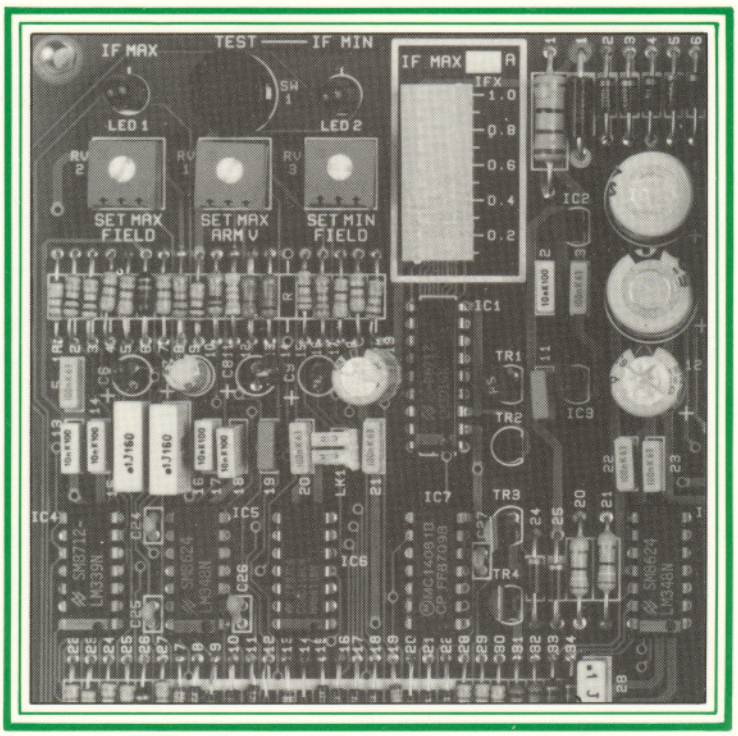
Instruction Manual



Field Controller FXM4

CONTROL TECHNIQUES
DRIVES LIMITED

HEALTH AND SAFETY AT WORK

Electrical devices can constitute a safety hazard.
It is the responsibility of the user to ensure the compliance of the installation with any acts or bylaws in force. Only skilled personnel should install and maintain this equipment after reading and understanding this instruction manual. If in doubt refer to the supplier.

DANGER
ELECTRIC SHOCK RISK

Note: The contents of this manual are believed accurate at the time of printing. The manufacturers, however, reserve the right to change the content and product specification without notice.

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Section 1 Introduction

The Controller FXM4 is suitable for controlling field current of DC motors up to approximately 20 amps. It consists of a single phase full wave thyristor controlled rectifier together with control circuit for field weakening systems. The unit also has a built in field failure relay and field ammeter.

Section 2 Specification

Supply Voltage
Single Phase 380/480V ±6% and 220/240V ±6% nominal 50/60 Hz.

Max. Field Voltage
220/440V max. depending on supply voltage.

Armature Voltage Feedback
220–500V DC (Fuse externally at 2A max.).

Field Current
Up to 20A.

Operating Temperature Range
0 – 50° C.

Storage Temperature Range
–40 – +70° C.

Maximum Relative Humidity
85%.

Thyristor Bridge
1 Phase asymmetrical (2 thyristor).

Electrical Isolation
Control electronics are isolated from the power circuit and impedance isolated from armature circuit.

Preset Controls
Maximum field current RV2.
Minimum field current RV3.
Maximum armature voltage RV1.

Field Failure Relay Contact Ratings
Voltage: V AC – 250
V DC – 50
Current – 4A

Switching: VA – 1000
W – 200

Power Terminals

L1 L2	Main AC input
F1 F2	DC Field Current output
A1 A2	Armature Voltage input

Signal Terminals

1	Field Economy input
2	0V common
3	External field current reference input (0. . . –10V)
4	– 15V
5	+15V
6	Field current signal output (0. . . +10V)
7	Armature voltage signal output (0. . . +10V)
8	Pole ┐
9	N/O ├ Field failure relay
10	N/C ┘

3.1 Supply Voltage

The unit has two voltage ranges set by LK2 (see Fig. 1). With LK2 in the 240V position a unit will operate from 220V – 6% to 240V + 6%. With the link in the 415V position the unit will operate from 380V – 6% to 480V + 6%.

