EPC3000 Carbon Potential Control Supplement

EPC3008, EPC3004

HA032987ENG Issue 1

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Eurotherm®

by Schneider Electric

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Introduction

This document is a supplement to the EPC series User Manual part number HA032842. Please read it together with the User Manual which is available from www.eurotherm.co.uk.

The EPC3000 series of controllers are application based. The user may order the controller with the application already configured or it may be selected by the ’Quick Configuration Codes’ when the controller is new by selecting ’C’ in Set 1/App.

Carbon Potential control is available in EPC3008 and EPC3004 only.

This application provides a starting point for a carbon potential controller of the type which may be found in a sealed quench furnace or in a continuous furnace with multiple zones. This particular application is designed to retrofit into both existing 2400 series controller applications and new applications alike. It does not contain a PV analogue retransmission, although it can easily be added if required.

The controller is a dual channel single loop controller where IO1 provides the ’enrich’ output and IO2 provides the ’dilute’ output. IO4 provides an output for a probe burnoff air solenoid. Contact inputs LA and LB are used to start probe cleaning and impedance checks respectively.

Setting the setpoint to 0 provides a robust means of inhibiting the carbon controller. for example, when in quench or when initially heating to operating temperature. In this inhibit state, some alarms are suppressed and the loop output will go to the ’TrackOP’ (by default all enrich and dilute additions will cease).

Remote setpoints can be written to Modbus address 277.

What’s in this Supplement

I/O fitted

General description of carbon potential control

Terminal connections

Soft wiring

Configuration parameters

I/O Fitted

When ordered as a Carbon Potential controller the following inputs and outputs should be fitted by default.

Location	Default option	Non-default option	Application use
I/O1	Relay	Triac or Logic	Enrich relay configured for time proportioning output
I/O2	Relay	Triac or Logic	Dilute output relay configured for time proportioning output
I/O3	Relay		General alarm relay configured for On/Off output
I/O4	Relay		Burnoff air output relay configured for On/Off output
D1	IE option board (4 X Digital I/O + Ethernet + Second PV input)	I8 option board (8 x Digital IO + Second PV Input)	General notification relay
LA	Logic IP		Start probe clean contact input
LB	Logic IP		Start probe check contact input
IP1	Thermocouple		Temperature input
IP2	Linear mV		Zirconia

Carbon Potential Control

Function

The Zirconia function block is intended for controlling the furnace atmosphere in heat treatment processes such as case hardening of steel, and in endothermic gas generators. It can also be used in glass, ceramics or combustion processes where the oxygen concentration of an atmosphere or flue gas needs to be measured and/or controlled.

The block receives a reading from a zirconia oxygen probe and a temperature measurement, and uses these to compute the following:

- Carbon potential. This a measure of the ability of a given atmosphere composition to diffuse carbon into a heated steel workload, expressed as the percentage (by weight) of carbon in the steel (typically 0 to 2.5%).
- Dew point. The dew point of a gas mixture is the temperature at which condensation and evaporation of its water vapour content are in equilibrium (at constant pressure).
- Oxygen concentration.

The function block contains algorithms for working with several commercially available oxygen probes. Supported probes are:

- AccuCarb probe by Furnace Control Corp (FCC) (United Process Controls).
- Advanced Atmosphere Control Corp (AACC) probes.
- AGA/Ferronova.
- Bosch lambda-style probes.
- Drayton (Therser) probes.
- Eurotherm (including Barber Coleman) probes.
- MacDhui (Australian Oxytrol) probes.
- Marathon Monitors (United Process Controls) probes.
- SSi (Super Systems Inc.) probes.

In addition, the method for calculating oxygen concentration can be selected independently from the probe type. Available methods include:

- The Nernst equation.
- A modified Nernst equation for use with Bosch lambda-style probes.
- A method based on empirical data by AGA/Ferronova.
- A back-calculation based on the value of carbon potential and a given CO concentration.

The function block continuously computes the carbon saturation limit. An alarm can be configured to alert operators whenever the carbon potential exceeds the saturation limit, greatly reducing the risk of soot deposits forming on work and surfaces within the furnace. A degree of tolerance can be defined.

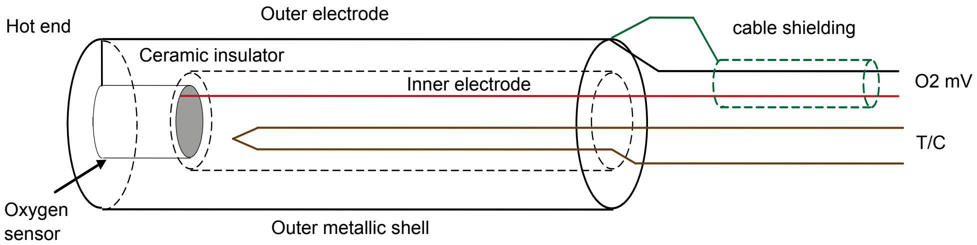
An algorithm for probe cleaning is provided. This allows probe cleaning to occur automatically after a specified interval (in continuous processes), as part of a setpoint programme (in batch processes), or started manually by the operator. In addition, a variety of diagnostics are provided to alert operators whenever probe cleaning has been ineffective, for example due to very heavy sooting.

A probe check algorithm is included for asset management which allows the probe impedance and condition to be monitored over time. An alarm can be configured to alert operators when the probe is approaching its end-of-life and should be replaced. The impedance measurement is achieved using the industry-standard shunt resistor methodology; a resistor is included on the IP2 analogue input as standard.

