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THE ART OF CONTROLS

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Fx4

ISS.1.08/00
APPLICATION NOTES FOR
A LA CARTÉ
FULL SEQUENCE CONTROL
BOARD

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CONTENTS.

FIGURES AND TABLES.

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1 Introduction.

The Fx4 is a range of electronic ignition full sequence control (FSC) boards designed for combustion appliances. The controls are designed to comply with the European standard for automatic gas burner controls, BS EN 298:1994.

It is exactly what we claim it to be – Ignition Control A La Carte. It embodies the considerable wealth of knowledge of Abbey Electronics in the field of electronic ignition controls and put these at the instant disposal of you, our customer. In essence the Fx4 allows you to specify in minute detail the functionality you expect from the control. These functionalities are then configured into stock units for immediate dispatch.

This means the Fx4 can be configured to be functionally compatible with ANY Ignition Full Sequence Controller on the market. This provides you, our customer with the confidence that the control you need will always be available at the time you want it. It cuts out development cycles and every new functional variant is based on proven and robust hardware.

The Fx4 is packaged in the familiar Abbey Electronics' compact FX series ignition control housing.

1.1 Why Use the Fx4?

Many applications are safety critical and it is undesirable to take the risk of exposing the user to any high voltage. Situations like this include swimming pools where water which is in direct contact with people is being pumped through an appliance. Other applications may be in establishments such as hospitals and old peoples homes. The Fx4 lends itself to use is any such environment by the fact that it can be operated from extremely low voltages as low as 5V dc or ac.

In any case, whether or not there are such safety considerations, the Fx4 offers such sophistication and flexibility in its design that it recommends itself for use in many situations requiring an electronic ignition controller.

Pin Details

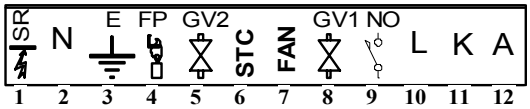

Figure 1 Pinout details for Fx4 (with external LED)

Figure 1 shows the pin out details of the Fx4. This is either a pin header or a 2-part screw terminal block connector. Other connector arrangement options can be provided according to the OEM's requirements. Figure 1 shows the pinout data for a design with Molex pin header which allows for the error LED to be externally connected for appliance panel mounting. The connection is across pins 11 (*Kathode*) and 12 (Anode).

The functions of the pins are self-explanatory but, for the avoidance of any doubt, they will be briefly discussed.

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1.2 Pin1: **SR**, Spark Return.

This is the reference terminal for the ignition spark. The terminal is either connected to pin 3 (earth) for separate ignition and flame sensing electrodes, or to pin 4 (flame probe) for a combined ignition and flame sensing electrode.

1.3 Pin2: **N,** The neutral pin or –ve terminal for a DC supply system.

1.4 Pin3: **E**, Earth terminal to be connected to the appliance earth.

1.5 Pin4: **FP**, Flame probe terminal for flame sensing.

1.6 Pin5: **GV2**, Main burner gas valve.

1.7 Pin6: **ST/CM**.

This pin has a dual function being both the common contact of the air pressure switch and the Start signal for the ignition sequence to begin. Note that only the Common and Normally Open terminals of the air pressure switch are used.

1.8 Pin7: **Fan** or Blower terminal.

1.9 Pin8: **GV1**, Pilot gas valve.
Warning!!! *This output must never be connected to the main valve of a burner. GV2 should be used instead for this purpose*.

1.10 Pin9: **NO**, The normally open contact of the air pressure switch.

Note that only the Common and Normally Open terminals of the air pressure switch are used.

1.11 Pin10: **L**, Live terminal or +ve terminal for a DC supply system.
It is recommended to protect the control with an in-line fuse of a value no greater than T2A.

1.12 Pin11: **K, C**athode terminal for option with external LED.

1.13 Pin12: **A,** Anode terminal for option with external LED.

Nomenclature

The name **FX4** refers to the basic full sequence control board, which can be offered in many configurations. A unique ordering number specified by the OEM fully describes the function of the control as shown in Figure 2.

