

Section 4: I.B.S. Intelligent Boiler Sequencing

- 4.1 Overview - Features & Benefits of I.B.S. control
- 4.2 Commissioning and Setting Up Procedure
 - 4.2.1 Guide to Commissioning Sequencing
- 4.4 Electrical Schematics Showing all Terminal Interconnections
 - 4.4.1 Sequencing Connection Diagram
 - 4.4.2 DTI/Sequencing Connection Diagram
- 4.5 Other Information and Illustrations.
 - 4.5.1 Sequencing Operation
 - 4.5.2 Sequencing Combinations
 - 4.5.3 Diagram showing Data Transmission/Reception
 - 4.5.4 Mini Mk5 Sequencing Status Information

4.1 INTELLIGENT BOILER SEQUENCING (I.B.S.)

Overview of System Operation: Features and Benefits

The Intelligent Boiler Sequencing software, which is included in every M.M. E.G.A. module, further extends the application possibilities of the system. The objective of this control form is to ensure that the minimum number of boiler/burner units are in operation at any one time to satisfy the heat requirement imposed upon the boiler plant, particularly in the case of multi boiler installations.

There are two variations of I.B.S. software that can be selected by the user via the Options procedure. The first variation relates to heating boilers and the second variation to steam boilers.

Heating Boilers Sequential Control:

A maximum of ten M.M. E.G.A. modules may be interconnected by a two wire screened data cable: (See interconnection drawing). Any string of modules interconnected as detailed can have one of it's number designated No. 1 or lead boiler. This identifying of "lead" boiler is achieved by either of the following methods:

- a) Connecting a mains voltage onto terminal No. 41.
- b) Instructing the modules via the D.T.I. module (Data Transfer Interface) by software.

Once a "lead" boiler has been selected the system works in the following way:

Typically every five minutes the sequencing software in the lead boiler identifies it's own firing rate by looking at the position of the fuel valve in the load index and also the maximum heating capacity of the No 1. "lead" boiler. This information would normally be entered when this boiler/burner unit is commissioned. Having established percentage firing rate, and maximum heating capacity, the I.B.S. software calculates the amount of heat being contributed to the system by this boiler. The I.B.S. software in the "lead" M.M. E.G.A. module then contacts in turn each of the modules connected to this loop and gathers similar information from each. The "lead" module's I.B.S. software then calculates the minimum number of boiler/burner units that need to be operational to satisfy the building load, imposed upon the plant at that time, and switches the remainder off. There is a terminal connection on the M.M. E.G.A. module for controlling a two port valve that would normally be installed in the boiler's return pipe connection to the common return header. This facility ensures that boilers that are switched "off line" do not contribute return temperature water to the flow header thereby diluting the flow temperature to the building: (See relevant data sheets and drawings showing the control sequence detailed above).

Example:

There are four boilers interconnected as above, each with a heating capacity of 586kW (2 Mbtu.) In the event of each boiler firing 440kW (1.5 Mbtu) (3/4 of it's maximum rate), the No. 1 lead boiler would instruct the No. 4 boiler to shut down and boilers No.s 1, 2 and 3 would adjust their firing rate to maximum. In both cases the boilers are contributing 1758kW (6 Mbtu) to the system but, after intervention of the I.B.S. sequencing software, three boilers only are carrying the load which is a more fuel efficient method of operation.

If the building load continued to decrease the three boilers would reach a point where they were each firing 390kW (1.33 Mbtu) each.

IBS Intelligent Boiler Sequencing

At this point the I.B.S. software would switch off the No. 3 boiler as two boilers would be capable of generating the 1172kW (4 Mbtu) required. When the load on the system increases, the reverse procedure applies, i.e. when, for example, two boilers are firing at near 100% load and the setpoint temperature on either of the modules is not being achieved, the I.B.S. software would switch on a third boiler to assist with the generation of the heat requirement. Any boiler can be nominated "lead" boiler by the connection of an input to the appropriate terminal or by a software instruction via the D.T.I.

Steam Boiler Sequential Control:

When the I.B.S. software control package is applied to steam boilers, it's operation is exactly the same as above but with the additional features and enhancements as explained in the following.

In the case of heating boilers only two states in the control form exist, either on or off. When steam boiler variation of I.B.S. is optioned there are three states which are controlled sequentially.