For a list of configurable parameters for the Zirconia function block, refer to "Configuration Parameters" on page 15.

Connections

The diagram below gives a schematic representation of a zirconia oxygen probe.



If the probe is situated in an area of high interference, it is preferable to use shielded wires for the voltage source of the probe (oxygen sensor) and the shielding connected to the outer metallic shell of the probe.

By default the temperature sensor (thermocouple) of the probe should be connected to:

- Sensor input IP1 (terminals V+ and V-).

The voltage source (oxygen sensor) of the probe should be connected to:

- Sensor input IP2 (terminals S+ and S-).

The zirconia probe generates a millivolt signal based on the ratio of oxygen concentration on the reference side of the probe (outside the furnace) to the amount of oxygen in the furnace.

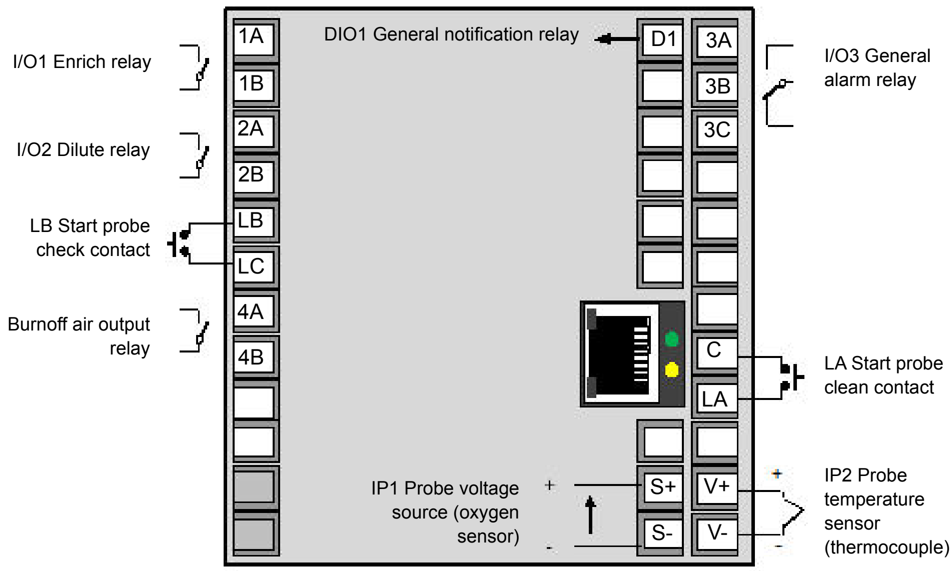
The controller uses the temperature and oxygen concentration signals to calculate the carbon potential of the furnace atmosphere. There are two outputs. One output is connected to a valve which controls the amount of an enrichment gas supplied to the furnace. The second output controls the level of dilution air.

These connections are illustrated in the schematics overleaf.

Physical Connections

The I/O assignment corresponds with the soft wiring shown in section "Soft Wiring" on page 10.

Default Connections to EPC3004 or EPC3008



Inhibit Carbon Control

Once carbon diffusion is complete and a workload moves to quench, it is usually desirable to inhibit the carbon potential control loop. It should usually be held inhibited until the next batch is charged and the hot chamber temperature is reached and stable.

This is achieved by configuring the setpoint to 0 (in practice a setting close to 0 may be found more practicable, the default in this application is 0.1). In this condition:

- The control loop is put into 'Track' mode and the output will follow the value at Loop.Output.TrackOP. By default this is 0, and so all enrich and dilute additions will cease.
- The 'minimum temperature' and 'process deviation' alarms are inhibited (all other alarms continue to be evaluated).

'Probe Clean Start' and 'Probe Check Start' contact inputs

As the sensors are used in furnace environments they require regular cleaning. Cleaning (Burn Off) is performed by forcing compressed air through the probe.

During cleaning the PV and output is frozen.

Contact inputs are assigned to start probe cleaning and probe impedance check routines.

These are momentary inputs that enable the plant Master to schedule probe cleaning and checking into its sequencing. If using a EPC3000 series controller as the temperature programmer, programme event outputs can be used. By wiring panel push buttons in parallel, operators are also able to start these diagnostic routines manually.

Typically, probe cleaning should be carried out at the beginning and end of a batch, with intermediate cleans for longer treatment cycles, but always follow the probe manufacturers recommendations.

Scheduling a probe impedance check into each batch is a good way to help ensure that a failing probe is detected early. Adding the measured probe impedance to batch records makes your commitment to quality even more visible to your customers

Home Screen Bar Graph

The bar graph on the home screen displays the loop Working Output, in %. It is ranged from -100 to +100%, where negative values signify dilution and positive values signify enrichment.

Comms Remote Setpoint

If a remote setpoint (RSP) is configured, the value can be written over digital communications to Modbus address 277.

When the remote setpoint is selected, the RSP must be written at least once every second. If updates stop then an alarm will trip and the loop will fallback to using the local setpoint.

Alarms

For the purposes of this application, alarms are defined as conditions or events which occur in the process.

There are 6 alarms configured in this application. If an alarm is not needed for a given process, it can be disabled by setting its Type parameter to 'Off'. The alarm strategy is intended to cover both continuous and batch processes.

The alarms are split into two groups, by severity, and each group causes a different output to operate.

