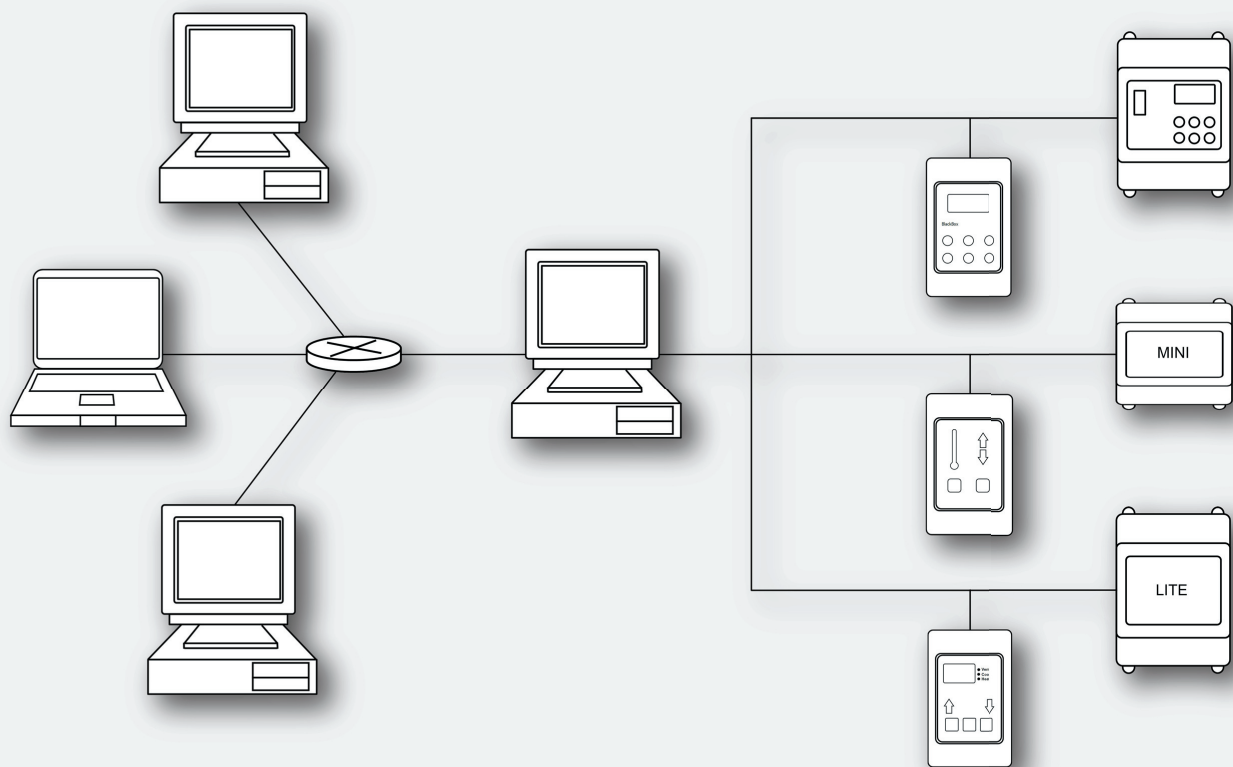


Overview

BLACKBOX MODULAR HVAC CONTROL SYSTEM



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This Technical Reference Manual describes the operation and specifications of the BlackBox series HVAC control system.

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1

Introduction

This manual provides an overview of the specifications and operation of the BlackBox series of HVAC controllers.

A Blackbox controller consists of a control module connected to a temperature sensor and one or more compatible interface modules (onboard and/or external).

External interface modules are available to:

- provide varying degrees of user access to controller functions.
- enable control of several HVAC systems from a single user interface module.
- enable integration of IAS zoning solutions.
- implement controller networks that may be monitored and controlled via PC based HMI software solutions.

The range is very flexible due to its modular design, delivering off the shelf solutions to suit most small to medium HVAC applications.

