Electronic Board

Section A -1
Direct Expansion System – Single Split

Single Compressor (D2.0)

Features

- COOL/DRY/FAN system control.
- AUTO/HIGH/MED/LOW indoor fan speed control.
- Compressor recycle protection (Anti short cycle timer).
- Air Swing (AC motor option)
- Air louvre (stepper motor option).
- LCD remote control reception.
- SLEEP function for COOL mode.
- Cold blast.
- Indoor antifreeze.
- Indications for thermistors' contact condition.
- Gas Leak detection.
- LEDs display for POWER, TIMER, SLEEP, DRY.
- 9-minute compressor forced on.
- Last states operation backup option

Functions

Hardware Setting

- **RMODE selections**

RMODE	Swing Angle Option	Gas Leak Mode
4k7	WM10F	OFF
10k	WM20F, WMXX1	OFF
20k	WM10F	ON
open	WM20F, WMXX1	ON

- **Power Up Settings**

During power up, the system can be configured to memorised the settings prior to power down. This is done by shorting the 2 way straight header JP1. The settings that are memorised are :-

a)   Mode & On/Off status
b)   Set Temperature
c)   Fan Speed
d)   DC swing
e)   AC swing
f)   Flap stop coordinate (for DC swing off mode)

These data or settings are save in non-volatile memory.

The CPU will save the updated settings into the memory 3 seconds after changes are confirmed.

If the swing mode is off, the flap will stop at the last stop position prior it is power down.

If the JP1 is not shorted, the power up setting is OFF mode, temperature setting is 24°C, indoor fan speed is high and swing mode is OFF.

- **Unit ON/OFF**

  ON/OFF triggering can be achieved by pressing the emergency ON/OFF button or the LCD remote controller ON/OFF button.

  When the emergency ON/OFF button is pressed, the system mode setting will rotate in the following sequence :-

  --------------->COOL > OFF >-------------------

 The corresponding LEDs will also follow suit.

  Pressing the remocon ON/OFF will toggle the system status either from ON to OFF or from OFF to ON.

- **Temperature Range And Setting**

The operating temperature range is 16 °C to 30 °C, both inclusive. Temperature setting is determined by the last LCD transmitter setting or default setting during power up. This setting is only effective under COOL and DRY modes.

- **Sleep function**

This function will increase or the set temperature with time. The COOL mode SLEEP profile is as follows:-
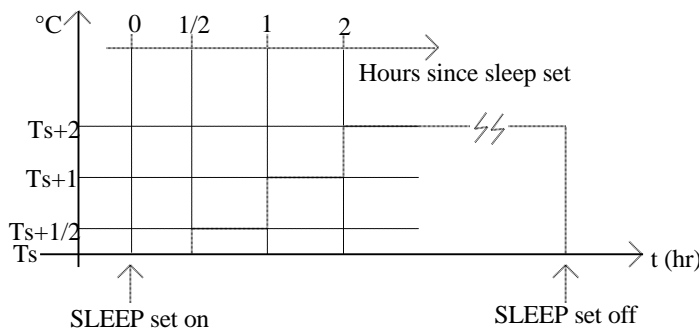
The SLEEP option is only available for COOL modes.

Protections

- **90-second Minimum Run Time for Thermostat**

For thermostat cycles, the compressor can only cut out after 90 seconds of running in the COOL or DRY mode. The compressor can be cut out at any time if the system is switched to FAN or OFF modes or in any other protection sequences.

- **3-Minutes Minimum OFF Time for Thermostat**

For thermostat cycles, the compressor can only cut in after a minimum period of 3 minutes from the time it cuts off.

- **Indoor Freeze Prevention**

This protection is only available in cooling cycle. It is activated when the indoor coil temperature is 1°C or cooler for at least 4 minutes.

- **Thermistor Contact Indicator**

The poor contact conditions of the room, indoor coil & outdoor coil thermistors are indicated as follows:

SENSOR	CONDITION	DISPLAY
i) ROOM SENSOR	SHORT OPEN AND COMP IS OFF	POWER BLINKS ONCE EVERY 2 SECS WHILE OTHER LEDS OFF

0.5 sec. (once)

LED ON

LED OFF

2 secs   2 secs
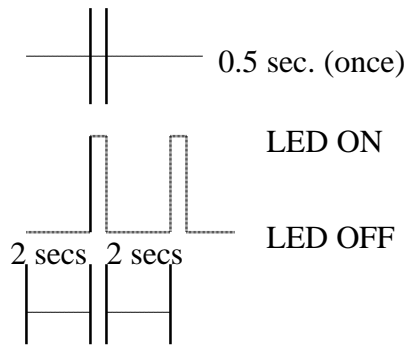
ii) INDOOR COIL	SHORT OR OPEN AND COMP IS OFF	POWER BLINKS TWICE EVERY 2 SECS WHILE OTHER LEDS OFF

0.5 sec. (twice)

LED ON

LED OFF

2 secs   2 secs
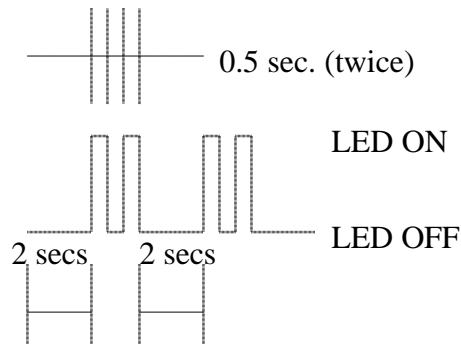
iii) INDOOR COIL	> 24°C FOR > 5 MINS AFTER RUN TIME > 30 MINS	POWER BLINK 3 TIMES EVERY 2 SECS WHILE OTHER LEDS OFF

0.5 sec. (3 times)

LED ON

LED OFF

2 secs   2 secs
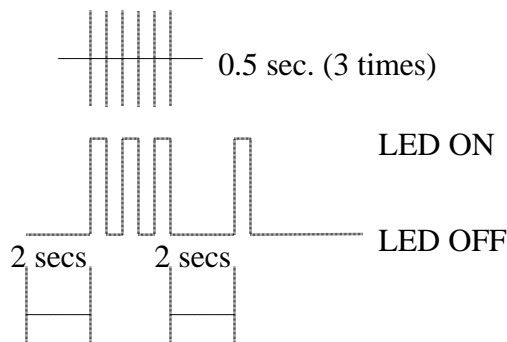
If either of the above faults is rectified, the power LED will cease blinking. For case (iii), the fault can only be reset by turning off and on the unit.

The LED blinking priority level is from (i) to (iii)

Fan Speed Selection

The indoor fan speeds are LOW, MEDIUM, HIGH or AUTO FAN in COOL mode. In FAN mode, only HIGH, MEDIUM and LOW speeds are allowed.

Fan speed selection is not allowed in DRY mode.

Air Swing

- **Air louvre**

In the air louvre option, the stepper motor will only run when the indoor fan runs. The louvre will be set at the maximum closing position when the main power is just turned on or when the unit is turned off. The swing angles of all operating modes (when swing option is activated) are as follow:

OPTION	MODE	SWING ANGLE	INITIAL ANGLE
WM20F	COOL/DRY/FAN	120° <= X <= 160°	160°
WM10F	COOL/DRY/FAN	100° <= X <= 140°	100°

where 0° is referred to as air louvre maximum closing point. The 160° and 140° as the maximum opening point for WM20F and WM10F respectively.

- **AC Swing (AC motor option)**

The air swing will be turned on if the swing option is selected and the indoor fan is running.

Operating Modes

The system mode is set by the LCD remocon. The actual mode will be shown on the mode LEDs.

Mode changes respond immediately after data reception.

Cold Start

When the unit restarts 2 hours after it has stopped or during power-on-reset start, it is considered a cold start.

Cool Mode

In Cool mode, the compressor will be cut in if the $Tr - Ts > 0.5°C$ and the compressor will be cut out if the $Ts - Tr > 1.0°C$, subject to timing protections.

In this mode, the indoor fan is always running. For manual speed, the indoor fan will run as per user set speed. In AUTO FAN speed, the indoor fan speed will run as follows:

HIGH FAN : $Tr > Ts + 0.5°C$
MEDIUM FAN : $Ts + 1.5°C > Tr > Ts – 0.5°C$
LOW FAN : $Ts – 0.5°C > Tr$

Dry Mode

During the first 12 minutes of the DRY mode run from:

  i) Cold Start
  ii) Mode change from FAN.

Dry mode must run under cool mode with AUTO indoor fan for 12 minutes or until

$$Tr \; < \; Ts - 1°C.$$

After this, the dry mode may run under either Zone A, B, C or D as below:

  i) if $Tr - Ts > 2°C$, the operation is in Zone A
  ii) if $1°C < Ts - Tr < 2°C$, then the operation is in Zone C.
  iii) if $0°C < Tr - Ts < 1°C$, then the operation is in Zone B.
  iv) if $Ts - Tr > 3°C$, then the operation is in Zone D.
  v) the other temperature ranges are dead bands for zone stability.

The sequence for the various zones are as shown:
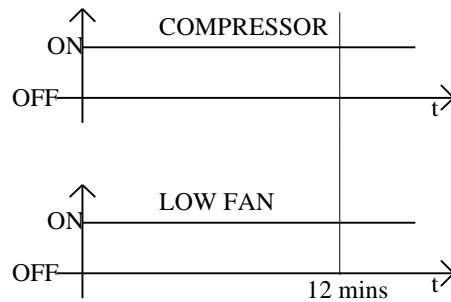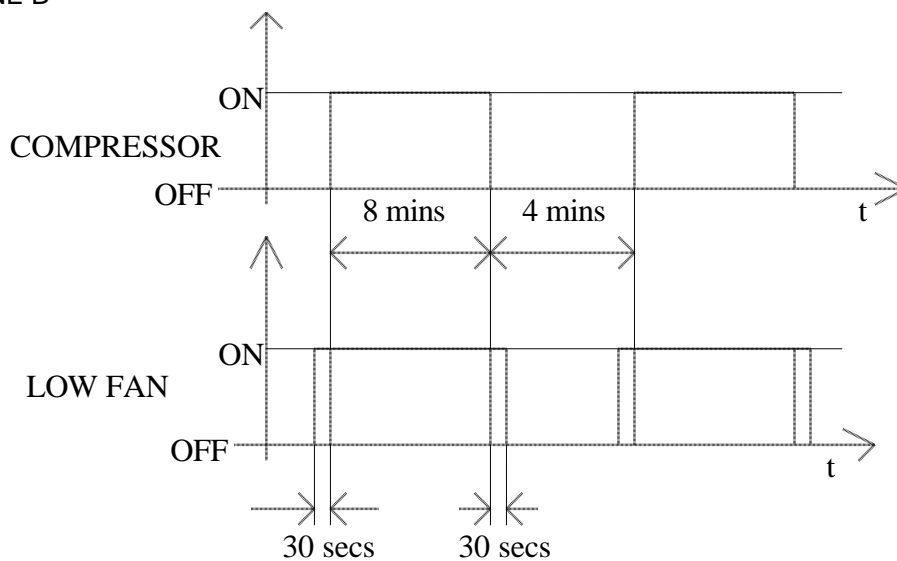
i) ZONE A

ii) ZONE B

iii) ZONE C

iv) ZONE D
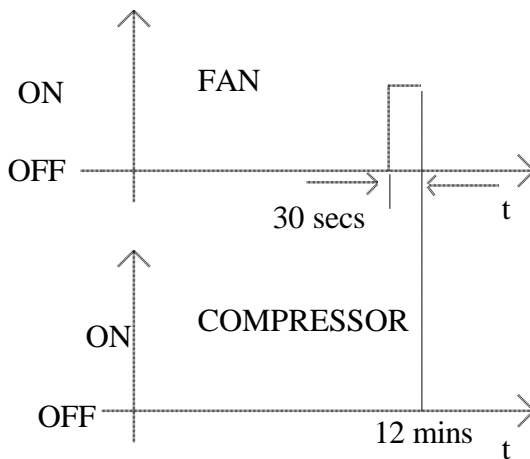
Fan Mode

Only HI, MED and LO speeds are allowed. When changing to FAN mode from COOL mode under AUTO fan speed, the default fan speed will be HI. In this case, upon return to COOL mode, the AUTO fan speed will be restored.

The compressor will stop during fan mode.

Off Mode

When the unit is off, no indication will be provided. All relays will be turned off immediately after the ON/OFF triggering.

9 Minutes Compressor Forced On

If the compressor has stopped for a minimum of 9 minutes and room temperature is above Ts-1 during Cool mode, the compressor will be forced to cut in at the user set speed.

This feature is available in Cool mode and non-MS model.

