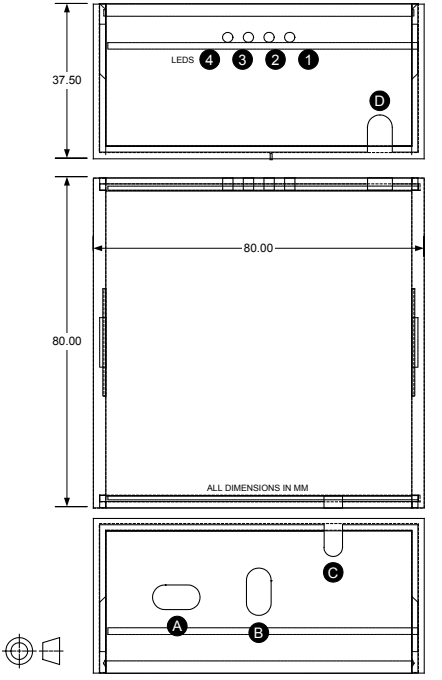
https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra

# RTD-RA

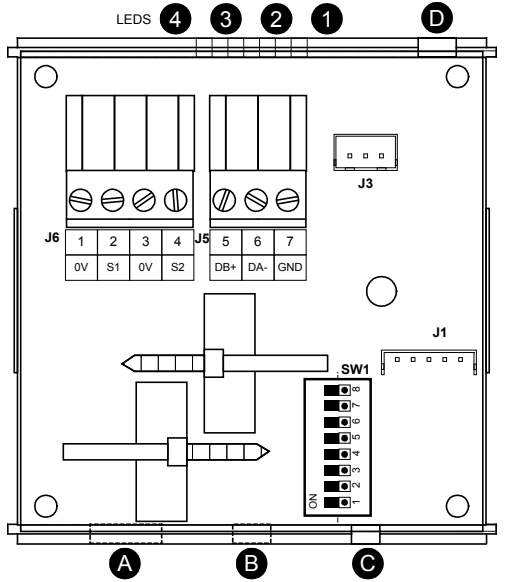
## Installation Instructions

English Installation Instructions

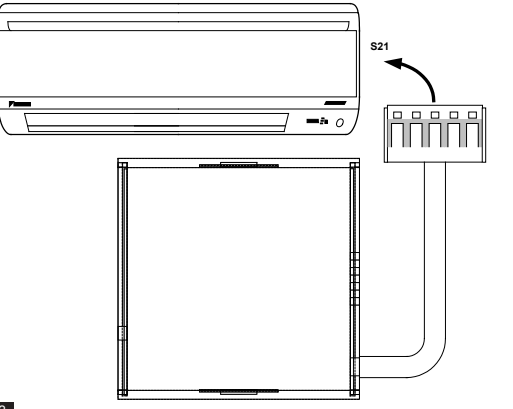



realtime
Control Systems

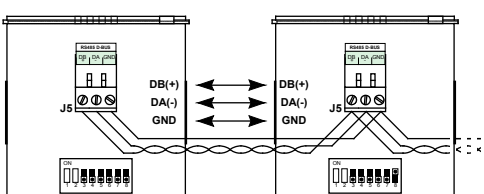
https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra




1

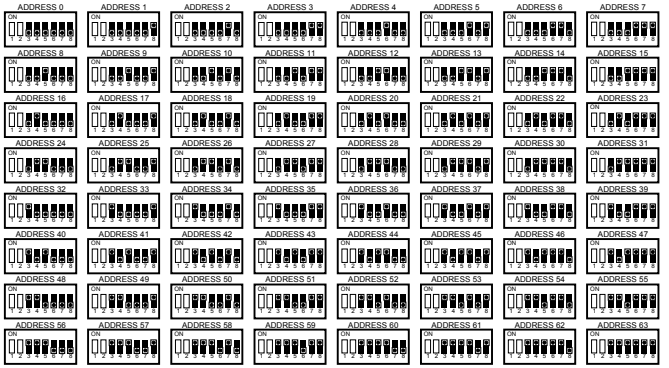



2



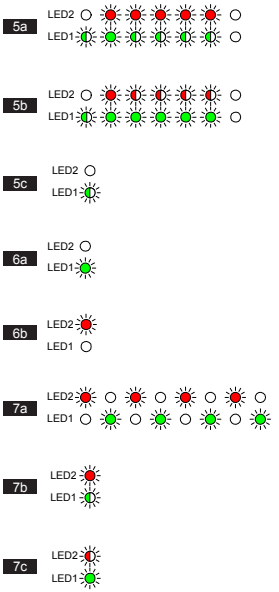

3

https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra




4

https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra



https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra

## ⚠ Warnings and Cautions

All cable connections to the device must be adequately secured by suitable strain relief fasteners. Cables supplied with strain relief bands must be fitted in the corresponding cable guide slot with the strain relief band inside of the enclosure.

The RTD must either be mounted in a suitable metal enclosure or plastic enclosure with a flammability rating of at least IEC60695-11-10 V-1. Do not install it inside the air-conditioning unit. In all cases access by non-qualified persons must be prevented (the enclosure may not accessible without a tool). The unit can be mounted horizontally or vertically.

RS485 Cables must use stranded 24awg shielded or unshielded twisted pair to Cat3, Cat4 or Cat5 specification. Use a twisted pair for connections DB,DA and an extra core for connection GND. Install RS485 cable to J5 terminals as shown in Figure 3.

Cable connections to J6 inputs must be 0.5 to 0.75 $mm^2$ multi-stranded screened twisted pair. The screen must be earthed at one end only. The maximum distance from the RTD to the input source is 200m.

## Specifications

### Electrical

| | |
|---|---|
| **Supply** | 15V DC, 50mA Regulated |
| **Power** | <1.0VA |
| **Connectors** | Rising clamp to 0.75$mm^2$ cable |

### Environmental

| | |
|---|---|
| **Temperature** | |
| **Storage** | -10oC to 50oC |
| **Operation** | 0oC to 50oC |
| **Humidity** | 0-90% RH non-condensing |

### Network

| | |
|---|---|
| **RS485** | <500m |

### Inputs

| | |
|---|---|
| **Volt-Free Contact** | S1..S2 5V, 1mA |

Your product is marked with the symbol shown to the left. This symbol on the product indicates that this product must not be disposed of with your other household waste. Inappropriate disposal may be harmful. Instead, it is your responsibility to dispose of your waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. Units must be treated at a specialized treatment facility for re-use, recycling and recovery. By ensuring this product is disposed of correctly, you will help to prevent potential negative consequences for the environment and human health. Please contact the installer or local authority for more information.

Observe precautions for handling Electrostatic Sensitive Devices

Additional information, including Modbus configuration and Fault Codes are available from ***www.realtime-controls.co.uk/rtd***

https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra

## Installation Instructions

The RTD-RA is a monitoring and control interface for the Room Air-conditioner range of air-conditioning units. The interface is compatible with the indoor units that have a S21 remote controller network connection. Control functions include:

STAND ALONE MODE: Allows energy-efficient operation of a Room Air-conditioner by restricting user operating ranges and unit locked off defined by volt-free contact input.

MODBUS SLAVE MODE: Allows control and monitoring of unit operation using RS485 Modbus commands.

RTD CLONE MODE: Configures the RTD-RA to duplicate the operating settings of another RTD or RTD-RA device on the RS485 network. Allows creation of group controlled devices.

RTD-10 DUTY/STANDBY SLAVE: Configures the RTD-RA to operate in an RTD-10 Duty/Standby network. An RTD-10 Master controlling Skyair or VRV units can be integrated with one or more Room Air Conditioners in a Duty/Standby configuration.

RTD-20 RETAIL CONTROL MODE: The RTD-RA can be integrated into an RTD-20 Retail Control network. The RTD-RA can be configured to operate as a User Control Zone or to operate in Clone Mode and duplicate the control settings from anther device on the network.

S21 CONNECTION (FIGURE 2)

The RTD-RA is supplied with a pre-fitted lead for power and communication with the Room Air-conditioner. The lead allows a maximum distance of 950mm from RTD-RA to the connection point in the indoor unit The lead must be fitted and secured through suitable access points in the air-conditioner and the connector must be inserted into port S21 on the Room Air-conditioner indoor unit control PCB.

