new control system. These blocks include logic gates, counters, timers, analogue signal processors, PID controllers, inputs and outputs.

To suit any custom configuration, a custom Screen List can also be designed. This Screen List may be a modified version, or a foreign language version, of the default Screen List provided.

More details on customisation of control are given in Section 7 of this manual.

6.2 MENU STRUCTURES AND SCREENS

6.2.1 SCREEN LISTS

The Elite Series screen list is comprised of multiple screens. Each individual screen, its function and options are discussed in detail in Section 8 of this manual.

A Screen List may also be a foreign language translation of the default screen list as discussed above. When operating in a specific configuration, the required Screen List may be selected (when in Commissioning Mode) from screen Y1.

6.2.2 SELECTION OF SCREENS

Screens are arranged in folded format. Each screen group has a main screen with the group identifying letter and description. Folded under this main screen can be a number of subscreens, each of which has a single parameter or mode for viewing or adjustment. These subscreens cannot be viewed until unfolded. Once unfolded, some subscreens have a numerical parameter which may be adjusted. Others may have a list of options with each option separately viewable and selectable. Extra screens or subscreens may become available when the Elite Series is in "Commissioning" mode.

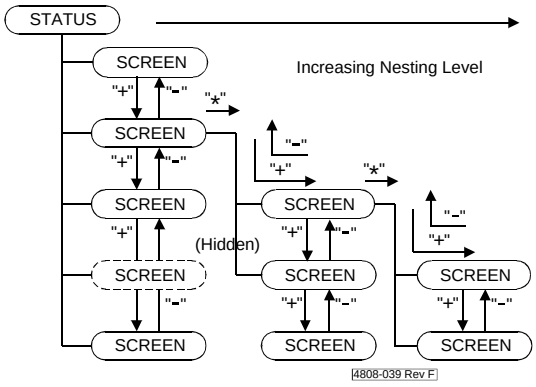

Figure 6.2: Screen Unfolding and Folding

Referring to Figure 6.2, when "+" or "-" are used to scroll through the screens, no subscreens are shown. If a particular subscreen is required, scroll to the associated group, then press and release "∗". This will unfold all of the screens associated with that group. "+" will move down through the subscreens, stopping on the last subscreen in a group. "-" will move up through the subscreens, until the group title is reached. This will cause the screens to automatically refold.

6.2.3 ADJUSTING A SCREEN VALUE

Before a screen value can be changed, the screen on view must have its attribute set to "read-write".

Once a screen group has been unfolded and a screen selected, the parameter or mode displayed on the control line may be adjusted. For a screen with access rights configured as "hidden" or "read only", this adjustment may only be made if the Elite Series is in COMMISSIONING mode.

Adjustment is done by depressing the "∗" key and using "+" or "-" keys, to increase or decrease the parameter respectively.

To adjust a numeric parameter, press "∗" and "+" to make it more positive. Press "∗" and "-" to make it more negative. The new value is stored to nonvolatile memory (EEPROM) on release of "∗" key.

To adjust a two-state parameter (e.g., HI/LO, Y/N) use "∗" and "+" or "-" to toggle the state of the parameter.

To select from a list, use "∗" and "+" or "-" keys to scroll through the choices. Release of "∗" key will store the displayed choice to the EEPROM.

6.2.4 OFF TO MODIFY

For maximum flexibility, most screens can be adjusted while the RodMax is running.

For reasons of safety, however, certain settings may not be adjusted while running. Attempts to do so will cause the display of the message OFF TO MODIFY.

6.3 OPERATING MODES

6.3.1 COMMISSIONING AND OPERATING MODES

Operation Mode

This is the normal operating mode of the drive. Each screen will have a pre-configured attribute, controlling whether it is hidden, read only, or read-write. Thus operator access to screens can be controlled.

Commissioning Mode

In this mode, each screen is visible and commissioning parameters may be adjusted, irrespective of the screen's attribute. Some parameters are not adjustable while the drive is started or running.

Access to Commissioning Mode may be controlled by a password.

6.3.2 SWAPPING BETWEEN OPERATION AND COMMISSIONING MODES

Selecting COMMISSIONING mode before a Password has been set:

Scroll to main screen Z.

Z COMMISSION= N

Press "∗" and "+" or "-". The status line should change to:

Z COMMISSION= Y

All screens will now be visible, and all parameters adjustable.

Selecting COMMISSIONING mode after a Password has been set:

Figure 6.3 illustrates the procedure for swapping between OPERATION and COMMISSIONING modes using a password.

Scroll to main screen Z. The display's control (bottom) line will read:

Z COMMISSION= N

Press "∗" and "+" or "-". The screen will automatically display:

PASSWORD= ZZZZZ

Now press "∗" and "+" or "-" until the correct password is reached. Then release the keys.

All screens will now be visible, and all parameters adjustable.

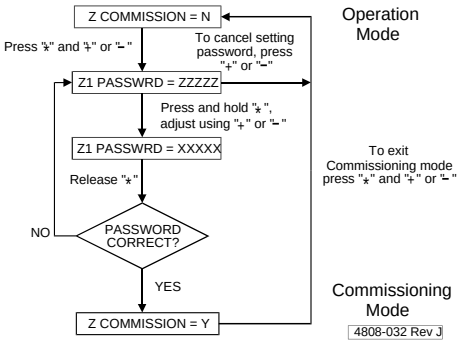

Figure 6.3: Setting Commission Mode after a Password has been set

Selecting OPERATION Mode:

To change from COMMISSIONING Mode to OPERATION Mode, scroll to main screen Z.

The display's control line will read:

Z COMMISSION= Y

Use "∗" and "+" or "-" to toggle to :

Z COMMISSION = N

Setting a Password for the First Time

Refer to Figure 6.4.

Once set to COMMISSIONING mode as described above, a password may be set up. Unfold screen group Z and scroll to screen Z1. The display will read:

Z1 PASSWORD= OFF.

Press "∗" and "+" or "-" to set the required password.

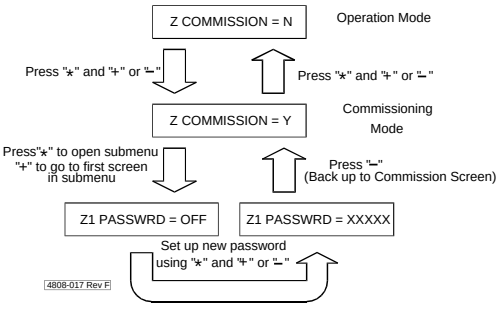

Figure 6.4: Setting a Password for the First Time

What happens if a password is unknown or forgotten?

Once a password has been entered, a special hashing number will be displayed on screen Z when trying to enter into COMMISSIONING mode.

The display will read:

Z PASSWORD= ZZZZZ

Take a note of this number and contact a PDL Electronics Applications Engineer, who with suitable authority will be able to pass this code through an algorithm to reconstruct the original password.

6.4 MENU SET-UP MODE

This mode is accessible when in commissioning mode, and enables the attributes of each screen to be set, The attribute controls access to the screen when in Operation Mode, as follows:

Hidden: The screen cannot be viewed or changed.

Read Only: The screen can be viewed, but not changed.

Read-Write: The screen can be viewed and the parameter changed when in Operation Mode.

Entering MENU SET-UP mode

The drive must be stopped before entering MENU SET-UP Mode.

While in COMMISSIONING mode and displaying the commissioning screen (screen Z), press "∗" for five seconds. The status (top) line of the display will be replaced with the message: MENU SET-UP MODE

Figure 6.5 illustrates the procedure for entering and exiting MENU SET-UP mode.

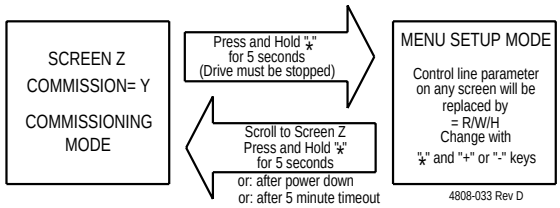

Figure 6.5: Entering and Exiting Menu Set-up Mode

Figure 6.6 shows a typical screen display when in MENU SET-UP mode.

Where ? = R (read only) or W (read-write) or H (hidden or invisible)

Figure 6.6: Typical Screen Display in Menu Set-up Mode

All screens will be unhidden, but the parameter value on each control line will be replaced by R or W or H (for read only/read-write/Hidden). The attribute can be altered by "∗" and "+" or "-".

Exiting MENU SET-UP Mode

This is achieved by pressing "∗" for more than five seconds.

Exit also occurs after more than five minutes of inactivity, or on start-up after power-down.

Initlialising user parameters in screen Y2 will return the menu setup to the default configuration.

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7 CUSTOMISATION OF CONTROL

7.1 PDL VYSTA® FOR WINDOWS CONFIGURATION SOFTWARE

Customisation of Control

The Elite Series Control Board processor has a number of logic and processing blocks integrated into the firmware. These can be configured to enhance one of the existing default configuration, or for configuring a completely new control system. These blocks include logic gates, counters, timers, analogue signal processors, PID controllers, inputs and outputs.

PDL Vysta® for Windows Editor

Configuration of these processing blocks is done by PDL Vysta® for Windows. PDL Vysta® for Windows is an editing software package which can be installed on a personal computer running Microsoft Windows. Each processing block is represented by an icon.

The icons can be placed on the screen and interconnected as required. Each icon has an associated dialogue box for naming and defining parameters. Each type of icon can be used as many times as required, within the limits of user memory within the Elite Series. The resultant schematic diagram can have comments and text attached, and a title block attached. The schematic can be printed.

Compilation and Decompilation of PDL Vysta® for Windows Schematics

A configuration schematic designed using the PDL Vysta® for Windows editor is compiled into a text-based Netlist**.** This list stores sufficient information to identify the blocks, their associated names, inputs, outputs, variables, interconnection information, and associated screens. When a file is saved inside the PDL Vysta® for Windows editor, it is saved in Netlist format.

When a saved file is opened, the Netlist is decompiled and icons will be regenerated for display on the screen.

The PDL Vysta® for Windows is available for Microsoft Windows 95/98 and Windows NT. PDL Part No. VYSTA

7.2 CUSTOM SCREEN CONFIGURATION

Screen Editor

The PDL Vysta® for Windows configuration software has a screen editing utility included. This enables a new Screen List to be created and down loaded to the Elite Series.

Creating or Modifying a Screen List

When creating a new Screen List, a dialogue box is presented to name and number the list. Then a Screen Window is presented enabling the hierarchical structure of the Screen List to be designed. Screen groups and subscreens can be inserted, deleted, or edited.

Editing a Screen

When a screen is selected for editing, a dialogue box appears. The screen title, attributes and text may be inserted. When down loaded to the Elite Series, this text will appear in the control line (second line) of the display.

The text can include variables, which can be set up as read only, or modifiable from the front panel of the Elite Series. These variables can be defined as the variable names assigned when configuring processing blocks, or system names.

7.3 PDL DRIVELINK FOR WINDOWS SOFTWARE PACKAGE

The DRIVELINK software package allows Vysta for Windows configuration to be downloaded to the Elite Series drives. It also allows the system code within the Elite to be updated with later revision software as it is developed.

This package is available for Microsoft Windows 95, and Windows NT. PDL Part No. 0407.

7.4 MODBUS COMMUNICATIONS CONNECTIONS BETWEEN PC AND DRIVE

7.4.1 THE ELITE SERIES TO PC CONNECTION

The Modbus serial communications format is used for data transfer between the Elite Series and a personal computer. The Elite Series is equipped with RS485 and RS232 ports, either of which (but not both) can be used.

For long range communication (more than five metres), or where connection to more than one drive is required, RS485 is the recommended connection. An RS485/RS232 protocol converter will be required, located near to the PC.

For one-to-one communication over a short range **and downloading system code**, the RS232 connection should be satisfactory. It is more noise sensitive than RS485, and can only be connected to a single drive. However direct connection is possible, without the need for a protocol converter.

7.4.2 CONFIGURING THE CONNECTION

Each Elite Series unit connected to the serial communications link will require a Modbus Address. Program this address on Screen H3a. This address must be unique to each drive on the same link.

The baud rate must be set on Screen H3b of the Elite Series. This should be set to the maximum (9600 baud). However if regular communications failures are noted, the baud rate may require reducing.

Configure the PDL Drivelink baud rate to match that of the connected drive(s). Configure the serial port to COM 1 if the 9-pin serial connector is available on the PC. If this port is used (e.g., by the mouse), configure the serial port to COM 2 (usually a 25-pin connector on the PC).

7.4.3 DOWN-LOADING FROM A PC TO THE ELITE SERIES

Once the serial connection is established and configured, a custom control configuration and custom Screen List can be down loaded from the PC to the Elite Series**.** On transfer, the Netlist files stored in the Elite are converted to Modbus code and transmitted via the configured RS232 port. The Netlist file can then be stored for future reference.

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8 THE DEFAULT SCREEN LIST

The Elite Series provides as a default a very flexible set of formats and functions for control inputs and outputs.

The Elite Series can be operated in Open Loop mode as a speed controller, or in Closed Loop mode as a torque or speed controller.

The Screen List available in the default configuration are shown in figures 8.1a to 8.1d.

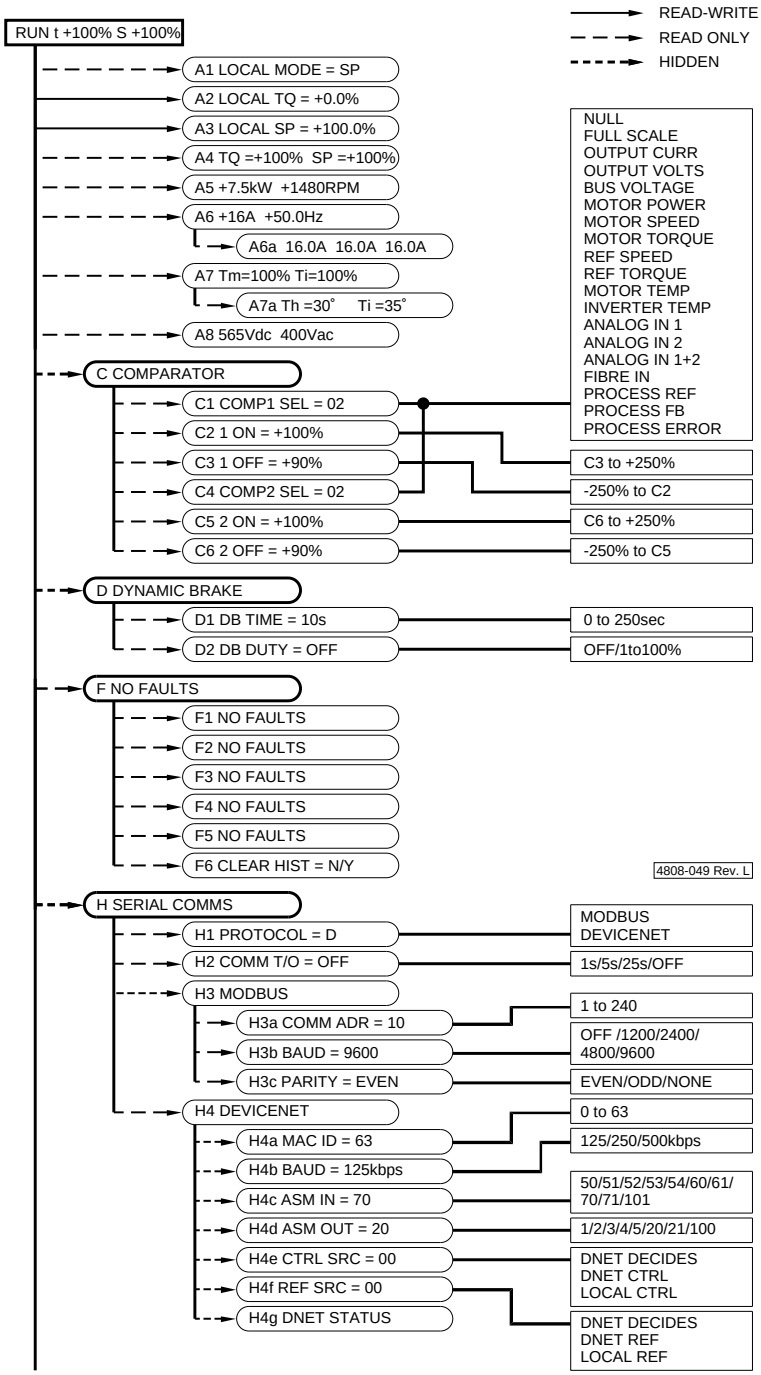


Figure 8.1a: Screen List A-H

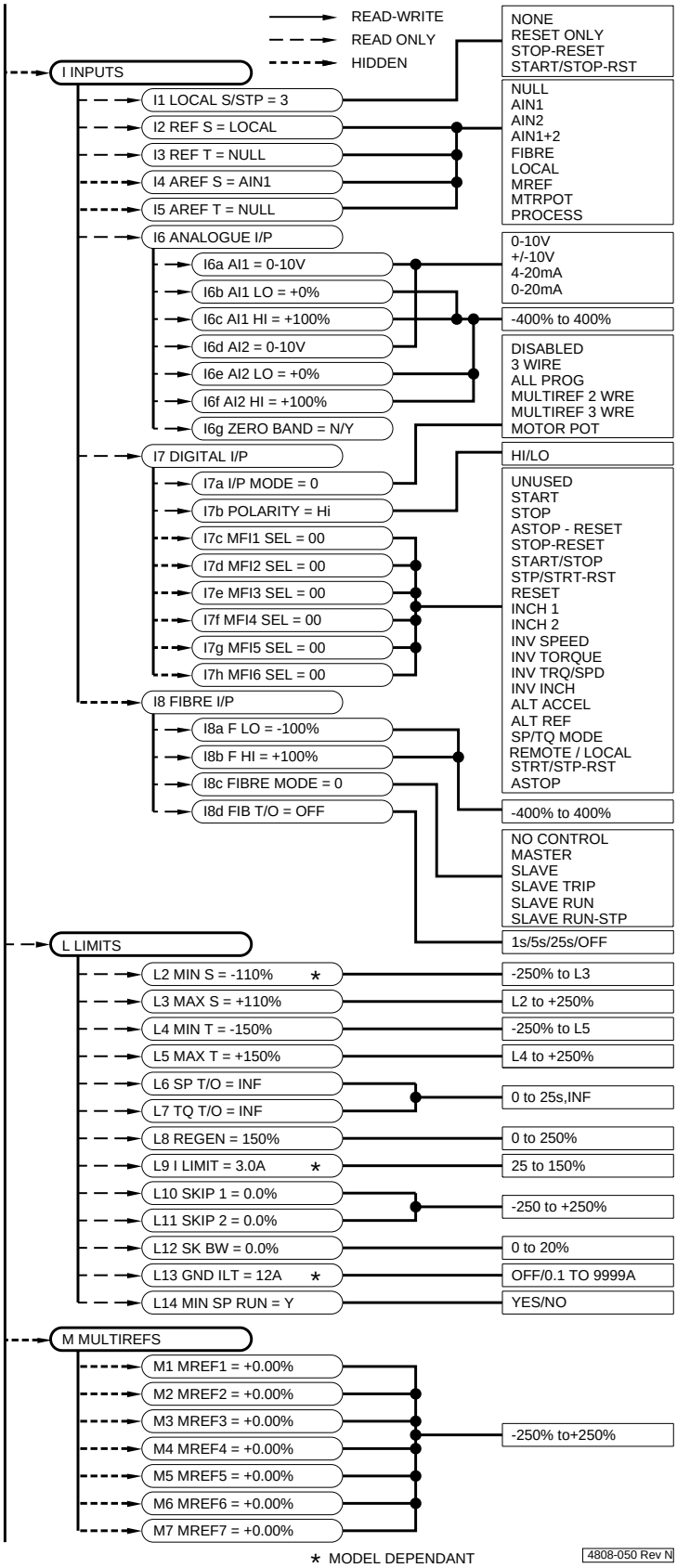


Figure 8.1b: Screen List I-M

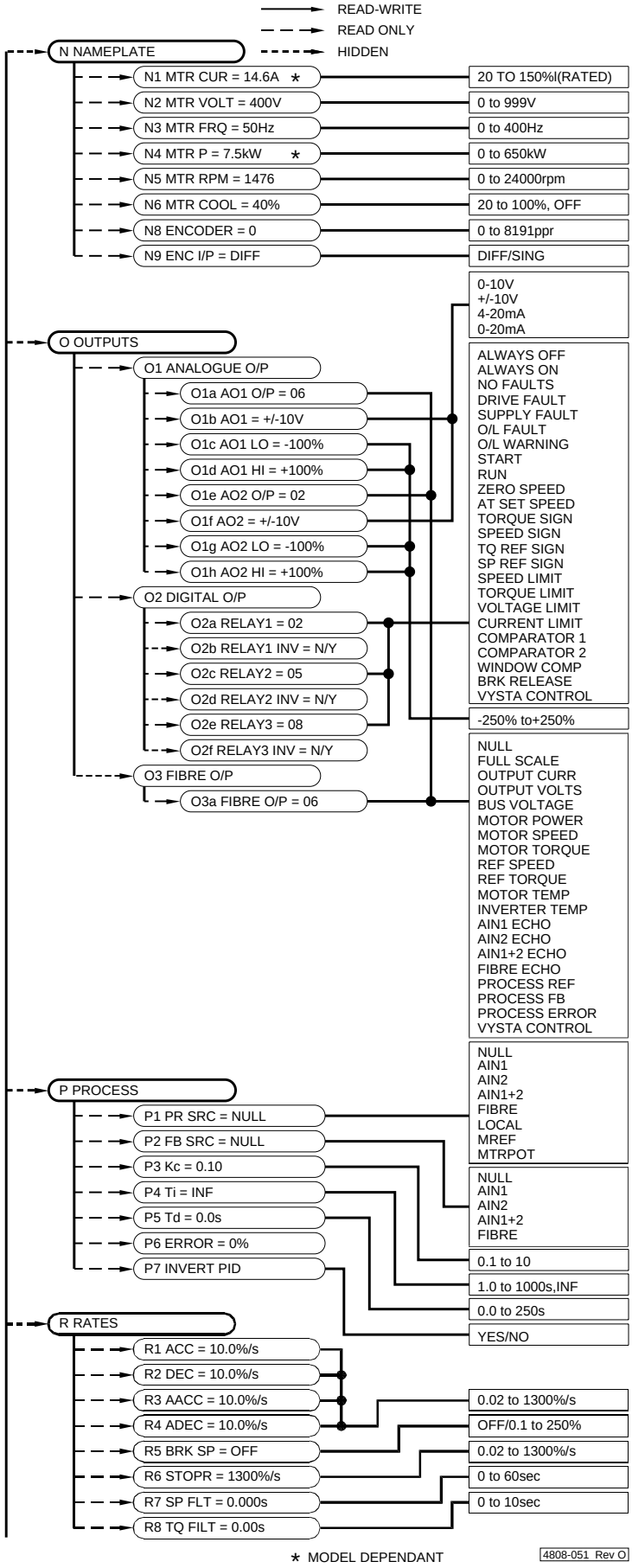


Figure 8.1c: Screen List N-R

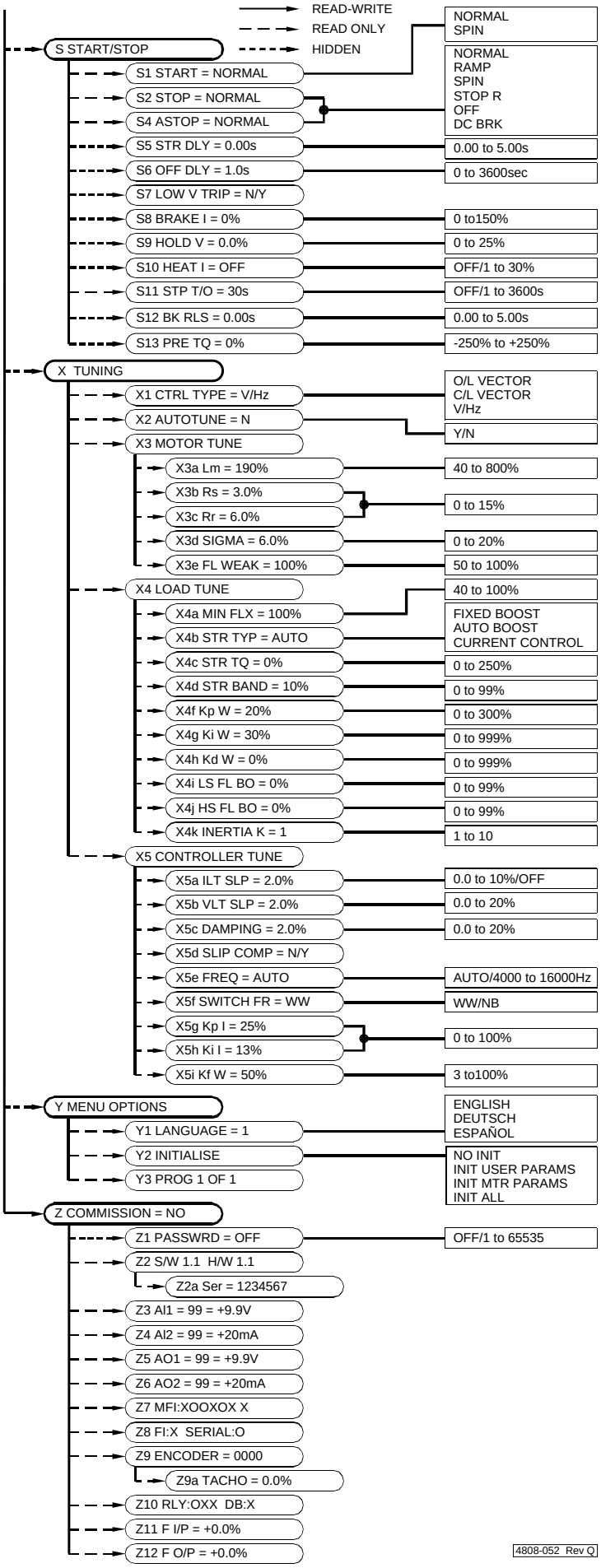


Figure 8.1d: Screen List S-Z

STATUS LINE

AA STATUS LINE

Screen AA

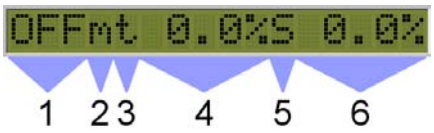
Description STATUS, OVERLOAD, TORQUE/CURRENT, SPEED, INDICATION

Units % of rated motor torque / amps; % of rated motor speed

Note: ALWAYS DISPLAYED

FUNCTION This is the top line of the display and is permanently present. The status line shows Elite Series status, overload condition, output torque or current and output speed. Indication of operational mode is also provided.

Reference



REF.	FUNCTION
1	Elite Series Status Indication Refer to Status Messages list opposite.
2	Overload Status Indicated by a lower case letter while overload is present. i - current exceeds Elite Series rating. The Elite Series will shut down to protect itself if the overload persists. m - current exceeds motor capability. The thermal model of the motor indicates the motor will become too hot if this condition persists. The Elite Series will eventually trip if the overload is not eliminated. o - Elite Series and motor overload exists.
3	Torque Mode Indicator T- Elite Series is in C/L vector torque mode. t- Elite Series is in C/L vector speed mode. I Elite Series is in VHz speed mode or O/L mode.
4	Motor Torque or Current Indication In C/L vector mode this shows the actual motor torque as a percentage of rated motor torque. In V/Hz or O/L mode the motor current is displayed in amps.
5	Speed Mode Indicator S - Elite Series is in speed mode. s - Elite Series is in torque mode.
6	Motor Speed Indication Shows actual motor speed as a percentage of rated motor speed.