Schematic Diagram

Section A – 2
Direct Expansion System – Single Split

Single Compressor (U1.4)

Features

- HEAT(heatpump or heater)/COOL/DRY/FAN/AUTO/DEFROST system control.
- Auxiliary heater for Heatpump model (Ceiling concealed, Ceiling Cassette, Ceiling Exposed only)
- AUTO/HIGH/MED/LOW indoor fan speed control.
- Compressor recycle protection (Anti short cycle timer).
- DC motor and AC motor swing control option.
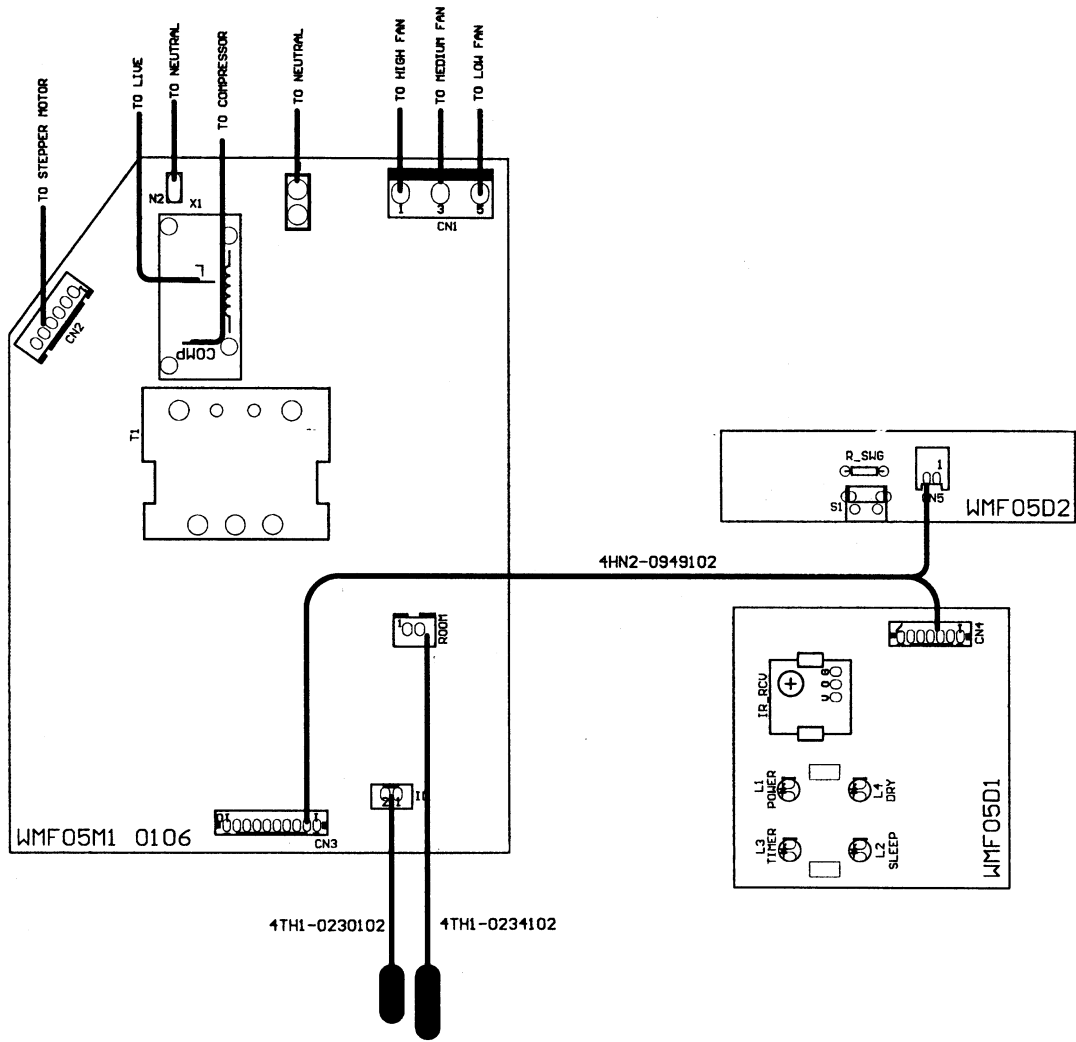- LCD remote control reception.
- Wired LCD (N2)control reception.
- SLEEP function for COOL, HEAT and AUTO mode.
- Cold start, Hot start and Hot keep.
- Frost/ice prevention in indoor coil for cooling cycle.
- Compressor overload protection.
- Indoor Antifreeze for cooling cycle.
- Indications for thermistors' contact condition.
- Memory (non volatile) backup for last state settings option.
- Compressor random restart during 1st thermostat cut in cycle.
- Gas leak detection option.
- Compressor 9 minutes force on (Cool mode only) option.
- ID option.
- Compressor overload manual/auto reset option.

Functions

Mode Selection

The system has 3 modes selection to be selected via the value of resistor RMODE. The following notations are used to represent the various modes selected:

MODES	AUTO	COOL	DRY	HEAT	FAN	DEFROST	RMODE
AP	X	X	X	X	X	C2.4 version	3K
AP	X	X	X	X	X	C2.3 version	7K5
AT	X	X	X	X	X	-	22K
EC	X	X	X	-	-	-	110K

where   X denotes modes available

Power Up Settings

During power up, the system can be configured to memorized the settings prior to power down. This is done by shorting the 2 way straight header JP1. The settings that are memorized are :-

a) Mode & On/Off status
b) Set Temperature
c) Fan Speed
d) DC swing
e) AC swing
f) Keylock (Wired control)

These data or settings are save in non-volatile memory.

The CPU will save the updated settings into the memory 10 seconds after changes are confirmed. However, it will take 3 seconds to update the memory if the unit change from ON to OFF state.

If the SWING mode is off, the flap will stop at the last stop position prior to power down.

If the JP1 is not shorted, the power up setting is OFF mode, temperature setting is 24°C, indoor fan speed is high and SWING mode is off.

Unit ON/OFF

There are 3 ways to turn on or off the system:

i) via ON/OFF triggering (ON/OFF button at handset)
ii) via delay timer or
iii) via real time ON/OFF timer

- **ON/OFF triggering**

   ON/OFF triggering can be achieved by pressing the emergency ON/OFF button or the LCD remote controller ON/OFF button. In doing so, the DELAY timer will be reset.

   When the emergency ON/OFF button is pressed, the system mode setting will rotate in the following sequence :-

   MODEL   SEQUENCE

   AP   ---------- > COOL > HEAT > OFF > ------------
   EC   ---------------> COOL > OFF >--------------------

   The corresponding LEDs will also follow suit.

   Pressing the remocon ON/OFF will toggle the system status either from ON to OFF or from OFF to ON.

- **Delay Timer**

   This delay timer is to simulate the ON/OFF pressing after the set number of hours and minutes. After triggering, the delay timer is set to 0 hours.

   Pressing ON/OFF will also reset this timer to 0 hours.

- **Real Time ON/OFF timer**

   When the real time ON timer set time matches the internal real time clock, the unit will be switched on. Similarly, when the OFF time matches the real time clock, the unit is switched off .The timer settings are retained so that similar switching can occur 24 hours later.

These timers will be reset if the emergency ON/OFF switch is pressed.

Temperature range and setting

The operating temperature range is 16 °C to 30 °C, both inclusive. Temperature setting is allowed in COOL, DRY, HEAT and AUTO modes.

Sleep function

This function will increase or decrease the set temperature with time. The COOL mode SLEEP profile is as follows:-
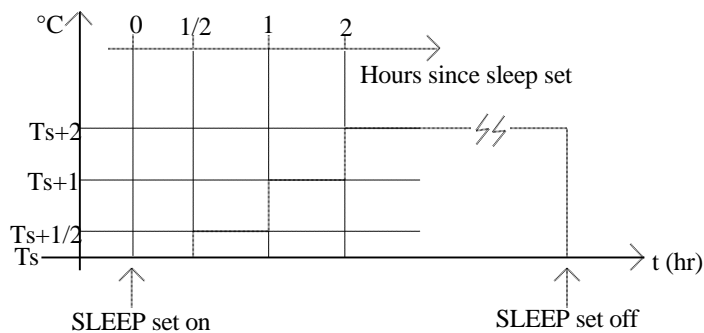
The HEAT mode SLEEP profile is as follows:
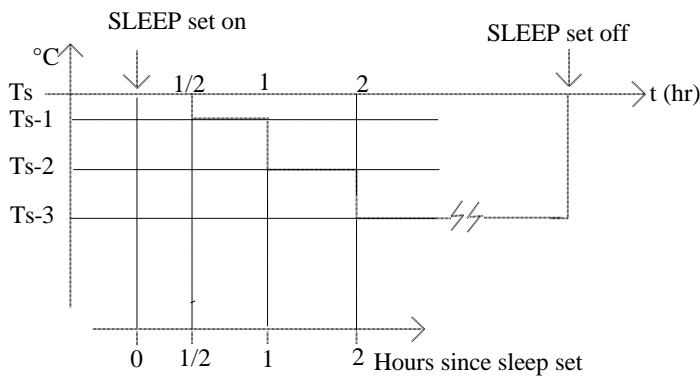
The SLEEP option is only available for COOL, HEAT and AUTO modes.

Protections

- **3-Minutes Minimum OFF Time for Thermostat**

    For thermostat cycles, the compressor can only cut in after a minimum period of 3 minutes from the time it cuts off except during valve changeover sequences.

- **140 seconds Minimum Run Time for Thermostat**

    For thermostat cycles, the compressor can only cut out after minimum 140 seconds of running in the current mode.

- **Compressor Overload Protection**

  There are two methods to detect the compressor overload; namely by the coil sensors and the hardware overload (normally close) switch.

  a) Coil Sensors Detection

  This protection is only available in COOL, DRY, HEAT and AUTO modes.

  In cooling cycle, when the Outdoor Coil temperature exceeds 68°C, both the compressor and outdoor fan will stop operating. In heating cycle, when the Indoor Coil temperature exceeds 68°C, the compressor, outdoor fan and 4 way valve will stop operating accordingly.

  The indoor fan will continue operating as per user set speed.

  The unit will auto reset if the temperature goes below 50°C. This is allowed once every power on reset. If the unit is required to auto reset everytime the overload occurs, a diode (1N4148 or equivalent) is required to insert into DOV.

  If the temperature goes below the permissible limit, the overload protection can be reset manually by triggering the ON/OFF key.

  b) Hardware Switch Detection

  This is a normally close switch. It is connected in series with the power supply to the controller. Once there is overload, the switch will open and power supply to controller will be cut off.

  During the first cycle of thermostat on since power on reset, a counter is increased by one and a timer starts to run. If the timer exceeds 3 minutes or the unit is turned off, the counter is reset to 0. During the increment, if the counter is > 5, the unit will declare compressor overload protection. This fault is manual resettable.

  The counter is saved in the non-volatile memory. If memory backup option is not selected, the counter is always set to 0 during power on reset. It is selectable if diode is inserted into DOV.

- **Outdoor fan speed control**

  a) Heat mode

  The outdoor fan will run cut off when the indoor coil temperature exceeds 57°C. The outdoor fan speed may resume when indoor coil temperature is lower than 50°C.

  The indoor fan speed will be forced to 1 speed higher than the user set speed when the indoor coil temperature exceeds 55°C; ie LOW fan will be forced to MEDIUM fan while MEDIUM fan will be forced to HIGH fan and there is no change if the user set speed is HIGH. It will resume at the user set speed when indoor coil temperature is lower than 48°C.

- **Indoor Anti freeze**

  This protection is only available in cooling cycle. There are two options :-

  The system will be in the Frost Prevention Mode if the Indoor Coil temperature reaches 1°C and cooler for at least 4 minutes. Upon confirmation, the compressor and the outdoor fan must be stopped . The compressor and the outdoor fan can only be restarted when the Indoor Coil temperature reaches 10°C and above for at least 1 minute.

Fan Speed Selection

The indoor fan speeds are LO, MED, HIGH or AUTO FAN in COOL, HEAT and AUTO modes.

In FAN mode, only HI, MED and LO speeds are allowed.

Air Louvre And Air Swing

In ac swing option, the swing will run if indoor fan is on and vice versa.

In the air louvre option, the stepper motor will only run when the indoor fan runs. The louvre will be set at the maximum closing position when the main power is just turned on or when the unit is turned off. The swing angles of all operating modes (when swing option is activated) are as follow,:

RSWG	REMARK	MODE	SWING ANGLE
22K	WM series 1	COOL/DRY/FAN	35° <= X <=75°
		HEAT	70° <= X <=100°
3K	WM10/15F	COOL/DRY/FAN	100° <= X <= 140°
		HEAT	80° <= X <= 110°
220R	WM20/25F	COOL/DRY/FAN	120°<= X <= 160°
		HEAT	100°<= X <= 140°

where 0° is referred to as air louvre maximum closing point.

If unit change from off mode to on mode , the flap will stop at the last position when it go from on to off mode.

Cold Start

When the unit restarts 2 hours after it has stopped or during power-on-reset start, it is considered a cold start.

Cool mode

In Cool mode, the compressor will be cut in if the $T_r - T_s > 0.5°C$ and the compressor will be cut out if the $T_r < T_s - 1.0°C$, subject to timing protections.

In this mode, the indoor fan is always running. For manual speed, the indoor fan will run as per user set speed. In AUTO FAN speed, the indoor fan speed will run according to the room temperature condition.

Dry mode

During the first 12 minutes of the DRY mode run from:

    i) Cold Start or
    ii) Mode change from HEAT, FAN or AUTO HEAT

Dry mode must run under cool mode with AUTO indoor fan for 12 minutes or until
$$T_r < T_s - 1°C.$$

After this, the dry mode may run under either Zone A, B, C or D as below:

    i) if $T_r - T_s > 2°C$, the operation is in Zone A
    ii) if $1°C < T_s - T_r < 2°C$, then the operation is in Zone C.
    iii) if $0°C < T_r - T_s < 1°C$, then the operation is in Zone B.

iv) if Ts - Tr > 3°C, then the operation is in Zone D.
v) the other temperature ranges are dead bands for zone stability.

The sequence for the various zones are as shown:

i) ZONE A

ii) ZONE B

iii) ZONE C

COMPRESSOR

ON

OFF

6 mins   6 mins

LOW FAN

ON

OFF

30 secs   30 secs

iv) ZONE D

ON   FAN

OFF

30 secs

ON   COMPRESSOR

OFF

12 mins

Heat mode

There are two models of heat mode, namely auto heatpump (AP) and auto heater (AT).

- **Heat pump Model**

  The compressor will be cut in if the $Tr < Ts - 1.0°C$ and it will be cut out if $Tr - Ts > 1.5°C$, subject to timing protections.

  For manual speed, the indoor fan will run as per user set speed. In AUTO FAN speed, the indoor fan speed will run according to the room temperature condition.