The basic board is identified by an integral PCB ident which is either *FX42xx* for 230V 50/60Hz version or *FX45xx* for the low voltage version. More specific identification of the respective board is by a sticker carrying strikeout boxes to show which version or configuration of control it is.

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When an OEM specification based on Figure 2 is received this specification is used as the stock description of the control. A unique two-digit identification number is allocated to represent this configuration. The two digits, *nn*, are concatenated with the first four characters of the OEM specification to form a unique stock code **F*x*4*v*nn**.

1.14 Permanent Operation Shut Down (POSD).

To cater for a situation where the Fx4 is required for permanent operation, the control will execute an automatic POSD every 55 minutes and carry out a full diagnostic check of its functionalities even whilst in the standby mode. This takes only about 5s. During this forced shut down, If a demand is on when the control has carry out a POSD, it will shut down the appliance and wait a maximum of 10s for the fan to stop. It will then complete its check and re-establish demand there is still a demand.

Marking

There is a sticker on the box carrying the identity F***x***4*v****nn*** and general specification. Three strikeout boxes are provided on the sticker for specifying ***x*** and ***nn***. Figure 4 shows an example of an identity sticker.

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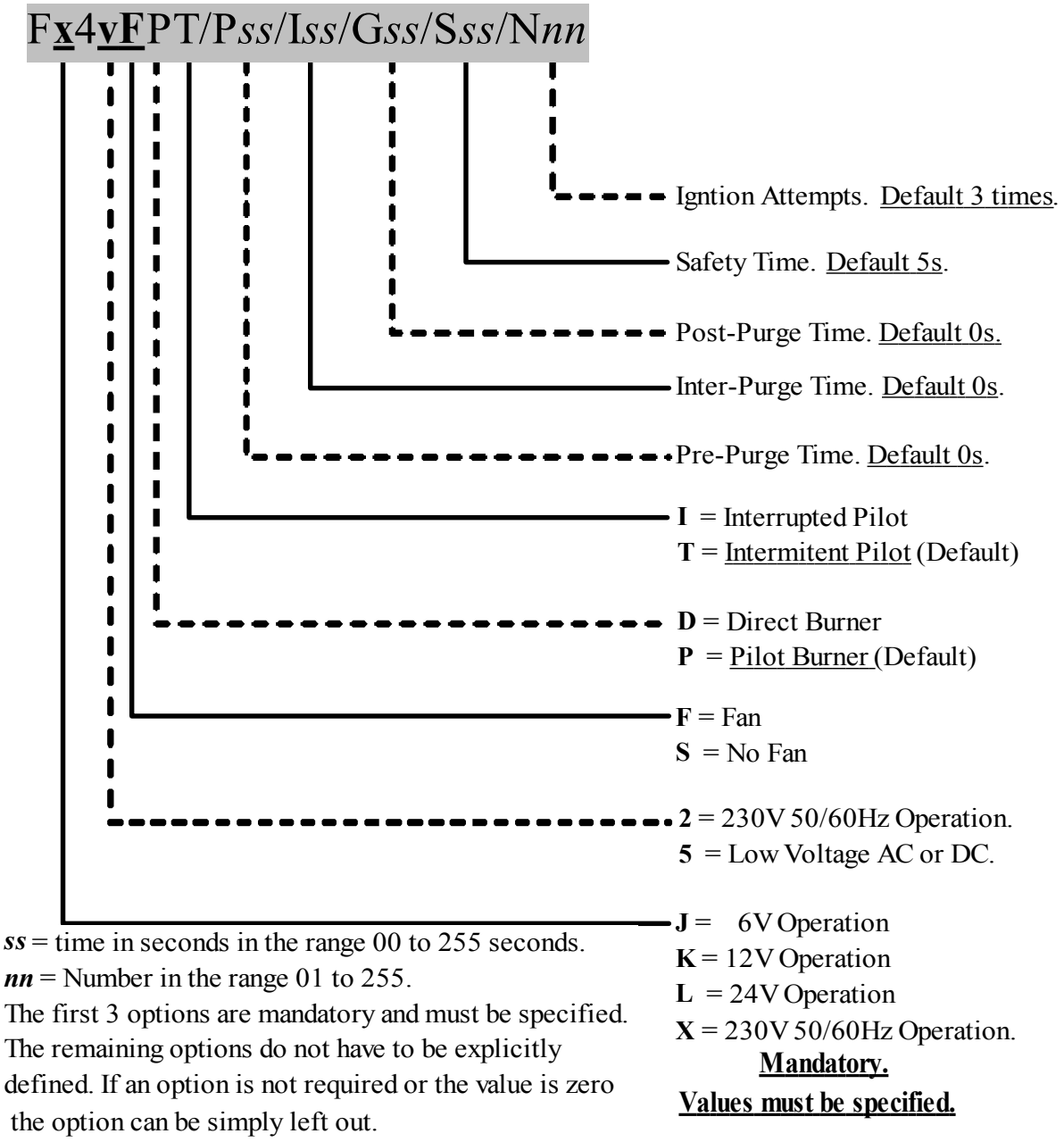

