BLACK PEAR II

BMS Interface for Toshiba Air-Conditioning

Installation and User Guide

Contents

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■ Warning Indications on the Air Conditioner Unit

Warning indication	Description
WARNING **ELECTRICAL SHOCK HAZARD** Disconnect all remote electric power supplies before servicing.	**WARNING** **ELECTRICAL SHOCK HAZARD** Disconnect all remote electric power supplies before servicing.
WARNING Moving parts. Do not operate unit with grille removed. Stop the unit before the servicing.	**WARNING** **Moving parts.** Do not operate unit with grille removed. Stop the unit before the servicing.
CAUTION High temperature parts. You might get burned when removing this panel.	**CAUTION** High temperature parts. You might get burned when removing this panel.
CAUTION Do not touch the aluminum fins of the unit. Doing so may result in injury.	**CAUTION** Do not touch the aluminum fins of the unit. Doing so may result in injury.
CAUTION **BURST HAZARD** Open the service valves before the operation, otherwise there might be the burst.	**CAUTION** **BURST HAZARD** Open the service valves before the operation, otherwise there might be the burst.

Important Information

➢ **All electrical work should be carried out by a competent person and wiring must be in accordance with the national electrical installation regulations.**

➢ **Ensure that installation work is done correctly using the information contained in this manual.**

➢ **Make all connections securely so that any outside forces acting on the cables are not applied to the terminals.**

➢ **Never modify or repair the Black Pear by yourself.**
Any attempt to do so will void the warranty.

➢ **To dispose of this product, consult your dealer.**

⚠ WARNING

1. **Using the specified wires, ensure to connect the wires, and fix wires securely so that the external tension to the wires do not affect the connecting part of the terminals.**
Incomplete connection or fixation may cause a fire, etc.

2. **Be sure to connect earth wire. (grounding work) Incomplete grounding** cause an electric shock. Do not connect ground wires to gas pipes, water pipes, lightning rods or ground wires for telephone wires.

3. **Appliance shall be installed in accordance with national wiring regulations.**
Capacity shortage of power circuit or incomplete installation may cause an electric shock or a fire.

⚠ CAUTION

- If incorrect/incomplete wiring is carried out, it will cause an electrical fire or smoke.

- Be sure to install an earth leakage breaker that is not tripped by shock waves.
If an earth leakage breaker is not installed, an electric shock may be caused.

- Be sure to use the cord clamps attached to the product.

- Do not damage or scratch the conductive core and inner insulator of power and inter-connecting wires when peeling them.

- Use the power cord and Inter-connecting wire of specified thickness, type, and protective devices required.

- Never connect 220-240V power to the terminal blocks (A , B , U1/U2, U3/U4 etc.) for control wiring (Otherwise,the system will fail).

REQUIREMENT

- For power supply wiring, strictly conform to the Local Regulation in each country.

- For wiring of power supply of the outdoor units, follow the Installation Manual of each outdoor unit.

- Perform the electric wiring so that it does not come to contact with the high-temperature part of the pipe. The coating may melt resulting in an accident.

- After connecting wires to the terminal blocks, provide a trap and fix wires with the cord clamp.

- Run the refrigerant piping line and control wiring line in the same line.

- Do not turn on the power of the indoor unit until vacuuming of the refrigerant pipes completes.

■ Power supply wire and communication wires specifications

Power supply wire and communication wires are procured locally.
For the power supply specifications, follow to the table below. If capacity is little, it is dangerous because overheat or seizure may be caused. For specifications of the power capacity of the outdoor unit and the power supply wires, refer to the Installation Manual attached to the outdoor unit.

Indoor unit power supply

- For the power supply of the indoor unit, prepare the exclusive power supply separated from that of the outdoor unit.

- Arrange the power supply, earth leakage breaker, and main switch of the indoor unit connected to the same outdoor unit so that they are commonly used.

- Power supply wire specification : Cable 3-core 2.5mm^2, **in conformity with Design 60245 IEC 57.**

▼ Power supply

Power supply	220-240V —, 50Hz	
Power supply switch/Earth leakage breaker or power supply wiring/fuse rating for indoor units should be selected by the accummulated total current values of the indoor units.		
Power supply wiring	Below 50m	2.5 mm^2

Control wiring, Central controller wiring

- 2-core with polarity wires are used for the Control wiring between indoor unit and outdoor unit and Central controller wiring.

- To prevent noise trouble, use 2-core shield wire,

- The length of the communication line means the total length of the inter-unit wire length between indoor and outdoor units added with the central control system wire length

1. <u>Supplied Parts</u>

Black Pear 2

DIN-rail clips

Cat-5 'Straight-Through' Ethernet cable

2. <u>Important</u>

- ➢ **All electrical work should be carried out by a competent person and wiring must be in accordance with the national electrical installation regulations.**
- ➢ **Ensure that installation work is done correctly using the information contained in this manual.**
- ➢ **Make all connections securely so that any outside forces acting on the cables are not applied to the terminals.**
- ➢ **Never modify or repair the Black Pear by yourself.**
  Any attempt to do so will void the warranty.
- ➢ **To dispose of this product, consult your dealer.**

> **This unit will require setting up, using either the touch screen or the built in web browser interface.**

3. <u>Product Overview</u>

The Black Pear 2 allows a building management system (BMS) to monitor and control air-conditioning units on a system without the need for a central controller.

It has been designed as a plug-in replacement for the original Black Pear BMS interface, with similar configuration options, all accessible via the touch screen or built-in web browser interface.

The unit incorporates a port which allows direct connection to the following system.

Manufacturer	HVAC network connection	Max. no. of units
Toshiba	U3/U4 TCC-Link	64

A BMS system can communicate with the Black Pear 2 using 3 communications protocols...

1) Modbus (Modbus-RTU via RS485 and Modbus/TCP).

2) BACnet/IP

3) Trend via ethernet. (Also requires an IQ3/4 outstation with spare memory).

> The Black Pear 2 can also be used on systems where a central controller is already present.

3.1 <u>Differences between Black Pear 1 and Black Pear 2</u>

➢ One product now handles all supported HVAC manufacturers and BMS protocols.

➢ The enclosure is approximately 5mm higher, but the width and all of the mounting holes are the same.

➢ A 7" TFT LCD with capacitive touch is fitted as standard.

➢ Configuration is now via the touch screen or web-browser.
The PC configuration software used for Black Pear 1 is not compatible.

➢ A real-time clock has been fitted.

➢ A scheduler has been implemented:

- 4 separate 7-day schedules can be defined.

- 1 schedule can be assigned to each group master unit.

➢ Modbus:

- The RS232 interface has been removed.

- A maximum of 22 slaves are used.

- 'R/C inhibit' registers and coils now allow individual controls to be inhibited.

➢ BACnet:

- COV subscription is now supported. Up to 256 subscriptions can be handled.

- Error code text and error state have been added to the object list.

- Maximum APDU length supported is now 480 octets.

4. Connection Details

> **All electrical work should be carried out by a competent person and wiring must be in accordance with the national electrical installation regulations.**
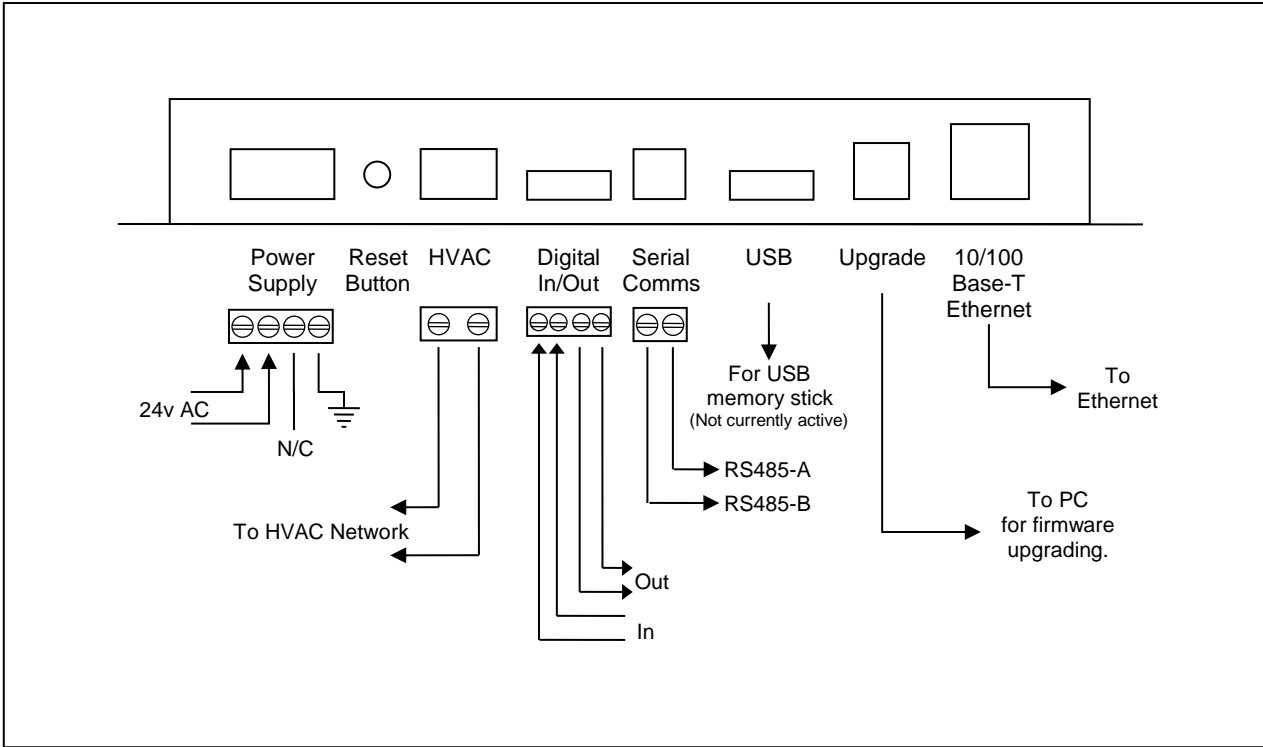
Fig. 1 Connection Details

4.1 Power Supply

The Black Pear 2 requires a 24v AC supply and has a consumption not exceeding 5VA. The internal fuse is rated T630mA.