- Alarms 1, 2 and 3 will cause the changeover relay at IO3 to become de-energised (this relay will also be de-energised if the power to the controller is interrupted). This relay indicates out-of-control conditions and can therefore be used to trigger process interlocks.
- Alarms 4 and 5 will cause the digital open-collector output at OptionDI1 to become closed. This is intended as a 'notification' output and is used for the less critical situations, where the controller can carry on controlling but the operator should be aware of a particular condition.

The following alarms are configured in this application.

Alarm	Function
1	**Soot alarm** The soot alarm will trip whenever the calculated carbon saturation limit is exceeded for more than 1 minute. Process action: While this alarm is active, the control loop will be put into Forced Manual mode. This causes enrichment to cease immediately until the process is below the saturation limit and the alarm has been acknowledged. Designed suppression: The soot alarm is suppressed if either of the probe input statuses report ’bad’ (detect on open circuit or high resistance). In such cases the sensor break alarm will trip.
2	**Minimum temperature alarm** The minimum temperature alarm will trip whenever the probe temperature goes below the minimum operating temperature specified in the zirconia block. This implies loss of control over the process. Process action: While below minimum operating temperature, the loop PV status will change to ’bad’, and the control loop will enter forced manual mode. By default, all enrichment and dilution additions will cease. Designed suppression: The minimum temperature alarm is suppressed whenever the probe thermocouple is broken (in which circumstance the sensor break alarm will trip). It is also suppressed while the loop is in inhibited (by setting the setpoint to 0).

<table>
<tr><th>Alarm</th><th>Function</th></tr>
<tr><td>3</td><td>Sensor break alarm

The sensor break alarm will trip if either the zirconia cell or probe thermocouple input statuses report ’bad’. This signifies no control of the process.

Process action:

While a sensor break persists, the loop PV status will change to ’bad’ and the control loop will enter forced manual mode. By default, all enrichment and dilution additions will cease.

Designed suppression:

The sensor break alarm is never suppressed</td></tr>
<tr><td>4</td><td>Process deviation band alarm

The process deviation alarm will trip whenever the loop PV (the calculated carbon potential) deviates outside of a given band around the working setpoint. By default, the width of the band is +/- 0.05 wt%C. This alarm has blocking enabled, which means that the PV must first have entered the deviation band before the alarm can trip.

Process action:

None.

Designed suppression:

The process deviation alarm is suppressed whenever there is a sensor break. It is also inhibited when the setpoint is 0 and while the instrument is in the configuration access level.</td></tr>
<tr><td>5</td><td>Remote Setpoint alarm

The RSP alarm will trip whenever updates to the RSP stop. This indicates communications failure. By default, the RSP must be written every 1 second to help to prevent this alarm from tripping.

Process action:

When this alarm is active, the RSP status will change to ’bad’ and the control loop will fallback to using the local setpoint. RSP tracking is enabled by default and, therefore, the operating point will be maintained.

Designed suppression:

The RSP failure alarm is suppressed whenever the remote setpoint has not been selected. It is also suppressed while the instrument is in the configuration access level.</td></tr>
<tr><td>6</td><td>Inhibit carbon control

The alarm 6 function block is used as an event which will activate when the Main.TargetSP = 0.

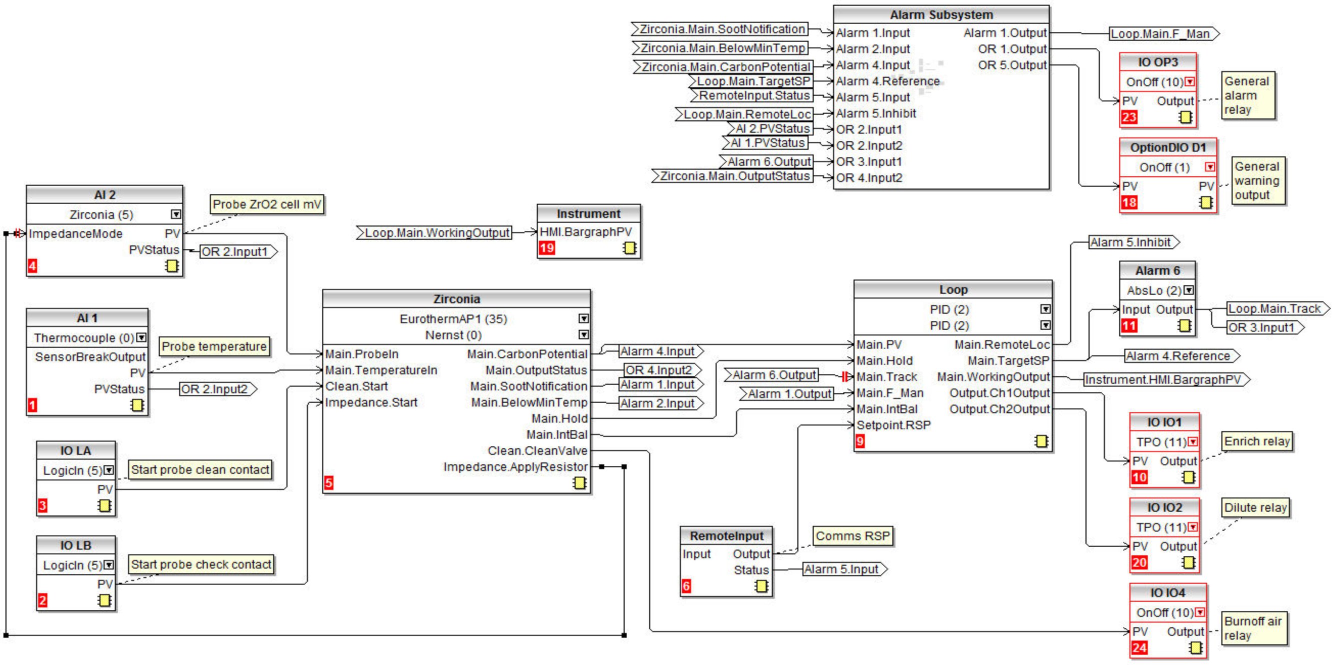
It is used to inhibit the carbon potential control loop once carbon diffusion is complete. See also section "Inhibit Carbon Control" on page 6.</td></tr>
</table>