Figure 2 Nomenclature for Fx4 Series Ignition Full Sequence Controllers.[1]

Classification

The classification of this control, according to BS EN 298, is:-

B B R V B B or B M R V B B

[1] Note that the safety time is hardware limited to 8s for Direct Burner applications.

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2 Specification

Supply Voltage (Phase Sensing is provided on the 230V version)	5 to 230[2]	Volts
Supply Voltage Tolerance	±10	%
Supply Frequency	50/60	Hz
Power Consumption (excluding peripherals)	5	VA max
Maximum Fan Current	1	Ampere
Pre-Purge Time	0 – 255[2]	s
Safety Valve:-		
Maximum Current	0.3	Ampere
Ignition:-		
Typical Spark Frequency	3	Sparks/Sec.
Maximum Spark Frequency	No limit	
Minimum Spark Frequency	No limit	
Spark Energy (gross)	20	mJ
Maximum Length of Lead	1.5	m
Type of Lead	EHT Multi-strand with break down voltage of at least 25kV.	
Spark Gap:-		
Recommended Setting	3.0 +1,-0	mm
Safety Time:-		
Maximum (Pilot)	255[2]	s
Maximum (Direct Burner)	8[2]	s
Minimum	1	s
Flame:-		
Type of detection	Ionisation.	
Flame Current Sensitivity:-	1.0[3]	µA
Nominal Probe Voltage	230	V a.c.
Probe Impedance	≥3	MΩ
Environmental:-		
Operating Temperature:-	-5 to +70	°C
Humidity:- (No condensation)	90	%RH

Enclosure:-
Depends on application but a minimum of IP20 is recommended. The enclosure must be of one of the following:-

i) All-metal construction with earthing provision to the main frame of the appliance.

ii) Totally non-conductive construction with no possible path of direct conduction onto the board.

---

2 OEM Specified. Safety Time is hardware limited to an absolute maximum of 16s for direct burner applications. However this limit decreases with increasing temperature and can be as low as 8s.

3 Variable by hardware change.

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Board Mounting:- Any attitude.

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3 Operation and Typical Application