The first is "on-line", this is when the boiler is operating purely under the control of the M.M. E.G.A. module's internal P.I.D. load controller.

The second state is "Standby Warming": In this case the boiler is operated at a reduced pressure setpoint, and runs for a number of minutes each hour: e.g. if the on-line boiler or boilers are set at a setpoint of 7 bar (100 p.s.i.) the standby warming boiler controls at a setpoint of 5 bar (72 p.s.i.). In this way if the load increases the standby warming boiler can begin to contribute steam quickly. The reduced setpoint is a user variable option in the same way as the normal control pressure setpoint. The number of minutes run time is also adjustable.

The third state is "off-line", this is with the burner shut down and the boiler cold. If the load on the boiler house increases, this boiler would move into a "warming" condition.

Apart from the variations detailed above, the steam sequencing works in precisely the same way as the heating boiler sequencing: The sequencing software package ensures that at all times the minimum number of boilers are operational to satisfy the load imposed on the boiler house.


Note:

It should be appreciated that all data and control variables can be shown on a screen via the addition of the D.T.I. module to the data loop. The screen and keyboard can be sited locally in the boiler house or the whole system can be addressed remotely via the normal telecommunications network. In the software in the D.T.I. there is a histogram facility which shows the firing rate and state of each boiler in the boiler house.

4.2.1 GUIDE TO COMMISSIONING SEQUENCING

Before any attempt is made to implement Sequencing operation, it is necessary that the fuel/air positions and load index are already entered. Refer to Sections 2 or 3 for Commissioning fuel/air positions.

The load index is implemented using the same ten point load index entry method used for the Flow Metering as detailed in Sections 2 and 3 of the manual. If the Flow Metering has already been optioned and the ten point load index entered then it is not necessary to enter this again. However if it is not entered, proceed as detailed below.


1. Set Option 57 to Value 1 (Refer to Section 2.2.4 - Setting Options).
2. Press  whilst 57 and 1 are being displayed in the Air and Required windows respectively.
3. Next time the burner starts the M.M. will automatically go into the ten point load index entry mode. The firing range is automatically divided into ten equal parts. Each of the ten divisions from high to low has a fuel flow value in whatever unit of flow measurement the user requires allocated to it. (All extrapolated fuel flow values between the ten points are calculated from a "best fit" mathematical formula).

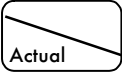
4. In this mode the  window will show fuel value in degrees angular.

The  window will be blank.

The  window and its associated   buttons will be used to enter the fuel flow in the chosen fuel flow unit per minute value.

Note:


- a) The  window confirms to the commissioning engineer which of the 10 points are currently being measured.

When the positioning motors are moving from one calibrated point to another the  display flashes. When it reaches the next point to be calibrated, with a flow value, the display remains steady.

- b) The minimum numerical value for fuel flow that can be entered into memory is 0.01. The maximum numerical value for fuel flow that can be entered into memory is 999.
- c) The values are entered in descending order, i.e. Point No.1 is maximum flame and Point No.10 is at minimum flame.

The 10 sequential points on the load index are allocated automatically by the M.M.

5. When fuel flow has been calculated or read off of a commissioning fuel flow meter the value is entered as detailed in Point No.4.

The  button is then pressed and the flow value is passed into the M.M. memory.

6. The above detailed data entry routine is repeated until all 10 points have flow values allocated to them.
7. When the last (10th) point has been entered the M.M. stops the burner and implements the calculations necessary to enable the Load Index to be actioned. Whilst the calculations are being carried out a rolling decimal point is displayed.
8. If it is not required to subsequently display the Flow Metering values, set Option 57 back to value 0.
9. If implementing "hot water" Sequencing set Options as follows ON EACH M.M.:

Set Option 16 to Value 1 or 3.
Set Option 33 to identification number accordingly.
Set Option 34 to the rating of burner.
Set Option 35 to time between Sequence scans.
ENSURE OPTION 53 IS SET TO 0.