1.1 Recommended Applications

The BlackBox series controllers are suitable for use on HVAC systems utilising any of the following control strategies:

1.1.1 Direct Expansion

- Configure for either reverse cycle or electric heat.
- Up to 3 stages of cooling/heating.
- 0-10v output on cooling call for modulating zone damper.
- 0-10v output on heating call for time proportional heating.

1.1.2 Chilled Water

- Dedicated pump call.
- Dedicated proof of flow input to prevent system damage.
- 0-10v output for modulating chilled water valve.
- Staged electric heat outputs.
- 0-10v output for time proportional or staged heating.

Water Cooled

- Pump call output.
- Dedicated proof of flow input to prevent system damage.
- Staged cooling outputs.
- Staged heating outputs.
- 0-10v output for time proportional electric heating.
-

Air Cooled

- Staged cooling outputs.
- Staged heating outputs.
- 0-10v output for time proportional electric heating.

1.1.3 Economy Cycle

- 0-10v output for modulating both outside air and return actuators
- Dedicated outside air sensor.
- Fully automatic economy change over.
- Staged heating output.
- 0-10v output for time proportional electric heating.

1.2 Control Modules

The control module is the core component of the BlackBox series of microprocessor driven HVAC controllers. Physically and electronically designed to offer simple installation and robust operation, BlackBox control modules are suitable for either DIN-Rail or surface mount applications.

Control modules in the BlackBox series share the following common features:

- 1 x 0-10 volt analogue output for cooling
- 1 x 0-10 volt analogue output for heating
- 2 x Universal inputs
- 1 x Digital input for proof of flow on pump call.
- 1 x Terminal connection to IASNet local communication bus (4 core + shield)
- 1 x Innocab connection to IASNet local communication bus (RJ12 socket).

Control modules are available in 4, 5 and 8 relay output configurations.

A variety of onboard and external interfaces are available offering varying degrees of access to the range of control functions and enabling networking capability (Refer to 1.3 - Interface Modules).

Variations on the standard platforms may be implemented on a per project basis. Contact IAS for more information.

1.2.1 Personality

Plug and play outputs make the BlackBox series the most flexible controller in its class. Control module outputs are allocated to the appropriate HVAC plant resources according to the personality imposed on the control module during the initialisation sequence, when power is first applied.

The controller personality can be imposed in one of two ways:

- Onboard configuration DIP switches
- An external interface module

If a compatible interface module is detected at initial power up, the device(s) transmits its personality to the control module, and when the initialisation sequence has successfully completed, the controller begins normal operation.

A control module can support multiple interface modules [optional interface expansion module(s) may be required]. Where more than one interface is connected, they may have different interface types but must have the same personality. If a personality conflict is detected during the initialisation sequence, the control module will enter Safety Mode and no relays will be energised until the issue is resolved.

BlackBox personalities are represented by a numerical code comprising of three digits, each from the range 0-3, and an optional fourth alphanumeric character to indicate special options.

The personality coding is directly referenced to the control module relay outputs and is always in the following order:

1. **Fan Outputs:** The first digit represents the number of fan outputs from 0, 1, 2, or 3.
2. **Cooling Outputs:** The second digit represents the number of cooling/compressor outputs.
3. **Heating Outputs:** The third digit represents the number of heating/reversing valve outputs.

Interface devices containing a numerical component in the product code are able to impose the corresponding personality on a control module.

1.2.2 Standard Control Settings

Following is a list of adjustable settings, common to all BlackBox series control modules, and their factory default values. An external interface module may be required to adjust these settings. For details on altering these settings refer to the relevant user guide.