Soft Wiring

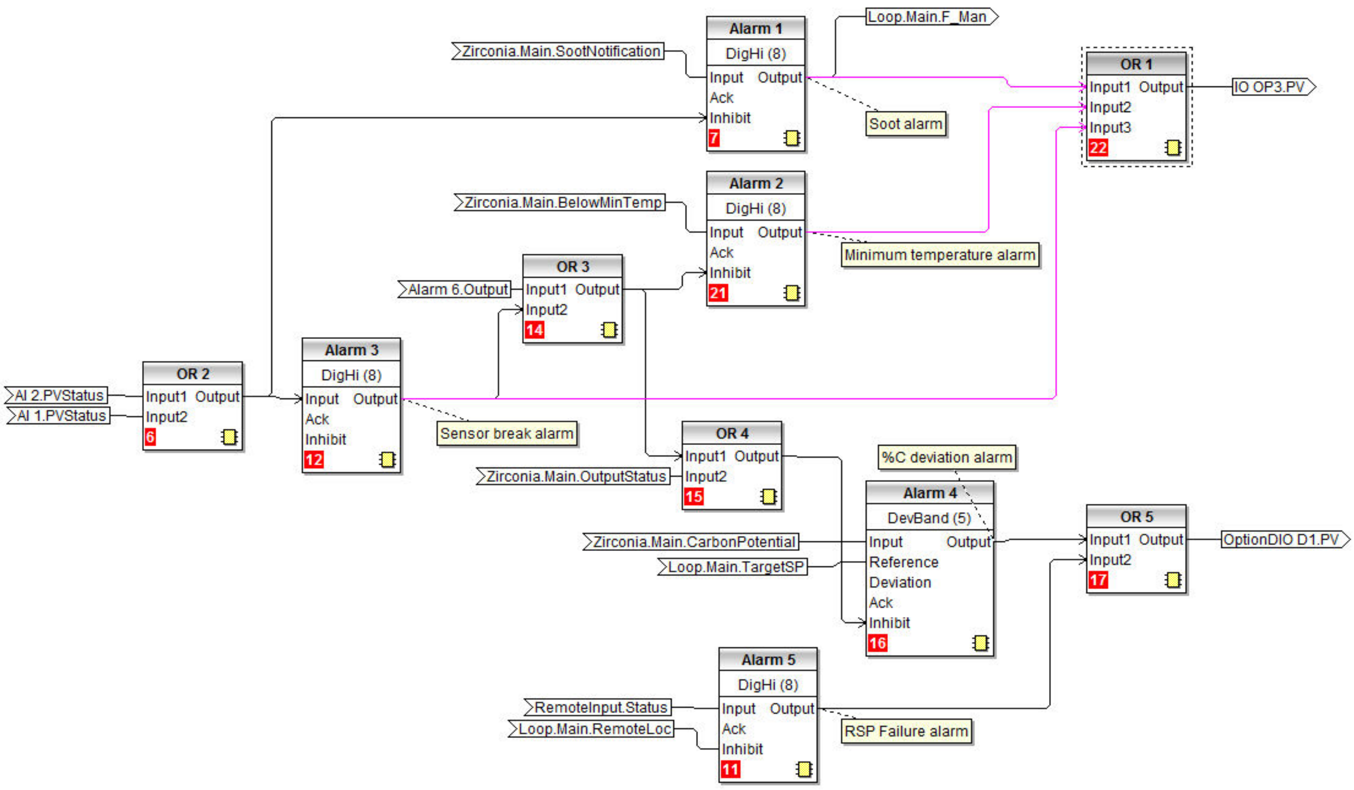
Soft wiring is carried out using iTools configuration software and for further information please refer to the iTools chapter in the User Manual HA032842. The following diagrams can be found by opening the Graphical Wiring tab in iTools.

Controller

The diagram shows the wiring of the function blocks applicable to this application. It can be modified by the user if required.



Alarm Subsystem



⚠ CAUTION

UNINTENDED EQUIPMENT OPERATION

Hardware Interlocks

Soft-wiring is not a substitute for hardware interlocks where any level of safety is required. It should be used in conjunction with separately included hardware interlocks.

Failure to follow these instructions can result in injury or equipment damage.

Non-default Parameter Settings

This table lists all instrument parameters that are changed from their coldstart defaults.