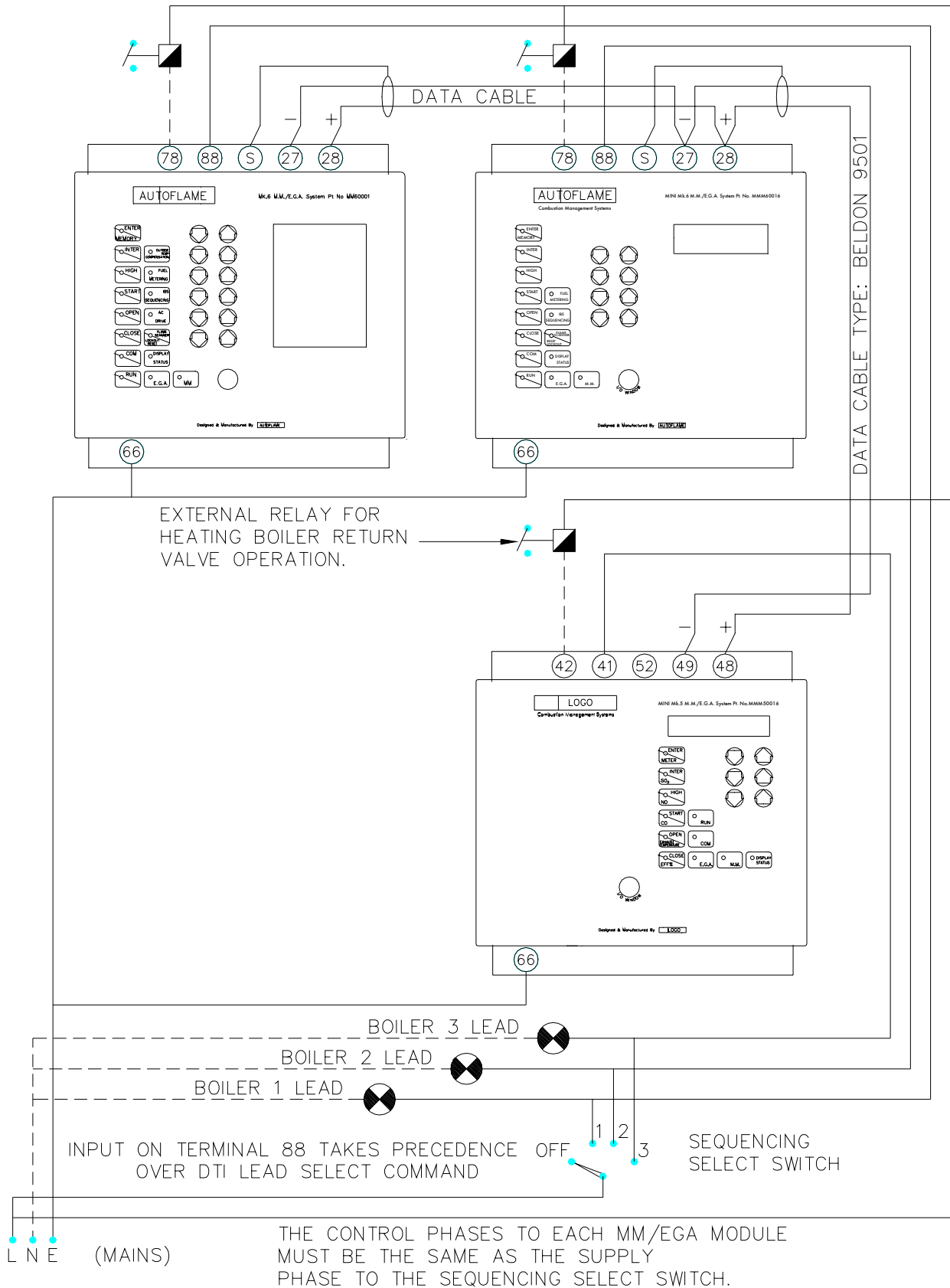
10. If implementing "steam" Sequencing set Options as follows ON EACH M.M.:

Set Option 16 to Value 1 or 3.
Set Option 33 to identification number accordingly.
Set Option 34 to the rating of burner.
Set Option 35 to time between Sequence scans.
Set Option 53 to the time required for the boiler to be off.
Set Option 54 to the time required for the boiler to be on.

Note: Options 53 and 54 are relevant to the "Stand-by Warming" state.
Option 53 is the indication to this M.M. that the Sequencing being done is either hot water or steam (i.e. 0 - Hot water, non zero value - Steam).