  These fan speeds are subjected to the following Hot start and Hot keep features:

  a) Hot Start

    During the cut in cycle, the indoor fan speed will modulate according to the indoor coil temperature:

      i) if the indoor coil temperature > 40°C, the indoor fan will run at user set fan speed.
      ii) if the indoor coil temperature < 18°C, the indoor fan speed will stop.
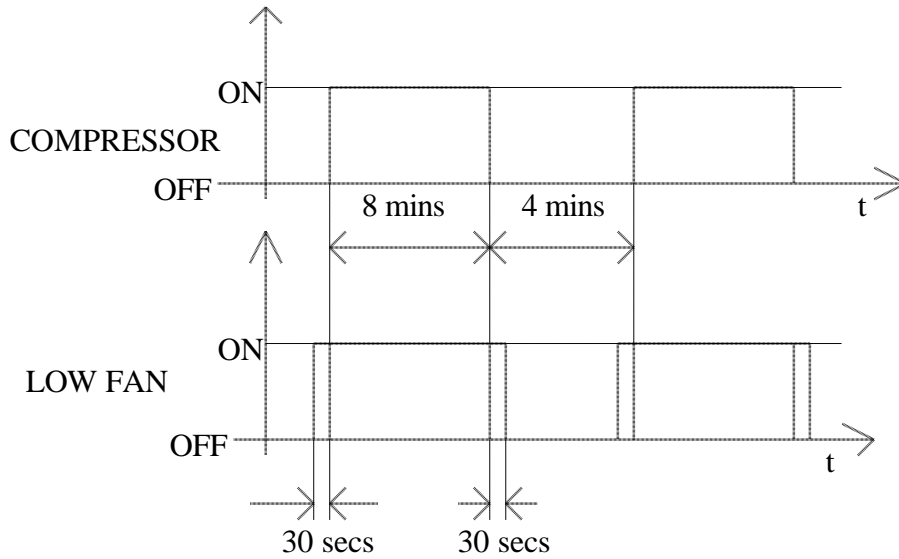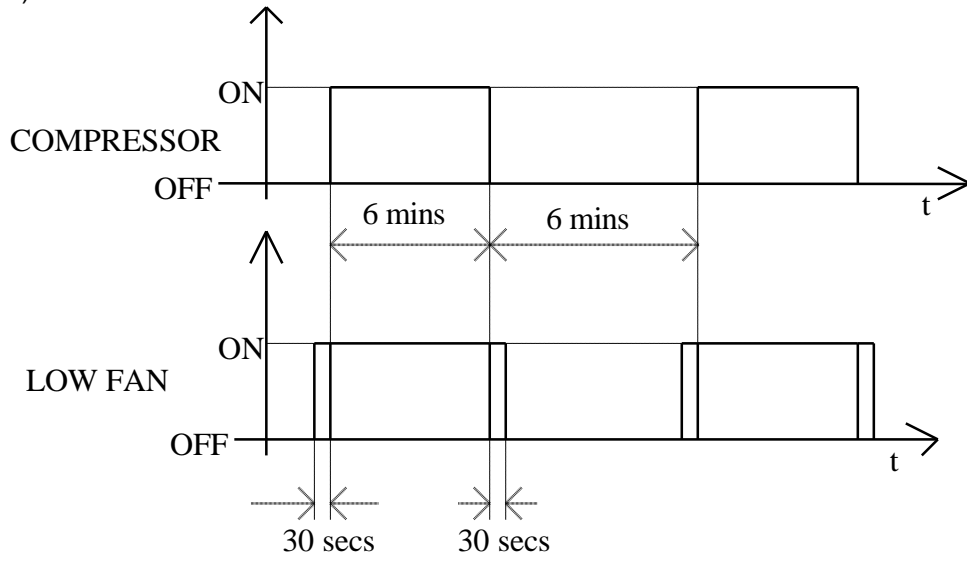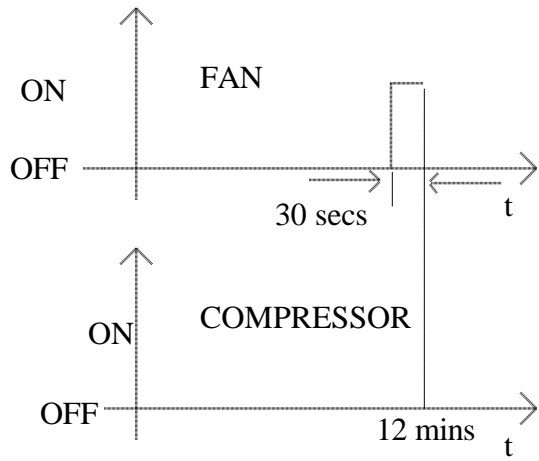   iii) if the indoor coil temperature crosses the 30°C mark, the indoor fan speed will be changed to low.

  b) Hot Keep

    When the compressor cuts out, the unit is in hot keep mode. There are 3 options of Hot Keep :-

    i) Fan on option

      This option is selected if a 110k ohm resistor is inserted into RFAN.

        a) if the indoor coil temperature > 40°C, the indoor fan will run at set speed.
        b) if the indoor coil temperature crosses 37°C, the indoor fan will run at low speed.
        c) if indoor coil temperature < 18°C, the indoor fan will stop.

    ii) Fan off option

      This option is selected if a 7k5 ohm resistor is inserted into RFAN.

        a) if the indoor coil temperature > 40°C, the indoor fan will run at set speed.
        b) if the indoor coil temperature crosses 37°C, the indoor fan will run at low speed.
        c) if indoor coil temperature < 30°C, the indoor fan will stop.

    iii) Fan low cycle on & off option

      This option is selected if a 22kohm resistor is inserted into RFAN.

      The low fan will cut in for 30 seconds and subsequently off for 120 seconds. These cycle of on and off will repeat.

  c) 4-way valve changing

    To run heatpump , the 4-way valve must turn ON. Upon return to a non-heat pump mode, the 4-way must turn OFF. The 4-way valve can only be changed 55+/- 5 seconds after the compressor has been cut out. Then the compressor may be cut in 4 seconds later.

  d) Auxiliary Heater

    This option is available for heat pump model only. It operates during heatpump thermostat cut in cycle and is subjected to the following conditions :-

a) It can only cut in after the indoor fan has cut in for at least 30 seconds.

b) It must cut out for at least 30 seconds before the indoor fan can cut off.

c) It must cut out if room temperature > 25°C . It is allowed to cut in if room temperature < 22.5°C.

d) It must cut out if indoor coil temperature > 55°C. It is allowed to cut in if indoor coil temperature < 48°C.

e) During cold start, it is allowed to cut in if outdoor coil temperature < 5°C.

f) It will cut in if room temperature is 3.5°C below set temperature and it will cut out if room temperature is 1.0°C below set temperature.

g) It is allowed to cut in during heatpump thermostat cut in cycle

For case (b), the auxiliary heater & indoor fan will cut out immediately during off mode & outdoor defrost cycle.

- **Heater Model**

The heater thermostat cycle is as per heatpump model except during heater cut off cycle, low indoor fan will cut in.

Auto mode

Under AUTO mode, the mode can be selected automatically between Heat and Cool mode, depending on the room temperature and Set Temperature. There is no cold start in Auto mode.

Fan mode

Only HI, MED and LO speeds are allowed. When changing to FAN mode using the emergency switch from COOL, HEAT or AUTO modes in any user set speed, the current running speed will be maintained. Should the mode return to COOL, HEAT or AUTO, then the user set speed will be restored.

The compressor and the outdoor fan will stop. Similarly, the 4-way valve will turn off.

Defrost mode

A defrost timer will start counting when the outdoor heat exchange thermistor is below +3°C.

The likelihood of ice frosting at the outdoor coil is characterised by 3 gradients of outdoor temperature shown in the chart below:

To
°C

+3
+2

C

30'   2 hrs

0
0   1 hr   time

-2

B

-4

A

-6

-8
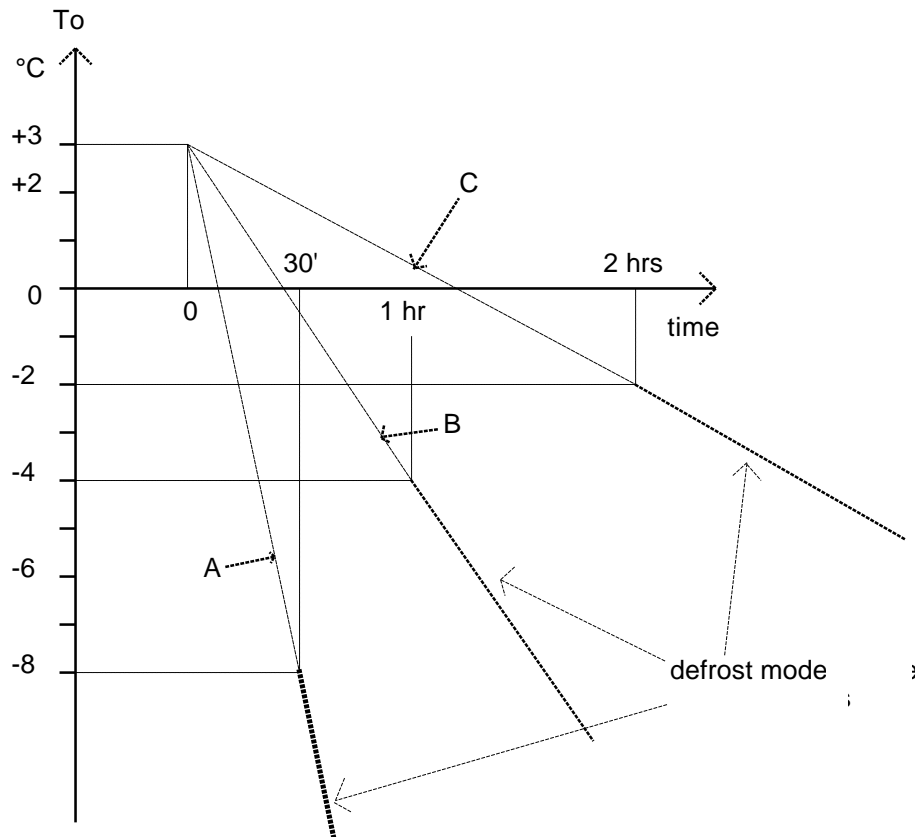
defrost mode

Defrost mode will be activated if the compressor run time is:

   i) 30 mins to 1 hour from +3°C reference point, if the outdoor coil temperature is <=-8°C, then the defrost mode can be started.

   ii) 1 hour to 2 hours from +3°C reference point, if the outdoor coil temperature is <=-4°C, then the defrost mode can be started.

   iii) more than 2 hours from +3°C reference point, if the outdoor coil temperature is <=-2°C, then the defrost mode can be started.

If unit in outdoor fan forced off mode, the defrost will not be allowed to be declared.

- **Defrost cycle**

   In the defrost cycle, the HEAT LED will blink with other LEDs off. Mode selection via the LCD remocon is acknowledged but the defrost cycle is unaffected until it is completed.

   There are two option of defrost cycles :-

   a) C2.4 option

      This option is selected if a 3k ohm resistor is inserted into RMODE.

      When defrost starts, the indoor fan, auxiliary heater, outdoor fan & 4-way valve will cut off while the compressor remains running.

      The defrost will terminate if :-

         i) temperature of outdoor exchange coil exceeds +10°C or
         ii) a minimum of 10 minutes compressor run time is achieved.

      At the end of the defrost cycle, the compressor cuts out. The 4-way valve switches on 15 +/- 5

seconds later. The compressor can cut in 20 seconds after the 4-way valve has cut in.

b) C2.3 option

This option is selected if a 7k5 ohm resistor is inserted into RMODE.

When defrost starts, the indoor fan, auxiliary heater, outdoor fan and compressor will cut out . The 4 way valve will cut out 55+/-5 seconds later before compressor will cut in 4 seconds subsequently .

The defrost will terminate if :-

i) temperature of outdoor exchange coil exceeds +10°C or
ii) a minimum of 10 minutes compressor run time is achieved.

At the end of the defrost cycle, the compressor cuts out. The 4-way valve switches on 55 +/- 5 seconds later. The compressor can cut in 4 seconds after the 4-way valve has cut in.

Off mode

When the unit is off, no indication will be provided. All relays will be turned off immediately after the ON/OFF triggering except the 4-way valve which is subjected to the 55 +/- 5 seconds protection where applicable.

Water pump

The water pump will on if compressor is on during cooling cycle. The pump will remain on for at least 5' after the comp is off.

During mode change from cooling to non cooling mode, the pump will on for minimum 5'.

During defrost cycle, the pump will on and will on for another 5' once the defrost cycle is terminated.

Water Level Switch

This normally close switch is to detect faults in water pump system. It will confirm for 30" for switch open and 60" for switch close.

Once switch is confirmed open, it will force compressor to cut off . If the switch is closed within 5', the compressor is allowed to cut in. If the switch does not close for more than 5', the system will warn user regarding this fault. The compressor is not allowed to cut in.

If the switch is confirmed opened twice within 30', the system assume there are faults.

Diagnostics

Error	OPERATION LED	Other LEDs	Seven Segments
Room Sensor missing	blinks 4 times	Fan blinks	E1 blinking
Indoor coil sensor missing	blinks 4 times	Sleep blinks	E2 blinking
Outdoor coil sensor missing	blinks 4 times	Dry blinks	E3 blinking
Compressor overload	blinks 1 time	Cool blinks	E4 blinking
Gas Leak	blinks 3 times	Cool & Dry blink	E5 blinking
Pump fault	blinks 2 times	Cool & Fan blink	E6 blinking
Outdoor defrost	-	Heat blinks	-

Selections

- **RMODE**

  This is used to configure the board's models :-
110k	-	EC
22k	-	AT
7k5	-	AHP with C2.3 defrost
3k	-	AHP with C2.4 defrost

- **RSWING**

  This is used to configure the board's DC swing angles :-
3k	-	WM10/15F
220r	-	WM20/25F

- **RFAN**

  This is used to configure board's hot keep specifications :-
110k	-	Fan on option
22k	-	Fan low cycle on & off option
7k5	-	Fan off option

- **RGL**

  This is used to enable or disable the gas leak and 9 minutes compressor forced on options :-
110k	-	No gas leak, No compressor force on
22k	-	No gas leak, Compressor force on on
7k5	-	Gas leak on, No compressor force on
3k	-	Gas leak on, Compressor force on on

- **DOV**

  This is used to configure the board's compressor overload options :-

with DOV	-	auto(temperature) and manual resettable
	-	hardware overload detection on
without DOV	-	manual resettable
	-	hardware overload detection off

9 Minutes Compressor Force On

This option is selected via resistor RGL.

If the compressor is idle for more than 9 minutes during cool mode and room temperature is Ts-1 (Ts = Set temperature)or warmer, the compressor is forced to cut in and the cycle is subjected to cool mode thermostat cut in/out conditions.

Gas Leak

This option is selected via resistor RGL.

The gas leak is declared if indoor coil temperature is > 24°C in cooling cycle or < 20°C in heating cycle.

The system will check the gas leak mode if compressor run time of 30 minutes is achieved. If above condition is met, the CPU will reconfirm the indoor coil temperature for another 5 minutes before declaring the gas leak mode. If the above condition is not met, the compressor run timer will be reset.

ID

There are 4 ID available :-

RID	ID
110k ohm	Universal
22k ohm	1
7k5 ohm	2
3k ohm	3

Note : Universal means the unit can receive any ID.