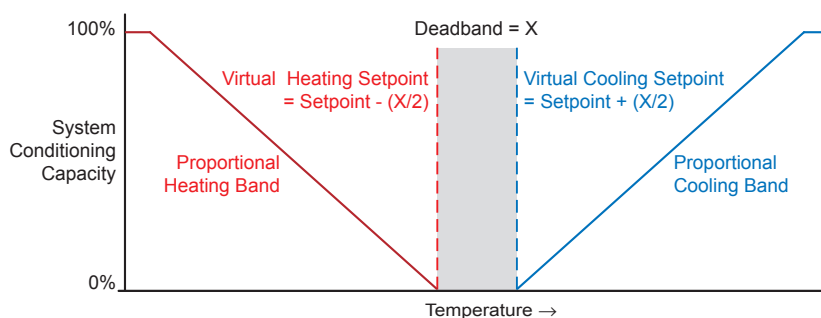
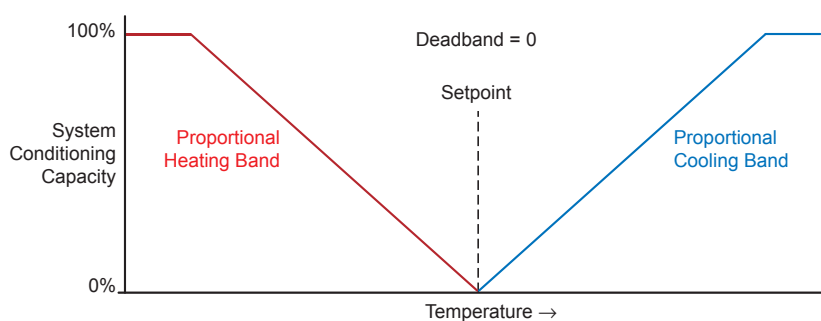
- **Setpoint (Default = 22.5 °C)**
Setpoint is the temperature the controller will try to maintain.
- **Mode (Default = Auto)**
Mode controls the operating mode of the system. Select from auto, cool, heat or vent. In auto mode the controller changes from heating to cooling as dictated by the ambient conditions.

- **Fan Speed (Default = Low)**
Fan Speed controls the indoor fan speed. Select from low, medium, high or auto. Auto fan decreases the fan speed as the temperature approaches setpoint.
- **Heat Fan (Default = Continuous)**
Heat Fan controls the indoor fan operation in heating mode. Select from continuous or auto/cyc. 'Auto/Cyc' causes the indoor fan to switch off between heating calls. If EDH has been selected (Refer to 1.2.4 - Hardware Settings) there is a fixed 4 minutes fan run on.
- **RunTimer (Default = Disabled)**
Run Timer counts down run hours from a preset limit. Select a time between 10 minutes and 24 hours in 10 minute increments to enable the Run Timer. At the end of the timer period the system switches off.
- **SetBack (Default = Disabled)**
SetBack is used to maintain temperature within preset limits at all times. If the temperature moves outside these limits the controller will turn on the HVAC plant and heat or cool as required to keep the temperature within the preset limits. These limits are separate and distinct from the normal setpoint.

1.2.3 Advanced Control Settings

Following is a list of advanced system settings, common to all BlackBox series control modules, and their factory default values. An LCD interface module is required to access these settings. For details on altering these settings refer to Section 3.6.

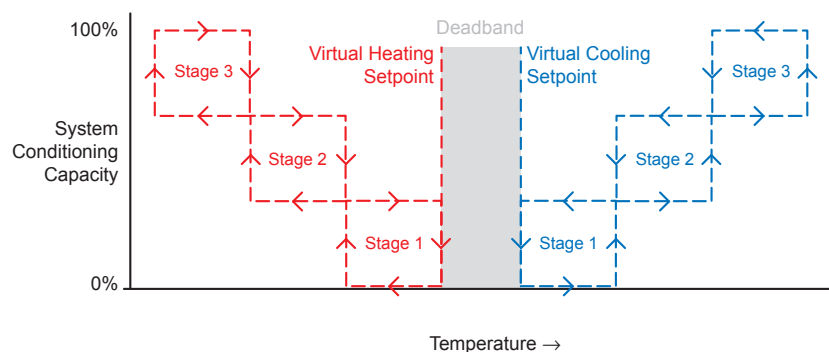
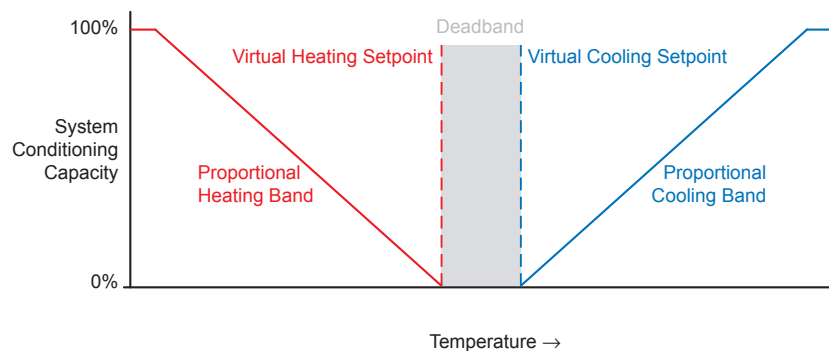
- **Delays (Default = 4 minutes)**
The compressor delay variable controls the length of time between compressor cycles - both on and off. Select from 4 seconds, 40 seconds or 4 minutes.
This setting can be overridden via the hardware settings (Refer to 1.2.4 - Hardware Settings).
- **Deadband (Default = 0 °C)**
Deadband variable defines the temperature range on each side of the setpoint where no corrective action takes place. A deadband value other than 0 results in the creation of separate virtual heating and cooling setpoints, either side of the controller setpoint, offset by half of the deadband value.
Adjustable in 1 °C increments to maximum 3 °C.