4.4 ELECTRICAL SCHEMATICS

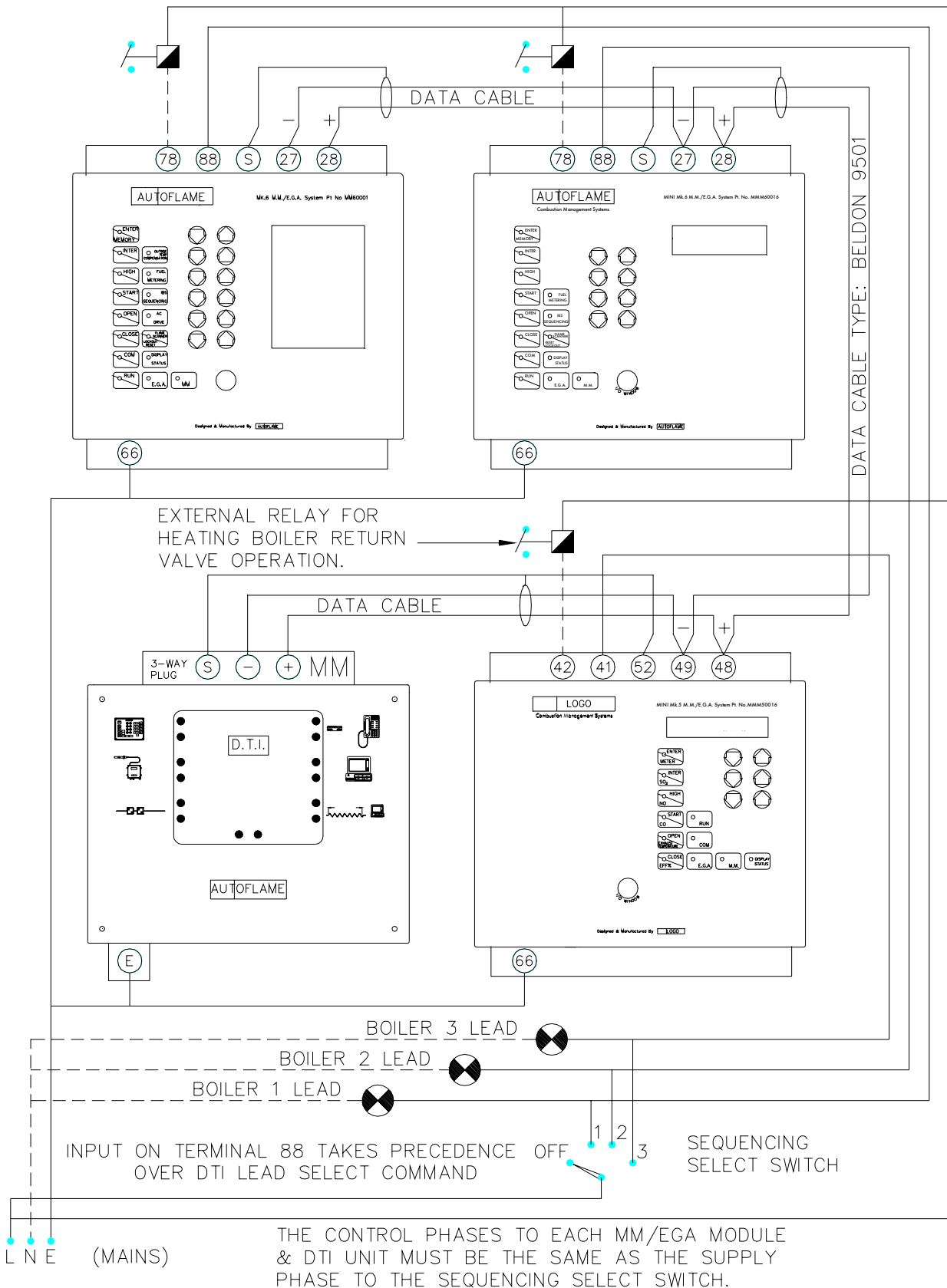
Sequencing Connection Diagram



16:08:00/4263/JCF

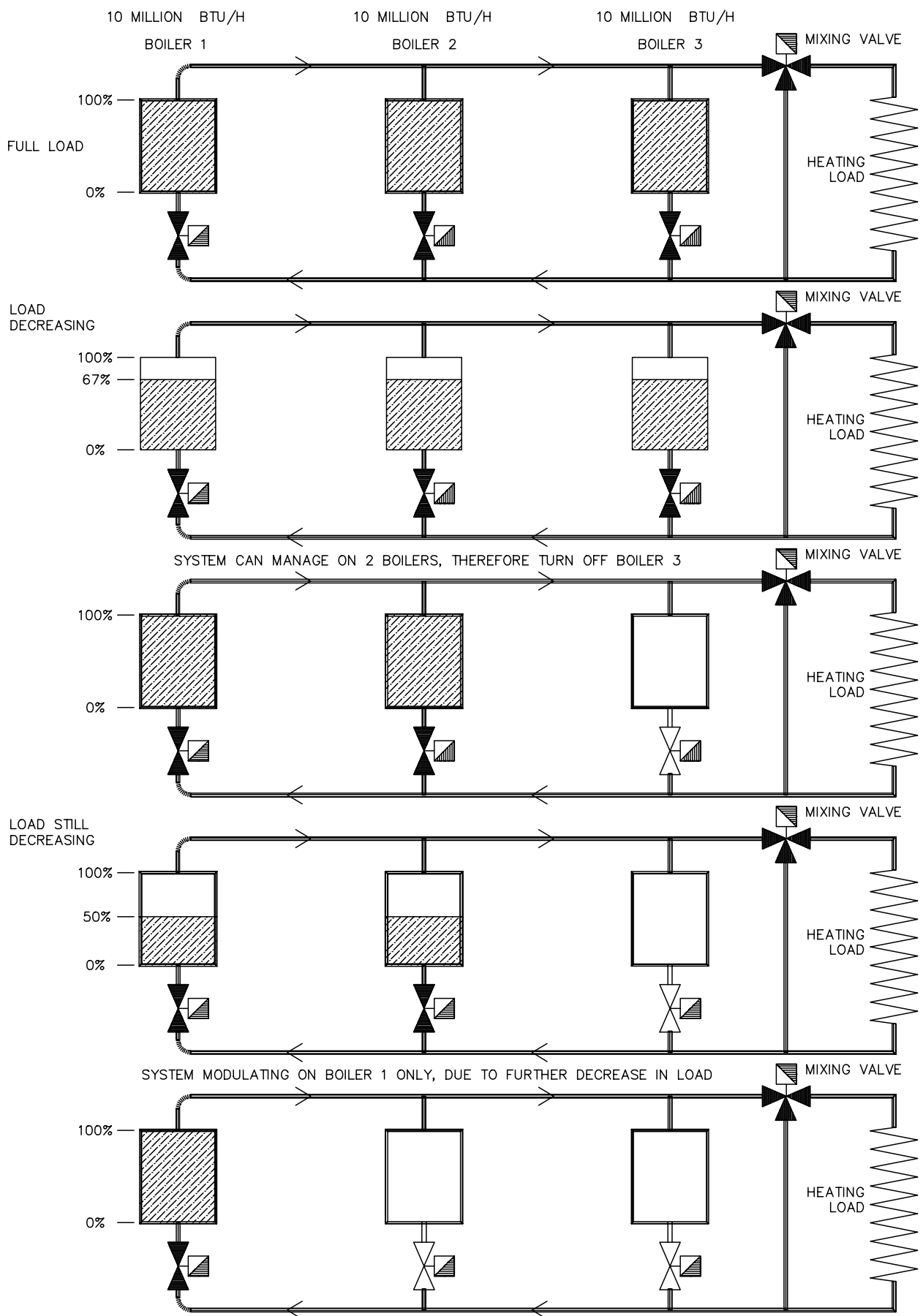
DTI/Sequencing Connection Diagram

If a voltage on terminal 88 is used to select lead boiler, it will take priority over a lead boiler set via the DTI.

