Z-MT
Zirconia Oxygen Analyzer

Operating Instructions

Basic, Advanced and
Auto-calibration Versions

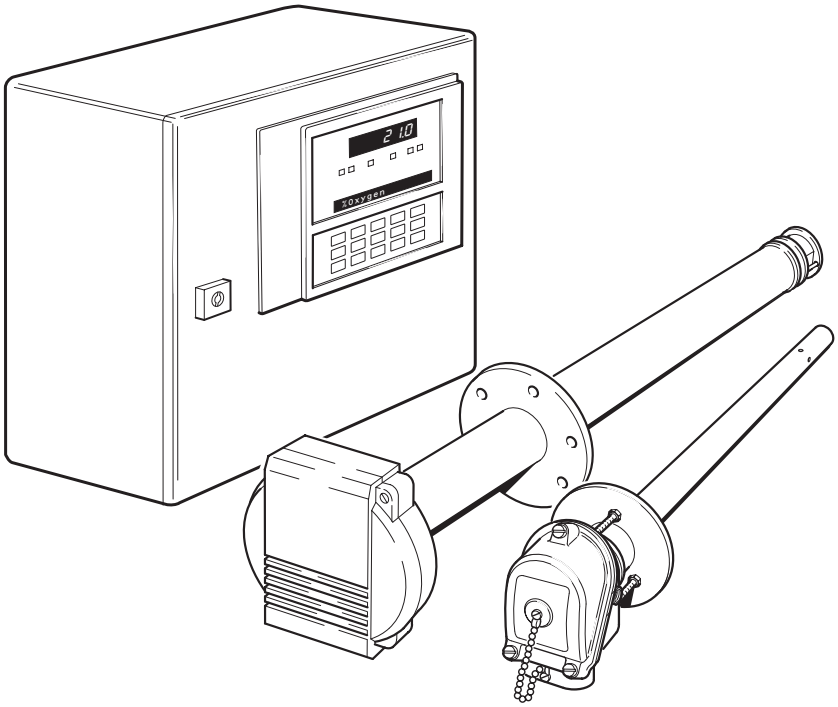


ABB Instrumentation

ABB KENT-TAYLOR

The Company

ABB Kent-Taylor is an established world force in the design and manufacture of instrumentation for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

As a part of ABB, a world leader in process automation technology, we offer customers application expertise, service and support worldwide.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

The NAMAS Calibration Laboratory No. 0255(B) is just one of the ten flow calibration plants operated by the Company, and is indicative of ABB Kent-Taylor's dedication to quality and accuracy.

BS EN ISO 9001

St Neots, U.K. – Cert. No. Q5907
Stonehouse, U.K. – Cert. No. FM 21106

EN 29001 (ISO 9001)

Lenno, Italy – Cert. No. 9/90A

Stonehouse, U.K. – Cert. No. 0255

Use of Instructions

Warning.
An instruction that draws attention to the risk of injury or death.

Caution.
An instruction that draws attention to the risk of damage to the product, process or surroundings.

Note.
Clarification of an instruction or additional information.

Information.
Further reference for more detailed information or technical details.

Although **Warning** hazards are related to personal injury, and **Caution** hazards are associated with equipment or property damage, it must be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process system performance leading to personal injury or death. Therefore, comply fully with all **Warning** and **Caution** notices.

Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

CONTENTS **Page**

1 INTRODUCTION

The Z-MT Trim Controller fine tunes or 'trims' the air/fuel ratio to the optimum value, based on continuous analysis of the flue gas oxygen content. The Z-FG and ZFG2 probes has a fast response to changes in flue gas oxygen content – typically 60 seconds for 95% change at normal flue gas temperature. During slow variation in fire rate full PI control is implemented using an oxygen/fire rate curve held in memory.

If the burner fire rate changes by a preset percentage (user set) in 1.28 seconds, the Z-MT automatically changes to Adaptive Feed Forward (AFF) control and uses an actuator position/fire rate curve held in memory. This data is retained in the event of power loss or power-down.

The control curves are established and entered initially by the engineer during commissioning trials and subsequently updated automatically during normal operation, thereby compensating for wear in linkages and bearings, ageing of the burner orifices, etc.

The Z-MT can be programmed for single or dual fuel operation, a separate set of curves being held in memory for each fuel. The memory data is protected against loss or corruption during power-down.

Manual control can be established at any time to enable the opening of inspection hatches, minor refits and repairs while the burner is operating.

The commissioning and electrical calibration procedures relating to the Trim Control features (detailed in Section 16) are additional to those contained in Operating Instructions ZMT/0011 and Commissioning and Calibration Procedures ZMT/0012.

This supplement provides information on those features of the Z-MT Trim Controller that differ from, or are additional to, those of the Z-MT Zirconia Oxygen Analyser and must be read in conjunction with the following:

Operating Instructions ZMT/0011 (Issue 4 onwards)
Commissioning and Calibration Procedures ZMT/0012 (Issue 4 onwards).

2 PREPARATION

As detailed in Section 2 of Operating Instructions ZMT/0011.

3 SITING

As detailed in Section 3 of Operating Instructions ZMT/0011.

4 MOUNTING

As detailed in Section 4 of Operating Instructions ZMT/0011.

5 CONNECTIONS

WARNING. Before making any connections ensure that the power supply and any high voltage or power-operated control circuits are switched off.

Schematic connection diagrams for Z-FG, ZFG2 and Z-GP2 probes are shown in Figs. 5.2 and 5.3 respectively (pages 3 and 4). Refer to Table 5.1 for cable/air tubing specifications.

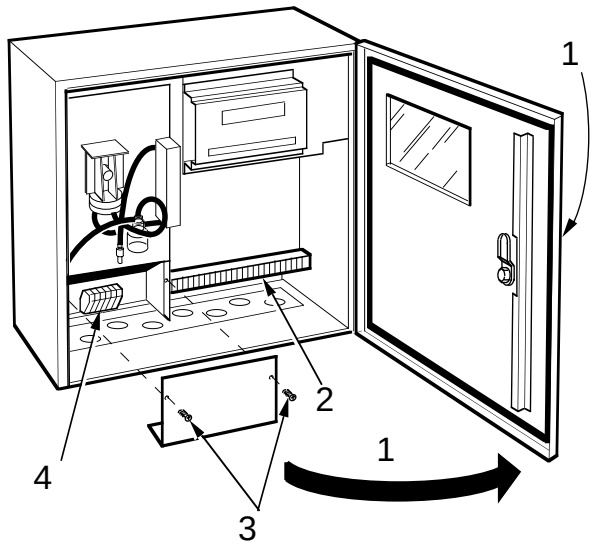


Fig. 5.1 Access to Terminals

5.1 Access to Terminals – Fig. 5.1

1 Unlock and open the door, hinged at the right hand edge (turn key clockwise to open).

2 Identify the signal connections terminal block.

To gain access to the mains connections terminal block:

3 Remove the two screws retaining the mains protection plate and remove the plate.

4 Identify the mains connections terminal block.

5.2 Preparation

When making connections note the following:

a) Use only the cables and air tubing specified in Table 5.1.

b) Ensure that all cables enter the Z-MT via the glands nearest to the appropriate screw terminals and are short and direct.

Note. Figs. 5.4 and 5.5 on page 7 show the recommended routing of cables for the most advanced Z-MT versions, i.e. those requiring the most cable entries. Alternative entries, nearer the appropriate screw terminals, may be used if some Z-MT facilities are not used.

5.3 Connection Details – Figs. 5.4 and 5.5

Connection details for Z-FG, ZFG2 and Z-GP2 probes are shown in Figs. 5.4 and 5.5 (page 7) respectively and are summarised in Table 5.2 on page 5.

Cable/Tubing Reference	Description
Cell output cable	16/0.2mm laid up red and blue twin copper braid with overall p.v.c. sheath **
Thermocouple cable	Ni-Cr/Ni-Al BS4937 type K and DIN IEC 584 (BS part no. 4) **
	Pt/Pt-Rh BS4937 types R and S and DIN IEC 584 (BS part nos. 1 and 2) **
Heater cable (Z-FG and ZFG2 probes only)	3-core 1mm^2 copper (20 metres max.) * 3-core 1.5mm^2 copper (32 metres max.) * 3-core 2mm^2 copper (69 metres max.) *
Air Tubing	$^1/_4$in. o.d. x $^1/_8$in. i.d. stainless steel, nylon or p.v.c. tube (100°C ambient max.)

* Total run length including flexible conduit.
** Must be routed away from the heater supply cable on extended cable runs.