- **Control Band (Default = 0.5 °C per stage)**

Control Band defines the width of the cooling and heating proportional bands of the 0-10 volt outputs. There is a separate control band for cooling and heating operation, starting from the virtual cooling and heating setpoints dictated by the deadband.

For multi-stage applications the value of both the stage separation and the switching differential is equal to the control band value divided by the number of stages.



- **Service Timer (Default = Disabled)**

The Service Timer monitors the system run time and at the end of the time period displays a selectable message. Select from 10-990 hours in 10 hour increments.

- **Universal Input message - S1 open (Default = S1 open)**

A message is displayed on the LCD screen when sensor 1 is open circuit. The default message can be replaced by one from the message library (Refer to 1.2.5 - Universal Inputs).

- **Universal Input message - S1 closed (Default = S1 closed)**

A message is displayed on the LCD screen when sensor 1 is closed (short) circuit. The default message can be replaced by one from the message library (Refer to 1.2.5 - Universal Inputs).

- **Universal Input message - S2 closed (Default = S2 closed)**

A message is displayed on the LCD screen when sensor 2 is closed (short) circuit. The default message can be replaced by one from the message library (Refer to 1.2.5 - Universal Inputs).

- **Service Timer message (Default = Service Required)**

The default message displayed when the service Timer expires can be replaced by one from the message library (Refer to 1.2.5 - Universal Inputs).

- **Custom message (Default = Service Required)**

The message library contains one entry of 2 lines of 8 characters that can be edited as required (Refer to 1.2.5 - Universal Inputs).

1.2.4 Hardware Settings

Each control module has the following hardware configuration settings.

Refer to the specification section in the relevant control module technical manual for locations.

DIP/SIP switches

The following table details the function of the hardware configuration DIP/SIP switches.

Control module DIP/SIP switch settings			
DIP #	Function	OFF (Factory Default)	ON
1	Compressor Delay	Software Selectable (4 minute default)	4 seconds max (overrides software)
2	Memory Lock (Diagnostic Use Only)	Disabled	Memory locked. Settings changes are discarded.
3	Restore Factory Default Settings	Disabled	Restore factory defaults at next reboot.
4	Heat Type	Reverse Cycle	Electric Duct Heat (EDH) or Cool Only

1.2.5 Universal Inputs

Analogue inputs S1 and S2 provide additional digital inputs for feedback loops in the following manner (voltage free clean contacts required):

- **S2 Closed Circuit = System Fault**
Short circuit analogue input 2 terminals (S2 and SC) to shutdown all conditioning relays (compressors and electric duct heaters). The fan relay will remain energised only if the system is On.
For 3 speed fan models in auto fan mode the controller will default to low fan speed. Manual changes to fan speed will be accepted.
LCD touchpads emit an audible warning (2 beeps every 16 seconds). Press MENU button to stop audible warning.
- **S1 Closed Circuit = Remote On/Off**
Short circuit analogue input 1 terminals (S1 and SC) to shutdown all relays.
- **S1 Open Circuit = Forced Vent Mode**
Open circuit analogue input 1 terminals (S1 and SC) to shutdown all conditioning relays (compressors and electric duct heaters), the fan and any reversing valve relays will remain energised. If the system is Off, the relay for the currently selected fan speed will be energised.
For 3 speed fan models in auto fan mode the controller will default to low fan speed. Manual changes to fan speed will be accepted.