Status Messages

Indication **STP**
Message STOPPED
Notes Motor stopped.

Indication **SPG**
Message STOPPING
Notes Motor is stopping.

Indication **RDY**
Message READY
Notes Elite Series is ready to run. A start command has been received but the bus voltage is too low to run or L14 run at minimum speed is set to NO and setpoint is below minimum speed (L2).

Indication **RUN**
Message RUNNING
Notes Motor is running.

Indication **INC**
Message INCHING
Notes Elite Series is responding to an inch command.

Indication **ILT**
Message CURRENT LIMITING
Notes Elite Series has altered the motor speed to maintain the motor current at or below the current limit setting.

Indication **VLT**
Message VOLTAGE LIMITING
Notes Elite Series is limiting the deceleration rate to avoid excessive regeneration (Vdc > 740V for 400V, Vdc > 825V for 500V).

Indication **Fnn**
Message FAULT TRIP
Notes Elite Series has tripped on a fault. Where “nn” indicates the fault number (refer to Screen F and Section 12 - Service and Maintenance for details).

Indication **OFF**
Message OUTPUT OFF
Notes Elite Series has switched off all output power.

Indication **SLT**
Message SPEED LIMITING
Notes Speed is being limited to value set by Screens L1 or L2.

Indication **TLT**
Message TORQUE LIMITING
Notes Torque is being limited to value set by Screens L3 or L4 or L8.

Indication **ATU**
Message AUTOTUNING
Notes Autotune in progress.

Indication **SPN**
Message SPIN STARTING
Notes Elite Series is searching for the speed of the motor.

Indication **HGT**
Message HEATING
Notes DC Heat is being applied to the motor.

Indication **LFX**
Message LOW FLUX STATUS
Notes Open loop vector controller has detected that the motor is close to stalling and has taken compensatory action.

A1 A2 A3 A4 A5 A6 A6a A7

SCREEN GROUP A: STATUS DISPLAYS

A1 LOCAL CONTROL MODE

Screen: LOCAL MODE=SP

Description: LOCAL KEYBOARD MODE SELECT
Range: SP (Speed) / TQ (Torque)
Default Value: SP (Speed)
OFF to Modify: No
Attribute: Read Only

FUNCTION: Sets the operating mode of the Elite Series if not otherwise selected (i.e. as a Multi-function input. Refer screen I7a).

SETTING UP: Select the desired operating (speed or torque) mode.

Note: The selected mode is indicated on the Status Screen by means of an uppercase "S" (speed mode) or uppercase "T" (torque mode).

A2 LOCAL TORQUE REFERENCE

Screen: LOCAL TQ= +0.0%

Description: LOCAL TORQUE REFERENCE
Range: -250% to +250%
Units: % of motor rated torque
Default Value: 0%
OFF to Modify: No
Attribute: Read-Write

FUNCTION: Local keyboard control of reference torque.

SETTING UP: The reference torque source (screen I3 or I5) must be set to LOCAL before this screen has an effect. Although it can be adjusted to ±250% of motor rated torque, the reference torque is constrained between the minimum and maximum torque (set by screens L4 and L5).

A3 LOCAL SPEED REFERENCE

Screen: LOCAL SP=+100.0%

Description: LOCAL SPEED REFERENCE
Range: -250% to +250%
Units: % of motor rated synchronous speed
Default Value: 100%
OFF to Modify: No
Attribute: Read-Write

FUNCTION: Local keyboard control of reference speed.

SETTING UP: The reference speed source (screen I2 or I4) must be set to LOCAL before this screen has an effect. Although it can be adjusted to ±250% of motor rated synchronous speed, the reference speed is constrained between the minimum and maximum speeds (set by screens L2 and L3).

A4 REFERENCE TORQUE, REFERENCE SPEED

Screen: TQ=+0.0%SP=+100%

Description: TORQUE REFERENCE, SPEED REFERENCE
Range: -250% to +250%; -250 to +250%
Units: % of motor rated torque; % of motor rated synchronous speed
Attribute: Read Only

FUNCTION: Shows reference torque and speed. This screen is displayed after power up or external reset.

A5 MOTOR POWER, MOTOR RPM

Screen: +7.5kW +1480RPM

Description: MOTOR POWER, MOTOR RPM
Range: -999kW to +999kW; -12000RPM to +12000RPM
Units: kW - Kilowatts; RPM - Revolutions per Minute
Attribute: Read Only

FUNCTION: Shows estimated motor power and motor speed in revolutions per minute (RPM). In Open Loop Mode and V/Hz control modes, the speed will be estimated.

SETTING UP: The motor rated kW (screen N4) and rated RPM (screen N5) must be entered for correct calibration of this screen.

A6 MOTOR CURRENT, STATOR FREQUENCY

Screen: +16.0A +50.0Hz

Description: MOTOR CURRENT, FREQUENCY OF AC APPLIED TO STATOR
Units: Amps; Hertz
Attribute: Read Only

A6a PHASE OUTPUT CURRENTS

Screen: 1.2A 1.2A 1.2A

Description: PHASE OUTPUT CURRENTS
Range: 0 to 1999A
Units: Amps
Attribute: Read Only

FUNCTION: This screen displays the individual phase currents of the Elite Series.

A7 MOTOR, INVERTER TEMPERATURES

Screen: Tm=100% Ti=100%

Description: ESTIMATED MOTOR TEMPERATURE; ESTIMATED INVERTER TEMPERATURE
Range: 0 to 150%; 65 to 150%
Units: % of motor rated temperature; % rated inverter temperature
Attribute: Read Only

FUNCTION: Shows motor temperature as estimated by the motor thermal model, and Elite (inverter) temperature as estimated by the inverter thermal model.

Note: The inverter thermal model is non-linear, starting at 66%, determined by the 30 second overload rating at 150% of rated inverter current in a 50°C ambient. Refer Section 4.1.1.

A7a ACTUAL HEATSINK & INTERNAL TEMPS

Screen: `Th= 23° Ti= 26°`

Description: HEATSINK TEMPERATURE; INTERNAL TEMPERATURE
Units: °C
Attribute: Read only

FUNCTION: This screen displays the actual measured heatsink and internal temperatures of the Elite.

A8 BUS AND OUTPUT VOLTAGES

Screen: `565Vdc 400Vac`

Description: DC BUS VOLTAGE; OUTPUT VOLTAGE
Units: Vdc;Vac
Attribute: Read only

FUNCTION: Shows the internal DC voltage of the Elite Series, and the AC voltage applied to the motor.

Note: The control system of the Elite Series will attempt to apply whatever voltage is necessary to achieve the calculated current requirement - therefore output voltages displayed with the motor disconnected or isolated may not relate to the voltage applied once the motor is connected.

NO.	SOURCE	UNITS
00	NULL	minimum signal output
01	FULL SCALE	maximum signal output
02	OUTPUT CURR	% of motor rated current
03	OUTPUT VOLTS	% of motor rated voltage
04	BUS VOLTAGE	% of motor rated voltage x 1.414
05	MOTOR POWER	% of motor rated power
06	MOTOR SPEED	% of motor rated speed
07	MOTOR TORQUE	% of motor rated torque
08	REF SPEED	% of motor rated speed
09	REF TORQUE	% of motor rated torque
10	MOTOR TEMP	% of motor rated temperature
11	INVERTER TEMP	% of inverter rated temperature
12	ANALOGUE IN 1	%
13	ANALOGUE IN 2	%
14	ANALOGUE IN 1+2	%
15	FIBRE IN	%
16	PROCESS REF	%
17	PROCESS FEEDBACK	%
18	PROCESS ERROR	%

Figure 8.2: Comparator Source Selection

SCREEN GROUP C: LEVEL COMPARATOR

Group Attribute: HIDDEN

Screens: `C1 COMP1 SEL= 02` / `C4 COMP2 SEL= 02`

Description: COMPARATOR SOURCE SELECTION
Range: 00-18 (Refer Figure 8.2)
Default Value: 02 (Output Current)
OFF to Modify: No
Attribute: Read Only

Screens: `C2 1 ON= +100%` / `C5 2 ON= +100%`

Description: COMPARATOR ON SETPOINT
Range: C3 to +250%; C6 to +250%
Units: % of Function Selected
Default Value: 100
OFF to Modify: No
Attribute: Read Only

Screens: `C3 1 OFF= +90%` / `C6 2 OFF= +90%`

Description: COMPARATOR OFF SETPOINT
Range: -250% to C2; -250% to C5
Units: % of Function Selected
Default Value: 90
OFF to Modify: No
Attribute: Read Only

FUNCTION: Provides two highly programmable relay output comparator functions. Each comparator may select one of a number of analogue levels. Screens C1 & C4, select from figure 8.2. The level at which the relay should turn ON and turn OFF is programmable (screens C2, C5 and C3, C6 respectively).

SETTING UP: If not required, leave set to default values. Where required, select the appropriate function for the Comparator (screens C1, C4) and set the desired ON and OFF levels (C2, C5 and C3, C6).
The output of Comparator is only available to the relay outputs. The desired relay must be configured to connect to the comparator (see screens O2).
The output of Comparator 1 and Comparator 2 may be connected to the relay outputs to form a window comparator. Comparator 1 sets the lower switching level and Comparator 2 sets the upper switching level.

Note: If ON/OFF levels are adjusted very closely together any noise in the signal may cause the relays to chatter, significantly reducing their life. Avoid this condition by ensuring a reasonable margin between the ON and OFF levels.

A7a
A8
C1
C4
C2
C5
C3
C6

D1

D2

SCREEN GROUP D: DYNAMIC BRAKE CONTROLS

Group Attribute HIDDEN

Screen D1 DB TIME= 10s

Description TIME CONSTANT OF DYNAMIC BRAKE RESISTOR
Range 0 to 250 sec
Units sec
Default Value 10
OFF to Modify No

Screen D2 DB DUTY=OFF

Description % DUTY RATING OF DYNAMIC BRAKE RESISTOR
Range OFF, 0 to 100%,
Units % of time on
Default Value OFF
OFF to Modify No

FUNCTION The Elite Series includes thermal model protection for a dynamic brake. To protect the brake resistor the Elite Series will stop (indicating BRAKE O/L) when the calculated use of the resistor exceeds its rating.

The percentage duty rating represents the average percentage of time the resistor may be operated for (when averaged over periods long in comparison to the time constant).

SETTINGUP Leave these screens set at 10s and OFF respectively unless an Elite Series dynamic brake option is fitted (the model is active whether a dynamic brake is fitted or not).

If a dynamic brake option is fitted, these screens MUST BE CORRECTLY SET according to the manufacturer's resistor specifications. The dynamic brake thermal model can only protect the resistor if it is correctly set - never consider using larger than specified figures.

Refer to Section 4.5 for dynamic brake resistor selection.

F

F1

F2

F3

F4

F5

F6

SCREEN GROUP F: FAULT HISTORY SCREENS

Group Attribute HIDDEN

Screen F 00 NO FAULT

Description FAULT DISPLAY SCREEN

FUNCTION Automatic display of fault information.

The Elite Series automatically shows this screen in the event of a fault tripping of the drive (unless a key has been pressed in the last 2 seconds).

In the event of a fault, the Elite Series may be reset by pressing the STOP-RESET button on the display unit, or using an externally configured RESET input.

Screens F1 00 NO FAULT
F2 00 NO FAULT
F3 00 NO FAULT
F4 00 NO FAULT
F5 00 NO FAULT

Description FAULT HISTORY LOG
Range 00 to 70 (Refer to Section 12)
Attribute Read Only

FUNCTION Display of fault history log.

Nested under Screen F is a list of the five most recent faults, in order of their occurrence, with the most recent fault first. This is the fault history log. It is used to retain information for maintenance personnel.

After the clearing of the current fault and resetting the Elite Series, the fault just cleared will move to the first position on the fault log. All other logged faults will move down one position. The oldest logged fault message will be lost.

The fault history log is retained when the power is removed from the Elite Series.

Screen F6 CLEAR HIST=N

Description CLEAR FAULT HISTORY LOG
Range Y (Yes) / N (No)
Default Value N (No)
OFF to Modify No
Attribute Read-Write

FUNCTION Clears the fault history log.

SETTINGUP Select Yes to clear the fault history log. The screen will automatically be set back to the default value N (No) once the fault history log is cleared.

SCREEN GROUP H: SERIAL COMMUNICATIONS

Group Attribute HIDDEN

Screen

Description SELECT SERIAL PROTOCOL TO USE
Range M (Modbus) / D (Devicenet)
Default Value M (Modbus)
OFF to Modify No

Note: DeviceNet operation requires an additional product (EDNI) to be used with the Elite Series.

Screen

Description SERIAL COMMUNICATIONS TIMEOUT PERIOD
Range 1 / 5 / 25 / OFF
Units sec
Default Value OFF
OFF to Modify No

FUNCTION The communications timeout period provides the option of tripping the Elite Series (indicating COMMS T/O) if the time since the last valid serial communications data transfer has exceeded the communications timeout period. Serial communications with the Elite Series is available via the RS232 serial communications terminals, RS485 serial communications terminals or serial communication interface. This allows the Elite Series to be controlled by a host computer such as a PLC or computer from a remote location, and enables the down loading of customised application configurations generated by the PDL Vysta® for Windows PC software package. All the controls, parameters and modes available on the Elite Series can be monitored or adjusted by using the serial communications option. For example, the host controller can start and stop the motor, control its speed, monitor the estimated motor temperature, and the status of the drive. In addition, the host controller can monitor a process by accessing unused digital and analogue inputs on the Elite Series.

SETTING UP When there is no host controller connected, the communications address and baudrate parameters have no effect. However, the communications timeout feature remains active, and, as such, should be set to "OFF". If the Elite Series serial communications feature is required, select the required address, baudrate, parity and timeout period.

SUBGROUP H3: MODBUS COMMUNICATION PARAMETERS

Subgroup Attribute Read Only

Screen

Description MODBUS SERIAL COMMUNICATIONS ADDRESS
Range 1 to 240
Default Value 10
OFF to Modify No
Attribute Read-Write

Screen

Description MODBUS SERIAL COMMUNICATIONS BAUDRATE
Range 1200 / 2400 / 4800 / 9600 / OFF
Units Bits/second
Default Value 9600
OFF to Modify No
Attribute Read-Write

FUNCTION Sets the Modbus serial communication baudrate.

SETTING UP The baudrate selection must match that of the Modbus master that is communicating with the Elite.

Screen

Description MODBUS PARITY SELECTION
Range EVEN / ODD / NONE
Default Value EVEN
OFF to Modify No
Attribute Read-Write

FUNCTION Sets the Modbus serial communication parity.

SETTING UP The parity selection must match that of the Modbus master which is communicating with the Elite.

SUBGROUP H4: DEVICENET COMMUNICATIONS PARAMETERS

Subgroup Attribute Read Only

These options will be valid if an Elite DeviceNet Interface (EDNI) module has been installed.

Screen

Description MAC IDENTIFICATION NUMBER
Range 0 to 63
Default Value 63
OFF to Modify No

FUNCTION Defines the Mac ID for the Elite Series unit.

SETTING UP Each unit must have a unique Mac ID.

Note: Changes to Mac ID have no effect until EDNi is reset via DeviceNet or the power is cycled.

H1 H2 H3a H3b H3c H4a

H4b

Screen H4b BAUD =125kps

Description DEVICENET COMMUNICATION BAUD RATE
Range 125 / 250 / 500
Units kbps
Default Value 125kbps
OFF to Modify No

H4c

Note: Changes to Baud Rate have no effect until EDNi is reset via DeviceNet or the power is cycled.

H4d

Screen H4c ASM IN =70

H4e

Description ASSEMBLY INPUT INSTANCE
Range
50 Basic Overload / Contactor Input (1 byte)
51 Extended Overload / Contactor Input (1 byte)
52 Basic Motor Starter Input (1 byte)
53 Extended Motor Starter 1 Input (1 byte)
54 Extended Motor Starter 2 Input (1 byte)
60 Basic Softstarter Input (1 byte)
61 Extended softstarter Input (1 byte)
70 Basic Speed Control Input (4 bytes)
71 Extended Speed Control Input (4 bytes)
101 PDL Control Input (8 bytes)
Default Value 70
OFF to Modify No

SETTINGUP Select the Input Instance that gives the required functionality. Refer to the EDNi Technical Manual (PDL part no. 4201-212) for further detail.

Screen H4d ASM OUT=20

Description ASSEMBLY OUTPUT INSTANCE
Range
1 Basic Contactor Output (1 byte)
2 Basic Overload Output (1 byte)
3 Basic Motor Starter Output (1 byte)
4 Extended Contactor Output (1 byte)
5 Extended Motor Starter Output (1 byte)
20 Basic Speed Control Output (4 bytes)
21 Extended Speed Control Output (4 bytes)
100 PDL Control Output (8 bytes)
Default Value 20

H4f

OFF to Modify No

SETTINGUP Select the Input Instance that gives the required functionality. Refer to the EDNi Technical Manual (PDL part no. 4201-212) for further detail.

H4g

Screen H4e CTRL SRC=00

Description DEVICENET CONTROL SOURCE
Range
00 DNET DECIDES
01 DNET CTRL
02 LOCAL REF
Default Value 00
OFF to Modify No

FUNCTION Controls where the Run & Reset commands for the Elite Series came from. Local control selects the normal Elite Series controls (keyboard and multifunction inputs). DNET CTRL selects the commands to come from the source selected by the "Control from Net" bit in the input instance.

Screen H4f REF SRC=00

Description DEVICENET REFERENCE SOURCE
Range
00 DNET DECIDES
01 DNET CONTROL
02 LOCAL CONTROL
Default Value 00
OFF to Modify No

FUNCTION Controls where the speed reference for the Elite Series comes from. Local Control selects the normal Elite Series reference. DNET CTRL selects the drives reference to come from DeviceNet and DNET DECIDES allows the Elite Series speed reference to come from the source selected by the "Reference from Net" bit in the input instance.

Screen H4g NO BOARD

Description DEVICENET INTERFACE STATUS
Range

No Board	No devicenet board fitted.
Off Line	Interface board not responding or network not powered up.
No Net Power	24Volts missing on DeviceNet network
Self-Testing	Powering up.
Standby	Network power OK but no communications established.
Operational	Network is OK and communication is established.
R Fault	Recoverable network fault has occurred.
NR Fault	Non-recoverable network fault has occurred.

SCREEN GROUP I: INPUTS

Group Attribute HIDDEN

I1 LOCAL START/STOP-RESET CONTROL

Screen

Description LOCAL START/STOP AND RESET CONTROL
Range 0-3 (Refer Figure 8.3)
Default Value 3 (Start/Stop-Reset)
OFF to Modify No
Attribute Read Only

FUNCTION Enables/disables the display unit's START, STOP and RESET functions.

SETTING UP

NO.	CODE	NOTES
0	NONE	Display unit START and STOP/RESET inactive. Allows operation without display.
1	RESET ONLY	Display unit START and STOP inactive. STOP/RESET key resets faults only.
2	STOP-RESET	Display unit START inactive. STOP and RESET functions active.
3	START/STOP-RST	Display unit START, STOP and RESET functions active.

Figure 8.3: Local Start/Stop-Reset Control

I2, I4 SPEED REFERENCE SOURCES

Screen

Description SPEED REFERENCE SOURCE
Range Refer Figure 8.4
Default Value LOCAL
OFF to Modify Yes
Attribute Read Only

Screen

Description ALTERNATIVE SPEED REFERENCE SOURCE
Range Refer Figure 8.4
Default Value AIN1 (Analogue Input 1)
OFF to Modify Yes
Attribute Hidden

FUNCTION Defines which input source is used as the speed reference (I2) or alternative speed reference source (I4).

Note: The alternative speed reference is a switchable second source option. This function is enabled by selecting alternative reference as a multi-function input, by appropriate selection of screens I7a and I7c to I7h.

SETTING UP Select the desired (and alternative, if required) speed reference source to suit your requirements.

Note: If the alternative speed reference is to be used, the Digital Input controlling this also selects the alternative torque reference source, so screen I5 must also be set appropriately.

I3, I5 TORQUE REFERENCE SOURCES

Screen

Description TORQUE REFERENCE SOURCE
Range Refer Figure 8.4
Default Value NULL (No Source Selected)
OFF to Modify Yes
Attribute Read Only

Screen

Description ALTERNATIVE TORQUE REFERENCE SOURCE
Range Refer Figure 8.4
Default Value NULL (No Source Selected)
OFF to Modify Yes
Attribute Hidden

FUNCTION Defines which input source is used as the torque reference (I3) or alternative torque reference source (I5).

Note: The alternative torque reference is a switchable second source option. This function is enabled by selecting alternative reference as a multi-function input, by appropriate selection of screens I7a and I7c to I7h.

SETTING UP Select the desired (and alternative, if required) torque reference source to suit your requirements.

Note: If the alternative torque reference is to be used, the Digital Input controlling this also selects the alternative speed reference source, so screen I4 must also be set appropriately.

CODE	REFERENCE SOURCE
NULL	NO SOURCE SELECTED
AIN1	ANALOGUE INPUT 1
AIN2	ANALOGUE INPUT 2
AIN1+2	ADDITION OF SCALED ANALOGUE INPUTS 1 + 2
FIBRE	FIBRE OPTIC INPUT
LOCAL	LOCAL SPEED/TORQUE CONTROL (SCREENS A3/A2)
MREF	MULTI-REFERENCE (SCREENS I7a, M1 TO M7)
MTRPOT	MOTORISED POTENTIOMETER (SCREEN I7a)
PROCESS	PROCESS CONTROL OUTPUT

Figure 8.4: Reference Source Selection

SUBGROUP I6: ANALOG INPUTS

I6a

Subgroup Attribute Read Only

I6b

I6a - I6f ANALOGUE INPUT FORMATTING AND SCALING CONTROLS

I6c

Screen I6a AI1=0-10V

Description ANALOGUE INPUT 1 FORMAT
Range Refer Figure 8.5
Default Value 0-10V
OFF to Modify Yes

I6d

Screen I6b AI1 LO= +0%

I6e

Description ANALOGUE INPUT 1 LOW SETPOINT
Range -400% to +400%
Units %
Default Value 0%
OFF to Modify No

I6f

Screen I6c AI1 HI=+100%

Description ANALOGUE INPUT 1 HIGH SETPOINT
Range -400% to +400%
Units %
Default Value +100%
OFF to Modify No

Screen I6d AI2=0-10V

Description ANALOGUE INPUT 2 FORMAT
Range Refer Figure 8.5
Default Value 0-10V
OFF to Modify Yes

Screen I6e AI2 LO= +0%

Description ANALOGUE INPUT 2 LOW SETPOINT
Range -400% to +400%
Units %
Default Value 0%
OFF to Modify No

Screen I6f AI2 HI=+100%

I6g

Description ANALOGUE INPUT 2 HIGH SETPOINT
Range -400% to +400%
Units %
Default Value +100%
OFF to Modify No

CODE	ANALOGUE INPUT FORMAT
0-10V	0 to 10Vdc input
+/-10V	-10 to +10Vdc input
4-20mA	4 to 20 mA input
0-20mA	0 to 20 mA input

Figure 8.5: Analogue Input Format Selection

SCALING Refer to Figure 8.6.

AI1 LO / AI2 LO
Sets the reference level when the minimum analogue level is applied to the respective input.

AI1 HI / AI2 HI
Sets the reference level when the maximum analogue level is applied to the respective input. The Elite Series input is interpolated linearly between the selected LO and HI settings.

LO settings may be greater than HI settings, thus providing inverse control (i.e. increasing the reference input decreases the reference speed, torque or process setpoint).

SETTING UP If it has been determined that one or both analogue inputs are needed as torque or speed reference sources, they must first be selected (screens I2 to I5).

Determine the required format of these analogue inputs, and set up on screens I6a, I6d.

Determine the range over which analogue control is desired. Adjust the LO setting (screens I6b, I6e) to the speed/torque desired at minimum analogue input. Adjust the HI setting (screens I6c, I6f) to the speed/torque desired at maximum analogue input (+10V/20mA).

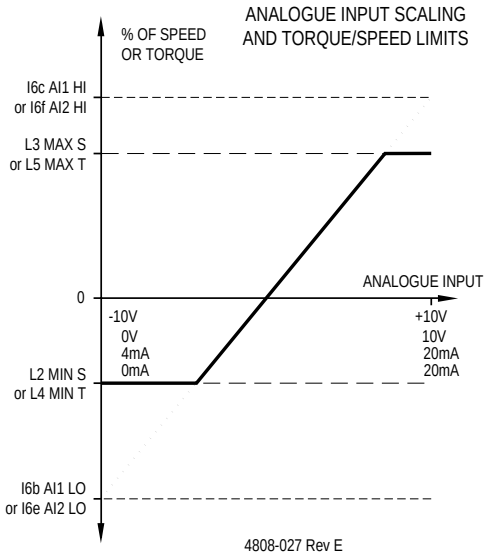


Figure 8.6: Analogue Input Scaling

I6g ANALOGUE ZERO BAND

Screen I6g ZERO BAND=N

Description ZERO BAND OF ±2% FOR ANALOGUE INPUT SOURCES
Range Y (Yes) / N (No)
Default Value N (No)
OFF to Modify No

FUNCTION To provide a definite zero region for analogue controls, especially for speed control.

This is important in applications where absolute zero speed (or torque) is required in conjunction with analogue control. It overcomes small errors in the reference voltage about the zero reference point.

SETTING UP Refer to Figure 8.7.
Not required if analogue reference inputs are not used.

If analogue input references are to be used to command exactly zero speed (or torque) or the motor shaft is to be locked (i.e. mechanical brake) at zero speed, the zero band must be set to Y (Yes).

If absolute zero speed (or torque) is not critical, the shaft is not mechanically locked at zero speed or the analogue reference forms part of a feedback loop, set the zero band to N (No).

Note: Zero band is provided since the digital tacho feedback employed in the Elite Series in Closed Loop Mode control mode is absolute - i.e. it cannot lose counts. Therefore any error in zero speed reference setting, however small, will be integrated over time causing the shaft to rotate.

The zero band function does not apply to the digital speed references (e.g. Local keyboard, fibre optic, or multi-reference select) since such zero settings are absolute.

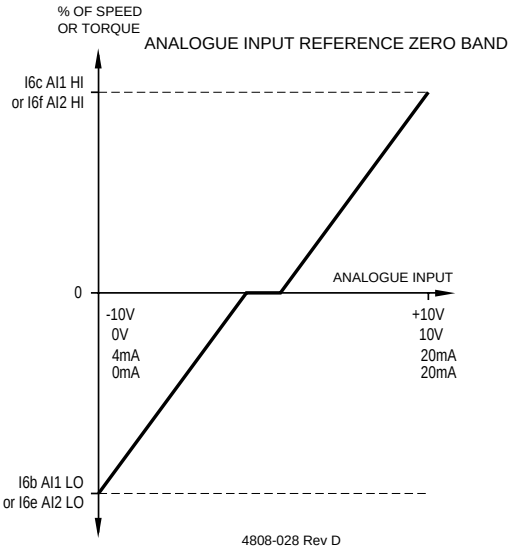


Figure 8.7: Analogue Input Reference Zero Band

SUBGROUP I7: DIGITAL INPUT

Subgroup Attribute Read Only

I7a - I7h DIGITAL INPUT CONTROLS

I7a MULTI-FUNCTION INPUT MODE SELECTION

Screen 

Description MULTI-FUNCTION INPUT MODE SELECTION
Range 0 to 5, refer Figure 8.8
Default Value 0 - DISABLED
OFF to Modify Yes

MULTI-FUNCTION SETTING UP WARNING

Altering the multi-function input mode of the Elite Series completely reconfigures the logic of operation of the input control terminals. Be very sure that you understand the operating mode that you require, and that any inputs already connected will not cause the unit to automatically start once your mode is selected.