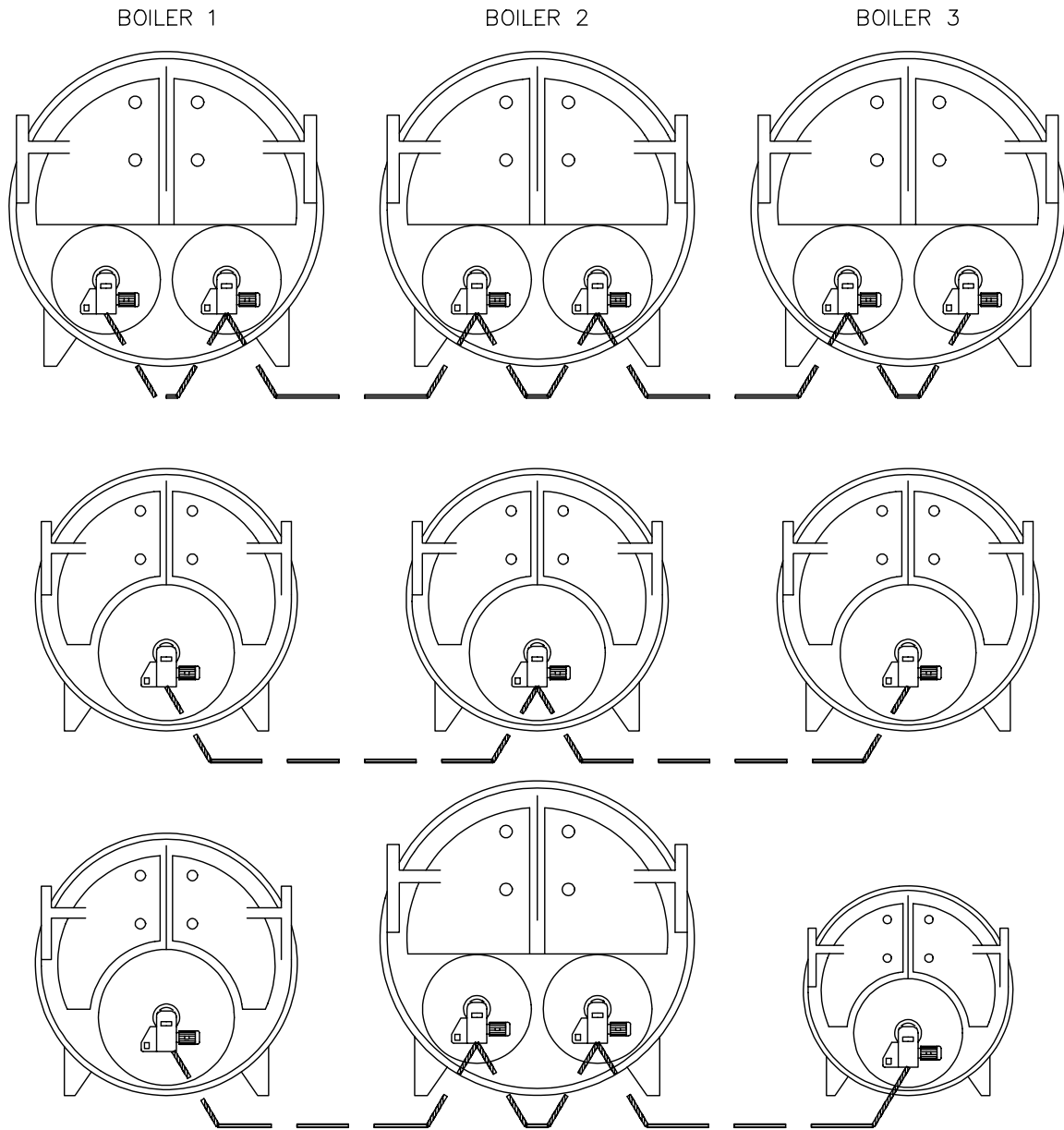


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EXAMPLE WITH 3 BOILERS



REVERSE PROCESS WHEN LOAD INCREASES

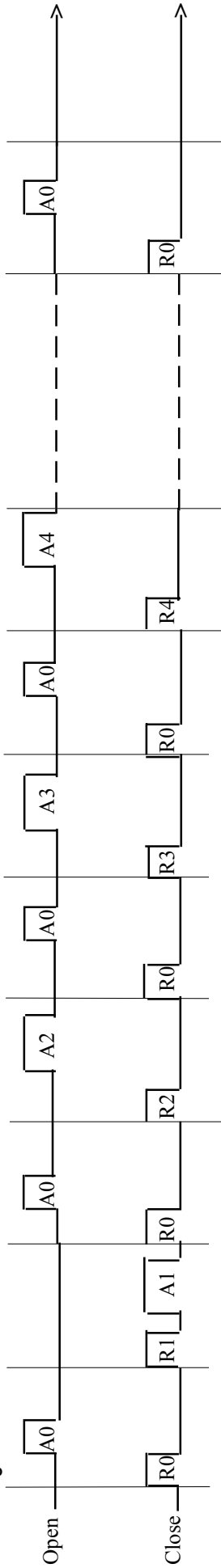


NOTE: TO OPERATE AUTOFLAME SEQUENCING A D.T.I. UNIT IS NOT REQUIRED

5: 5: 88/1319/SBK

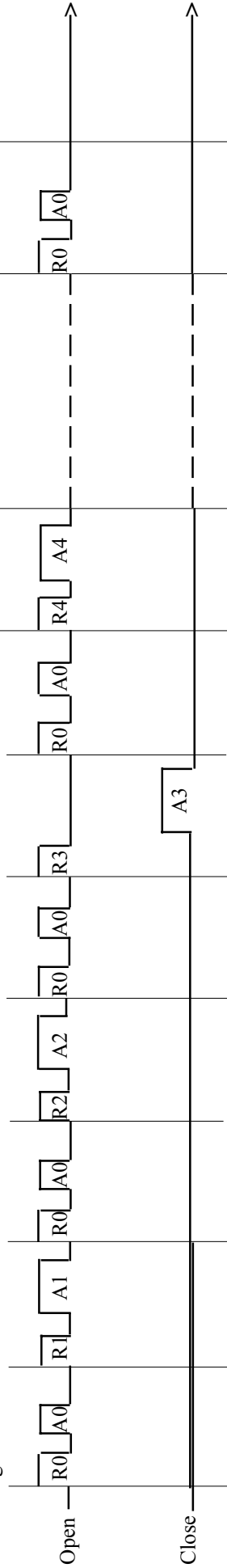
Diagram showing Example of Data Communications with Reference to Flickering L.E.D.s

This is the M.M. that is working communications:
 Eg.: - M.M. No. 1.



Same waveforms apply to M.M. No.s 5 to 10.

This is an M.M. that is not working communications.
 Eg.: M.M. No. 3.

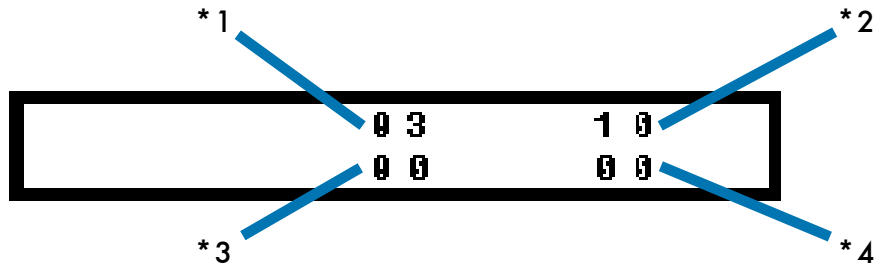


Note:- Only 1 M.M. works the communications.

- R0 - Request to D.T.I.
- R1 - Request to M.M. 1
- R2 - Request to M.M. 2
- R3 - Request to M.M. 3
- R4 - Request to M.M. 4
- R5 - Request to M.M. 5
- R6 - Request to M.M. 6
- R7 - Request to M.M. 7
- R8 - Request to M.M. 8
- R9 - Request to M.M. 9
- R10 - Request to M.M. 10