> **THIS EQUIPMENT MUST BE EARTHED**

4.2 HVAC Communications Network

These are non-polarized, and should be connected to the HVAC communications network as per the HVAC manufacturers' standard central controller installation instructions.

4.3 <u>Serial Communication Port</u>

This connector provide access to the Modbus registers using 2-wire RS485.
The port configuration is as follows:

  Modbus RTU
  9600 baud, 8 data bits, no parity, 1 stop bit

The RS485 interface can be used on a compatible serial communications network shared by multiple RS485 devices. The 'Base Slave Address' must be set to prevent multiple units using the same slave numbers.

It is recommended that screened twisted-pair cable is used.
RS485-A is the non-inverting signal and is also named RS485+
RS485-B is the inverting signal and is also named RS485-
The cable screen should be connected to ground at one end only.
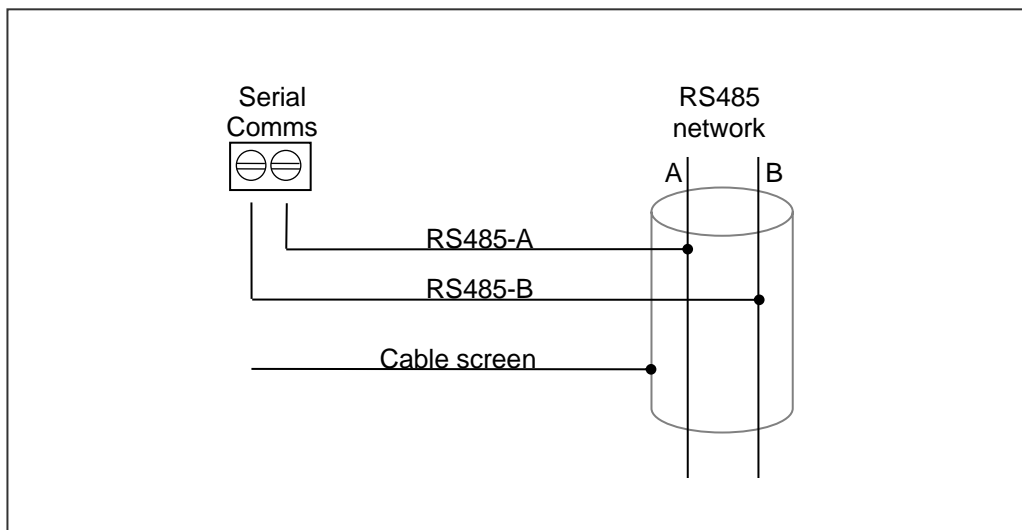
Fig. 2 RS485 Comms Lead Wiring Diagram

4.4 <u>Digital Input / Output</u>

The digital input functions as the 'Global Forced Off' signal. This is a normally-closed, volt-free signal.

Upon detecting an 'Open' input, all available fancoils will be switched off and their remote-controllers will be inhibited. These settings are refreshed every 10 seconds while the input is 'Open'.

When the input is subsequently 'Closed', the remote-controller inhibits are removed, but the fancoils remain off (provided a 'Global-Off' signal has not been generated from another source).

The digital output currently has no functionality.

4.5 <u>USB</u>

This is a standard USB-A socket for use with a USB memory stick.
It is currently not active.

4.6 <u>Upgrade</u>

This is a standard USB-B socket and is only used for upgrading the firmware, as an alternative to using the ethernet interface.

> **Ensure that the correct USB driver has been installed prior to connecting the Black Pear 2 to a PC.**

4.7 <u>Ethernet</u>

The Black Pear 2 is a 10/100Base-T half/full duplex device. It supports auto-negotiation and also features auto-crossover (Auto-MDIX), allowing the use of either a straight-through or crossover cable.

It supports either DHCP or static IP address setting.
If static IP is used, then the Black Pear 2 will require the IP address, gateway address and subnet-mask configuring to match the host network it is attached to.

> **If the unit is only being accessed via the local network then set the gateway address to be the same as the IP address, otherwise enter the address of the appropriate gateway or router.**

5. <u>Air-Conditioning Address Configuration</u>

The systems need to be set up as if a manufacturer's standard central controller is to be fitted. The Black Pear 2 can replace or work in parallel with a central controller.

Units can be grouped within the Black Pear via the HVAC configuration page. The groupings determine which unit addresses can accept commands from the BMS system.

The group number is defined as 'the lowest indoor unit address within the group'. This then becomes the 'master' address for the group, and is the only address within that group that can accept commands.

The other units within a group can be classed as 'slave' units and contain the same status parameter values as the 'master', apart from Return Air Temp and Error Code, which are unique to each unit.

> **Attempting to write a command to a 'slave' unit will have no effect.**

If you wish to be able to monitor slave units within a group, ensure that they are configured as individual units (via the A/C system) and grouped using the Black Pear.

5.1 Toshiba Connection and Addressing Example

Connect to outdoor unit terminals U3 and U4, as per a standard central controller.
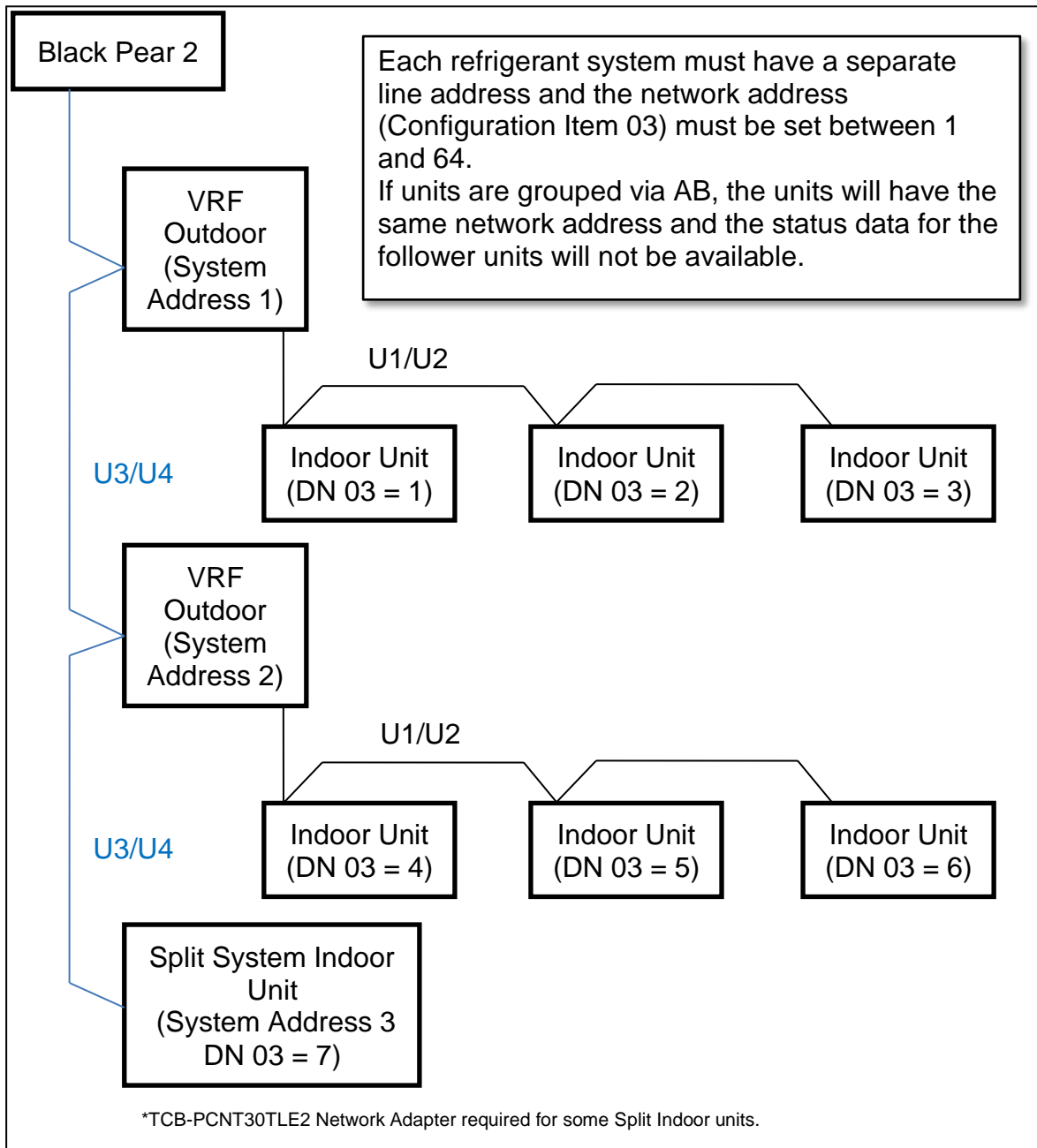
Fig. 6 Toshiba Wiring Example

6. <u>User Interface</u>

6.1 <u>Startup Sequence</u>

Shortly after power-up or a system reset, the system overview page appears, ready to start the initial HVAC scan.	After a short delay, the scan will start.	Once the scan has completed, the overview screen will look like this. All units found during the scan will be highlighted on the grid, in various colours.

