

SINGLE PHASE CONVERTOR TYPE 540/541

PRODUCT MANUAL

HA047490

Issue 3



WARNING

This equipment contains hazardous voltages and hazardous rotating mechanical components.

Loss of life, severe personal injury or property damage can result if instructions contained in this manual are not followed.

Only qualified personnel should work on this equipment, and only after becoming familiar with all safety instructions regarding installation, operation and maintenance procedures contained in this manual. The successful and safe operation of this equipment is dependent on proper handling, installation, operation and maintenance of the equipment

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1 INTRODUCTION

The 540/1 single phase controllers are designed as armature voltage controllers for DC shunt motors up to 10¹/₂KW (14HP).

The 540 regenerative controller is intended to provide a full 4 quadrant armature controller for motor currents up to 35A. The 541 non regenerative controller provides 2 quadrant motor armature control in the same current range. Both controllers are capable of operating from either line to line or line to neutral supplies up to 480V AC at 45 to 65Hz but require an additional auxiliary supply of 110/240V AC for the control circuits.

The 540/541 controllers are designed as system products and incorporate as a standard feature a sophisticated electronic control system for speed and current control including a setpoint ramp for smooth acceleration and deceleration. Other standard features include field failure, fuse failure, motor overtemperature and zero speed detection. The power circuits are fully isolated from the control circuits which allows simple interconnection of controllers to form a system, while customer inhibit/enable inputs provide for safety interlocks.

All units are designed for simple mounting by means of keyhole slots whilst control interconnections are made via simple two part connectors for easy removal. Only power connectors require the use of a screwdriver.

Commissioning and the location of faults (both within the controller and external to it) are greatly assisted by built in Condition Indicators which show the status of the various system alarms. Further assistance is available by use of the optional Diagnostic Test unit type 5570 which provides access to 27 alarms, inputs and principal circuit nodes throughout the controller. This unit, which is available as a portable hand-held instrument also has output sockets for the connection of an oscilloscope, chart recorder or other instruments.

2 TECHNICAL DETAILS

2.1 GENERAL

- Control Circuits : Fully isolated from power circuits.
- Control Action : Advanced PI with fully adaptive current loops for dynamic performance.
- Control Modes : Speed Control.
Torque (Armature Current) Control.
- Speed Control : By tachogenerator feedback as standard.
Armature Voltage feedback can be simply implemented by addition of the 5590 Armature Voltage Feedback Unit.
- Speed Range : 100 to 1 typical with tacho feedback.
- Adjustments : For all drive parameters on plug-in 'personality' card.
- Protection : Interline device networks.
High energy MOV's.
Overcurrent (instantaneous).
Overcurrent (inverse/time).
Field failure.
Motor overtemperature.
Zero speed detection.
"Sub Cycle" overcurrent trip with 'Reset'.
Absolute fault protection by high speed backup fusing.
- Diagnostics : Principal circuit node and function access.
Digital LCD monitoring.
LED circuit state indication.
LED dynamic trend display.
External monitoring/recording/CRT facilities.

2.2 ELECTRICAL RATINGS

- Power Configuration : 540 - Two Anti-parallel single phase Thyristor bridges.
541 - One single phase Thyristor bridge.
- Power Supply : Single Phase, line to line or line to neutral 45 - 65Hz no adjustment necessary for frequency change.
- Voltage ranges: 110 - 240V } ± 10%
380 - 415V }
440 - 480V }
- Control Supply : Single Phase 45 - 65Hz.
- Voltage ranges: 110 - 240V } ± 10%
220 - 240V }

Output Ratings	:	<u>Current</u>	<u>Power</u>
		Power Rating at 380/415V	25A
		300V Armature	35A
			7.5Kw (10HP)
			10.5 (14HP)
Temperature	:	Operating temperature range 0 to 55°C	
		Maximum rated ambient 45°C	
		Maximum Ambient 55°C derated at 1 1/2% per °C above 45°C	
Altitude	:	Rated at up to 500 meters above sea level.	
		Derate above 500m at 1% per 200m up to a maximum altitude of 5,000 meters.	

2.3 MECHANICAL DETAILS

Mounting Centres	:	Horizontal 170mm
		Vertical 311mm
Overall Width	:	241mm
Overall Height	:	330mm
Overall Depth	:	180mm
Weight	:	7Kg.
Minimum Airflow Clearance	:	70mm above and below
Control Terminations	:	Plug-on connectors with retaining catches
Power Terminations	:	Busbars with 6mm screws and captive nuts.
Access	:	Hinge-down/lift/off overall cover
		Hinge-down Control PCB with legend plate

BLOCK 4: 1 Digit identifying field supply configuration.

- 0 -
- 1 -
- 2 - Internally supplied full-wave rectifier.
- 3 - Internally supplied half-wave rectifier.
- 4 -
- 5 - Externally supplied full-wave rectifier.
- 6 - Externally supplied half-wave rectifier.

BLOCK 5: 1 Digit identifying the control supply voltage (AC).

0	1	2	3	4
110v	115v		220v	240v

BLOCK 6: 3 Digits identifying the tachogenerator feedback voltage at full speed.

The three digits in this block form a number between 010 and 999 which represents the actual tacho feedback voltage, rounded to the nearest whole number and with leading zeros added where necessary.

For example:- 123 VOLTS = 123
 45.6 VOLTS = 046

or conversely:- CODE 090 = 90 VOLTS ± 0.5v
 CODE 180 = 180 VOLTS ± 0.5 v

BLOCK 7: 4 Binary digits identifying the setting of the four internal option switches.

Each digit defines the setting of one switch and can take the value 0 (=OFF) or 1 (=ON) as follows:-

First digit, switch 1:

- 0 = OFF - Armature current meter reads modulus.
- 1 = ON - Armature current meter reads Bipolar (+ and -).

Second digit, switch 2:

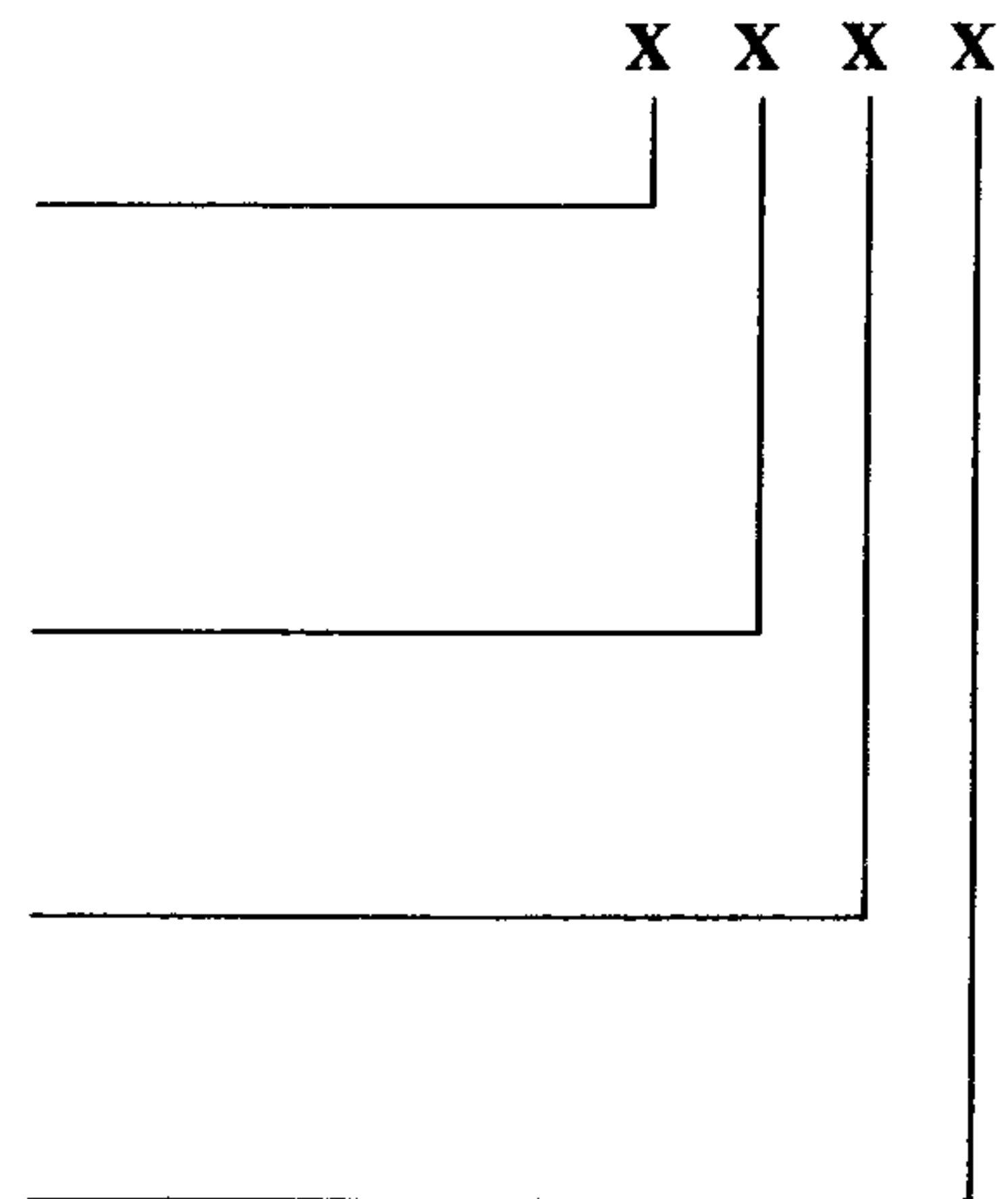
- 0 = OFF - Standstill logic disabled.
- 1 = ON - Standstill logic enabled.

Third digit, switch 3:

- 0 = OFF - Setpoint ramp connected.
- 1 = ON - Setpoint ramp disconnected.

Fourth digit, switch 4:

- 0 = OFF - Setpoint ramp rate 1 - 20 seconds.
- 1 = ON - Setpoint ramp rate 0.1 - 2 seconds.