Table 5.1 Cable References and Air Tubing Specification

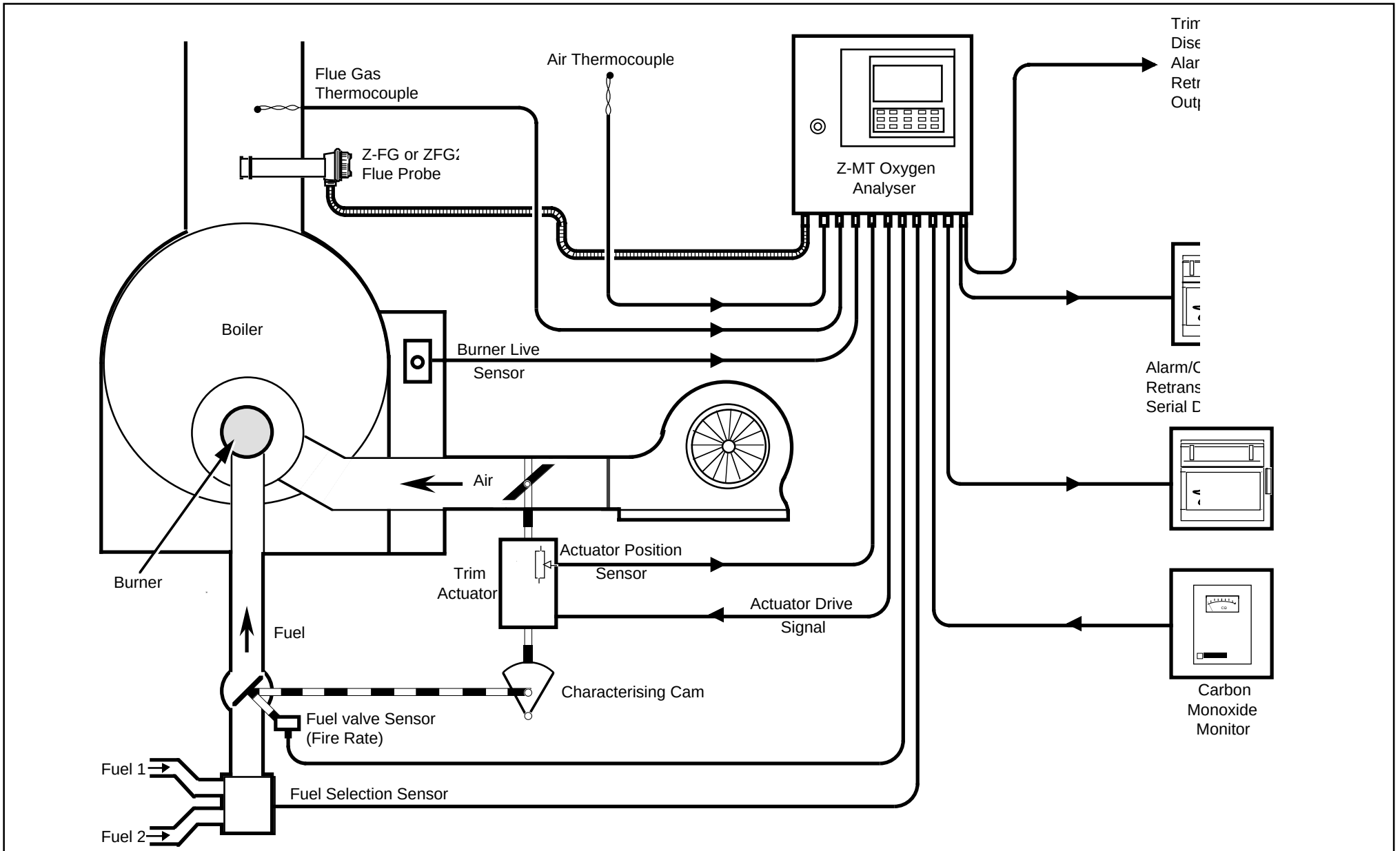


Fig. 5.2 Schematic Diagram, Z-FG or ZFG2 Probe

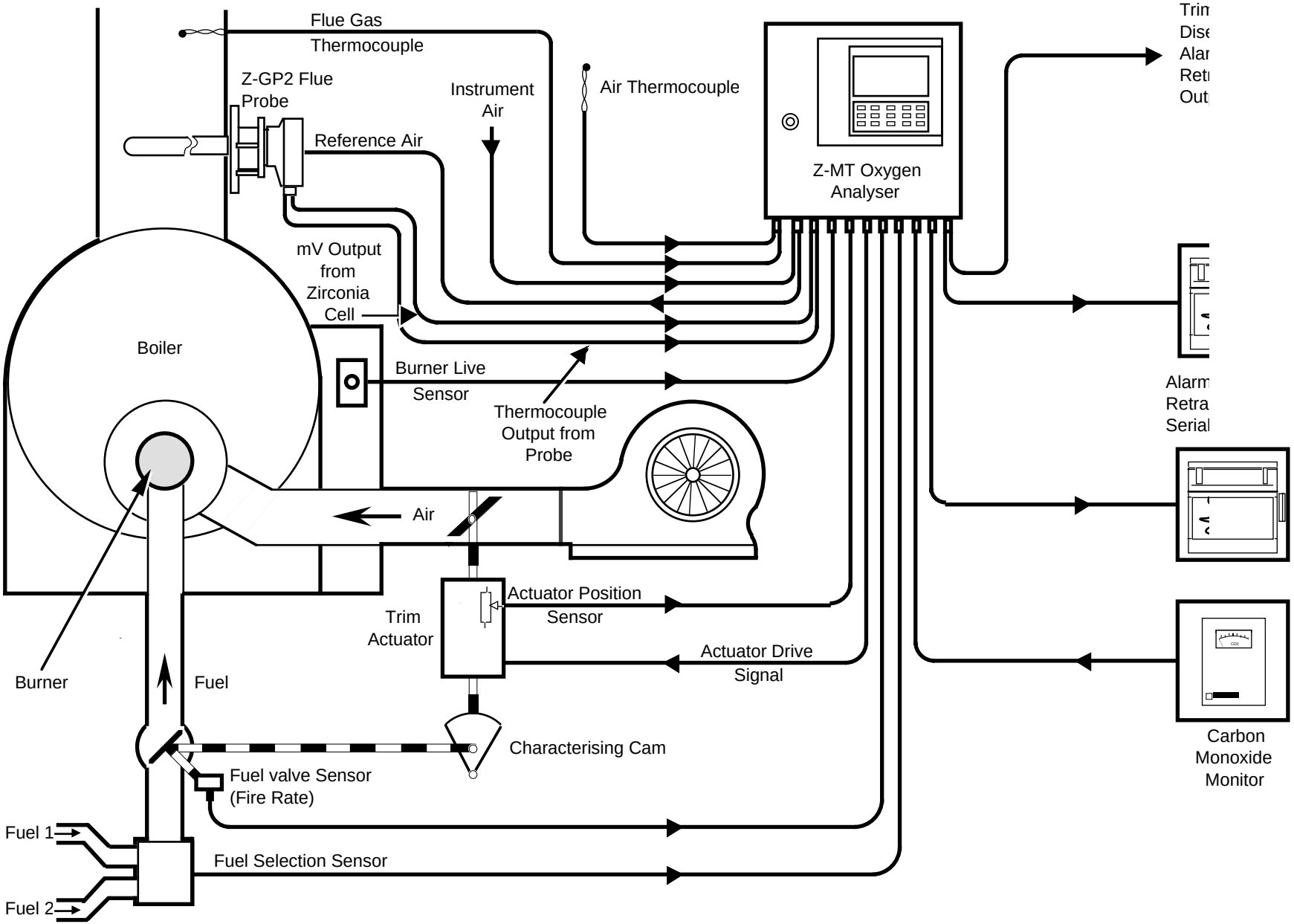


Fig. 5.3 Schematic Diagram, Z-GP2 Probe

Terminal Reference | **Connection**

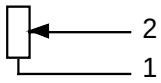
Heater
H, H — Probe heater supply
E — Earth

Mains Supply*
L — Line
N — Neutral
E — Earth

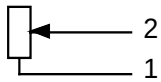
Probe Cell Output
PROBE CELL (–, +) — From probe cell

Thermocouples
PROBE T/C (–, +) — From probe thermocouple
FLUE T/C (–, +) — From flue thermocouple
AIR T/C (–, +) — From air thermocouple

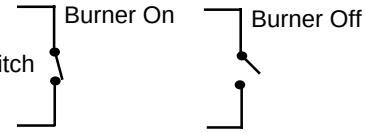
Damper Position
DAMPER POSITION 1
DAMPER POSITION 2



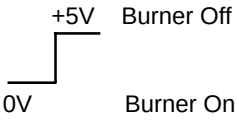
Burner Load
BURNER LOAD 1
BURNER LOAD 2



Burner Input
BURNER I/P +
BURNER I/P –
switch

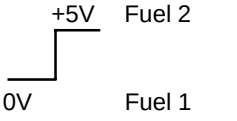


or Logic input



Fuel Selector
Fuel (–, +)
Switch

or Logic input



Terminal Reference | **Connection**

Carbon Monoxide Retransmission Signal
CO/IP (–, +) — 4 to 20mA from external monitor

Output 3

Double Relay
1 normally closed
2 common — Relay 2
O/P MODULE 3
3 normally open
4 normally closed
5 common — Relay 1
6 normally open

Analogue Retransmission + Relay
1 positive
2 negative — Analogue retransmission 2
O/P MODULE 3
3 —
4 normally closed
5 common — Relay 1
6 normally open

Output 2

Trim Relays
1 normally open
2 not used
O/P MODULE 2
3 not used
4 normally closed
5 normally open — Trim Relays

Output 1

Analogue Retransmission + Relay
1 positive
2 negative — Analogue retransmission 1
O/P MODULE
3 normally closed
4 common
5 normally open — Trim 'hard' disengage relay

***** Refer to Section 6.1 of Operating Instructions ZMT/0011 to check the mains input voltage

Table 5.2 Electrical Connections

5.3.1 Z-FG and ZFG2 Probes – Fig. 5.4
Fit suitable cable glands into the entries to be used (see Table 5.2 on previous page and Fig. 5.4) and blank-off any unused entries using the bungs supplied.

Make connections ① to ⑭ as applicable.

① Mains:
Brown to 'L'
Blue to 'N'
Green/Yellow 'E'

② Flue thermocouple:
White to 'FLUE T/C +'
Blue to 'FLUE T/C –'

③ Air thermocouple:
White to 'AIR T/C +'
Blue to 'AIR T/C –'

④ Damper Position:
'DAMPER POSITION 1'
'DAMPER POSITION 2'

⑤ Burner Load:
'BURNER LOAD 1'
'BURNER LOAD 2'

⑥ Burner Input:
'BURNER I/P +'
'BURNER I/P –'

⑦ Automatic (remote) fuel selector (dual fuel versions only):
Switch connections (polarity unimportant) ─ 'FUEL +', 'FUEL –'

Logic connections ─ 'FUEL +' (positive), 'FUEL –' (negative)

⑧ Carbon monoxide retransmission signal (4 to 20mA):
Positive to 'CO I/P +'
Negative to 'CO I/P –'

⑨ Output 3 (refer to Section 15 for clarification):

Double relay – 'O/P MODULE 3'
'1' – normally closed
'2' – common
'3' – normally open
─ Relay 4

'4' – normally closed
'5' – common
'6' – normally open
─ Relay 3

Single relay + analogue output – 'O/P MODULE 3'
'1' – positive
'2' – negative
─ Analogue retransmission 3
'3' – not connected
'4' – normally closed
'5' – common
'6' – normally open
─ Relay 3

⑩ Output 2 (refer to Section 15 for clarification):

Single relay – 'O/P MODULE 2'
'1' – motor
'2' and '3' not connected
'4' – Link to O/P Module 1, terminal 5
'5' – motor

⑪ Output 1 (refer to Section 15 for clarification):

Double relay + analogue output – 'O/P MODULE 1' terminals

'1' – positive
'2' – negative
─ Analogue retransmission 1

'3' – normally closed
'4' – common
'5' – normally open
─ Relay 1 (Trim 'hard' disengage relay)

⑫ Secure the Z-FG AND ZFG2 conduit fitting in the gland plate and make the following connections:

Cell output	–	red to 'PROBE CELL +' blue to 'PROBE CELL –' screen to 'PROBE CELL E'
Probe thermocouple	–	white to 'PROBE T/C +' blue to 'PROBE T/C –'
Heater	–	brown to 'H' ┐ polarity blue to 'H' ┘ unimportant green/yellow to 'E'

⑬ Connect the probe reference air tube to the pump/regulator supply spigot.

⑭ If the surrounding air is contaminated connect a length of suitable piping to the inlet compression fitting and route to an uncontaminated environment (or air supply for regulator version).

5.3.2 Z-GP2 Probes – Fig. 5.5
Carry out steps ① to ⑪ as detailed in section 5.3.1. above.

Make connections ⑫ to ⑭, as applicable.

⑫ Cell output:
Red to 'PROBE CELL+'
Blue to 'PROBE CELL –'
Screen to 'PROBE CELL E'

Cell thermocouple:
White to 'PROBE T/C +'
Blue to 'PROBE T/C –'

⑬ Connect the probe reference air tube to the outlet compression fitting (rear fitting).

⑭ If the surrounding air is contaminated, connect a length of suitable tubing to the inlet compression fitting (front fitting)

6 SETTING UP

As detailed in Section 6 of Operating Instructions ZMT/0011.

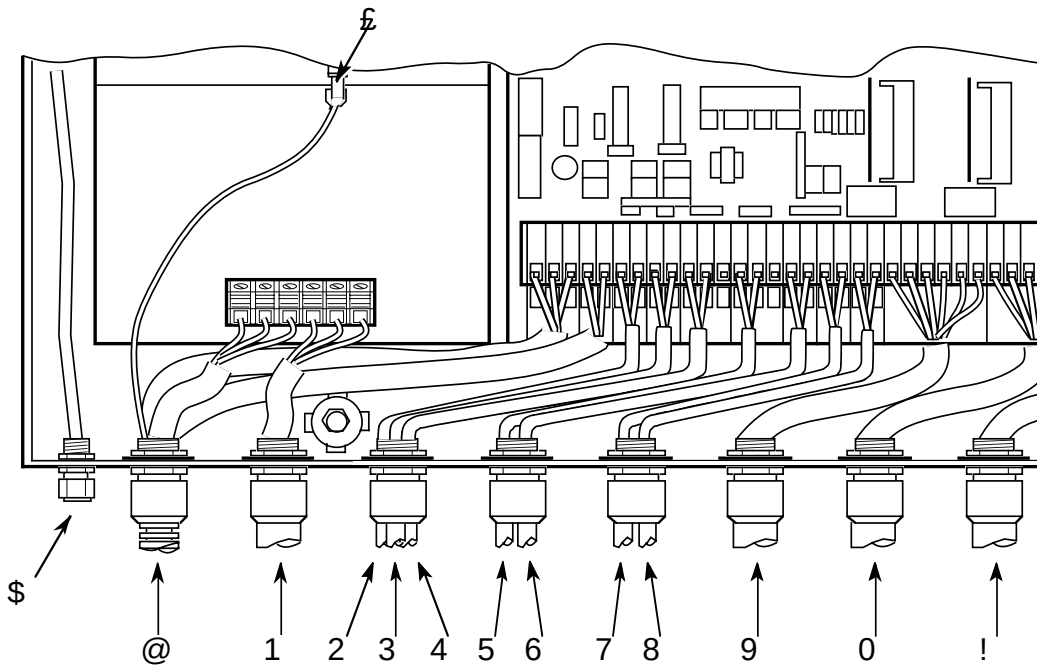


Fig. 5.4 Connection Details – Z-FG and ZFG2 Probes

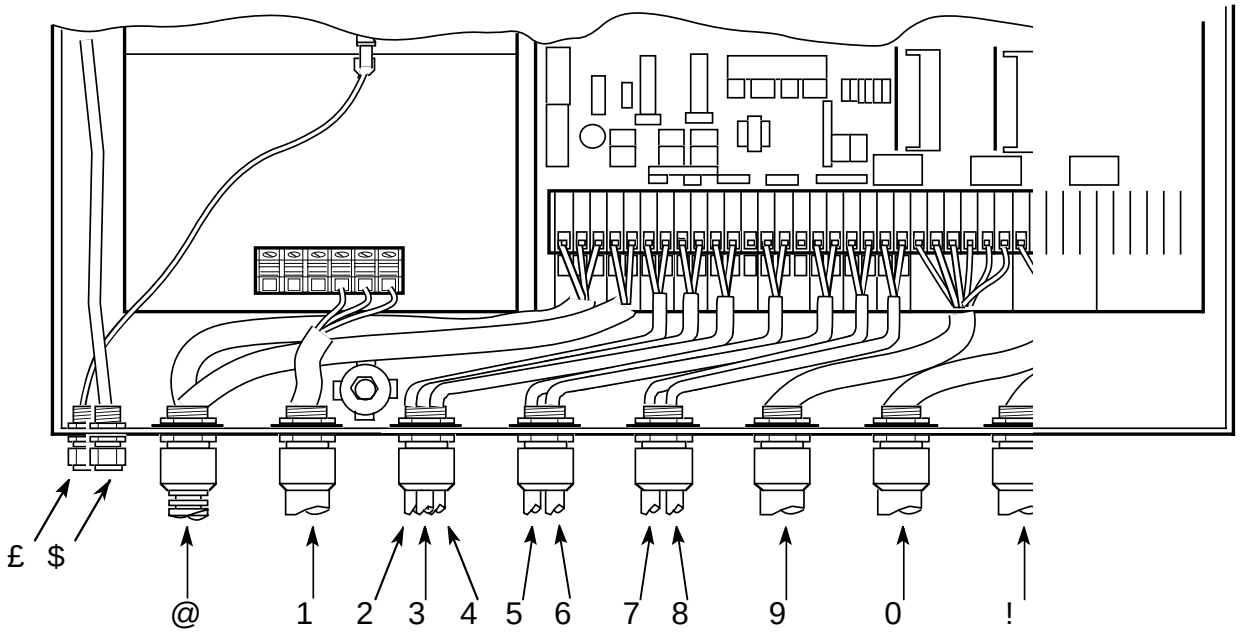


Fig. 5.5 Connection Details – Z-GP2 Probes

7 FAMILIARISATION WITH DISPLAYS, CONTROLS AND L.E.D INDICATIONS

The Trim functions of the Z-MT Controller are accessed by four membrane switches on the switch panel (see Fig. 7.1). Front panel l.e.d.s (see Fig. 7.2) indicate the trim control state. All other displays and controls are as detailed in Section 7 of Operating Instructions ZMT/0011.

Functions of additional switches –Fig. 7.1:

O_2 Set Pt	'Oxygen Set Point' switch – used for accessing **Oxygen Set Point Page** (see Section 11.1 on page 11).
A/M	'Auto/Manual Operation' switch – used for accessing **Automatic/Manual Operation Selection Page** (see Section 11.2 on page 12).
Load	'Load' switch – used for accessing the **Fire Rate Page** (see Section 11.3 on page 14).
Act Pos	'Actuator Position' switch – used for accessing the **Actuator Position** page (see Section 11.4 on **Page** 16).