The controlled rectifier part of the circuit may be operated from any AC voltage less than 480V provided the control circuit is supplied within the above range. To achieve this remove fuses FS1 and FS2 and connect control circuit supply to two push-on connectors situated just above the fuses (see Fig. 1).

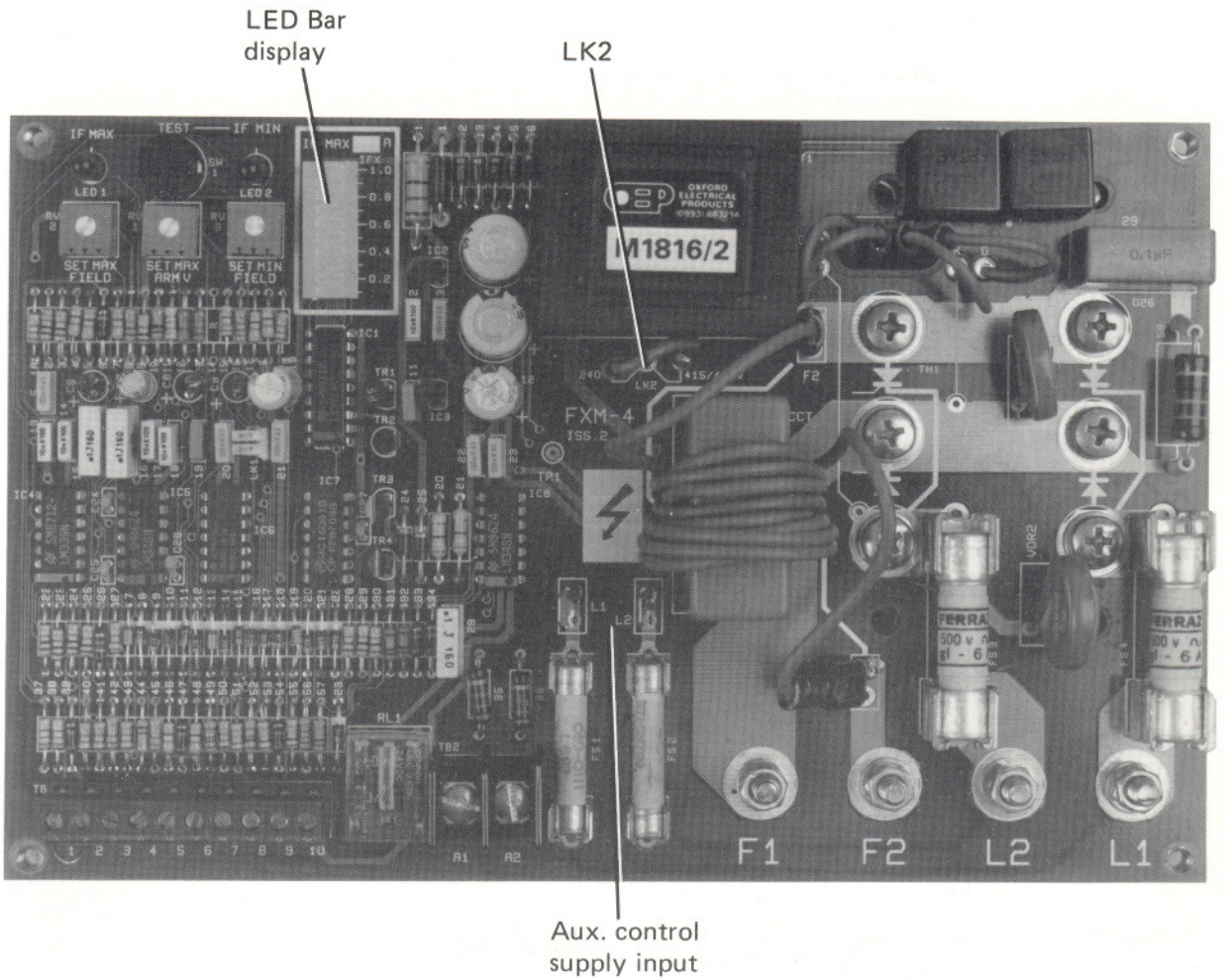

Fig. 1 FXM4 Field Controller

3.2 Field Current Selection

The maximum field current of the unit is determined by the number of turns through the DCCT and the value of the burden resistors R14 and R15 which have 1.5K and 680R fitted as standard. Therefore with one turn through the CT and LK1 fitted the maximum current is 20A. Other currents can be set as follows:—

		MAX FIELD CURRENT	
	NO. OF TURNS	LK1 FITTED	LK1 NOT FITTED