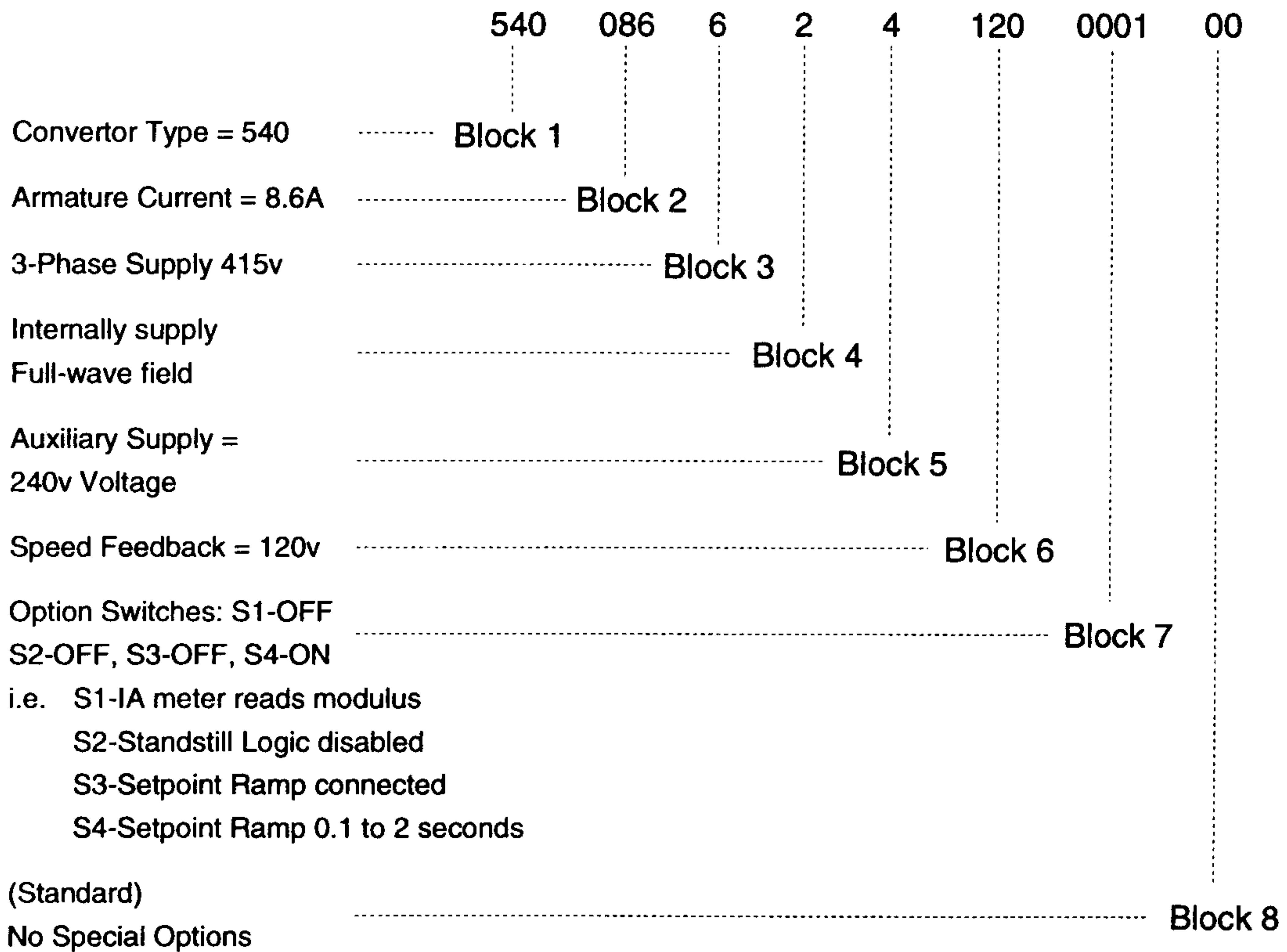


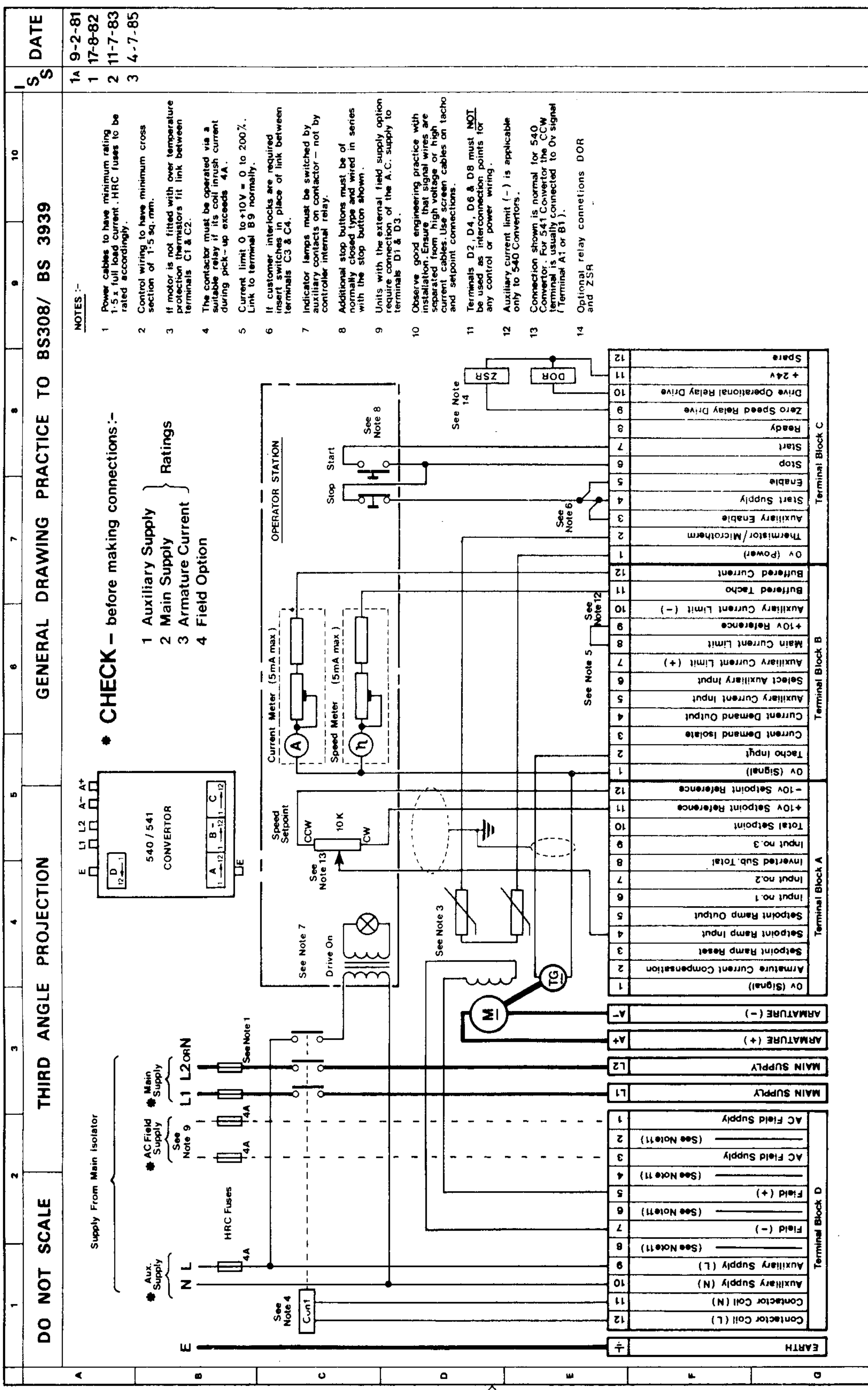
BLOCK 8: 2 Digits identifying special options.

- 00 - No special options
- 01 - 98 - Documented special options
- 99 - Undocumented special options; specify requirement

PRODUCT CODE EXAMPLE

In all communications please quote the full Model No. (Product Code) and Serial No. both of which contain important product information. An explanation of a typical Product Code is shown below.





DRAWN D.J.H.

CHECKED *RJS*

DESIGN APPROVAL D.T.S.

MANF. APPROVAL

MATERIAL

FINISH

DIMS IN M.M. APPLY OVER FINISH
(EXCEPT FOR PAINT AND LACQUER)

GENERAL X ± 0.4
TOLERANCE X.X ± 0.2 | HOLES < Ø7mm
X.XX ± 0.1 | -0.02 + 0.07

ASSEMBLED ON

550 Shackleton system drives

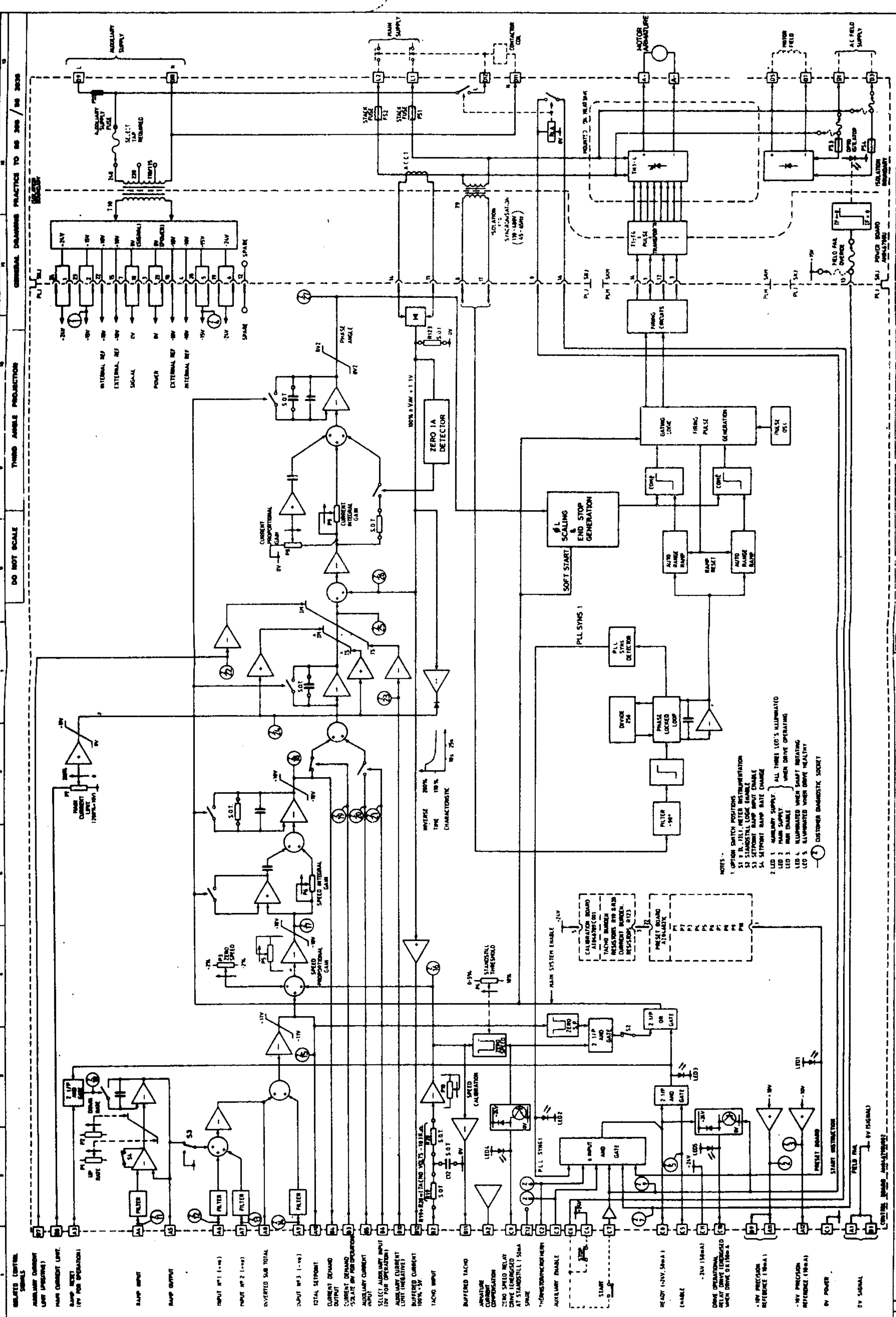
EI

SCALE

TITLE
540/541 Converter
Basic Wiring Diagram.

DRAWING NUMBER
HJ 047176 D

SHT. 1
OF 1 SHT.



RELATED SIGNALS
 MAIN CURRENT LIMIT (PUSHBUTTON)
 MAIN CURRENT LIMIT (PUSHBUTTON)
 RAMP RESET (BY PWR OPERATION)
 RAMP OUTPUT
 RAMP OUTPUT
 INPUT #1 (1-10V)
 INPUT #2 (1-10V)
 INVERTED SUB TOTAL
 INPUT #3 (1-10V)
 TOTAL SETPOINT
 CURRENT DEMAND OUTPUT
 CURRENT DEMAND INPUT (SCALE BY PERFORMANCE)
 AUXILIARY CURRENT INPUT (FOR OPERATION)
 SELECT AUXILIARY INPUT (BY OPERATION)
 AUXILIARY CURRENT LIMIT (THRESHOLD)
 100% SW
 TACHO INPUT
 BUFFERED TACHO
 ARMATURE CURRENT COMPENSATION
 ZERO SPEED RELAY DRIVE ENGAGED AT STANDBY (1.5mA SPARE)
 100% SPEED/NOISE
 AUXILIARY ENABLE
 START
 READY (24V, 5mA) ENABLE
 -24V (150mA) DRIVE OPERATIONAL WHEN DRIVE IS 0.150mA
 -10V PRECISION REFERENCE (100mA)
 0V POWER
 0V SIGNAL