The S21 lead enters the RTD-RA through Port D on the enclosure as shown in Figure 1, the lead is supplied pre-fitted to J1 on the RTD-RA PCB. The fitted strain relief band on the cable must be located on the inside of the enclosure.

RS485 NETWORK INSTALLATION (FIGURE 3)

The RS485 D-Bus network requires a twisted pair cable connecting terminals DB(+) and DA(-) on each RTD-RA. Terminal DB must be connected to all other DB terminals. Terminal DA must be connected to all other DA terminals. In addition the common terminal GND on all devices must be connected together. If a shielded cable is used then the shield can be used for this purpose. It is recommended that the GND connection is connected to local Earth at one point only. The network must be installed as a daisy-chained point-to-point Bus configuration, Star and Ring connections must NOT be used.

The RS485 Network lead must be connected to terminals J5 on the RTD-RA PCB and must be fitted through Port B on the enclosure as shown in Figure 1. The PCB mounted strain-relief must be used to secure the network cable. Cables must have a maximum outside diameter of 5mm.

https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra

RS485 NETWORK LENGTH

Standard installation for total network distances of up to 500m can be achieved following the basic daisy-chaining method showed in the above Figure 3. The network can be extended further using RS485 repeaters.

LED FUNCTIONALITY

When the RTD-RA is powered up, or if it looses communication with the Remote Controller the RTD-RA enters A/C Unit search mode. Led behaviour is shown in the following figures

| | |
|---|---|
| Power-Up sequence: Factory Configuration | Figure 5a |
| Power-Up sequence: Custom Configuration | Figure 5b |
| A/c Unit Search. After power-up and during unit configuration | Figure 5c |
| No Fault State | Figure 6a |
| Unit Fault | Figure 6b |
| Device configuration error | Figure 7a |
| AC Unit Missing (U5 Fault) | Figure 7b |
| RS485 Communications timeout | Figure 7c |

LED Key:

| | | |
|---|---|---|
| ○ OFF | ON | Flashing |

ADDRESSING

The RTD-RA has the facility to create control groups using multiple RTDs connected together on the RS485 D-Bus network. In standard configuration up to 64 RTD-RA devices can be connected together. Each RTD is assigned a D-Bus address using the configuration switches SW1.3 to SW1.8. (FIGURE 4).

RTD-RA STANDARD INPUTS

Inputs S1 and S2 are wired between the labelled Sensor terminal and the adjacent 0V terminal on the same connector block

S1 and S2 cables must be 0.5 to 0.75mm$^2$ multi-stranded screened twisted pair. The screen must be earthed at one end only. The maximum distance from the RTD-RA to the input source is 200m.

S1 and S2 cables should be connected to terminals J6 on the RTD-RA PCB and must be fitted through Port A on the enclosure as shown in Figure 1. The PCB mounted strain-relief must be used to secure the network cable. Cables must have a maximum outside diameter of 5mm.

It is recommended that volt-free contacts or switch mechanisms have gold plated contacts to ensure a low resistance circuit when the switch is made.

https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra

MODBUS CONFIGURATION

| | |
|---|---|
| **Network** | 3 wire RS485 |
| **Mode** | Modbus RTU Slave |
| **Baud** | 9600* |
| **Parity** | None* |
| **Stop bits** | 1 |
| **Register Base** | 0 |

**RTD interfaces can be configured with different baud rate and parity settings if required*

Modbus address range 0 to 63 set using SW1 (Figure 5).

*Details of the Modbus Protocol can be found in the **Modicon Modbus Protocol Reference Guide** available on the internet.*

MODBUS REGISTERS

The RTD-RA supports two types of register, analogue *Holding Registers* and analogue *Input Registers*. Register Addresses are '0' based in the range 0..65535.

| Register Type | Access | Function |
|---|---|---|
| Holding Register | Read/Write | Control and Command Registers |
| Input Register | Read Only | Readback and Monitoring Registers |

All analogue and digital values are accessed through these registers. All register values are 2 byte (16 bit) values.