Parameter	Value
AI.2.Type	Zirconia (5)
AI.2.Resolution	X (0)
AI.1.Resolution	XX (1)
AI.1.RangeHigh	600.0
AI.1.SensorBreakType	Low (1)
RemoteInput.1.RangeHi	160.0
RemoteInput.1.RangeLo	-60.0
RemoteInput.1.ScaleHi	160.0
RemoteInput.1.ScaleLo	-60.0
RemoteInput.1.Resolution	XX (1)
RemoteInput.1.Units	C_F_K_Temp (1)
Loop.1.Config.Ch2ControlType	PID (2)
Loop.1.Config.PropBandUnits	EngUnits (0)
Loop.1.Setpoint.RangeHigh	160.0
Loop.1.Setpoint.RangeLow	-60.0
Loop.1.Setpoint.SPHighLimit	160.0
Loop.1.Setpoint.SPLowLimit	-60.0
Loop.1.Setpoint.RSP_En	On (1)
Loop.1.Setpoint.SPTracksRSP	On (1)
OptionDIO.1.Type	OnOff(1)
IO.4.Type	DCOP (4)
IO.4.DemandHigh	500.0
IO.4.DemandLow	0.0
IO.4.OutputHigh	20.0
IO.4.OutputLow	4.0
Alarm.3.Type	DigHi (8)
Alarm.3.Latch	Auto (1)
Alarm.1.Type	DigHi (8)
Alarm.1.Latch	Auto (1)
Alarm.1.Delay	60.0
Alarm.2.Type	DigHi (8)
Alarm.2.Latch	Auto (1)
Alarm.2.StandbyInhibit	On (1)
Alarm.4.Type	DevBand (5)
Alarm.4.Latch	Auto (1)

Parameter	Value
Alarm.4.Block	On (1)
Alarm.4.StandbyInhibit	On (1)
Alarm.4.Deviation	5.0
Alarm.4.Hysteresis	0.5
Alarm.5.Type	DigHi (8)
Alarm.5.StandbyInhibit	On (1)
Alarm.6.Type	DigHi (8)

Messages

The following process messages may be displayed:

#	Message	Parameter	Op	Val	Prio
1	SOOT ALARM	Instrument.Diagnostics.AlarmStatusWord	M	1	H
2	MIN TEMPERATURE ALARM	Instrument.Diagnostics.AlarmStatusWord	M	4	H
3	SENSOR BREAK ALARM	Instrument.Diagnostics.AlarmStatusWord	M	16	H
4	DEVIATION ALARM	Instrument.Diagnostics.AlarmStatusWord	M	64	H
5	RSP FAILURE ALARM	Instrument.Diagnostics.AlarmStatusWord	M	256	H
6	CLEAN RECOVERY FAILURE	Zirconia.Clean.RecoveryWarn	<>	0	L
7	CLEAN TEMPERATURE EXCEEDED	Zirconia.Clean.TempExceeded	<>	0	L
8	PROBE IMPEDANCE HIGH	Zirconia.Impedance.ImpedanceWarn	<>	0	L
9	PROBE CHECK RECOVERY FAILURE	Zirconia.Impedance.RecoveryWarn	<>	0	L
10	BURNOFF IN PROGRESS	Zirconia.Main.ProbeState	=	1	L
11	PROBE RECOVERING	Zirconia.Main.ProbeState	=	2	L
12	PROBE CHECK IN PROGRESS	Zirconia.Main.ProbeState	=	3	L
13	PROBE RECOVERING	Zirconia.Main.ProbeState	=	4	L

Parameter Promotion Tables

Parameters may be promoted between Operator Levels as listed in the table below. For more information on parameter promotion please refer to the User Manual HA032842.

#	CISP	Level	Access	Mnemonic
1	Zirconia.Main.DewPoint	1 + 2	R/O	DEW.PT
2	Zirconia.Main.ProbeIn	1 + 2	R/O	PRB.IN
3	Zirconia.Main.TemperatureIn	1 + 2	R/O	TMP.IN
4	Loop.Main.WorkingOutput	2	R/O	W.OUT
5	Zirconia.Main.ProcessFactor	2	R/W	PF
6	Zirconia.Main.COFactor	2	R/W	COF
7	Zirconia.Main.H2Factor	2	R/W	H2F
8	Loop.Main.RemoteLoc	1 + 2	R/W	R-L
9	Loop.Setpoint.SPHighLimit	2	R/W	SP.HI
10	Loop.Setpoint.SPLowLimit	2	R/W	SP.LO
11	Loop.Setpoint.SP1	1 + 2	R/W	SP1
12	Loop.Setpoint.SP2	1 + 2	R/W	SP2
13	Zirconia.Clean.TimeToClean	1 + 2	R/O	C.TMR
14	Zirconia.Clean.Start	1 + 2	R/W	CLEAN
15	Zirconia.Clean.Abort	1 + 2	R/W	ABRT.C
16	Zirconia.Clean.MsgReset	1 + 2	R/W	C.RST
17	Zirconia.Impedance.Start	1 + 2	R/W	Z.STRT
18	Zirconia.Impedance.Abort	1 + 2	R/W	Z.ABRT
19	Zirconia.Impedance.Impedance	1 + 2	R/O	IMPED
20	Zirconia.Impedance.MsgReset	1 + 2	R/W	Z.RST
21	Loop.Autotune.AutotuneEnable	2	R/W	TUNE
22	Loop.PID.Ch1PropBand	2	R/W	PB.H
23	Loop.PID.Ch2PropBand	2	R/W	PB.C
24	Loop.PID.IntegralTime	2	R/W	TI
25	Loop.PID.DerivativeTime	2	R/W	TD
26	Loop.PID.ManualReset	2	R/W	MR
27	Loop.PID.CutbackHigh	2	R/W	CBH
28	Loop.PID.CutbackLow	2	R/W	CBL
29	Loop.Output.OutputHighLimit	2	R/W	OUT.HI
30	Loop.Output.OutputLowLimit	2	R/W	OUT.LO
31	Intrument.Info.CustomerID	2	R/W	CS.ID

Configuration Parameters

Zirconia List (ZIrC)

The Zirconia list is available in Level 3 or Configuration level. To enter these levels refer to the User Manual part number HA032842.