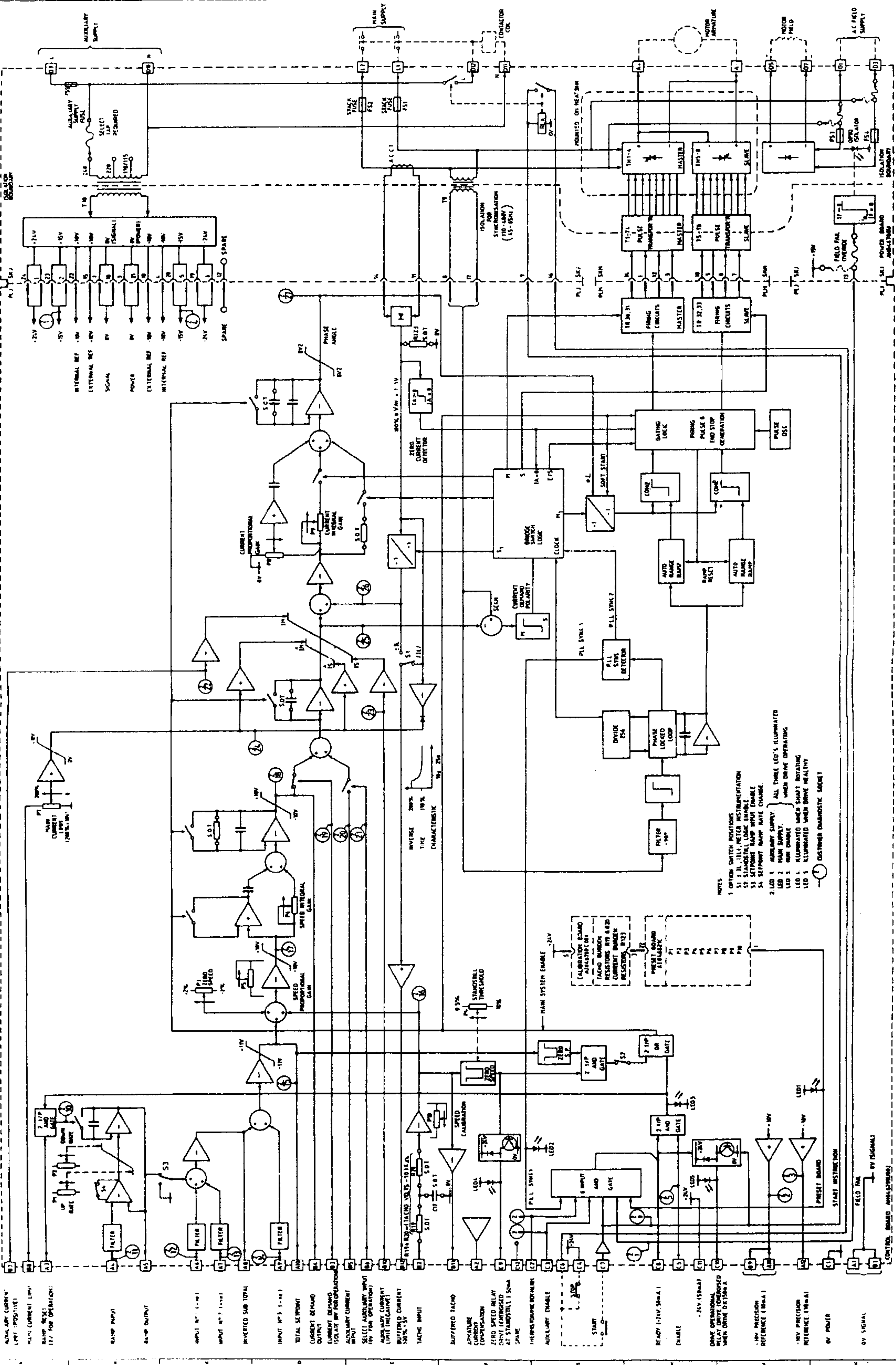
NOTES:
 1. OFFER SWITCH POSITIONS
 S1 R. 100% MOTOR INSTANTANEOUS
 S2 STANDBY LOGIC ENABLE
 S3 SETPOINT RAMP INPUT CHANGE
 S4 SETPOINT RAMP RATE CHANGE
 2. LED 1: AUXILIARY SUPPLY ALL THREE LED'S ILLUMINATED WHEN DRIVE OPERATING
 LED 2: MAIN SUPPLY
 LED 3: RUN ENABLE
 LED 4: ILLUMINATED WHEN SHUNT INSTANTANEOUS
 LED 5: ILLUMINATED WHEN DRIVE HEALTHY
 CUSTOMER DANGEROUS SOCKET

GENERAL DRAWINGS PRACTICE TO BS 2000 / BS 2008
 DO NOT SCALE
 THIRD ANGLE PROJECTION
 TITLE: S41 BLOCK DIAGRAM
 SCALE: 1:1
 SHEET: 1 OF 1
 NUMBER: NH 056819 F
 DATE:

GENERAL DRAWING PRACTICE TO BS 308 / BS 3923

THIRD ANGLE PROJECTION

DO NOT SCALE



Shackleton system drives		TITLE S40 BLOCK DIAGRAM
DIMS. IN MM APPLY OVER FINISH EXCEPT FOR PARTS AND JOINTS		SCALE 1:1
MATERIAL SHEET CHECKED APPROVED		DRAWN BY CEP
FINISH APPROVED		PROJECT NUMBER PH04.6191 F
DATE 08 08 88		PART 1 1

- NOTES
- 1. OPTION SWITCH POSITIONS
 - 2. LED 1: AUXILIARY SUPPLY
 - 3. LED 2: MAIN SUPPLY
 - 4. LED 3: RUN ENABLE
 - 5. LED 4: ILLUMINATED WHEN SHUNT ROTATING
 - 6. LED 5: ILLUMINATED WHEN DRIVE HEALTHY
 - 7. CUSTOMER DIAGNOSTIC SOCKET

ISOLATED CONTROL SIGNALS

AUXILIARY CURRENT LIMIT POSITIVE

MAIN CURRENT LIMIT POSITIVE

RAMP RESET 1V FOR OPERATION

RAMP INPUT

RAMP OUTPUT

INPUT #1 (-10V)

INPUT #2 (-10V)

INVERTED SUB TOTAL

INPUT #3 (-10V)

TOTAL SETPOINT

CURRENT DEMAND OUTPUT

CURRENT REFERENCE

CURRENT REFERENCE

SELECT AUXILIARY INPUT 1V FOR OPERATION

AUXILIARY CURRENT LIMIT NEGATIVE

BUFFERED CURRENT 100% 3V

TACHO INPUT

BUFFERED TACHO

ADAPTIVE CURRENT COMPENSATION

ZERO SPEED RELAY DRIVE ENGAGED AT STANDSTILL 1.5mA

HEATING/TEMPERATURE

AUXILIARY DISABLE

START

READY (11V, 5mA)

ENABLE

-24V (50mA)

DRIVE OPERATIONAL WHEN DRIVE OUTPUT 2

-10V PRECISION REFERENCE (10mA)

-10V PRECISION REFERENCE (10mA)

0V POWER

0V SIGNAL

GENERAL DRAWING PRACTICE TO BS 308/BS 3939

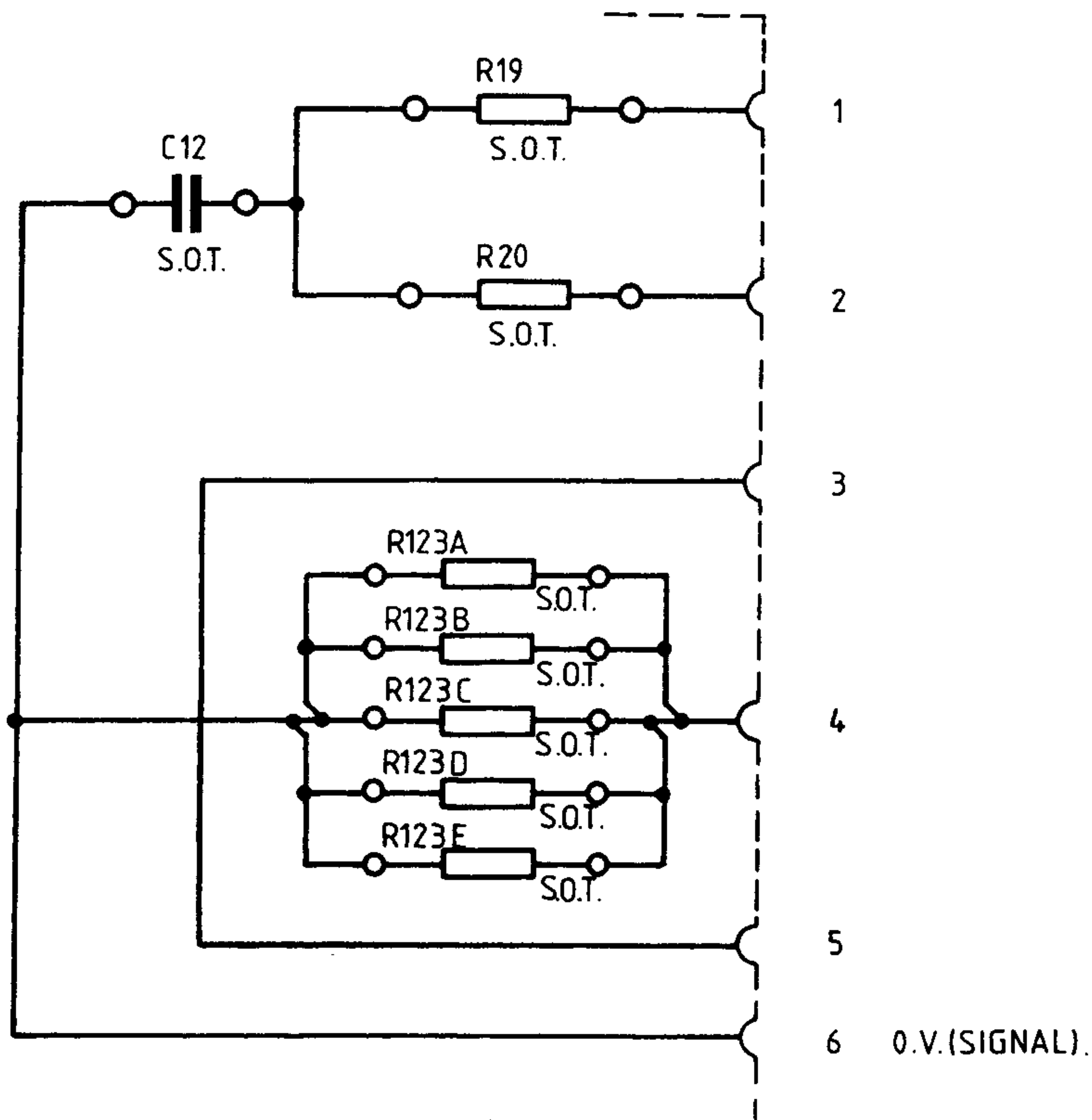
DATE

DO NOT SCALE

THIRD ANGLE PROJECTION

1 1.6.81
2 8.10.82

TACHO SCALING RESISTORS (R19 & R20) 2% M.F.
UP TO 200V R19 + R20 = (TACHO VOLTS - 10) × 1,000 OHMS.
OVER 200V FIT EXTERNAL RESISTOR ADDITIONAL TO R19 & 20 IN SERIES
WITH TACHO LEAD TO TERMINAL B2.



CURRENT CALIBRATION RESISTOR R123.

$$R123 = \frac{2,200}{\text{FULL LOAD CURRENT (AMPS)}^{-1}} \text{ OHMS.}$$

FIT 2% M.F.

DRAWN C.E.F.	MATERIAL	SCALE	DIMS. IN M.M. APPLY OVER FINISH (EXCEPT FOR PAINT AND LACQUER)	
CHECKED			X = ± 0.4	HOLES < Ø 7mm - 0.02 + 0.07
DESIGN APPROVAL DTS	FINISH	ASSEMBLED ON	GENERAL X.X = ± 0.2 TOLERANCE X.XX = ± 0.1	
MANF. APPROVAL			TITLE P.C.B. CIRCUIT DIAGRAM FOR CALIBRATION BOARD.	
			DRAWING NUMBER AI046789C001	SHT. 1 OF 1 SHTS.