- A0 - Answer from D.T.I.
- A1 - Answer from M.M. 1
- A2 - Answer from M.M. 2
- A3 - Answer from M.M. 3
- A4 - Answer from M.M. 4
- A5 - Answer from M.M. 5
- A6 - Answer from M.M. 6
- A7 - Answer from M.M. 7
- A8 - Answer from M.M. 8
- A9 - Answer from M.M. 9
- A10 - Answer from M.M. 10

4.5.4 Mini Mk5 Sequencing Status Information

If parameter 32 = 1 then the information below is displayed instead of the Flow Metering Grand Total. (Totalising still continues to work in the background).



Sequencing Status Information

<u>Sequence Code:</u>		<u>Sequence Code:</u>		
<u>Steam</u>		<u>Hot Water</u>		
0	On		On	* 1
1	Standby/Warming		Off	
2	Off		Off	
3	Off		Off	
Receiving Sequencing Information		CR1 Relay Status		* 2
0	= No	0	= Off	
1	= Yes	1	= On	
Unused		Status of Input 41		* 3
		0	= 0V AC	
		1	= 230V AC (110V AC)	
		Disabled Status		
		0	= Enabled	* 4
		1	= Disabled	
Lead Boiler				
0	=	No Lead Boiler Selected		
1 to 10	=	Number of Lead Boiler		