R BURDEN	10	2A	1.5
	9	2.2	1.7
$= \frac{10}{IF \times T}$	8	2.5	1.9
	7	2.9	2.1
	6	3.3	2.5
IF = FIELD CURRENT (A)	5	4.0	3.0
T = No. of Turns (increase to	4	5.0	3.8
$2.5mm^2$ above 6A)	3	6.7	5.0
	2	10.0	7.5
	1	20.0	15

Other values can be obtained by fitting different burden resistors or increasing the number of turns.

3.3 Automatic field weakening of armature controlled drive to provide constant horsepower speed range.

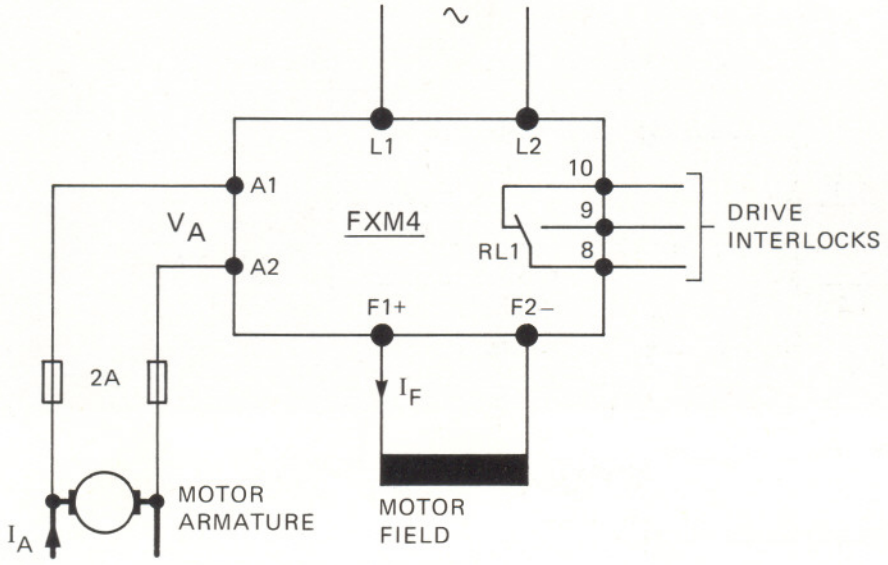

Fig. 2

With this system, the armature voltage (VA) is increased to a maximum with fixed field current (IF) to provide a constant torque speed range. Speed is then further increased by weakening of field with constant armature voltage providing a constant power speed range.

For a DC Motor:

Power (KW) = $V_{ARM} \times I_{ARM}$ approximately

Speed (N) $\propto \frac{V_{ARM}}{I_{FLD}}$

3.4 Constant Field Current Controller

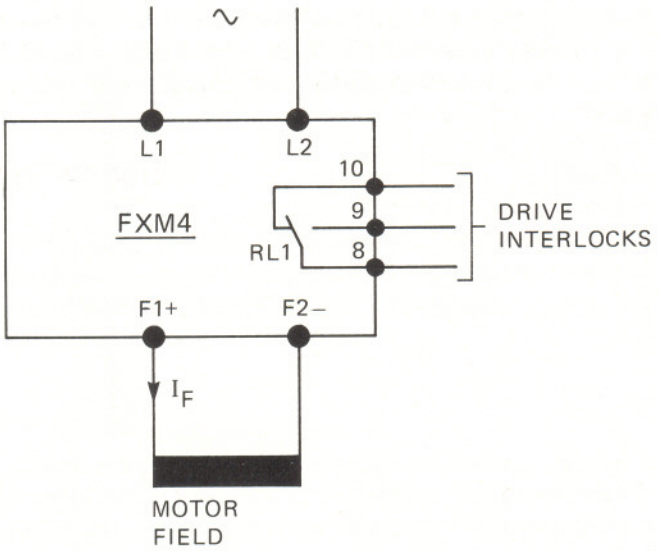

Fig. 3

In this system, the field current is stabilized to be independent of supply voltage and temperature variations.

3.5 Field Current Control From External Reference

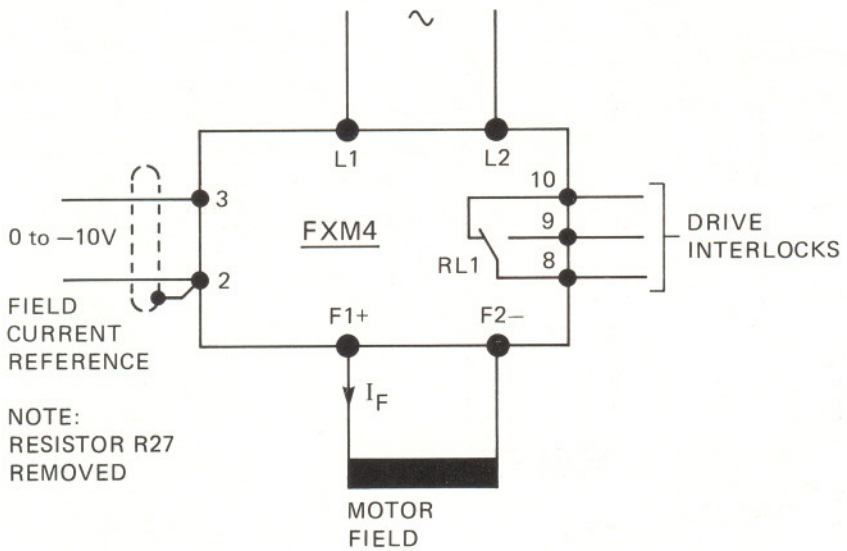

Fig. 4

In this mode the field current is controlled by a 0 to –10V reference applied to terminal 3, e.g. for load sharing or coiler control. Resistor R27 is removed in this mode.

Section 4 Adjustments

4.1 Field Current Monitor and Relay RL1

A 'Bar LED' meter is provided to give an indication of field current. Full scale indication is 1.0 x IF max. The value of IF max. is indicated on the printed circuit board (fig. 1). RL1 functions as a field failure relay and closes and opens when the 0.1 x IF max. LED is energised and de-energised respectively.

4.2 Set Maximum Field Current (RV2)

This control should only be adjusted when LED1 is alight. Fully clockwise rotation corresponds to full scale deflection on the monitor and generally this will be matched to the maximum motor field current. However, should a lower maximum field current be required, this control should be turned anti-clockwise.

4.3 Set Minimum Field Current (RV3)

This control should only be adjusted when LED2 is lit and this may be accomplished by pressing push switch SW1. The minimum field current can be set within the range 0.1 to 0.9 IF max, as indicated by the monitor, and it should be set just below the minimum working field current of the motor. If it is adjusted to below 0.1 IF max., the field failure relay will de-energise.

4.4 Set Maximum Armature Voltage (RV1)

When the drive has a field weakening range, this control sets the maximum armature voltage (and hence the speed) at which the field current begins to weaken. This control can only be set with motor running as follows:

Turn RV1 fully anti-clockwise.

Run drive up to full speed.

Adjust RV1 so that the motor armature voltage corresponds to the maximum rated value.

Section 5 Outline of Operations

Refer to schematic diagram (fig. 5).