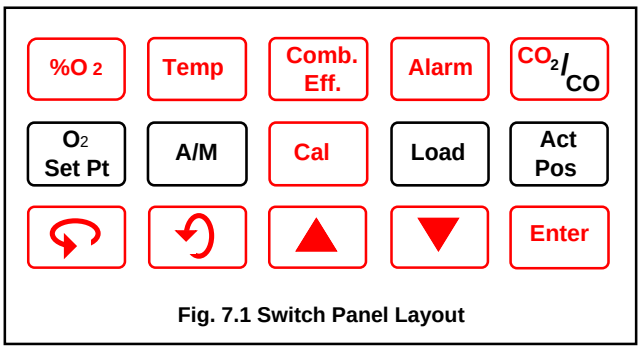


Fig. 7.1 Switch Panel Layout

L.E.D. indications – Fig. 7.2:

BURNER ON	Illuminated when the burner is on.
MANUAL	Illuminated when trim control is in Manual mode (see Section 11.2 on page 12).
TRIM ON	Illuminated when Automatic/Manual trim control is engaged.

Only one of the following can be illuminated at any one time indicating the type of control for automatic mode (see Section 11.6.3 on page 19).

P.I.D	Illuminated when in P.I.D control.
FEED FWD	Illuminated when in feed forward control.
PREST NEUTRAL TRIM	Illuminated when in preset neutral control.

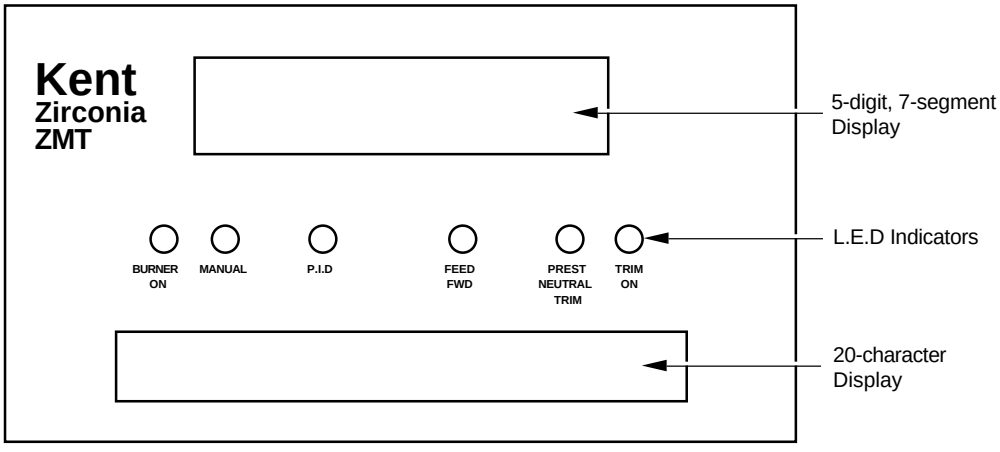


Fig. 7.2 Displays and L.E.D. Indicators

8 INITIAL START-UP

As detailed in Section 8 of Operating Instructions ZMT/0011.

9 SIMPLE FAULT FINDING

As detailed in Section 9 of Operating Instructions ZMT/0011.

10 PROGRAMMING GENERAL

The overall programming chart is shown in Fig. 10.1. The **User Pages** associated with trim control are highlighted. Programming procedures for these pages are detailed in Section 11.

Fig. 11.1 gives a summary of the new **User Pages** and an additional parameter in the **Carbon Dioxide/Carbon Monoxide Page**. For programming details and summaries of all other programming pages refer to Section 11, and Figs. 11 and 16 on pages 13 and 31 respectively, in the Operating Instructions ZMT/0011.

The **Commissioning Page** parameters are programmed prior to despatch and cannot be accessed. For full commissioning procedures refer to:

Standard Z-MT	Commissioning and Calibration manual ZMT/0012.
Trim Control	Section 16 on page 21.

10.1 Access to Secure Parameters

Secure parameters in individual pages can be accessed by operating and holding the 'Raise' switch for approximately 3 seconds, at any non-secure parameter in the page.

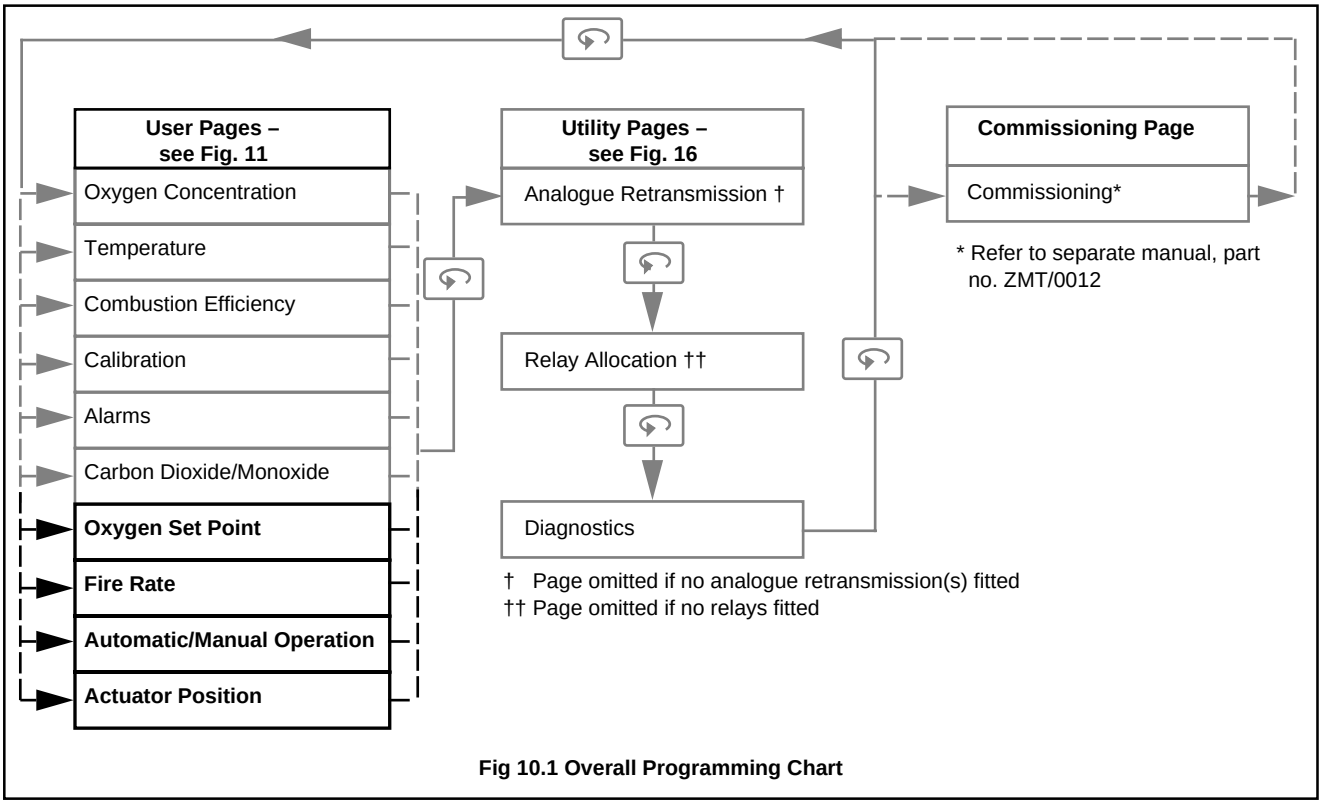


Fig 10.1 Overall Programming Chart

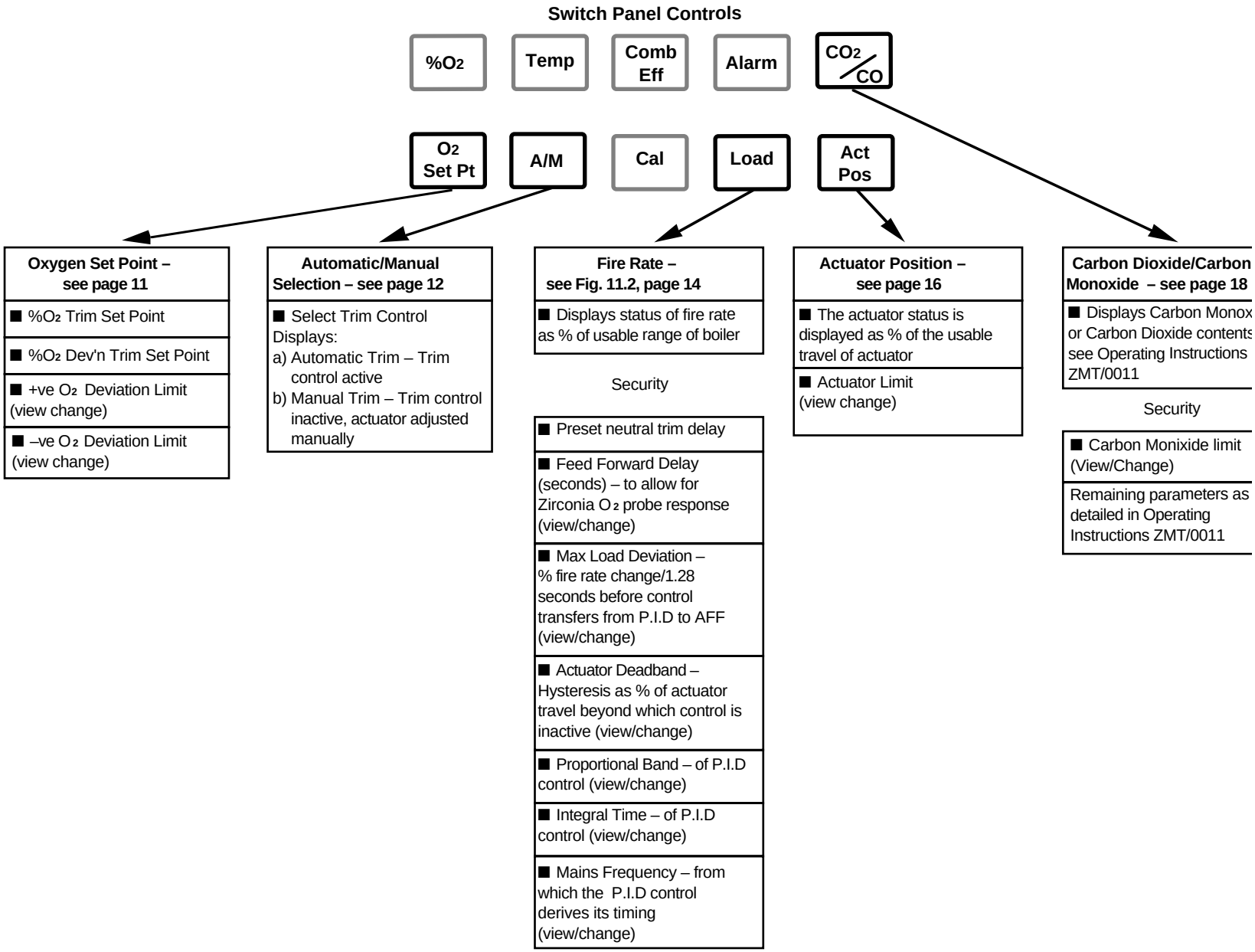


Fig. 11.1 Summary of Additional User Pages and Parameters

11 PROGRAMMING – USER PAGES

As detailed in Section 11 of Operating Instructions ZMT/0011 with the following additions.

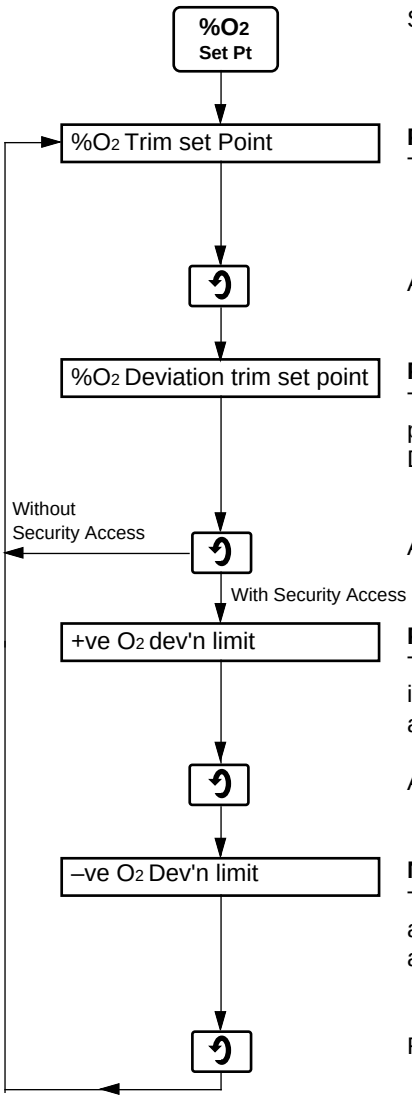
The majority of User parameters associated with trim control are located in four new programming pages:

Oxygen Set Point Page	–	see Section 11.1
Automatic/Manual Operation Selection Page	–	see Section 11.2
Fire Rate page	–	see Section 11.3
Actuator Position page	–	see Section 11.4

One additional parameter (**Setting Carbon Monoxide Limit**) has been added to the **Carbon Dioxide/Carbon Monoxide** page – see Section 11.5

11.1 Oxygen Set Point Page

The optimum percentage oxygen value (set point) corresponding to the particular fire rate, is calculated from the stored percentage oxygen/fire rate curve.



Select the **Oxygen Set Point Page**

Percentage Oxygen Trim Set Point
The optimum percentage oxygen value (set point) is shown on the upper display.

Advance to next parameter.

Percentage Deviation Trim Set Point
The deviation in percentage oxygen (as measured by the Zirconia probe) from the percentage oxygen set point is shown on the upper display.
Deviations above set point are positive; deviations below set point are negative.

Advance to next parameter.