All connected LCD interfaces will display a message on the screen for each digital input trigger and the service timer trigger. If multiple trigger events occur at the same time, the message displayed is based on the following priority:

1. SYSTEM FAULT
2. SERVICE TIMER
3. REMOTE ON/OFF
4. FORCED VENT

The factory default messages may be replaced by one from the message library (see next page) via the Advanced Settings Menu.

A Nexus interface will display trigger indication for the universal inputs in the following manner:

1. SYSTEM FAULT - $\overline{S2C}$
2. REMOTE ON/OFF - $S1C$
3. FORCED VENT - $S1b$

1.2.6 Message Library

The message library contains a selection of entries that may be used provide a clear indication of the function of each universal input. A LCD interface is required to display or alter these messages. The same message may be linked to more than one trigger.

The library contains one custom entry of 2 x 8 character lines.

Abbreviated version displayed on message selection screen	Message displayed on screen after trigger is activated
<Blank>	
SERVICER (Default Custom Message)	SERVICE REQUIRED
DoorOpen	Door Open
VentMode	Vent Mode
RemoteOf	Remote Off
RemoteSh	Remote Shutdown
CleanFil	Clean Filters
ServiceR (Default Service Timer Message)	Service Required
NoWaterF	No Water Flow
FanOverl	Fan Overload
FireShut	Fire Shutdown
ACPlantF	AC Plant Fault
HPFault	HP Fault
LPFault	LP Fault
HP/LPFau	HP/LP Fault
S1OpenCi (Default Forced Vent Input Message)	S1 Open Circuit
S1Closed (Default Remote On/Off Input Message)	S1Closed Circuit
S2Closed (Default System Fault Input Message)	S2Closed Circuit

1.2.7 Control Module Comparison Chart

Specifications			Standard Control Modules			
			BB8 Chrono	BB5 Nexus	BB5 Lite	BB4 Mini
Environmental	Transport	Temperature Range	0 - 80 °C			
		Humidity	10 - 80 %			
	Operation	Temperature Range	0 - 50 °C			
		Humidity	10 - 80 %			
		Altitude	0 - 2000 m			
Electrical	Power Supply	Supply Voltage	240VAC ± 10%			
		Frequency	50-60Hz			
		Connection Type	3 x Terminal			
Communications	IASNet Bus - to external interfaces	Connection Type	5 x Terminal / 1 x InnoCab socket (RJ12)			
		Cable Type	4 Core + 1 Shield / 5 Core + Shield (flat)			
		Data Refresh Time	1s			
	Microwire Bus - to clock module	Connection Type	Integrated	IDC10 Socket		NA
		Data Refresh Time	1s			
Inputs	Analogue (see 2.1.1 - Universal inputs)	Number	2			
		Type	NTC Thermistor - 47 kΩ @ 25 °C			
		Connection Type	2 x Terminal			
		Cable Type	2 Core + 1 Shield			
		Data Refresh Time	1s			
	Digital	Number	8	1	1	1
		Connection Type	2 x Terminal			
		Operation	Momentary Switch Mode or Latched Mode (Close to run: Open to stop)	Latched Mode (Close for flow - Open for no flow)		
Outputs	Relay	Number	8	5	5	4
		Maximum Load	2.5 A (Inductive)	7 A (Inductive)	7 A (Inductive)	2.5 A (Inductive)
		Connection Type	2 x Terminal (Common, Normally Open)	3 x Terminal (Common, Normally Open, Normally Closed)		
		Status Indication	Via onboard LCD Display	Onboard Coloured LEDs	Via LCD display only	Onboard Coloured LEDs
	Analogue	Number	2			
		Type	1 x 0-10 VDC spanning cooling Control Band 1 x 0-10 VDC spanning heating Control Band			
	Annual Timeclock			Built-in	Optional	Optional
Physical Characteristics		Enclosure Material	ABS			
		Weight	600 g	610 g	560 g	300 g
		Dimensions	174 (L) x 117 (W) x 56 (H)	174 (L) x 117 (W) x 56 (H)	174 (L) x 117 (W) x 56 (H)	133 (L) x 105 (W) x 48 (H)