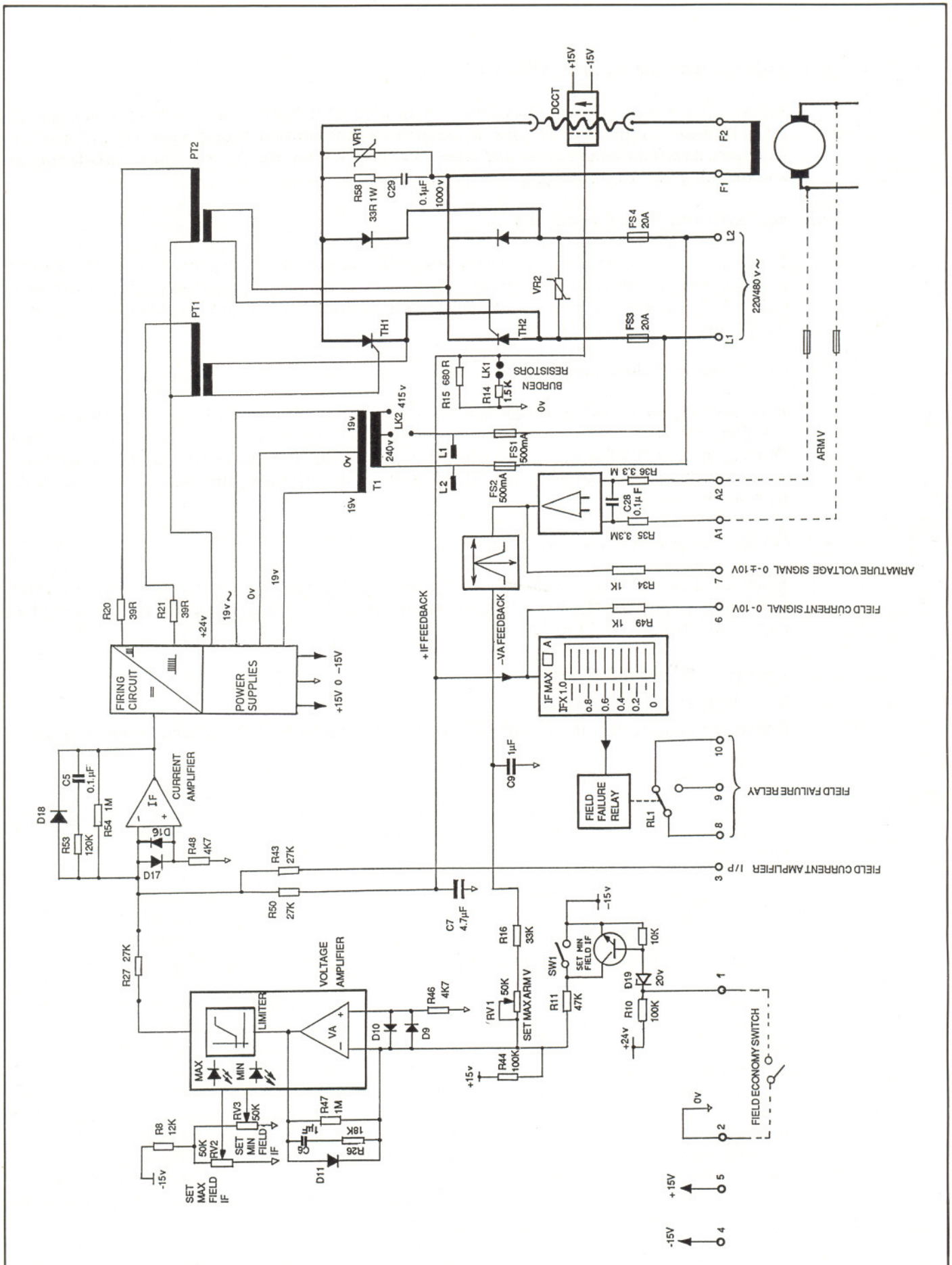

Fig. 5 Block Diagram

Section 5 Outline of Operations

5.1 Thyristor Convertor

The thyristor converter consists of 1 thyristor module and 1 diode module, each containing a pair of series connected thyristors or diodes. The models are interconnected on the back of the printed circuit board to form a single phase asymmetrical bridge (2 thyristor). Associated with the Converter, are RC snubbers and transient voltage suppressors.