DESCRIPTIONS OF MULTI-FUNCTION INPUT MODES

0 **Disabled -** Disables all multifunction digital inputs. If the Display Unit Start/Stop-Reset is enabled from screen I1, then the motor may be started and stopped using the Display Unit. Useful for commissioning by keyboard control without interference from external inputs. **The PTC/Ext Trip input is still active in this mode.**

1 **Remote (3 Wire) Control -** Enables Start/Stop-Reset control from external inputs.

MFI 1 ASTOP-RESET
MFI 2 START
MFI 3 STOP-RESET
MFI 4 INVERT SPEED
MFI 5 INVERT TORQUE
MFI 6 SPEED/TORQUE

If the Display Unit Start/Stop-Reset are enabled from screen I1, then the motor may also be started and stopped using the Display Unit.

2 **All Programmable** - Each of the six inputs (MFI 1 to MFI 6) can individually be programmed to one of many functions, using screens I7c to I7h respectively.

3 **Multi-reference, 2 Wire** - Two of the six inputs (MFI 5, MFI 6) may be used to select from the multi-reference settings (Y, Z; refer to screens M4 to M7), allowing a selection of four preset references.

The remaining four inputs (MFI 1 to MFI 4) may be individually programmed using screens I7c to I7f respectively.

4 **Multi-reference, 3 Wire** - Three of the six inputs (MFI 4 to MFI 6) may be used to select from the multi-reference settings (X, Y, Z; refer to screens M1 to M7), allowing a selection of zero plus seven preset references.

The remaining three inputs (MFI 1 to MFI 3) may be individually programmed using screens I7c to I7e respectively.

5 **Motorised Potentiometer** - Offers reference control by UP (increase reference) or DOWN (decrease reference) push buttons.

UP (increase reference) (MFI 5) is defined as normally open and may be parallel connected to provide distributed control points. DOWN (decrease reference) (MFI 6) is defined as normally closed and may be series connected to provide distributed control points.

The speed reference source (screen I2 or I4) and/or the torque reference source (screen I3 or I5) must be set to the motorised potentiometer ("MTRPOT") selection.

MFI 1 to MFI 4 may be individually programmed using screens I7c to I7f respectively.

In Mode 5 (motorised potentiometer) adjustment is possible from minimum to maximum as follows (refer to screens M4 and M5):

MREF4 - Minimum Reference
MREF5 - Maximum Reference

By setting the minimum reference to be greater than the maximum reference, reverse control may be implemented.

The adjustment rate is scaled to allow full scale adjustment in ten seconds. On power up, the motorised potentiometer reference is set to MREF4 unless the minimum and maximum values span zero in which case the reference is set to zero.

Hints: Mode 0 is a special "safe" multi-function mode in which all inputs are disabled except for the PTC/Ext Trip Input. In this mode the Elite Series will not respond to external terminal inputs, but it will show the state and operation of the analogue and multifunction inputs on the control status display screens (screens Z3 to Z12). Before finally selecting your desired operating multifunction mode, use this mode to safely inspect the status and operation of all of your inputs. If the previous setup of the Elite Series is not known - remove the link from the External Trip input (terminal T19). This will trip the Elite Series and prevent possible instantaneous starting of the motor upon applying power.

The status of the six inputs can be observed on screen Z7.

Note: The multifunction Speed/Torque reference modes can be selected using screens I2-I5.

INPUT MODES		CONTROL INPUT TERMINAL FUNCTIONS					
NO.	NAME	INPUT 1 (Terminal 13)	INPUT 2 (Terminal 14)	INPUT 3 (Terminal 15)	INPUT 4 (Terminal 16)	INPUT 5 (Terminal 17)	INPUT 6 (Terminal 18)
0	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED
1	Remote (3 Wire) Control (3 WIRE)	ASTOP-RST	START	STP-RST	INV SP	INV TQ	SP/TQ
2	All Programmable (ALL PROG)	MFI 1	MFI 2	MFI 3	MFI 4	MFI 5	MFI 6
3	Multi-Reference 2 Wire (MULTIREF 2WRE)	MFI 1	MFI 2	MFI 3	MFI 4	Y	Z
4	Multi-Reference 3 Wire (MULTIREF 3WRE)	MFI 1	MFI 2	MFI 3	X	Y	Z
5	Motorised Potentiometer (MOTOR POT)	MFI 1	MFI 2	MFI 3	MFI 4	UP	DOWN

Figure 8.8: Multi-Function Input Mode Selection

I7b **MULTI-FUNCTION INPUT INVERSION**

Screen: I7b POLARITY=HI

Description: MULTI-FUNCTION INPUT LOGICAL INVERSION
Range: HI (Active High) or LO (Active Low)
Default Value: HI (Active High)
OFF to Modify: Yes

FUNCTION: The Elite Series has the ability to have its input circuits operated in two modes:

ACTIVE HIGH (I7b POLARITY= HI)
Pull input high to activate.

ACTIVE LOW (I7b POLARITY= LO)
Pull input low to activate.

This screen changes the biasing of the digital input circuits, to bias low when active high is selected, or bias high when active low is selected. It also changes the polarity of the input logic running in the processor.

Note 1: Changing the input polarity allows the user to select the voltage level required to close the input circuits - either 24Vdc (when configured as active high) or 0Vdc (when confirgured in active low).
Refer to Figure 8.9 for details.

Note 2: The setting of this screen is not modified when the Elite Series is initialised from Screen Y2. The default (factory set) mode for this screen is:

ACTIVE HIGH (I7b POLARITY= HI)
Pull input high to activate.

Note 3: The setting of this screen can not be modified unless Screen I7a is set to DISABLED. This is to prevent possible starting upon changing the digital input polarity.

WARNING It is strongly recommended that all Elite Series on any one site should be configured for either ACTIVE HIGH or ACTIVE LOW to minimise the risk of non-fail-safe operation if the Elite Series are exchanged. The mode would probably be set up to correspond to that used by other models of drive used on site.

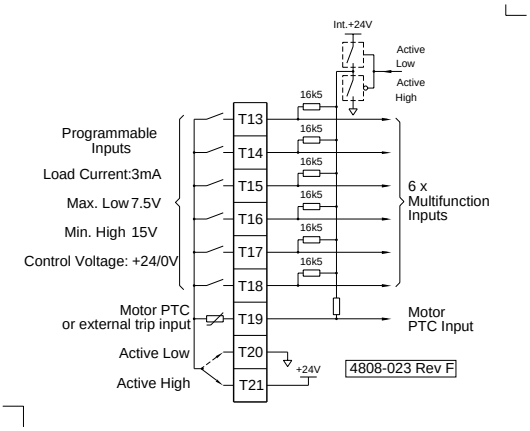


Figure 8.9: Active High / Active Low Selection

I7c - I7h **MULTI-FUNCTION INPUT SELECTIONS**

Screen: I7c MFI1 SEL= 00

Description: MULTI-FUNCTION 1 INPUT SELECTIONS; TERMINAL T13
Range: 00 to 19, refer Figure 8.10
Default Value: 00 (Unused)
OFF to Modify: Yes
Attribute: Hidden

Screen: I7d MFI2 SEL= 00

Description: MULTI-FUNCTION 2 INPUT SELECTIONS; TERMINAL T14
Range: 00 to 19, refer Figure 8.10
Default Value: 00 (Unused)
OFF to Modify: Yes
Attribute: Hidden

Screen: I7e MFI3 SEL= 00

Description: MULTI-FUNCTION 3 INPUT SELECTIONS; TERMINAL T15
Range: 00 to 19, refer Figure 8.10
Default Value: 00 (Unused)
OFF to Modify: Yes
Attribute: Hidden

Screen: I7f MFI4 SEL= 00

Description: MULTI-FUNCTION 4 INPUT SELECTIONS; TERMINAL T16
Range: 00 to 19, refer Figure 8.10
Default Value: 00 (Unused)
OFF to Modify: Yes
Attribute: Hidden

Screen: I7g MFI5 SEL= 00

Description: MULTI-FUNCTION 5 INPUT SELECTIONS; TERMINAL T17
Range: 00 to 19, refer Figure 8.10
Default Value: 00 (Unused)
OFF to Modify: Yes
Attribute: Hidden

Screen: I7h MFI6 SEL= 00

Description: MULTI-FUNCTION 6 INPUT SELECTIONS; TERMINAL T18
Range: 00 to 19, refer Figure 8.10
Default Value: 00 (Unused)
OFF to Modify: Yes
Attribute: Hidden

FUNCTION: Certain input modes are able to be selected from screen I7a which offer programmable input functions. There are a maximum of six inputs and each may be programmed individually using screens I7c to I7h. The selection of functions available is shown in Figure 8.10.

SETTING UP: Determine which input mode is required (screen I7a). Program each input, MFI 1 to 6, screens I7c to I7h, as required.

Be very careful that you have selected the correct functions.

Always check operation under safe conditions before entering the system into service.

NO.	INPUT	INACTIVE STATE	FUNCTION / NOTES
00	Unused	N/A	Input has no effect
01	Start	Open	Commands start, latching
02	Stop	Closed	Commands stop (screen S2), latching
03	Alternative Stop-Reset	Closed	Commands alternative stop (screen S4) while active; latches stop (screen S2); reset on opening edge
04	Stop-Reset	Closed	Commands stop (screen S2); latching; reset on opening edge
05	Start/Stop	Open	Commands start when closed; stop when open
06	Stop/Start-Reset	Open	As 05, but provides reset on closing edge
07	Reset	Open	Reset upon closing edge
08	Inch 1	Open	Inches (jumps to speed mode) at setting of MREF1 (screen M1); Inch is dominant only if "STOP" is closed; Closing Inch 1 and Inch 2 give Inch 3 (MREF3)
09	Inch 2	Open	Inches (jumps to speed mode) at setting of MREF2 (screen M2); Inch is dominant; Closing Inch 1 and Inch 2 gives Inch 3 (MREF3)
10	Invert Speed	Open	Inverts sign of speed reference
11	Invert Torque	Open	Inverts sign of torque reference
12	Invert Torque-Speed	Open	Inverts sign of both torque and speed references
13	Invert Inch	Open	Inverts sign of inch reference
14	Alternative Acceleration	Open	Toggles selected acceleration and deceleration rates in conjunction with screen R5 (Accel/Decel break speed)
15	Alternative Reference	Open	Selects alternative reference (screens I4, I5)
16	Speed/Torque Mode	Open	Switches to torque control mode
17	Remote/Local	Open	Disables writes by Serial Comms and Comms timeout fault
18	Start/Stop-Reset	Open	As 05, but provides rest on opening edge
19	Alternative Stop	Closed	As 03, but without reset

Figure 8.10: Multi-Function Input Functions

SUBGROUP I8: FIBRE OPTIC INPUT

Subgroup Attribute HIDDEN

I8a - I8d FIBRE OPTIC INPUT SCALING CONTROLS

Screen 

Description FIBRE INPUT LOW SETPOINT
Range -400% to +400%
Units % of motor rated synchronous speed or torque
Default Value -100%
OFF to Modify No
Attribute Read Only

FUNCTION Defines the scaling of the Fibre Optic input.

Screen 

Description FIBRE INPUT HIGH SETPOINT
Range -400% to +400%
Units % of motor rated synchronous speed or torque
Default Value +100%
OFF to Modify No
Attribute Read Only

FUNCTION Defines the scaling of the Fibre Optic input.

Screen 

Description FIBRE OPTIC CONTROL MODE SELECTION
Range 0-5, refer Figure 8.11
Default Value 0 (No Control)
OFF to Modify Yes
Attribute Read Only

FUNCTION A master/slave fibre optic network enabling synchronised starting/stopping and fault response of the Elite Series connected via a fibre optic loop. Refer General Application Note 4216-045 for more detail.

SETTINGUP Only one Elite Series in the loop should be set to master.

NO.	FIBRE MODE	FUNCTION
0	NO CONTROL	No response to the fibre optic control
1	MASTER	Overall control of the network
2	SLAVE	Full slave control
3	SLAVE TRIP	Slave control with Trip/Reset related control only
4	SLAVE RUN	Slave control with run control only
5	SLAVE RUN/STP	Slave control with run control and stop on trip

Figure 8.11: Fibre Optic Control Mode Selection

Note: The setting on this screen does not affect the transmission or reception of reference information which is controlled by screens I8a, I8b, and O3a.
Setting the Control Mode to a Fibre Mode other than 0 (No Control) may result in any of the Elite Series on the fibre Network starting automatically. An MFI configured as a STOP function will override a RUN command received over the Fibre Network.

I8a

I8b

I8c

I8d

Screen: I8d FIB T/O=OFF

Description: FIBRE OPTIC INPUT TIMEOUT PERIOD
Range: 1s / 5s / 25s / OFF
Units: Sec
Default Value: OFF
OFF to Modify: Yes

FUNCTION: Provides the option of tripping the Elite Series (indicates "F27 FIBRE T/O") if the time since the last valid fibre optic input signal has exceeded the timeout period.

SCREEN GROUP L: LIMITS

Group Attribute: READ ONLY

L2

L2, L3 SPEED LIMITS

Screen: L2 MIN S=-110%

Description: MINIMUM SPEED
Range: -250% to L3 (Maximum Speed)
Units: % of motor rated synchronous speed
Default Value: Frames 1 to 4 - -110%
Frames 5 to 7 - 0%
OFF to Modify: No

L3

Screen: L3 MAX S=+110%

Description: MAXIMUM SPEED
Range: L2 (Minimum Speed) to +250%
Units: % of motor rated synchronous speed
Default Value: +110%
OFF to Modify: No

FUNCTION: Sets the speed limits within which the Elite Series can be commanded to operate the motor. Commands to operate beyond these limits (e.g. from speed reference input, or as a result of speed control demands) will be limited to these limits.

Note that a negative reference speed implies motor operation in reverse.

SETTING UP: Adjust minimum and maximum speed limits according to your application requirements.

L4

L4, L5 TORQUE LIMITS

Screen: L4 MIN T=-150%

Description: MINIMUM TORQUE
Range: -250% to L5 (Maximum Torque)
Units: % of rated motor torque
Default Value: -150%
OFF to Modify: No

L5

Screen: L5 MAX T=+150%

Description: MAXIMUM TORQUE
Range: L4 (Minimum Torque) to +250%
Units: % of rated motor torque
Default Value: +150%
OFF to Modify: No

FUNCTION: Sets the torque limits within which the Elite Series can be commanded to operate the motor. Commands to operate beyond these limits (e.g. from torque reference input, or as a result of speed control demands) will be limited to these limits.

SETTING UP: Adjust minimum and maximum torque limits according to your application limits.

Note: The motor will draw current in approximate proportion to the torque demanded. Therefore be sure that the Elite Series connected is able to supply the current necessary to supply the torque required. Do not select minimum or maximum torque which will require the Elite Series to produce more than 150% of its rated output current.

When running in Closed Loop control mode, torque limiting will be indicated if the shaft encoder signals are lost.

L6

L7

L8

L9

L6, L7 TIMEOUT CONTROLS

Screen

Description SPEED LIMIT TIMEOUT
Range 0 to 25 sec / INF (Infinite)
Units Seconds
Default Value INF (Infinite)
OFF to Modify No

Screen

Description TORQUE LIMIT TIMEOUT
Range 0 to 25 sec / INF (Infinite)
Units Seconds
Default Value INF (Infinite)
OFF to Modify No

FUNCTION To provide the option of automatically tripping the Elite Series if the speed or torque limits are encountered for a period of time between 0 and 25 seconds.

SETTING UP The Elite Series will automatically limit speed or torque (screens L2 - L5) if required. In some processes this is normal and may occur continuously, in which case these screens should be set to never timeout - i.e. Set to infinite.

In other processes, such activity indicates loss of process control which may be tolerated for a brief period of time, or may call for immediate tripping of the process. In such cases these screens may be set to the appropriate time.

Torque limit timeout control also protects against shaft encoder signal loss when running in Closed Loop control mode.

Zero settings equate in action to instantaneous speed or torque shear-pin functions.

Note: The Torque limit timeout is also used for Current limit timeout.

L8 REGENERATION LIMIT

Screen

Description REGENERATION LIMIT
Range 0 to 250%
Units % of motor power
Default Value 150%
OFF to Modify No

Note: Regeneration Limit only applies to Elite Series operating in Open Loop or Closed Loop Vector mode.

FUNCTION When the sign of the load torque and motor speed are different the motor acts as a generator (e.g. when decelerating high inertia loads).

This function automatically limits the torque applied (by controlling motor speed) to control the amount of regenerated power. The object of this is to keep the regenerated power within the system's capabilities (whether relying on natural losses or using a dynamic brake).

In utilising this function the optimum braking performances can be achieved without danger of loss of control due to regeneration beyond the system's ability to dispose of it.

SETTING UP If the application does not involve regeneration, this screen need not be adjusted. When relying on natural losses to dissipate regenerated power adjust this level to the estimated loss level (typically 5 to 10 percent) and confirm correct (i.e. trip free) operation by experiment.

When utilising a dynamic brake, set this screen to the appropriate (short or long term) power limit level according to the application requirement and brake dissipation capability.

L9 CURRENT LIMIT CONTROLS

Screen

Description CURRENT LIMIT
Range 0.25 / 1.50 times Elite Series nominal rating
Default 1.2 times Elite Series nominal rating
OFF to Modify No

FUNCTION To maintain load current within controllable bounds (status = ILT). Torque limit timeout (screen L7) provides a setable maximum time of active current limit, beyond which the Elite Series will automatically trip (Fault status = TQ LIM T/O).

If the torque limit timeout period is set at zero, the current limit function effectively acts as a "SHEARPIN", providing rapid over-torque protection.

In Open Loop mode, the current limit is restricted to 125% of the drive current rating even if the value entered is higher. This is to preserve the integrity of the current waveshape, which is important for Open Loop mode control.

SETTING UP Where not strictly part of the required setup for the particular application leave this set at 1.2 x Elite Series nominal rated current (refer Figures 2.1 to 2.4).
If there is a particular requirement for this function (e.g. for torque limiting or to ensure the motor cannot approach the overload setting and thus will not trip out) set the current limit to the desired value.

Hints: For normal operation, avoid choosing values much below the motor's rated current as various effects (starting torque settings, rapid acceleration or deceleration) can lead to confusing results.

In a well set up application current limit should never be required. Current limit acts to override incorrect Elite Series setup or load problems. If current limit action is observed during normal operation of the Elite Series or process, check that the setup is correct - particularly check acceleration, deceleration, motor parameters and boost settings.

L10 to L12 SKIP SPEEDS

Screen: L10 SKIP1= +0.0%

Description SKIP SPEED 1
Range -250% to +250%
Default 0%
OFF to Modify No

Screen: L11 SKIP2= +0.0%

Description SKIP SPEED 2
Range -250% to +250%
Default 0%
OFF to Modify No

Screen: L12 SK BW=0.0%

Description SKIP BANDWIDTH
Range 0% to 20%
Default 0%
OFF to Modify No

FUNCTION Refer to Figure 8.12.
To provide two zones of reference speeds that cannot be set. The object is to provide "keep out" area of operation which may be selected so that natural mechanical system resonances can be avoided.
Skip speeds 1 and 2 define the middle of each skip zone. The skip bandwidth defines the width of the zones.

SETTING UP Complete other commissioning first. Determine points, and breadths of any (two) mechanical resonances in your system. Enter skip speeds and desired bandwidth.

To turn off skip speeds set SK BW to 0.0%.

Check operation and readjust as necessary.

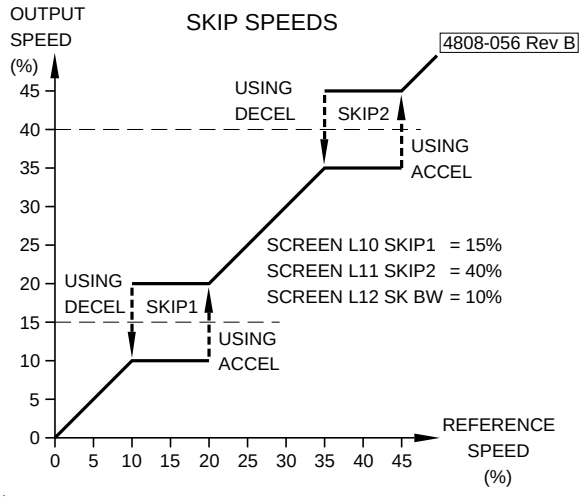


Figure 8.12: Skip Speeds

L13 GROUND CURRENT LIMIT

Screen: L13 GND ILT= 12A

Description GROUND CURRENT LIMIT
Range OFF / 0.1 to 9999A
Units Amps/Phase
Default 30% of Inverter rated current per phase

FUNCTION To set the limit of ground current that is acceptable.

L14 RUN AT MINIMUM SPEED

Screen: L14 MIN SP RUN=Y

Description RUN AT MINIMUM SPEED
Range Y (Yes) / N (No)
Default Y (Yes)

FUNCTION If set to N (No) then the Elite Series will change to the READY state if the reference speed is reduced to below the minimum speed while running.

L10 L11 L12 L13 L14

M1

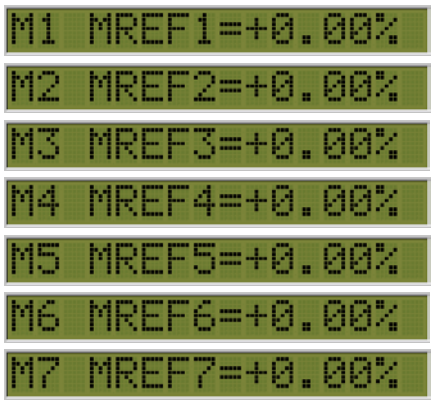
SCREEN GROUP M: MULTI-REFERENCE SETPOINTS

M2

Group Attribute HIDDEN

M3

Screens



M4

M5

M6

Description MULTI-REFERENCE SETPOINTS
Range -250% to +250%
Units % of rated motor speed or torque
Default Value 0.00%
OFF to Modify No

M7

FUNCTION These are reference setpoints into which user values can be loaded.

SCREEN	TITLE	SPECIAL FUNCTIONS
M1	MREF1	INCH1
M2	MREF2	INCH2
M3	MREF3	INCH3
M4	MREF4	MOTOR POT MIN
M5	MREF5	MOTOR POT MAX

Figure 8.13: Multi-Reference Special Functions

Note: Figure 8.13 shows special functions that can be assigned to the multi-reference setpoints using either the Motorised Pot input mode or All Programmable input mode (screen I7a) with INCH 1 and INCH 2 multi-function input selection in screens I7c to I7h.

SCREEN	TITLE	MULTI-REFERENCE FUNCTIONS	
		Y MFI 5 (T17)	Z MFI 6 (T18)
M4	MREF4	O	O
M5	MREF5	O	X
M6	MREF6	X	O
M7	MREF7	X	X

O = Open, X = Closed

Figure 8.14: Multi-Reference 2 Wire Functions

Note: Figure 8.14 shows special functions assigned to Multi-reference setpoints MREF4 to MREF7 when using multi-function input mode 03 (MULTIREF 2WRE) selected from screen I7a. Multi-reference setpoints MREF1 to MREF3 are available as in Figure 8.13.

SCREEN	TITLE	MULTI-REFERENCE FUNCTIONS		
		X MFI 4 (T16)	Y MFI 5 (T17)	Z MFI 6 (T18)
	ZERO	O	O	O
M1	MREF1	O	O	X
M2	MREF2	O	X	O
M3	MREF3	O	X	X
M4	MREF4	X	O	O
M5	MREF5	X	O	X
M6	MREF6	X	X	O
M7	MREF7	X	X	X

O = Open, X = Closed

Figure 8.15: Multi-Reference 3 Wire Functions

Note: Figure 8.15 shows special functions assigned to multi-reference setpoints MREF1 to MREF7 when using multi-function input mode 04 (MULTIREF 3WRE).

SETTINGUP Adjustment is only necessary when a function requiring multi-references is selected.

Determine the speed or torque reference level needed for each state and enter this value.

SCREEN GROUP N:
MOTOR NAMEPLATE DATA

Group Attribute HIDDEN

Screen N1 MTR CUR= 0.0A

Description RATED (NAMEPLATE) MOTOR CURRENT
Range 20% to 150% of Elite Series Size
Units Amps
Default Value 75% (Dependent on Elite Series model)
OFF to Modify No
Attribute Read Only

Screen N2 MTR VOLT=400V

Description RATED (NAMEPLATE) MOTOR VOLTAGE
Range 0 to 999V
Units Volts
Default Value 400
OFF to Modify No
Attribute Read Only

Screen N3 MTR FRQ= 50Hz

Description RATED (NAMEPLATE) MOTOR FREQUENCY
Range 25 to 400Hz
Units Hertz
Default Value 50
OFF to Modify No
Attribute Read Only

Screen N4 MTR P =0.00kW

Description RATED (NAMEPLATE) MOTOR POWER
Range 0 to 650kW,
50% to 150% of Elite Series rated kW
Units Kilo Watts
Default Value Dependent on Elite Series model
OFF to Modify No
Attribute Read Only

Note: If the motor nameplate power is listed in horsepower(hp) then convert to kilowatts(kw) by using the following formula:

$$kW = \frac{hp \times 746}{1000}$$

Screen N5 MTR RPM= 0

Description RATED (NAMEPLATE) MOTOR SPEED
Range 200 to 24000 RPM
Units Revolutions per minute
Default Value Dependent on Elite Series model
OFF to Modify No
Attribute Read Only

Screen N6 MTR COOL= 40%

Description MOTOR COOLING AT ZERO SPEED
Range 20 to 100% / OFF
Units % of cooling at rated speed
Default Value 40%
OFF to Modify No
Attribute Read Only

FUNCTION Calibrates the Elite Series for the motor being driven. Provides information for the thermal model motor protection.

The Elite Series must be correctly sized to control the motor being driven. The motor should be between 50% and 150% of the Elite Series rated power (kW) and the motor must have between two and twelve poles.

The thermal model includes correction for the reduced efficiency of standard motor cooling at reduced speed by interpolating between the zero speed cooling term (screen N6) and rated cooling at rated speed (refer Figure 4.2). The thermal model is reset when power is removed from the Elite Series.

SETTING UP These parameters must be set before operating the Elite Series. Invalid combinations of values will be detected as "Parameter Fault" error, tripping the Elite Series.
Enter motor rated (nameplate) parameters - current, voltage, frequency, power and speed (rpm). Where the nameplate includes multiple options or the configuration (star/delta) of the windings has been altered, be sure to enter the correct data for your configuration.
Estimate the efficiency of cooling of your motor at zero speed and enter this figure. (This is very application dependent - as a guide, 40% is typical. Where open frame, force cooled or water cooled motors are used, higher zero speed cooling efficiency will be achieved.) If extended operation at low speed leads to tripping due to the motor thermal model, check the motor. If it is clearly not very hot, the zero speed cooling figure may be safely increased. The motor thermal model may be disabled by setting the motor cooling parameter to OFF. Independent external thermal protection should then be applied to the motor.