6.2 <u>System Overview Key</u>

01	Unit Off (red unit number)	**02**	Unit On (green unit number)
	Master unit (dark blue background)		Slave unit (light blue background)
	Unit has not been detected (grey button)		Unit in error (flashing red outline)
	Display Configuration Menu	UU gg	UU = Unit number gg = Group number

6.3 <u>Unit Control</u>

Tapping a detected unit will display the manual control screen.
The control options visible will depend on the type of unit selected.

Tap the page curls to show the next/previous detected unit.
Tap the green arrow to return to the system overview screen.

6.4 Configuration Menu

	Restore			Protocol
🔓	**Restore** Restore factory defaults.		🔓	**Protocol** Configure BMS protocols.
🔓	**Date and Time** Set clock and network time server.		🔓	**HVAC** Configure HVAC interface and groupings.
🔓	**Schedule** Create schedules and attach to groups.		🔓	**Unit Names** Change unit names.
🔓	**Security** Set pin code.		🔓	**Web Server** Configure web interface.
	Error Log View list of alarms detected			**Information** Show firmware details.
	Diagnostics Show various diagnostic info.			**Reboot** Perform a system reset. This is recommended after any changes to the configuration.
🔓	**Network** Setup ethernet interface.			

🔓	**Pin Code Required** Indicates options requiring the pin code. Once the correct pin has been entered, it will not need re-entering until the configuration button is pressed on the system overview screen. Factory default pin code: 0000

6.5 Recommended Initial Setup Sequence

1) Configure HVAC
   - Select manufacturer.
   - Configure unit groupings and global-off functionality.
2) Configure network
   - Select DHCP or Static IP
   - If Static IP, enter IP address, gateway address, subnet mask and DNS addresses.
3) Select BMS protocol
   - Enable and setup required protocol (Note: Modbus is always enabled).
4) Set date and time
   - Set the clock manually or use the network time feature to automatically set it.
5) Reboot
   - This is always recommended after making changes to the configuration.

6.6 <u>Configuration Menu Options</u>

Below is a list of the configuration menu entries, together with a brief description of the settings and information that are available.

The configuration pages accessed via the web browser interface give a little bit more information about each item.

Restore	Reload Factory Defaults (see Appendix C for details)
Date and Time	Set Data & Time manually Setup Network Time Server for automatic time setting
Schedule	Edit Schedules Assign Schedules to Groups
Security	Set Pin Code
Error Log	View Error History (not retained through power-outage or reboot)
Diagnostics	Show information for Ethernet, Trend, BACnet and webserver
Network	Set Device/Hostname Enable DHCP or set Static IP address
Protocol	Configure BACnet, Trend and Modbus interfaces
HVAC	Set HVAC manufacturer Set Unit groupings Enable/Disable Global-Off for each group Set R/C inhibit for each group
Unit Names	Alter unit names (used on-screen and by BACnet)
Web Server	Enable/disable webserver interface Alter TCP port number used
Information	Firmware/Hardware version information BMS protocol enable/disable status
Reboot	Force the Black Pear 2 to restart (recommended after altering configuration)

7. <u>Web Browser Interface</u>

The Black Pear 2 has a built-in webserver which allows the system to be monitored, controlled and configured using a web browser. The pages can be viewed on both desktop PCs and mobile devices, provided the web browser is up to date.
To access the webserver, type the IP address of the Black Pear 2 into the address bar of the browser.

<u>Notes:</u>	1) The current IP address of the Black Pear 2 can be found under 'Ethernet' on the Diagnostics page.
	2) Only 1 active connection to the web browser interface is allowed at a time.

There are 3 different views available, Group View, Unit View and Configuration. These are selectable using the ☰ button in the top right corner of the page.

7.1 <u>Group View</u>

'Group view' shows only the master unit for each group, together with the current settings. Global-Off status for this group, error status and return air temperature are also displayed.

Clicking the ⋮ symbol displays a secondary menu, which currently has an entry to show the member units of that group.

7.2 <u>Unit View</u>
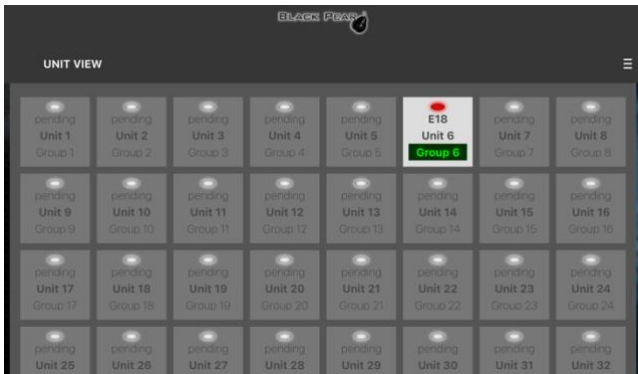
'Unit view' shows an overview of the HVAC system, highlighting all the units that have been detected.

Clicking on a detected unit displays the current status of that unit, and whether or not it is a group master.
The settings can only be changed if the unit is a group master.

7.3 <u>Configuration Page</u>
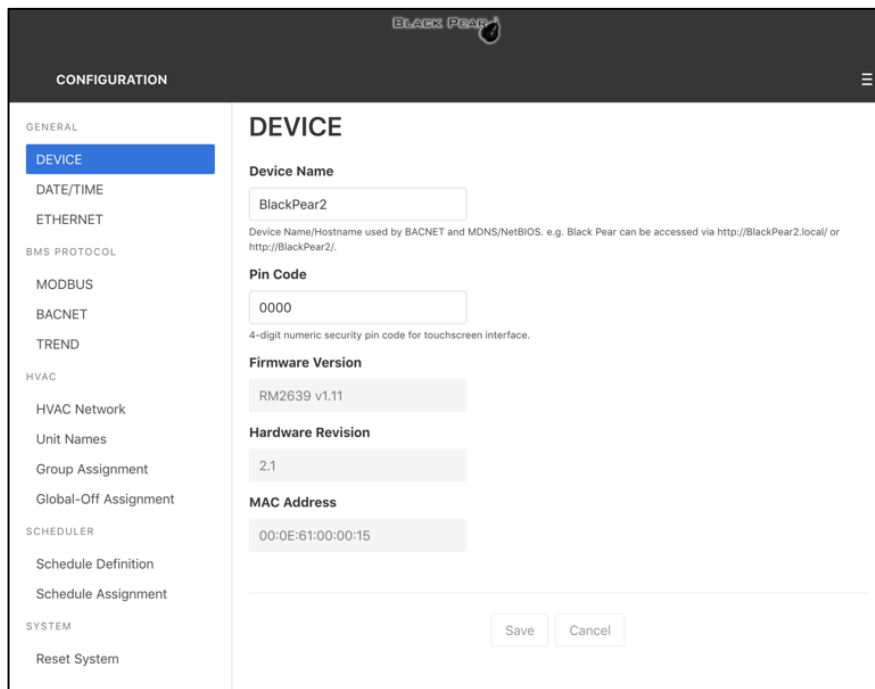
The configuration menu will either be on the left or across the top, depending on the width of the web browser page.

> **<u>Note:</u>**   After making changes on a page, click the 'Save' button at the bottom of the page to update the Black Pear 2 settings.

When configuration is complete, click the 'Reboot' button on the 'Reset System' page.