1.3 Interface Modules

BlackBox series interface modules are categorized by the combination of interface, personality, and connection type. The features and personality required will dictate the type of interface that should be selected for a given application.

External communications to and from BlackBox series controllers is via the IASNet communications bus. Multiple external interfaces may be connected to this bus. Interfaces may be categorized as either user interfaces or network interfaces.

Refer to the BlackBox HMI Technical Manual for detailed information.

1.3.1 Onboard User Interface Modules

The following types of onboard user interface modules are available:

Mini

The Mini onboard interface consists of a single setpoint adjustment pot. The onboard interface is enabled by a slide switch and imposes a 022 personality on the control module. Multi coloured LEDs indicate relay assignment and status.

Nexus

The Nexus interface consists of a 3 x 7 segment LED digital display and six buttons providing access to a reduced set of the controller configuration settings. An 8 way DIP switch allows personality selection from one of three preprogrammed options.

Chrono

The Chrono onboard interface features a 16 character (2 x 8 character lines) backlit liquid crystal display and six buttons providing full access to the controller configuration settings via a menu system. An 8 way DIP switch allows personality selection from one of eight preprogrammed options.

1.3.2 External User Interface Modules

The following types of external user interface modules are available. Not all personalities are available for each interface type. External interfaces send and receive data, and are powered, via the IASNet bus. Refer to the BlackBox HMI Technical Manual for details.

RCP

The Remote Control Panel is a tamper-proof wall mounted interface with On/Off button and system status indicator LEDs for Run, Fault and After Hours. A jumper block on the rear of the device allows selection of one of three preprogrammed personalities (111, 122 and 131). A second jumper block is provided to allow selection of a fixed setpoint. If enabled, this will override setpoint adjustment from any other interface connected to the control module.

BLB

The BLB series touchpads offer a simple graphical LED display with access to a limited set of control functions. Access to these functions may be further limited via the DIP switches on the rear of the device. BLB touchpads are available in 122 and 311 personalities only.

DIG

The DIG series touchpads combines full personality authority and the simplicity of a limited feature set, with a 2 x 7 segment LED digital display. Access to these functions may be further limited via the DIP switches on the rear of the device. DIG touchpads are available in 122 and 311 personalities only.

LCD

The LCD series touchpads features a 16 character (2 x 8 character lines) backlit liquid crystal display and six buttons providing full access to the controller configuration settings via an easy to use menu system. Access to these functions may be limited via the DIP switches on the rear of the device. LCD touchpads are available to suit all personalities.

Service LCD

The service LCD touchpad features the 16 character backlit liquid crystal display providing full access to the controller configuration settings. The touchpad is personality neutral. When connected to a BlackBox series control module, the touchpad displays the personality of that control module.

1.3.3 Network Interface Modules

Bridge interface modules enable local communications between devices on the IASNet bus, and global communications from IASNet to other protocols.

Blackbox Bridge

The BlackBox Bridge module provides local network capability for multiple BlackBox control modules in a master / slave arrangement.

Smartzone Bridge

The Smartzone Bridge module provides local network capability for a single BlackBox control module to connect to a single IAS Smartzone zoning system.

BlackBox RS485 interface

The RS485 interface module provides global network capability for BlackBox control modules to be connected to a RS485 network and controlled from a PC. One RS485 interface module is required for each BlackBox control module. The global network can support up to 256 control modules.