N8 ENCODER SENSOR CALIBRATION

Screen N8 ENCODER= 0

Description PULSES PER REVOLUTION OF TACHO ENCODER
Range 0 to 8191 ppr
Units Pulses per revolution
Default Value 0
OFF to Modify No

FUNCTION To operate the Elite Series in Closed Loop Vector control mode, feedback of the motor shaft position is required. The Elite Series is designed to accept input from an incremental shaft encoder. This parameter calibrates the Elite Series to the number of pulses per motorshaft revolution generated by the encoder.

SETTING UP Enter the encoder's number of pulses per motor shaft revolution. Any gearing between the motor and encoder must be taken into account.

Note: See also Section 4.2.

Full details on selection and mounting of the shaft encoder are detailed in Section 5.4.7.

Full details on checking of the shaft encoder are detailed in Section 10.

N9

N9 ENCODER INPUT TYPE SELECTION

Screen

Description SELECTION OF THE TYPE OF ENCODER
Range SING (Single-ended) / DIFF (Differential)
Default Value DIFF (Differential)
OFF to Modify Yes

FUNCTION The input circuit on the control board can be configured to accept either style of shaft encoder. Differential type is recommended for its superior noise-rejection capabilities.

Note: Full details on selection and mounting of the shaft encoder are detailed in Section 5.4.7.

Full details on checking of the shaft encoder are detailed in Section 10.

SCREEN GROUP O: OUTPUTS

Group Attribute HIDDEN

SUBGROUP O1: ANALOGUE OUTPUTS

Subgroup Attribute Read Only

O1a

O1e

O1a, O1e ANALOGUE OUTPUTS SOURCE SELECTION

Screens

Description ANALOGUE OUTPUT SOURCE SELECTION
Range 00 to 19 - refer figure 8.16
Default Value AO1 O/P= 06 (Motor Speed)
AO2 O/P= 02 (Output Current)
OFF to Modify Yes

FUNCTION Provides the ability to select the driving source for each of the two analogue outputs, from the following list:

NO.	SOURCE	UNITS
00	NULL	minimum signal output
01	FULL SCALE	maximum signal output
02	OUTPUT CURR	% of motor rated current
03	OUTPUT VOLTS	% of motor rated voltage
04	BUS VOLTAGE	% of motor rated voltage x 1.414
05	MOTOR POWER	% of motor rated power
06	MOTOR SPEED	% of motor rated speed
07	MOTOR TORQUE	% of motor rated torque
08	REF SPEED	% of motor rated speed
09	REF TORQUE	% of motor rated torque
10	MOTOR TEMP	% of motor rated temperature
11	INVERTER TEMP	% of inverter rated temperature
12	ANALOGUE IN 1	%
13	ANALOGUE IN 2	%
14	ANALOGUE IN 1+2	%
15	FIBRE IN	%
16	PROCESS REF	%
17	PROCESS FEEDBACK	%
18	PROCESS ERROR	%
19	VYSTA CONTROL	%

Figure 8.16: Analogue and Fibre Output Source Selection

SETTINGUP Select the desired analogue signal source for each of the two analogue outputs.

Select the format of each output using Screens O1b, O1f. Adjust the scaling using Screens O1c and O1d for Analogue Output 1, and O1g and O1h for Analogue Output 2.

O1b-O1d, O1f-O1h

ANALOGUE OUTPUT FORMATTING AND SCALING CONTROLS

Screen `O1b AO1=+/-10V`

Description ANALOGUE OUTPUT 1 FORMAT
Range Refer figure 8.17
Default Value +/-10V
OFF to Modify Yes

Screen `O1c AO1 LO=-100%`

Description ANALOGUE OUTPUT 1 LOW SETPOINT
Range -250% to +250%
Units %
Default Value -100%
OFF to Modify No

Screen `O1d AO1 HI=+100%`

Description ANALOGUE OUTPUT 1 HIGH SETPOINT
Range -250% to +250%
Units %
Default Value +100%
OFF to Modify No

Screen `O1f AO2=+/-10V`

Description ANALOGUE OUTPUT 2 FORMAT
Range Refer figure 8.17
Default Value +/-10V
OFF to Modify Yes

Screen `O1g AO2 LO=-100%`

Description ANALOGUE OUTPUT 2 LOW SETPOINT
Range -250% to +250%
Units %
Default Value -100%
OFF to Modify No

Screen `O1h AO2 HI=+100%`

Description ANALOGUE OUTPUT 2 HIGH SETPOINT
Range -250% to +250%
Units %
Default Value +100%
OFF to Modify No

CODE	ANALOGUE OUTPUT FORMAT
0-10V	0 to 10Vdc, > 1 kohm load
+/-10V	-10 to +10Vdc, > 1 kohm load
4-20mA	4 to 20 mA, < 500 ohm load
0-20mA	0 to 20 mA, < 500 ohm load

Figure 8.17: Analogue Output Format Selection

FUNCTION Provides the ability to change each of the two analogue outputs to one of the four formats listed in Figure 8.17.

SCALING AO1 LO / AO2 LO
Maps the AO1 LO / AO2 LO level to the minimum output signal level for the selected output format.

AO1 HI / AO2 HI
Maps the AO1 HI / AO2 HI level to the maximum output signal level for the selected output format.

The Elite Series analogue outputs are interpolated linearly between the selected LO and HI settings.

LO settings may be greater than HI settings, thus providing inverse control (i.e. increasing the analogue output source level decreases the analogue output signal level).

SETTING UP No action is required if no devices are connected to these terminals.

Determine the required format of these analogue outputs to suit the external devices being driven by their respective output terminals, and set up on Screens O1b, O1f.

Determine the range over which analogue control is desired.

Adjust the LO setting (screens O1c, O1g) to the desired minimum analogue output signal (-10V/0V/4mA/0mA).

Adjust the HI setting (screens O1d, O1h) to the desired maximum analogue output signal (+10V/20mA).

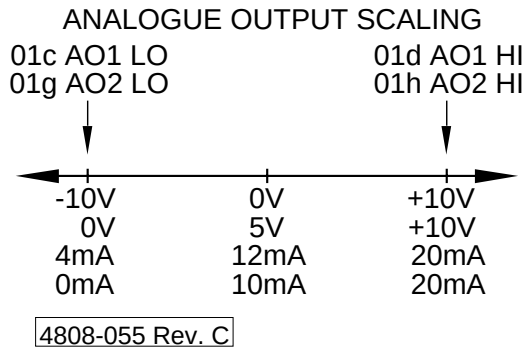


Figure 8.18: Analogue Output Scaling

Each analogue output may be tested by selecting its source to be FULL SCALE (screens O1a, O1e to selection 01).

Example 1: Analogue Output 1 (AO1) is formatted as a ±10V output and is used to drive an analogue meter to represent motor speed for a 1440 rpm motor across the range -3000 rpm to +3000 rpm.

Set the source via screen O1a to:
O1a AO1 O/P=06 (actual motor speed)

Set the format via screen O1b to:
O1b AO1=+/-10V (-10Vdc to +10Vdc)

Set the scaling via screens O1c and O1d to:
O1c AO1 LO= -200%
O1d AO1 HI=+200%
of rated synchronous speed of 1500 rpm.

With this setup, Analogue Output 1 (AO1) would output -4.8Vdc when the motor was rotating in the reverse direction at 1440 rpm.

$$\left(\frac{\text{Actual Motor Speed}}{\text{Rated Synchronous Speed}}\right)\times\frac{10\text{V}}{200\%/100\%}=-4.8\text{V}$$

Where actual motor speed = -1440rpm and rated synchronous speed = 1500rpm.

O2a

O2c

O2e

O2b

O2d

O2f

Example 2: Analogue Output 2 (AO2) is formatted as a 4-20mA output and is used to drive into a 4-20mA PLC analogue input to represent motor current for a 20A motor across the range 0A to 50A.

Set the source via screen O1e to:
O1e AO2 O/P=02 (actual motor current)

Set the format via screen O1f to:
O1f AO2=4-20mA

Set the scaling via screens O1g and O1h to:
O1g AO2 LO=0.0%
O1h AO2 HI=+250%

With this setup, Analogue Output 2 (AO2) would source 10.4mA when the motor was drawing 20A.

SUBGROUP O2: DIGITAL O/P RELAYS

Subgroup Attribute Read Only

O2a, O2c, O2e RELAY SELECTIONS

Screens

Description RELAY CONTROL SOURCE SELECTION
Range 00 to 23, refer figure 8.19
Default Value RELAY1 = 02 (No faults)
RELAY2 = 05 (Overload fault)
RELAY3 = 08 (Run)
OFF to Modify No

FUNCTION Provides the ability to link each relay to one of the outputs shown in figure 8.19.

All relays have a 250ms minimum pulse width.

SETTINGUP No action required if relays are not to be used.

Select the desired source for each relay. If necessary, set up associated level setting screens (i.e. comparators C1 to C6).

O2b, O2d, O2f RELAY INVERSION

Screens

Description INVERT THE LOGIC OF THE OUTPUT RELAY
Range Y (Yes) / N (No)
Default Value N (No)
OFF to Modify No
Attribute Hidden

FUNCTION Provides the ability to invert the function of each output relay if desired.

SETTINGUP No action required unless relays are used and an inverted output is necessary.

Determine desired logic inversion and select as necessary.

Note: RELAY1 has both normally open contacts (T1, T2) and normally closed contacts (T2, T3).

RELAY2 has normally open contacts (T4, T5).

RELAY3 has normally open contacts (T6, T7).

NO.	DISPLAY	ENERGISED STATE	DISCRIPTION
00	ALWAYS OFF	N/A	Can be used to manually force this state.
01	ALWAYS ON	Drive Powered	Indicates supply present at drive.
02	NO FAULTS	No Fault	No faults present; failsafe.
03	DRIVE FAULT	Fault	Drive related fault or low supply.
04	SUPPLY FAULT	Fault	Supply phase fault or low supply.
05	O/L FAULT	Fault	Motor or drive overload trip
06	O/L WARNING	Warning	Motor or drive predictive overload; warning.
07	START	Started	Drive has responded to a start command.
08	RUN	Running	Drive is active; running.
09	ZERO SPEED	Standstill	Motor at standstill (+/-1% of its rated speed).
10	AT SET SPEED	At Set Speed	Motor at set speed (+/-1% of set speed).
11	TORQUE SIGN	Negative (-)	Sign of direction of motor torque.
12	SPEED SIGN	Reverse (-)	Sign of direction of motor speed.
13	TQ REF SIGN	Negative (-)	Sign of direction of reference torque.
14	SP REF SIGN	Reverse (-)	Sign of direction of reference speed.
15	SPEED LIMIT	At Limit	Drive is operating at either speed limit (screen L2, L3).
16	TORQUE LIMIT	At Limit	Drive is operating at either torque limit (screen L4, L5).
17	VOLTAGE LIMIT	Voltage Limiting	Drive is operating at voltage limit.
18	CURRENT LIMIT	Current Limiting	Drive is operating at current limit.
19	COMPARATOR 1	Above ON Level	De-energises below OFF level (screens C2, C3).
20	COMPARATOR 2	Above ON Level	De-energises below OFF level (screens C5, C6).
21	WINDOW COMP	Inside Window	Comparator 1 ON and Comparator 2 OFF.
22	BRAKE RELEASE	Release	See Brake Release.
23	VYSTA CONTROL		Controlled by Vysta program.

Figure 8.19: Relay Source Selection

Brake Release:

This function can be used to release a mechanical brake on the motor. The output is activated after the start delay period and deactivated one second before the end of the off delay period (refer screens S6, S12 and S13).

For further details on the operation of the brake release function refer General Application Note 4216-058.

SUBGROUP O3: FIBRE OUTPUT

Subgroup Attribute Hidden

O3a FIBRE OUTPUT SOURCE SELECT

Screen: O3a FIBRE O/P=06

Description FIBRE OUTPUT SOURCE SELECTION
Range 00 to 19 - refer Figure 8.16
Default Value 06 (Motor Speed)
OFF to Modify No
Attribute Read Only

FUNCTION Provides the ability to select the driving source for the Fibre Optic output.

SETTING UP Select the desired fibre signal source from Figure 8.16.

SCREEN GROUP P: PROCESS CONTROL

Group Attribute HIDDEN

Introduction The Elite Series process controller is a fully featured PID regulator. The setpoint and feedback sources may be selected from a wide choice of options. If selected the PID output is routed at the reference source to provide a speed or torque reference source (refer screens I2, I4, I3, I5). Refer to Application Note 4216-048 for more detail about using the process controller.

Tuning The process controller may be tuned using manual Ziegler-Nichols techniques or by starting with the default values:

Increase the Controller Gain (screen P3) until oscillation first occurs; then set to approximately 40% this setting.

Decrease the Integration Time (screen P4) until oscillation occurs; then set back to approximately 150% this setting.

Increase the Differential Time (screen P5) until minimal overshoot has been achieved but oscillation has not occurred. Typically the Differential Time would not exceed 25% of the Integration Time.

P1 PROCESS CONTROL SETPOINT SOURCE

Screen: P1 PR SRC=NULL

Description PROCESS CONTROL SETPOINT SOURCE
Range Refer Figure 8.20
Default Value NULL
OFF to Modify Yes
Attribute Read Only

FUNCTION Defines which input source is used as the setpoint source for process control.

CODE	PROCESS CONTROL SETPOINT SOURCE
NULL	NO SOURCE SELECTED
AIN1	ANALOGUE INPUT 1
AIN2	ANALOGUE INPUT 2
AIN1+2	ADDITION OF SCALED ANALOGUE INPUTS 1 + 2
FIBRE	FIBRE OPTIC INPUT
LOCAL	LOCAL SPEED / TORQUE CONTROL (SCREENS A3 / A2)
MREF	MULTI-REFERENCE (SCREENS I7a, M1 TO M7)
MTRPOT	MOTORISED POTENTIOMETER (SCREEN I7a)

Figure 8.20: Process Control Setpoint Source

SETTING UP Select the desired process control setpoint source to suit your requirements. Refer to Figure 3.10.

O3a
P1

P2

P2 PROCESS CONTROL FEEDBACK SOURCE

Screen

P3

Description PROCESS CONTROL FEEDBACK SOURCE
Range Refer Figure 8.21
Default Value NULL
OFF to Modify Yes
Attribute Read Only

P4

FUNCTION Defines which input source is used as the feedback source for process control.

CODE	PROCESS CONTROL FEEDBACK SOURCE
NULL	NO SOURCE SELECTED
AIN1	ANALOGUE INPUT 1
AIN2	ANALOGUE INPUT 2
AIN1+2	ADDITION OF SCALED ANALOGUE INPUTS 1 + 2
FIBRE	FIBRE OPTIC INPUT

Figure 8.21: Process Control Feedback Source

SETTINGUP Select the desired process control feedback source to suit your requirements. Refer Figure 3.10.

P3, P4, P5 PROCESS CONTROL PID SETTINGS

Screen

Description CONTROLLER GAIN (Kc)
Range 0.01 to 10.0
Default Value 0.10
OFF to Modify No
Attribute Read Only

FUNCTION Defines the controller gain (Kc) of the process controller.

SETTINGUP Select the desired controller gain to suit your requirements.

Screen

P5

Description INTEGRATION TIME (Ti)
Range 1s to 1000s / INF (Infinite)
Default Value INF (Infinite)
OFF to Modify No
Attribute Read Only

P6

FUNCTION Defines the integration time of the process controller.

P7

SETTINGUP Select the desired integration time to suit your requirements.

Anti-windup protection limits the process controller integrator.

Setting the integration time too small leads to faster error correction but the possibility of overshoot or instability.

Note: The process controller has a sampling period (Ts) of 100ms.

Screen

Description DIFFERENTIATION TIME (Td)
Range 0.0s to 250s
Default Value 0.0s
OFF to Modify No
Attribute Read Only

FUNCTION Defines the differentiation time of the process controller.

SETTINGUP Select the desired differentiation time to suit your requirements. Typically left at the default value of 0.0s for pump and HEVAC applications.

Screen

Description PROCESS ERROR
Default Value 0.0%
Attribute Read Only

FUNCTION Displays the difference between the process setpoint (screen P1) and the process feedback (screen P2).

Screen

Description INVERT PID
Range Y (Yes) / N (No)
Default Value N (No)
Attribute Read Only

FUNCTION Setting this screen to Y (Yes) inverts the output of the PID.

When set to N (No), the PID response to a drop in the feedback signal is to increase the output speed. This is typically the response required when using the PID for constant pressure control. A drop in pressure (feedback) due to a higher demand will require the pump speed to increase to maintain the pressure.

When set to Y (Yes), the PID response to a drop in the feedback signal is to decrease the output speed. This is typically the response required when using the PID for temperature control. A decrease in temperature (feedback) due to a lower demand will require the cooling fan speed to decrease to maintain the temperature.

SCREEN GROUP R: ACCEL / DECEL RATES

Group Attribute HIDDEN

R1, R2 ACCELERATION AND DECELERATION RATES

Screen: R1 ACC =10.0%/s

Description ACCELERATION RATE

Screen: R2 DEC =10.0%/s

Description DECELERATION RATE
Range 0.02 to 1300%/sec
Units % of motor rated synchronous speed per second
Default Value 10.0%/s
OFF to Modify No
Attribute Read Only

FUNCTION Controls the rates of change of speed (acceleration or deceleration) of the Elite Series.

SETTING UP These rates should be set according to suitability to a process. In high performance applications it may be desirable to calculate the maximum rates with respect to torque capability of the drive system and motor/load inertia. In some cases it may be desirable to adjust the rate to a very high level and rely on the automatic torque limit function - this will give the fastest response.

Generally, use the slowest settings acceptable for your application. An acceleration rate which is too fast may cause the drive to overload (status ILT) and automatically override your setting with a slower one. A deceleration rate which is too fast can cause the motor to regenerate (status VLT) into the drive and automatically override your setting with a slower one.

Being realistic with these settings generally leads to a more successful commissioning. Where fast accelerations/decelerations are called for, it is often best to use slower settings initially, until all other operations are proven.

Freewheel to stop (instead of controlled deceleration) can be achieved by setting the Stop mode (screens S2, S4) to spin or OFF.

Regeneration limit may be used to automatically provide maximum deceleration rate for the given losses of a system as an alternative to fixed deceleration. See screen L8.

EXAMPLE For a 4 pole 50Hz motor with rated synchronous speed of 1500rpm; setting 5%/s acceleration rate would accelerate the motor from 0% speed (standstill) to 100% speed (1500rpm) in 20s.

Note: Remember when using extended (long) deceleration rates, adjust the Stop Timeout (screen S11) appropriately.

R3, R4, R5 ALTERNATIVE ACCELERATION RATES

Screen: R3 AACC=10.0%/s

Description ALTERNATIVE ACCELERATION RATE
Range 0.02 to 1300%/sec
Units % of motor rated synchronous speed per second
Default Value 10.0%/s Frames 1 to 3
5.0%/s Frame 4
2.0%/s Frames 5 to 7
OFF to Modify No
Attribute Read Only

Screen: R4 ADEC=10.0%/s

Description ALTERNATIVE DECELERATION RATE
Range 0.02 to 1300%/sec
Units % of motor rated synchronous speed per second
Default Value 10.0%/s Frames 1 to 3
5.0%/s Frame 4
2.0%/s Frames 5 to 7
OFF to Modify No
Attribute Read Only

Screen: R5 BRK SP= OFF

Description BREAK SPEED FOR ALTERNATIVE ACCEL/DECEL
Range OFF / 0.1 TO 250%
Units % of motor rated synchronous speed
Default Value OFF
OFF to Modify No
Attribute Read Only

FUNCTION These alternative acceleration and deceleration settings are provided to offer the ability to achieve alternative rates. They may be accessed in two ways:

i) Access by break point

Screen R5 is used to select a break speed **below** which the alternative rates are active.

ii) Access by utilising alternative acceleration rate multi-function control

A multi-function input (Option 14, screens I7c to I7h) via screen I7a. The acceleration/deceleration rates which are not currently in use (as controlled by screen R5) are chosen when the input is active (closed).

SETTING UP Program the desired control (multi-function input selection or break point) as desired. Set the alternative rates to the desired levels.

The break speed for alternative accel/decel (screen R5) defaults to zero, effectively disabling the alternative rates for normal use.

R1 R2 R3 R4 R5

R6

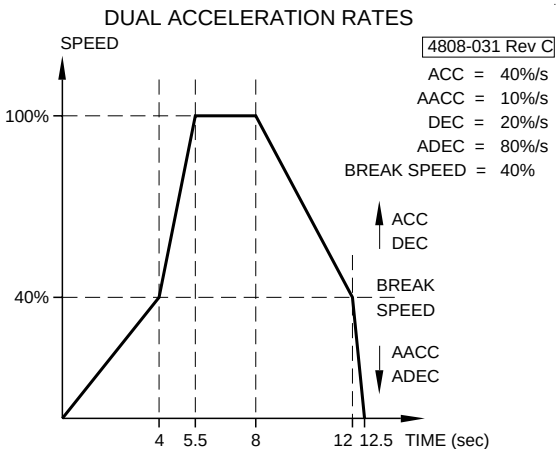


Figure 8.22: Dual Acceleration/Deceleration Rates

Note: Remember when using extended (long) deceleration rates, adjust the Stop Timeout (screen S11) appropriately.

R6 STOP DECELERATION RATE

Screen: R6 STOPR=1300%/s

Description: DECELERATION (STOPPING) RATE USED WHEN STOPPING
Range: 0.02 to 1300%/sec
Units: % of motor rated synchronous speed per second
Default Value: 1300
OFF to Modify: No
Attribute: Read Only

FUNCTION: When the Elite Series receives a "stop-rate" command (see screens S2, S4) this deceleration rate is used.

This provides the ability to separately program running accel/decel rates (e.g. to suit a control system) and a different stop-rate (e.g. to provide a very fast stop for safety reasons).

This function overrides normal and alternative deceleration rates.

R7

SETTINGUP: If this function is desired, set to the appropriate deceleration rate. Set desired stop mode screen (screen S2, S4) to STOPR.

R8

R7 SPEED FILTER TIME CONSTANT

Screen: R7 SP FLT=0.000s

Description: SPEED S-CURVE FILTER TIME CONSTANT (used to "soften" acceleration and deceleration)
Range: 0 to 60s
Units: Seconds for 100%/s change in acceleration and deceleration
Default Value: 0.0s/100%/s Frames 1 to 3
1.0s/100%/s Frame 4
2.0s/100%/s Frames 5 to 7
OFF to Modify: No
Attribute: Read Only

FUNCTION: Provide "S-CURVE" filtering to changes in speed reference, including STOP and START commands. The S Curve filter limits the changes of acceleration and deceleration. It is often used to "soften" acceleration and deceleration, especially in hoists and elevators.

Also useful for improving deceleration under high inertia.

Active only in speed control mode. Not active during Stop Rate stop.

SETTINGUP: Leave set at the default value if not required. Setting at a value other than 0 will affect the unit's ability to follow a speed profile. Increase this value to improve deceleration under voltage limits.

R8 TORQUE FILTER TIME CONSTANT

Screen: R8 TQ FILT=0.00s

Description: TORQUE FILTER TIME CONSTANT
Range: 0 to 10.0 sec
Units: Seconds
Default Value: 0.0 sec
OFF to Modify: No
Attribute: Read Only

FUNCTION: Provides low-pass filtering to changes in torque reference, including STOP and START commands. This controls the rate of change of output torque.

It is often used to "soften" changes in torque. It is especially useful when changing the sign of the torque. If there is any backlash in the mechanical system it can soften the taking up of the backlash.

Active only in torque control modes.

SETTINGUP: Adjust if the shock due to sudden changes in commanded torque exhibit undesirable effects in the mechanical system.
If the time constant is set to one second, the response to a 100% torque reference step change will be a 63% change in the reference torque after one second.

SCREEN GROUP S: START AND STOP MODES

Group Attribute HIDDEN

S1 START MODE

Screen: S1 START=NORMAL

Description USUAL STARTING MODE
Range NORMAL / SPIN
Default NORMAL
OFF to Modify No
Attribute Read Only

FUNCTION In V/Hz operation this screen provides the option of a special starting mode for motor loads which may be spinning when started (e.g. freewheeling fans).

Problems can occur if a spinning load is started conventionally (i.e. Elite Series turns on at zero hertz, before accelerating to the set speed) as the load must first be stalled to near zero speed, before being accelerated.

When spin start is selected, the Elite Series starts at the maximum frequency, instead of zero hertz. If the set speed does not match the spinning speed of the load, an over current situation arises, causing the Elite Series to operate in current limit and reduce its output frequency until the frequency matches the speed of the the load. Once the frequencies match, the current will be reduced and the load will be accelerated normally toward the set point.

Note: When spin starting from the maximum frequency, the direction is set to the same as the reference speed. When the reference speed is 0.0, the spin start will be in the positive direction.

SETTING UP If the Elite Series will not normally be required to start spinning loads or is operating in Closed Loop Vector Mode, set the starting mode to NORMAL (ramp) acceleration.

If starting into spinning loads is a specific requirement of your application, set the starting mode to SPIN. During a spin start, while the Elite is trying to match the output frequency with the motor speed, the output current will be controlled independently of the motor current limit (screen L9) and the torque limit timeout (screen L7). For most reliable starting, set the torque limit timeout to above 0.0s to prevent “Shearpin” tripping once the Elite matches the motor speed.

For reliable low speed spin starting, the Start Torque (screen X4c) must be set correctly. Set the screen using Normal start.

S2 STOP MODE

Screen: S2 STOP =NORMAL

Description USUAL STOPPING MODE
Range Refer Figure 8.23.
Default Value NORMAL
OFF to Modify No
Attribute Read Only

FUNCTION Select the stopping mode to use (refer Figure 8.23).

SETTING UP Be sure to understand the function which the process needs. Usually the default (NORMAL) setting will be appropriate. Select other modes to suit the application.

S4 ALTERNATIVE STOP MODE

Screen: S4 ASTOP=NORMAL

Description ALTERNATIVE STOPPING MODE
Range Refer Figure 8.23
Default Value NORMAL
OFF to Modify No
Attribute Read Only

FUNCTION Select the stopping mode to use (refer Figure 8.23).

The alternative stop mode is used if the MFI input function Alternative Stop-Reset is activated.

SETTING UP Be sure to understand the function which the process needs. Usually the default (NORMAL) setting will be appropriate. Select other modes to suit the application.

Mode	V/Hz and Open Loop	Closed Loop Vector Speed Mode	Closed Loop Vector Torque Mode
NORMAL	Applies a zero speed reference and decelerates to zero speed		Applies a zero torque reference and coasts to zero speed
RAMP	Same a NORMAL		Transitions to speed control and performs a normal speed controlled stop - i.e. decelerates to zero speed
SPIN	Turns outputs off for the off delay time then changes to OFF state	Transitions to torque control and performs a normal torque controlled stop - i.e. coasts to zero speed	Same as NORMAL
STOP-RATE	Same as NORMAL except the special stop deceleration rate (screen R6) is used		Transitions to speed control and performs a speed controlled stop using the special stop deceleration rate (screen R6)
OFF	Immediately disables the output - i.e. coasts to zero speed		Immediately disables the output - i.e. coasts to zero speed
DC BRAKE	Applies a DC current as set by screen S8 until the end of the OFF delay time		Applies a DC current as set by screen S8 until the end of the OFF delay time

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Figure 8.23: Stopping Modes

For further information on Start and Stop modes refer to General Application Note 4216-058.