8. <u>Modbus Interface</u>
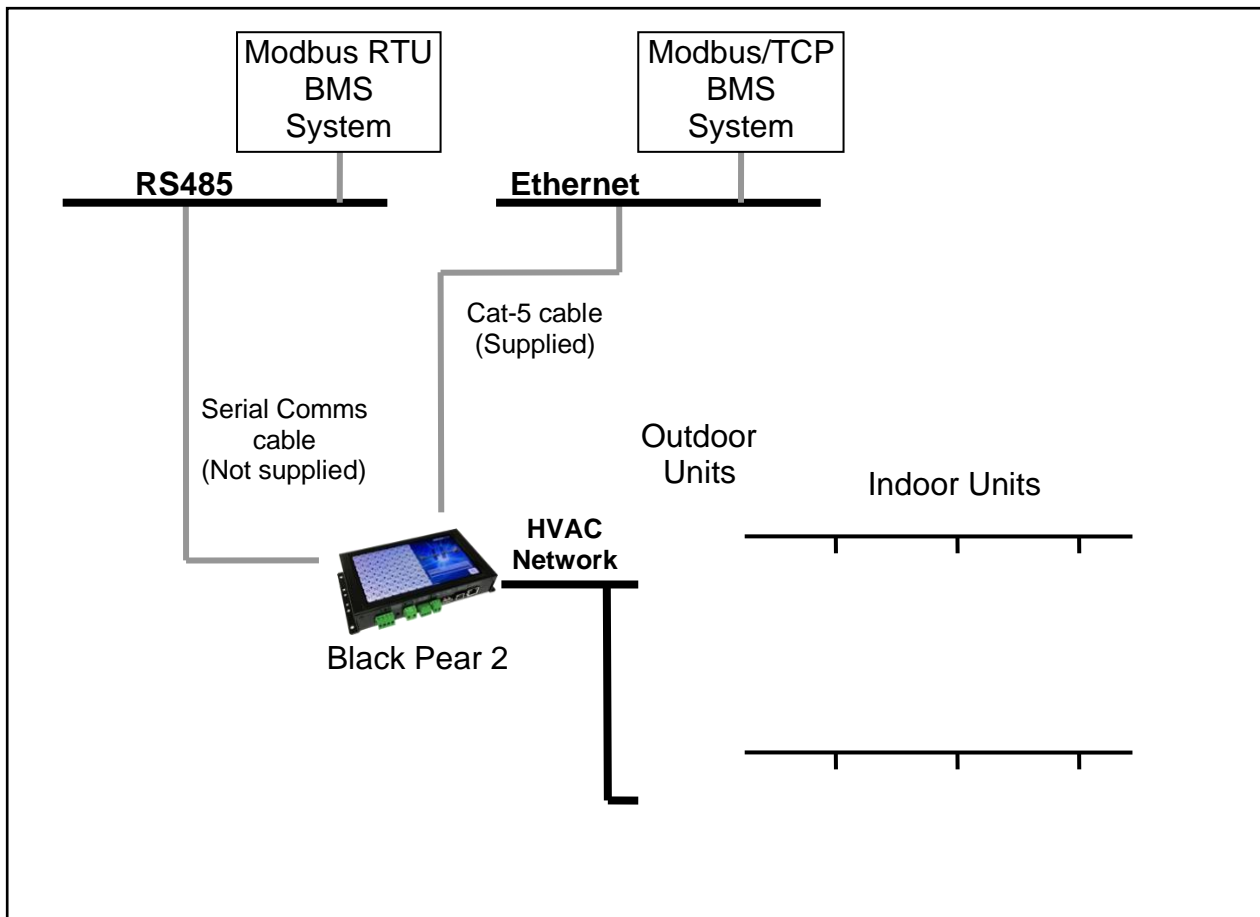
Fig. 7 Modbus System Example

8.1 <u>Port Configurations</u>

RS485 interface
  Modbus RTU
  9600 baud, 8 data bits, no parity, 1 stop bit

Network interface
  Modbus/TCP
  2 simultaneous Modbus/TCP client connections are supported:
          1 only uses TCP port 502 (default Modbus/TCP port)
          2 uses a user configurable TCP port number

Modbus functions supported
   Fn 1   Read Coils
   Fn 3   Read Holding Registers
   Fn 5   Write Single Coil
   Fn 6   Write Single Register
   Fn 16   Write Multiple Registers (Max. 16 registers at once)

8.2 HVAC Status and Control Registers

The Black Pear 2 behaves as 22 modbus slaves. Each slave contains 90 registers (Offset = 0 to 89).

The default 'Base Slave Address' is 1, meaning the Black Pear will respond to msgs for slaves 1 to 22. The Base Slave Address can be adjusted from 1 up to 200. A setting of 200 means the Black Pear will respond to msgs for slaves 200 to 221.
This is useful to prevent address clashing when the Black Pear unit is attached to a serial communications network containing multiple Modbus devices.

Some BMS systems have limited slave address resources, so the 'Single Slave Access' feature means the Black Pear can be configured to respond to just 1 slave address (i.e. the 'Base Slave Address' setting).

The Black Pear maps the data from the air conditioner units into Modbus registers accessed by two Modbus parameters 'Slave No.' and 'Offset'.

All slave numbers referred to in this document assume the default Base Address.

On a system with a maximum of 50 units, slaves 1 to 16 each represent 3 units (A,B & C), and slave 17 represents 2 units (A & B).
On a system with a maximum of 64 units, slaves 1 to 21 each represent 3 units (A,B & C), and slave 22 represents 1 unit (A).
Each slave is organised as follows:

General Information		
Unit A	Unit B	Unit C
Offset 0	Offset 10	Offset 20

Extended Information		
Unit A	Unit B	Unit C
Offset 30	Offset 40	Offset 50

Extra Information		
Unit A	Unit B	Unit C
Offset 60	Offset 70	Offset 80

General information for a single unit	
Register Offset	Stored Value
0	Return Air Temp
1	Error Code
2	Setpoint (R)
3	Mode (R)
4	Fan Speed (R)
5	Setpoint (W)
6	Mode (W)
7	Fan Speed (W)
8	On/Off (R)
9	On/Off (W)

Extended information for a single unit	
Register Offset	Stored Value
0	Air Direction (R)
1	Air Direction (W)
2	R/C Inhibit (R)
3	R/C Inhibit (W)
4	Ventilation (R) ✶
5	Ventilation (W) ✶
6	Error Code (DispA)
7	Error Code (DispB)
8	Reserved
9	Unused

Extra information for a single unit	
Register Offset	Stored Value
0	'Hi-res' Return Air
1	'Hi-res' Setpoint (R)
2	'Hi-res' Setpoint (W)
3	Unused
4	Unused
5	Unused
6	Unused
7	Unused
8	Unused
9	Unused

See Section 8.6 for an overview of Modbus slave and offset usage.

Examples:
1) To read the current fan speed of unit 8

Single Slave Access = Off		
Slave	Function	Offset
3	3	14

Single Slave Access = On		
Slave	Function	Offset
1	3	194

2) To read the current mode of unit 48

Single Slave Access = Off		
Slave	Function	Offset
16	3	23

Single Slave Access = On		
Slave	Function	Offset
1	3	1373

✶ Not currently supported

8.3 <u>Coil Usage</u>

On/Off, inhibits and error status can also be accessed via 'Coils'. The inhibits can be controlled all at once or individually.

Each slave contains 48 coils, organised as follows:

Coil Offset	Definition	Coil Offset	Definition
0	Unit A On/Off (R)	24	Unit A Inhibit Setpoint (R)
1	Unit A On/Off (W)	25	Unit A Inhibit Setpoint (W)
2	Unit B On/Off (R)	26	Unit B Inhibit Setpoint (R)
3	Unit B On/Off (W)	27	Unit B Inhibit Setpoint (W)
4	Unit C On/Off (R)	28	Unit C Inhibit Setpoint (R)
5	Unit C On/Off (W)	29	Unit C Inhibit Setpoint (W)
6	Unit A Inhibit Any (R)	30	Unit A Inhibit Fan Speed (R)
7	Unit A Inhibit All (W)	31	Unit A Inhibit Fan Speed (W)
8	Unit B Inhibit Any (R)	32	Unit B Inhibit Fan Speed (R)
9	Unit B Inhibit All (W)	33	Unit B Inhibit Fan Speed (W)
10	Unit C Inhibit Any (R)	34	Unit C Inhibit Fan Speed (R)
11	Unit C Inhibit All (W)	35	Unit C Inhibit Fan Speed (W)
12	Unit A Inhibit On/Off (R)	36	Unit A Inhibit Air Dir (R)
13	Unit A Inhibit On/Off (W)	37	Unit A Inhibit Air Dir (W)
14	Unit B Inhibit On/Off (R)	38	Unit B Inhibit Air Dir (R)
15	Unit B Inhibit On/Off (W)	39	Unit B Inhibit Air Dir (W)
16	Unit C Inhibit On/Off (R)	40	Unit C Inhibit Air Dir (R)
17	Unit C Inhibit On/Off (W)	41	Unit C Inhibit Air Dir (W)
18	Unit A Inhibit Mode (R)	42	Unit A Error Status (R)
19	Unit A Inhibit Mode (W)	43	Not used
20	Unit B Inhibit Mode (R)	44	Unit B Error Status (R)
21	Unit B Inhibit Mode (W)	45	Not used
22	Unit C Inhibit Mode (R)	46	Unit C Error Status (R)
23	Unit C Inhibit Mode (W)	47	Not used

<u>Note</u>
Coil access is not available when 'Single Slave Access' is enabled.