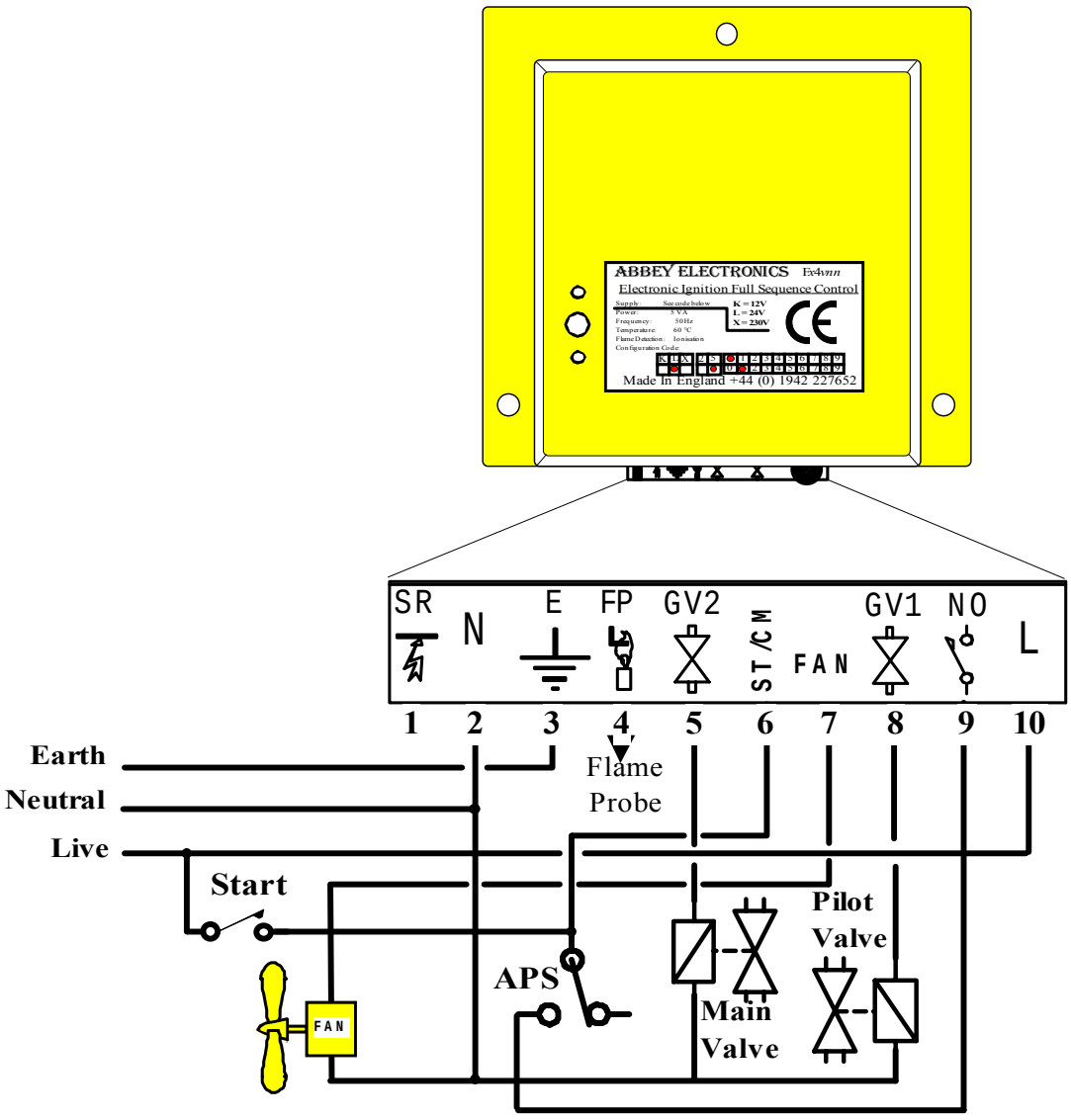

Figure 3 Typical Wiring Diagram for the Fx4[4]

[4] For non-fanned appliances there is no APS but there has to be a physical link in its place, i.e. a permanent link should be provided between pins 6 and 9.