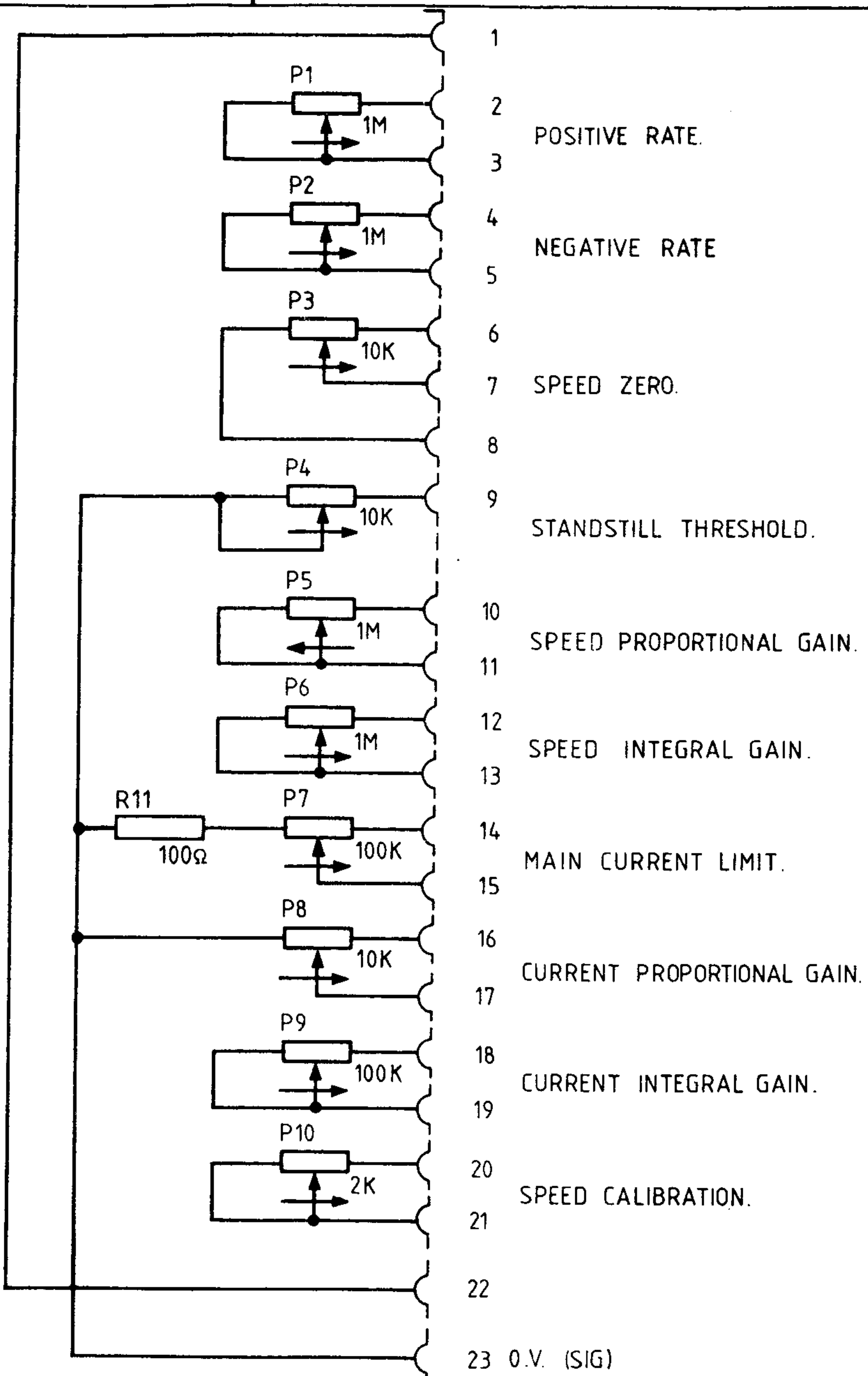
GENERAL DRAWING PRACTICE TO BS 308/BS 3939

IS	DATE
1	1.6.81
2	6.4.82
3	7.4.82
4	19.5.82

DO NOT SCALE

THIRD ANGLE PROJECTION

OPTION AH046821U002



DRAWN C.E.F. CHECKED DESIGN APPROVAL DTS. MANF. APPROVAL	MATERIAL FINISH	SCALE ASSEMBLED ON	DIMS. IN M.M. APPLY OVER FINISH (EXCEPT FOR PAINT AND LACQUER) X = ± 0.4 GENERAL X.X = ± 0.2 TOLERANCE X.XX = ± 0.1 HOLES < Ø 7mm - 0.02 + 0.07
TITLE P.C.B. CIRCUIT DIAGRAM FOR PRESET BOARD.			DRAWING NUMBER AI046821C001
SSD Shackleton system drives		EI	SHT. 1 OF 3 SHTS.

4 BASIC SETTING UP AND OPERATING INSTRUCTIONS

4.1 BEFORE ATTEMPTING TO CONNECT POWER:

CAREFULLY CHECK:

- 4.1.1 Auxiliary power supply voltage is correct.
- 4.1.2 Main power supply voltage is correct.
- 4.1.3 Armature voltage and current ratings.
- 4.1.4 Field option, voltage and current rating.
- 4.1.5 All external wiring circuits -
 - Power connections
 - Control connections
 - Motor connections

NOTE:

Completely disconnect the controller before point to point checking with a buzzer or when checking insulation resistance with a megger.

- 4.1.6 For damage to equipment or wiring.
- 4.1.7 For loose ends, clippings, drilling chips, etc., lodged in the drive or electrical equipment.
- 4.1.8 Inspect the motor, in particular the commutator for any extraneous matter. If an air line is available it is recommended to blow over the commutator.

Check that the brushes are properly seated and that the brush spring tensions are adequate. If possible check that the motor (and vent fan motor when fitted) can be turned freely by hand.

ENSURE:

- (a) That rotation of the machinery in either direction will not cause a hazard.
- (b) That nobody else is working on another part of the equipment that can be affected by powering up.
- (c) That other equipment will not be adversely affected by powering up.

4.2 PREPARATION

- 4.2.1 Prevent the Main L1 and L2 power supply and single phase auxiliary supply from becoming connected to the drive by removing the main external HRC fuses.
- 4.2.2 Disconnect the load from the motor shaft if possible.
- 4.2.3 If there is any doubt about the integrity of a particular installation, insert a high wattage resistor, i.e. fire elements, in series with the motor armature.

- 4.2.4 Check the tachogenerator calibration resistors and current calibration resistors on the small plug-in card which is accessible under the front cover.

NOTE:

These resistors should be good quality 2% metal film type.

Tachogenerator Calibration:

The two resistors R19 and R20 should be roughly equal in value and scaled as follows:

For full speed tacho voltages of up to 200 Volts:

$$R19 + R20 = (\text{tacho Volts} - 10)K \text{ Ohms}$$

For full speed tacho voltages greater than 200 Volts, an external resistor, value RE, is required in series with the tachogenerator connection to terminal B2.

If the maximum values of R19 and R20 are fitted giving 190K total i.e R19 = 120K and R20 = 68K that is R19 + R20 = 188K approximately 190K, and assuming a burden of 50K. Then RE is given by the formula:-

$$RE = \frac{\text{tacho Volts} - 200}{5} \text{ K Ohms}$$

The power dissipation of this resistor is given by the formula:-

$$RE = (\text{tacho Volts} - 200) \times 5 \text{ milliwatts.}$$

Armature Voltage Feedback

This is achieved by using a 5590 armature feedback as detailed in manual HA055403. R19 + R20 are both to be fitted with a shorting link to provide 10V feedback.

Full Load Armature Current Calibration:

Armature current is scaled by resistors R123 A, B, C, D and E. The combined value of all these resistors in parallel should be calculated as follows:-

$$R123 = \frac{2200}{\text{Full Load Amps} - 1} \text{ Ohms}$$

NOTE:

The armature current calibration should NEVER be changed to increase the current above the factory set value without prior consultation with Eurotherm Drives.

- 4.2.5 Check the preset potentiometer settings on the larger plug-in card which is accessible under the front cover. The potentiometers are normally factory set to positions which

will provide adequate performance in most load/controller configurations. It is recommended that initially the presets are left in these positions and that fine tuning of the system is done, if necessary, at the end of the commissioning process.

The one exception to this is the main current limit preset; note the setting of this control and then turn it fully anti-clockwise.

The initial setting of the presets should thus be as follows:

Pot No.	Description	Normal Initial Setting
1.	<u>Setpoint ramp up rate</u> Clockwise rotation gives more rapid acceleration.	Midway
2.	<u>Setpoint ramp down rate</u> Clockwise rotation gives more rapid deceleration.	Midway
3.	<u>Zero speed</u> It should not be necessary to adjust this initially on a new factory tested drive.	About midway
4.	<u>Standstill threshold</u> Sets low speed drive quench level if the standstill logic switch is set to position 1. Clockwise sets lower speed.	Midway
5.	<u>Speed proportional</u> Clockwise increases speed loop gain.	20% clockwise
6.	<u>Speed integral</u> Clockwise decreases speed loop integral time constant.	20% clockwise
7.	<u>Main current limit</u> Clockwise increases current limit up to maximum 200% FLC * short-term overload.	Fully anti-clockwise (zero current)
8.	<u>Current proportional</u> Clockwise increase current loop gain	Midway
9.	<u>Current Integral</u> Clockwise decreases current loop integral time constant	Fully anti-clockwise
10.	<u>Speed Calibration</u> Clockwise increases motor speed	About midway

* Full Load Current

4.2.6 Set Option Switch

This is a small 4-toggle (DIL) switch located on the main control board near to the left-hand end of the diagnostic socket. To access the switch it is necessary to remove the push-on protective panel attached to the Main Control printed circuit board.

SWITCH S1: Buffered Current Signal
(terminal B12)

UP = ON = Armature current meter reads \pm Amps. For applications employing a centre-zero meter.

DOWN = OFF = Meter reads modulus. For applications employing a unidirectional meter.

NOTE:

In 541 units the Armature Current Meter will always read + Amps, regardless of the setting of switch S1, since these convertors cannot product negative output current.

SWITCH S2: Standstill Logic

UP = ON = Standstill logic enabled. This will disable the drive whenever the Total Setpoint is zero and the speed is below the standstill threshold set by P4.

DOWN = OFF = Standstill logic inoperative

SWITCH S3: Setpoint Ramp Connection

DOWN = OFF = Setpoint Ramp Output internally summed with Input No. 1 and Input No. 2.

UP = ON = Setpoint Ramp Output internally disconnected from the summing amplifier (but still available at terminal A5).

SWITCH S4:

UP = ON = Setpoint ramp rate adjustable from 0.1 - 2 seconds.

DOWN = OFF = Setpoint ramp rate adjustable from 1 second to 20 seconds.

For most applications the switches would be set as follows:

S1 set UP (ON) = Current meter reads \pm .

S2 set DOWN (OFF) = Standstill logic inoperative.

S3 set Setpoint ramp connected.

S4 set DOWN (OFF) = Setpoint ramp adjustable from 1 - 20 seconds.

4.2.7 Plug a Diagnostic Test Unit type 5570 into the socket on the control printed circuit board, observing correct orientation of the connector (see Diagnostic Test Facility). This unit is not essential to the successful commissioning of a drive but it very much simplifies the procedure and can save a considerable amount of time.

4.3 CHECKING THE DRIVE AND SETTING UP:

4.3.1 When all the preceding steps are completed the auxiliary power supply can be connected to terminals D9 and D10, (but do not connect the L1 and L2 main power supply at this stage). Immediately check that the correct voltage appears between D9 and D10.

4.3.2 Now check:

- i) The drive condition indicators - these are 5 LED lamps at the lower right-hand corner of the Main Control printed circuit board. LED No's 1 and 5 should be on.
- ii) Check the +24V (nominal) supply at terminal C11 (with respect to C1) to be between 22 and 30 Volts DC.
- iii) If a Diagnostic Test Unit (5570) is available, check the $\pm 15V$ supplies at switch positions 1 and 4.
- iv) Check the +10V supply rail:
Switch to diagnostic test point 2 or measure the voltage between terminals A11 (+10V) and A1(0V).
- v) Check the -10V supply rail:
Switch to diagnostic test point 3 or measure the voltage between terminals A12 (-12V) and A1 (0V).

4.3.3 If a Diagnostic Test Unit is available, check that all other test point readings are as shown in Diagnostic Chart 3.

4.3.4 Check that a speed demand signal is available. This will normally appear as an input to the Setpoint Ramp on terminal A4 (diagnostic test point 11).

Additional setpoint inputs may also appear at:

Input No. 1 (+), terminal A6 (Diagnostic 12)

Input No. 2 (+), terminal A7 (Diagnostic 13)

Input No. 3 (-), terminal A9 (Diagnostic 14)

NOTE:

The sum of the setpoint voltages appears at terminal A10 (Diagnostic 15) as the Total Setpoint voltage.

4.3.5 If possible, check the polarity of the tachogenerator signal by rotating the motor shaft manually in the "forward" direction (i.e., the direction which should correspond to a positive setpoint at A4):

The voltage at terminal B2 (or B11) should go positive.
The voltage at Diagnostic test point 16 should go negative.

4.3.6 Press the "Drive Start" pushbutton or otherwise initiate START:

The Main supply contactor (L1 and L2) should pull in and latch via the control relay within the drive.

Press the "Drive Stop" pushbutton or otherwise initiate STOP:

The main supply contactor should drop out, de-energised. If not disconnect all power supplies and check the Stop-Start circuit and contactor wiring.

NOTE:

The main contactor should NEVER be operated by any means other than the drive internal contactor control circuit as shown in the wiring diagram HJ047176D.

WARNING:

DO NOT PROCEED FURTHER UNLESS THE STOP/START CIRCUITS AND CONTACTOR OPERATE CORRECTLY.

4.3.7 Turn off all power supplies to the equipment and when the whole system is totally isolated and safe, re-connect the Main L1 and L2 supply.

4.3.8 Turn on Auxiliary single phase supply.

4.3.9 Turn on Main L1 and L2 supply.

4.3.10 Turn the Speed Setpoints to zero so that the Total Setpoint voltage is zero (terminal A10, Diagnostic 15).

4.3.11 Check that the Main Current Limit preset (P7) is set to zero (fully anti-clockwise).

4.3.12 Initiate "Drive Start" and immediately check that the correct field voltage appears between terminals D5 and D7. Note that this will be high voltage DC, so proceed with extreme caution. Do not continue if this is not correct, but switch off all supplies and re-check the Product Code.