Different data types are returned using specific conventions

| Data Type | Range | Convention |
|---|---|---|
| Digital | 0..1 | 0=FALSE, 1=TRUE |
| Integer | 0..65535 | No scaling required |
| Temperature | 0..65535 | Temperatures values are generally returned *multiplied by 100* to allow greater precision. To allow for negative temperature the value is returned as a *signed integer*, this means that any value greater than 32767 must be converted into a negative value by subtracting 65536.<br>Examples:<br>A readback value of 2150 is a positive temperature so:<br>2150 / 100 = 21.50°C<br>A readback value of 65036 is a negative temperature so:<br>65036 – 65536 = -500<br>-500 / 100 = -5.00°C |

Registers are accessed using standard Modbus functions. The following four functions are supported by the RTD interface.

| Function Code (hex code) | Function Name | Register Count |
|---|---|---|
| 03 (03h) | Read Holding Registers | 1..10 |
| 04 (04h) | Read Input Registers | 1..10 |
| 06 (06h) | Preset Single Holding Register | 1 |
| 16 (10h) | Preset Multiple Holding Register | 1..10 |

In this document, Holding registers are written as `H0010` where '`H`' indicates *Holding* register and '`0010`' indicates the register address 0010. Similarly Input registers are referred to as `I0010` where '`I`' indicates an *Input* register

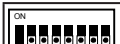
https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra

## STAND-ALONE MODE

The RTD-RA will operate in Stand-Alone Mode if SW1.3 to SW1.8 are set to OFF.

S1 Unlock Only

S1 Unlock+ON




User Setpoint Control

Wide deadband Mode

| Input | Name | Range (default) |
|---|---|---|
| S1 | Unit Unlock | **Open Circuit: Unit OFF + Locked**<br>Closed Circuit: Unit Unlock (+Switch ON) |
| S2 | Unoccupied Temp/ Extended Mode | **Open Circuit: Not Active**<br>Closed Circuit: Standard Unoccupied Temperature Protection<br>10k Resistor: Extended Mode + Unoccupied Temperature Protection |

**Unit Lock (S1)** If Input S1 is Open-Circuit then the unit will be locked OFF and will not operate except during Unoccupied Temperature Protection. If Input S1 is Closed-Circuit then the unit can be switched on by the User.

DIP Switch SW1.1 determines the operation of the unit when S1 is initially Closed-Circuit. If SW1.1 is OFF then the unit will unlock and remain OFF. If SW1.1 is ON then the unit will be switched ON when it is unlocked.

**Unoccupied Temperature Protection (S2)** If a Short-Circuit is applied to Input S2 then the unit will be overridden and operate in Heating if the room temperature falls below 12°C at any point, even if input S1 is Open-Circuit. Heating will continue to operate until the room temperature rises above 15°C. If room temperature rises above 28°C the unit will operate in Cooling until temperature falls below 25°C.

**Extended Mode (S2)** If a 10kΩ resistor* is applied to input S2 then the RTD-RA will operate in Extended Mode. In Extended Mode the Unoccupied Temperature Protection function is activated with an extended temperature range as shown in Table 1. If Wide Deadband mode is selected the Wide Deadband Temperature range is also adjusted as shown in Table 1.

**A 10k Resistor is supplied with the RTD-RA, attached to the front of the installation manual*

| | Standard Mode | Extended Mode |
|---|---|---|
| Low Temperature Mode On | <12°C | <5°C |
| Low Temperature Mode Off | >15°C | >12°C |
| High Temperature Mode On | >28°C | >32°C |
| High Temperature Mode Off | <25°C | <29°C |
| Wide Deadband Heat Setpoint | 21°C | 21°C |
| Wide Deadband Cool Setpoint | 25°C | 28°C |

Table 1.

WIDE DEADBAND MODE

Setting DIP Switch SW1.2 ON activates Wide Deadband mode. In this mode the Setpoint and Operating Mode of the Room Air-conditioner

https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra

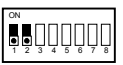
are determined by the RTD-RA. The User can switch the unit ON and OFF and change the Louvre and Fanspeed settings, however changes to Setpoint and Mode are overridden. The Room Temperature is monitored and the unit is switched between FAN and HEAT or COOL if the temperature is outside of the Wide Deadband Heating or Cooling setpoints, determined by selection of Standard or Extended Mode.