S1 S2 S4

S5

S5 START DELAY TIME

Screen: `S5 STR DLY=0.00s`

S6

Description	START DELAY TIME
Range	0 to 5 sec
Units	Seconds
Default Value	0.00s
OFF to Modify	No
Attribute	Hidden

FUNCTION — Sets a period of time following the receipt of a START command before accelerating the motor.

Operates in speed control only. It is intended to provide time for slow release functions to operate (particularly hoist brakes in cranes) before accelerating the motor.

SETTING UP — Leave set to zero (default) unless the application specifically requires such a delay.
If required, set the appropriate delay.

S6 OFF DELAY TIME

Screen: `S6 OFF DLY= 1.0s`

Description	OFF DELAY TIME
Range	0 to 3600 sec
Units	Seconds
Default Value	1.0s
OFF to Modify	No
Attribute	Hidden

FUNCTION — Sets the period of time that the Elite Series maintains the magnetising flux in the motor after coming to zero speed when stopping. It is desirable to maintain the flux if the motor is expected to restart without a delay (the reason for this is that when starting from the "OFF" state, flux must first be built up before attempting to accelerate the motor or provide torque. This may take several hundred milliseconds, and such a delay may be undesirable in some situations).
The delay may also be used in applications to maintain control of the motor at zero speed, until the brake is applied, before turning the motor off.

S7

SETTING UP — Leave set to the default setting unless the application requires a special value.
Set to the appropriate time according to your process.

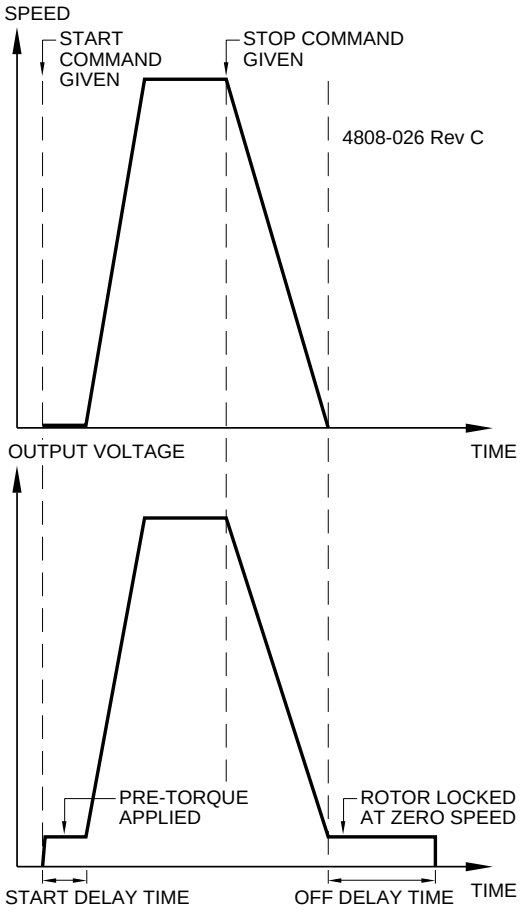


Figure 8.24: Start and Off Delay Times

S7 MAINS POWER LOSS RESPONSE

Screen: `S7 LOW V TRIP=N`

Description	MAINS POWER LOSS RESPONSE
Options	Y (Yes) / N (No)
Default Value	N (No)
OFF to Modify	No
Attribute	Hidden

FUNCTION — The high voltage (mains supply) power loss function provides an optional response to a power loss situation.

Upon power loss or brown out conditions, the Elite Series continues to operate normally until the energy supplied to the motor load discharges the inverter high voltage DC bus to its minimum working voltage. At this stage the output power from the inverter is disabled to prevent further energy consumption by the load, but otherwise the Elite Series continues to operate from the remaining energy in the DC bus. The minimum voltage for the Elite Series is 250Vdc, for the frames 5 to 7 the minimum is 385Vdc. Depending on the size of the Elite Series (and hence the energy in its DC bus), the control board can stay active for several seconds during such an event. While in this state (before the DC bus discharges below the switch mode power supply minimum operating voltage) the Elite Series is able to restart and continue normal operation when the mains supply returns to normal.

If the high voltage (mains supply) power loss function is set to not trip (N), the Elite Series will stay active as long as there is sufficient DC supply (perhaps several seconds). If the mains returns to normal while the control board is still active, the Elite Series will restart automatically.

If the high voltage (mains supply) power loss function is set to trip (Y), the Elite Series will trip and register a mains low fault after a two second power loss and require resetting. If the mains returns to normal within two seconds, the Elite Series will restart automatically.

SETTING UP The decision of whether to trip or not is usually based upon questions of the safety of automatically restarting equipment after brief power outages, the ability of associated equipment to continue normal operation and the reliability required of a process.
If required, the Elite Series control board may be powered with a 24Vdc supply. External 24Vdc connection information is given in Section 5.5.

S8 DC BRAKE CURRENT LEVEL

Screen: `S8 BRAKE I= 0%`

Description DC BRAKE CURRENT LEVEL
Range 0 to 150%
Units % of motor rated current
Default 0.00%
OFF to Modify No
Attribute Hidden

FUNCTION Sets the level of current to be applied to the motor while DC Braking. This level of current is applied for the OFF DELAY TIME (screen S6). In Closed Loop Vector Mode, this current is applied while stopping and during the off delay time.

SETTING UP DC braking is used to stop the motor without regenerating power into the Elite Series. In some circumstances this allows for faster stopping than regenerative braking. It should be noted that during DC braking the energy of the load is dissipated within the motor and the Elite's motor thermal model does not take this into account.

Adjust the current level until the desired braking is achieved.

S9 DC HOLDING VOLTAGE IN V/Hz

Screen: `S9 HOLD V= 0.0%`

Description DC HOLDING VOLTAGE
Range 0 to 25%
Units % of motor rated voltage
Default 0.00%
OFF to Modify No
Attribute Hidden

FUNCTION Sets the amount of DC voltage applied to the motor during the off delay period in V/Hz mode. When applied, the DC current causes the motor to resist movement and is used to brake the motor.

SETTING UP If motor braking after stopping is not required leave set to 0. First set the off delay time to a suitable value (say 2 seconds) and adjust the hold voltage to give the required amount of hold when the motor is stopped (but not off).

Note: DC hold is only used in V/Hz mode and is not used if the DC-BRAKE stopping mode is selected.

S10 DC HEATING CURRENT

Screen: `S10 HEAT I=OFF`

Description DC HEATING CURRENT
Range OFF / 1 to 30%
Units % of motor rated current
Default OFF
OFF to Modify No
Attribute Hidden

FUNCTION Sets the amount of DC current applied to the motor after the off delay period or before a start command is received. This provides standby (anti-condensation) heating to the motor.

SETTING UP If motor heating is not required leave set to OFF. To set, with the motor stopped, increase the DC heating level until the current level indicated by the screen top line is approximately 10 to 25% of motor rated current.

WARNING: High voltage will be present on the motor terminals while DC heating is employed. **DO NOT USE** to dry out an already wet motor.

S11

S11 STOP TIMEOUT

Screen: `S11 STP T/O= 30s`

S12

Description	STOP TIMEOUT
Range	OFF / 1 to 3600 sec
Units	Seconds
Default Value	30s Frames 1 to 3 60s Frame 4 120s Frames 5 to 7
OFF to Modify	No
Attribute	Read Only

FUNCTION — To provide the safety function of automatically tripping the Elite Series if the motor has not stopped within the selected Stop Timeout period once a stop signal has been received.

SETTINGUP — This function is typically used to protect against incorrectly set parameters maltuning the Elite Series and preventing a controlled stop. The controlled stop time is the time to stop under normal conditions and is determined from the maximum speed (screen L3), deceleration rates (screens R2, R4, and R6), speed filter time constant (screen R7), and off delay (screen S6). The Stop Timeout period should be set to a value greater than the controlled stopping time. Alternatively, the controlled stopping time may be measured experimentally and the Stop Timeout set appropriately.

Note: With a high input supply voltage, the Elite Series has limited headroom in the DC bus to absorb regenerated power from a high inertia motor/load combination. This may prevent the Elite Series from being able to follow the requested speed reference profile. The Stop Timeout may be used to provide protection against loss of control from excessive regeneration.

The Stop Timeout is also useful for protecting against incorrectly set speed PID settings in closed loop vector mode.

S12 BRAKE RELEASE TIME

S13

Screen: `S12 BK RLS=0.00s`

Description	BRAKE RELEASE TIME
Range	0.00 to 5.00s
Units	SECONDS
Default	0.00s
OFF to Modify	No
Attribute	Hidden

FUNCTION — Sets a period of time from the activation of the brake release relay until accelerating the motor. The brake release relay is activated after the start delay (screen S5).

SETTINGUP — Leave set to zero unless using a mechanical brake. Set to the time it takes for the mechanical brake to free and adjust in conjunction with the pre-torque (screen S13) to produce a smooth torque as the brake releases.

S13 PRE TORQUE

Screen: `S13 PRE TQ= 0%`

Description	PRE TORQUE
Range	-250% to +250%
Units	% of motor rated torque
Default	0%
OFF to Modify	No
Attribute	Hidden

FUNCTION — Sets the amount of torque to apply during the start delay and brake release time.

SETTINGUP — Leave set to zero unless using a mechanical brake. Set to produce a smooth torque as the brake releases.

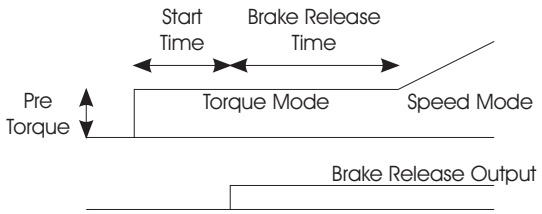


Figure 8.25: Pre Torque

SCREEN GROUP X: TUNING

Group Attribute HIDDEN

X1 CONTROL TYPE SELECTION

Screen

Description SELECTION OF OPERATING MODE
Range O/L = Open Loop Mode
C/L = Closed Loop Vector Mode
V/Hz = V/Hz
Default Value V/Hz
OFF to Modify Yes
Attribute Read Only

FUNCTION This selection determines the type of operating mode for the Elite Series.

V/Hz:
No external feedback is required to operate in this mode. Selection the of control type V/Hz forces the control mode to Speed Control.

Closed Loop Mode:
This control type requires an incremental encoder to be mounted on the motor to provide direct feedback on actual rotor speed. Commissioning and auto-tuning must be completed before selecting this control type. Closed Loop Vector Mode is used where there are high requirements for speed accuracy or torque control is required.

Open Loop Mode:
The Open Loop Mode is a speed control mode active only for frames 1 to 4. This mode of operation can provide improved starting torque and speed accuracy compared to V/Hz mode. No external feedback is required to operate in this mode, which can offer features of the Closed Loop Vector Mode. Commissioning and autotuning must be completed before selecting this control type.

SETTING UP V/Hz mode should be used for initial commissioning to check the operation of any shaft encoder fitted to the motor and to check motor rotation direction.

Once initial commissioning is complete, select Closed Loop Vector Mode, Open Loop Mode or V/Hz as required.

V/Hz mode **must** also be employed when multiple motors are connected to the Elite Series output.

V/Hz or Closed Loop Vector Mode must be used if a Vysta progam is loaded into the Elite Series.

X2 AUTOTUNE MODE SELECTION

X1

Note: Autotune only applies to Elite Series operated in open loop or closed loop vector mode.

Screen

Description AUTOTUNES MOTOR
Range N (No) / Y (Yes)
Default Value None
OFF to Modify Yes
Attribute Read Only

FUNCTION The motor must be correctly characterised for good dynamic performance. This can be done automatically by the Elite Series.

Autotuning will automatically set optimum values for the following parameters (without turning the motor):

X3a Lm	Motor Main Inductance
X3b Rs	Stator Resistance
X3c Rr	Rotor Resistance

The motor must be stopped for Autotuning to function correctly.

WARNING: Autotuning may apply voltage to the terminals of the motor. Check that all personnel are clear of the motor and attached machinery, and that it is safe to operate the motor.

Note: Manual tuning of the Motor/Drive is required for optimum performance in dynamic applications.

SETTING UP Ensure that LOCAL control is enabled (screen I7a = 00 DISABLED) before autotuning the motor.

Screen X2 selects AUTOTUNE options, as follows:

X2 AUTOTUNE = N
Autotuning not active.

X2 AUTOTUNE = Y
This tunes the motor without moving the motor.

X2

Autotuning may take from several seconds to complete.

Refer to Section 9 for details on preliminary commissioning.

X3a

SUBGROUP X3: MOTOR TUNING

Subgroup Attribute Read Only

X3b

X3a to X3d MOTOR IMPEDANCES

Note: Only applies to Elite Series operated in open loop or closed loop vector mode.

Screen

Description MAIN INDUCTANCE
Range 40 to 800%
Units % of rated impedance
Default Value 190% (Dependant on Elite Series model)
OFF to Modify No

FUNCTION The main inductance of the motor defines the magnetising current. This is a key parameter directly affecting motor fluxing.

SETTINGUP This parameter is self-adjusting and should set itself up under autotuning (screen X2). Typical values range from 75% (for small motors) to 800% for large motors.

The correctness of the setting may be gauged by first ensuring that the Elite Series is operating in full vector control (speed control) mode. Now operate the motor at no load at some defined speed (e.g. 50%) and check that the output voltage matches the percentage speed (i.e. approximately 50% of rated voltage in this case).

If the voltage does not match, adjust the main inductance value up (will decrease voltage) or down (will increase voltage).

Screen

Description STATOR RESISTANCE
Range 0 to 15.0%
Units % of rated impedance
Default Value 3.0% (Dependant on Elite Series model)
OFF to Modify No

X3c

FUNCTION The stator resistance represented as a percentage of rated impedance.

X3d

SETTINGUP This parameter is self-adjusting and should set itself up under the autotuning feature (screen X2).
Usually the stator resistance varies approximately between half to twice the rotor resistance (see screen X3c Rr).

X3e

In Open Loop mode, care should be taken to set this correctly. The value can be set using Autotune. Alternatively, the per cent rated slip value can be used (see X3c below).

Screen

Description ROTOR RESISTANCE
Range 0 to 15.0%
Units % of rated impedance
Default Value 6.0% (Dependant on Elite Series model)
OFF to Modify No

FUNCTION Sets rotor resistance of the motor. This is a key parameter directly affecting output torque.

SETTINGUP This parameter is self-adjusting and should set itself up under autotuning (screen X2). The parameter should set itself to approximately the rated slip of the motor - i.e.

$$\text{Slip}\,(\%) = 100 \times \frac{\text{Sync Speed} - \text{Rated Speed}}{\text{Sync Speed}}$$

The setting should change dynamically with changing motor temperature. The accuracy of this setting may be checked by observing output voltage variation during a step load change. If the voltage dips upon a small increase in load, Rr is set too high. If the voltage overshoots, Rr is set too low. If set correctly, the voltage should not change significantly. This setting should be checked when the motor is at its normal operating temperature.

For Open Loop mode, set up as per Closed Loop Vector Mode.

This value will also influence the accuracy of slip compensation (screen X5d).

Screen

Description TOTAL LEAKAGE
Range 0 to 20%
Units % of rated impedance
Default Value 6.0%
OFF to Modify No

FUNCTION The total leakage inductance represented as a percentage of main inductance.

SETTINGUP This parameter is not usually adjusted by the user.

In Open Loop mode, sigma should be set to 6% for motors below 7.5kW and for motors above this, 6% should suffice for most cases.

X3e FIELD WEAKENING POINT

Screen

Description FIELD WEAKENING POINT
Range 50 to 100%
Units % of available voltage
Default Value 90%
OFF to Modify No

FUNCTION May be used to force the Elite Series to enter the field weakening region at less than the maximum potential voltage. The advantages of this is that it then leaves some voltage available to maintain full vector control - i.e. response in the field weakening region is improved.

The disadvantage is that since full voltage is not available, rated power cannot be achieved. If left at 100%, full voltage is applied to the motor and in the field weakening region vector control transitions to slip control. Torque response is slower in, and during exit of, this region.

SETTING UP If highly dynamic performance is not required (near maximum output voltage of the Elite Series), set to 100%. Otherwise leave set to approximately 90%. Note that the achievable motor power will be reduced in proportion.

For Open Loop mode, this value is also the point at which the system transitions between Open Loop normal mode and Open Loop overspeed mode.

SUBGROUP X4: LOAD TUNING

Subgroup Attribute Read Only

X4a DYNAFLUX MINIMUM FLUX LEVEL

Note: Dynaflux only operates in V/Hz control mode.

Screen 

Description DYNAFLUX MINIMUM FLUX LEVEL
Range 40% to 100%
Default 100%

FUNCTION Sets the minimum flux level that the motor will be operated at under reduced load conditions.

The Elite incorporates the Dynaflux (dynamic flux) automatic motor flux optimising system. This system is particularly useful for reducing noise and power loss by automatically reducing motor flux levels (and so losses and noise), in reduced load situations.

SETTING UP If the flux reducing feature is not required, leave set at 100% (factory set value).

Dynaflux is best suited for slowly varying loads (e.g. pump and fan). This is due to the possibility of motor stall, upon a rapid load increase at a time when there is insufficient fluxing.

For fan and pump (or similar) loads, set to the lowest value, consistent with reliable operation. Usually 40% will be suitable.

Using a value which is too low can lead to instability or surging. If this occurs, increase the minimum flux level.

Selecting intermediate levels of minimum fluxing caters for more dynamic loads with reduced amounts of Dynaflux action.

Set the minimum flux level to 100% for highly dynamic loads (e.g. servos and cranes).

X4b STARTING BOOST TYPE

Note: Starting Boost selection is only available in V/Hz control mode.

Screen 

Description STARTING BOOST TYPE
Range FIX (Fixed Voltage) / AUTO (Automatic Voltage) / CUR (Current Controlled)
Default Value AUTO (Automatic Voltage)
OFF to Modify Yes

FUNCTION Provides compensation to start difficult loads. Under V/Hz control a compensating boost may be applied to the motor in order to obtain full torque at low frequency. This screen permits configuration for AUTO (Automatic Voltage Boost), FIX (Fixed Voltage Boost), or CUR (Current Controlled Boost). Open Loop mode can use any setting of this variable.

SETTING UP The Start Boost Type provides three different starting torque profiles - the most suitable of which depends on the application.

AUTO (Automatic Voltage Boost)
For normal single motor operation, the automatic voltage boost (AUTO) provides the best performance. In this mode the boost level is automatically adjusted according to the load conditions. Automatic voltage boost does not operate at zero frequency, therefore applications which are required to produce torque at zero frequency (e.g. hoists) must have the Start Boost Type set to FIX or CUR.

FIX (Fixed Voltage Boost)
This starting boost type may be used with simple non-varying loads. However, for multiple motor operation, fixed voltage boost (FIX) must be selected to provide reliable starting.

CUR (Current Controlled Boost)
Current controlled boost (CUR) should be used for high stiction loads that are unable to be started using the voltage boost modes AUTO or FIX. This mode allows the starting profile to be tuned using screens X4c and X4d, where the boost level and the region it operates over are defined.

Note: Screen X4c defines the level of boost that will be applied and must be set to a level appropriate to the motor being used.

X4c

X4c STARTING TORQUE ADJUSTMENT

Screen

X4d

Description STARTING TORQUE (BOOST) ADJUSTMENT
Range 0 to 250%
Default Value 0%
OFF to Modify No

FUNCTION Provides improved low speed torque performance when an encoder is not used, i.e. in Open Loop Mode or V/Hz modes (refer to screen X1).

SETTINGUP This screen has different setting up procedures depending on the control mode (screen X1) and the starting boost type (screen X4b) selected.

When using V/Hz with Automatic or Fixed Voltage Boost, adjustment should be made until sufficient starting torque is developed to start the load. If the load is such that the adjustment levels required to start the load causes the Elite Series to enter a current limiting protection state, then Current Controlled Boost (rather than Automatic or Fixed Voltage Boost) is recommended.

When using V/Hz with Current Controlled Boost, adjust the Starting Torque level so that the load starts and smoothly accelerates. High levels of adjustment may require the Torque Limit screens (screens L4 and L5) and Current Limit screen (screen L9) to be adjusted. The Starting Torque adjustment should be used in conjunction with the Starting Band adjustment (screen X4d) to provide the desired starting torque profile. Levels far in excess of that required by the load should be avoided, as this will cause increased heating of the motor.

When using Open Loop Mode, adjust the starting Torque to the desired starting Torque level.

When using Closed Loop Vector Mode the starting torque adjustment has no affect.

X4f

X4d STARTING BAND ADJUSTMENT

X4g

Note: Start Band only operates in V/Hz mode if current controlled boost is selected.

Screen

Description STARTING (BOOST) BAND ADJUSTMENT
Range 0 to 99% of rated (nameplate) motor frequency
Default Value 10%
OFF to Modify No

FUNCTION Provides speed related profiling of the starting torque for the Current Controlled Boost (screen X4b STR TYPE=CUR).

For Open Loop, this parameter determines the transition from Open Loop start mode to Open Loop normal mode. When stopping, the drive will re-enter the Open Loop start mode from Open Loop normal mode. This will occur when the speed drops to 4.5% below the STR BAND value. In Open loop mode this cannot be increased above 50% as the overspeed band can be reduced to 50% speed.

SETTINGUP Adjust the Starting Band to define the region (from zero speed) where the current controlled starting torque is required. When the output speed exceeds this band the boost level will be automatically adjusted to a reduced level to minimise the heating effects of possible high levels set by screen X4c.

Loads that are characterised by high stiction but relatively low inertia will usually only require a small starting band. High inertia loads may require prolonged Current Controlled Boost to ensure smooth acceleration of the load.

It is recommended that the minimum band adjustment necessary to start and accelerate the load be used to avoid undue heating of the motor.

Note: If this band is set to the default 0% then the starting torque level set by Screen X4c will not have its full effect.

X4f to X4h ROTOR SPEED PID LOOP GAINS

Note: Only operates in Open Loop or Closed Loop Vector mode.

Screen

Description ROTOR SPEED PID LOOP PROPORTIONAL GAIN
Range 0 to 300%
Default Value 20%
OFF to Modify No

FUNCTION The proportional gain of the rotor speed PID controller.

Affects the response, stiffness and damping of the speed loop.

In Open Loop mode, set up as per Closed Loop Vector mode.

SETTINGUP The default value is a low, conservative setting. While this may not give the fastest speed response, it will generally be stable. Only adjust this value if setting up for a high performance application.

When the system inertia is low, typical maximum values range from 30% (small motors) to 35% (large motors).

Where significantly higher inertia are present, the gain may be increased.

Gain settings which are too high may cause rapid oscillation of the motor shaft.

Screen

Description ROTOR SPEED PID LOOP INTEGRAL GAIN
Range 0 to 999%
Default Value 30%
OFF to Modify No

FUNCTION The integral gain of the rotor speed holding PID controller. Affects the long term speed hold accuracy of the speed control loop.

In Open Loop mode, set up as per Closed Loop Vector mode.

SETTINGUP The default value is a fairly conservative (over damped) gain, generally assuring stability, but at the penalty of slowed response.

A typical maximum value is 50% when the motor has a low attached inertia. With higher inertia, the integral gain may need to be reduced, although increasing the proportional term may retain stability.

Gain Settings which are too high may cause rapid oscillation of the motor shaft.

Screen 

Description ROTOR SPEED PID LOOP DERIVATIVE GAIN
Range 0 to 999%
Default Value 0%
OFF to Modify No

FUNCTION The derivative gain of the rotor PID controller. May improve damping of the PID loop in some cases.

SETTING UP Rarely used. Usually left set to default (zero).

X4i LOW SPEED FLUX BOOST

Screen 

Description FLUX BOOST A
Range X4j to 99%
Default Value 0%
OFF to Modify No

FUNCTION Boost flux to cope with large or unstable loads when operating in Open Loop mode. Increased flux means less torque current is needed to generate a given torque.

SETTING UP Leave at default unless a large or unstable load is present, a conservative setting of up to 15% is recommended for these loads.

X4j HIGH SPEED FLUX BOOST

Screen 

Description FLUX BOOST B
Range 0% to X4i
Default Value 0%
OFF to Modify No

FUNCTION Used in conjunction with FLUX BOOST A in order to phase out the adjustment linearly at higher speeds in order to prevent early onset of Open Loop Mode overspeed mode.

SETTING UP Leave set to zero if phasing out of FLUX BOOST A is required. For a constant flux boost set to the X4i setting.

X4k INERTIA COMPENSATION

Screen 

Description INERTIA COMPENSATION
Range 1 to 10
Units none
Default 1

FUNCTION The compensation factor for inertia is required for large inertia loads if slip compensation or open loop mode is used. Used for enhancing stability and not for tuning of the speed controller.

SUBGROUP X5: CONTROLLER TUNING

Subgroup Attribute Read Only

X5a CURRENT LIMIT SLIP VALUE

Note: V/Hz and Open Loop mode only.

Screen 

Description CURRENT LIMIT SLIP VALUE
Range 0.0% to 10% / OFF
Default Value 2.0% (dependent on Elite Series model)
OFF to Modify No

FUNCTION To actively reduce the Elite frequency or acceleration to maintain load current within controllable bounds (status=ILT).

SETTING UP Do not adjust this unless current limit action is unstable. Nominally this value should be set to the rated percent slip of the motor. To improve stability of current limit use a lower figure (the penalty against this is that predictive current limit action will occur at an earlier stage, more severely limiting acceleration rates and possibly intruding more into the normal area of operation).

For optimal operation in Open Loop mode set value to motor slip in percent.

X5b VOLTAGE LIMIT SLIP

Note: V/Hz only

Screen 

Description VOLTAGE LIMIT SLIP
Range 0.0% to 20%
Default Value 2.0% (dependent on Elite Series model)
OFF to Modify No

FUNCTION If a motor is overdriven (e.g. by decelerating its attached load too fast) it will regenerate into the Elite. Too much regeneration will cause the Elite to take evasive action ("voltage limiting") by reducing the deceleration rate as regeneration occurs.

The voltage limit slip setting is an adjustment which is used to enhance the stability of voltage limiting control.

SETTING UP Do not adjust this setting unless voltage limiting is unstable. Nominally this value should be set to the rated percent slip of the motor. To improve stability of voltage limit use a lower value. The penalty against this is that voltage limiting will occur at an earlier stage, thus affecting deceleration more.

The speed filter setting (screen R7) may also be used to improve stability during voltage limiting.

For optimal operation in Open Loop mode, set value to motor slip in per cent.

X4h X4i X4j X4k X5a X5b

X5c

X5c **NO LOAD DAMPING**

Screen

X5d

Description NO LOAD DAMPING
Range 0% to 20%
Default Value 2.0% (dependent on Elite Series model)
OFF to Modify No

X5e

FUNCTION Some motors may become unstable and appear to surge when operated at light load and at certain speeds. The damping term may be introduced to eliminate this tendency.

SETTING UP Do not adjust this value unless light load stability problems exist.

Increase setting to improve stability. Increasing the setting too far may induce instability.

No load damping introduces very small output frequency variations (typically <0.1 Hz). If absolute fixed output frequency is a specific requirement of your application, set to 0.0%.

X5d **SLIP COMPENSATION**

Note: V/Hz only

Screen

Description ENABLE SLIP COMPENSATION
Range N (No) / Y (Yes)
Default Value N (No)
OFF to Modify No

FUNCTION Changes the output frequency based on the load current to compensate for the slip of the motor.

SETTING UP If Speed regulation under varying load is required in V/Hz or open Loop control modes - turn on.

May be enabled when using Open loop mode, this will assist with speed regulation when in operating in the Open Loop mode overspeed region.