8.4 <u>Additional Register Usage</u>

Slave	Offset	Single Slave Offset	Description	Valid Settings
22	20	1910	HVAC Network Status	00: Waiting 01: Searching 02: Ready 03: Unknown
22	21	1911	System Force Off	00: Not active 01: Active

See Section 10.5 for a description of these additional registers.

8.5 <u>Parameter Settings</u>

8.5.1 <u>Toshiba Settings for Modbus and Trend</u>

Parameter	Settings	Notes
Return Air Temperature	-35ºC to 92ºC	Read-only
'Hi-res' Return Air	-35.0ºC to 92.0ºC	register contains the value multiplied by 10. eg. 235 = 23.5ºC
Error Code	4 digit error code where 8000 = 'No Error' 6999 = 'Unit Not Present'	Read-only See Appendix D
Setpoint Temperature	18ºC to 29ºC	
'Hi-res' Setpoint	18.0ºC to 29.0ºC	register contains the value multiplied by 10. eg. 255 = 25.5ºC
Operation Mode	00: Fan (Draft) 01: Cool 02: Heat 03: Dry 04: Auto 05: (Not Used)	
	06: AutoCool 07: AutoHeat	Not settable
	08: Heat Exchange 09: VN-Auto 10: VN-Bypass	VN units only
Fan Speed	00: Low 01: Medium 02: High 03: Auto	
On/Off	00: Off 01: On	
Air Direction	00: Horizontal 01: 22½ deg 02: 45 deg 03: 67½ deg 04: Vertical 05: Swing 06: Hold	
Local R/C Inhibit	00: No inhibited controls 01: On/Off 02: Mode 04: Setpoint 08: Fan Speed 16: Air Direction	Individual inhibits can be combined by adding settings together. eg. Inhibit All = 31

8.6 Modbus Table Overview

Unit Address	Slave	General Info Base Offset	Extended Info Base Offset	Extra Info Base Offset	Single Slave Access		Coil Base Offsets	
					General Info Base Offset	Extended Info Base Offset	On/Off	Inhibit
1	1	0	30	60	0	30	0	6
2	1	10	40	70	10	40	2	8
3	1	20	50	80	20	50	4	10
4	2	0	30	60	90	120	0	6
5	2	10	40	70	100	130	2	8
6	2	20	50	80	110	140	4	10
7	3	0	30	60	180	210	0	6
8	3	10	40	70	190	220	2	8
9	3	20	50	80	200	230	4	10
10	4	0	30	60	270	300	0	6
11	4	10	40	70	280	310	2	8
12	4	20	50	80	290	320	4	10
13	5	0	30	60	360	390	0	6
14	5	10	40	70	370	400	2	8
15	5	20	50	80	380	410	4	10
16	6	0	30	60	450	480	0	6
17	6	10	40	70	460	490	2	8
18	6	20	50	80	470	500	4	10
19	7	0	30	60	540	570	0	6
20	7	10	40	70	550	580	2	8
21	7	20	50	80	560	590	4	10
22	8	0	30	60	630	660	0	6
23	8	10	40	70	640	670	2	8
24	8	20	50	80	650	680	4	10
25	9	0	30	60	720	750	0	6
26	9	10	40	70	730	760	2	8
27	9	20	50	80	740	770	4	10
28	10	0	30	60	810	840	0	6
29	10	10	40	70	820	850	2	8
30	10	20	50	80	830	860	4	10
31	11	0	30	60	900	930	0	6
32	11	10	40	70	910	940	2	8
33	11	20	50	80	920	950	4	10
34	12	0	30	60	990	1020	0	6
35	12	10	40	70	1000	1030	2	8
36	12	20	50	80	1010	1040	4	10
37	13	0	30	60	1080	1110	0	6
38	13	10	40	70	1090	1120	2	8
39	13	20	50	80	1100	1130	4	10
40	14	0	30	60	1170	1200	0	6
41	14	10	40	70	1180	1210	2	8
42	14	20	50	80	1190	1220	4	10
43	15	0	30	60	1260	1290	0	6
44	15	10	40	70	1270	1300	2	8
45	15	20	50	80	1280	1310	4	10
46	16	0	30	60	1350	1380	0	6
47	16	10	40	70	1360	1390	2	8
48	16	20	50	80	1370	1400	4	10

Unit Address	Slave	General Info Base Offset	Extended Info Base Offset	Extra Info Base Offset	Single Slave Access		Coil Base Offsets	
					General Info Base Offset	Extended Info Base Offset	On/Off	Inhibit
49	17	0	30	60	1440	1470	0	6
50	17	10	40	70	1450	1480	2	8
51	17	20	50	80	1460	1490	4	10
52	18	0	30	60	1530	1560	0	6
53	18	10	40	70	1540	1570	2	8
54	18	20	50	80	1550	1580	4	10
55	19	0	30	60	1620	1650	0	6
56	19	10	40	70	1630	1660	2	8
57	19	20	50	80	1640	1670	4	10
58	20	0	30	60	1710	1740	0	6
59	20	10	40	70	1720	1750	2	8
60	20	20	50	80	1730	1760	4	10
61	21	0	30	60	1800	1830	0	6
62	21	10	40	70	1810	1840	2	8
63	21	20	50	80	1820	1850	4	10
64	22	0	30	60	1890	1920	0	6

9. <u>Trend Interface</u>
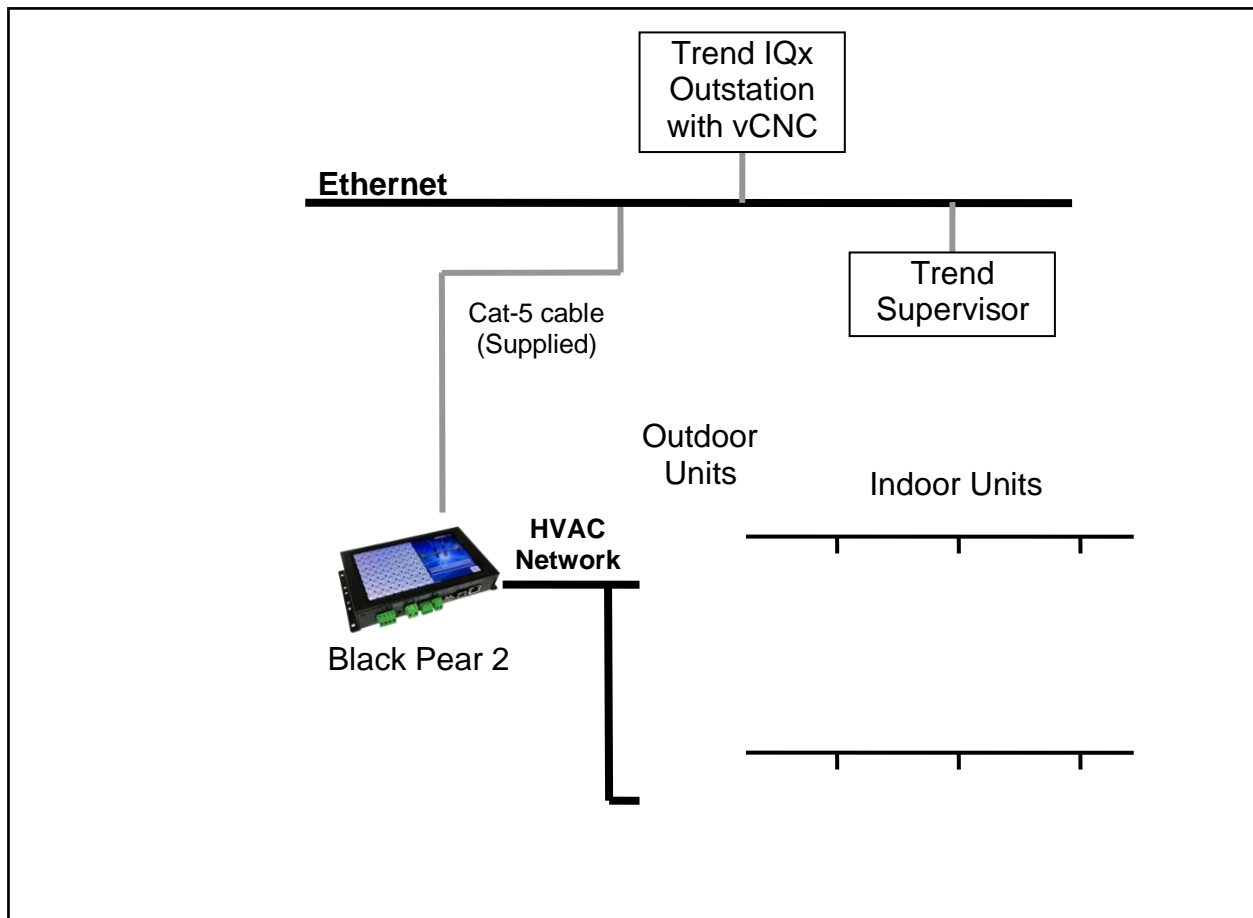
Fig. 8 Trend System Example

The Black Pear connects via Ethernet to a CNC or the virtual CNC port of a Trend IQ outstation, and uses sensors, switches and knobs defined in the IQx memory to mirror a range of HVAC parameters, making them available on a Trend network.