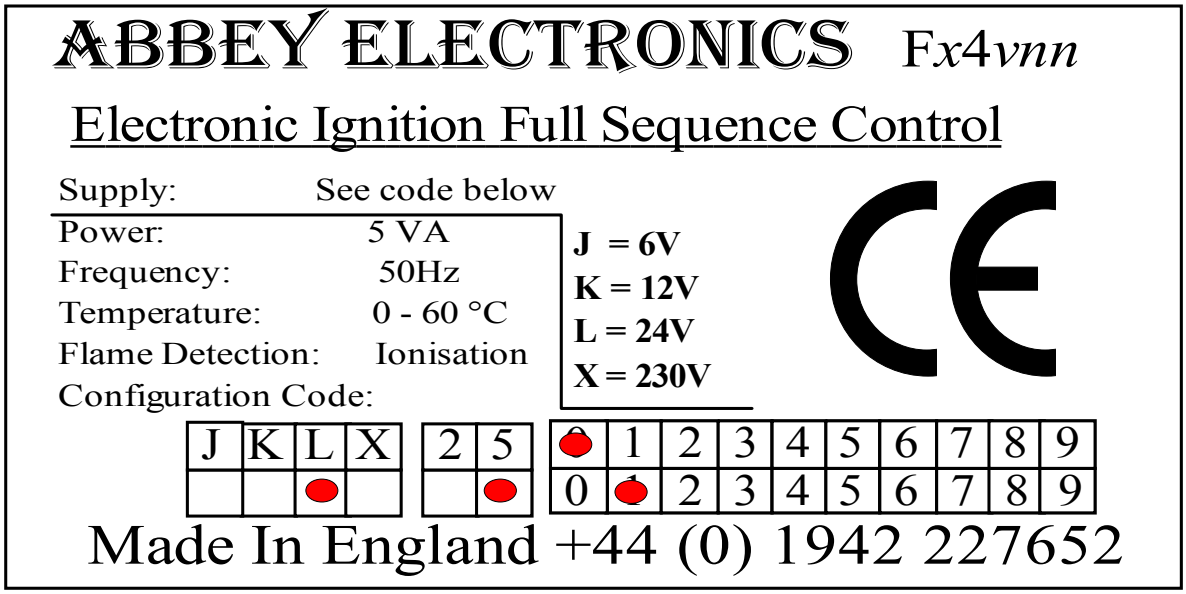

Figure 4 Example of identification sticker designating FL4501

Figure 3 shows a typical wiring diagram for the Fx4. The diagram is self explanatory enough but the following points will be clarified.

In normal operation a permanent live or supply is maintained to the board. The start of a control sequence is initiated by applying the live supply to terminal 6 (ST/CM) of the board.

Self Diagnostics

Although possible, it is not normally desirable to connect pin 6 permanently to the supply (pin 10) and then use the supply to initiate sequence control. This is because each time the supply is reapplied the board carries out a number of self-diagnostics to ensure that it is in good operational condition and that it is safe to control the appliance. This takes about five seconds to complete before the control is ready to start a control sequence. This kind of delay may not be acceptable in some applications especially in instantaneous appliances such as combination boilers.

Also the power will then have to removed to terminate a demand session. Removing the power from the Fx4 at the end of the demand is not recommended is that it makes it impossible for the control to carry out any post demand operations such as post-purge.

In cases where any delay is immaterial and where no need for post demand functions exist, the control can indeed be used by permanently connecting terminals 6 and 10 together. In that case all that is needed to start or stop a sequence is to apply or remove the supply.

The error lamp is permanently lit during self-diagnostics. It is turned off at the end if all is well.

If an error is detected during self-diagnostics, the error lamp will start to flash to indicate that there is a problem. The number of flashes, punctuated by a longer pause, indicates the error

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number which can then be correlated to Table 1 on page 12. This error cannot be overridden or cleared by removing power from pin 6. It can only be cleared by removing power from the control.

Even whilst operating normally, the control is constantly monitoring both itself and external components to maintain a safe condition. Any problem detected will result immediately in safety shutdown and the LED flashing will provide an indication of the problem. Unlike the error declared during self-check, this error can be cleared by removing power from pin 6.

For fanned appliances, if another sequence is started immediately after completing one, a potential error condition arises. This is because the fan has not slowed down sufficiently for the APS to drop out. The control therefore may see a closed APS at the start of a sequence when it expects an open one. It will attempt to resolve this problem by waiting for up to 10 seconds to see if the APS drops out. If the APS drops out at any time within the waiting time, the Fx4 will proceed immediately with the sequence. Otherwise an APS error will be declared. While the Fx4 is in this waiting period, the status LED will flash at the rapid rate as an indication of this situation.