Check that the motor ventilation fan, if fitted, is rotating in the correct direction. Check the direction visually as the fan starts since a centrifugal fan may produce considerable air flow even when rotating in the wrong direction.

4.3.13 Check that all Drive Condition Indicators except LED4, are lit. Refer to the Diagnostic section for explanation of the LED functions.

4.3.14 Check that the Standstill Logic is switched OFF (Option Switch 2).

NOTE:

- (a) During the following stages (4.3.15 and 4.3.16) be ready to stop the drive immediately should the motor try to overspeed.

- (b) Before altering any connections make sure that all Auxiliary and main power supplies are totally isolated from the drive and equipment and that the motor is stationary.

4.3.15 Adjust the Speed Setpoint so that the Total Setpoint voltage is about 0.5 Volts (terminal A10, Diagnostic 15).

Slowly increase the Main Current Limit setting up to about 20% FLC (i.e. not more than 1 volt at Diagnostic test position 24). Since the Total Setpoint is set to 0.5V the motor speed should increase to only 5% of full speed. If this speed is exceeded, reversed connection of the tacho or field is implied, quickly turn the Main Current Limit (P7) to zero (anti-clockwise).

Disconnect all supplies and reverse either the field or tacho connections, then reconnect the supplies and repeat the test. If the motor still runs out of control check the tacho and the continuity of its wiring. Proceed only when this test is satisfactorily completed.

4.3.16 When the Main Current Limit (P7) set to about 20% FLC slowly increase the Total Setpoint voltage to +1 volt (terminal A10, Diagnostic 15). The motor should now run at about 10% Full Speed and LED 4 should light.

NOTE:

When correctly connected and operating normally at constant speed the Speed Feedback voltage (Diagnostic 16) will be equal to the Total Setpoint voltage (Diagnostic 15) but of opposite polarity. Under these conditions the Speed Error voltage (Diagnostic 17) will be zero. If this condition cannot be achieved, the system is probably in current limit (this is most likely at this stage if the load is coupled to the motor). Increase the setting of the Main Current Limit (P7) slowly until motor accelerates to the set speed and the Speed Error signal falls to zero.

4.3.17 Check the motor direction; if it is incorrect disconnect all supplies and reverse both tacho and field connections.

4.3.18 540 Drives Only:

Adjust the Total Setpoint voltage to about -1V and check that the motor runs in control in the reverse direction.

4.3.19 (a) 540 Drives:

Set the Speed Setpoint to zero and adjust the Speed Zero preset potentiometer (P3) for minimum shaft creep. (Alternatively the Speed Zero potentiometer may be used to adjust the balance of maximum speed in forward and reverse directions).

(b) 541 Drives:

Set the Speed Setpoint to zero. Turn the Speed Zero preset potentiometer (P3) clockwise until the motor shaft turns, then back-off P3 until the shaft just stop turning.

- 4.3.20 Gradually increase the Speed Setpoint to maximum and check that the shaft speed is nominally correct. If fine adjustment of the top speed is required, the Maximum Speed potentiometer (P10) provides $\pm 10\%$ trim.

NOTE

If the load is connected to the motor it may be necessary to increase the Main Current Limit control (P7) setting to achieve full speed.

- 4.3.21 540 Drives Only:

Reverse the Speed Setpoint and check the maximum reverse speed.

- 4.3.22 Reset the Main Current Limit (P7) to its original position, which was noted in part 4.2.5 of this procedure. If in doubt set the control (P7) to 60% clockwise rotation (6V measured at Diagnostic 24) corresponding to a maximum armature current of 1.2 times Full Load. Fully clockwise rotation of P7 (10V measured at Diagnostic 24) corresponds to an armature current level of twice full load.

Note that if the drive runs into an overload condition, the current is automatically reduced on an inverse time characteristic back to 110% of full load. If the overload facility is not required, the Main Current Limit potentiometer (P7) should be turned progressively anti-clockwise, almost to the midway position - this will limit the current to just above Full Load.

4.4 RUNNING PERFORMANCE ADJUSTMENTS:

- 4.4.1 Disconnect all supplies and connect the motor to its load. Set the speed setpoint to zero, reconnect the supplied and switch on.

Increase the speed setpoint and check that the drive runs smoothly under load; the speed should be stable and the armature current should be steady.

The Proportional and Integral potentiometers (P5, P6, P8 and P9) as preset by Eurotherm Drives will provide stable and responsive performance under most load conditions. Thus if instability is observed it is important to first check the load and couplings:

If there is a cyclic variation of the armature current check the mechanical couplings to the load - this is a common cause of apparent instability in either the speed or motor current. If speed instability is present check whether the repetition rate of the instability is related to any of the mechanical revolution rates of the load - if it is the instability frequency will vary with speed. This form of instability may be reduced by adjustment of the drive presets, but total elimination of the problem may require improvement of the load characteristics.

- 4.4.2 Instability due to incorrect setting of the drive control parameters can occur and is recognisable because its frequency will be relatively independent of the drive speed. If this form of instability is present, or if the application demands that the drive is trimmed for optimum response, then the stability controls may be adjusted as follows. Note that while the speed stability and response may be improved without the use of a Diagnostic Unit or Oscilloscope it is difficult to optimise the current response without such instrumentation. Consequently, the following procedure assumes that both instruments are available.

4.4.3 Current Loop Adjustment (P8 and P9)

With all power supplies disconnected, disconnect the field wires from terminals D5 and D7 labelling each wire clearly so that it can later be reconnected with the correct polarity. Transfer the "Field Fail" plug to the "Override" position on the Power Supply printed circuit board.

NOTE

- (i) It is now possible to operate the drive in a stalled condition. Great care must be taken not to damage the motor by overheating. If the motor is fitted with a force ventilation fan, arrange that it is connected and running during the test. In any case **DO NOT** remain in the stalled condition for long periods.
- (ii) Although the field supply is disconnected the motor may still produce some torque due to residual or compound field flux. It is essential therefore, to mechanically lock the motor shaft, or apply sufficient load to prevent rotation during the following procedure.

4.4.4 The optimum setting of the Current Proportional and Integral presets (P8 and P9) depends, to some extent, on the setting of the Main Current Limit (P7). Thus P7 should be correctly adjusted to suit the load, before adjustment of P8 and P9 is attempted.

4.4.5 When the Main Current Limit control is correctly set, proceed as follows:

If the Speed Setpoint is applied via the Setpoint Ramp, set the Ramp Rate presets P1 and P2 fully clockwise and Option Switch S4 UP (ON), to provide the fastest ramp rate. Set the Speed Proportional and Integral presets (P5 and P6) fully clockwise to provide the fastest rate of change of Current Demand signal (observable at Diagnostic 25).

Connect the Diagnostic Unit to the Control printed circuit board (accessed via the outer cover - observe correct orientation of plug into the socket). Connect the Oscilloscope to the output sockets on the Diagnostic Unit and switch to Diagnostic 26. This provides access to a safe, isolated signal representing the armature current waveform where $\pm 1.1V = \pm 100\%$ full load current.

4.4.6 (a) 540 Drives:

Reconnect the supplies and switch on. Observe the armature current waveform while changing the polarity of the Current Demand signal (by varying the Speed Setpoint). With each change of Current Demand polarity the current should increase rapidly, but without overshoot and then remain steady. If necessary adjust P8 and P9 slowly to obtain a Critically Damped performance, i.e. the fastest response possible without overshoot, as shown in Figure 3 below.

Figures 1 and 2 show typical armature current waveforms where P8 and P9 are incorrectly set and indicate the adjustment required to improve the drive performance, to conform with that of Figure 3.

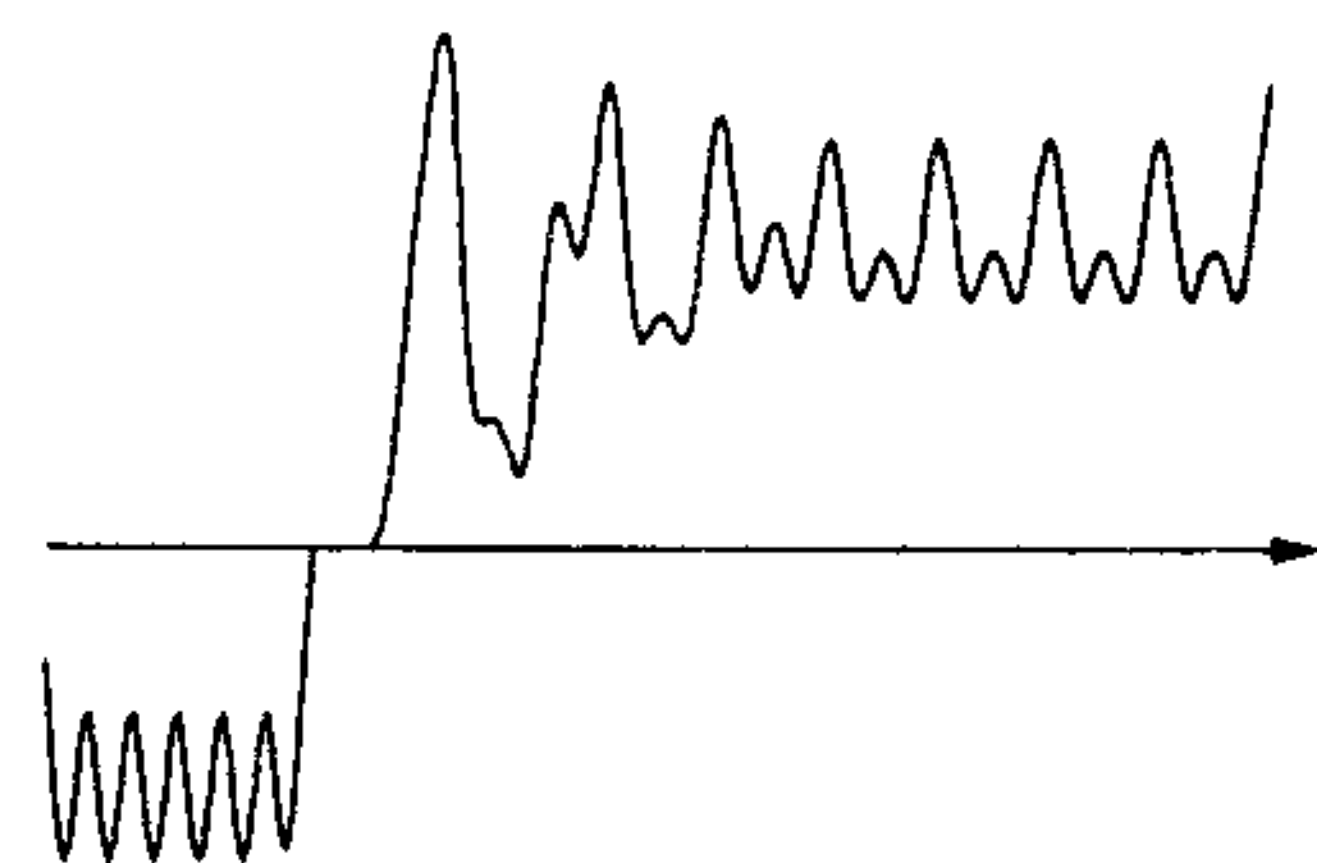


FIGURE 1. ARMATURE CURRENT WAVEFORM:
Current Loop controls incorrectly set -
Integral Time Constant too short - increase
Current Loop Integral Time Constant by
rotating P9 anticlockwise.

In general, clockwise rotation of the presets will improve the speed of response, but rotating the controls too far will tend to introduce overshoot.

(b) 541 Drives:

Reconnect the supplies and switch on. While observing the armature current waveform, suddenly increase the Current Demand signal by rapidly increasing the Speed Setpoint from zero to +10V (then reduce the Setpoint to zero again; note that the armature current will return more rapidly to zero if the Speed Zero preset is set anti-clockwise). With each increase of Current Demand the current should increase rapidly, but without overshoot and then remain steady. If necessary adjust P8 and P9 slowly to obtain a Critically Damped performance, i.e., the fastest response possible without overshoot, as shown in Figure 3*.

Figures 1* and 2* show typical armature current waveforms where P8 and P9 are incorrectly set and indicate the adjustment required to improve the drive performance, to conform with that of Figure 3*.

In general, clockwise rotation of the presets will improve the speed of response, but rotating the controls too far will tend to introduce overshoot.