1.3.4 Connection

The connection type indicates the method of connection to the BlackBox series control module. BlackBox series control modules support both connection types. There are external interfaces using the following connection types:

TL: This indicates the module is to be connected to the IASNet terminals (V+ V- D1 D2).

IC: This indicates the module is to be connected to the IASNet Innocab socket (RJ12).

1.3.5 Special options

The following special HVAC and multi-channel timer personalities are also available.

Economy Cycle Controller

013E, 131E and 133E are economy cycle personalities that use outside air to provide the first cooling stage when conditions are suitable.

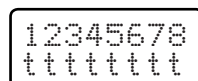
The controller will only enter economy mode if an outside air sensor is connected to the sensor 2 terminals (S2 & SC), and, the outside air temperature will assist the cooling call (S2 temperature is 2 °C lower than S1 temperature).

During economy mode the controller shifts the cooling relay stages 1 °C away from their normal activation points and uses the V1 (0-10V) cooling output to modulate an outside air damper.

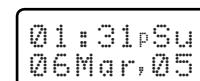
TIME SW⁸ - 8 channel timeswitch

The TIME SW⁸ personality provides 15 timer programs to switch the eight relay outputs. Eight digital inputs provide manual override for each associated output. When the TIME SW8 personality is selected, only the timeswitch functions are displayed on the screen (HVAC functions – which are not available – are not shown).

Timer Display



Clock Display



1.4 Networking

BlackBox series controllers may be networked in two ways.

1. Local network
2. Global network

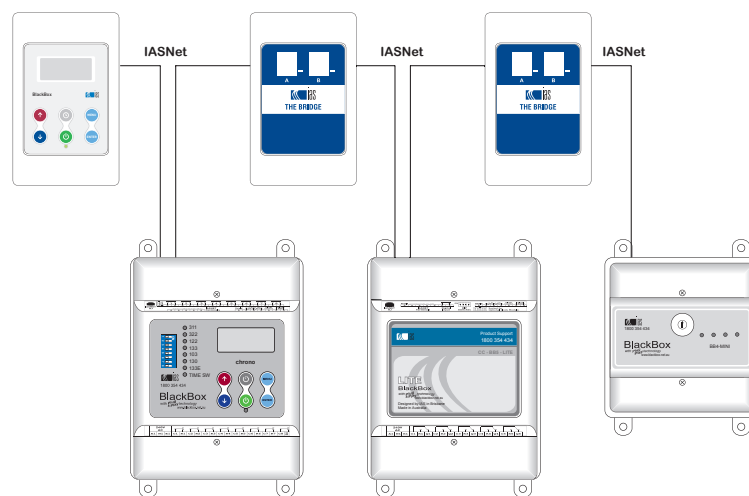
Refer to the BlackBox Networking Technical Manual for detailed information.

1.4.1 Local Networks

A local IAS controller network consists of a master BlackBox control module connected to one or more compatible control modules via a bridge module on the IASNet communications bus of each module.

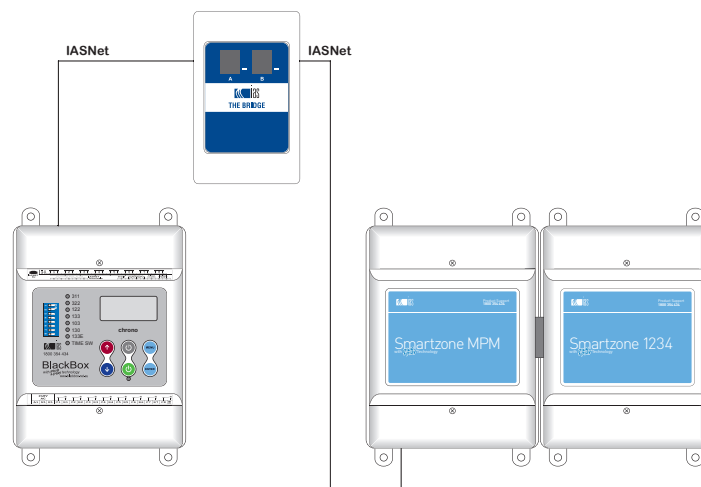
BlackBox to BlackBox Network

Multiple BlackBox control modules may be connected to a local network. The first controller is the master controller. All subsequent controllers are slave controllers.