Access to the Zirconia list is summarised below.

1. Press to show the 'ZIRCONIA PROBE' list (ZI rC). From this list you can configure the zirconia function block. There are four sub-lists - Main, Set-up, Clean and Impedance.
2. Press to select the first sub-list (mAIn)
3. Press or to scroll between the sub-lists, (mAIn, CONF, CLn, ImP)
4. When the required sub-list has been selected, press to scroll through the parameters in this list

Notes:

1. In the following lists, analogue values shown in the 'Value' column are generally defaults.
2. R/W = Read and write in the level stated or all higher levels (if no level is stated then the parameter is always R/W)
5. R/O = Read only in the level stated or all higher levels (if no level is stated then the parameter is always R/O)

Main Sub-list (Zirconia Header)

Parameter Mnemonic Press ↻ to select in turn	Parameter Name	Value Press ▲ or ▼ to change values (if read/write, R/W)		Description	Access
STATE	PROBE STATE			Indicates the probe and function block's current operating state.	L3 R/O
		mEAS	0	Measuring. The probe is good and the controller is calculating the properties of the atmosphere (carbon potential, dew point and oxygen concentration).	
		burn	1	Burnoff. A probe clean sequence is in progress. The burnoff air valve is open.	
		CLn.R	2	Cleaning Recovery. A probe clean sequence is in progress. The block is waiting for the zirconia probe to recover from burnoff. The burnoff air valve has closed.	
		ImP	3	Impedance Check. A probe check sequence is in progress. The load resistor is applied and the block is waiting for the measurement to settle.	
		ImP.R	4	Impedance Recovery. A probe check sequence is in progress. The load resistor has been removed and the block is waiting for the zirconia probe to recover.	
		min.t	5	Below Min Temp. The probe temperature is below the configured minimum temperature. All calculated outputs are set to 0.0. Cleaning and probe checks are inhibited.	
		bAd	6	Input Bad. The temperature and/or probe mV input is not indicating correctly. All calculated outputs are set to 0.0. Cleaning and probe checks are inhibited.	
C POT	CARBON POTENTIAL			The calculated carbon potential, in wt%C. Carbon Potential is a measure of the ability of a given atmosphere composition to diffuse carbon into a heated steel workpiece, expressed as a percentage of carbon in the steel (by weight). The value is clipped in the range from 0 to 2.55wt%C.	L3 R/O
DEW PT	DEW POINT			The calculated dew point (in the configured instrument temperature units). The dew point of a gas mixture is the temperature at which condensation and evaporation of its water vapour content are in equilibrium (at constant pressure). Dew point is often used as a process variable for control of an endothermic gas generator. The value is clipped in the range equivalent to −60°C to +160°C.	L3 R/O
O2	OXYGEN			The calculated concentration of oxygen in the measured atmosphere (expressed in the units configured by the 'Oxygen Units' parameter).	L3 R/O
SAT LM	SATURATION LIMIT			The calculated carbon potential in wt%C above which soot deposits are likely to form on surfaces in the furnace. This value is sometimes referred to as the 'soot line'.	L3 R/O
OUT ST	OUTPUT STATUS	Good	0	This reports that the status of the Carbon Potential, Dew Point and Oxygen calculated outputs is correct.	L3 R/O
		bAd	1	If the status is Bad, the values should not be relied upon.	
SOOT	SOOT NOTIFICATION	YES	1	This flag is set to Yes if the following condition is met: Carbon Potential > (Saturation Limit × Soot Scalar) That is, if the carbon potential in the furnace becomes high enough to potentially cause a deposit of soot on surfaces in the furnace. The 'Soot Scalar' parameter allows a degree of tolerance to be defined. Typically this could be wired to a digital alarm.	L3 R/O
		No	0	The furnace is operating normally below the carbon saturation limit	
COF	CO FACTOR	20.0		Defines the 'CO Factor' in %CO. The default value is 20.0%. This factor is used in the calculation of the carbon potential. Nominally, it represents the percentage of carbon monoxide in the furnace atmosphere, by volume. In practice, however, it is often used as a general compensation factor, to bring the calculated carbon potential into agreement with the value determined by shim stock or multi-gas analysis. To help prevent harsh changes in controller output, an integral balance will be issued whenever this value is changed.	L3 R/W