Schematic Diagram
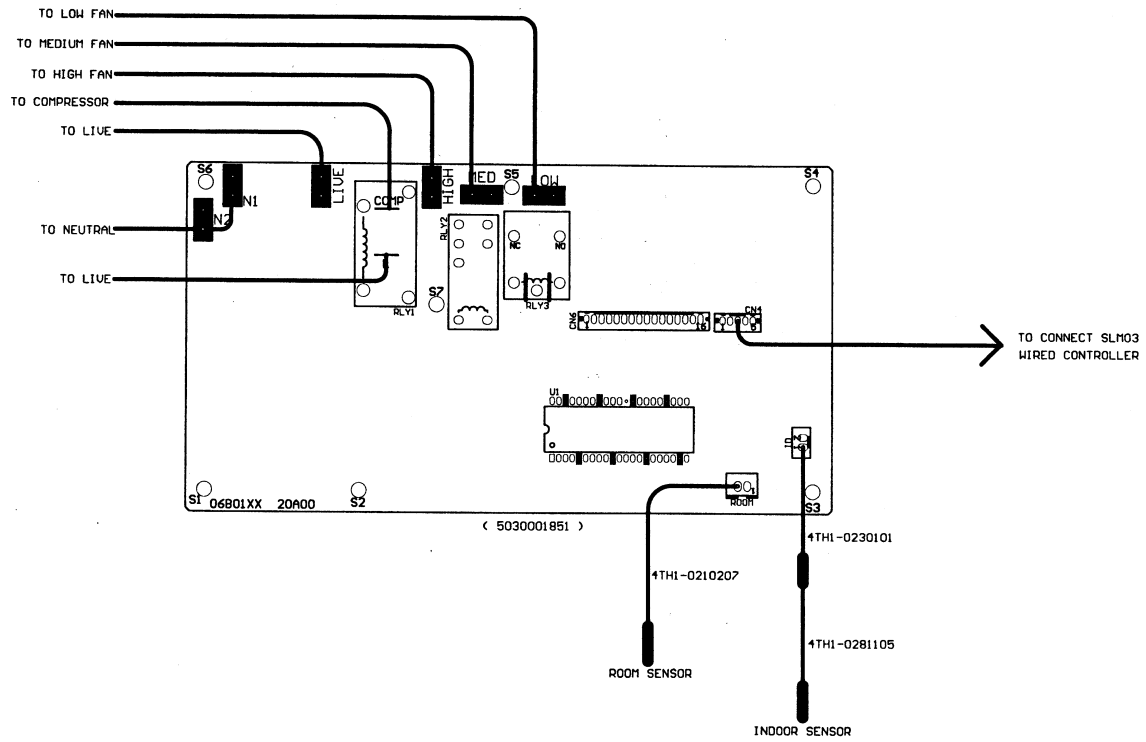
U1.4 for Ceiling Concealed Cooling Only
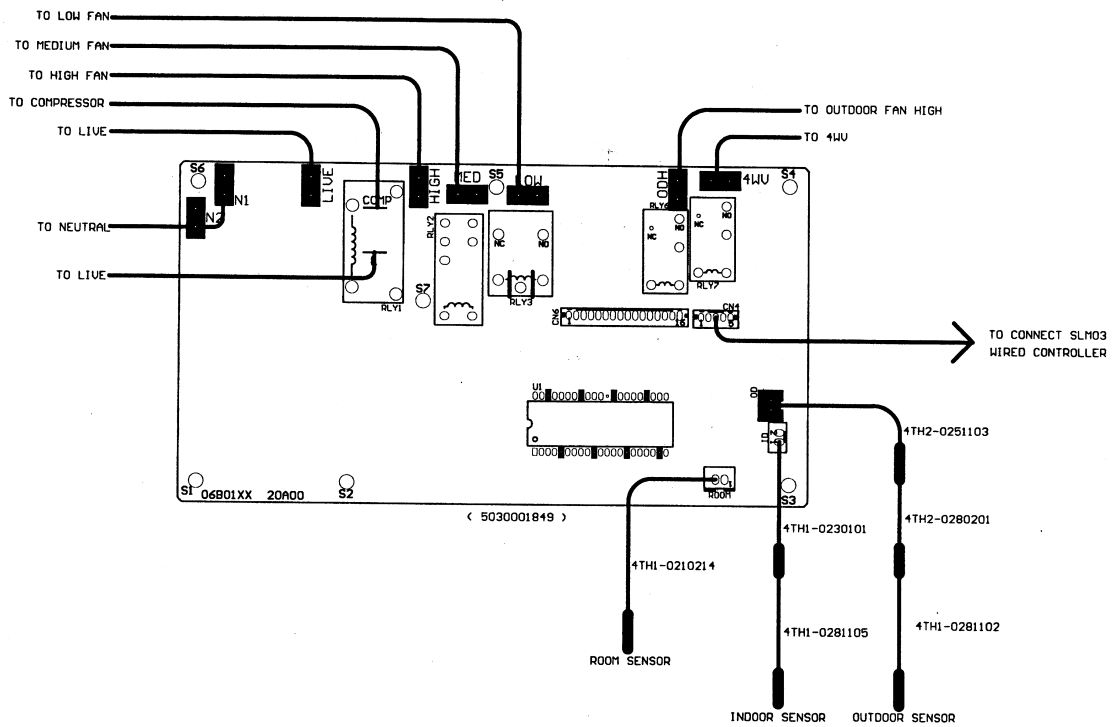
U1.4 for Ceiling Concealed Heatpump
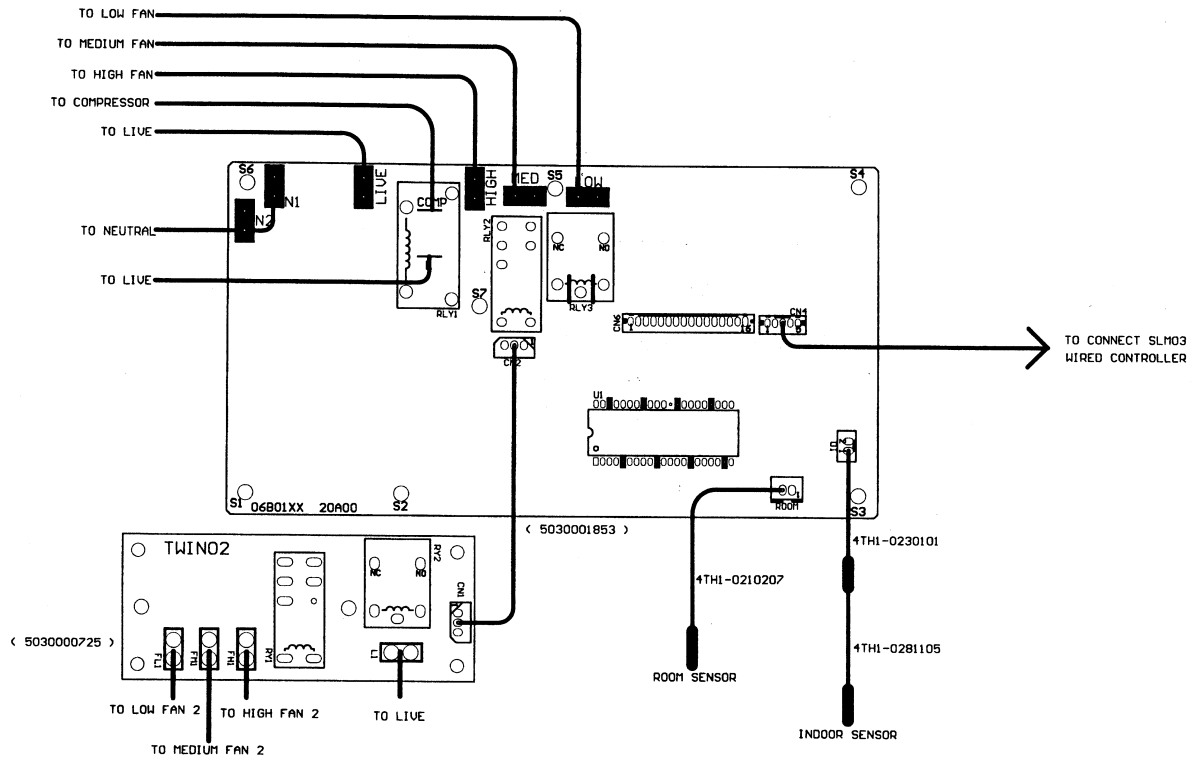
U1.4 for Ceiling Concealed Cooling Only (twin board)
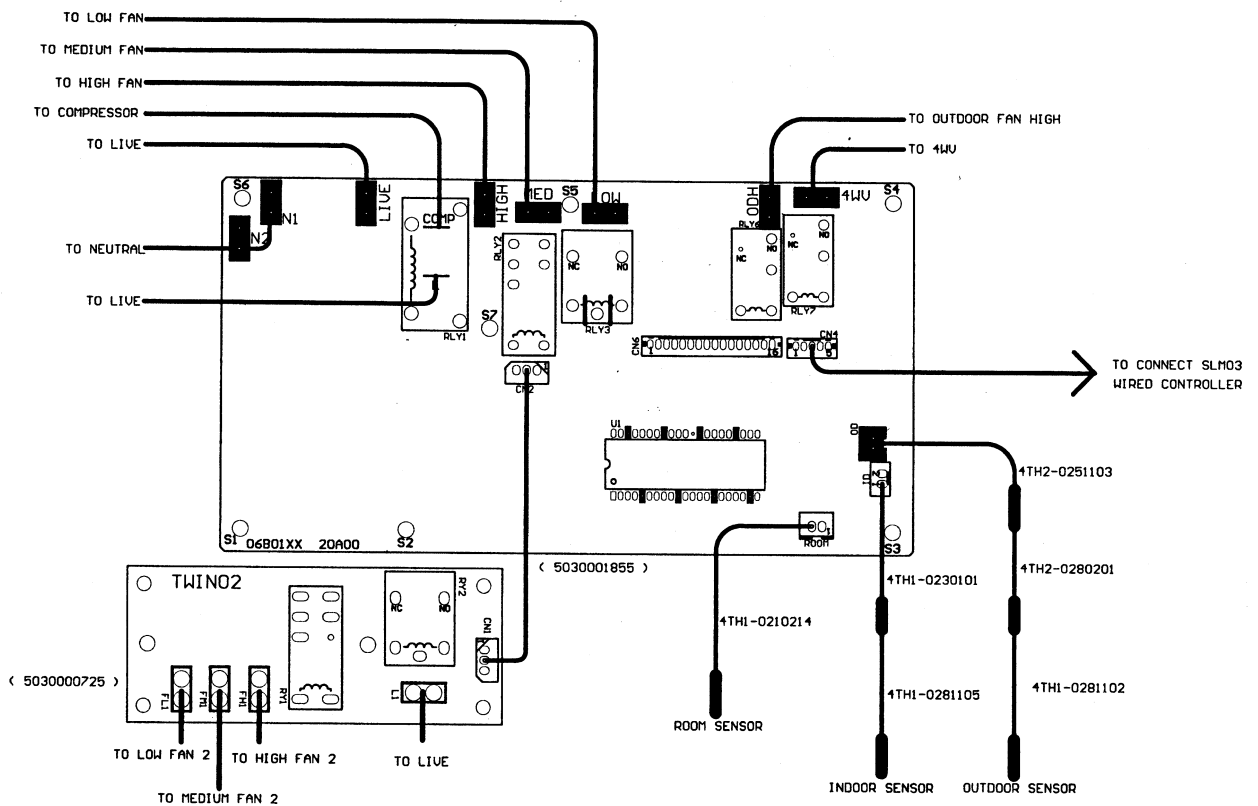
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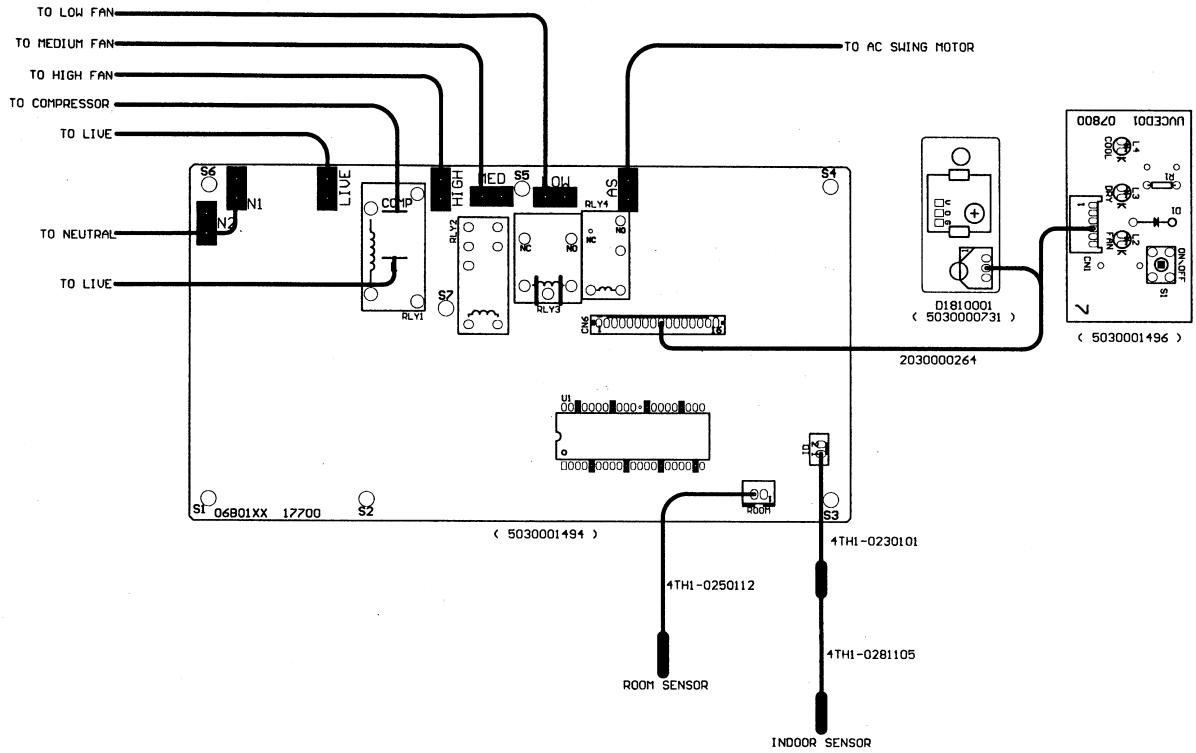
U1.4 for Ceiling Exposed Cooling Only
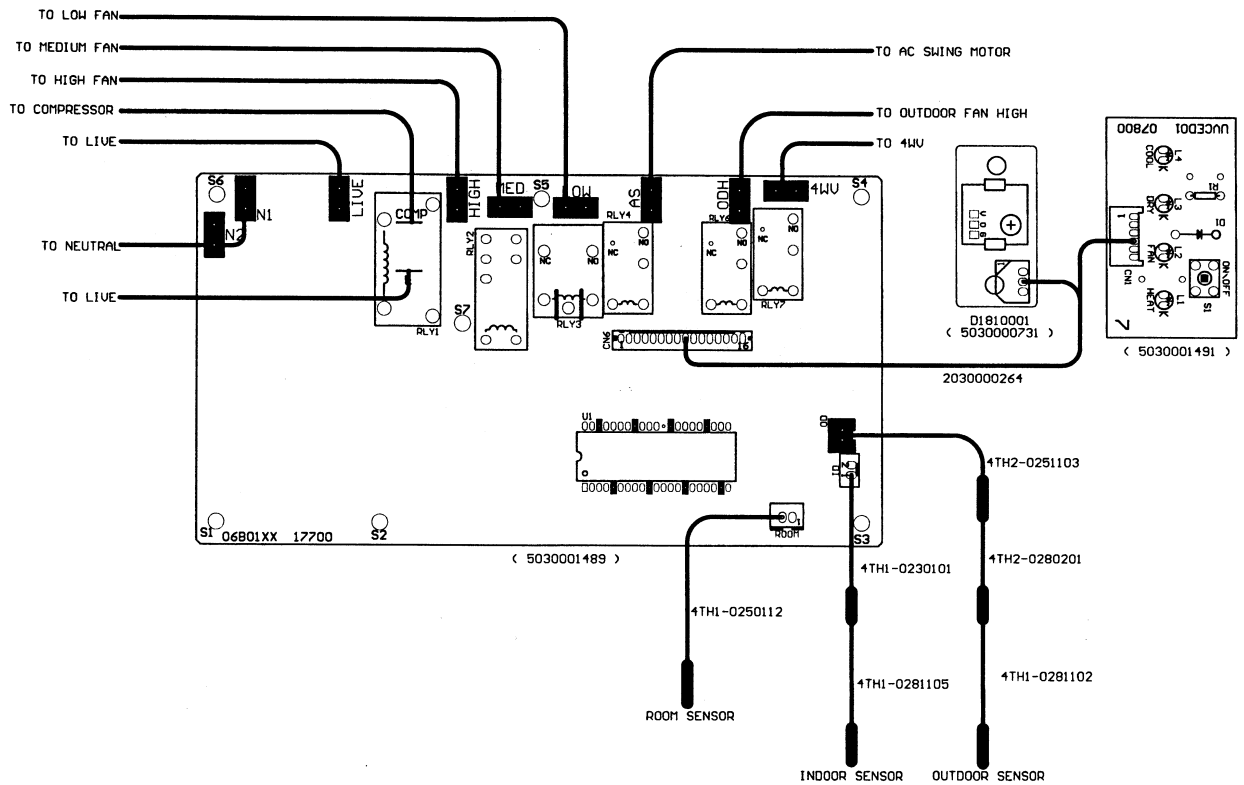
U1.4 for Ceiling Exposed Heatpump
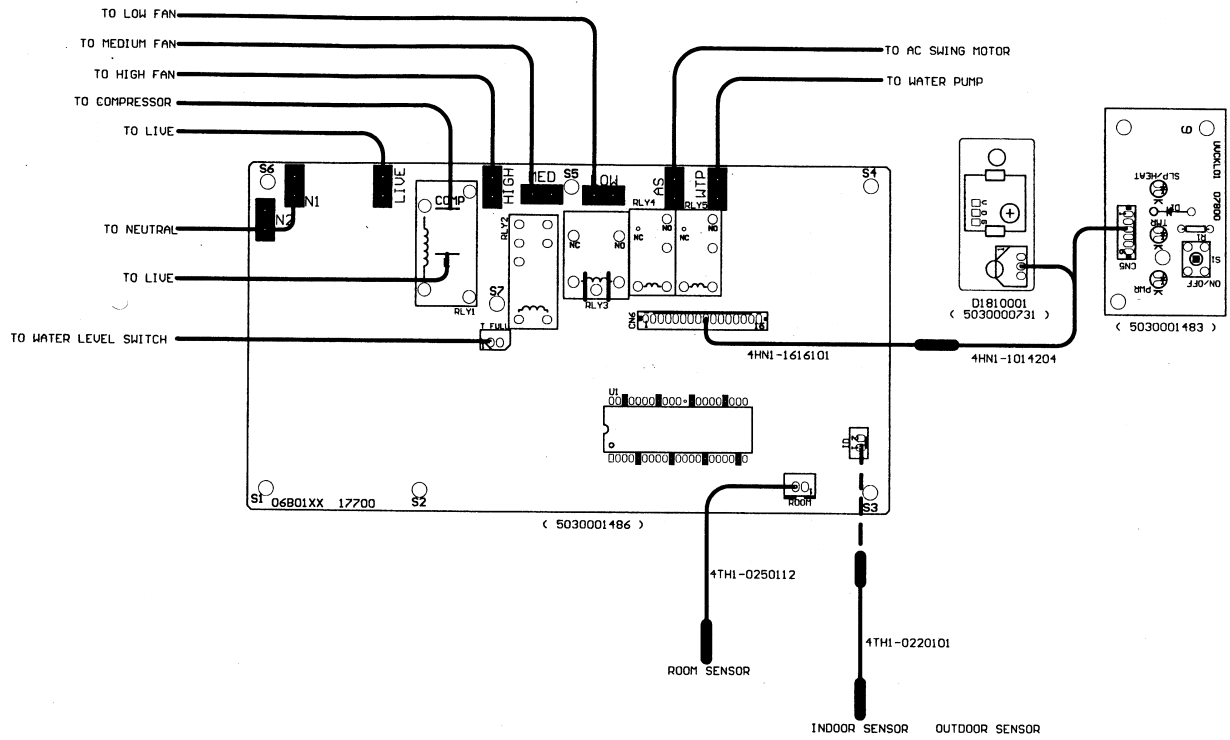
U1.4 for Ceiling Cassette Cooling Only
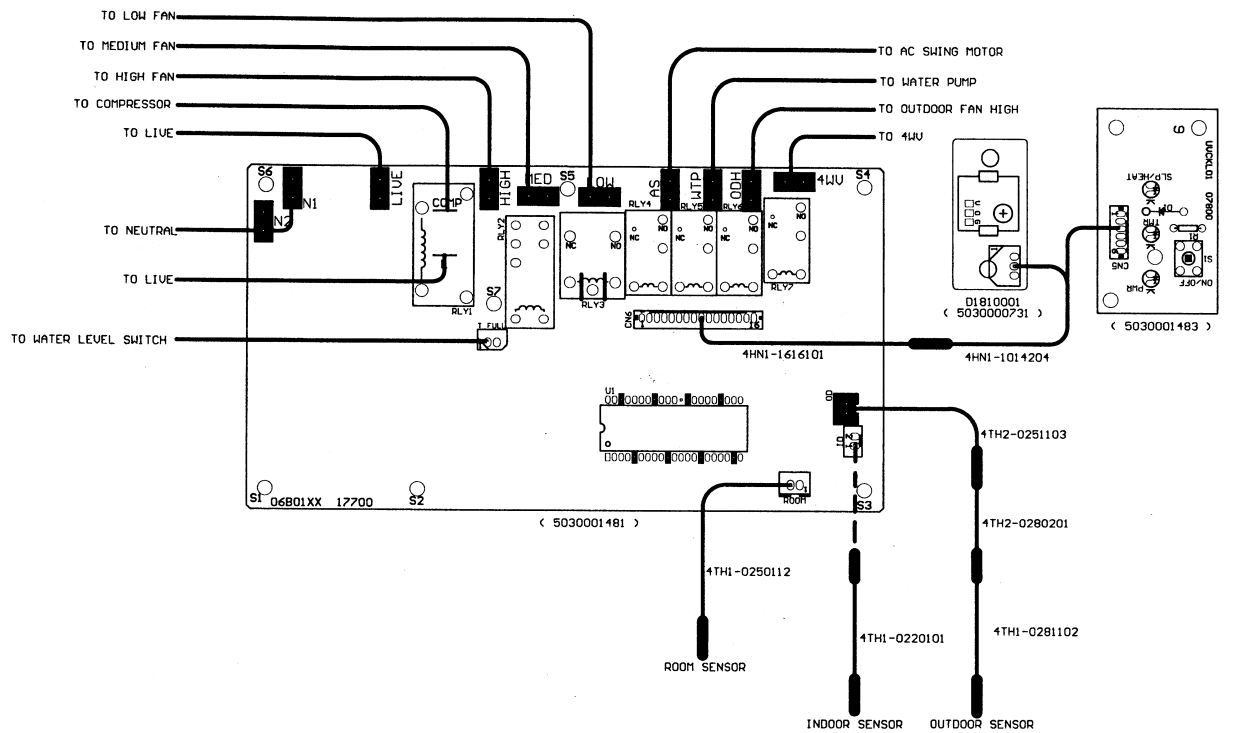
U1.4 for Ceiling Cassette Heatpump