## Modbus Slave Operation

If the RTD-RA Modbus Address is configured to a value of 1 or higher then the RTD-RA will function as a Modbus Slave device and all stand-alone functions will be disabled. All control commands are written from Modbus.

MODBUS MASTER TIMEOUT

The RTD-RA can be configured to operate with an optional Modbus Master timeout. In this configuration if no Holding Register writes occur for a period of 120 seconds then a timeout event will occur and all A/C units will be switched on with their current settings. In a timeout condition the RTD Leds will indicate an *RS485 Communications Timeout* as illustrated in the *LED Functionality* section of this datasheet. SW1 DIP Switch settings to enable or disable Modbus Master Timeout are shown in the following table.

| Switch Setting | Function |
|---|---|
|   | No Timeout |
| | Timeout if no Holding Register WRITE command for 120 seconds.<br>All units switched ON with current settings.<br>Remote controllers UNLOCKED. |
| | Timeout if no Holding Register WRITE command for 120 seconds.<br>All units switched ON with current settings.<br>Remote control LOCK state unchanged. |

https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra

## Control Functions

UNIT CONTROL

The RTD-RA can be used to control all of the operating functions of the air-conditioning system that are available from a standard remote controller. All control registers are analogue Holding Registers.

| Holding Register | Name | Range |
|---|---|---|
| H0001 | Setpoint | Heat: 10..30, Cool: 18..32[1] |
| H0002 | Fanspeed | 0..5 (0: Auto, 1:Fan 1, 2: Fan 2, 3: Fan 3, 4: Fan 4, 5: Fan 5[2]) |
| H0003 | Mode | 0..4 (0:Auto, 1:Heat, 2:Fan, 3:Cool, 4:Dry) |
| H0004 | Louvre | 0..1 (0:Stop, 1:Swing) |
| H0005 | OnOff | 0..1 (0:Off, 1:On) |
| H0037 | Force Thermo Off | 0..1 (0:Enable Thermo, 1:Thermo Off) |

*[1] Setpoint Ranges may vary. Check model for supported ranges.*
*[2]Certain models support less than 5 fan speeds. Check model for supported speeds.*

CONTROL UPDATE MODE

A Global Update Register determines how the control commands update the unit and if local control operation is locked or unlocked. Four update modes are available:

| Update Mode | Keypad Button(s) | Functionality |
|---|---|---|
| 0:LastTouch | Unlocked | Unit setting is updated when a holding register WRITE occurs even if the value is unchanged. |
| 1:Central | Locked | The corresponding keypad buttons are locked. The value in the holding register is repeatedly written to the unit. |
| 2:Local | Unlocked | Updates to holding registers are not sent to the unit. |
| 3:OnChange | Unlocked | Unit setting is updated when a holding register WRITE occurs only if the value CHANGES. |

The *Last Touched* update mode allows updates from local control or Modbus registers. This requires that WRITES to the Modbus holding register only occur when a change is made. If the Modbus master repeatedly writes the value then this will overwrite the user setting. The *On Change* update mode can be used if repeated writes occur, in which case updates are only sent to the AC unit if the written value changes.

The *Global Update* register **H0010** can be used to set the update mode.

| Holding Register | Name | Lock Mode* |
|---|---|---|
| H0010 | Global Update | **0:LastTouch**,1:Central,2:Local,3:OnChange |

The default settings on power up are all fields in Last Touch mode.

CONTROL LIMITING

The Control Limit registers allow adjustment from the remote controller or central controller to be limited to specified ranges. The setpoint can be optionally limited to minimum and maximum specified values. Fanspeed, Mode and Louvre settings can also be limited to specific settings using an inhibit value. If the limit values are set to 0 then no limit is applied.

| Holding Register | Name | Range |
|---|---|---|
| H0020 | Setpoint Min | 16..32, **0 = No Limit** |
| H0021 | Setpoint Max | 16..32, **0 = No Limit** |

https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra

| | | |
|---|---|---|
| H0022 | Fanspeed Inhibit | **0 = No Inhibit**, else Inhibit Value |
| H0023 | Mode Inhibit | **0 = No Inhibit**, else Inhibit Value |
| H0024 | Louvre Inhibit | **0 = No Inhibit**, else Inhibit Value |