Positive Percentage Oxygen Deviation From Set Point Limit
This is the maximum positive deviation from set point allowed before the trim actuator is moved to the preset neutral trim position (variable between 0% and 10% of actuator travel range)

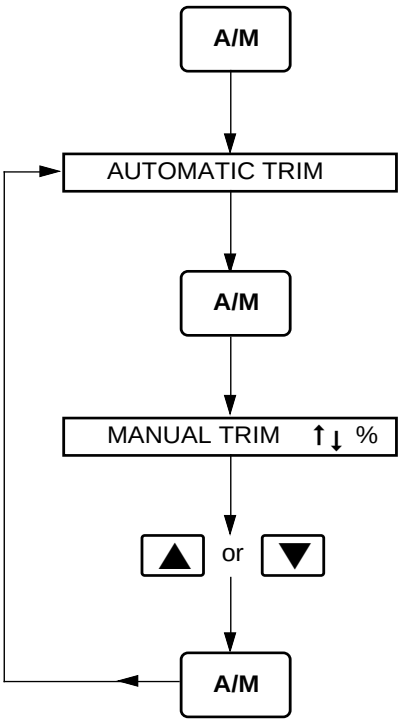
Advance to next parameter.

Negative Percentage Oxygen Deviation From Set Point Limit
This is the maximum negative deviation from set point allowed before the trim actuator is moved to the preset neutral trim position (variable between 0% and –5% of actuator travel range)

Return to top of **Oxygen Set Point Page**.

11.2 Automatic/Manual Operation Selection Page

The trim status (Automatic or Manual) is selected and displayed in this page. Operation of the A/M switch toggles between Automatic and Manual modes. The default control mode on power-up is automatic.



Operate to select the **Automatic/Manual Operation Selection Page**. 'AUTOMATIC TRIM' is displayed.

Automatic Control Mode Selected
The actuator position (%) is shown in the upper display.

Operate to change to Manual trim control.

Manual Control Mode Selected

Adjust the actuator position as required.
The actuator position (%) is shown in the upper display.

Operate to change to Automatic trim control.

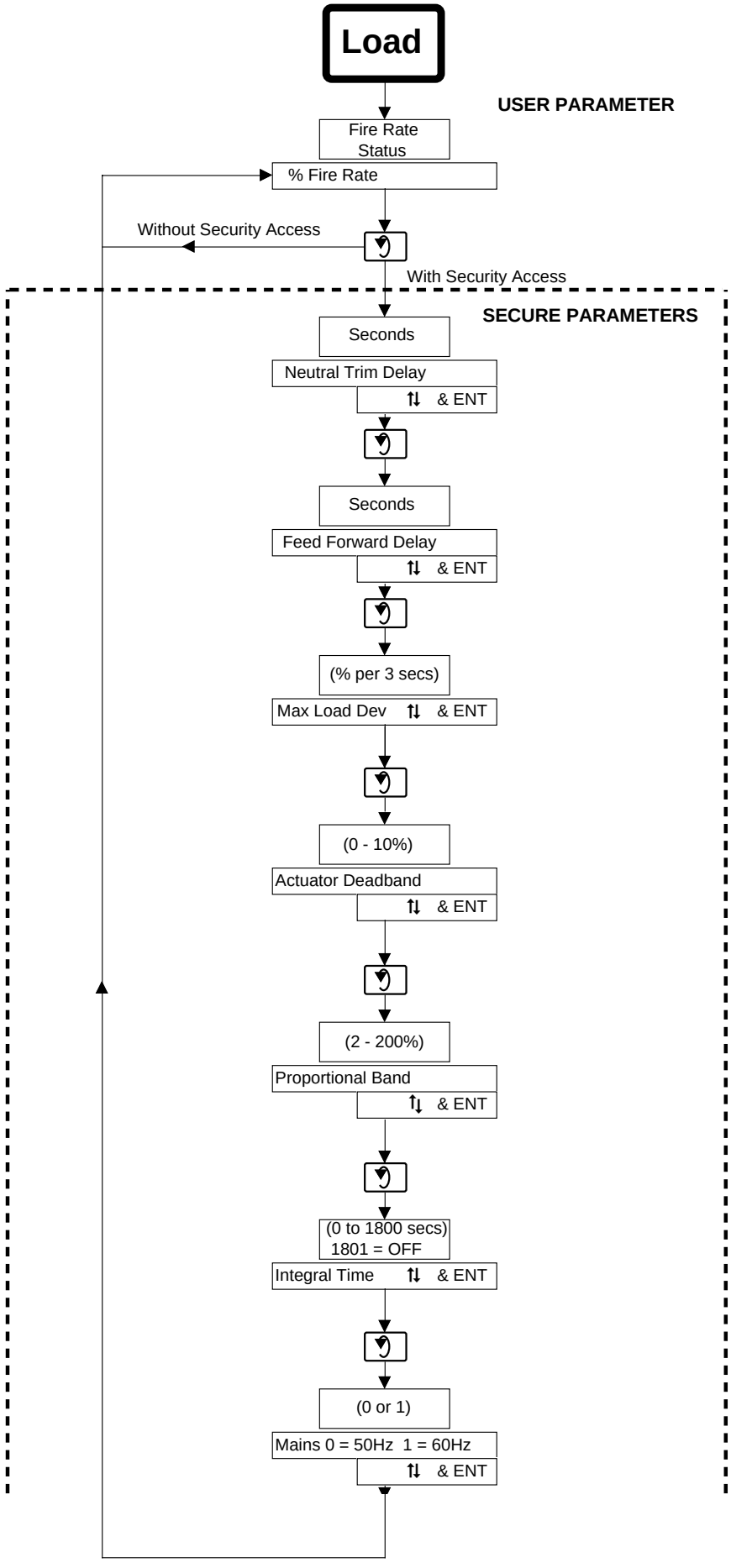
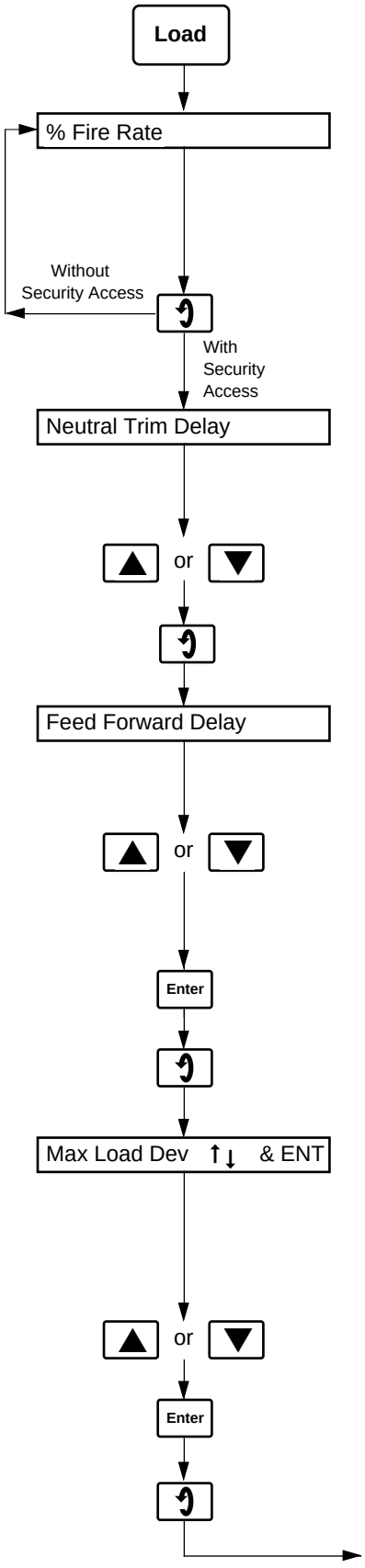


Fig. 11.2 Fire Rate Page Programme Chart

11.3 Fire Rate Page
Refer to Fig 11.2 when carrying out the following procedures.

Note. The **USER PARAMETERS** in this page can only be viewed. To change any parameter, the **SECURE PARAMETERS** must be accessed – see Section 10.1 on page 9.



Select **Fire Rate Page**.

USER PARAMETEI

Percentage Fire R
In this parameter the status of the fire rate is displayed as a percentage of the usable range of the boiler load.
The fire rate is derived from a sensor on the boiler load index or from a parameter directly determined from it. The fire rate is defined as linear with available signal (resistance or current).

Advance to next parameter (with security access).

SECURE PARAMETE

Neutral Trim Time De
If an alarm which moves the trim actuator to neutral trim is detected, the actuator stays in neutral trim for the time set at this parameter.

Set the delay, between 0.1 and 409.5 seconds in 0.1 second increments.

Advance to next parameter.

Feed Forward Time De
This is the delay in seconds (to allow for the probe response time) before transfer from Adaptive Feedforward Mode (AFF) to PI mode. The delay time is shown in the upper display.

Set the delay, between 0.1 and 409.5 seconds in 0.1 second increments.

For Kent-Taylor Zirconia probes a reasonable starting point is 60 seconds.

Store.

Advance to next parameter.

Maximum Load Deviat
The maximum allowable change of fire rate is 1.28 seconds and is shown in the upper display. This is the rate beyond which the control transfers from PI mode to adaptive feedforward mode. The limit is determined by the response time of the Zirconia oxygen probe and is the rate beyond which the probe cannot give reliable tracking of the percentage oxygen content of the flue gas.

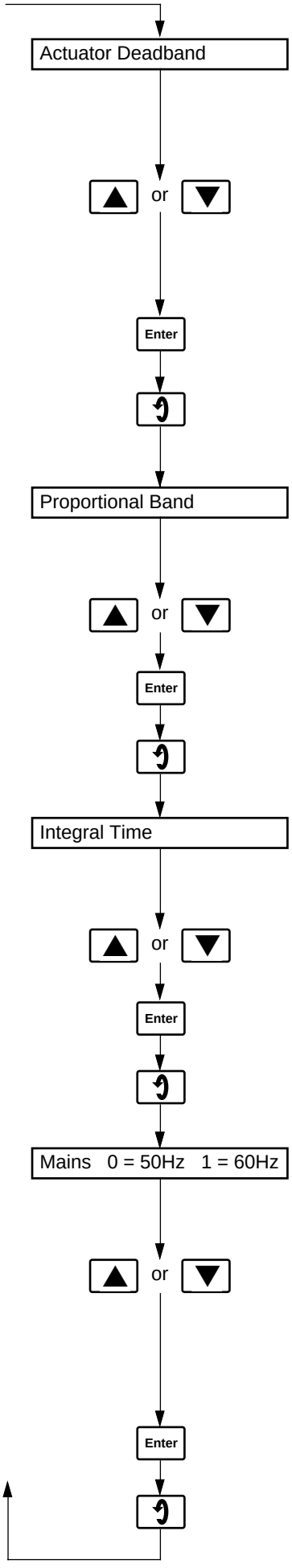
Set maximum load deviation limits.

Store.

Advance to next parameter.

Continued on next page.

Continued on next page.



Actuator Deadba
This is a hysteresis value in terms of percentage travel of the actuator, over which the trim control is not active. The value is shown in the upper display.
This deadband setting prevents instability and hunting of the control.

Set the actuator deadband value, between 0 and 10%.

The optimum value depends upon the boiler design and, for a new installation, should be determined experimentally with a starting value of approximately 5%.

Store.

Advance to next parameter.

Proportional Ba
The proportional parameter of the PI control is shown in the upper display.

Set the proportional band value, between 2 and 500%.

Store.

Advance to next parameter.

Integral Tin
The integral time parameter of the PI control is shown in the upper display.

Set the integral time value, between 1 and 1801 seconds. A setting of 1801 disables this parameter.

Store.

Advance to next parameter.

Mains Frequen
The mains frequency, from which the PI control derives its timing is selected at this parameter

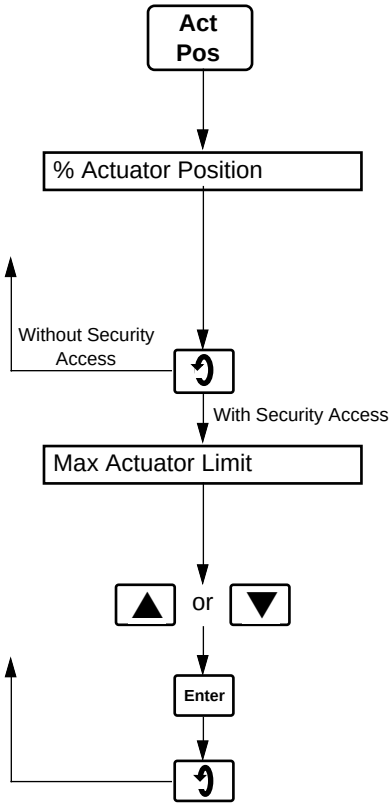
Select the mains frequency code:
'0' – 50Hz
'1' – 60Hz

The selected code is shown in the upper display.

Store.

Return to top of **Fire Rate Pag**

11.4 Actuator Position Page



Select **Actuator Position Page**.

Percentage Actuator Pos
The position of the actuator (as a percentage of the available actuator travel) is shown in the upper display. The reading is taken from a sensor in the actuator (resistance or current inputs permissible). The percentage of range is defined as linear with respect to the sensor signal.

Advance to next parameter.

Actuator Position L
The position limit is the maximum allowable actuator position for a given fire rate (adjustable between 0% and ±50% from mid point of actuator travel range) – see Fig. 11.3.

Set the actuator position limit, between 0 and 50%.

Store.