The DC output voltage from the converter is shown in fig 6 at approximately half VF max. The gate pulses are also shown and it can be seen that the thyristors are fired 180° apart.

On the right side of the printed circuit board are the electronic power supply transformer T1, firing pulse transformer PT1 and PT2 and current transformer DCCT for monitoring field current.

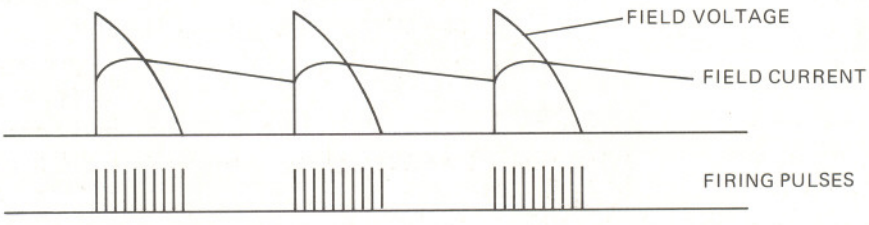

Fig. 6

5.2 Control Electronics

The control electronics are contained on the left side of the printed circuit board and consist of:

(a) Thyristor Firing Circuit.
(b) Field Current Amplifier.
(c) Voltage Amplifier.
(d) Field Current Monitor and Field Failure Relay.

The firing circuit generates the thyristor trigger pulses and is designed to phase-displace the trigger pulses with respect to the supply voltage wave form in response to a variable DC control voltage applied to its input.

The field current amplifier controls the field current of the motor and prevents variations due to temperature, supply fluctuations, etc. The negative reference for the field current is derived from the output of a voltage amplifier or directly from an input on terminal 3, and the positive feedback from the current transformer DCCT and burdens R14 and R15.

The voltage amplifier senses the armature voltage via R16 and RV1 and compares it with a fixed positive reference via R44 and +15V supply. If the armature voltage is below the maximum value (adjustable by RV1) the output of a voltage amplifier is at its maximum negative value and hence the field current is also at its maximum value. In this condition, LED 1 will be lit and the field current is adjustable by the set maximum field potentiometer RV2. When the armature voltage reaches its maximum value, the output of the voltage amplifier begins to fall and hence also the field current. Further increases in speed is then at constant armature voltage but with reducing field current. The field current is prevented from falling below a minimum value by limiting the positive going swing of the voltage aplifier to a negative voltage. LED2 indicates that minimum field has been reached and its value is adjustable by the set minimum field potentiometer (RV2).

The field current monitor measures the voltage across the current transformer burden resistors. Field failure relay, RL1, operates when the IF x 0.1 LED goes out.

Section 6 Fault Finding

The following fault finding chart is not exhaustive but shows the general procedure to be adopted for a typical drive system.

FAULT	POSSIBLE CAUSE	ACTION
Main contactor will not close.	FFR not energised (RL1).	Check fuses FS 1/2/3/4 on printed circuit board.
Field current monitor indicates zero.		Check field connections. Check maximum field potentiometer not set fully anti-clockwise.
Drive will not run up to maximum speed.	Maximum armature voltage set too high.	Adjust maximum armature voltage as described in section 4.4.
Field current monitor stays at a maximum.	No armature voltage feedback	Check fuses feeding terminals A1 and A2.
Drive lacks torque.	Maximum armature voltage set too low.	Adjust armature voltage as described in section 4.4.
Overload trips when loaded.	Maximum field set too low.	Adjust maximum field current as described in section 4.2.
Field failure relay RL1 trips drive under rapid acceleration.	Minimum field current potentiometer set too low.	Adjust minimum field current as described in section 4.3.

7.1 Printed Circuit Board (FXM4) (Fig. 1)

Unscrew four corner fixing screws. Unplug thyristor module gate leads. Unscrew 6 screws connecting thyristor and diode modules (TH1 & D26) and remove P.C.B. When replacing these 6 screws a tightening torque of 3.5Nm should not be exceeded.