X5f

X5e, X5f **MODULATION**

X5g

Screen

Description MODULATION FREQUENCY
Options AUTO / 4000 to 16000 (Refer to Note)
Units Hertz
Default Value AUTO
OFF to Modify No

X5h

X5i

FUNCTION Alters the output frequency to the motor. May be used to avoid mechanical noise within the motor. AUTO allows the Elite's thermal management system to optimise the switching frequency to maintain reliable operation.

Note: Maximum frequency is frame size dependant.
Frames 1 to 2 16,000 Hz
Frames 3 to 4 10,000 Hz
Frames 5 to 7 8,000 Hz

Screen

Description MODULATION TYPE
Options WW (Whisper Wave) / NB (Narrow Band)
Units Hertz
Default Value WW (Whisper Wave)
OFF to Modify No

FUNCTION Alters the type of noise produced by the motor. Narrow band produces a conventional fixed frequency noise spectrum. Whisper Wave is a special mode which distributes the noise over a wider frequency range. The noise produced in Whisper Wave mode is usually found to be less annoying and easier to mask.

SETTING UP To allow for direct comparison of the motor acoustic noise level, this mode may be switched while the Elite Series is running. Choose the option that you find most suitable.

Whisper Wave or Narrow Band should be selected to minimise the audible noise.

X5g, X5h **CURRENT CONTROL LOOP GAIN**

Screen

Note: Not V/Hz
Description CURRENT PI LOOP PROPORTIONAL GAIN
Range 0 to 100%
Default Value 25%
OFF to Modify No

FUNCTION Proportional gain of the current control loop internal to the flux vector controller.

SETTING UP This parameter is not usually adjusted by the user.

Screen

Note: Not V/Hz
Description CURRENT PI LOOP INTEGRAL GAIN
Range 0 to 100%
Default Value 13%
OFF to Modify No

FUNCTION Integral gain of the current control loop internal to the flux vector controller.

SETTING UP This parameter is not usually adjusted by the user.

X5i **ROTOR SPEED FILTER CONSTANT**

Note: Closed Loop Vector mode only

Screen

Description ROTOR SPEED FILTER CONSTANT
Range 3 to 100%
Default Value 50%
OFF to Modify No

FUNCTION A filter gain in the rotor speed feedback. Can improve stability if the encoder coupling to the motor is not completely direct, or not perfect (e.g. due to any degree of backlash or elasticity in the coupling).

Note: The filter time constant in msec is 100/Kfw

SETTING UP Usually left set to 50%. Decrease Kfw to increase effect of filter.

SCREEN GROUP Y: MENU OPTIONS

Group Attribute Hidden

Y1 LANGUAGE SELECTION

Screen: Y1 LANGUAGE = 1

Description SELECTS LANGUAGE OF SCREEN LIST
Range 1 = ENGLISH
2 = DEUTSCH
3 = ESPANOL
Default Value 1 = ENGLISH
OFF to Modify No
Attribute Read Only

FUNCTION Determines the language displayed by the Elite Series.

SETTING UP Choose the required language. Further languages will be available on an "as required" basis.

Y2 INITIALISE

Screen: Y2 INITIALISE

Description SELECTS LEVEL OF INITIALISATION OF PARAMETERS AND MODES
Range Refer Figure 8.26
Attribute Read Only

DISPLAY	DESCRIPTION
NO	Not initialising
INIT USER PARAMS	Initialises all user parameters including menu setup mode with the exception of the motor parameters (screens N1 to N6, and X3 to X5)
INIT MTR PARAMS	Initialises all motor parameters (screens N1 to N6, and X3 to X5)
INIT ALL VARS	Initialises all parameters. Available after F18 fault.

Figure 8.26: Initialisation Levels

FUNCTION This screen allows for the initialisation of parameters (setting to default values) to the desired level.

If you want to retain settings for re-entry after initialisation, record these settings first, (e.g. on the appropriate Commissioning Configuration Record at the end of this manual).

SETTING UP Select the required level and release the keys. The display will show INITIALISING... while doing so, and returns to standard Y2 screen when completed.

Y3 CONTROL PROGRAM SELECTION

Screen: Y3 PROG 1 OF 1

Description CONTROL PROGRAM SELECTION
Default Value 1
OFF to Modify Yes
Attribute Read Only

FUNCTION Determines the control program that is running. See Section 7.

SCREEN GROUP Z: COMMISSIONING SCREENS

Group Attribute Read-Write

Z COMMISSIONING MODE

Screen: Z COMMISSION=N

Description COMMISSIONING MODE
Range Y (Yes) / N (No)
Default Value N (No)
OFF to Modify No
Attribute Read-Write (if password is OFF)
Read Only (if password is set)

FUNCTION Commissioning mode is a special mode that allows the commissioning engineer to modify commissioning data.

SETTING UP Set to YES to enter commissioning mode.

The commissioning mode is normally protected with a password set from Screen Z1. This prevents unauthorised modification to commissioning data.

Once the commissioning data has been entered (and a password set if required), this screen should be set to NO.

Setting to COMMISSIONING mode before a Password has been set:

Scroll to Main Screen Z.
Z COMMISSION=N

Press "∗" and "+" or "–". The control line should change to:
Z COMMISSION=Y

All screens will now be visible, and all parameters are adjustable.

Selecting COMMISSIONING mode after a Password has been set:

Scroll to Main Screen Z. The display's control (bottom) line will read:
Z COMMISSION=N

Press "∗" and "+" or "–". The screen will automatically display:
PASSWORD=ZZZZZ

Where the number shown as "ZZZZZ" is a special hashing number and is required for lost passwords. Refer to the description of Screen Z1.

Now press "∗" and "+" or "–" until the correct password is reached. Then release the keys.

The display's control (bottom) line will now read:
Z COMMISSION=Y

All screens will now be visible, and all parameters adjustable.

Selecting OPERATION Mode:
To change from COMMISSIONING Mode to OPERATION Mode, scroll to Screen Group Z.

The display's control line will read:
Z COMMISSION=Y

Use "∗" and "+" or "–" to toggle to :
Z COMMISSION=N

Z1

Z1 COMMISSIONING MODE PASSWORD

Screen

```
Z1 PASSWORD=OFF
```

Z2

Description COMMISSIONING MODE PASSWORD
Range OFF / 1 to 65535
OFF to Modify No
Attribute Hidden

Z2a

FUNCTION Allows the commissioning engineer to set a password to protect against unauthorised modification of commissioning parameters.

SETTING UP Once set to COMMISSIONING mode as described above, a password may be set up. Unfold Screen Group Z and scroll to Screen Z1. The display will read:

Z1 PASSWORD = OFF.

Press "*" and "+" or "–" to set the required password.

What happens if a password is unknown or forgotten?

Once a password has been entered, a special hashing number is displayed on Screen Z when trying to enter COMMISSIONING mode.

The display will read:

Z PASSWORD= ZZZZZ

Take a note of this number and contact a PDL Electronics Applications Engineer, who with suitable authority will be able to pass this code through an algorithm to reconstruct the original password.

Z2 SOFTWARE AND HARDWARE REVISIONS

Screen

```
ELITE 16.0A 400V
Z2 S/W1.1 H/W1.1
```

DISPLAY TOP LINE
Description Displays Elite Series rated size and voltage.

Z3

DISPLAY BOTTOM LINE
Description SOFTWARE AND HARDWARE REVISION NUMBERS

Z4

Attribute Read Only

FUNCTION Shows the revision number (X.X) of the software and hardware currently fitted to the Elite Series.

Z2a CONTROL BOARD SERIAL NUMBER

Screen

```
Z2a Ser=1234567
```

Description CONTROL BOARD SERIAL NUMBER
Attribute Read Only

FUNCTION Displays the serial number of the control board currently fitted to the Elite Series.

Z3 ANALOGUE INPUT 1 STATUS

Screen

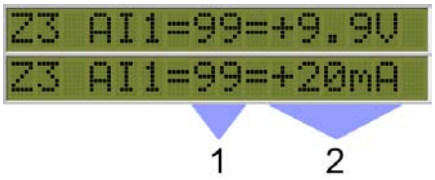
```
Z3 AI1=99=+9.9V
```

or

```
Z3 AI1=99=+20mA
```

Description STATUS OF ANALOGUE INPUT 1
Range 00 to 99;
-10V to +10V or 0 to 20mA
Attribute Read Only

Reference



Ref.	FUNCTION
1:	Status of Analogue Input 1 (terminal T26) 00 to 99% of the input range For ±10V input, -10V = 00, +10V = 99 For 0-10V input, 0V = 00, +10V = 99 For 4-20mA input, 4mA = 00, 20mA = 99 For 0-20mA input, 0mA = 00; 20mA = 99
2:	Status of Analogue Input 1 (terminal T26) For ±10V input, -10V to +10V For 0-10V input, 0V to +10V For 4-20mA input, 4mA to 20mA For 0-20mA input, 0mA to 20mA

Z4 ANALOGUE INPUT 2 STATUS

Screen

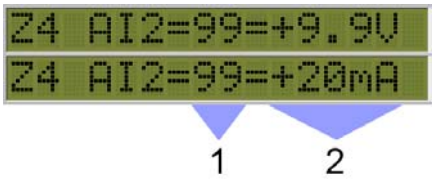
```
Z4 AI2=99=+9.9V
```

or

```
Z4 AI2=99=+20mA
```

Description STATUS OF ANALOGUE INPUT 2
Range 00 to 99;
-10V to +10V or 0 to 20mA
Attribute Read Only

Reference



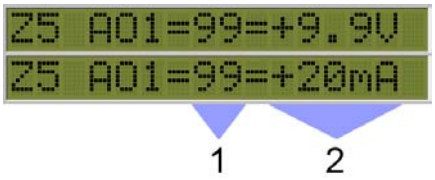
Ref.	FUNCTION
1:	Status of Analogue Input 2 (terminal T27) 00 to 99% of the input range For ±10V input, -10V = 00, +10V = 99 For 0-10V input, 0V = 00, +10V = 99 For 4-20mA input, 4mA = 00, 20mA = 99 For 0-20mA input, 0mA = 00; 20mA = 99
2:	Status of Analogue Input 2 (terminal T27) For ±10V input, -10V to +10V For 0-10V input, 0V to +10V For 4-20mA input, 4mA to 20mA For 0-20mA input, 0mA to 20mA

Z5 ANALOGUE OUTPUT 1 STATUS

Screen


or


Description STATUS OF ANALOGUE OUTPUT 1
Range 00 to 99;
-10V to +10V or 0 to 20mA
Attribute Read Only

Reference


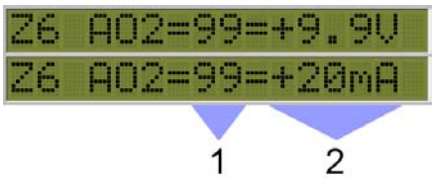
Ref.	FUNCTION
1:	Status of Analogue Output 1 (terminal T23) 00 to 99% of the input range For ±10V output, -10V = 00, +10V = 99 For 0-10V output, 0V = 00, +10V = 99 For 4-20mA output, 4mA = 00, 20mA = 99 For 0-20mA output, 0mA = 00; 20mA = 99
2:	Status of Analogue Output 1 (terminal T23) For ±10V output, -10V to +10V For 0-10V output, 0V to +10V For 4-20mA output, 4mA to 20mA For 0-20mA output, 0mA to 20mA

Z6 ANALOGUE OUTPUT 2 STATUS

Screen


or


Description STATUS OF ANALOGUE OUTPUT 2
Range 00 to 99;
-10V to +10V or 0 to 20mA
Attribute Read Only

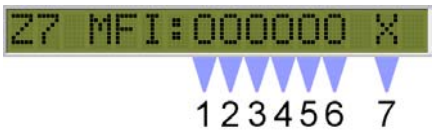
Reference


Ref.	FUNCTION
1:	Status of Analogue Output 2 (terminal T24) 00 to 99% of the input range For ±10V output, -10V = 00, +10V = 99 For 0-10V output, 0V = 00, +10V = 99 For 4-20mA output, 4mA = 00, 20mA = 99 For 0-20mA output, 0mA = 00; 20mA = 99
2:	Status of Analogue Output 2 (terminal T24) For ±10V output, -10V to +10V For 0-10V output, 0V to +10V For 4-20mA output, 4mA to 20mA For 0-20mA output, 0mA to 20mA

Z7 MULTIFUNCTION INPUT STATUS

Screen


Description STATUS OF MULTI-FUNCTION INPUTS
Range O (Open) or X (Closed)
Attribute Read Only

Reference


Ref.	FUNCTION
1:	Status of Digital Input 1 (terminal T13)
2:	Status of Digital Input 2 (terminal T14)
3:	Status of Digital Input 3 (terminal T15)
4:	Status of Digital Input 4 (terminal T16)
5:	Status of Digital Input 5 (terminal T17)
6:	Status of Digital Input 6 (terminal T18)
7:	Status of External Trip Input (terminal T19)

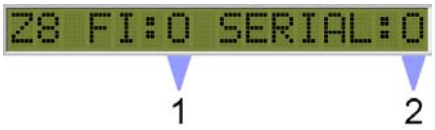
Status O (Open)
X (Closed)

Note: Multi-function inputs - O or X represent only an Open (circuit not connected to the common) or a Closed (circuit connected to the common) respectively.

Z8 FIBRE OPTIC INPUT STATUS; SERIAL INPUT STATUS

Screen


Description STATUS OF FIBRE OPTIC INPUT;
STATUS OF SERIAL INPUT
Range O (Inactive) or X (Active);
O (Inactive) or X (Active);
Attribute Read Only

Reference


Ref.	FUNCTION
1:	Status of Fibre Optic Input
2:	Status of Serial Input

Status O (Inactive)
X (Active)

Note 1: An Active (X) status indicates that a valid fibre optic data packet has been received since the last screen update. An Inactive (O) status indicates that no valid data packet has been received since the last screen update.

Note 2: An Active (X) status indicates that a valid serial communication data packet has been received since the last screen update. An Inactive (O) status indicates that no valid data packet has been received since the last screen update.

Z9

Z9 ENCODER COUNT

Screen

Z9a

Description ENCODER COUNT
Range 0 to 16383
Attribute Read Only

Z10

FUNCTION Encoder counter; displays the number of edges counted by the incremental encoder input terminals (terminals T31 to T34). Increasing count should correspond with forward rotation (see Section 4.2 and screen N8 for more information).

EXAMPLE: For a 2000 ppr encoder, this status screen should increase by 2000 counts for a 360° rotation of the motor shaft, in the forward direction.

Z9a ENCODER SPEED

Screen

Description ENCODER SPEED
Attribute Read Only

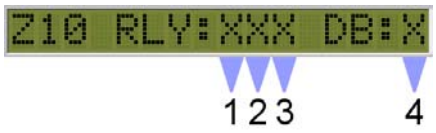
FUNCTION Displays the speed of the encoder as a percent of motor synchronous speed.

This screen is useful for checking for faults in the encoder and encoder wiring.

Z10 OUTPUT RELAY STATUS; DYNAMIC BRAKE OUTPUT STATUS

Screen

Description STATUS OF OUTPUT RELAYS;
STATUS OF DYNAMIC BRAKE OUTPUT
Range O (Open) or X (Closed);
O (Open) or X (Closed);
Attribute Read Only



Z11

Reference

Ref.	FUNCTION
1:	Status of Output Relay 1 (Terminals T1/T2)
2:	Status of Output Relay 2 (Terminals T4/T5)
3:	Status of Output Relay 3 (Terminals T6/T7)
4:	Status of Dynamic Brake (DB) Output

Z12

Status O (Open)
X (Closed)

Note 1: RLY1 is normally open on terminals T1/T2
RLY1 is normally closed on terminals T2/T3
RLY2 is normally open on terminals T4/T5
RLY3 is normally open on terminals T6/T7

The status of the change-over relay (RLY1) on the normally closed terminals (terminals T2/T3) is the inverse of reference 1.

Note 2: A Closed (X) status indicates that the Dynamic Brake (DB) output has been closed in the interval since the last screen update. An Open (O) status indicates that the Dynamic Brake (DB) output has not been closed in the interval since the last screen update.

Z11, Z12 FIBRE OPTIC INPUT AND OUTPUT STATUS

Screen

Description FIBRE OPTIC INPUT STATUS
Range -250% to +250%
Attribute Read Only

FUNCTION Indicates the level of the data on the fibre optic input port.

The status indicates the magnitude and sign of the data packet being received by the Elite Series fibre optic input port.

Refer to Screen Z8 for an indication of fibre optic input errors.

Screen

Description FIBRE OPTIC OUTPUT STATUS
Range -250% to +250%
Attribute Read Only

FUNCTION Indicates the level of the data on the fibre optic output port.

The status indicates the magnitude and sign of the data packet being sent by the Elite Series fibre optic output port.

Refer to Screen Z8 for an indication of fibre optic input errors.

9 PRELIMINARY COMMISSIONING OF THE ELITE SERIES

9.1 COMMISSIONING WITHOUT MOTOR

9.1.1 FOREWORD

This commissioning guide is not intended to fully commission the Elite Series to it's final application. It is intended to prepare the drive to have its final configuration installed (possibly by others).

This commissioning should only be undertaken after all wiring has been completed and verified as detailed in Section 6 of this manual.

9.1.2 CHECKS BEFORE POWERING UP

CHECK INSTALLATION

Check that the Elite Series will not be subject to an unacceptable environment. Check that adequate cooling airflow is available. Check that no tools, swarf, or hardware have been left in the drive.

CHECK POWER WIRING

Check that all supply and motor cabling is correctly dimensioned for the application, the Elite Series is bonded to earth, and electrical connections are secure. The cable between the Elite Series and motor should be of screened construction, with the screen (forming the earth connection) solidly bonded to the motor and the Elite Series chassis. Ensure that the motor and power wiring are not transposed. Check that the correct fuses (Figures 2.1 to 2.4) are fitted at the supply.

CHECK CONTROL WIRING

Control wiring must be screened and run separately from power cables.

Check that there are no loose strands, and that all terminal screws or bolts have been tightened. Check that the multi function input wiring conforms to the required configuration i.e. – active high or active low (screen I7b). Note that the default configuration is active high.

CHECK COOLING FAN WIRING

On Elite Series frames 5 to 7, the correct cooling fan operating voltage must be selected. This is achieved by moving the link in the fan terminal block (the blue wire in figure 9.1) to the appropriate setting. This should be set to the same value as the Elite Series input voltage.

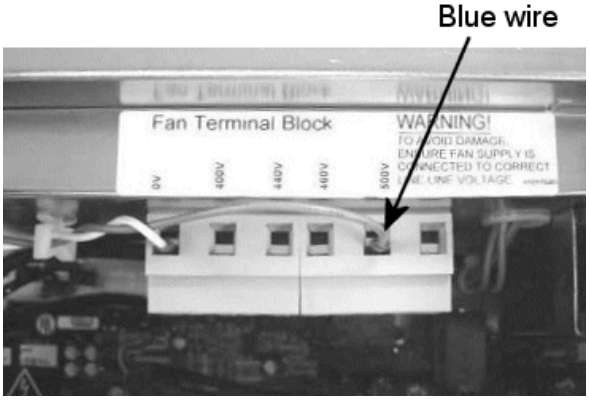


Figure 9.1: Fan Terminal Block

9.1.3 APPLYING POWER TO THE ELITE SERIES

WARNING: If the previous setup of the Elite Series is not known – remove the link from the External Trip Input (Terminal T19). This will trip the unit and prevent possible instantaneous starting of the motor upon applying power to the Elite Series. This circuit should also be opened in the event of the "loss of control" situation.

BEFORE PROCEEDING, ISOLATE THE MOTOR.

Switch on the mains supply to the Elite Series.

CHECK DRIVE OPERATION

Check that the cooling fan is blowing air through the heatsink.

Check that the display lights up. Screen A4 will be initially displayed (unless the Elite Series has tripped on a protective fault in which case screen F will be displayed).

Check that the DC "Bus Live" LED is glowing red.

9.2 PRELIMINARY SETUP

Initially the motor should be energised and controlled without using any external input devices. Thus it is recommended to set up the Elite Series for operation under front panel control. This is achieved by setting up the following screens.

Y1 Reinitialise the user parameters from screen Y2. This returns most of the screens to their default settings.

N1 to N5 Enter the motor current, volts, frequency, kW and RPM. (Copy from the motor's rating plate)

I1 LOCAL S/STP = 3
(Enables the local keypad start / stop-reset)

I2 REF S = LOCAL
(Reference speed source = local ketboard)

I7a I/P MODE = 0
(Disables the multi function inputs)

L1 MIN SPD = 50%
(Sets the minimum speed limit to 50%)

A3 LOCAL SP = 0%
(Sets local speed to zero)

A1 LOCAL MODE = SP
(Sets to speed control mode)

X1 CONTROL TYPE = V/Hz
(Sets for V/Hz speed control mode)

This configures the operation mode to V/Hz speed control mode. If open or closed loop operation mode is required, this parameter should be set correctly later.

9.3 ENERGISING THE MOTOR

WARNING: Check that all personnel are clear of the motor and attached machinery including any belt drive and the counter balance weight, and that it is safe to operate the motor. If the motor is out of sight of the Elite Series motor controller, it may be necessary to have someone in radio or telephone contact with yourself standing by the motor, to ensure safety and to report any unusual occurrences.

Remove the isolation from the motor. If the motor has been disconnected, power down the Elite Series, allow to discharge, and reconnect the motor terminals. Power up the drive and proceed.

START the Elite Series by using the front panel START push-button.

Scroll to Screen A3 and increase the speed by pressing "∗" then "+".

Check that the motor is turning in the expected (forward) direction. If not, STOP the Elite Series, power it down, wait for it to discharge, and swap any two motor terminations over. Power up the drive and proceed.

9.3.1 MOTOR AUTOTUNING

The motor must be correctly characterised for accurate torque, energy and position calculations and for good dynamic performance if closed loop vector mode is used. This can be done automatically by the Elite Series. Autotuning is controlled from Screen X2.

Autotuning will automatically set optimum values for the following parameters (without turning the motor):

X3a	**L m**	Motor Main Inductance
X3b	**Rs**	Stator Resistance
X3c	**Rr**	Rotor Resistance
X3d	**SIGMA**	Total Leakage Inductance

The Elite Series must be in local control (i.e. I7a = 0 DISABLED) and the motor must be stopped for Autotuning to function correctly.

WARNING: Autotuning applies voltage to the terminals of the motor. Check that all personnel are clear of the motor and attached machinery, and that it is safe to operate the motor.

Screen X2 selects AUTOTUNE options, as follows:

X2 AUTOTUNE = NO Autotuning not active.

X2 AUTOTUNE = YES This tunes the motor without moving the motor.

Autotuning may take several seconds to complete.

9.4 PRELIMINARY COMMISSIONING COMPLETE

The Elite Series motor controller has now been completely installed and checked. The unit is now ready for final commissioning.

10 FINAL COMMISSIONING OF THE ELITE SERIES

10.1 PRELIMINARY CONTROL SETUP

10.1.1 FOREWORD

The Elite Series has an advanced and adaptable set of motor control features.

A very flexable set of options for configuration of the digital, analogue and fibre optic inputs and outputs; coupled with multiple ramp rates and start stop modes allows the user to modify the Elite Series motor controller to suit their process control system.

The adaptability of the Elite Series per permits the user to tailor the performance requirments through selecting V/Hz or Open Loop control mode (speed control) and the Closed Loop control mode (speed and torque control).

The screen list is shown in Section 8 of this manual.

Before proceeding, ensure that the Elite Series is in COMMISSIONING mode. Refer to Section 6.3 for details.

10.1.2 CHECKING OF ANALOGUE INPUTS

If analogue inputs are being used to control the Elite Series, they must have their format correctly configured. By default, Analogue Input 1 is 0 to 10Vdc, and Analogue Input 2 is 0 to 10Vdc. These may be re-configured if necessary by using screens I6a (Analogue Input 1) and I6d (Analogue Input 2).

Once correctly configured, the Analogue Input 1 (terminal T26) and Analogue Input 2 (terminal T27) can be checked by observing screen Z3 (refer figure 10.1) and screen Z4 respectivily.

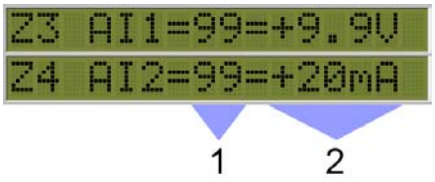


Figure 10.1: Screens Z3, Z4 - Analogue Input Status

Reference 1: Indicates the relative level of the Analogue Input in percent.

For ±10V input,	-10V = 0%;	+10V = 99%
For 0 to 10V input,	0V = 0%;	+10V = 99%
For 0 to 20mA input,	0mA = 0%;	20mA = 99%
For 4 to 20mA input,	4mA = 0%;	20mA = 99%

Reference 2: Indicates the actual level of the Analogue Input either in Volts or mA.

For voltage input,	-10V to +10V
For current input,	0mA to 20mA

10.1.3 CHECKING OF ANALOGUE OUTPUTS

If analogue outputs are being used, their formats must be correctly configured to suit the devices they are driving. Both outputs may be configured for 0-10Vdc, ±10Vdc, 4 to 20mA or 0 to 20mA. By default, Analogue Output 1 is ±10Vdc, and Analogue Input 2 is ±10Vdc. These may be re-configured if necessary by using screens O1b (Analogue Output 1) and O1f (Analogue Output 2).

Once their respective formats are configured, the operation of the outputs can be confirmed as follows. For Analogue Output 1, scroll to screen O1a, and select Mode 1 (Full Scale). For Analogue Output 2, scroll to screen O1e and select Mode 1 (full Scale). This should cause the respective analogue outputs to be driven to their maximum. Check that the driven devices are driven to their full scale. When these tests are complete, restore screens O1a and O1e to the required modes (if known).

Once correctly configured, the Analogue Output 1 (terminal T23) and Analogue Output 2 (terminal T24) can be checked by observing screen Z5 (refer figure 10.2) and screen Z6 respectivily.

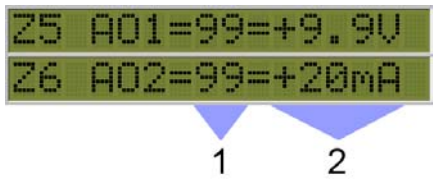


Figure 10.2: Screens Z5, Z6 - Analogue Output Status

Reference 1: Indicates the relative level of the Analogue Output in percent.

For ±10V input,	-10V = 0%;	+10V = 99%
For 0 to 10V input,	0V = 0%;	+10V = 99%
For 0 to 20mA input,	0mA = 0%;	20mA = 99%
For 4 to 20mA input,	4mA = 0%;	20mA = 99%

Reference 2: Indicates the actual level of the Analogue Output either in Volts or mA.

For voltage input,	-10V to +10V
For current input,	0mA to 20mA

10.1.4 CHECKING OF DIGITAL INPUTS

Scroll to screen Z7. The six characters on the left of the bottom row of characters show the states of the six digital inputs. Refer to Figure 10.3, references 1 to 6.

Reference 7 in Figure 10.3 shows the state of the motor PTC thermistor. If no thermistor or other external trip device is fitted, the corresponding control terminal (T19 on the Control Board) should be closed: i.e.

- Linked to +24Vdc (terminal T21) when configured for ACTIVE HIGH, or
- Linked to 0V (terminal T20) when configured for ACTIVE LOW.

A “X” represents CLOSED and indicates that the digital input is connected to the circuit common (+24Vdc for ACTIVE HIGH or 0V for ACTIVE LOW).