Return to top of **Actuator Position Pa**

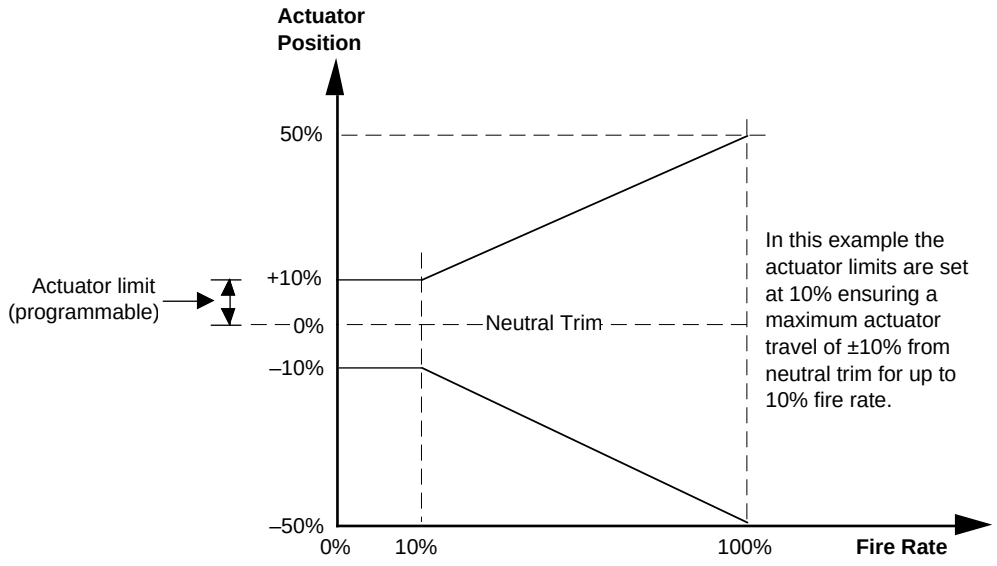


Fig. 11.3 Actuator Position Limits

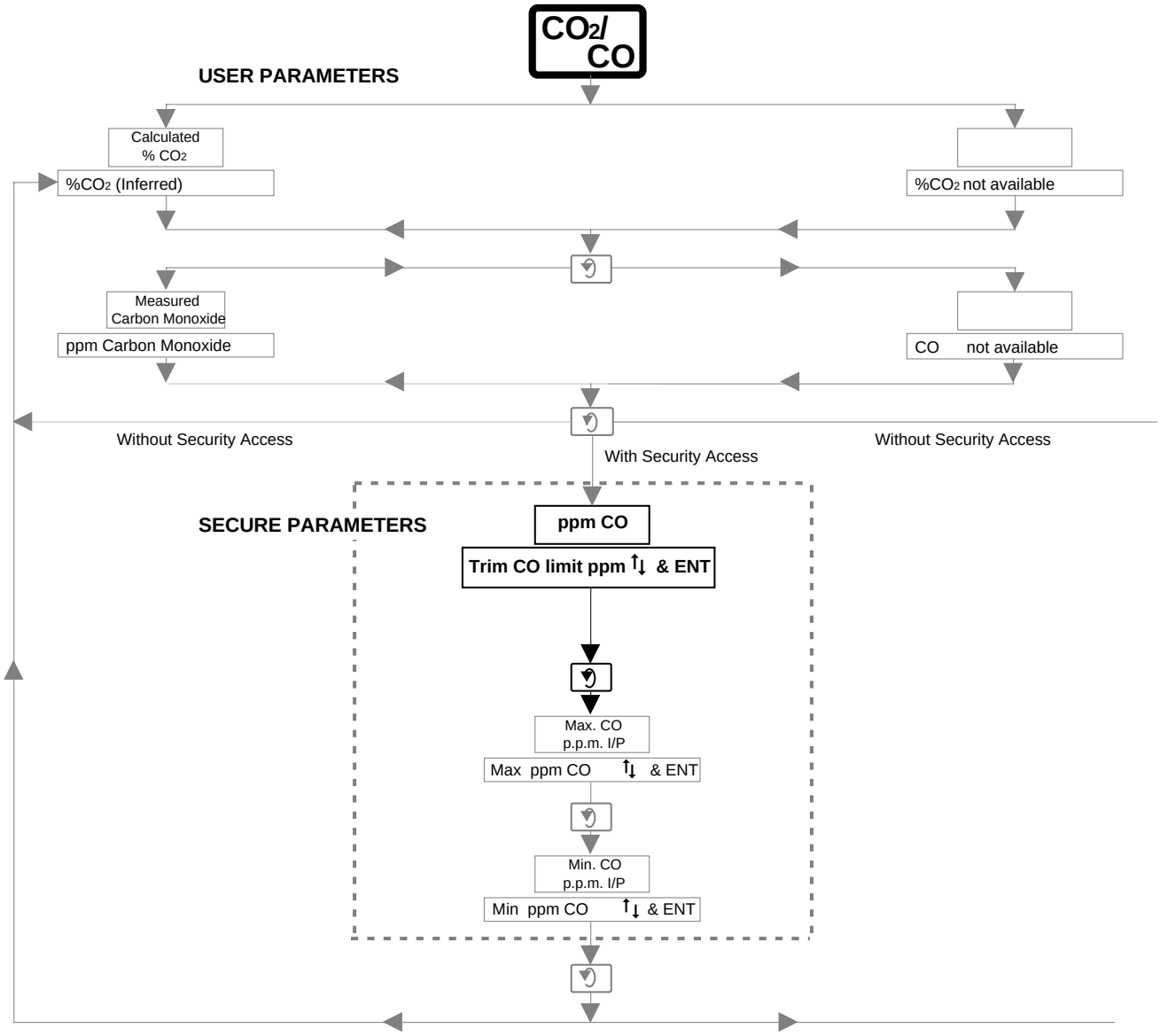
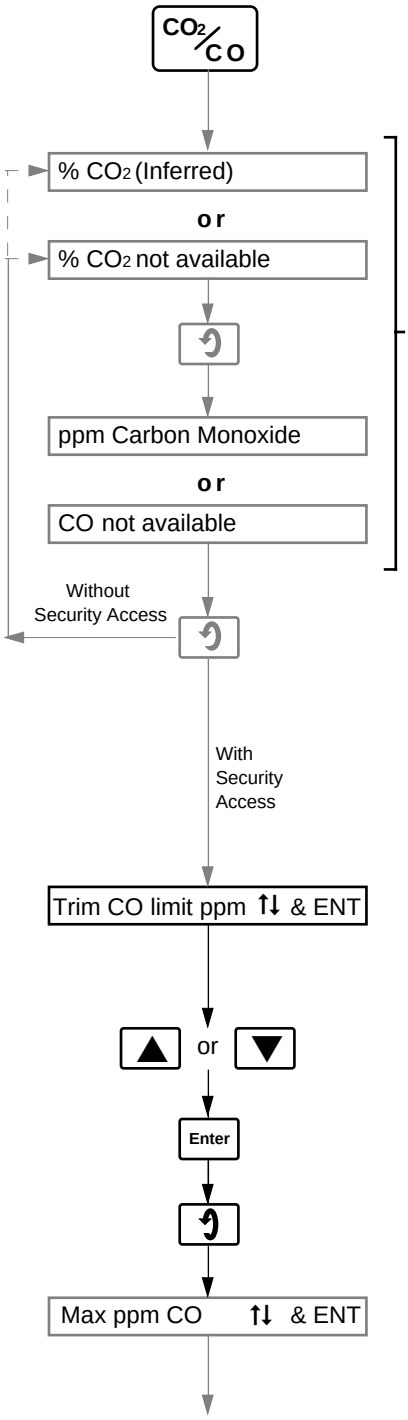


Fig. 11.4 Carbon Dioxide/Carbon Monoxide Page Programme Chart

11.5 Carbon Dioxide/Carbon Monoxide Page

For installations with a carbon monoxide monitor linked into the ZMT unit it is possible to set a limit on ppm carbon monoxide, above which the Trim Control automatically disengages. The actuator moves to the neutral trim position (mid-point of travel) and control transfers to the manual mode. The new parameter **ppm Carbon Monoxide Upper Lim** is shown highlighted below and in Fig. 11.4, previous page – refer also to Section 11.6.2. All other parameters are as detailed in Section 11.7 of Operating instructions ZMT/0011.



Select **Carbon Dioxide/Carbon Monoxide Page**.

USER PARAMETER

The User Parameters are as detailed in Section 11.7 of Operating Instructions ZMT/0011.

Return to top of **Carbon Dioxide/Carbon Monoxide Page** (without security access),

or

Advance to next parameter (with security access).

SECURE PARAMETE

ppm Carbon Monoxide Upper
The ppm carbon monoxide trip limit is shown in the upper display.

Set the ppm carbon monoxide limit.

Store.

Advance to next parameter.

Details of the remaining secure parameters are as shown in Section 11.7 of Operating Instructions ZMT/0011.

11.6 Alarms/Fault Conditions/Out of Limit Situations

If the unit is unable to apply reliable control to the air-fuel ratio due to lack of correct input data or abnormal operation of the burner, the Z-MT 's reaction is dependent on the nature of the alarm. These fall into two categories:

'soft disengage alarms' – see Section 11.6.1
'hard disengage alarms' – see Section 11.6.2.

In the event of an alarm the relevant alarm message is shown in the 20-character display on the Z-MT front panel – see Fig. 7.2 on page 8.

11.6.1 Soft Disengage Alarms

A 'soft disengage alarm' indicates a temporary minor fault condition. If a 'soft disengage' fault is detected the Z-MT overrides, but does not disengage, the automatic trim control and drives the trim actuator to the preset neutral trim position (i.e. mid travel position, set up during commissioning) making the burner safe.

There are five 'soft disengage alarms':

	Alarm Message	Cause
a)	cell warm up	the cell is warming up
b)	cell stabilising	the cell is stabilising
c)	burner off	the burner is off
d)	max act limit	the actuator is out of limits
e)	max oxygen limit	the oxygen is out of limits.

11.6.2 Hard Disengage Alarms

A 'hard disengage alarm' indicates a major fault condition. If a 'hard disengage' fault is detected the Z-MT disengages the automatic trim control and applies a 24V a.c. drive signal to the trim actuator driving it to a safe neutral position.

Automatic trim control re-engages when the fault and alarm conditions are cleared.

There are three 'hard disengage alarms':

	Alarm Message	Cause
a)	cell under temp	cell under temperature.
b)	broken cell T/C	broken cell thermocouple.
c)	excess CO	carbon monoxide over limit.

11.6.3 L.E.D. Indications

The six l.e.d. indicators on the front panel indicate the trim control state.

BURNER ON – illuminated when burner is on and extinguished when burner is off

MANUAL – illuminated when in manual mode and extinguished in automatic mode

P.I.D, **FEED FWD** and **PRSET NEUTRAL TRIM** – the l.e.d. illuminated indicates the auto control mode type. Only one of these l.e.d.s can be illuminated at any one time. In manual mode all three l.e.d.s are extinguished

TRIM ON – illuminated when automatic/manual trim is engaged. When a hard disengage alarm is detected automatic/manual trim is disengaged and the l.e.d is extinguished.

12 PROGRAMMING — UTILITY PAGES

As detailed in Section 12 of Operating Instructions ZMT/0011.

13 PROBE CALIBRATION

As detailed in Section 13 of Operating Instructions ZMT/0011.

14 IDENTIFICATION

See overleaf.

15 SPECIFICATION

As detailed under **SPECIFICATION** in Operating Instructions ZMT/0011.

14 IDENTIFICATION

Basic Type Number	Probe Type	Reference Air Supply	Probe Temerature Control	Fuel Option (See Note 1)		Efficiency	Trim Control	Output Module 1	Output Module 2	Output Module 3	Mains Voltage
Digits 1,2,3/	4	5	6/	7,8,9,10		11	12	13/	14	15	16
ZMT Micro-processor based Oxygen analyser	1 ZGP2	0 None 1 Pump + Air Gauge 4 Regulator	0 None	1st 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17	2nd 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17	0 None	0 None	0 None 4 Analogue + Relay	0 None 1 One Relay 4 Analogue + Relay	0 None 1 One Relay 2 Two Relays 5 Serial Output	1 110V 50/60 Hz 2 230V 50/60 Hz
	2 ZFG or ZFG2	0 None 3 Pump (Z-FG) 4 Regulator (Z-FG)	1 Temp. Control			1 Efficiency	0 None	0 None 4 Analogue + Relay	0 None 1 One Relay 4 Analogue + Relay	0 None 1 One Relay 2 Two Relays 4 Analogue + Relay 5 Serial Output	
	3 Other	0 None 1 Pump + Air Gauge 2 Regulator (Z-FG) 3 Pump (Z-FG) 4 Regulator	0 None 1 Temp. Control			1 Efficiency	2 Relay Trim	0 None 4 Analogue + Relay (Note 2)	2 Two trim relays	0 None 1 One Relay 2 Two Relays 4 Analogue + Relay 5 Serial Output	
						1 Efficiency	1 Ana-logue Trim	0 None 4 Analogue + Relay (Note 3)	0 None 1 One Relay 4 Analogue + Relay	0 None 1 One Relay 2 Two Relays 4 Analogue + Relay 5 Serial Output	

Notes

1. Fuel options available:

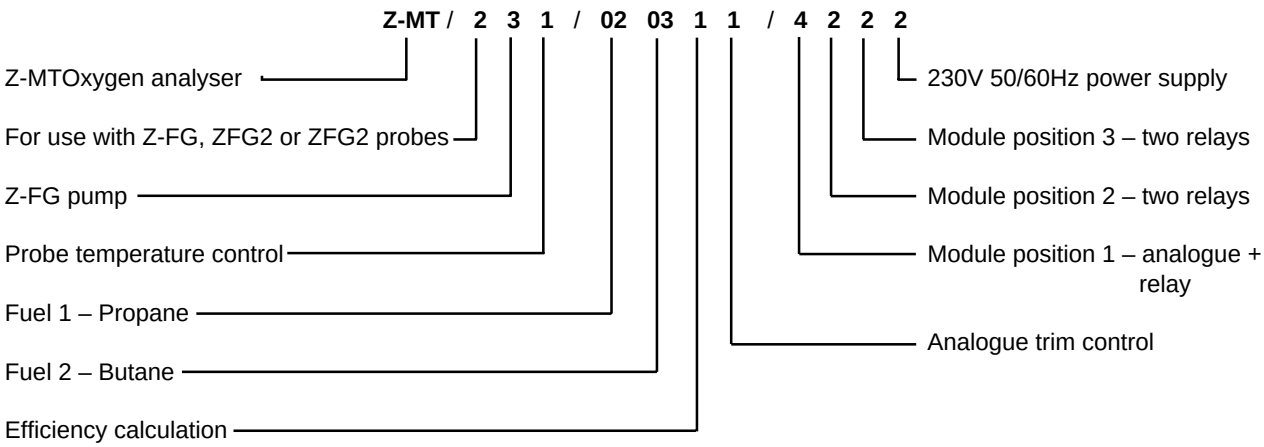
00 No fuel specification	05 Heavy oil	10 No. 4 Oil	15 Steam coal
01 Natural gas	06 General fuel oil	11 No. 5 Fuel oil	16 Anthracite
02 Propane	07 Naptha	12 No. 6 Fuel oil	17 Coke
03 Butane	08 Kerosene	13 Coal (general)	For non-standard fuels
04 Medium oil	09 Distillate oil	14 Bituminous coal	contact the company.