Section A – 3
Direct Expansion System – Single Split

Multi Compressor (SQ1.0)

Features

- Sequential control and balance loading with up to 4 stage compressors
- Selectable stage differential temperature
- 2 Auxilliary heater with enable/disable selection
- Single speed indoor fan
- 7 days programmable timer
- Cool/Heat/Auto/Fan system control
- Cold blast, Spurt heat, Hot start and Hot keep
- Wired LCD control panel
- Self diagnostic feature, error/warning indications
- Energy saving function for Cool, Heat and Auto modes
- Compressor high pressure protection
- Compressor trip/low refrigerant warning
- Compressor high temperature protection
- Outdoor alternative defrost cycle in Heat mode
- Indoor antifreeze protection and filter check in Cool mode
- Memory backup, auto random restart option

Model Selection

Model and Number of Compressor

The controller can be configured into different specification by chnaging the resistance value of R42:

Configuration	Value of R42 (W)
a) Heatpump 2 compressors	1K
b) Heatpump 3 compressors	3.3K
c) Heatpump 4 compressors	9.1K
d) Cooling/Heater* 2 compressor	20K
e) Cooling/Heater* 3 compressor	47K
f) Cooling/Heater* 4 compressor	open

*Cooling or Heater model depending on SW1 and SW2 setting. If number of heater is 0 it is cooling model, if number of heater is 1 or 2 it becomes heater model.

Number of Heater
SW1 and SW2 are used to set number of Heater. For Heatpump model, they are auxiliary heaters. For heater model, they are heaters that will turn on in heat mode.

Configuration	SW1	SW2
a) No heater (0 heater)	Off	Off
b) 1 heater	On	Off
c) 2 heater	On/Off	On

Factory preset: SW1=off, SW2=off (no heater)

Auto Mode
Auto Mode can be enabled/disabled using SW5 (only applicable for Heatpump and Heater model).

Configuration	SW5
Auto mode off	Off
Auto mode on	On

Factory preset: SW5=off (Auto mode off)

Stage Differential Temperature
Stage Differential Temperature is the temperature difference from 1 stage compressor to another stage compressor. See Figure 4.2 and 4.4 for more details. The stage differential temperature can be selected from the range shown below:

Configuration	SW3	SW4
a) Default	Off	Off
b) 0.5ºC	On	Off
c) 1.0ºC	Off	On
d) 1.5ºC	On	On

Factory preset: SW3=off, SW4=off (Default)

*1.5ºC only valid for 2 and 3 compressor model. For 4 compressor model, maximum allowed is 1.0ºC.

The default differential temperature is base on number of compressor model, the setting is as below:

Model	Differential Temperature
2 compressors	1.5°C
3 compressors	1.0°C
4 compressors	0.5°C

Hot Keep Option

Configuration	SW6
i) Fan off	Off
ii) Fan on	On

(follow hot keep condition)   Factory preset: SW6=off (fan off)

Defrost Options

- **Derivative Defrost Option**

Configuration	SW7
Derivative Defrost off	Off
Derivative Defrost on	On

Factory preset: SW7=off (Derivative Defrost option off)

- **Defrost Cycle Option**

Selects whether compressor will turn off or remain on when 4WV changes at beginning of defrost cycle.

Configuration	SW8
Compressor off	Off
Compressor on	On

Factory preset: SW8=off (compressor off)

EEPROM Backup Option

Configuration	JH1	
EEPROM Backup on	Close	(power on follow last state)
EEPROM Backup off	Open	(power on in off mode)

Factory preset: JH1 closed (EEPROM Backup on)

Operating Modes

The system has 4 operating modes to select with respect to each model selection :

MODEL	AUTO	COOL	HEAT	FAN	
SQCn		X		X	
SQHnh		X	X	X	(SW5=off)
SQHnh	X	X	X	X	(SW5=on)
SQHTnh		X	X	X	(SW5=off)
SQHTnh	X	X	X	X	(SW5=on)

where X denotes modes available

Functions

Power Up Settings

- **Power Up On/Off Setting**

  The system will power up on or off base on last state where the main supply was cut off for models where backup memory is enabled (JH1 short) and backup data valid.

  Whereas the system will always power up in off mode when backup memory is disabled or backup data corrupted (JH1 open)

- **Power Up Settings**

  a) With backup memory valid, power up settings will follow settings in the backup memory

  b) Without backup memory (JH1 open) or backup memory data corrupted, the power up settings will follow last settings on the LCD panel in condition that the battery on the LCD panel is functioning. In case where the backup battery on the LCD panel is weak, the power up setting will be 25°C, Cool mode.

Unit On/Off

There are 2 ways to turn on or off the system:

    i) via On/Off triggering on the LCD panel or on the display panel.
    ii) via 7 days timer

- **On/Off Triggering**

  On/Off triggering can be achieved by pressing On/Off key on the wired controller or on the display panel. Pressing the On/Off will toggle the system status either from On to Off or from Off to On.

- **7 Days Programmable Timer**

  There are two 7 days programmable timers namely On Timer and Off Timer. This timer can be overridden by the On/Off pressing.

- **Off mode**

  When the unit is off, the on/off LED on the LCD panel will be off. All relays will be turned off immediately after the ON/OFF triggering except the 4-way valves, and indoor fan which are subjected to protection where applicable.

Temperature Range and Setting

The operating temperature range is 61°F to 86°F (16°C to 30°C), both inclusive. Temperature setting is determined by the wired controller setting or default setting during power up. The temperature setting is only effective under Cool, Heat and Auto modes.

Indoor Fan Speed

There is one indoor fan with single fan speed.

Cold Start

When the unit restarts 2 hours after it has stopped or during power-on-reset start, it is considered a cold start.