The Fx4 is designed for "Permanent Operation" according to the definition of clause 7.4.5 of EN298:1994. To comply with this requirement, the control will carry out an automatic Permanent Operation Shut Down (POSD) after every 55 minutes of continuous operation followed by an immediate relighting sequence provided there is still a demand. This is in order to ascertain that there has been no undetected internal faults in the control. The FL45xxx version which has additional method of monitoring the flame detection circuitry. Whilst in the running mode with the burner lit, the FL45xxx can carry out a complete check of its internal flame detection circuitry. It does this imperceptibly every 59 seconds.

Operation Sequence

A sequence is started by applying a live[5] to pin 6 (ST/CM). This could be done directly, via a thermostat or other similar controller.

The LED will immediately light to indicate demand.

This is followed by powering the Fan and a Prepurge sequence if one is defined.

After the Prepurge and provided everything is okay, the control attempts an Ignition. During Ignition attempt the LED will flash at an intermediate rate to indicate this event. Once the burner is lit the LED will revert to being permanently lit and will remain lit until demand is satisfied.

If the burner does not light at first attempt the Fx4 will attempt ignition as many times as have been defined before going to Lockout. Attempt duration is defined for the control by its Safety Time. The safety time can be anything from 0 to 255s for a pilot application but is hardware limited to 8s for direct burner applications.

If the control goes into a Lockout or anything else goes wrong during the sequence, the LED will flash at a slow rate to indicate the error code.

[5] Note that "Live" is used generically to mean the operating voltage of the control and not necessarily 230V a.c.

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If the burner lights (in whatever configuration is specified) the control then proceeds to supervise the flame until end of demand is signalled by removing live from pin 6.

Any failure during flame supervision will immediately result in the control entering a safe condition and declaring an error.

Table 1 Error Code and explanation for Fx4

Code	Explanation	Most Likely Causes / Recommended Action.
	The following Errors can only occur during a demand.	
1	A Lockout has occurred	Burner failed to ignite, Gas supply failure, Spark failure, anything else that could interrupt gas supply.
2	On-board problem with fan circuit.	Board Failure. Change Board.
3	Problem with APS	APS found in closed state when it should be open.
4	Problem with APS	APS found in open state when it should be closed.
5	Flame detection failure.	Board Failure. Change Board.
6	Fan failure during operation.	Check Fan and APS.
7	Flame Circuit failure during operation.	Board Failure. Change Board.
8	Reserved	
9	Reserved	
	The following Errors can only occur during start-up or POSD self diagnostics.	
10	Flame detection fault.	Board Failure. Change Board.
11	APS function fault.	Check APS and Fan. If okay, change Board.
12	Internal Fan function fault.	Board Failure. Change Board.
13	Internal Fan function fault.	Board Failure. Change Board.
14	Internal GV1 function fault.	Board Failure. Change Board.
15	Internal GV1 function fault.	Board Failure. Change Board.
16	Internal GV2 function fault.	Board Failure. Change Board.
17	Internal GV2 function fault.	Board Failure. Change Board.
18	Internal GV2 function fault.	Board Failure. Change Board.
	These Errors are only on Issue 3 boards onward.	
19	Internal Hardware Timer fault	Board Failure. Change Board.
20	Internal Hardware Timer fault	Board Failure. Change Board.
21	Internal Hardware Timer fault	Board Failure. Change Board.
22	Internal Hardware Timer fault	Board Failure. Change Board.

LED Indication

There is an LED provided on the Fx4 which is used to indicate the status of the control. It conveys a wide range of useful information to the user. Besides being ON during a demand or OFF when there is not, it has three flashing patterns for information conveyance. A slow rate (1.25 flashes/s) is used to indicate error condition. The LED flashes a number of times, punctuated by a longer pause of 2.25s, to indicate the error number.