2. This relay is dedicated to trim hard disengage.

3. This relay and analogue retransmission are both dedicated to trim retransmission and trim hard disengage.

Table 15.1 Identification of Instrument Code Number

14.1 Code Number Example



16 COMMISSIONING AND ELECTRICAL CALIBRATION PROCEDURES

16.1 Introduction

The commissioning and calibration procedures detailed in this manual relate to the Trim Control features only and are additional to those contained in the Commissioning and Calibration Procedures ZMT/0012.

16.2 Preparation

Before attempting to commission the Z-MT Trim Controller with the burner, the Z-MTunit must be set-up and calibrated with its Zirconia oxygen probe – see Operating Instructions ZMT/0011.

Check the installation to ensure that the sensors and actuator have been correctly installed and wired to the Z-MTunit and that mechanical linkages are connected and move freely.

During the Trim/Burner commissioning procedures the Z-MTunit is programmed with the following parameters:

a) Electrical calibration of Fire Rate and Actuator Position inputs against input signals.

b) The % oxygen/Fire Rate profiles within the automatic Trim Control range — see Fig. 16.1.

Before the commissioning procedures can commence, the internal security switch must be set to enable access to the commissioning parameters.

16.3 Access to the Commissioning and Calibration Parameters – Fig. 16.2

The Commissioning and Calibration Parameters are enabled/ disabled by a pair of rocker switches located on the main processor board. For access to the switches:

1 Unlock and open the door.

2 Identify the switches.

3 Set **both** switches to the required position.

N.B. Ensure that the switches are **disabled** after any commissioning or calibration checks/changes to prevent any tampering with the settings.

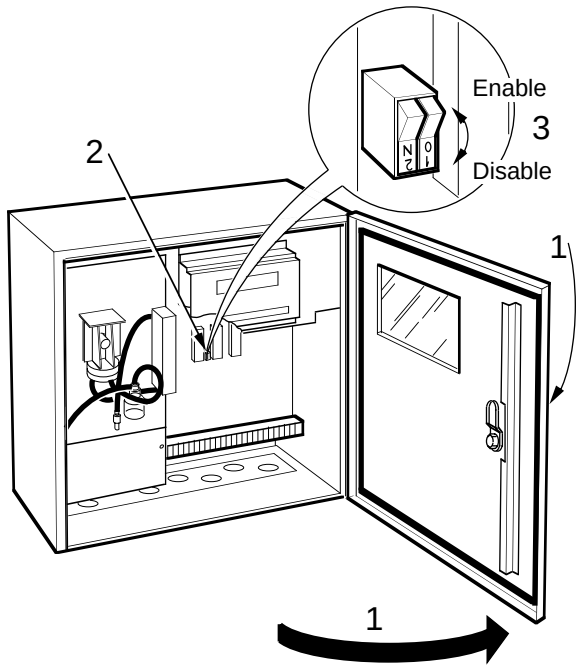


Fig. 16.2 Access to Commissioning Page and Calibration Parameters

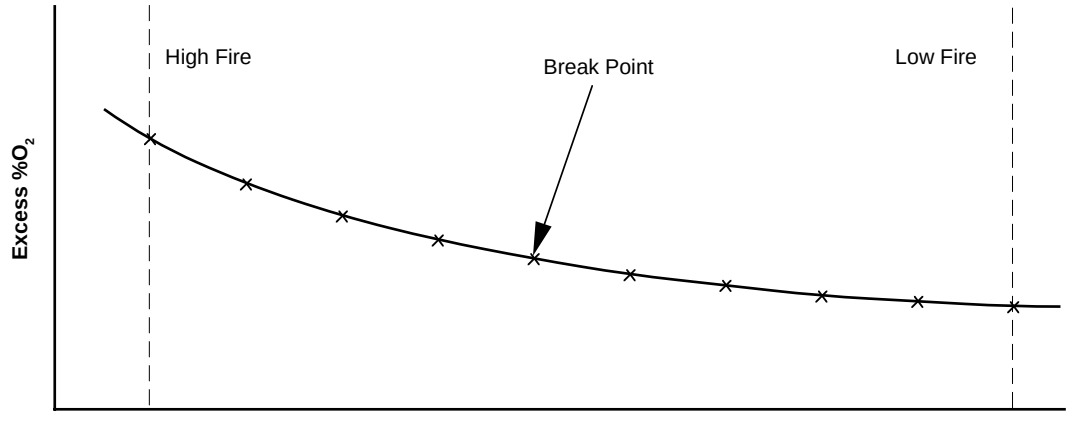


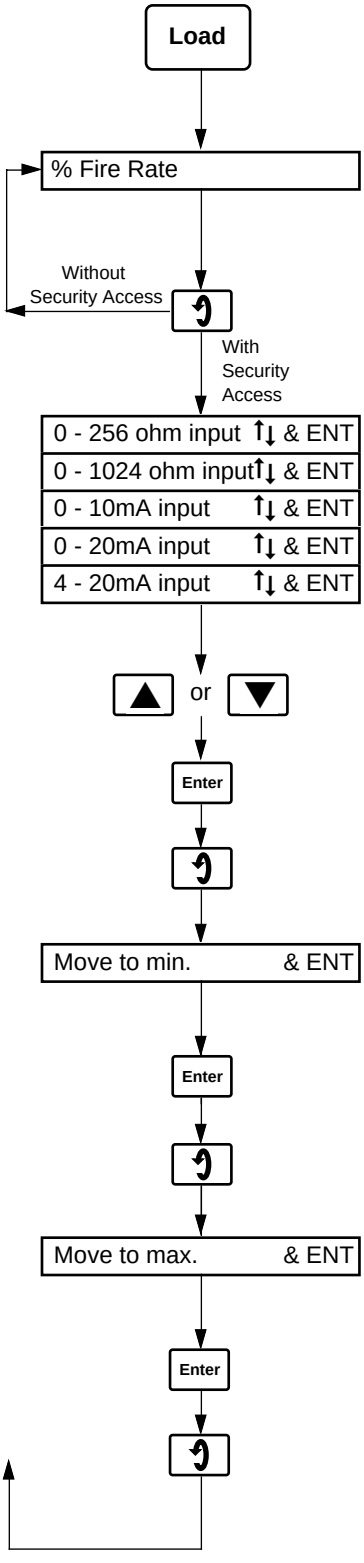
Fig.16.1 % Oxygen/Fire Rate Profiles within Automatic Trim Control Range

16.4 Electrical Calibration

Before attempting to programme control curves into the Z-MT memory, the Burner Load (Fire Rate) and Actuator Position inputs must be calibrated. The inputs accept resistance slide-wire or current signals. Select 'Manual' mode using the A/M switch. Set the security switches to enable access to the commissioning and calibration parameters – see Section 16.3.

16.4.1 Fire Rate Actuator Position Inputs

Note The **USER PARAMETERS** in this page can only be viewed. To change any parameter, the **SECURE PARAMETERS** must be accessed – see Section 10.1 on page 9.



Select **Fire Rate Page**.

USER PARAMETE

Percentage Fire R
The status of the Fire Rate is displayed as a percentage of the usable range of the boiler load.

Advance to next parameter (with security access).

SECURE PARAMETE

Input Type and Ra

Select the input type and range most appropriate to the available input signal format.

Store.

Advance to next parameter.

Move to Minimum (Fire F
Move the Fire Rate sensor to minimum – refer to the boiler manual.

Store.

Advance to next parameter.

Move to Maximum (Fire F
Move the Fire Rate sensor to maximum – refer to the boiler manual.

Store.

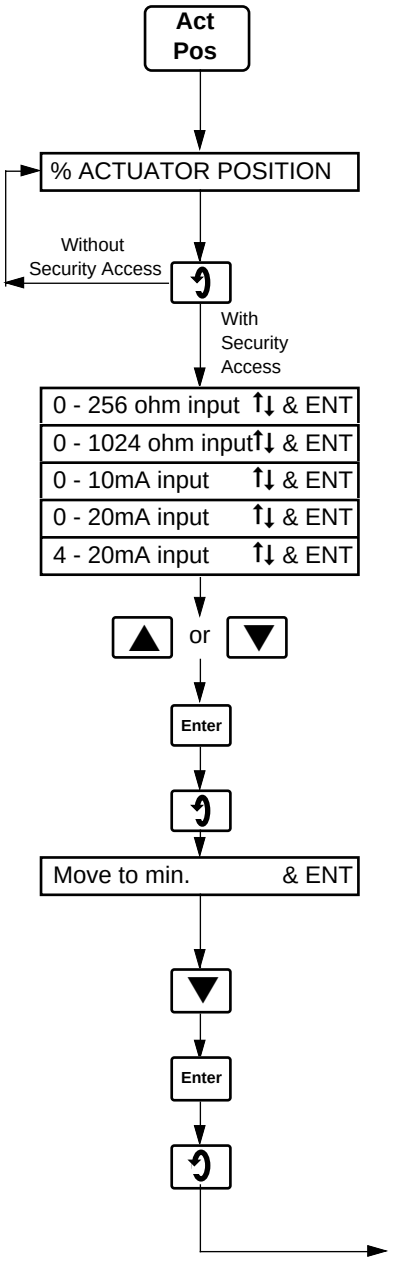
Advance to next parameter.

Return to top of **Fire Rate Pag**

Note The display of percentage fire rate (0 to 100%) is now scaled linearly with respect to the two input signal levels programmed above.

16.4.2 Actuator Position In

The **USER PARAMETERS** in this page can only be viewed. To change any parameter, the **SECURE PARAMETERS** must be accessed – see Section 10.1 on page 9.



Select **Actuator Position** page.

USER PARAMETEI

Percentage Actuator Pos
The Actuator Position status is displayed as a percentage of the actuator's available travel.

Advance to next parameter (with security access).

SECURE PARAMETE

Input Type and Rai

Select the input type and range most appropriate to the available input signal format.

Store.

Advance to next parameter.

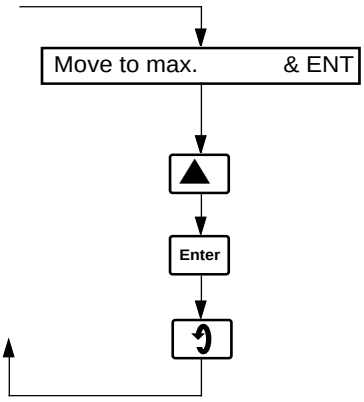
Move to Minimum (Actuator Pos

Operate and hold the 'Lower' switch until the actuator is at its minimum position.

Store.

Advance to next parameter.

Continues on next page.



Continued from previous page.

Move to Maximum (Actuator Pos

Operate and hold the 'Raise' switch until the actuator is at its maximum allowable position.

Store.

Advance to next parameter.

Return to top of **Actuator Position P**

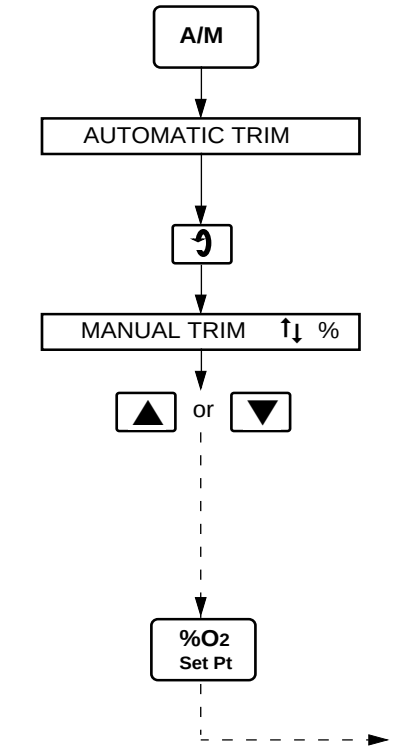
The ZMT unit is now electrically calibrated for its input signals. The boiler may now be fired and the 'Trim Control' curves programmed into memory – see Section 16.5.

Note. The ZMT unit defines 'neutral trim' as the position at which the actuator sensor gives a signal output midway between the minimum and maximum limits programmed above.

16.5 Commissioning The Trim Controller

16.5.1 Programming The Trim Control Curves

The following procedures assume that the percentage oxygen v's fire rate for the burner is known.



Select the **Automatic/Manual Operation Selector** page. 'AUTOMATIC TRIM' is displayed when the trim control is active, i.e. in automatic mode. When Automatic trim control is disengaged 'MANUAL TRIM' is displayed.

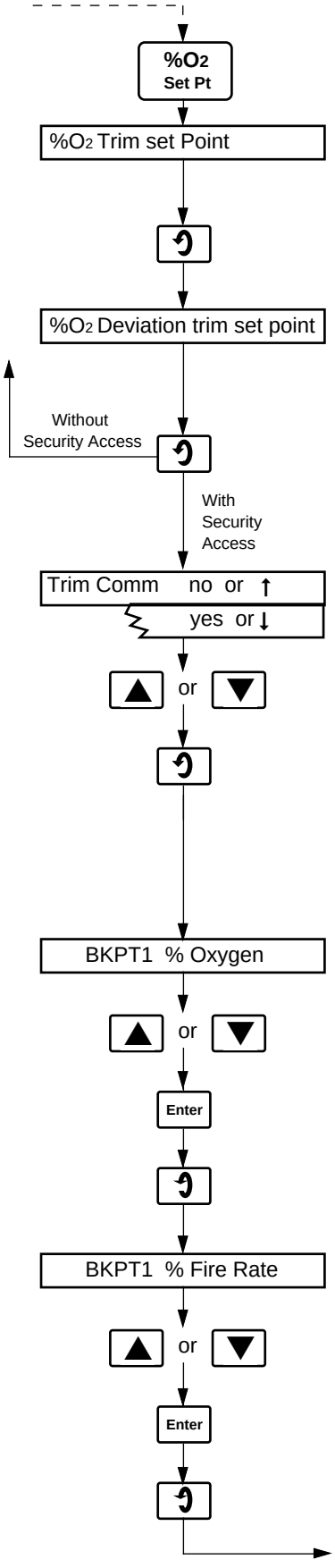
Automatic/ Trim Control

Press to select Manual trim control.