A “O” represents OPEN and indicates that the digital input is NOT connected to the circuit common (+24Vdc for ACTIVE HIGH or 0V for ACTIVE LOW).

Check that each switch in turn, when operated, closes the correct circuit, and check that the multi-function input switch wiring configuration corresponds to what has been set on screen I7b POLARITY=H/L.

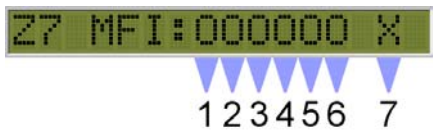


Figure 10.3: Screen Z7 - Digital Input Status

10.1.5 CHECKING OF DIGITAL OUTPUTS

If any of the three output relays are being used for remote status indication, they will need checking for correct operation. For Relay 1, scroll to screen O2a, and select Mode 1 (ALWAYS ON) and relay not inverted on screen O2b. This should force the relay ON, and the external connected device should reflect this. Set up Relays 2 and 3 in the same way, using screens O2c to O2f respectively. When these tests are complete, restore screens O2a to O2f to the required modes (if known).

Screen Z10 reflects the status of the output relays. References 1, 2 and 3 of Figure 10.4 refer to Relays 1, 2 and 3 respectively.

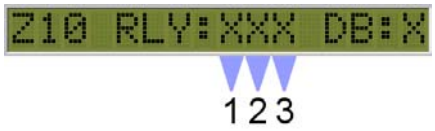


Figure 10.4: Screen Z10 - Digital Output Status

10.1.6 SHAFT ENCODER CONFIGURATION

If a shaft encoder is to be used to operate the Elite Series in closed loop control mode, appropriate configurations must be programmed as follows:

Type of Encoder:

The type of encoder (single ended output or differential output) must be identified, and programmed into screen N9.

Encoder Pulses per Revolution:

This parameter must be programmed into screen N8, as the encoder pulses per revolution of the motor shaft. If the encoder is driven directly from the motor shaft, then this figure will be the shaft encoder pulses per revolution. If the encoder in indirectly driven, for example by a toothed belt and pulley arrangement, then any ratio change must be accounted for. If it is impossible to determine the drive ratio between the motor shaft and the encoder shaft, then the ratio may be calculated by carefully turning the motor shaft through an exact number of revolutions, and observing the change in count on screen Z9. Divide the count change by the number of revolutions of the motor shaft, and enter the result into screen N8.

10.1.7 CHECKING OF SHAFT ENCODER (IF FITTED)

If a shaft encoder is fitted to the motor (i.e. for operation in closed loop control mode) check that the encoder is correctly connected.

Check screen Z9. It should be indicating a changing encoder pulse count. If this screen does not register any change in count, even though the motor is turning, check the encoder mechanical coupling and electrical connections.

If the motor is running in a forward direction (indicated by REF SPD, displayed by screen A4, being +ve) the encoder count Screen Z9 should be counting UP. Also the status (top) line of the display should indicate a +ve actual speed. If the encoder is indicating that the motor is running in a reverse direction, but in fact the motor is running in the preferred forward direction, swap two encoder outputs. For a differential output type shaft encoder, either swap wires into control terminals T31, T32 (A, /A) or swap wires into terminals T33, T34 (B, /B). For a single-ended output type encoder, that does not have /A, /B outputs, swap wires into terminals T31, T33 (A, B).

10.1.8 DYNAMIC BRAKE CONFIGURATION (IF FITTED)

If a dynamic brake has been installed in conjunction with the Elite Series, configure by setting screens D1 and D2.

D1 DB Time Constant - Time that the brake resistor will take to reach 64% of its final temperature if continuously energised.

D2 DB Duty Average - Percentage of time that the resistor may be energised for, without damage (when averaged over periods long in comparison to the time constant).

If the dynamic brake resistor has been supplied by PDL Electronics Ltd., the suggested settings will have been supplied. If a dynamic brake has not been fitted, leave at the default values.

If the dynamic brake is being used, check the status on screen Z10 (refer Figure 10.5, reference 1). During normal operation, a Closed (X) status indicates that a dynamic brake has operated since the last screen update. An Open (O) status indicates that the dynamic brake has not operated since the last screen update.

Figure 10.5: Screen Z10 - Dynamic Brake Status

10.1.9 CHECKING OF FIBRE OPTIC INPUT

Screen Z8 displays the status of the Fibre Optic Input (and Serial Input).

If the fibre optic input port is being used as a speed or torque reference then check that an X is displayed on screen Z8 (refer Figure 10.6, reference 1). A Closed (X) status indicates that a valid fibre optic data packet has been recieved since the last screen update. An Open (O) status indicates that no valid data packet has been recieved since the last screen update. An X (closed) should be displayed at all times when the fibre optic input is recieving valid data.

10.1.10 CHECKING OF SERIAL INPUT

Screen Z8 displays the status of the Serial Input (and the Fibre Optic Input).

If the serial port is being used check that an X is being displayed on screen Z8 (refer Figure 10.6, reference 2). A Closed (X) status indicates that a valid serial data packet has been recieved since the last screen update. An Open (O) status indicates that no valid data packet has been recieved since the last screen update.

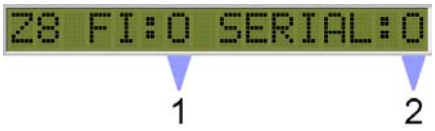


Figure 10.6: Screen Z8 - Fibre and Serial Input Status

10.2 OPERATION MODE AND CONFIGURATION

Section 8 shows the available screen list by default and gives full descriptions of all screens.

10.2.1 OPERATION MODES

The Elite Series may be set up to run in one of four operating modes. These are shown in Figure 10.7.

V/Hz Operating Mode:

For general purpose speed control applications, e.g. pumps, fans, conveyors etc. A shaft encoder is not needed. This open loop speed control mode generates an output with a fixed voltage vs frequency profile. Suitable for running multiple parallel motors from one Elite Series. Select by setting Screen X1 Control Type = V/Hz.

Also use V/Hz mode when autotuning an Elite Series motor controller.

Closed Loop Vector Mode - Torque Control:

For use in torque control applications, e.g. winder systems, position control applications with an external speed-position controller. A quadrature shaft encoder will be required on the motor, to provide rotor position feedback.

Te set up this mode of operation, set the encoder pulses per motor shaft revolution on screen N8 and program screen X1 to Closed Loop Vector. Then select torque control mode, either by appropriately configuring one of the multi-function inputs (screen I7c to I7h, selection 16 Speed/Torque Mode) and activating the switch, or by setting for torque control mode (screen A1 LOCAL MODE = TQ).

Closed Loop Vector Mode - Speed Control:

Recommended for servomotor type applications, where fast dynamic response is required, and for crane hoists and other applications where full torque capability at zero speed is required. A quadrature shaft encoder will be required on the motor, to provide rotor position and speed feedback.

Te set up this mode of operation, set the encoder pulses per motor shaft revolution on screen N8 and program screen X1 to Closed Loop Vector. Then select speed control mode, either by appropriately configuring one of the multi-function inputs (screen I7c to I7h, selection 16 Speed/Torque Mode) and deactivating the switch, or by setting for speed control mode (screen A1 LOCAL MODE = SP).

When operating in closed loop vector mode, switching between speed control and torque control modes can be done without stopping the Elite Series.

Open Loop Operating Mode:

For general purpose speed control applications, e.g. pumps, fans, conveyors etc. A shaft encoder is not needed. Configuration to this mode is set by programming screen X1 to Open Loop Vector.

10.2.2 INPUT CONFIGURATION

If Start-Stop/Reset is not required from the display unit, set screen I1 to NONE (0) or to desired mode.

Select the required speed or torque reference source from screens I2, I3. If an alternative source is required, e.g. for local/remote or auto/manual control, select from screens I4, I5.

If Analogue Input 1 is to be used as a reference source, set format and scaling from screens I6a, I6b, I6c. Similarly, screens I6d, I6e, I6f set up Analogue Input 2.

If a zero band is required, set on screen I6g. This sets a definite zero speed or zero torque region when using either analogue input.

If the fibre optic input is to be used as a reference source, set scaling from screens I8a, I8b.

Configure the multi-function inputs (MFI's) from screens I7. Screen I7a programs the MFI's in groups, while I7c to I7h programs each individually.

Configure the MFI's for active high or active low from screen I7b.

10.2.3 OUTPUT CONFIGURATION

Select the function, format and scaling of Analogue Output 1 from screens O1a to O1d. Similarly, screens O1e to O1h set up Analogue Output 2.

Select the required output relay functions from screens O2a, O2c, O2e, and their sense from screens O2b, O2d, O2f.

If using the fibre optic output, set function and scaling from screens O3a to O3c.

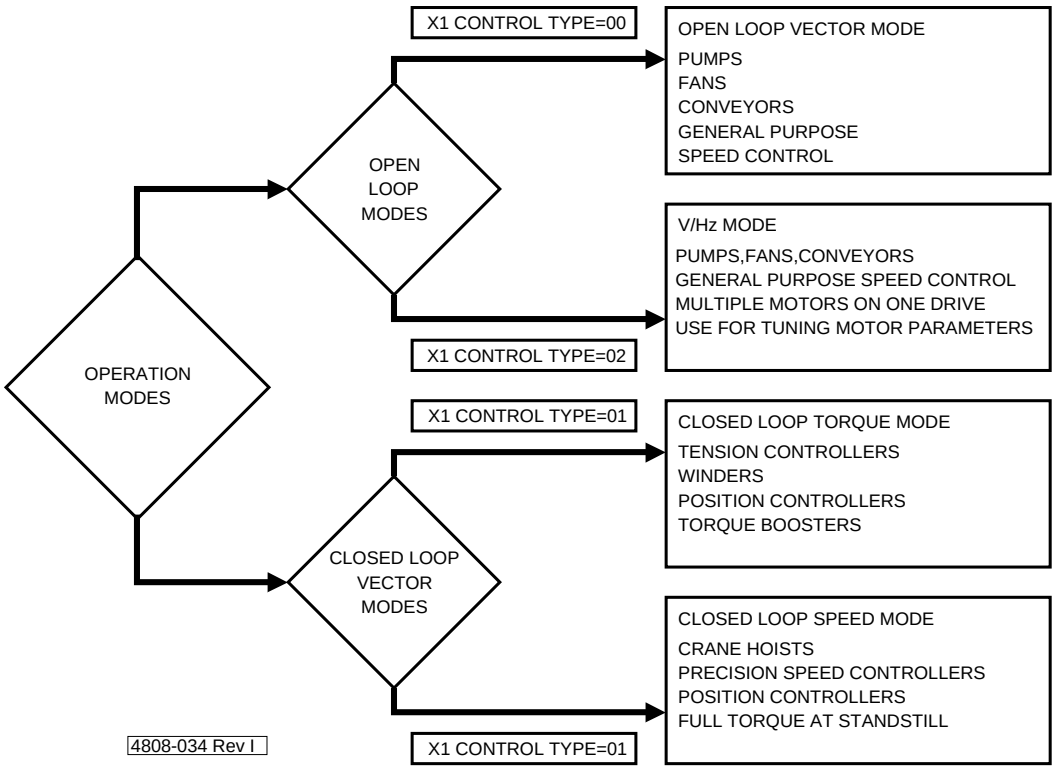


Figure 10.7: Elite Series Operation Modes

10.2.4 ACCELERATION AND DECELERATION RATES

If operating the Elite Series as a speed controller, set required acceleration and deceleration rates from screens R1, R2. Generally, set for the required response without torque limiting when accelerating (indicated by TLT on status line of display) and without excess regeneration on deceleration (indicated by VLT on status line of display). These rates are active only when speed controlling.

If two rates are required, set alternative rates and break speed on screens R3 to R5.

Set required deceleration rate when emergency stopping on screen R6.

Set an appropriate Stop Timeout on screen S11.

10.2.5 SPEED AND TORQUE LIMITS

Set speed limits on screens L2, L3. Normally set outside the range of the speed reference input. Should be active only when in torque control mode on light load. Indicated by SLT on status line of display.

Set torque limits on screens L4, L5. Normally set outside the range of the torque reference input. Should only be active when in speed control modes, on overloads (indicated by TLT on status line of display). Also torque limiting becomes active on loss of shaft encoder pulses when running in closed loop vector mode.

Set speed limit timeout on screen L6. Drive will trip if speed limiting exceeds this time.

Set torque limit timeout on screen L7. Drive will trip if torque limiting exceeds this time. Provides protection against loss of shaft encoder pulses.

10.2.6 MULTI-REFERENCES

Set screens M1 to M7 in conjunction with certian input modes (screen I7) as preset torque or speed references.

COMMISSIONING CONFIGURATION RECORD — SCREENS

DRIVE NO: _____ MODEL: _____

LOCATION: _____

MOTOR kW: _____ A: _____ V: _____

POLES: _____ RPM: _____

RECORD 1 RECORD 2

DATE: __/__/__ __/__/__

BY: _____ _____

	SCREEN	UNIT	RECORD 1	RECORD 2
KEYBOARD CONTROLS				
A1	LOCAL MODE =SP		_____	_____
A2	LOCAL TQ =+0.0%	%	_____	_____
A3	LOCAL SP =+100.0%	%	_____	_____
COMPARATOR CONTROLS				
C1	COMP1 SEL =02		_____	_____
C2	COMP1 ON =+100%	%	_____	_____
C3	COMP1 OFF =+90%	%	_____	_____
C4	COMP2 SEL =02		_____	_____
C5	COMP2 ON =+100%	%	_____	_____
C6	COMP2 OFF =+90%	%	_____	_____
SERIAL COMMUNICATIONS CONTROLS				
H1	PROTOCOL =M		_____	_____
H2	COMM T/O =OFF	sec	_____	_____
H3a	COMM ADR =10		_____	_____
H3b	BAUDRATE = 9600	bps	_____	_____
H3c	PARITY =EVEN		_____	_____
H4a	MAC ID =63		_____	_____
H4b	BAUDRATE =125	kbps	_____	_____
H4c	ASM IN =70		_____	_____
H4d	ASM OUT =20		_____	_____
H4e	CTRL SRC =00		_____	_____
H4f	REF SRC =00		_____	_____
INPUT CONTROLS				
I1	LOCAL S/STP =3		_____	_____
I2	REF S =LOCAL		_____	_____
I3	REF T =NULL		_____	_____
I4	AREF S =AIN1		_____	_____
I5	AREF T =NULL		_____	_____

	SCREEN	UNIT	RECORD 1	RECORD 2
I6a	AI1 =0-10V		_____	_____
I6b	AI1 LO =0%	%	_____	_____
I6c	AI1 HI =+100%	%	_____	_____
I6d	AI2 =0-10V		_____	_____
I6e	AI2 LO =0%	%	_____	_____
I6f	AI2 HI =+100%	%	_____	_____
I6g	ZERO BAND =N		_____	_____
I7a	I/P MODE =0		_____	_____
I7b	POLARITY =HI		_____	_____
I7c	MFI1 SEL =00		_____	_____
I7d	MFI2 SEL =00		_____	_____
I7e	MFI3 SEL =00		_____	_____
I7f	MFI4 SEL =00		_____	_____
I7g	MFI5 SEL =00		_____	_____
I7h	MFI6 SEL =00		_____	_____
I8a	F LO =-100%	%	_____	_____
I8b	F HI =+100%	%	_____	_____
I8c	FIBRE MODE =0		_____	_____
I8d	FIB T/O =OFF		_____	_____
LIMITS				
L2	MIN S =-110%	%	_____	_____
L3	MAX S =100%	%	_____	_____
L4	MIN T =-150%	%	_____	_____
L5	MAX T =+150%	%	_____	_____
L6	SP T/O =INF	sec	_____	_____
L7	TQ T/O =INF	sec	_____	_____
L8	REGEN =150%	%	_____	_____
L9	I LIMIT =*	Amp	_____	_____
L10	SKIP1 =+0.0%	%	_____	_____
L11	SKIP2 =+0.0%	%	_____	_____
L12	SK BW =0.0%	%	_____	_____
L13	GND ILT =*	Amp	_____	_____
L14	MIN SP RUN = Y		_____	_____
MULTI-REFERENCE				
M1	MREF1 =+0.00%	%	_____	_____
M2	MREF2 =+0.00%	%	_____	_____
M3	MREF3 =+0.00%	%	_____	_____
M4	MREF4 =+0.00%	%	_____	_____
M5	MREF5 =+0.00%	%	_____	_____
M6	MREF6 =+0.00%	%	_____	_____
M7	MREF7 =+0.00%	%	_____	_____

	SCREEN	UNIT	RECORD 1	RECORD 2
MOTOR NAMEPLATE PARAMETERS				
N1	MTR CUR=*	Amp		
N2	MTR VOLT =400V	Volt		
N3	MTR FRQ =50Hz	Hz		
N4	MTR PWR =*	kW		
N5	MTR RPM =*	RPM		
N6	MTR COOL =40%	%		
N8	ENCODER=0			
N9	ENC I/P=DIFF			
OUTPUT SIGNALS				
O1a	AO1 O/P =06			
O1b	AO1 =+/-10V			
O1c	AO1 LO =-100%	%		
O1d	AO1 HI =+100%	%		
O1e	AO2 O/P =02			
O1f	AO2 =+/-10V			
O1g	AO2 LO =-100%	%		
O1h	AO2 HI =+100%	%		
O2a	RELAY1 =02			
O2b	RELAY1 INV =N			
O2c	RELAY2 =05			
O2d	RELAY2 INV =N			
O2e	RELAY3 =08			
O2f	RELAY3 INV =N			
O3a	FIBRE O/P=06			
PROCESS				
P1	PR SRC =NULL			
P2	FB SRC =NULL			
P3	Kc =0.10			
P4	Ti=INF	sec		
P5	Td =0.0s	sec		
P6	ERROR=0%	%		
P7	INVERT PID=N			
RATES				
R1	ACC =*	%/sec		
R2	DEC=*	%/sec		
R3	AACC =*	%/sec		
R4	ADEC =*	%/sec		
R5	BRK SP =OFF	%		
R6	STOPR =1300%/s	%/sec		
R7	SP FLT =*	sec		
R8	TQ FILT =0.00s	sec		

	SCREEN	UNIT	RECORD 1	RECORD 2
START / STOP MODES				
S1	START =NORMAL	%		
S2	STOP =NORMAL	%		
S4	ASTOP =NORMAL	%		
S5	STR DLY =0.00s	%		
S6	OFF DLY =1.0s	sec		
S7	LOW V TRIP =N			
S8	BRAKE I =0%	%		
S9	HOLD V =0.0%	%		
S10	HEAT I =OFF	%		
S11	STP T/O =*	sec		
S12	BK RLS =0.00s	sec		
S13	PRE TQ =0%	%		
IMPEDANCES AND GAINS				
X1	CTRL TYPE =V/Hz			
X3a	Lm =*	%		
X3b	Rs =*	%		
X3c	Rr =*	%		
X3d	SIGMA =6.0%	%		
X3e	FL WEAK =100%	%		
X4a	MIN FLX =100%	%		
X4b	STR TYPE =AUTO			
X4c	STR TQ =0%	%		
X4d	STR BAND =10%	%		
X4f	Kp w =20%	%		
X4g	Ki w =30%	%		
X4h	Kd w =0%	%		
X4i	LS FL BO =0%	%		
X4j	HS FL BO =0%	%		
X4k	INERTIA k=1			
X5a	ILT SLP =*	%		
X5b	VLT SLP =*	%		
X5c	DAMPING=*	%		
X5d	SLIP COMP=N			
X5e	FREQ=AUTO	Hz		
X5f	SWITCH FR=WW			
X5g	Kp I =25%	%		
X5h	Kp I =13%	%		
X5i	Kf w =50%	%		
MENU OPTIONS				
Y1	LANGUAGE =1			
Y3	PROGRAM=1			
COMMISSION = Y				
Z1	PASSWORD=OFF			
Z2	S/W REVISION			
Z2	H/W REVISION			

NOTE: * Denotes drive size dependent defaults

COMMISSIONING CONFIGURATION RECORD — CONTROL TERMINALS

													Wire Designation	Wire Colour
Relay 1	N.O.	T1	O2a				O2b					T1		
		T2	Relay Selection =				Inverted=Y/N					T2		
	N.C.	T3										T3		
Relay 2	N.O.	T4	O2c				O2d					T4		
		T5	Relay Selection =				Inverted=Y/N					T5		
Relay 3	N.O.	T6	O2e				O2f					T6		
		T7	Relay Selection =				Inverted=Y/N					T7		
External D.B. Switch		T8	D1				D2					T8		
		T9	D.B. Time =				D.B. Duty =					T9		
+24V		T10	I1									T10		
Display DATA		T11	Local Start/Stop-Reset=									T11		
0V		T12										T12		
Multi-function Inputs MFI 1		T13	I7a				I7c	MFI 1=				T13		
MFI 2		T14	Multi-function Input Mode =				I7d	MFI 2=				T14		
MFI 3		T15					I7e	MFI 3=				T15		
MFI 4		T16					I7f	MFI 4=				T16		
MFI 5		T17					I7g	MFI 5=				T17		
MFI 6		T18					I7h	MFI 6=				T18		
Ext Trip/PTC		T19	External Trip /PTC Input									T19		
0V		T20	I7b	Digital Input Polarity = High/Low								T20		
+24V		T21										T21		
0V		T22					O1b	0-10V ±10V 4-20mA 0-20mA	O1c	Lo = %		T22		
Analogue Ouput 1		T23	O1a	Output =					O1d	Hi = %		T23		
Analogue Ouput 2		T24	O1e	Output =			O1f	0-10V ±10V 4-20mA 0-20mA	O1g	Lo = %		T24		
0V		T25							O1h	Hi = %		T25		
Analogue Input 1		T26	I6a	0-10V/ +/- 10V 4-20mA/0-20mA			I6b	Lo = %	I6c	Hi = %		T26		
Analogue Input 2		T27	I6d	0-10V/ +/- 10V 4-20mA/0-20mA			I6e	Lo = %	I6f	Hi = %		T27		
Potentiometer Supply 10V		T28										T28		
0V		T29										T29		
Encoder Supply +5V @ 100mA		T30										T30		
Encoder Input	A	T31	N8	Encoder PPR =			N9	Encoder Type =				T31		
	$\overline{A}$	T32										T32		
	B	T33										T33		
	$\overline{B}$	T34										T34		
0V		T35										T35		
User Supply +24V @500mA		T36										T36		
0V		T37										T37		
Isolated RS485	A	T38	H3a	Comunications Address=			H3b	Baudrate = 1200 2400 4800 9600 OFF	H2	Comms Timeout = 1s/5s 25s/OFF		T38		
	B	T39										T39		
Isolated 0V		T40										T40		
Isolated RS232	Rx	T41										T41		
	Tx	T42										T42		
Fibre Optic In		FI	I8a	Lo = %			I8b	Hi = %	I8c	Mode		FI		
Fibre Optic Out		FO	O3a	Output =								FO		

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11 APPLICATION EXAMPLE — SIMPLE FAN SPEED CONTROL

A typical application example is for simple fan speed control using a potentiometer to set 0-10V speed reference, and pushbuttons for remote start and stop-reset control. External speed monitoring is achieved using a simple 0-10V meter representing 0-100% speed. This section shows the configuration, wiring and adjustment of a typical example.

The example given is of a system of the following specification:

Control signal 0-10V (potentiometer)

Motor 5.5kW, 11.4A, 400V, 1450rpm

Elite Model E012

Stop/Start control 3 wire

Direction control None required

Example Configuration Table

The configuration table (not including irrelevant and/or settings that have not been altered from factory set values) and wiring configurations follow:

DRIVE NO:_____ **MODEL:** E012

LOCATION: Fan Speed Control

MOTOR kW: 5.5 **A:** 11.4 **V:** 400

POLES: 4 **RPM:** 1450

SCREEN UNIT RECORD 1

MOTOR NAMEPLATE PARAMETERS

Set up the motor information of screen group N:

N1	MTR CUR	A	11.4
N2	MTR VOLT	V	400
N3	MTR FRQ	Hz	50
N4	MTR P	kW	5.5
N5	MTR RPM	rpm	1450
N6	MTR COOL	%	40

LIMITS

Set up the limits of operation using in screen group L:

L2	MIN S	%	0.0
L3	MAX S	%	+100
L9	I LIMIT	A	17.1 (represents 150%)

INPUT CONTROLS

Set up the control sources via screen group I:

I1	LOCAL S/STP		0 (local control disabled)
I2	REF S		AIN1
I6a	AI1		0-10V
I6b	AI1 LO	%	0
I6c	AI1 HI	%	+100
I7a	I/P MODE		1 (remote 3 wire control)

SCREEN UNIT RECORD 1

OUTPUT SIGNALS

External speed monitoring is achieved via screen group O:

O1a	AO1 O/P		06 (% of motor speed)
O1b	AO1		0-10V
O1c	AO1 LO	%	0
O1d	AO1 HI	%	+100

RATES

The ramp rates are then set via screen group R:

R1	ACC	%/s	5.0
R2	DEC	%/s	5.0
R6	STOPR	%/s	10.0

START is activated by momentarily closing the normally open pushbutton connected at terminal T14. This starts the Elite Series and accelerates the motor to the reference speed defined by the potentiometer connected at terminal T26.

STOP is activated by momentarily opening the normally closed pushbutton connected at terminal T15. This stops the Elite Series and decelerates the motor to zero speed.

The acceleration and deceleration rates are defines by screens R1 and R2.

By momentarily opening the normally closed EXT TRIP pushbutton connected at terminal T19 the Elite Series will trip, displaying the fault condition “22 EXT/PTC”.

By opening the normally closed switch connected at terminal T13, the Elite Series will stop, decelerating the motor using the stop rate defined by screen R6 (this overrides the deceleration rate defined by screen R2). If any internal or external fault should occur, then the Elite Series may be reset (once the fault condition has been removed) upon the opening edge of the ASTOP-RESET switch.

12 SERVICE AND MAINTENANCE

WARNING: Observe the safety precautions detailed at the beginning of this manual.

12.1 FAULT FINDING

Faults in the Elite Series will fall into one of five major categories:

- Failure of an external control device, e.g. switch or analogue input device.
- Protective fault operation with resulting display message.
- Incorrect settings, set up or adjustment resulting in unsatisfactory performance.
- Encoder failure.
- Electrical failure within the drive.

12.1.1 ELECTRICAL FAILURE

Electrical failure is rare but can occur in the power electronic circuits or in the control circuits. A problem with the power electronics will usually evidence itself as an input fuse failure, and subsequent loss of power to the Elite Series, or as a "Desaturation fault" or " Current Trip fault" which is persistent or can not be reset. Note that the desaturation fault indication also can be caused by wiring faults or load related problems. Often severe electrical faults will cause physical damage which must be checked for and corrected before any attempt is made to restart the Elite Series.

Electrical failure is generally not repairable by the user. Repair is achieved by returning the faulty unit to PDL Electronics or their authorised Service Agent. Before disconnection, try to record commissioning parameters either on paper or by uploading to a PC running PDL Drivecomm for Windows. If, due to the nature of the fault, you cannot power up the unit to do this recording, it may be possible to liven the Control Board by back-feeding with 24Vdc. Refer to Section 5.5 for instructions.

12.1.2 PROTECTIVE FAULT OPERATION

The Elite Series is designed to trip when a fault or user programmed trip function is detected. The fault message will be displayed on the LCD display. Refer to Section 12.2 for detailed descriptions.