There is an intermediate flash of 5 flashes/s which is used to indicate Ignition attempt in progress.

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Lastly, there is a fast rate of 10 flashes/s which can be seen when the Fx4 is in a kind of operational waiting mode such as trying to resolve the correct state of the APS or implementing a compulsory shut down after 55 minutes of continuous operation.

At initial power up when the Fx4 is powered, it will carry out a self-check. The LED is permanently lit during this process and goes off immediately, and stay off, if all is well. If all is not well, an error will be declared. As soon as the control detects the fault, it will turn off the LED for a about 1.5s and then begin to flash to indicate the error number.

Table 2 Stock Code assignment for Fx4 configurations

(Option letters are shown in bold font, followed by possible values. Default values, if any, are shown in underlined font. Refer to Figure 2)

nn	**F**	x	**4**	Working Voltage (**v**,2,5)	Fan (**F**, F,S)	Burner Style (**P**, D,P)	Pilot Style (**T**, I,T)	Pre-Purge Time (**P**, 0s)	Inter-Purge Time (**I**, 1s)	Post Purge (**G**, 0s)	Safety Time (**S**, 5s)	Ignition Attempts (**N**, 3)	Comments
DEVELOPMENT CHIPS AND SAMPLES													
X01	*[6]	*	*	*	F	D	*	05	05	05	05	03	
X02	*	*	*	*	F	P	I	05	05	05	05	03	
X03	*	*	*	*	F	P	T	05	05	05	05	03	
X04	*	*	*	*	S	D	*	2	*	*	05	03	
X05	*	*	*	*	S	P	I	2	*	*	05	03	
X06	*	*	*	*	S	P	T	2	*	*	05	03	
X07	*	*	*	*	F	P	I	10	10	10	05	03	
X10	*	*	*	*	S	P	T	*	2	*	72	03	FL45SPT/S72/N3 (FL45X10)
X98	*	*	*	*	S	D	*	*	5	*	25	03	Chip Samples
X99	*	*	*	*	F	P	T	256	256	256	256	255	Chip Samples
PRODUCTION ISSUE BOARDS													
00													
01													

[6] * *Irrelevant* or *Does Not Apply*.

nn	**F**	x	**4**	Working Voltage (**v**,2,5)	Fan (**F**, F,S)	Burner Style (**P**, D,P)	Pilot Style (**T**, I,T)	Pre-Purge Time (**P**, 0s)	Inter-Purge Time (**I**, 1s)	Post Purge (**G**, 0s)	Safety Time (**S**, 5s)	Ignition Attempts (**N**, 3)	Comments
02	F	L	**4**	5	S	P	T	*	02	*	72	03	FL45SPT/S72/N3 (FL45X10)
03													
04													
05													
06	F	L	**4**	5	F	P	T	-	-	-	05	03	FL45FPTS05N03
07													
08													
09													
10													
11													
12													
13													
14													
15													

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Definition of Terms

APS	Air Pressure Switch. Device for making sure that there is forced convection through the appliance.
Direct Burner Ignition	Lighting the main burner directly instead of via a pilot burner.
Ignition Attempt	The number of times, interrupted by a closing of the gas valve and reopening it, that the control will attempt to ignite the burner before going into a lockout condition.
Intermittent Pilot	A pilot burner which is kept burning concurrently with the main burner and extinguished with it.
Inter-Purge Time	The dead time, with running fan or blower, between ignition attempts. This is the same as the Waiting Time for non-fanned appliances.
Interrupted Pilot	A pilot burner which is lit before the main burner and then extinguished once the main burner lights.
Lockout	A safe condition where the control has ceased all attempts at ignition or operation and is waiting passively for an intervention.
Post-Purge Time	The length of time that the fan will be left running following cessation of demand.
Pre-Purge Time	The length of time that the fan will be left running before the control attempts to ignite the burner for the first time in a demand sequence.
Safety Time	The length of time that the gas valve will be left open during an ignition attempt before being shut down if flame is not established.

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