Manual Trim Cont

Set the upper display to read '0'.

Proceed to **Oxygen Set Point Page**, opposite.



Continued from opposite page.

Select the **Oxygen Set Point page**

Percentage Oxygen Trim Set Point
The optimum percentage oxygen value (set point) is shown on the upper display.

Advance to next parameter.

Percentage Deviation Trim Set Point
The deviation in percentage oxygen (as measured by the Zirconia probe) from the percentage oxygen set point is shown on the upper display.

Advance to next parameter.

Trim Commissioning Yes or ↓
Trim commissioning is enabled/disabled at this parameter.

Select 'Trim Comm yes or ↓'.

Advance to next parameter.

The programming of the trim curve commences at this point. There are 10 percentage oxygen and percentage fire rate break points to be set. Table 16.1 (page 27) may be used to record % Oxygen and % Fire Rate figures for each fuel and break point.

Percentage Oxygen Break Point 1
The Break Point value is shown in the upper display.

Set the % oxygen for Break Point 1.

Store.

Advance to next parameter.

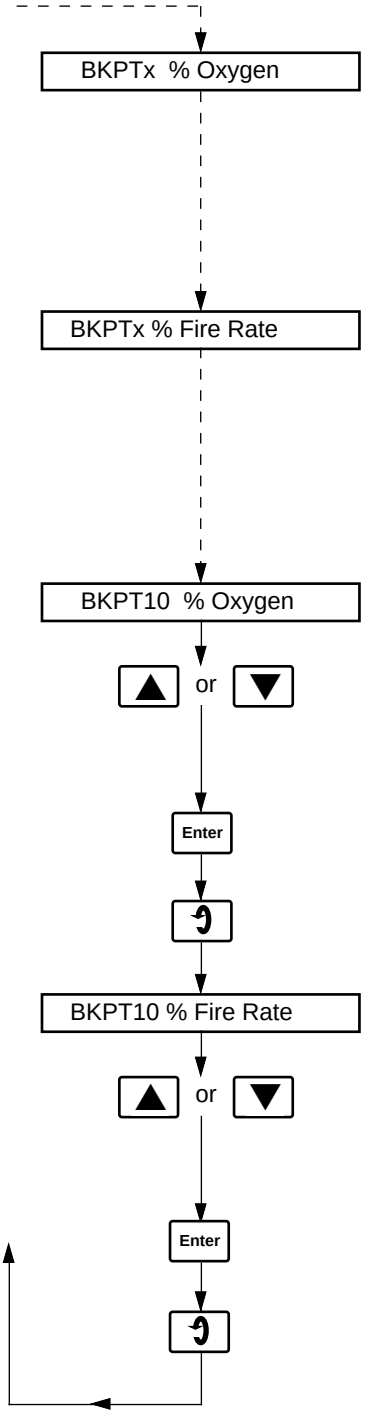
Percentage Fire Rate Break Point 1
The Break Point value is shown in the upper display.

Set the % Fire Rate for Break Point 1.

Store.

Advance to next parameter.

Continued on next page.



Continued from previous page.

Repeat the procedures in **Percentage Oxygen Break Point** and **Percentage Fire Rate Break Point** for **Break Points** 2 to 9.

Set the % oxygen for this Break Point.
This setting must be lower than that set for the previous break point otherwise the upper display flashes and the value set is not accepted.
To stop the upper display flashing set a new acceptable value and operate 'Enter'.

Set the % Fire Rate for this Break Point.
This setting must be higher than that set for the previous break point otherwise the upper display flashes and the value set is not accepted.
To stop the upper display flashing set a new acceptable value and operate 'Enter'.

Percentage Oxygen Break Point
The Break Point value is shown in the upper display.

Set the % oxygen for Break Point 10.
This setting must be lower than that set for break point 9 otherwise the upper display flashes and the value set is not accepted.
To stop the upper display flashing set a new acceptable value and operate 'Enter'.

Store.

Advance to next parameter.

Percentage Fire Rate Break Point
The Break Point value is shown in the upper display.

Set the % Fire Rate for Break Point 10.
This setting must be higher than that set for break point 9 otherwise the upper display flashes and the value set is not accepted.
To stop the upper display flashing set a new acceptable value and operate 'Enter'.

Store.

Return to top of **Oxygen Set Point Page**

Note When all ten Break Points have been set, operating the parameter advance switch automatically stores the neutral trim value (0%) for all actuator positions corresponding to the break points – see Fig. 16.3.

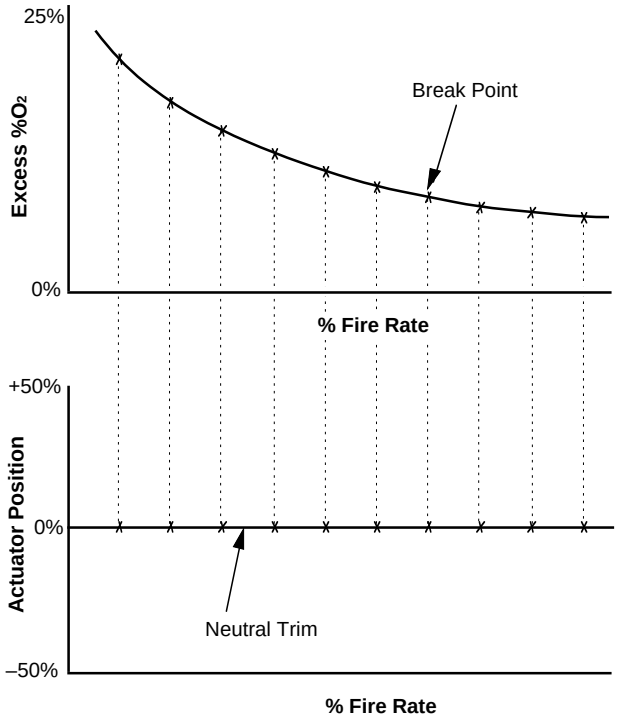


Fig. 16.3 Trim Control Break Points

Table 16.1 may be used to record % Oxygen and % Fire Rate figures for each fuel and break point.

Break Point	Fuel 1		Fuel 2	
	% Oxygen	% Fire Rate	% Oxygen	% Fire Rate
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Table 16.1 % Oxygen/% Fire Rate

APPENDIX A1

A1.1 Mode of Operation – Figs. A1.1 to A1.4

The Z-MT Trim Controller is designed to operate with burners that already have preset air-fuel ratio adjustment, i.e. cam/profile control. In operation, the Trim Controller fine tunes (trims) the air-fuel ratio for optimum efficiency, based upon continuous analysis of the flue gas oxygen content, using an in-situ Zirconia oxygen probe.

When the trim parameters are out of limit, such that the trim control does not function, the unit reverts to the original preset air-fuel ratio as determined by the cam/profile (neutral trim) – see Fig. A1.1.

CAUTION. When installing the Trim Control, all safety features and functions of the original cam/profile must remain connected – the Trim Controller is a fine tuner for the cam/profile, not a substitute.

The Z-FG and ZFG2 Zirconia oxygen probes, although fast in its response, has a finite response time, typically 60 seconds for 95% change at normal flue gas temperatures and flow rates. During slow variations of fire rate, the Zirconia oxygen probe accurately tracks the flue gas oxygen content and full PI control is implemented using an oxygen/fire rate curve held in the Z-MT's memory.

During fast burner modulation, where the burner changes exceed the rate at which the Zirconia oxygen probe can reliably respond, the control automatically transfers to the Adaptive Feed Forward (AFF) mode. In AFF mode the air-fuel ratio is set by the actuator position/fire rate curve (held in the Z-MT's memory), until the burner changes slow down to the point where the Zirconia oxygen probe again accurately tracks the flue gas oxygen content, the control returns to full PI control – see Fig. A1.2.

The Z-MT transfers to AFF control when the fire rate changes by a preset percentage (user adjustable) in 1.28 seconds.

In AFF mode the control actuator moves to its last known correct position for the current fire rate. This position is obtained from the 'Actuator Position/Fire Rate' curves held in memory.

To prevent instability in AFF mode the actuator has a deadband between 1% and 10% of available actuator movement – see Section 11.3.

The AFF 'Actuator Position/Fire Rate' curves are continually updated against the actual actuator position, compensating for bearing and linkage wear, in readiness for the next implementation of AFF mode (see Figs. A1.3 and A1.4) if:

a) the Z-MT is in PI control
b) there are no hard or soft disengage alarms
c) the deviation from oxygen set point is less than 0.2%.

A1.2 Anti-hysteresis – Fig. A1.5

Hysteresis can arise between increasing and decreasing fire rate actuator positions due to wear in linkages and bearings. Two 'Actuator Position/Fire Rate' curves are held in memory for each fuel used; one for increasing rates and the other for decreasing rates. Both are continuously updated by the AFF software – see Fig. A1.5.

A1.3 Manual Mode

When Manual control is selected control of the trim actuator is transferred from PI or AFF control to the 'Raise' and 'Lower' switches. The trim actuator can now be moved manually in the forward or reverse direction. Transfer back to PI control is bumpless.

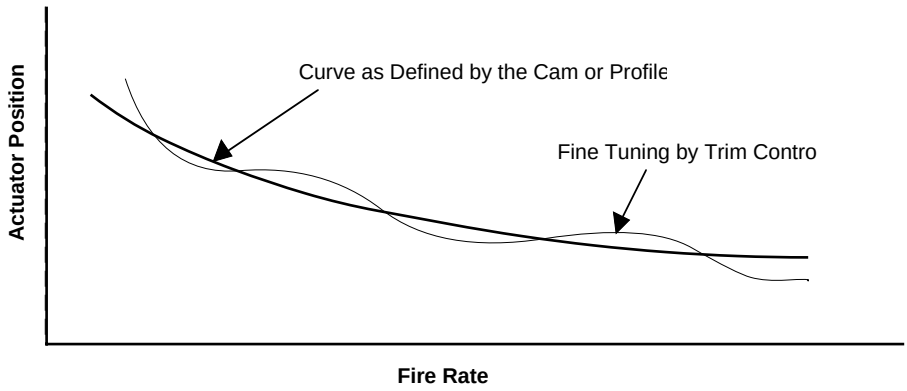


Fig. A1.1 Trim Control – Neutral and Fine Tuning Curves

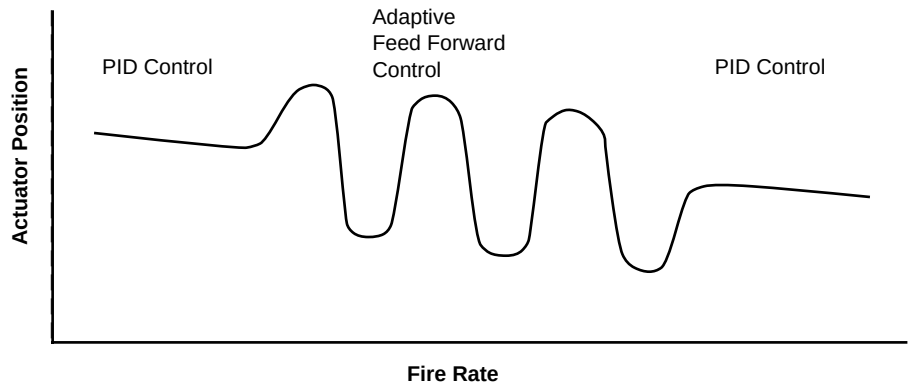


Fig. A1.2 Control Changes (PI – AFF – PI)

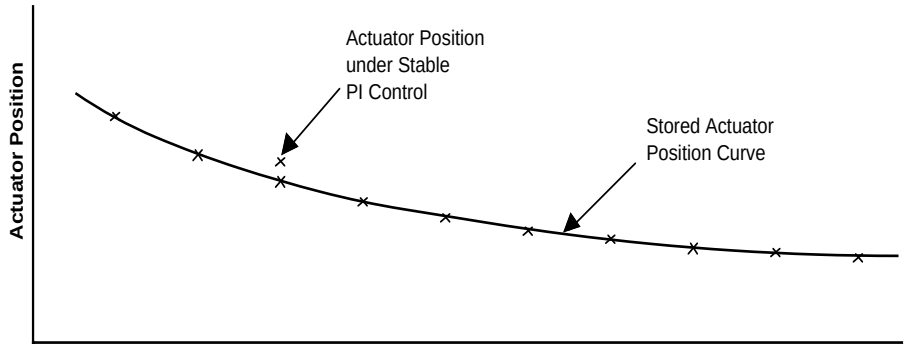


Fig. A1.3 Trim Control Curve Before Correction

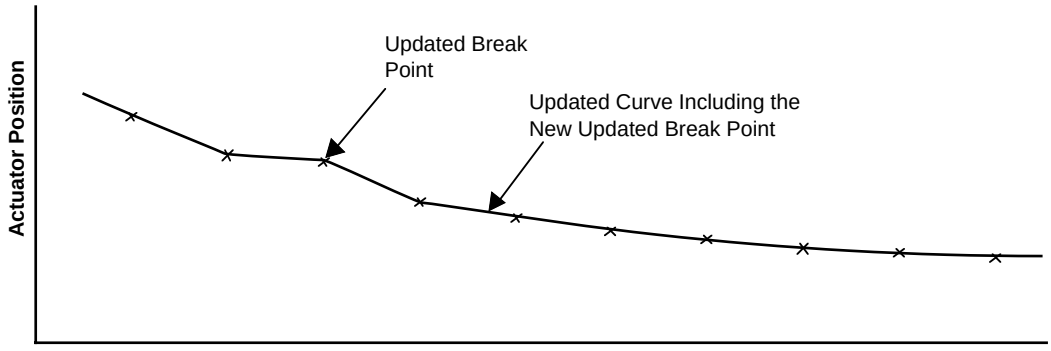


Fig. A1.4 Trim Control Curve After Correction

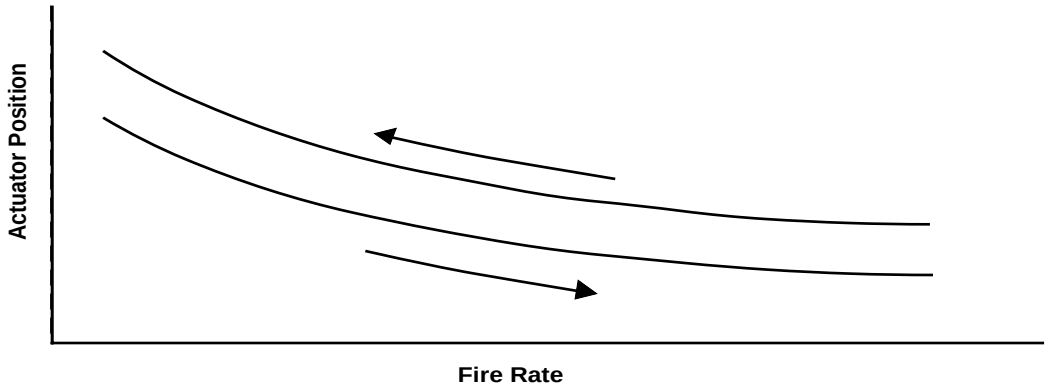


Fig. A1.5 Actuator Position/Fire Rate Curves (for Anti-hysteresis)

A1.4 Alarm Mode of Operation – Fig. A1.6
There are two categories of alarm, soft disengage alarms and hard disengage alarms. The Z-MT reacts differently to each category.