9.1 <u>Trend Process Description</u>

Startup Sequence

1) Power up
2) Waiting for initial scan
3) Perform initial HVAC scan
4) Initial scan complete
5) Connect to CNC port
6) Transfer current HVAC status to required Trend outstation ("First Pass")
7) Disconnect from CNC port
8) Wait for re-connection time
9) Connect to CNC port
10) Poll the objects for each active HVAC unit in the Trend outstation, then either
      Update the HVAC if the value of a Trend object has been altered, or
      Update the Trend object if the value of an HVAC parameter has changed.
11) Disconnect from CNC port
12) Wait for re-connection time
13) Goto 9

At power-up, the Black Pear will wait for the initial HVAC scan to begin. During this scan, all available 'active' HVAC units are discovered. Once the scan is complete, the Black Pear will transfer all current parameter settings to the appropriate objects in the destination Trend outstation. This process is called the 'First Pass'. This ensures that the values in the Black Pear and the Trend device are in sync. Until the 'First Pass' is complete, all commands sent from the Trend network to the Black Pear will be ignored.

The re-connection time is calculated from the CNC Usage setting within the Black Pear. This ensures that all Black Pear devices sharing a single CNC have enough time to connect.

<u>Notes:</u>
①   Some Trend systems will generate 'network alarms' due to the repeated connection and disconnection of the Black Pear to the CNC.
Setting the CNC Usage = 0 will allow a single Black Pear to remain connected to the CNC, thus preventing these alarms from being generated.

> **Following a reconfiguration of the Trend outstation, it is important that the Black Pear is restarted, to guarantee that all parameters are in sync.**

9.2 Trend IQx Outstation Configuration

3 sensors, 2 switches and 4 knobs are required to store all the parameters for a single unit.

The table below shows how to calculate the number of each object required :

Fan Coil Parameter	Sensor No.	Switch No.	Knob No.
Return Air	S+((FC-1)*3)		
Error Code	S+((FC-1)*3)+1		
{HVAC specific} ①	S+((FC-1)*3)+2		
On/Off		W+((FC-1)*2)	
Inhibit		W+((FC-1)*2)+1	
Setpoint			K+((FC-1)*4)
Mode			K+((FC-1)*4)+1
Fan Speed			K+((FC-1)*4)+2
Air Direction			K+((FC-1)*4)+3

where   FC   = Fan Coil Address (1 to 64)
               S   = Sensor Base Address
               W   = Switch Base Address   } These are configurable
               K   = Knob Base Address

E.g.
If   Sensor Base Address   = 100
          Switch Base Address   = 50
          Knob Base Address   = 50

then the following table shows the object numbers required for addresses 1,2,50,63 and 64.

	FC 1	FC 2	…	FC 50	…	FC 63	FC 64
Sensors	100 to 101	103 to 104	…	247 to 249	…	286 to 287	289 to 290
Switches	50 to 51	52 to 53	…	148 to 149	…	174 to 175	176 to 177
Knobs	50 to 53	54 to 57	…	246 to 249	…	298 to 301	302 to 305

The Black Pear can be configured to enable only those objects of interest to the user, therefore reducing the memory overhead required in the IQ outstation. Any objects enabled in the Black Pear which aren't defined in the Trend outstation will simply be ignored during the polling sequence.
Note that this does not change the sensor, switch and knob numbers associated with each HVAC parameter.

> **If a sensor has been added to the sequence table then its 'Value' output must be connected to its 'Source Value' input, otherwise it will return a reading of zero.**

See Appendix D for details of the memory requirements in the Trend outstation.

9.3 Parameter Settings

See the tables in Section 8.5 for a list of valid parameter settings.

10. <u>BACnet Interface</u>

<div align="center">
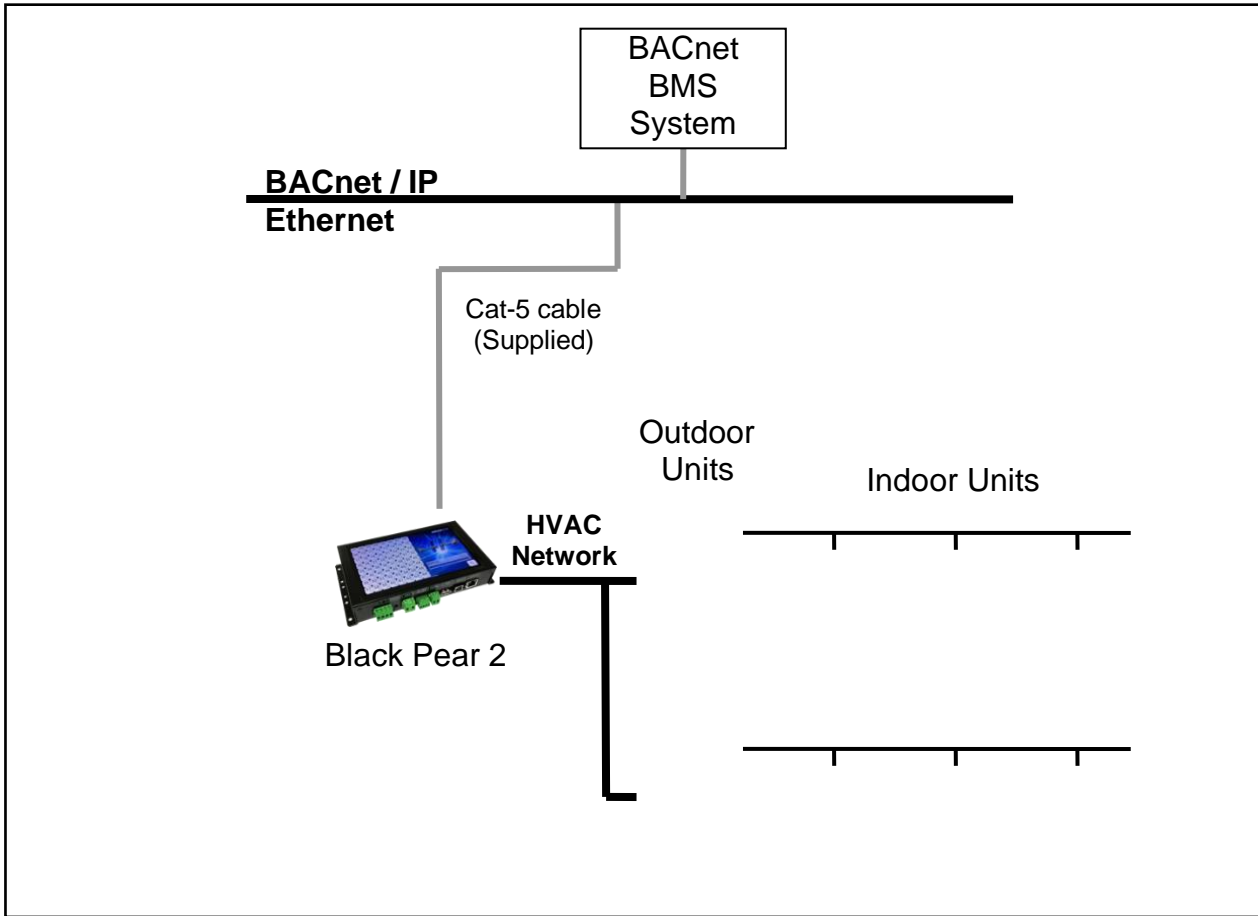
Fig. 9 BACnet System Example

</div>

The BLACK Pear 2 is designed to work with a BACnet/IP network as described in the ANSI/ASHRAE Standard 135-2010.