Cool Mode

- **Sequential Control**

The starting sequence for indoor fan, outdoor fan and compressors is shown in *Figure 4.1*.

```
           2 seconds
Start      ──────────▶   Indoor fan
           15 seconds                 2 seconds
           ──────────▶   outdoor fan 1  ──────────▶   compressor 1*
           15 seconds                 2 seconds
           ──────────▶   outdoor fan 2  ──────────▶   compressor 2*
           15 seconds                 2 seconds
           ──────────▶   outdoor fan 3  ──────────▶   compressor 3*
           15 seconds                 2 seconds
                         outdoor fan 4  ──────────▶   compressor 4*
```
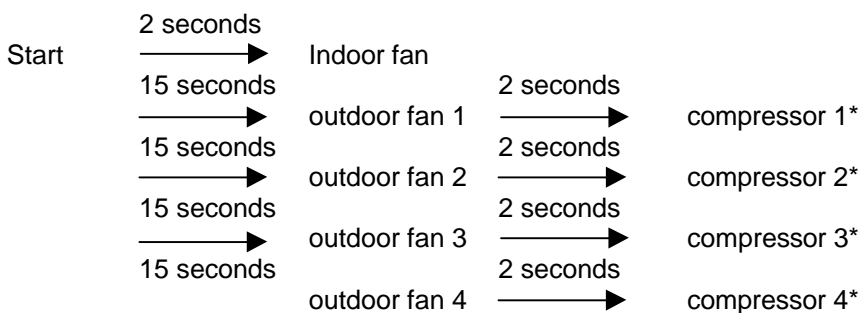
Figure A3.1 : Starting sequence for fans and compressors

The compressors will be turned on one by one depending on the on/off conditions shown in *Figure A3.2*. There is a 15s interval (stage timer) between 2 compressor's turn on sequence. When a compressor is turned on its running time is recorded on its run time counter. When it is off the counter is stop.

a) 0.5°C differential temperature

b) 1.0°C differential temperature

c) 1.5°C differential temperature (up to 3 compressors model only)
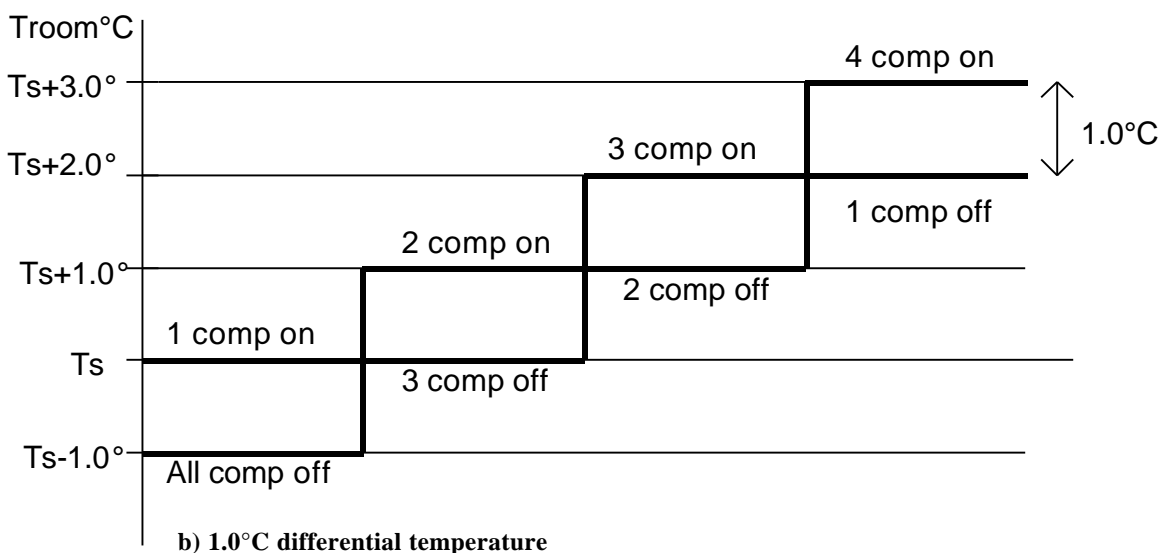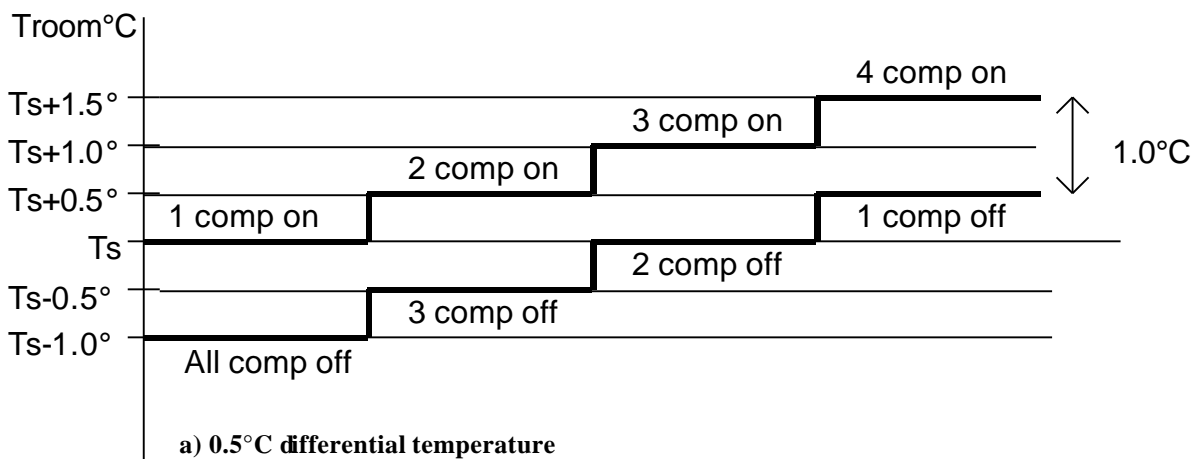
Figure A3.2 : Cool Mode compressor on/off conditions

Heat Mode (Heatpump Model)

- **Sequential Control**

The starting sequence for indoor fan, outdoor fan and compressors is as shown in the following:

Start   —2 seconds→   Indoor fan $^+$ —2 seconds→   all 4 way valves

—15 seconds→   outdoor fan 1   —2 seconds→   compressor 1*

—15 seconds→   outdoor fan 2   —2 seconds→   compressor 2*

—15 seconds→   outdoor fan 3   —2 seconds→   compressor 3*

—15 seconds→   outdoor fan 4   —2 seconds→   compressor 4*   —15 seconds→   Heater 1*   —15 seconds→   Heater 2*
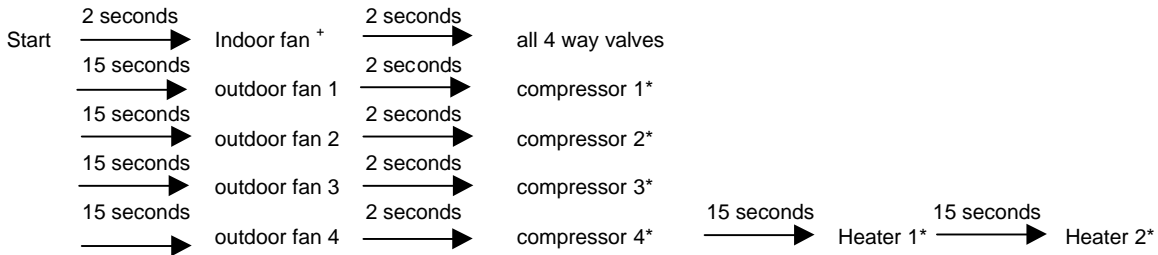
* if available and applicable

Figure A3.3 : Starting sequence when 4 compressors needed to be turned on

The compressors (heatpumps) will be turned on one by one depending on the on/off conditions shown in *Figure A3.4*. There is a 15 seconds interval between 2 compressor's turn on sequence. When a compressor is turned on its running time is recorded on its run time counter. When it is off the counter is stop.
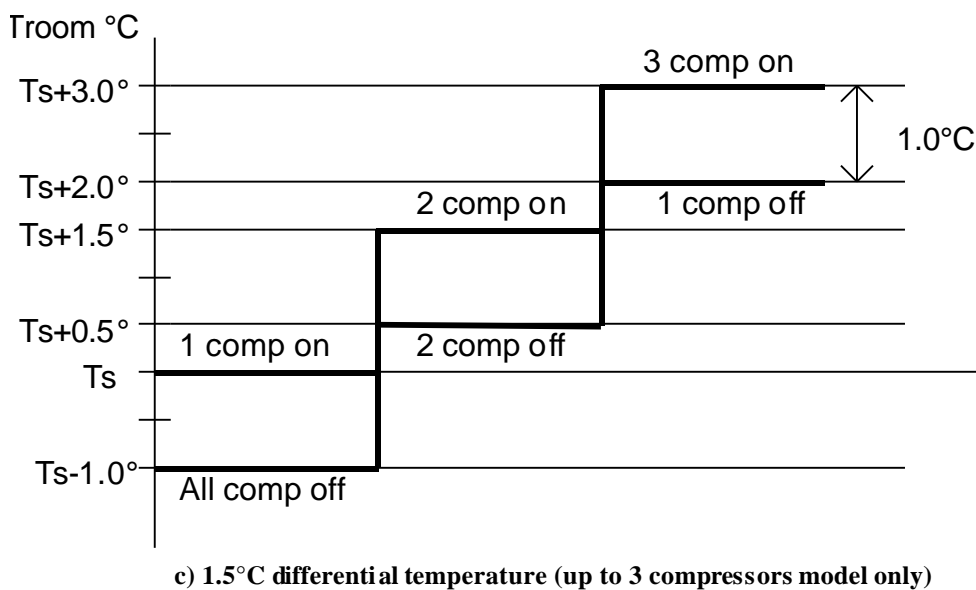

a) 0.5 differential temperature

b) 1.0 differential temperature

c) 1.5 differential temperature (up to 3 compressors model only)
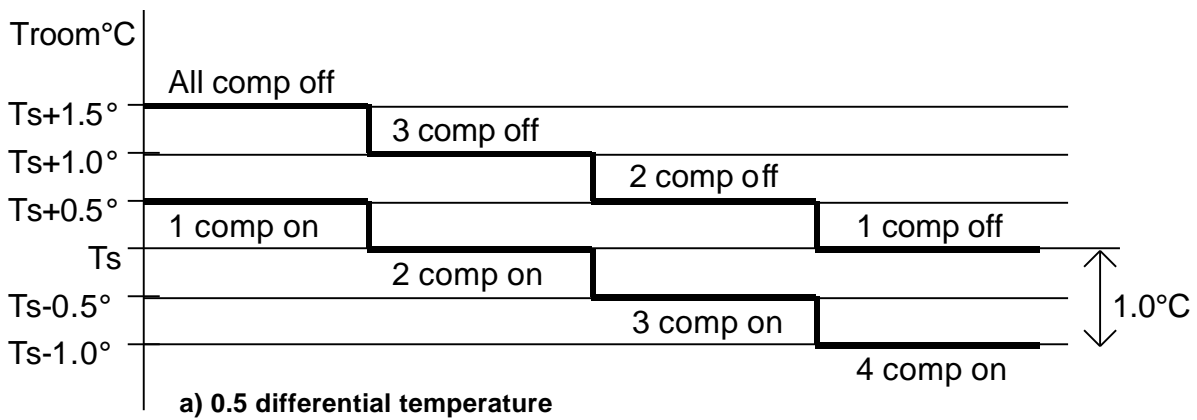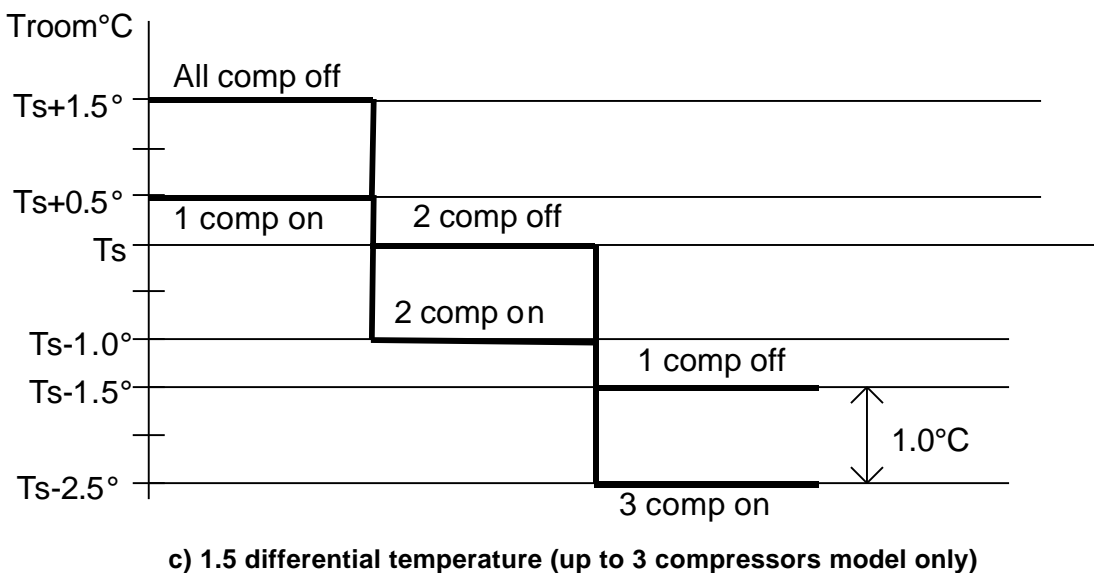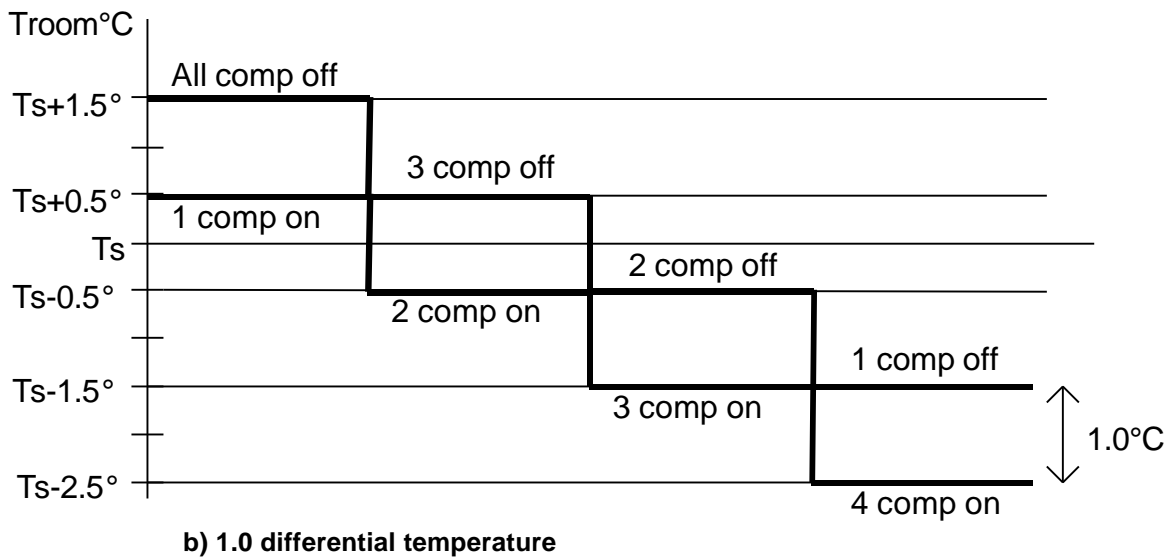
Figure A3.4 : Heat Mode compressor on/off conditions

- **Hot Start**

  When at least 1 compressor cuts in, the indoor fan will run according to indoor coil temperature:

  a) if any of the indoor coil temperature >= 30°C, the indoor fan will run.
  b) if all the indoor coil temperature <= 15°C, the indoor fan speed will stop.