* Note that in 541 non-regenerative drives the current waveform will increase from zero instead of the negative value shown in the figures.

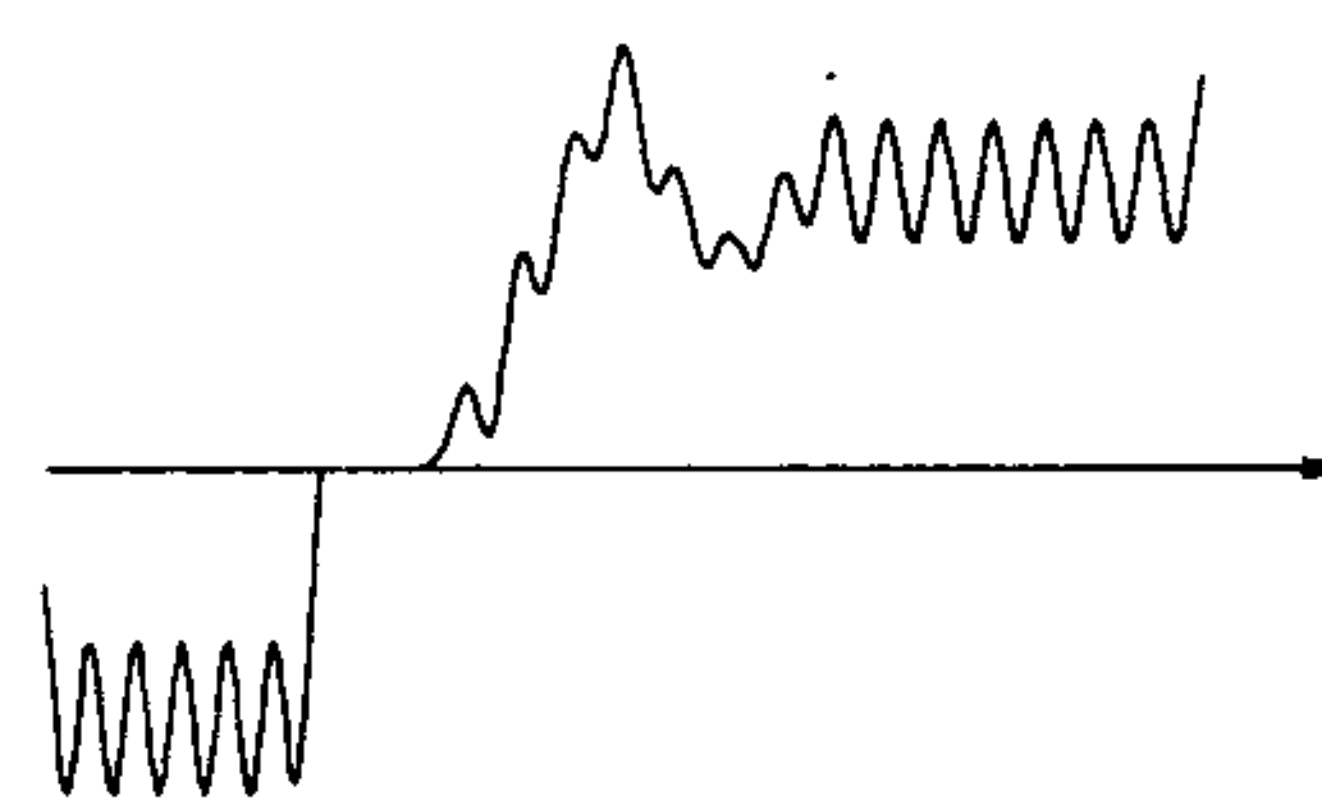


FIGURE 2. ARMATURE CURRENT WAVEFORM: Current Loop controls incorrectly set - Proportional Gain too low - increase Current Loop Proportional Gain by rotating P8 clockwise.

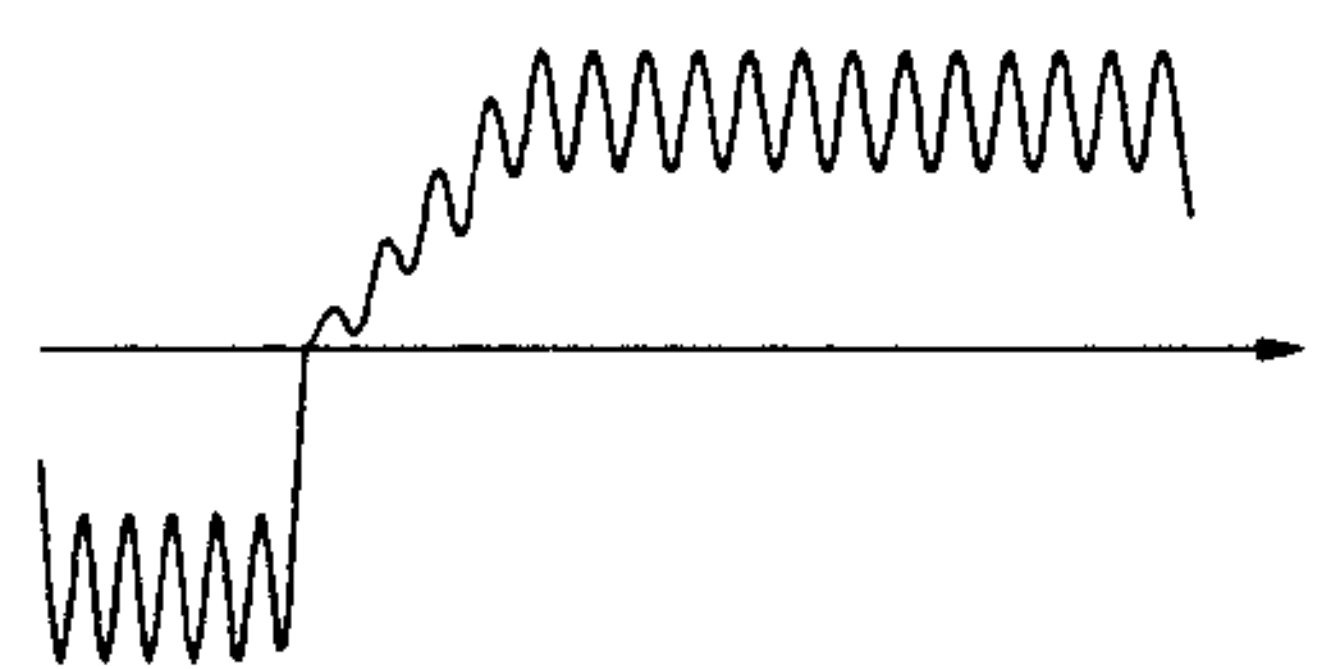


FIGURE 3. ARMATURE CURRENT WAVEFORM: Current Loop Response (P8 & P9) correctly adjusted.

4.4.7 When the Current Loop response adjustment is completed, switch off the drive and disconnect all supplies.

Transfer the "Field Fail" plug back to its original position and reconnect the field wires to terminals D5 and D7 ensuring that they are replaced in their original positions i.e. with correct polarity. Remove any mechanical devices previously used to lock the motor shaft.

4.4.8 Speed Loop Adjustment (P5 and P6)

If the Speed Setpoint is applied via the setpoint ramp turn P1 and P2 fully clockwise and switch S4 UP (ON). Set the Speed Setpoint to zero. Switch the Diagnostic Unit to position 16 so that the Oscilloscope displays the scaled Tacho Feedback signal ($\pm 10V = \pm$ full speed).

4.4.9 Reconnect the supplies and initiate Start. Apply a small set change (about 20%) to the Speed Setpoint input and observe the speed response. If necessary adjust the Speed Proportional and Speed Integral presets (P5 and P6) gradually to obtain a Critically Damped performance i.e the fastest response possible without overshoot, as shown in Figure 4, Curve (c). In general, clockwise rotation of the presets will improve the rate

of response, but advancing the controls too far will tend to introduce overshoot. The optimum setting of P5 and P6 will be a compromise between the two extremes shown in Curves (a) and (b), Figure 4.

- 4.4.10 When the Speed Loop adjustment is completed reset Option Switch S4 to its original position.
- 4.4.11 If the Speed Setpoint is applied via the Setpoint Ramp, then the acceleration and deceleration rates of the drive, in response to a change of input, are individually adjustable by the Positive and Negative Rate presets, P1 and P2. The fastest rates are achieved by setting the controls fully clockwise. The range of the potentiometers can be selected by Option Switch S4 to be either 0.1 - 2 seconds or 2 to 20 seconds to Full Speed.
- 4.4.12 Reset Option Switch S2 (Standstill Logic) to its original position. Note that if it is desired to eliminate shaft creep at zero setpoint in 540 regenerative drives then this switch should be set to the UP (ON) position. This provides a "deadband" about zero speed which is adjustable by the Standstill Threshold preset (P4) over the range ± 0.5 to $\pm 4\%$ of Full Speed. The armature current will be totally interrupted when the shaft speed is within the band set by P4 and the Total Setpoint voltage is zero, at any other time the drive will operate normally.

NOTE

The setting of the Zero Speed preset P3 will effect the symmetry of operation of the Standstill Logic about zero.

- 4.4.13 The drive should now be ready to operate. It is now essential to check the remaining control circuitry for correct operation. In particular, check that all Emergency Stop buttons and external interlocks work efficiently.