Fanspeed, Mode and Louvre inhibit values are calculated by adding the inhibit values for each setting to be inhibited. The values are as follows

*Fan Inhibit*

| Fanspeed | Inhibit Value |
|---|---|
| Auto | **1** |
| Fan 1 | **2** |
| Fan 2 | **4** |
| Fan 3 | **8** |
| Fan 4 | **16** |
| Fan 5 | **32** |

*Mode Inhibit*

| Run Mode | Inhibit Value |
|---|---|
| AUTO | **1** |
| HEAT | **2** |
| FAN | **4** |
| COOL | **8** |
| DRY | **16** |

*Louvre Inhibit*

| Louvre Position | Inhibit Value |
|---|---|
| Stop | **1** |
| Swing | **2** |

Examples:

To limit the Mode setting to Heat, Cool and Fan:

Mode Inhibit Value = AUTO + FAN + DRY
= (1 + 4 + 16)
= 21

## Readback Data

All readback data is available in analogue Input Registers.

UNIT READBACK

Unit data is available for each of the indoor units on the P1,P2 network. Unit Input registers are numbered using the indoor unit numbering in the range 1 to 16 x 100 added to an offset relating to a specific feature.

| Input Register | Name | Range | Notes |
|---|---|---|---|
| I0121 | Is Fault | 0..1 | 0: No Unit Fault, 1: Unit in Fault |
| I0122 | Fault Code | 0..65535 | 255: No Fault, else fault code |
| I0123 | Return Air Temperature | Degrees C x 100 | Unit Return Air Sensor Value |
| I0130 | Thermo On | 0..2 | 0:Idle/Fan, 1:Heating, 2:Cooling |
| I0131 | Coil Inlet Temperature | Degrees C x 100 | Coil Inlet Temperature |

FAULT CODES

Fault codes are encoded using a standard table to allow standard Daikin fault codes to be generated from the readback value. The **no fault** value is 255.

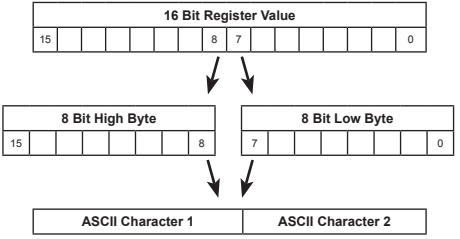
https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra

Special fault codes generated by the RTD are as follows

| Code Value | Meaning |
|---|---|
| 0 | Waiting for data |
| 255 | No Fault |
| 14384 | (80) Group Fault, timeout on no units found |

All other codes are Daikin fault codes. The full table of fault code values is available from ***http://www.realtime-controls.co.uk/rtd***

Fault codes returned from a Modbus Input register are 16 bit values. The fault code is encoded in the 16 bit value by encoding the two 8 bit fault characters in the high and low byte parts of the 16 bit value. Each of the 8 bit values represents an ASCII text character.




Example:

A fault code value of 16689 is returned.

HighByte(16689) = 65 = ASCII Character ‘A’

LowByte(16689) = 49 = ASCII Character ‘1’

Fault Code: ‘A1’

## RTD Clone Mode

| Input | Name | Range (default) |
|---|---|---|
| S1 | SPARE | |
| S2 | Clone Mode | **Open Circuit: Modbus Slave Mode**<br>Closed Circuit: Clone Mode Active |

If input S2 is Closed-Circuit then the RTD-RA will operate in RTD Clone Mode. This mode disables Modbus Slave Mode. In RTD Clone Mode the RTD-RA will search the network for an RTD device at the next lower address, so if the RTD-RA is Address 1, then it will search for a **Clone Master** RTD at Address 0. If an RTD device is detected, including another RTD-RA, then the RTD-RA will activate Clone Operation, local user control is disabled and the control functions Setpoint, Fanspeed, Mode, Louvre, On/Off and Force Thermo Off will be copied from the Clone Master.