  However when auxiliary heater is running, indoor fan always run.

- **Hot Keep**

  When all the compressors cut out or compressors not running, the indoor fan will run according to indoor coil temperature:

  a) if any of the indoor coil temperature >= 40°C, the indoor fan will run.
  b) if all the indoor coil temperature <= 15°C, the indoor fan will stop.

  Hot keep can be enable or disable via SW6. When fan off is selected, indoor fan will stop when all compressors cut off.

- **Auxiliary Electric Heater**

Electric heater can be enabled or disabled by user on the LCD panel using heater button. For model with 1 electric heater, when heater button is pressed the display on LCD will be:

"HEATER 1" -> " " -> "HEATER 1" ->...

For model with 2 electric heater, the display would be:

"HEATER 1" -> "HEATER 1 2" -> " " -> "HEATER 1" ->...

The Electric Heater 1 will be turned on subjects to following conditions:

a) Heater 1 is enabled AND
b) $T_r <= 22.5°C$ AND
c) All indoor coil temperature is <=50°C AND
d) 40 seconds after the indoor fan has cut in AND
e) $T_r <=$ temperature where last available comp turns on*-1.5ºC. (Depends on number of compressors & differential temperature, see Table 4.1)
f) All the available compressor has been turned on (in case any compressors cannot be turned on due to protection, then heater will be turned on after the last compressor that can be turned on.)

The Electric Heater 2 will be turned on subjects to following conditions:

a) After 15s heater 1 on
b) Heater 1 2 is enabled AND
c) $T_r < 22.5°C$ AND
d) All indoor coil temperature is <=50°C AND
e) 40 seconds after the indoor fan has cut in AND
f) **$T_r <=$ temperature where last available comp turns on*-2.5ºC**. (See Table 4.1)
g) All the available compressor has been turned on (in case any compressors cannot be turned on due to protection, then heater will be turned on after the last compressor that can be turned on.)

Heater 2 will cut out when:

a) Heater 2 is disabled OR
b) **$T_r >=$ temperature where last available comp turns on-1.5ºC** OR
c) $T_r >= 25°C$ OR
d) any of the indoor coil temperature is >=55°C

Heater 1 will cut out when:

a) Heater 1 2 is disabled OR
b) $T_r >=$ temperature where last available comp turns on OR
c) $T_r >= 25°C$ OR
d) any of the indoor coil temperature is >=55°C

Indoor fan will be forced on for 40 seconds before heater turns on and forced to remain on 40 seconds after all heaters off.

*Temperature where last available comp turns on:
Table below showing temperature where last available compressor turns on (room temperature, T_r) relating to set temperature Ts (ºC)

Stg. Diff.	HEAT Mode			AUTO HEAT Mode		
	0.5	1.0	1.5	0.5	1.0	1.5
2 Comp	Ts	Ts – 0.5	Ts – 1.0	Ts – 1.5	Ts – 2.0	Ts – 2.5
3 Comp	Ts – 0.5	Ts – 1.5	Ts – 2.5	Ts – 2.0	Ts – 3.0	Ts – 4.0
4 Comp	Ts – 1.0	Ts – 2.5	N/A	Ts – 2.5	Ts – 4.0	N/A

Table 4.1

- **4-Way Valve Changing**

To run heatpump, all the 4-way valves will be ON. Upon return to non-heat pump mode, all the 4-way valves will be turned off. A 4-way valve can only be changed 55+/- 5 seconds after the compressor has been cut out, then the compressor may be cut in 4 seconds later. When the 4-way valve has been changed and the compressor has not been cut in, the 4-way valve may still be changed again immediately.

Heat Mode (Heater Model)

- **Sequential Control**

The heater on sequence when the system power on in heat mode is shown in *Figure 4.5*:

$$\text{Start} \xrightarrow{\text{2 sec}} \text{indoor fan} \xrightarrow{\text{40 sec}} \text{Heater1*} \xrightarrow{\text{15 sec}} \text{Heater2*}$$
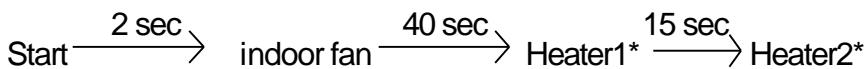
*If available & applicable

Figure A3.5 : Starting sequence when 2 heaters needed to be turned on.

When heater is enabled, heater on/off condition is as shown in *Figure 4.6*. When heater is disabled, heater will always off.
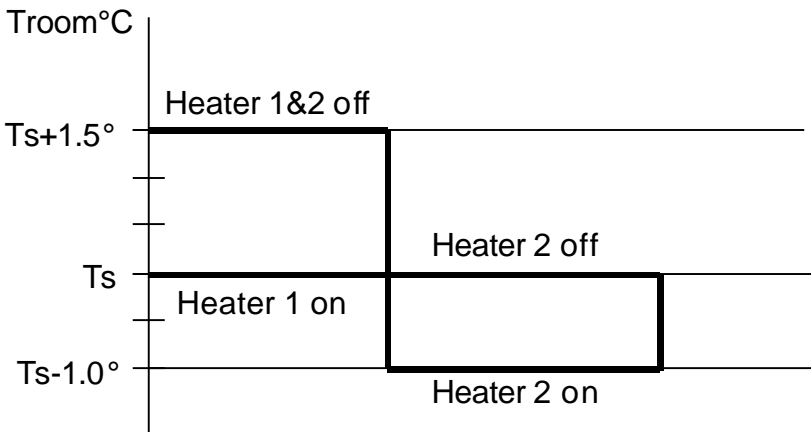
Figure A3.6 : Heater on/off condition

Auto Mode

In Auto mode, operating mode will be selected automatically between Heat and Cool mode, depending on the Room Temperature and Set Temperature.

Fan Mode

The indoor fan is only running with single speed. The compressors and outdoor fans will stop. The 4-way valve will turn off as well.

Energy Saving Function

This function will increase or decrease the set temperature with time.

The Cool mode Energy Saving profile is shown in *Figure A3.7*.
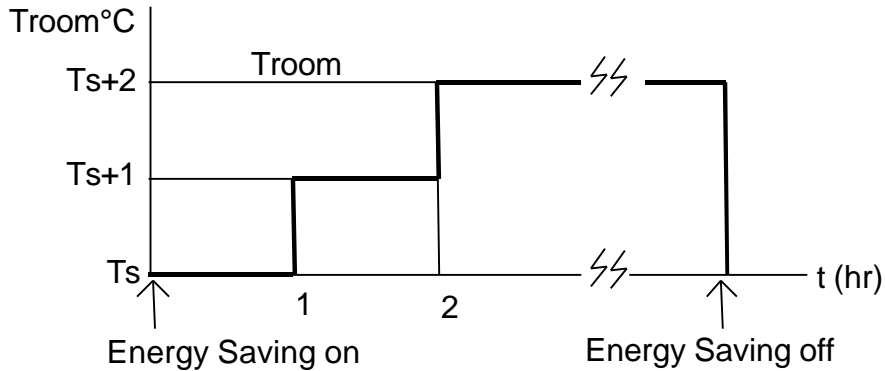
Figure A3.7 : Cool Mode Energy Saving profile

The Heat mode Energy Saving profile is shown in *Figure A3.8*.
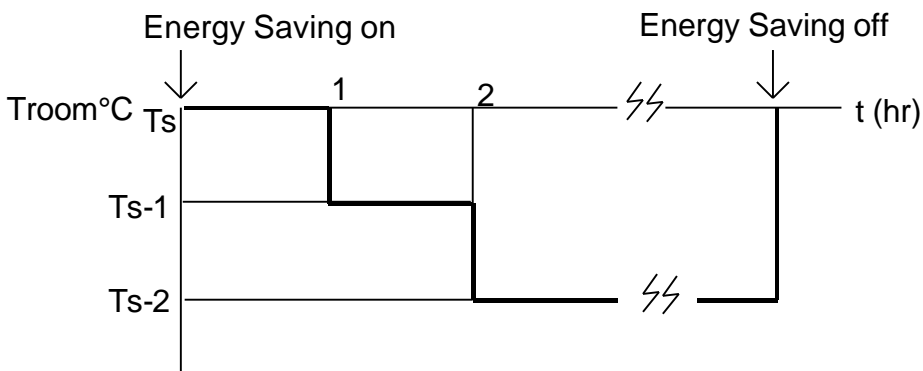
Figure A3.8 : Heat Mode Energy Saving profile

The option is only available for Cool, Heat and Auto modes.

Protections

- **5 minute Minimum Run Time for Compressor**

  For thermostat cycles, a compressor can only cut out after running for 5 minutes in the current mode. The compressor can be cut out at any time if the system is switched to other modes.

- **3-Minutes Minimum Off Time for Compressor**

  For thermostat cycles, a compressor can only cut in after 3 minutes from the time it cuts off except during 4-way valve changeover sequences where it can cut in 5 seconds after 4-way valve changeover.

- **Compressor High Pressure Protection**

  If any of the compressor has high pressure trip, error code will be indicated on LCD. The compressor is not allowed to cut in for 3 minutes (error code will be shown for 3 minutes). If the compressor has high pressure trip for 3 times in 30 minutes, it cannot be restarted automatically. (can be reset by triggering

the on/off button)

- **Compressor High Temperature Protection**

    a) Cool and Auto Cool modes

    When the Outdoor Coil temperature for a particular compressor exceeds 68°C, the compressor and its outdoor fan will stop operating. Other compressors will perform thermostat cycle as usual. The indoor fan will still continue to run even if all the compressors are cut off due to high temperature protection.

    b) Heat and Auto Heat mode

    When the Indoor Coil temperature for a particular compressor exceeds 59ºC, the outdoor fan will stop. When Indoor coil temperature exceeds 62°C, the compressor and its outdoor fan will stop. Other compressors will perform thermostat cycle as usual. The indoor fan will still continue to run but subjected to hot keep condition, if all the compressors are cut off due to high temperature protection.

    When any compressor for a particular model cuts off due to high temperature, and there is at least one compressor is running as usual, the compressor that cut off can be turned on when its temperature falls below 55°C. Outdoor fan can be turned on when temperature falls below 50ºC.

    If all the available compressors were cut off due to high temperature protection, the system can only be reset manually by trigering the ON/OFF button. If the system is not reset, the compressors cannot restart.

- **Compressor Trip / Low Refrigerant Warning**

    A compressor is said to be tripped or low refrigerant if the conditions below suspected:

    Cool and Auto Cool modes

    i) After minimum run time of 5 minutes
    ii) $T_r - T_{incoil} <= 3ºC$ (i.e. indoor coil not cold enough)

    Heat and Auto Heat modes

    i) After minimum run time of 5 minutes
    ii) $T_{incoil} - T_r <= 3ºC$ (i.e. indoor coil not hot enough)

    Once the error confirmed, the compressor number on LCD panel will be blinking, error code will be shown and LED blinks. However the compressor is not stopped. Once the error is cleared, the LCD display resumes as normal.

- **Indoor Antifreeze Protection and Filter Check**

This protection is only available in Cool modes. A compressor will enter Antifreeze mode if :

    i) its Indoor Coil Temp. reaches 1°C and below for at least 1 minute.
    ii) the compressor has run for at least 10 minutes.

Upon confirmation, the compressor and the outdoor fan must be stopped. Other compressors will run as usual. The compressor and its outdoor fan can only be restarted when,

    i) after a minimum stop time of 3 minutes.
    ii) the Indoor Coil Temp. reaches 12°C and above for at least 1 minute.
    iii) another mode of operation is selected.

- **Outdoor Defrost**

Defrost mode can only be entered from heat mode (not selectable by user). A defrost timer will start counting when any of the outdoor coil temperature is below +3°C.

a) Conventional Defrost Condition - The likelihood of ice frosting at the outdoor coil is characterised by 3 gradients of outdoor temperature shown in *Figure 4.11*:
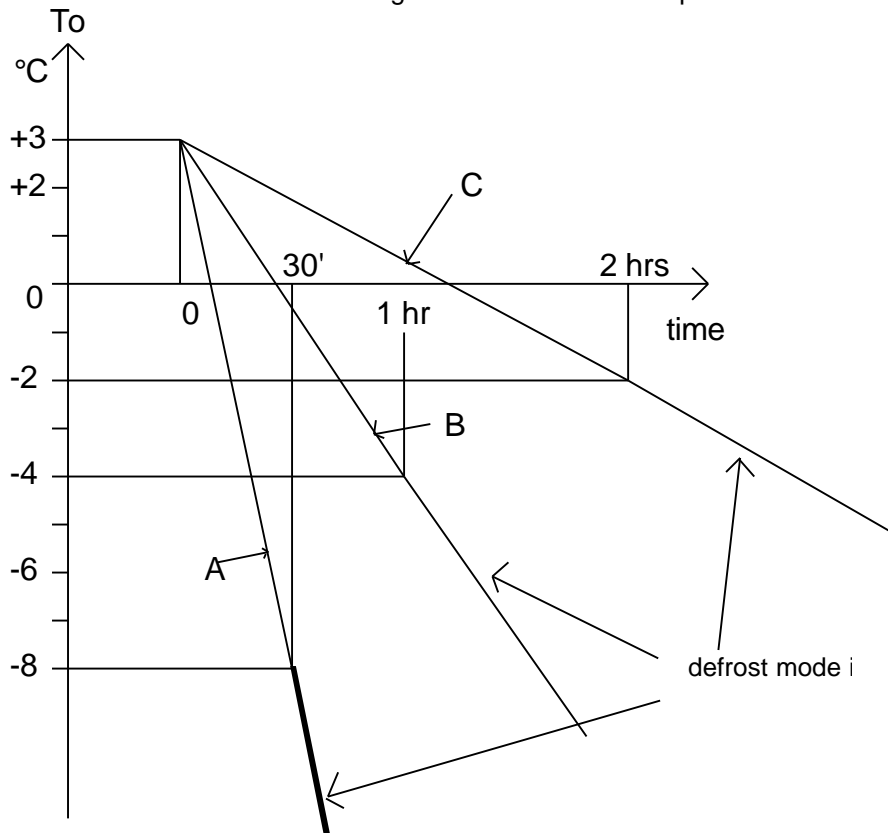
Figure A3.9 : Conventional Defrost Condition

Defrost condition will be met if the accumulated compressor run time is:

i) 30 mins to 1 hour from +3°C reference point, if the outdoor coil temperature is <=-8°C, then defrost mode can be started.

ii) 1 hour to 2 hours from +3°C reference point, if the outdoor coil temperature is <=-4°C, then defrost mode can be started.

iii) more than 2 hours from +3°C reference point, if the outdoor coil temperature is <=-2°C, then defrost mode can be started.