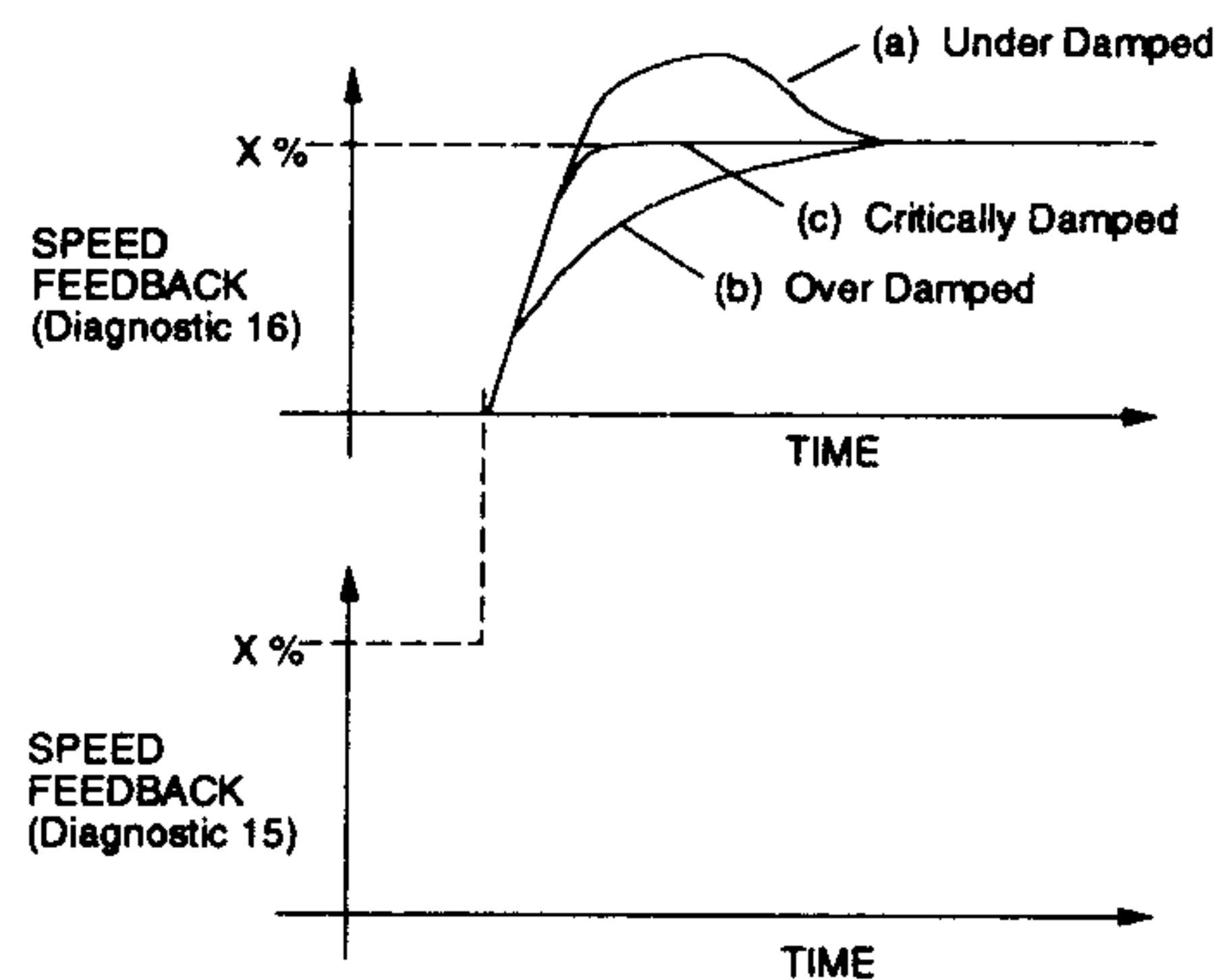


FIGURE 4 TYPICAL SPEED RESPONSE CURVES

5 540/541 CONVERTOR TERMINAL ALLOCATION

TERMINAL NO.	FUNCTION	COMMENTS
A1	0V (Signal)	
A2	Armature Current	Used only for applications involving field weakening.
A3	Setpoint Ramp Reset*	Force to 0V to reset ramp output to zero volts.
A4	Setpoint Ramp Input*	0V to $\pm 10V$ is equivalent to 0 to \pm Full Speed. Input impedance = 200K Ohm.
A5	Setpoint Ramp Output**	Internally summed with Input No. 1 and Input No. 2 via switch S3.
A6	Setpoint Input No. 1*	0V to \pm Full Speed. Input impedance = 20K Ohm.
A7	Setpoint Input No. 2*	0V to \pm Full Speed. Input impedance = 20K Ohm.
A8	Inverted sub Total Output	Equal to algebraic sum of Inputs No.1, No.2 plus the setpoint ramp output (if switch S3 is off).
A9	Setpoint Input No. 3*	0 to $\pm 10V = 0$ to \pm Full Speed. Input impedance = 20K Ohm. Note that Input No.3 is of the opposite sense to Inputs No.1, No.2 and the setpoint ramp input.
A10	Total Setpoint***	Equal to: Input No.1, plus Input No.2, plus setpoint ramp output (if S3 closed), minus Input No.3 (Maximum output = $\pm 11V$).
A11	+ 10V Setpoint Reference	Maximum Load Current (A11 and B9) = 10mA.
A12	- 10V Setpoint Reference	Maximum Load Current = 10mA.

* These terminals should be left open circuit if not used.

** Ramp period (for a 10V change at the output) is variable, approximately, from 0.1 seconds to 2 seconds (S4 on) and from 1 second to 20 seconds (S4 off).

*** In 541 controllers a Total Setpoint of +10V represents a demand for full speed. In the 540 regenerative controller +10V represents full forward speed, -10V represents full reverse speed.

TERMINAL NO.	FUNCTION	COMMENTS
B1	0V (Signal)	
B2	Tacho Input	Has the same sign as the 'Total Setpoint' under steady state conditions. Calibration: 1K Ohm volt.
B3	Current Demand Isolate*	Force to 0V to disconnect current demand signal.
B4	Current Demand Output*	0V to $\pm 10V = 0$ to $\pm 200\%$ Full Load Current. In the case of 541 controllers the current demand signal will be positive for armature current to flow.
B5	Auxiliary Current Input*	0V to $\pm 10V = 0$ to $\pm 200\%$ Full Load Current. In the case of 541 controllers the current demand signal must be positive for armature current to flow.
B6	Select Auxiliary Input*	Force to 0V to sum auxiliary current input with current demand.
B7	Auxiliary Current Limit (+)*	0V to +10V = 0 to +200% Full Load Current. Normally held at +200% by internal resistor.
B8	Main Current Limit	0V to +10V = 0 to $\pm 200\%$ Full Load Current.
B9	+10V Reference	Maximum Load Current (B9 and A11) = 25mA.
B10	Auxiliary Current Limit*	0V to -10V = 0 to -200% Full Load Current. Normally held at -200% by internal resistor.
B11	Buffered Tacho Output	0V to $\pm 10V$ is equivalent to 0 to $\pm 100\%$ Full Speed. Has the same polarity as the tacho input voltage.
B12	Buffered Current Output	Modulus or Bipolar output selected by S1. S1 off (Modulus): 0V to +10V = 0 to ± 200 Full Load. S1 on (Bipolar): 0V to $\pm 10V = 0$ to $\pm 200\%$ Full Load. In the case of 541 controllers this setting of S1 is immaterial since only positive current can flow.

* These terminals should be left open circuit if not used.

TERMINAL NO.	FUNCTION	COMMENTS
C1	0V (Signal)	
C2	Thermistor/Microtherm	Drive is disabled if the resistance between C1 and C2 exceeds approximately 1.8K. If a thermistor is not used C1 and C2 must be linked together.
C3	Auxiliary Enable	Normally connected to +24V. Drive disabled when input is open circuit (or the input voltage is less than approximately 10V). Also disables 'Ready' and 'Drive Operational' outputs.
C4	+24V	Supply to stop switch contacts.
C5	Enable	Normally connected to +24V. Drive disabled when input is open circuit (or the input voltage is less than approximately 11V).
C6	Stop	Common connection of stop and start control switches. (Internal Control Relay retaining contact).
C7	Start Command	When a start command via a control switch is applied to this terminal the internal contactor control relay is energised.
C8	Ready Output	High (+24V, 50mA) when the following are enabled:- <ol style="list-style-type: none"> 1. Main Supply (P.L.L. Sync 1). 2. Thermistor/Microtherm - (Terminal C2). 3. Auxiliary Enable (Terminal C3). 4. Field Fail. 5. Start Instruction (via start and stop contacts). 6. Preset Board Interlock.
C9	Zero Speed Relay Drive	50mA Max. Connect relay coil between C9 and C11 (+24V). Relay energised when speed is below the 'standstill threshold' set by P4.
C10	Drive Operational Relay Drive	50mA Max. Connect relay coil between C10 and C11 (+24V). Relay energised when the drive is operational, de-energised if 'ready' (C8) is disabled while 'start' instruction is present.
C11	+24V	Zero speed and drive operational relay supplies.
C12		Spare.

TERMINAL NO.	FUNCTION	COMMENTS
D1	AC Field Supply	} AC Input to Field Rectifier Bridge - only required for units having the external field supply option.
D2	No Connection*	
D3	AC Field Supply	
D4	No Connection*	
D5	Field (+)	} Field Rectifier Bridge output to motor field terminals.
D6	No Connection*	
D7	Field(-)	
D8	No Connection*	
D9	Auxiliary Supply (L)	} 1Mains Input to control circuitry and contactor control relay.**
D10	Auxiliary Supply (N)	
D11	Contactoer Coil (N)	} Control relay output to contactor coil.
D12	Contactoer Coil (L)	

* Terminals D2, D4, D6 and D8 are unused to provide additional isolation between adjacent high voltage terminals, they **MUST NOT** be used as interconnection points for any control or power wiring.

** Absolute maximum input = 240V, 50/60Hz. Ensure that the input voltage complies with the selected control transformer tapping.

6 INTERNAL OPTION SWITCHES

BUFFERED CURRENT SIGNAL (TERMINAL B12):-

For applications employing a centre zero meter, switch 'S1' on.
For applications employing a unidirectional meter, switch 'S1' off.

STANDSTILL LOGIC:-

To enable standstill logic, set switch 'S2' on. This will disable the drive whenever the 'total setpoint' and the speed feedback signals are below the standstill threshold level set by P4.

To inhibit the standstill logic set switch 'S2' off.

SETPOINT RAMP

Output:-

To prevent internal addition of the ramp output to inputs No.1 and No. 2, switch 'S3' on.

To allow direct internal connection of the ramp output to the setpoint buffer, switch 'S3' off.

Ramp Rate:-

To select fast ramp rate range (0.1 to 2 seconds) switch 'S4' on.
To select slow ramp rate range (1 to 20 seconds) switch 'S4' off.

7 DRIVE CONDITION INDICATORS

- LED 1 : **AUXILIARY SUPPLY**: When illuminated indicates that the preset and calibration boards are fitted, that the auxiliary supply is connected and the auxiliary supply fuse (F5) is good.
- LED 2 : **MAIN SUPPLY**: When illuminated indicates that the main supply is connected, that the contactor has closed, and that the main drive fuses F1 and F2 are good.
- LED 3 : **RUN ENABLE**: When illuminated indicates that the 'Enable' input (Terminal C5) and the 'Ready' signal are enabled*.
- LED 4 : **SHAFT ROTATING**: Illuminated when the scaled tacho voltage exceeds the standstill threshold set by P4.
- LED 5 : **DRIVE OPERATIONAL**: Illuminated when the drive is operational, extinguished if 'Ready' (Terminal C8) is disabled* while the 'Start Instruction' is present.

* The 'Ready' signal will only be enabled if all of the following signals are high:-

- 1) Main Supply (P.L.L. Sync 1).
- 2) Thermistor/Microtherm.
- 3) Auxiliary Enable
- 4) Field Fail.
- 5) Start Instruction.
- 6) Preset Board Interlock.

**540/541 DRIVE CONDITION INDICATOR
REFERENCE TABLE**

Test Reference						STOP CONDITION
Auxiliary Supply					● ON ○ OFF ∅ EITHER	
Main Supply						
Run Enable						
Shaft Rotating						
Drive Operational						
	1	2	3	4	5	CONDITION
A	●	○	○	○	●	NORMAL STOP
B	○	○	○	○	○	NO AUXILIARY SUPPLY Check 1. Auxiliary supply voltage on terminals D9 and D10. 2. Auxiliary supply transformer tappings selected correctly. 3. Auxiliary supply fuse FS5.
C	○	○	○	●	●	PRESETS OR CALIBRATION BOARDS NOT FITTED Check 1. Presets PCB fitted correctly. 2. Calibration PCB fitted correctly.
D	●	○	○	●	●	INDICATES SHAFT ROTATING WITHOUT POWER Check 1. Connection to terminal B2. This is tacho input and maybe picking up noise. 2. If shaft is rotating this could be due to an over run load on the motor. This could be dangerous. Check the cause and stop the motor proceeding.

**540/541 DRIVE CONDITION INDICATOR
REFERENCE TABLE**

Test Reference	Auxiliary Supply					START CONDITION ● ON Ø EITHER ○ OFF
	Main Supply					
	Run Enable					
	Shaft Rotating					
	Drive Operational					
	1	2	3	4	5	
E	●	○	○	○	●	<p>DRIVE REMAINS IN NORMAL STOP CONDITION WHEN START IS INITIATED</p> <p>Check 1. Start instruction diagnostic Z9.</p> <p>2. Continuity of Stop line connections. (Terminals C4 to C6).</p>
F	●	●	●	●	●	NORMAL RUN, SHAFT ROTATING
G	●	●	●	○	●	<p>NORMAL RUN, SHAFT STATIONARY</p> <p>Check 1. Total speed setpoint diagnostic Z15.</p> <p>2. Main Current limit diagnostic Z24.</p> <p>3. Auxiliary current limits on diagnostic: Z22 and Z23.</p> <p>4. Current demand isolated diagnostic Z19.</p> <p>5. Motor Armature connections.</p> <p>6. Tacho connections correct, diagnostic Z16.</p> <p>7. Motor not stalled. If motor is stalled, diagnostic Z26 will indicate armature current.</p> <p>When operating in current control mode.</p> <p>Check points 2, 3, 5, 7 and</p> <p>8. Auxiliary current input diagnostic Z20.</p> <p>9. Auxiliary current input selected diagnostic Z21.</p>

**540/541 DRIVE CONDITION INDICATOR
REFERENCE TABLE**

Test Reference						FAULT CONDITION ○ ON ∅ EITHER ● OFF
Auxiliary Supply						
Main Supply						
Run Enable						
Shaft Rotating						
Drive Operational						
	1	2	3	4	5	CONDITION
H	●	○	○	○	○	DRIVE INDICATING FAULT CONDITION Check 1. Main power connected. 2. Main Contactor operating. 3. Contactor coil resistance. 4. Main fuses F1 and F2.
I	●	●	○	○	○	DRIVE INDICATING FAULT CONDITION Check 1. Motor thermistor OK, diagnostic Z6. 2. Field fail OK, diagnostic Z7. 3. Auxiliary enable signal, diagnostic Z8. 4. Field fuses FS3 and FS4. Note: If the field is supplied or controlled externally, check the external field circuit.
J	●	●	○	○	●	DRIVE INHIBITED Check 1. Drive enable diagnostic Z5. 2. Check external wiring and interlocks in enable circuit connections to terminal C5.