Property	Setting
Segmentation	Not Supported
Maximum APDU length supported	480 octets
Object List	Supported
Device ID	User settable
Device Name	User settable
Object Names	User settable
Maximum COV subscriptions	256

10.1 <u>Object Types</u>

Object Type		Supported
Analog Input	0	Yes
Analog Output	1	Yes
Analog Value	2	
Binary Input	3	Yes
Binary Output	4	Yes
Binary Value	5	Yes
Calendar	6	
Command	7	
Device	8	Yes
Event Enrollment	9	
File	10	
Group	11	
Loop	12	
Multi-State Input	13	Yes
Multi-State Output	14	Yes
Notification Class	15	
Program	16	
Schedule	17	
Averaging	18	
Multi-State Value	19	
Trend Log	20	
CharacterString Value	40	Yes

10.2 <u>Service List</u>

Supported Services		Notes
Confirmed COV Notification	1	
Subscribe COV	5	
Read Property	12	
Read Property Multiple	14	
Write Property	15	
Write Property Multiple	16	
Device Communication Control	17	
Re-Initialize Device	20	Only 'ColdStart' implemented
I-Have	27	
Unconfirmed COV Notification	28	
Who-Has	33	
Who-Is	34	
I-Am	36	

10.3 <u>Object Lists</u>

10.3.1 <u>Toshiba Object List</u>

Object	Object Type	Instance No.	'Present Value' Settings	Notes
On/Off (Setup)	Binary Output	1xxx01	Inactive: Off Active: On	
On/Off (State)	Binary Input	1xxx02	Inactive: Off Active: On	
Error Code	Analog Input	1xxx03	4 digit error code where 8000= 'No Error' 6999= 'Unit Not Present'	See Appendix F
Operation Mode (Setup)	Multi-State Output	1xxx04	01: Fan 02: Cool 03: Heat 04: Dry 05: Auto 06: N/A	
			07: Auto Cool 08: Auto Heat	Not settable
			09: Heat Exchange 10: VN-Auto 11: VN-Bypass	VN units only
Operation Mode (State)	Multi-State Input	1xxx05	01: Fan 02: Cool 03: Heat 04: Dry 05: Auto 06: N/A	
			07: Auto Cool 08: Auto Heat	
			09: Heat Exchange 10: VN-Auto 11: VN-Bypass	VN units only
Fan Speed (Setup)	Multi-State Output	1xxx06	01: Low 02: Medium 03: High 04: Auto	
Fan Speed (State)	Multi-State Input	1xxx07	01: Low 02: Medium 03: High 04: Auto	
Room Temperature	Analog Input	1xxx08	-35.0ºC to 92.0ºC	
Setpoint Temperature (Setup)	Analog Output	1xxx09	18.0ºC to 29.0ºC	①
Setpoint Temperature (State)	Analog Input	1xxx10	18.0ºC to 29.0ºC	①

Object	Object Type	Instance No.	'Present Value' Settings	Notes
Local R/C Inhibit (Setup)	Binary Output	1xxx11	Inactive: Off Active: Inhibit	
Local R/C Inhibit (State)	Binary Input	1xxx12	Inactive: Off Active: Inhibited	
Air Direction (Setup)	Multi-State Output	1xxx13	01: Horizontal 02: 22½ deg 03: 45 deg 04: 67½ deg 05: Vertical 06: Swing 07: Hold	
Air Direction (State)	Multi-State Input	1xxx14	01: Horizontal 02: 22½ deg 03: 45 deg 04: 67½ deg 05: Vertical 06: Swing 07: Hold	
(Unused)		1xxx15		
(Unused)		1xxx16		
{HVAC Specific}	Analog Input	1xxx17		②
Error Code Text	CharacterString Value	1xxx18	HVAC Manufacturers' Error Code	
Error State	Binary Input	1xxx19	Inactive: Ok Active: In Error	
(Unused)		1xxx20		
(Unused)		1xxx21		
(Unused)		1xxx22		
HVAC Network Status	Multi-State Input	100023	01: Waiting 02: Searching 03: Ready 04: Unknown	
System Force Off	Binary Value	100024	Inactive: Off Active: On	
Device	Device	zzz		zzz = 1 to 4194302

where xxx represents unit address 001 to 064

10.4 <u>Object Names</u>

Object	Object Name	Notes
On/Off (Setup)	nnn (ON_w)	
On/Off (State)	nnn (ON_r)	
Error Code	nnn (ECode)	
Operation Mode (Setup)	nnn (MD_w)	
Operation Mode (State)	nnn (MD_r)	
Fan Speed (Setup)	nnn (FS_w)	
Fan Speed (State)	nnn (FS_r)	
Room Temperature	nnn (RA)	
Setpoint Temperature (Setup)	nnn (SP_w)	
Setpoint Temperature (State)	nnn (SP_r)	
Local Inhibit (Setup)	nnn (LI_w	
Local Inhibit (State)	nnn (LI_r)	
Air Direction (Setup)	nnn (AD_w)	
Air Direction (State)	nnn (AD_r)	
Error Code Text	nnn (Error Text)	
Error State	nnn (Error State)	
HVAC Network Status	Sys_HVAC_Network_Status	
System Force Off	Sys_Force_Off	

where 'nnn' is the unit name entered via the 'Unit Name' configuration page.

### <u>Notes:</u>

①   Setting the setpoint to 1 dp is reliant on the HVAC unit accepting setpoint commands to this resolution.

10.5 <u>System Objects</u>

There are 2 'System' objects contained within the Black Pear, which are classed as global objects. A description of each is detailed below.

System Object	Description
HVAC Network Status	Read-only object providing an indication of the communication status between the Black Pear and the HVAC network. The various states are defined as follows: <u>Waiting:</u> The Black Pear has been restarted and is preparing to start scanning the HVAC network. <u>Searching:</u> The Black Pear is performing its initial scan of the HVAC network, looking for active units within the allowable address range. <u>Ready:</u> The initial scan is complete and the Black Pear will now accept new commands. <u>Unknown:</u> An undefined state has been detected. <u>Note</u>: Until the status = 'Ready', commands send to the Black Pear will be ignored.
System Force Off	Writeable object to enable and disable the 'global off' command.

Appendix A : Physical Dimensions
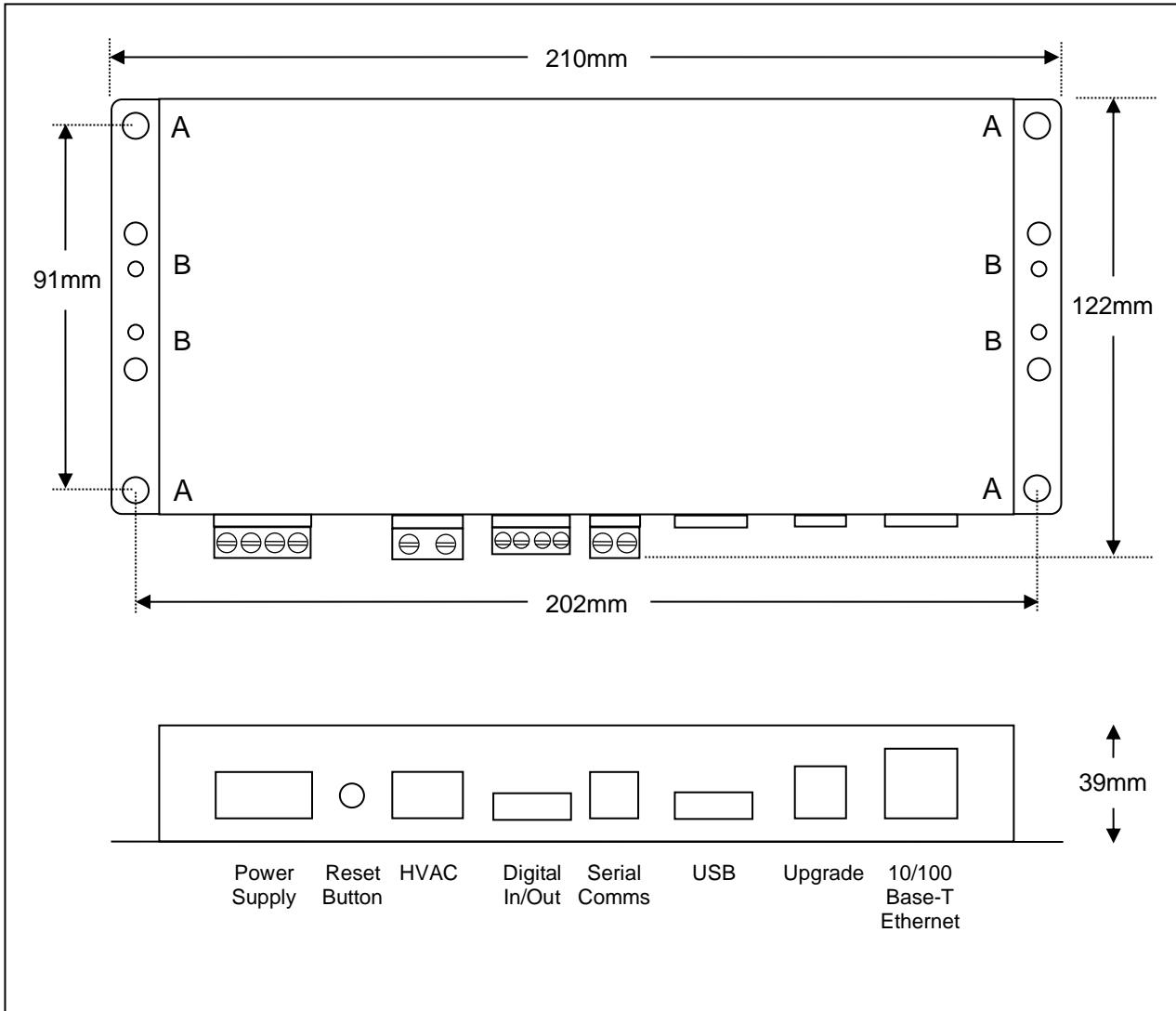
Fig. 10 Dimensions

The holes marked 'A' should be used when mounting the enclosure on a back panel.

The holes marked 'B' can be used to attach the supplied din-rail clips.

Appendix B : Reset Button

The Reset Button currently only has 1 function :

1) To force the unit into 'bootloader' mode ready for a firmware update.