Parameter Mnemonic	Parameter Name	Value		Description	Access
Press ↻ to select in turn		Press ▲ or ▼ to change values (if read/write, R/W)			
H2F	H2 FACTOR	40		Defines the 'H2 Factor' in %H_2. The default value is 40.0%. This factor is used in the calculation of the dew point. Nominally, it represents the percentage of hydrogen in the furnace atmosphere, by volume. In practice, however, it is often used as a general compensation factor, to bring the calculated dew point into agreement with observed values. To help prevent harsh changes in controller output, an integral balance will be issued whenever this value is changed.	L3 R/W
PF	PROCESS FACTOR			This value is only used if the 'Probe Type' is set to MMI. It defines a 'Process Factor' which is used as a general 'rolled-up' compensation factor to take into account the various parameters of the furnace, its atmosphere and the load being treated. It is often used to bring the calculated carbon potential and/or dew point into agreement with observed values.	L3 R/W
PRB.IN	PROBE MV INPUT			Voltage reading from the zirconia probe (in millivolts). Acceptable range is from 0mV to 1800mV. If required, a compensation offset can be applied to this value by setting the 'Probe Offset' parameter.	L1 R/O
TMP.IN	TEMPERATURE INPUT			The temperature of the measured atmosphere. This will often come from the thermocouple at the zirconia probe tip. If required, a compensation offset can be applied to this value by setting the 'Temp Offset' parameter.	L1 R/O
P.BIAS	PROBE OFFSET	0		If required, an offset value can be specified here (in mV). It acts as a compensation factor for the incoming 'Probe mV Input' signal.	L3 R/W
T.BIAS	TEMPERATURE OFFSET	0.0		If required, a temperature offset can be specified. It is applied to the incoming 'Temperature Input' signal.	L3 R/W
	Hold	YES No	1 0	This flag is set to Yes when the block is carrying out probe cleaning or a probe impedance check. Typically, in a control strategy, this output can be used to switch the control loop into HOLD mode.	Available in iTools only
	IntBal	YES No	1 0	Typically, in a control strategy, this output may be used to trigger an integral balance, in order to avoid step changes in the process variable from causing discontinuities ('bumps') in the control loop output. Connect this output to the IntBal input on the Loop block. Certain events will cause the zirconia block to request an integral balance, for example changing the gas factors or when transitioning into the Measuring state.	Available in iTools only
	BelowMinTemp	Yes No	1 0	This flag is asserted whenever the probe temperature input is below the 'Minimum Temperature parameter'. This is often used to inhibit alarms and similar.	Available in iTools only

Conf Sub-List

Parameter Mnemonic Press ↻ to select in turn	Parameter Name	Value Press ▲ or ▼ to change values (if read/write, R/W)		Description	Access
PROBE	PROBE TYPE			Selects the probe type	Conf R/W L3 R/O
		mml	25	Probes by Marathon Monitors (MMI) (United Process Controls).	
		AACC	26	Probes by the former Advanced Atmosphere Control Corp. (AACC)	
		drAY	27	Probes by Drayton Probes	
		Accu	28	Probes by Furnace Control Corp. (FCC) (United Process Controls).	
		SSi	29	Probes by Super Systems Inc. (SSi).	
		mAc.d	30	Probes by MacDhui (Australian Oxytrol).	
		boSh	31	Bosch lambda style probes.	
		bAr.C	32	Probes by Barber Coleman.	
		FErr	33	Calculations by AGA/Ferronova.	
		mU	34	No calculation. The probe voltage will be passed straight to the CarbonPotential output.	
		API	35	API series probes by Eurotherm by Schneider Electric	
		ACP	36	ACP series probes by Eurotherm by Schneider Electric	
		O2	3	Probe is used for oxygen measurement only. Disables Carbon Potential and Dew Point calculations. For example, use this option for an oxygen trim controller in a combustion system.	
O2 .TYP	OXYGEN CALCULATION			Selects the methodology for calculating the oxygen concentration. For most probes, the Nernst equation is most suitable. Different methodologies for Bosch lambda probes and by AGA/Ferronova are also provided. Alternatively, the option to back-calculate the oxygen concentration from a calculated carbon potential is available (NernstCP).	Conf R/W L3 R/O
		nErn	0	The standard Nernst equation.	
		boSh	1	A modified Nernst equation suitable for Bosch lambda style probes.	
		FErr	3	An alternative method by AGA/Ferronova based on empirical data.	
		CP	4	The oxygen concentration will be back-calculated from the Carbon Potential and an 'ideal' CO concentration.	
O2 UNT	OXYGEN UNITS			Selects how the proportion of O_2 in the measured atmosphere is expressed.	Conf R/W L3 R/O
		PPrS	0	Partial pressure	
		Pcnt	2	Percent	
		PPm	6	Parts per million	
CO .IDL	IDEAL CO	20.0		This input is only used if Oxygen Calc is set to NernstCP. It represents the percentage of carbon monoxide in the furnace atmosphere by volume. The function block uses the supplied value as a calibration factor when back-calculating the oxygen concentration from the calculated carbon potential.	L3 R/W
MIN .T	MINIMUM TEMPERATURE	720.0		Defines a minimum operating temperature for the zirconia probe. If Temperature Input < Minimum Temperature, the block will not perform any calculations, cleaning or impedance testing	L3 R/W
SOOT K	SOOT SCALAR	1.00		This is a multiplicative scaling factor which can be used to raise or lower the calculated sooting threshold. This flag will be set to Yes if the following condition is met: Carbon Potential > (Saturation Limit × Soot Scalar) Different values of 'Soot Scalar' may be appropriate for different alloys. It could also be used to approximate the carbide limit	L3 R/W