8 DIAGNOSTIC UNIT (5570)

SWITCH POSITION ALLOCATION

CUSTOMER DIAGNOSTIC SOCKET

<u>SWITCH POSITION</u>	<u>DESCRIPTION</u>
1	+15V Supply
2	+10V Precision Reference
3	-10V Precision Reference
4	-15V Supply
5	Enable
6	Thermistor/Microtherm
7	Field Fail
8	Auxiliary Enable
9	Start Instruction
10	Setpoint Ramp Enable
11	Setpoint Ramp Input
12	Input No. 1
13	Input No. 2
14	Input No. 3
15	Total Setpoint
16	Speed Feedback
17	Speed Error
18	Current Demand
19	Select Current Demand
20	Auxiliary Current Input
21	Select Auxiliary Input
22	Auxiliary Current Limit (Positive)
23	Auxiliary Current Limit (Negative)
24	Main Current Limit
25	Total Current Demand (Inverted)
26	Current Feedback
27	Phase Angle

DIAGNOSTIC CHART

DIAGNOSTIC TEST UNIT - VOLTAGE MEASUREMENTS

TEST NO.	DIAGNOSTIC TEST POINT DESCRIPTION	CONDITION	VOLTAGE
1	Internal +15V supply	Auxiliary Power ON	+15V \pm 0.15V Maximum 100Hz ripple = 25mV peak to peak
2	External +10V supply Note: These supplies are buffered from internal reference supplies and have a maximum output current capability of 10mA	Auxiliary Power ON	+10V \pm 0.025V Maximum 100Hz ripple = 5mV peak to peak
3	External -10V Supply	Auxiliary Power ON	-10V \pm 0.025V Maximum 100Hz ripple = 5mV peak to peak
4	Internal -15V Supply	Auxiliary Power ON	-15V \pm 0.025V Maximum 100Hz ripple = 25mV peak to peak
5	Drive Enable Enable = +24V (Nominal) on terminal C5 Inhibit = open circuit to terminal C5	Enable Inhibit	+10V \pm 4V -4V \pm 1V
6	Motor Thermistor/Microtherm	Motor temperature correct Motor over temperature	+9V \pm 1V +2V \pm 4V
7	Field Fail Notes: 1. Internally supplied fields will normally excite when the main power supply is connected to the drive i.e., only in the run condition, with the main contactor energised. 2. Excitation of externally controlled fields will depend on the application. 3. Permanent magnet motor, field weakening and remove field supply applications will employ field failure override. This will provide a constant 'field normal' signal	Field Normal Field Fail	+13V \pm 2.15V +4V \pm 5.5V
8	Auxiliary Enable Enable = +24V (Nominal) on terminal C3 Inhibit = open circuit to terminal C3	Enable Inhibit	+19V \pm 3V -1.5V \pm 0.5V
9	Start Instruction Run = +24V (Nominal) on terminal C7 Stop = Open Circuit or No Volts on terminal C7	Run Stop	+19V \pm 3V -1.5V \pm 0.5V
10	Setpoint Ramp Reset Enable = Open circuit to terminal A3 Reset to Zero = Connect terminal A3 to A1 (0V) Note: Setpoint ramp output is also reset to zero when Run Enable LED 3 is out.	Ramp Enable AND Run Ramp Reset OR Stop	-14V \pm 1.15V 0V \pm 0.1V

* 540 Controllers only
† FLC = Full Load Current

TEST NO.	DIAGNOSTIC TEST POINT DESCRIPTION	CONDITION	VOLTAGE
11	Setpoint Ramp Input Connects directly to terminal A4 and measures the incoming speed demand signal. If terminal A4 is not used the voltage measured should be zero.	Variable Input: 100% forward speed demand. Zero speed or terminal A4 not used. 100% reverse speed demand*.	+10V 0V -10V
12	Input No. 1 Connects directly to terminal A6 and measures the incoming speed demand signal. If terminal A6 is not used the voltage measured should be zero.	Variable Input: 100% forward speed demand. Zero speed or terminal A6 not used. 100% reverse speed demand*.	+10V 0V -10V
13	Input No. 2 Connects directly to terminal A7 and measures the incoming speed demand signal. If terminal A7 is not used the voltage measured should be zero.	Variable Input: 100% forward speed demand. Zero speed or terminal A7 not used. 100% reverse speed demand*.	+10V 0V -10V
14	Input No. 3 Connects directly to terminal A9 and measures the incoming inverted speed demand signal. If terminal A9 is not used the voltage measured should be zero. Note: That input No. 3 is of the opposite sense to all other speed inputs.	Variable Input: 100% forward speed demand. Zero speed or terminal A9 not used. 100% reverse speed demand*.	-10V 0V +10V
15	Total Setpoint This is the sum of all the speed demand signals, i.e. Input No. 1, plus Input No. 2, plus Setpoint Ramp Input (if S3 is OFF), minus Input No.3. It is clamped to a maximum output of $\pm 11V$.	Variable Input: 100% forward speed demand. Zero speed. 100% reverse speed demand*.	+10V 0V -10V
16	Speed Feedback This is the scaled and buffered tachogenerator speed feedback signal (under steady state conditions it should be of opposite polarity but equal in magnitude to the Total Setpoint measured on diagnostic 15).	Variable Signal: 100% forward speed demand. Zero speed. 100% reverse speed demand*.	-10V 0V +10V
17	Speed Error This is of opposite polarity to the difference between the Total Setpoint and speed feedback voltages. The magnitude of this signal is dependant on the setting of the Speed Proportional Gain (P5) and includes any Zero Speed offset value.	Run - Variable Signal- Normal Steady State value- Stop - Total Setpoint = 0V Total Setpoint \neq 0V	up to $\pm 10V$ 0V Approximately 0V \pm 0.2V up to $\pm 10V$

* 540 Controllers only
† FLC = Full Load Current

TEST NO.	DIAGNOSTIC TEST POINT DESCRIPTION	CONDITION	VOLTAGE
24	<p>Main Current Limit Overrides Auxiliary Current Limits (see Diagnostic 22 and 23) Scaling:- 0 to +10V equivalent to 0 to 200% Full Load Current (FLC) Characteristics:- (i) When set between 0 to 5.5V (0 to 110% FLC†) the set current is available continuously. (ii) When set between 5.5 and 10V (110 to 200% FLC†) the current is controlled by an overload inverse time characteristic. The absolute limit is fixed at the set value and the current is allowed to exceed 110% FLC† for a short time before it is automatically cut back to 110%. The time allowed in this over current region depends on the magnitude of the overload e.g. 150% load is permitted for approximately 30 seconds before cut back starts. 200% Load is permitted for approximately 10 seconds before cut back starts.</p>	Variable Voltage depending upon the input to terminal B8 (normally +10V) and the setting of the Main Current Limit Potentiometer P7.	0 to +10V
25	<p>Total Current Demand (Inverted) This is the net current demand signal (inverted). It is limited by the current limit settings and the overload inverse time characteristic. It is held to zero except in the run condition when it is released by the Main System Enable. The Main System Enable depends on the "Run/Enable" signal (LED 3) and on the Standstill logic (if switch S2 is closed).</p>	<p>Variable demand in Run condition:- Positive Bridge Current = 200% FLC† Zero Current. Negative Bridge = 200% FLC†* In stop condition.</p>	-10V 0V +10V 0V
26	<p>Current Feedback Measured armature current signal. This is an isolated signal which is directly proportional to the Armature Current. Under steady state conditions it should be of opposite polarity and reduced magnitude to the Total Current Demand signal at Diagnostic 25.</p>	<p>Variable signal in run condition:- Positive Bridge Current = 200% FLC† Zero Current. Negative Bridge Current = 200% FLC†*</p>	+2.2V 0V -2.2V
27	<p>Phase Angle This signal is held to zero except in the run condition when it is released by Main System Enable. Main System Enable depends on the "Run/Enable " signal (LED 3) and on the Standstill Logic (if switch S2 is closed).</p>	<p>Variable Signal in run condition:- Positive phase angle*. Zero phase angle. Negative phase angle.</p>	up to 10V 0V up to -10V

* 540 Controllers only
† FLC = Full Load Current

9 SPARE PART IDENTIFICATION LIST 540, 541

<u>Printed Circuit Boards</u>	<u>Part Number</u>	
Single Phase Control Board 540	...	AH051900U002
Single Phase Control Board 541	...	AH051900U003
Calibration Board	...	AH046789U002
Preset Potentiometer Board	...	AH046821U002
Power Supply Board	...	This PCB is Product Code dependant - select from the chart below:-

SUPPLY VOLT OPTION (PRODUCT CODE BLOCK 3)	540 FIELD OPTION 0,2 OR 5 PRODUCT CODE BLOCK 4	540 FIELD OPTION 3 OR 6 PRODUCT CODE BLOCK 4	541 FIELD OPTION 0,2 OR 5 PRODUCT CODE BLOCK 4	541 FIELD OPTION 3 OR 6 PRODUCT CODE BLOCK 4
0 - 110V 1 - 115V 2	AH046788U002	AH046788U005	AH046788U011	AH046788U014
3 - 220V 4 - 240V				
5 - 380V 6 - 415V	AH046788U003	AH046788U006	AH046788U012	AH046788U015
7 - 440V 8 - 460V 9 - 480V	AH046788U004	AH046788U007	AH046788U013	AH046788U016

SPARE PART IDENTIFICATION LIST 540, 541

<u>Fuses</u>	...	<u>Part Number</u>
Auxiliary Supply Fuse (FS5), 3A 250V, (1 off used)	...	CH020033 or CH460033 CSA/UL LIST ED
Field Supply Fuses (FS3 and 4)* (2 off used) - 6.3A 440V, Ferraz F84392)	...	CH200632
Main Supply Fuses (FS1 and 2)* (2 off used)	...	These Fuses are Product code dependant - select from the chart below:-

CONVERTOR TYPE (PRODUCT CODE BLOCK 1)	OUTPUT CURRENT RATING (PRODUCT CODE BLOCK 2)	FUSE PART NUMBER
540 and 541	Up to 20A (001 - 0200) (30A Rating)	CH110034
540 and 541	20.1A to 25A (0201 - 0250) (35A Rating)	CH110353
540 and 541	25.1 to 35A (0251 - 0350) (55A Rating)	CH110553

*** IMPORTANT NOTE:** These are High Speed Semiconductor Protection Fuses, use of any other type invalidates Warranty and may result in serious damage to the controller.

SPARE PART IDENTIFICATION LIST 540, 541

SEMICONDUCTORS

Field Bridge - These items are Product Code dependant - select from the chart below:-

V.D.R. (6 off used)

SUPPLY VOLTAGE OPTION (PRODUCT CODE BLOCK 3)	FIELD BRIDGE PART NUMBER	V.D.R. PART NUMBER
0 - 110V 1 - 115V 2 - 3 - 220V 4 - 240V	CW047076	CK047723
5 - 380V 6 - 415V	CW047076	CK047692
7 - 440V 8 - 480V 9 - 480V	CW047379	CK047693

Thyristors part numbers



These are Product Code dependant select from the chart below:-

SUPPLY VOLTAGE OPTION (PRODUCT CODE BLOCK 3)	OUTPUT CURRENT (PRODUCT CODE BLOCK 2) 540 & 541		
	UP TO 20A (0000-02000) (18A RATING)	20.1 - 25A (0201-0250) (25A RATING)	25.1 - 35A (0251-0350) 40A RATING)
0 - 110V 1 - 115V 2 - 3 - 220V 4 - 240V	CF047889		CF047891
5 - 380V 6 - 415V	CF047889 (CF047889U014)		CF047891 CF047891U014)
7 - 440V 8 - 460V 9 - 480V	CF047894		CF047896

SPARE PART IDENTIFICATION LIST 540, 541

<u>MISCELLANEOUS</u>	<u>PART NUMBER</u>
Mains Transformer *	CO047008
Pulse Transformer *	CO040301
Connector, Female, 4 way (complete set of 12)	LA047525
Connector , Male, 4 way, PCB Mounting *	CI047088
Front Cover - 540 and 541	LA047222
Legend Plate Assembly (including W Buttons)	LA047282
W Buttons	FI044705
Ribbon Cable Assembly 14 way	CM052762
Ribbon Cable Assembly 24 way	CM052761
Product Code/Serial No. Label	GA047080U001

* PCB Mounted Components

ISS.	MODIFICATION	CP.NO.	DATE	APPROVAL
1	Initial Issue			GDR
2	540/541 Manual enhanced by addition of:- a) Introduction b) Technical details c) Drive condition indicator table d) Spares list e) Block diagram of 541	1315	07.02.89	GDR
3	Added Basic Setting up and Operating Instructions.	8379	22.06.93	
FIRST USED ON		MODIFICATION RECORD 540/541 Product Manual		
 EUROTHERM DRIVES		DRAWING NUMBER	SHT.	
		ZZ047490C	1 of 1	