Function 1 – Enable 'Bootloader' Mode

Bootloader mode allows the firmware to be updated from a PC.

Press and hold in the reset button while powering up the unit. Continue to hold in the reset button for approx. 5 seconds, until the bootloader screen appears. The unit is now in bootloader mode.

> **Note:**
> Enabling the bootloader in this way is only necessary if
> a) the firmware update software fails to automatically put the unit into bootloader mode, or
> b) the application program is somehow corrupted and will not boot.

Appendix C: Factory Default Settings

Configuration Subject	Option	Setting
HVAC	Manufacturer	Toshiba
	Central Controller Present	False
	HVAC Address	1
	HVAC Voltage Output	False
	Outdoor sensor address	24
	Master Wall RC	False
	Global-Off Functionality	All Enabled
Ethernet	Device/Hostname	BlackPear2
	DHCP Enabled	False
	Static IP address	192.168.1.20
	Static Gateway address	192.168.1.20
	Static Subnet Mask	255.255.255.000
	DNS 1	8.8.8.8
	DNS 2	8.8.4.4
Modbus	Base Slave Address	1
	Single slave access	False
	Alternate TCP port	502
	Max slaves	22
Trend	Enabled	False
	Outstation Address	11
	CNC IP Address	192.168.1.21
	CNC Address	101
	CNC Port Number	10101
	CNC Usage	1
	Sensor Base Address	100
	Switch Base Address	50
	Knob Base Address	50
	Pin code enabled	False
	Pin Code	0000
	Object enable	All objects enabled
BACnet	Enabled	False
	Device ID	200
	UDP Port	47808
	Register as Foreign Device	False
	BBMD Address	192.168.1.22
	Foreign Device Reg TTL	1800

Configuration Subject	*Option*	*Setting*
Date and Time	Enable SNTP	False
	Time Server	time.google.com
	Poll Once	False
Security	Admin Pin code	0000
Unit Names	Unit 1	'Unit 1'
	Unit 2	'Unit 2'
	⋮	⋮
	Unit 64	'Unit 64'
Unit Groups	Unit 1	Group 1
	Unit 2	Group 2
	⋮	⋮
	Unit 64	Group 64
Scheduler	Enabled	False
	Scheduled Events	None defined

Appendix D : Trend Outstation Memory Usage

1) The table below shows how much memory (in brIQs) each parameter requires :

Parameter	Trend Module	Size (brIQs)	Comments
Return Air Temp	Sensor	76	
Error Code	Sensor	76	
On/Off	Switch	10	
Inhibit	Switch	10	
Setpoint	Knob	13	
Mode	Knob	13	
Fan Speed	Knob	13	
Air Direction	Knob	13	

2) A Trend IQ3 has a capacity of 10000 to 45000 brIQs depending on the model and an IQ41x has a capacity of 10000 brIQs.

	IQ3xcite	IQ3xact	IQ3xcite			IQ41x
I/O Max	0	12	16	96	128	
IQ3 brIQs	-	10,000	30,000	30,000	37,000	-
IQ3/XNC brIQs	45,000	20,000	-	45,000	-	-
IQ41x brIQs						10,000

3) This table shows the number of brIQs needed for various system sizes and parameter requirements:

Parameter Usage	brIQs per FC	16 FC system	32 FC system	50 FC system	64 FC system
All common parameters	224	3584	7168	11200	14336
Return Air Error Code	152	2432	4864	7600	9728
Return Air Error code On/Off Setpoint	175	2800	5600	8750	11200
Return Air Error Code On/Off Inhibit Setpoint Mode Fan Speed	211	3376	6752	10550	13504

4) This table shows the absolute maximum number of FCs which can be stored in various Trend outstations.

Parameter Usage	IQ3xcite/ XNC	IQ3xact	IQ3xact/ XNC	IQ3xcite/ 16	IQ3xcite/ 96	IQ3xcite/ 128	IQ41x
All common parameters	200	44	89	133	133	165	44
Return Air Error Code	296	65	131	197	197	243	65
Return Air Error code On/Off Setpoint	257	57	114	171	171	211	57
Return Air Error Code On/Off Inhibit Setpoint Mode Fan Speed	213	47	94	142	142	175	47

Note:

1) When calculating the number of outstations required for a system, it is recommended to allow some spare capacity for strategy and other configuration data.

2) A single Black Pear device can only communicate with 1 Trend outstation, but multiple Black Pears can communicate with the same Trend outstation, provided there is enough memory in the Trend unit.

Appendix E : Error Codes

The Black Pear 2 stores error codes as a 4 digit number. Apart from a few 'Special' ones listed below, the error code can easily be converted into the manufacturers' actual error code.

Special Black Pear Error Codes	Description
6995	Unit has stopped communicating (no activity for 15 minutes)
6999	Unit does not exist on the system
8000	No error detected

Toshiba Cross Reference

Black Pear Error Code	Toshiba Error Code	Description
1005	C05	Sending error in TCC-LINK central control device
1006	C06	Receiving error in TCC-LINK central control device
1012	C12	Batch alarm of general-purpose equipment control interface
2001	E01	Communication error between indoor and remote controller (Detected at remote controller side)
2002	E02	Sending error of remote controller
2003	E03	Communication error between indoor and remote controller (Detected at indoor side)
2004	E04	Communication circuit error between indoor and outdoor (Detected at indoor side)
2006	E06	Decrease of No. of indoor units
2007	E07	Communication circuit error between indoor/outdoor (Detected at outdoor side)
2008	E08	Duplicated indoor addresses
2009	E09	Duplicated master remote controllers
2010	E10	Communication error between indoor P.C.board
2012	E12	Automatic address start error
2015	E15	No indoor automatic address
2016	E16	Capacity over / No. of connected indoor units
2018	E18	Communication error between indoor header and follower units
2019	E19	Outdoor header units quantity error
2020	E20	Other line connected during automatic address
2023	E23	Sending error in communication between outdoor units
2025	E25	Duplicated follower outdoor address
2026	E26	Decrease of No. of connected outdoor units
2028	E28	Follower outdoor unit error
2031	E31	IPDU communication error
3001	F01	Indoor TCJ sensor error
3002	F02	Indoor TC2 sensor error
3003	F03	Indoor TC1 sensor error
3004	F04	TD1 sensor error
3005	F05	TD2 sensor error
3006	F06	TE1 sensor error
3007	F07	TL sensor error
3008	F08	TO sensor error
3010	F10	TA sensor error
3012	F12	TS1 sensor error
3013	F13	TH sensor error
3015	F15	Outdoor temp. sensor misconnection (TE1,TL)
3016	F16	Outdoor pressure sensor misconnection (Pd,Ps)
3023	F23	Ps sensor error
3024	F24	Pd sensor error
3029	F29	Indoor other error
3031	F31	Outdoor EEPROM error
4001	H01	Compressor break down
4002	H02	Magnet switch error / Overcurrent relay operation / Compressor error (lock)
4003	H03	Current detection circuit error
4004	H04	Comp-1 case thermo operation

Black Pear Error Code	Toshiba Error Code	Description
4006	H06	Low pressure protective operation
4007	H07	Low oil level protection
4008	H08	Oil level temp. sensor error
4014	H14	Comp-2 case thermo operation
4016	H16	Oil level detection circuit error / Magnet switch error / Overcurrent relay error
6003	L03	Duplicated indoor header units
6004	L04	Duplicated outdoor line address
6005	L05	Duplicated indoor units with priority (Displayed in indoor unit with priority)
6006	L06	Duplicated indoor units with priority (Displayed in unit other than indoor unit with priority)
6007	L07	Group line in individual indoor unit
6008	L08	Indoor group/Address unset
6009	L09	Indoor capacity unset
6010	L10	Outdoor capacity unset
6020	L20	Duplicated central control addresses
6028	L28	Maximum number of outdoor units exceeded
6029	L29	No. of IPDU error
6030	L30	Auxiliary interlock in indoor unit
6031	L31	IC error
7001	P01	Indoor fan motor error
7003	P03	Discharge temp. TD1 error
7004	P04	High-pressure switch detection error
7005	P05	Phase-missing detection / Phase order error
7007	P07	Heat sink overheat error
7010	P10	Indoor overflow error
7012	P12	Indoor fan motor error
7013	P13	Outdoor liquid back detection error
7015	P15	Gas leak detection
7017	P17	Discharge temp. TD2 error
7019	P19	4-way valve inverse error,
7020	P20	High-pressure inverse error
7022	P22	Outdoor fan IPDU error
7026	P26	G-Tr short circuit protection error
7029	P29	Comp position detection circuit error
7030	P30	Follower indoor unit error (Group error)
7031	P31	Follower indoor unit error (Group error)

> Note: For further information regarding the above error codes, please contact your local Toshiba A/C supplier, or Toshiba A/C technical support.

Appendix F : Document Revision History

Date	Document Ver	Firmware Ver	By	Comments
05/11/2020	v0.01	v1.11	mcb	Started Black Pear 2 manual.
20/11/2020	v0.10	v1.11	mcb	Full draft version.
25/11/2020	v1.00	v1.11	mcb	First full release version.

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