Multiple RTD-RAs can operate in Clone Mode on a network, allowing group control from a single RTD or RTD-RA Clone Master.

https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra

## RTD-10 Duty/Standby Slave Operation

When configured for RTD-10 Duty/Standby Slave Operation the RTD-RA should be configured with an address in the range 1 to 8 as shown in Figure 4. An RTD-10 configured as a Duty/Standby Master will monitor the fault state and temperature condition of the RTD-RA and will operate the RTD-RA as a Duty/Standby Slave as documented in the *RTD-10 Installation Manual* (see ***www.realtime-controls.co.uk/rtd)***.

The RTD-10 Duty/Standby Master will support up to 7 slaves in any combination of RTD-10 and RTD-RA.

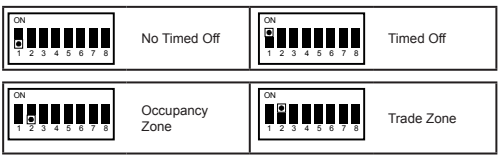
A/C UNIT OPERATION

The RTD-RA unit mode is set to COOL and A/C unit operation is completely locked to prevent local operation. The setpoint, fanspeed and louvre operation will be transmitted from the RTD-10 Master. If communications with the master is interrupted, after 120 seconds the RTD-RA will operate the A/C unit in COOL with 21C setpoint.

## RTD-20 USER CONTROL ZONE

The RTD-RA can be configured to operate as an RTD-20 User Control Zone (UCZ). RTD-20 UCZ Mode is activated by adding the RTD-RA to an RTD-20 Retail Control network, or by inserting a 10k resistor* into S1 to activate stand-alone UCZ operation. A User Control Zone allows users to alter unit operation during the OCCUPIED period. The Zone Primary co-ordinates the User Control Zone and ensures the zone is shut down when UNOCCUPIED or during FIRE conditions. User Control zones can be configured to support areas with permanent or temporary occupancy.

**A 10k Resistor is supplied with the RTD-RA, attached to the front of the installation manual*




When operating in an RTD-20 network, when the zone is UNOCCUPIED the A/C unit is locked and switched off. When unlocked the A/C unit is restricted to allow only AUTO and FAN modes. If other modes are selected the mode will be overridden. At the start of occupancy the mode is always reset to AUTO. Setpoints are also limited to the Retail Primary configured range  See the RTD-20 Installation Manual for configuration information for the RTD-20 Retail Primary Zone.

https://daikin-p.ru/catalog/vse-zapchasti-kondicionerov-daikin/zapchast-daikin-rtd-ra

| Input | Name | Range (default) |
|---|---|---|
| S1 | Min Comfort/ Stand-Alone | **Open Circuit: Not Active**<br>Closed Circuit: Minimum Comfort in Timed Mode<br>10k Resistor: Stand-alone Operation |
| S2 | Clone Mode | **Open Circuit: User Control Zone**<br>Closed Circuit: Clone Mode |

**Timed Zone (DIP SW1.1)** If SW1.1 is ON then the UCZ will operate as a timed zone based on unit operation, after 1 hour of operation the unit will switch off. When operating as timed User Control Zone the until will be initially OFF at the start of occupancy, manually switching the unit on will start the timed operation

**User Zone Type (DIP SW1.2)** If SW1.2 is OFF then the unit will unlock and switch ON using the OCCUPIED time signal from the Zone Primary. If SW1.2 is ON the unit will unlock and switch ON using the TRADE time signal from the Zone Primary.

**Minimum Comfort Control (S1)** When active Minimum Comfort control will maintain the room to Setpoint Range +/-2°C when the Zone Primary generates an OCCUPIED signal, even if the User Control Zone is currently OFF or controlled to the TRADE time signal.

**Clone Mode(S2)** If input S2 is Closed-Circuit then the RTD-RA will operate in Clone Mode instead of UCZ mode. In RTD Clone Mode the RTD-RA will search the network for an RTD device at the next lower address, so if the RTD-RA is Address 1, then it will search for a **Clone Master** RTD at Address 0. If an RTD device is detected, including another RTD-RA, then the RTD-RA will activate Clone Operation, local user control is disabled and the control functions Setpoint, Fanspeed, Mode, Louvre, On/Off and Force Thermo Off will be copied from the Clone Master. The RTD-RA will still transmit data to the Retail Primary.

Multiple RTD-RAs can operate in Clone Mode on a network, allowing group control from a single RTD or RTD-RA Clone Master.