A1.4.1 Soft Disengage Alarms
a) cell warming up
b) cell stabilising
c) burner off
d) actuator out of limits
e) oxygen out of limits

When a soft disengage alarm condition exists the Z-MT moves to preset neutral trim. When the alarm condition ceases to exist the Z-MT remains in preset neutral trim for a preset (user set) time period before returning to P.I.D control – see Fig. A1.6.

A1.4.2 Hard Disengage Alarms
a) cell under temperature
b) broken cell thermocouple
c) carbon monoxide over limit

When a hard disengage alarm condition exists the Z-MT physically disconnects the trim actuator positioner (hard disengage) and sends a 24V a.c. signal to the trim actuator driving it to neutral trim. When the alarm condition ceases to exist the Z-MT remains in neutral trim for a further 60 seconds before returning to P.I.D control – see Fig. A1.6. This occurs in both manual and automatic trim modes.

A1.4.3 Return to PI Control
When the Z-MT is in automatic trim mode and PI control alarm conditions could arise to transfer to feed forward control, preset neutral trim or hard disengage. The route back to P.I.D control is shown in Fig. A1.6.

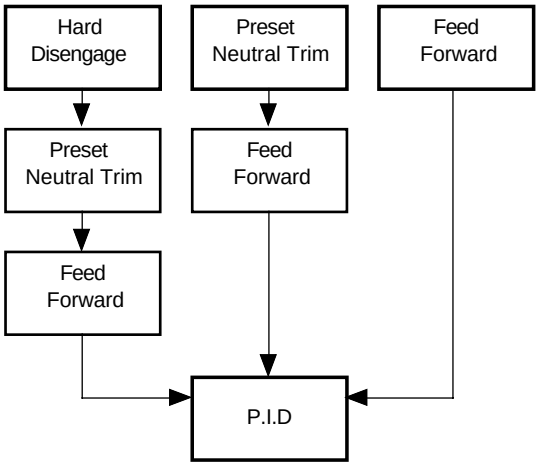


Fig. A1.6 Return to P.I.D Control

A2 Typical Installation Schematic

Fig. A2.1 is the schematic of a typical 'Trim' control installation.

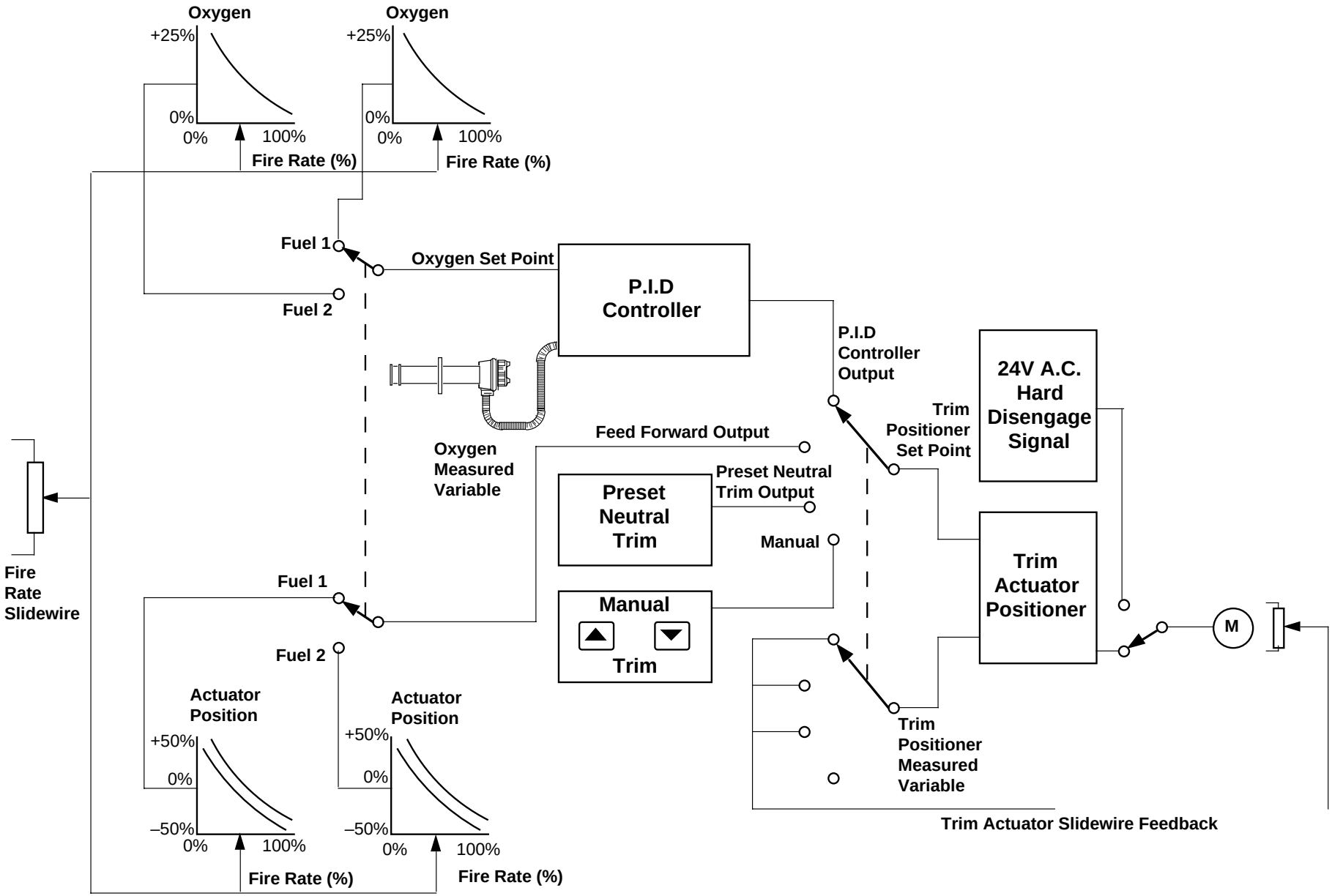


Fig. A2.1 Z-MT Trim Control, Typical Installation Schematic

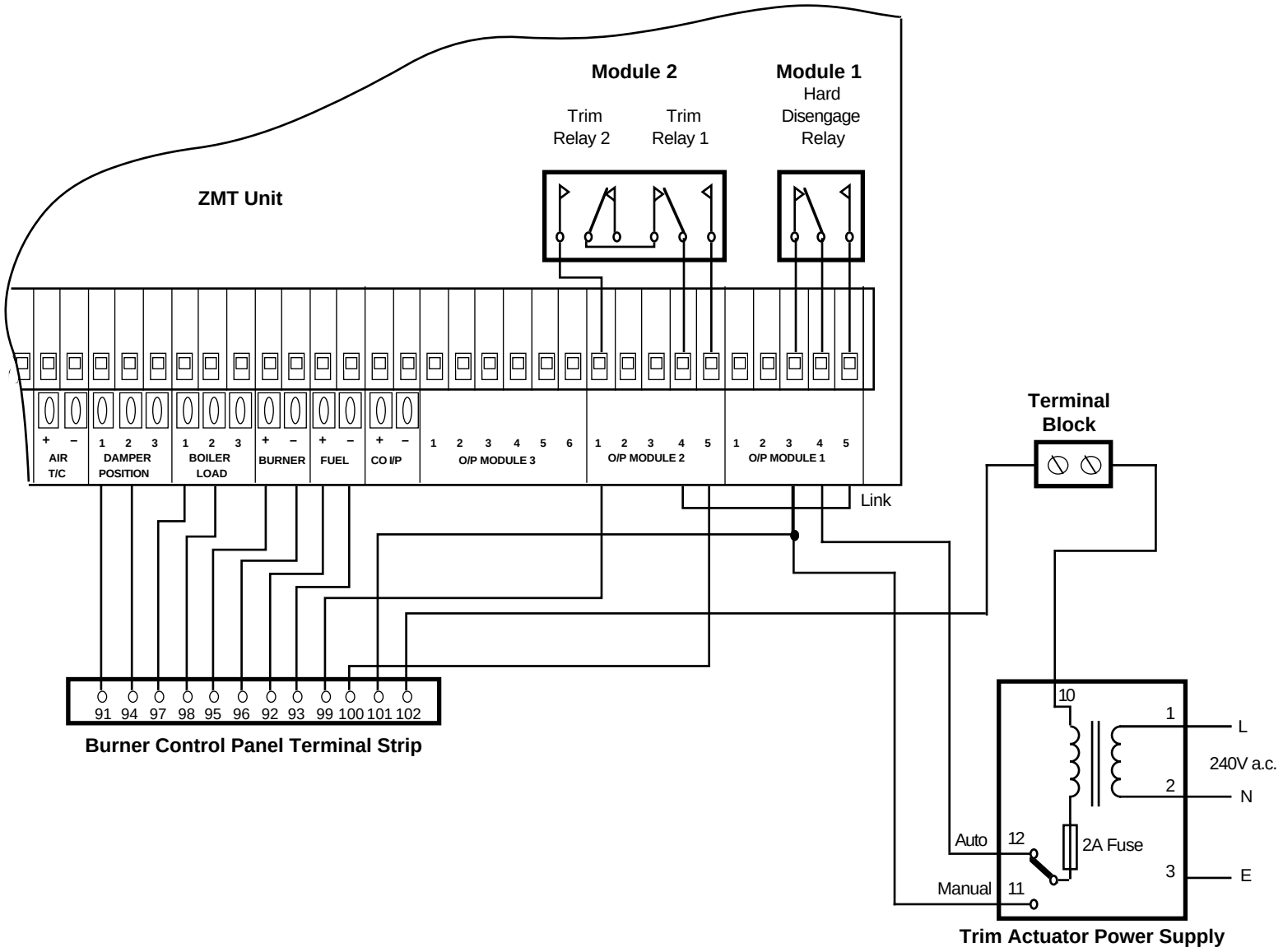


Fig. A3.1 Oxygen Trim Wiring with Saake Servo Motor

Notes.

PRODUCTS & CUSTOMER SUPPORT

A Comprehensive Instrumentation Range

Analytical Instrumentation

- ***Transmitters***
  On-line pH, conductivity, and dissolved oxygen transmitters and associated sensing systems.
- ***Sensors***
  pH, redox, selective ion, conductivity and dissolved oxygen.
- ***Laboratory Instrumentation***
  pH and dissolved oxygen meters and associated sensors.
- ***Water Analyzers***
  For water quality monitoring in environmental, power generation and general industrial applications including: pH, conductivity, ammonia, nitrate, phosphate, silica, sodium, chloride, fluoride, dissolved oxygen and hydrazine.
- ***Gas Analyzers***
  Zirconia, katharometers, hydrogen purity and purge-gas monitors, thermal conductivity.

Controllers & Recorders

- ***Controllers***
  Digital display, electronic, pneumatic. Discrete single-loop and multi-loop controllers which can be linked to a common display station, process computer or personal computer.
- ***Recorders***
  Circular and strip-chart types (single and multi-point) for temperature, pressure, flow and many other process measurements.

Electronic Transmitters

- ***Smart & Analog Transmitters***
  For draft, differential, gauge and absolute pressure measurement. Also, liquid level and temperature
- ***I to P Converters and Field Indicators***

Flow Metering

- ***Magnetic Flowmeters***
  Electromagnetic, insertion type probes and water meters.
- ***Turbine Flowmeters***
- ***Wedge Flow Elements***
- ***Mass Flow Meters***
  Transmitters, sensors, controllers and batch/display units.

Level Control

- ***Submersible, Capacitance & Conductivity.***

Pneumatic Instrumentation

- ***Transmitters***
- ***Indicating Controllers***
- ***Recording Controllers***

Customer Support

ABB Kent-Taylor provides a comprehensive after sales service via a Worldwide Service Organization. Contact one of the following offices for details on your nearest Service and Repair Centre.

United Kingdom

ABB Kent-Taylor Limited
Tel: +44 (0)1480 475321
Fax: +44 (0)1480 470787

United States of America

ABB Instrumentation Inc.
Tel: +1 716 2926050
Fax: +1 716 2736207

Italy

ABB Kent-Taylor SpA
Tel: +39 (0) 344 58111
Fax: +39 (0) 344 56278

Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification. Periodic checks must be made on the equipment's condition.

In the event of a failure under warranty, the following documentation must be provided as substantiation:

1. A listing evidencing process operation and alarm logs at time of failure.
2. Copies of operating and maintenance records relating to the alleged faulty unit.

The Company's policy is one of continuous product improvement and the right is reserved to modify the information contained herein without notice.

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