12.1.3 ENCODER FAILURE

The Elite Series cannot continue to operate in **Closed Loop mode** if the encoder signals are missing or excessively corrupted by noise. Should the signals be lost, the unit will indicate 0% speed. If the Elite Series is operating in speed control and the encoder signal is lost then the output frequency and shaft speed will drop to only a few percent and the unit will typically indicate torque or current limit.

If you cannot run the Elite Series above a certain speed in spite of a high speed reference signal, and torque limit is indicated at this speed, this may indicate that the encoder signals are becoming unreadable by the Control Board. The usual cause of this is excess encoder cable capacitance. This can be overcome by using a screened cable of lower capacitance per metre, using a shorter cable run, or by selecting a complementary output or differential output type shaft encoder. These types of encoder can drive a higher capacitance than a single-ended open collector type.

To check the encoder connection and function use V/Hz control mode (by setting screen X1) and monitor the encoder screen Z9.

If the motor speed or torque is erratic; check that the encoder is mounted correctly to the rotor and is not slipping.

12.1.4 INCORRECT SET-UP OR ADJUSTMENT

Many problems will stem from an inappropriate configuration or maltuned control parameters.

Ensure the correct input mode and reference source is chosen and that the programmable input selections are appropriate. Note that some input modes are designed to operate in conjunction with other parameters and may be affected by the reference source selection.

In some instances the Elite Series may be unable to follow the prescribed control signals. This will be indicated by the various limit status indications (as seen on the Status Screen). The torque, speed, and regeneration limits (L screens) are user selectable within bounds and must be set to suit the application.

All the screens apart from those which define the motor ratings and vector control parameters (N and X screens) can be returned to the factory default settings using the Initialise User Parameters function in screen Y2. The level of initialisation can be chosen. Refer to Section 8 of this manual for details. Use this feature if the set-up is unknown.

12.1.5 POOR VECTOR CONTROL TUNING

If the parameters in the X and N screens are not correctly adjusted the Elite Series may operate erratically. Excessive current draw, vibration and motor noise, and the failure to accelerate indicate possible maladjustment. Generally if **autotuning** has been employed, this problem should not occur. Autotuning can be invoked from screen X2. Full details on tuning options are given in Section 9.

If when running in Closed Loop Vector control mode, the Elite Series output voltage is very sensitive to load torque and/or the torque reading is in error and does not correspond to the expected current (rated current at rated torque) then parameters X3a and X3c may be incorrect. If the Elite Series operates correctly in torque control mode but is unstable in speed control mode then the speed control parameters X4f, X4g, X4h and X5i may be maltuned.

All the X and N screens can be returned to the factory default settings using the Initialise Motor Parameters function (screen Y2). Use this feature if the setup is unknown. Reinitialisation will cause a "ZERO PARAM" fault indication which can be reset only after the N screen nameplate parameters are reprogrammed.

12.1.6 FAILURE OF EXTERNAL CONTROL DEVICE

A problem with the signal processing circuitry may cause erratic and possibly rough operation or cause the Elite Series to fail to respond to control signals. External wiring faults or incorrect setup can also stop the Elite Series responding to control signals in the desired manner. Therefore special provision has been made to simplify the checking of the incoming signals and input circuitry. Refer to screens Z3 to Z12 for diagnostic information.

12.1.7 FAILURE OF THE DISPLAY UNIT

Should the Elite Series fail to communicate with the Display Unit, the message **NO COMMS** will be displayed. This indicates that the 24Vdc supply to the Display Unit is functioning but invalid (or no) communications has been received by the Display Unit. Check the connection to the Display Unit from the Elite Series unit.

12.2 THE FAULT SCREEN

(See also Status Messages, Screen AA)

12.2.1 CONTROL OF THE FAULT SCREEN

Fault messages are automatically displayed on the Fault Screen (screen F).

There is a **fault log** folded as subscreens of the fault screen. This fault log records the previous five faults, with the first screen being the most recent fault. This fault log may be inspected at any time.

When a fault is cleared and the Elite is reset, the fault message will be moved to the first of the screens folded behind the fault screen. All existing messages on the fault log will be moved down one screen, with the oldest message being discarded. The fault message on the main fault screen will be replaced by **NO FAULT**.

12.2.2 FAULT CODES

Fault conditions, their interpretation and suggested remedies are listed below.

Fault **00 NO FAULT**
Detail No fault detected
Possible cause Normal operation
Action None required

Fault **01 LOW Vdc**
Detail Mains voltage has dropped too low (LOW V TRIP - screen S7).
Sense level Model dependant
Possible cause Mains interruption, dip.
Action Check supply conditions. Disable Low Volts Trip (refer detailed description of screen S7).

Fault **02 HIGH Vdc**
Detail DC bus voltage has risen to a dangerous level.
Sense level 820Vdc (E018 to E046)
900Vdc (Other Sizes)
Possible cause Very high mains surge; Excessive regeneration from regenerative load or excessive deceleration rate (refer detailed description of screen R2); Earth fault on motor; Dynamic Brake failure or undersized;
Action Reduce deceleration rate; Check motor circuit for earth fault; Apply Speed Filter via screen R7.

Fault **03 HI Vdc T/O**
Detail DC bus voltage has risen to a dangerous level.
Sense level 750Vdc for greater than 5 seconds (E018 to E046)
850Vdc for greater than 5 seconds (Other Sizes)
Possible cause Mains too high for too long; Earth fault on motor.
Action Check mains supply voltage; Check motor circuit for earth fault.

Fault **04 SUPPLY FLT**
Detail Input supply phase voltage imbalance
Sense level 40Vac ripple voltage in Elite DC bus. Phase imbalance is most sensitive under heavy load conditions. Under light load conditions, the Elite will run satisfactorily with only two phases connected.
Possible cause Loss of phase; fuse; motor phase loss; motor winding fault.
Action Check supply conditions; check wiring to motor; check motor.

Fault **05 S/W DL FLT**
Detail Incorrect software downloaded.
Possible cause Data transmission error; incompatible software and hardware revisions.
Action Download correct software.

Fault **06 EEPROM FLT**
Detail Nonvolatile memory (EEPROM) is faulty
Possible cause IC failure
Action Seek service.

Fault **07 I LIM FLT**
Detail Output current has reached a dangerous level.
Sense level 220% of Elite Series rated current.
Possible cause Short circuit; wiring fault; circuit fault; motor fault.
Action Check entire output circuit and motor for wiring or winding faults; Check output circuit contactors or isolators for correct operation.

Fault **08 U+ DESAT**
09 V+ DESAT
10 W+ DESAT
11 U– DESAT
12 V– DESAT
13 W– DESAT
14 NEG DESAT
Detail Automatic protection of the internal power switching semiconductor device has operated.
Possible cause Short circuit; extreme overcurrent; wiring fault; circuit fault; motor fault; IGBT desaturation; IGBT failure.
Action Check entire output circuit and motor for wiring or winding faults; If fault persists when output leads are disconnected, replace or service the Elite Series.

Fault **15 ELITE O/L**
Detail The temperature calculated by the Elite Series inverter thermal model has reached a dangerous level.
Sense level 150% of Elite Series rated current for 30 seconds at 50° C. Maximum continuous operation possible without trip is 105% of Elite Series rating.
Possible cause Continuous overload of Elite Series.
Action Check load requirements.

Fault **16 MOTOR O/L**
Detail The temperature calculated by the thermal model of the motor has reached a dangerous level.
Sense level 110%
Possible cause Excessive load on motor (current draw too high); motor load exceeds cooling capacity at the operating speed; motor phase loss; motor winding fault; motor thermal model parameters incorrectly set. Refer also to the detailed descriptions of screens N1 and N6.
Action Check load and thermal model settings in screens N1 and N6.

Fault **17 BRAKE O/L**
Detail The temperature calculated by the thermal model of the dynamic brake resistor has reached a dangerous level.
Sense level Set by dynamic brake thermal model in screens D1 and D2.
Possible cause Excessive regeneration for the resistor specified in screens D1 and D2. Incorrect values entered.
Action Check values (refer detailed descriptions of screens D1 and D2); Reduce regeneration via screen L8; Select a bigger braking resistor; Reduce deceleration rate (screen R2).
Note: Active whether a dynamic brake is connected or not.

Fault **18 DATA FLT**
Detail Nonvolatile memory (EEPROM) reading error. This fault can only be cleared using screen Y2 to initialise user and motor settings. Be sure motor is isolated before resetting fault and entering correct data.
Sense level Check sum in memory.
Possible cause Spurious fault; faulty memory.
Action If fault recurs, replace Elite Series.

Fault **19 ZERO PARAM**
Detail Zero parameters (N screens) have been detected.
Possible cause Elite Series has been reinitialised; ex-factory state; error in set up.
Action Enter all N values correctly.

Fault **20 PARAM FLT**
Detail Inconsistent set of parameters (N screens, L9 screen) selected.
Possible cause Error in set up; wrong values chosen.
Action Enter consistent set of N values.

Fault **21 GROUND FLT**
Detail Excessive current flow to ground.
Sense level Internally set.
Possible cause Motor or cable insulation fault.
Action Check motor and cables (isolate from Elite Series first). Refer to screen L13.

Fault **22 EXT/PTC**
Detail External trip device has operated. External motor winding temperature sensor (PTC, thermostat etc.) circuit (terminal T19) has operated.
Sense level Circuit resistance exceeds 4kOhms.
Possible cause Operation of external trip device; Motor has become too hot (motor load exceeds cooling capacity at the operating speed); Fault in sensor wiring.
Action Check motor temperature and sensor wiring; Check external trip switch (if fitted).

Fault **23 H/S TEMP**
Detail Elite Series heatsink too hot.
Sense level 90°C.
Possible cause Poor ventilation; obstructed ventilation path; Elite Series cooling fan failure; local ambient temperature exceeds 50°C.
Action Check fan is operating; Check ventilation and thermal conditions; Improve cooling; Clean fins with compressed air; Seek service.

Fault **24 INT TEMP**
Detail Elite Series internal temperature too hot.
Sense level 80°C.
Possible cause Poor ventilation; obstructed ventilation path; Elite Series heatsink and internal cooling fan failure; local ambient temperature exceeds 50°C.
Action Check heatsink and internal cooling fans are operating; Check ventilation and thermal conditions; Improve cooling; Seek service.

Fault **25 COMMS TRIP**
Detail Host computer generated trip.
Sense level –
Possible cause Trip generated by the host computer via serial communications.
Action No action required.

Fault **26 COMMS T/O**
Detail Time since last valid serial communication has exceeded timeout period on screen H2.
Sense level Set by communications timeout value on screen H2.
Possible cause Serial communications wiring faults; host computer fault; incorrect settings on screens H1 to H4.
Action Check complete serial communications system; Check screen settings; Seek service.

Fault **27 FIBRE T/O**
Detail Time since last valid fibre optic input has exceeded timeout period on screen I8d.
Sense level Set by Fibre T/O value on screen I8d.
Possible cause Speed or torque reference (screens I2 to I5) selected from fibre optic port with no fibre optic cable connected; fibre optic cable connected to fibre optic output port instead of input port; fibre optic cable fault.
Action Check fibre optic cable; Check screen settings; Seek service.

Fault **28 OVERSPEED**
Detail Maximum output speed has been exceeded.
Sense level 300% of motor rated frequency; absolute maximum 450Hz.
Possible cause Loss of control of the motor while being driven by load; excessive load.
Action Check actual operating conditions to determine cause; Adjust load or set up to eliminate problem.

Fault **29 TQ LIM T/O**
Detail At torque limit for longer than specified.
Sense level Set by screen L7.
Possible cause Load condition or inappropriate setting of screen L7; encoder failure.
Additional causes for this fault occurring during Open Loop mode starting are: Insufficient start torque (screen X4c), Too high an acceleration rate (screens R1, & R3), Insufficient start delay (screen S5). Another possible cause is the motor is overloaded while in Open Loop mode.
Action Check load condition or alter screen L7.
For Open Loop mode starting fault adjust any of the three screens mentioned above as follows:
Increase start torque (screen X4c).
Decrease acceleration rate (screen R1).
Increase the torque limit (screens L4 & L5).
Increase Rs(screen X3b).

Fault **30 SP LIM T/O**
Detail At speed limit for longer than specified.
Sense level Set by screen L6.
Possible cause Load condition or inappropriate setting of screen L6.
Action Check load condition or alter screen L6.

Fault **31 CAL FLT**
Detail Internal reference voltage levels are incorrect.
Possible cause Elite Series fault. Seek service.

Fault **32 S/W T/O**
Detail Internal timing requirements exceeded.
Possible cause PDL Vysta® for Windows configuration too complex.
Action Simplify configuration.

Fault **33 LVDC FLT**
Detail Failure of the low voltage dc power supplies.
Possible cause Heatsink cooling fan failure; control PCB failure.
Action Seek service.

Fault **34 VYSTA TRIP**
Detail Custom configuration developed using PDL Vysta® for Windows has deliberately tripped the Elite Series.
Possible cause Refer to custom configuration schematic.
Action Refer to custom configuration schematic.

Fault **35 NO DISPLAY**
Detail The Elite Series has detected that the display unit is disconnected or faulty. The Elite Series will trip on this fault only if the display unit is enabled via screen I1 (I1 LOCAL S/STP= 1,2 or 3).
Possible cause Display removed by personnel; display mounted more than 3m distance from the Elite Series unit; faulty display unit.
Action Connect display unit and disable keyboard mode using screen I1 (I1 LOCAL S/STP=0); reduce distance; replace display unit.

Fault **36 EPLD TRIP**
Detail An unrecognised fault has been detected by the control board EPLD.
Possible cause Power supply fault.
Action Reset fault; if fault persists, seek service or replace the Elite Series.

Fault **37 WATCHDOG**
Detail An unknown fault has reset the Control Board microcontroller.
Possible cause Power supply fault; PDL Vysta® for Windows configuration too complex.
Action Reset fault; if fault persists, seek service or replace the Elite Series; simplify PDL Vysta® for Windows configuration.

Fault **38 NO VYSTA PRG**
Detail User Program not set
Action Reload Program via Drivelink software

Fault **39 FIBRE TRIP**
Detail The Elite Series has tripped due to a fault being reported via the Fibre Optic Network
Cause See other Elites connected to the network.
Action Reset fault on the other Elites.

Fault **40 ILIMIT T/O**
Detail The hardware current limit has been active for longer than 30 seconds.
Possible Cause A partial short circuit in the cabling or motor.
Action Check cables and motor for possible short circuit.

Fault **41 STOP T/O**
Detail The system has not stopped within the time-out set by screen S11.
Possible Cause Parameters set incorrectly: Stop Timeout (screen S11), Decel rates (screens R2, R4, R6), Speed filter (screen R7). Mal-tuned speed PID in vector systems.
Action Check all parameters. Check Dynamic brake.

Fault **43 MAS U+ DES**
44 MAS U- DES
45 MAS V+ DES
46 MAS V- DES
47 MAS W+ DES
48 MAS W- DES
49 SLV U+ DES
50 SLV U- DES
51 SLV V+ DES
52 SLV V- DES
53 SLV W+ DES
54 SLV W- DES
Detail Internal protection of a semiconductor switching device has occurred.
MAS = Master Ultradrive Elite.
SLV = Slave Ultradrive Elite.
DES = DESAT.
Possible Cause Output short circuit; extreme output over current; wiring fault; IGBT Desaturation; IGBT failure.
Action Check entire output circuit and motor for wiring or winding faults. If fault persists when output leads are disconnected, replace or service the Ultradrive Elite.

Fault **55 MAS I FLT**
Detail The MASTER Ultradrive Elite output current has reached a dangerous level.
Possible Cause Short circuit; wiring fault; circuit fault; motor fault.
Action Check entire output circuit and motor for wiring or winding faults; Check output circuit contactors and or isolators for correct operation.

Fault **56 SLV I FLT**
Detail The SLAVE Ultradrive Elite output current has reached a dangerous level.
Possible Cause Short circuit; wiring fault; circuit fault; motor fault.
Action Check entire output circuit and motor for wiring or winding faults; Check output circuit contactors and or isolators for correct operation.

Fault **57 DESAT/OCT**
Detail The SLAVE drive indicates a common desat or over current fault.
Possible Cause Short circuit; wiring fault; circuit fault; motor fault.
Action Check entire output circuit and motor for wiring or winding faults; Check output circuit contactors and or isolators for correct operation.

Fault **58 CURR IMB**
Detail The MASTER and SLAVE Ultradrive Elite output current is out of balance.
Sense Level 10% of actual individual Drive output current.
Possible Cause Mismatch of IGBTs, output impedances or input rectifier.
Action Check entire output circuit including IGBTs, output bus work, DC bus fuses, and input rectifier.

Fault **59 SLV HS FLT**
Detail The SLAVE Drive has detected either MASTER or SLAVE drive heatsink is TOO HOT.
Sense Level 80°C.
Possible Cause Poor ventilation; obstructed ventilation path; Elite Series cooling fan failure; local ambient temperature exceeds 50°C.
Action Check fan is operating; check ventilation and thermal conditions; Improve cooling; Clean fins with compressed air. Seek service.

Fault **60 SLV DC HI**
Detail The SLAVE Ultradrive Elite dc bus voltage has risen to a dangerous level.
Sense Level 820Vdc
Possible Cause DC bus inter-link cable fault.
Action Check dc bus inter-link.

Fault **61 SLV EPLD**
Detail The SLAVE Ultradrive Elite internal processing units have faulted.
Possible Cause Faulty or unprogramed SLAVE drive control board.
Action Reset all Drive parameters using the INILTILISE ALL VAR at screen Y2; replace SLAVE drive Control Board.

Fault **62 CONNECT FLT**
Detail The MASTER and/or SLAVE Ultradrive Elite looming connections are incorrect.
Possible Cause The fibre optic connections are plugged in incorrectly or not working.
Action Check all the wiring connections.

Fault **63 SLV WDT**
Detail An unknown fault has reset the SLAVE drive Control Board.
Possible Cause Power supply fault; Software fault.
Action Reset fault; seek service or replace the SLAVE drive Control Board.

Fault **64 SLV EEPROM**
Detail The SLAVE drive Control Board's nonvolatile memory (EEPROM) is faulty.
Possible Cause IC failure.
Action Seek service.

Fault **65 SLV PSU**
Detail The SLAVE Ultradrive Elite Control Board power supply failure.
Possible Cause Faulty IC.
Action Seek service.

Fault **66 SLV DATA**
Detail The SLAVE Ultradrive Elite Control Board's nonvolatile memory (EEPROM) reading error. This fault can only be cleared using screen Y2 to initialise settings. Isolate motor before resetting fault.
Sense level Check sum in memory.
Possible Cause Spurious fault; faulty memory.
Action If fault recurs, replace SLAVE paralleling card.

Fault **67 SLV CAL**
Detail The SLAVE Ultradrive Elite drive select modules are incorrect.
Possible Cause Incorrect combination of drive select modules are plugged into the SLAVE drive select card.
Action Check both drive select modules are identical on the SLAVE drive Control Board.

Fault **68 SLV SW VER**
Detail SLAVE Ultradrive Elite has incorrect software loaded.
Possible Cause The SLAVE drive control board data transmission error; incompatible software and hardware revisions.
Action Download correct software to SLAVE drive Control Board.

Fault **69 SLV PCBTEM**
Detail The SLAVE Ultradrive Elite internal temperature is too hot.
Sense level 70°C
Possible Cause Poor ventilation; obstructed ventilation path; fan failure; local ambient temperature exceeds 50°C.
Action Check fan is operating; Check ventilation and thermal conditions; Seek service.

Fault **70 DC FUSE FLT**
Detail Fuse monitoring device has operated. External fuse monitoring circuit on SLAVE Ultradrive Elite Parallel Board T30 has operated.
Possible Cause One of the monitored fuses has failed and the monitoring switch has opened.
Action Check for continuity on fuse monitoring circuit; look for open circuit in wiring.

12.3 USE OF LED INDICATORS

The LED indicators on the Display Unit provide visual indication of the unit's status as follows:

LED **ON**
Functional indication Mains power is supplied and stored charge is present.
Actual indication +24V functioning on the Display Unit.
Implication Primary and secondary switchmodes functioning.

LED **RUN**
Functional indication Elite Series is running.
Actual indication Output devices enabled.
Implication Elite Series is functional.

LED **OK (Steady)**
Functional indication Elite Series is operating normally.
Actual indication Elite Series ready to operate.
Implication No fault is present.

LED **OK (Flashing)**
Functional indication Fault trip.
Actual indication Output disabled.
Implication A fault (screen F) has tripped the Elite Series.

12.4 FUSE FAILURE

The Elite Series incorporates electronic protection. The few fuses included are for SAFETY back up.

Supply Fuses

Fitted by customer at point of supply.

Possible reason for failure
Wrong fuses; Supply surge; Age or cyclic stress failure; Fault in supply cable to Elite Series; Elite Series failure.

Action Check supply cable; check Elite Series unit . Isolate Elite Series and replace fuses. If OK reconnect Elite Series and re-test. If failure persists replace Elite Series or request service.

+24Vdc User Supply Fuse (F1)

Fitted beneath the expansion board cover beneath the normal Display Unit position.

Possible reason for failure
Overload of the +24Vdc supply or low voltage supplies derived from +24Vdc. Faulty external equipment connected to the User +24Vdc supply. 230Vac accidentally connected to the +24Vdc input supply.

Action Check external equipment connected to the +24Vdc supply. Replace fuse. If failure persists request service.

Microdrive Elite Series Supply Fuses

These fuses must be fitted at the point of input termination to the Elite Series. Refer to figures 2.1 to 2.4 for recommended fuses. These fuses are fitted to limit fault energy let-through to protect cables and upstream switchgear.

Possible reason for failure
Wrong fuses; supply surge; age or cyclic stress failure; fault in supply cable to Elite Series; Elite Series failure.

Action Check input cables and Elite Series for any signs of a fault. Isolate Elite Series and replace with correct fuses. Test. If OK, reconnect Elite Series and re-test. If failure persists replace Elite Series, or request service.

Ultradrive Elite Frames 5 to 7
DC Bus Fuses

These fuses are fitted to limit fault energy and prevent damage to the Power PCB.

Possible reason for failure
Supply surge; age or cyclic stress failure; wrong fuses; fault in output cable to motor; Ultradrive Elite Series failure.

Action Isolate Ultradrive Elite Series. Check output cables; check Ultradrive Elite Series; Unless confident fault found and cured, contact service agent. Replace fuses. Reconnect Ultradrive Elite Series and test. If failure persists replace Ultradrive Elite Series, or request service.

Ultradrive Elite Frames 5 to 7
F1/F2 2A 440Vac SMPS DC Bus Fuses

Fitted on Ultradrive Elite frames 5 to 7 DC Fuse PCB to protect the Power PCB and DC bus cable loom to the Power PCB.

Possible reason for failure
Fault in switch mode power supply or loom to Power PCB.

Action Replace fuses. If failure persists, replace Ultradrive Elite Series Power PCB assembly, or request service.

WARNING: These fuses must not be replaced with glass fuses (glass fuses will rupture and cause catastrophic damage). Use only the specified 440Vac 2A ceramic fuse.

Ultradrive Elite frames 5 to 7
10A 440Vac Heatsink Fan Supply Fuses

Fitted on the Ultradrive Elite frames 5 to 7 SCR PCB to protect against transient suppression overload; and to protect against heatsink fan failure.

Possible reason for failure
Supply surge; faulty heatsink cooling fan.

Action Replace fuse, check fan operation. If failure persists, replace heatsink cooling fan(s), or request service. Use only the specified 440Vac ceramic fuses.

WARNING: These fuses must not be replaced with glass fuses (glass fuses will rupture and cause catastrophic damage). Use only the specified 440Vac 2A ceramic fuse.

12.5 SPARE PARTS LISTS

A comprehensive list of spare parts is available from our website. Please go to **www.pdlelectronics.com** for any requirments.

13 ANCILLARY PRODUCTS

The following ancillary products have been designed and manufactured to be compatable with the Elite Series range of variable speed drives. For more detailed information please refer to the PDL Product Catalogue - 4880-041.

DeviceNet Option

PDL Part No. EDNi
For Use With All Elite models

This option is internally mounted and used to interface the Elite Series directly to a DeviceNet network.

Interbus Option

PDL Part No. IBUS
For Use With All Elite models

The Interbus option provides an interface which allows the Elite Series to be connected directly to an Interbus network.

Profibus Option

PDL Part No. PBUS
For Use With All Elite models

The Profibus option provides an interface which allows the Elite Series to be connected directly to a Profibus network.

Elite Serial Bus Interface

PDL Part No. ESBi
For Use With All Elite models

This option is internally mounted and used to interface the Elite Series to an external communication adapter.

110Vac Isolated Interface

PDL Part No. EII1
For Use With All Elite models

The Elite Series 110Vac Isolated Interface enables the user to interface 110Vac control logic levels for the digital control of the Elite Series. The interface fits inside the Elite Series termination area.

Display Unit (3M Cable)

PDL Part No. E000-621S
For Use With All Elite models

This option allows the display unit to be remotely mounted up to 3 meters away from the Elite.

The display unit has an IP54/NEAM 12 protection rating (front and sides only) when mounted against a hard flat surface. To maintain this protection rating the protective screw caps must be fitted.

Dynamic Brake 15

PDL Part No. B015
For Use With All Elite models

The Dynamic Brake 15 provides the Elite Series with the ability to cope with short term regenerated power as may be experienced during the deceleration of a high inertia load.

Note that the Microdrive Elite E002 to E022 and ME002 to ME021 have a dynamic brake transistor fitted as standard. An external resistor will still be required.

Dynamic Brake 140

PDL Part No. B140
For Use With All Elite models

The Dynamic Brake 140 provides the Elite Series with the ability to cope with regenerated power as may be experienced during the deceleration of a high inertia load (e.g. a large fan or centrifuge), or a regenerative load (e.g. lowering of a crane hoist).

Shaft Encoder

PDL Part No.	Shaft Encoder	0322-EN
	Mounting Bracket	0300-BR
	Encoder Coupling	0300-CP
For Use With	All Elite models	

A shaft encoder will be needed if the Elite Series is to operate in closed loop flux vector control mode. A shaft encoder is fitted when precise and accurate control of the motor is required.

Plinths

PDL Part No.	UE170 to UE250	0398
	UE305 to UE540	0399
	UE620 to UE700	0400
For Use With	Ultradrive Elite	

The Plinths fit neatly underneath the Ultradrive Elite frames 5 to 7, lifting them to a standard 2 meter switchboard height and provide room for any additional electronic or power products that may be required.

18 Pulse Rectifier

PDL Part No. FE540-18P
For Use With UE170 to UE620

The 18 Pulse Rectifier (FE540-18P) is designed to supply a single frame 5 to 7 Ultradrive Elite.

The FE540-18P, when connected to a suitable 18 pulse transformer, will reduce the harmonic current distortion on the input of the transformer.

EDM Filter

PDL Part No.	Up to 250A motor	ED250C20
	Up to 340A motor	ED340C20
	Up to 480A motor	ED480C20
	Up to 660A motor	ED660C20
For Use With	Up to 660 Amp motors	

The EDM Filter is designed to filter the output voltage from the AC Variable Speed Drive. The dv/dt output from the filter is limited to less than 500V/us and the pulse width modulation related common-mode voltage is attenuated by more than 90%. Both of these filtering functions assist in the mitigation of premature bearing failure in large AC induction motors as a result of the Electric Discharge Machining (EDM) process.

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Commissioning Notes:

Bardac Corporation

40 Log Canoe Circle
Stevensville, MD 21666 USA
Toll Free: 1-888-667-7333 (888-ON-SPEED)
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