7.2 Thyristors and Diode Modules (Fig. 7)

Remove P.C.B. as described above. Unscrew modules from aluminium heat sink. When replacing modules a maximum tightening torque of 5.5Nm should not be exceeded.

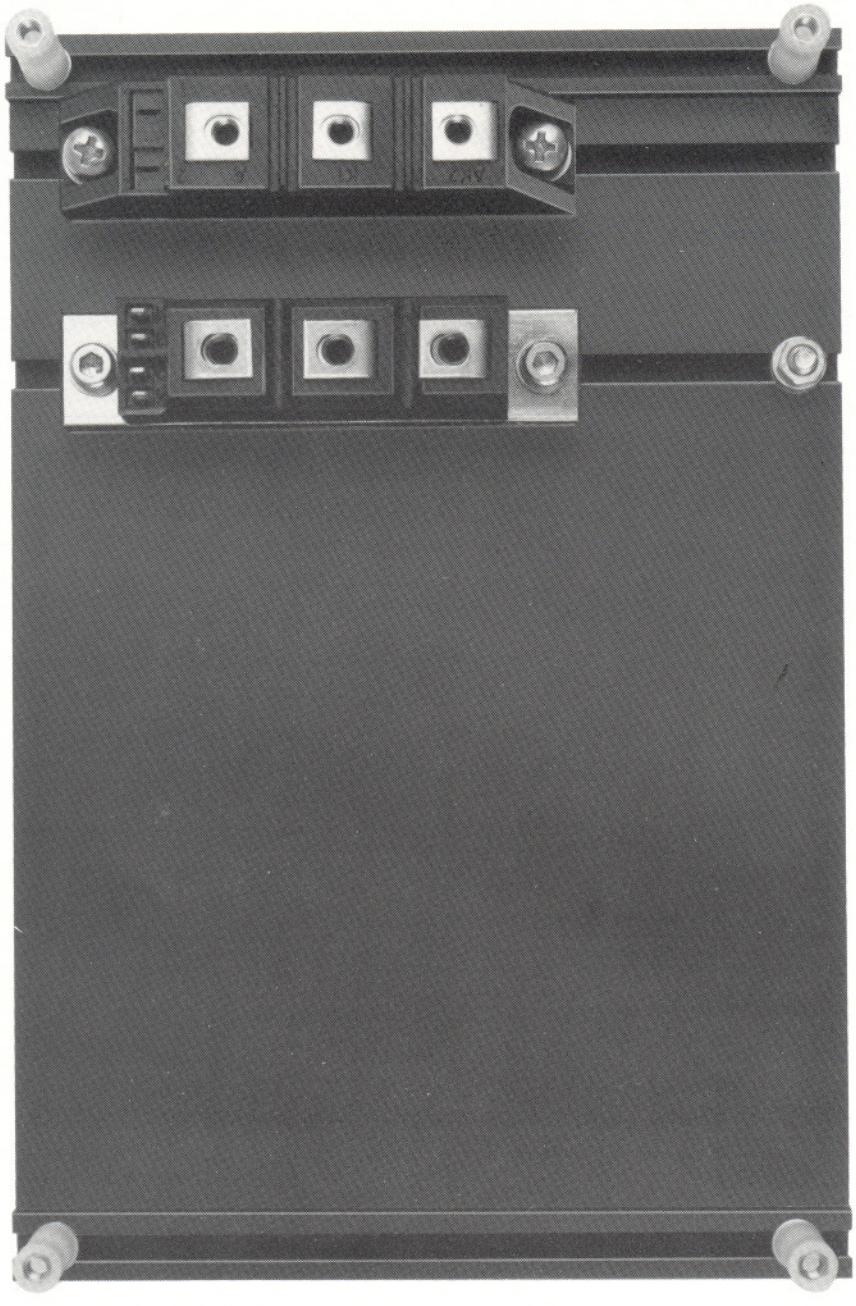

Fig. 7 Heatsink with Thyristor and Diode Modules