BlackBox to Smartzone Network

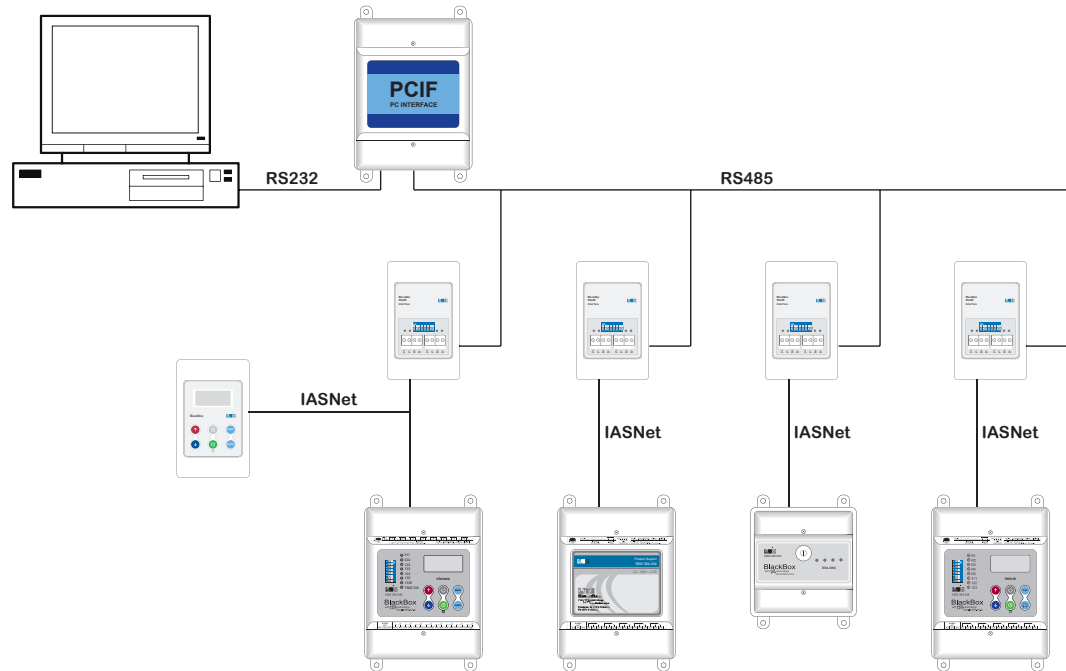
A BlackBox control module may be connected to an IAS Smartzone zoning system to provide an integrated plant control and VAV zoning system.



1.4.2 Global Networks

A global IAS controller network is connected to and controlled from a PC over a RS485 network. Monitoring and control functionality is established via Microsofts Dynamic Data Exchange (DDE) protocol.

The network can have a maximum of 256 nodes. Each node supports a single compatible IAS device.



The following elements are required to establish a network of IAS controllers:

PC

Minimum system requirements:

- Pentium 500MHz,
- 256Mb RAM,
- Windows 98, NT, 2000, XP
- Serial port

IAS PC interface module

The IAS PC interface module acts as a portal for the DDE server software to the RS485 network. Network packets from the RS485 network are translated into a format understood by the DDE server.

Blackbox RS485 interface module

The IAS 485 bridge module provides the network address and IASNet translation services required for communication with the IAS DDE server.

DDE server application

The IAS DDE server application (DDE_BMS.exe) is installed on the PC and defines the item descriptors available to create DDE items to enable read/write access to all standard and advanced control functions.

In response to read/write commands from a DDE client application the IAS DDE server establishes a polling communications channel with the individual RS485 interface modules.

DDE client application

There is a wide range of compatible DDE client applications available, with varying levels of complexity. Examples of DDE client applications include Microsoft Excel and Infilink from KEP.

Documentation of the creation of specific DDE items for these applications is beyond the scope of this document. Refer to the documentation specific to those applications in conjunction with the Networking Technical Manual to create suitable DDE items.

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