Clean Sub-List

Parameter Mnemonic Press ↻ to select in turn	Parameter Name	Value Press ▲ or ▼ to change values (if read/write, R/W)		Description	Access
CLN EN	ENABLE CLEANING	On OFF	1 0	Set to On to enable automatic probe cleaning or Off to disable it. A clean can always be started using the 'Start Clean' input regardless of this setting	L3 R/W
CLEAN	START CLEAN	No YES	0 1	A rising-edge will begin a probe cleaning sequence	L2 R/W
ABRT C	ABORT CLEAN	No YES	0 1	A rising-edge will abort a probe burnoff. Measurement will resume once the probe recovers.	L2 R/W
	Clean Valve	on OFF	0 1	Control output for the burnoff air valve. Off = valve closed, On = valve open. Typically this will be wired to a digital or relay output.	Available in iTools only
C .TMR	TIME TO CLEAN	04:00		Time remaining until the next automatic probe cleaning sequence is due to start. Default 4 hours.	L1 R/O
C MV	LAST PROBE MV	0		The probe mV reading at the end of the last burnoff. If the value is greater than 200mV, this may indicate deterioration or poor adjustment of the burnoff air supply or probe degradation due to heavy sooting.	L3 R/O
C RCOV	LAST RCOV TIME	0.0		Time taken for the probe mV to return to 95% of its value before the last burnoff began	L3 R/O
	RecoveryWarn	No Yes	0 1	Indicates probe degradation. This is a flag which is set to Yes if the probe mV reading does not return to 95% of its pre-burnoff value within the permitted recovery time (set by 'Max Clean Recovery Time').	Available in iTools only
	Temp exceeded	No Yes	0 1	This is a flag which is set to Yes if the temperature of the probe exceeds the configured maximum ('Maximum Temperature') during the last burnoff. This could indicate a potentially damaging exothermic reaction on the probe surface.	Available in iTools only
	Aborted	No Yes	0 1	This is a flag which is set to Yes if the last burnoff was aborted before it could finish.	Available in iTools only
C RST	CLEAN MESSAGE RESET	No YES	0 1	A rising-edge on this input will reset the 'RecoveryWarn', 'Temp exceeded' and 'Aborted' status flags	L2 R/W
BRNOF	BURN OFF TIME	180.0		Configures the duration of the burnoff phase of the probe cleaning sequence. Default 3 minutes.	L3 R/W
C FRQ	CLEAN FREQUENCY	04:00		Configures the interval between automatic probe cleans. Default 4 hours.	L3 R/W
MAX .T	MAXIMUM TEMPERATURE	1100.0		Sets the maximum temperature allowed during probe burnoff. The burnoff is aborted if exceeded. Default 1100^{O}C.	L3 R/W
C MIN R	MIN CLEAN RECOVERY TIME	1.0		Sets the minimum recovery time allowed after burnoff, before measurement resumes. Range 0 to 90 seconds. Default 1 second.	L3 R/W
C MAX R	MAX CLEAN RECOVERY TIME	90.0		Sets the maximum recovery time allowed after burnoff, before measurement resumes. If the probe has still not recovered within this amount of time then measurement will be forced to resume and the RecoveryWarn flag will be set. Default 90.0 seconds. Maximum range 499h:59m:59s	L3 R/W

Impedance Sub-List

Parameter Mnemonic Press ⟳ to select in turn	Parameter Name	Value Press ▲ or ▼ to change values (if read/write, R/W)		Description	Access
Z.RUN	START PROBE CHECK	No YES	0 1	A rising-edge will begin a probe impedance check. Ensure that the atmosphere and temperature are stable before starting a test otherwise a false reading may result. Probe impedance testing is a useful indication of probe health. Your probe manufacturer's recommendations should be followed. However, as a general guideline it is recommended to test a probe's impedance on at least a weekly basis, and more frequently as the probe approaches its end of life. Typically a probe impedance of greater than 50kΩ indicates that the probe should be replaced.	L3 R/W
Z.ABRT	ABORT PROBE CHECK	No YES	0 1	A rising-edge will abort a running probe impedance check. Normal operation will resume once the probe recovers.	L3 R/W
IMPED	PROBE IMPEDANCE	0.0		The measured probe impedance (in kΩ)	R/O
	apply resistor	No Yes	0 1	Control output for applying the test resistor across the probe. No = no resistor, Yes = apply resistor. The controller has a resistor built into the analogue input for this purpose. This output should be connected to the ApplyResistor input on the appropriate Analogue Input block.	Available in iTools only
	impedance warn	No Yes	0 1	This flag is set to Yes if the probe's measured impedance exceeds the Impedance Threshold	Available in iTools only
	lasr rcov time			The time taken for the probe mV reading to return to 99% of its pre-check value.	Available in iTools only
	Recovery notification	No Yes	0 1	This flag is set to Yes if the probe mV reading does not return to 99% of its pre-check value within the permitted recovery time (set by 'Max Check Recovery Time')	Available in iTools only
	aborted	No Yes	0 1	This flag is set to Yes if the last impedance check was aborted before it could finish	Available in iTools only
Z.MAX.R	MAX CHECK RECOVERY TIME	30.0		Maximum recovery time allowed after the test resistor has been removed and before measurement resumes	L3 R/W
Z.THRS	IMPEDANCE THRESHOLD	50.0		Defines a alarm threshold for the probe impedance (in kΩ). If the measured probe impedance exceeds this value, then the 'Impedance Warn' parameter is set to Yes.	L3 R/W
Z.RST	PROBE CHECK MESSAGE RESET	No YES	0 1	A rising-edge on this input will reset the ImpedanceWarn, RecoveryWarn and Aborted status flags	L3 R/W

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