Defrost cycle

Only ONE compressor can enter defrose mode at one time. If more that 2 compressors fulfill defrost condition, the compressor with maximum accumulated run time will enter defrost cycle.

Pre Defrost Cycle
When one compressor is confirmed to run defrost cycle, one compressor will turn on for 2 minutes before the specific compressor enters defrost cycle. If no compressor can be turned on in 2 minute, defrost cycle will still running. If no other compressor run heat mode & one compressor running defrost, indoor fan will turn off irrespect of hot keep & hot start conditions, except when heater is on.

<u>Defrost Cycle</u>
After 2 minutes pre defrost cycle, depends on defrost option set by SW8, for compressor on option, outdoor fan & 4-way valve will cut off and the compressor runs defrost cycle.

For compressor off option, the compressor and its outdoor fan will be cut out, then 55 seconds later its 4-way valve switches OFF. Then 4 seconds later the compressor will turn on with its outdoor fan off.

The other compressors will perform thermostat cycle operation as usual with both indoor and outdoor fans on.

The compressor that runs defrost cycle is consider running cool cycle, therefore one compressor will be forced on in heat cycle (if available) to cancel the cooling effect. For example if current Tr-Ts condition requires 1 compressors to run heat mode, then the situation is: 1 compressor runs defrost cycle (cool), 2 compressor run heat cycle and so on.

<u>Terminate Defrost Cycle</u>
The compressor then runs with its outdoor fan off until temperature of its outdoor coil exceeds +10°C or a minimum of 10 minutes compressor run time is achieved (if compressor that runs defrost trip, its defrost cycle ends), after that the compressor will be stopped, and the defrost cycle is completed. Then 55seconds later 4-way valve switches on where the Heat cycle can continue to run (compressor can cut in in 5 seconds).

C2.4 option: At the end of the defrost cycle, the compressor cuts out. Then 4-way valve switches on 15 +/- 5 seconds later. The compressor can cut in 20 seconds time.

Thermistor Error

The poor contact conditions of the room, indoor coil & outdoor coil thermistors are indicated via the wired control panel using error code on the LCD. For indoor coil and outdoor coil sensors, the error is indicated if any of the sensors is open or close.

SENSOR	ERROR CONDITIONS
i) INDOOR COIL	<-44°C for > 2 s *OR*
	>76°C for > 2 s *OR*
	OPEN OR CLOSE
ii) OUTDOOR COIL	<-44°C for > 2 s *OR*
	>76°C for > 2 s *OR*
	OPEN OR CLOSE
iii) ROOM	<-33°C *OR*
	>50°C *OR*
	OPEN OR CLOSE

When either of the above faults is confirmed, the system will run as normal. The compressor and outdoor fan related to the errorneous sensor cannot be turned on. If either of the above faults is confirmed rectified, the respective error code is cleared.

Test Mode (Calibration)

The system will enter test mode when pin 13 of HD404318S IC is tied to 0V during power on.

The system will start in off mode in test mode. For system with MAX1483 option, pin 13 must be released from 0V to enable communication between the Mainboard and SQLCD LCD

panel.

The relays on the Mainboard will be turned on by one after the ON/OFF button (dry contacts on the Mainboard) is pressed as shown below:

ON/OFF Pressing	Relay that turned ON	LCD Display
1	COMP1	COMP1
2	COMP 2	COMP12
3	COMP 3	COMP123
4	COMP 4	COMP1234
5	INFAN	COMP1234
6	HEATER1	COMP1234
7	HEATER2	COMP1234
8	4WV1	COMP1234
9	4WV2	COMP1234
10	4WV3	COMP1234
11	4WV4	COMP1234
12	OUTFAN1	COMP1234
13	OUTFAN2	COMP1234
14	OUTFAN3	COMP1234
15	OUTFAN4	COMP1234

NOTE: All relays that turned on remain on in subsequent steps.

The system can only return to normal operation after being powered off and then power on with pin 13 released from 0V.

Error Code - Error code is displayed on the LCD panel. When system on and error code is shown, the on/off LED on the LCD panel will blink. When system off, error code is still display for thermister error but the on/off LED will be off.

E01	Require manual reset	E19	Indoor coil sensor 4 short
E02	Compressor 1 high temperature (overload)	E20	Indoor coil sensor 1 open
E03	Compressor 2 high temperature (overload)	E21	Indoor coil sensor 2 open
E04	Compressor 3 high temperature (overload)	E22	Indoor coil sensor 3 open
E05	Compressor 4 high temperature (overload)	E23	Indoor coil sensor 4 open
E06	Compressor 1 high pressure trip (or contact open)	E24	Outdoor coil sensor 1 short
E07	Compressor 2 high pressure trip (or contact open)	E25	Outdoor coil sensor 2 short
E08	Compressor 3 high pressure trip (or contact open)	E26	Outdoor coil sensor 3 short
E09	Compressor 4 high pressure trip (or contact open)	E27	Outdoor coil sensor 4 short
E10	Compressor 1 trip (or low refrigerant)	E28	Outdoor coil sensor 1 open
E11	Compressor 2 trip (or low refrigerant)	E29	Outdoor coil sensor 2 open
E12	Compressor 3 trip (or low refrigerant)	E30	Outdoor coil sensor 3 open
E13	Compressor 4 trip (or low refrigerant)	E31	Outdoor coil sensor 4 open
E14	Room sensor short	E32	Compressor 1 deice
E15	Room sensor open	E33	Compressor 2 deice
E16	Indoor coil sensor 1 short	E34	Compressor 3 deice
E17	Indoor coil sensor 2 short	E35	Compressor 4 deice
E18	Indoor coil sensor 3 short		

Schematic Diagram
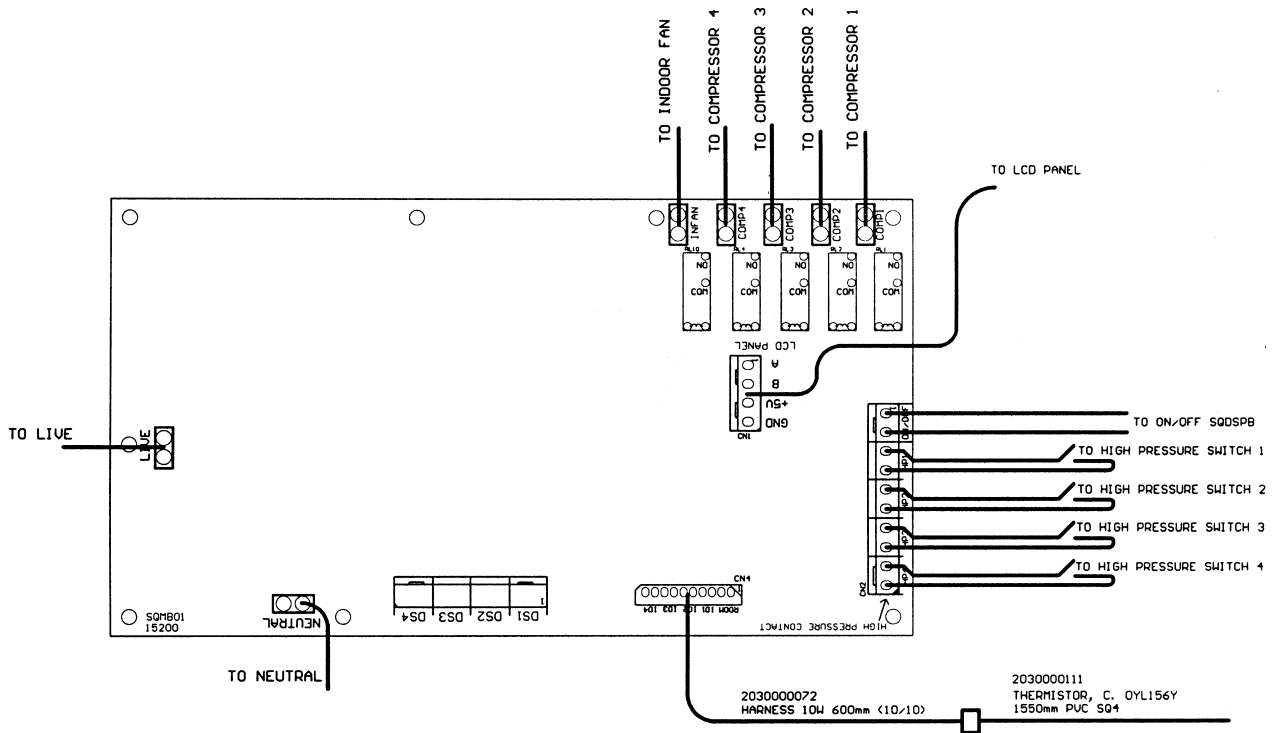
SQ1.0 Cooling Only
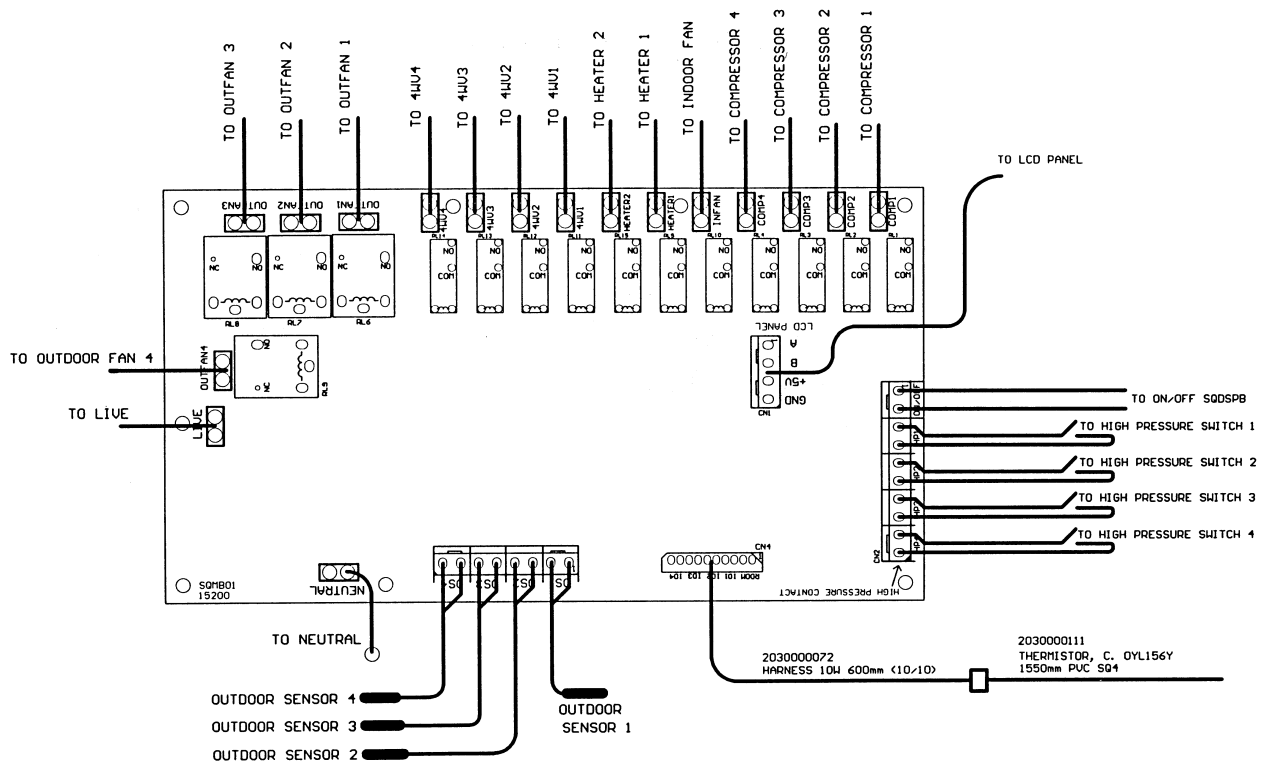
SQ1.0 Heatpump

Section A – 4
Direct Expansion System – Multi Split

Indoor Controller (MS10)

Features

- HEAT(heatpump or heater)/COOL/DRY/FAN/AUTO system control.
- Auxiliary heater for Heatpump model.
- AUTO/HIGH/MED/LOW indoor fan speed control.
- DC motor and AC motor swing control option.
- LCD remote control reception.
- Wired LCD (N2)control reception.
- Real time clock.
- Real time ON/OFF timer.
- Delay timer up to 15 hours.
- SLEEP function for COOL, HEAT and AUTO mode.
- Cold start, Hot start and Hot keep.
- Frost/ice prevention in indoor coil for cooling cycle.
- Compressor overload protection for heating cycle.
- Indoor Antifreeze (2 options) for cooling cycle.
- Indications for thermistors' contact condition.
- Seven segments display for room temperature in °C or °F options.
- Memory (non-volatile) backup for last state settings option.
- Compressor random restart during 1st thermostat cut in cycle.
- Compressor 9 minutes force on (Cool mode only) option.
- ID option.
- Compressor overload manual/auto reset option.
- On line testing activation (OnTac)
- Outdoor coil sensor exist detection

Functions

Mode Selection

The system has 3 modes selection to be selected via the value of resistor RMODE. The following notations are used to represent the various modes selected:

MODES	AUTO	COOL	DRY	HEAT	FAN	DEFROST	RMODE
AP	X	X	X	X	X	-	3K
AP	X	X	X	X	X	-	7K5
EC	-	X	X	-	X	-	110K

where   X denotes modes available

Power Up Settings

During power up, the system can be configured to memorised the settings prior to power down. This is done by shorting the 2 way straight header JP1. The settings that are memorised are :-

   a) Mode & On/Off status
   b) Set Temperature
   c) Fan Speed
   d) DC swing
   e) AC swing
   f) Flap stop coordinate (for DC swing off mode)
   g) Keylock (Wired control)

These data or settings are save in non-volatile memory.

The CPU will save the updated settings into the memory 10 seconds after changes are confirmed. However, it will take 3 seconds to update the memory if the unit changes from on to off state.

If the swing mode is off, the flap will stop at the last stop position prior it is power down.

If the JP1 is not shorted, the power up setting is OFF mode, temperature setting is 24°C, indoor fan speed is high and swing mode is off.

Unit ON/OFF

- **ON/OFF triggering**

ON/OFF triggering can be achieved by pressing the emergency ON/OFF button or the LCD remote controller ON/OFF button. In doing so, the DELAY timer will be reset.

When the emergency ON/OFF button is pressed, the system mode setting will rotate in the following sequence :-

MODEL	SEQUENCE
AP	---------- > COOL > HEAT > OFF > ------------
EC	--------------> COOL > OFF >-------------------

The corresponding LEDs will also follow suit.

Pressing the remocon ON/OFF will toggle the system status either from ON to OFF or from OFF to ON.

Temperature Range And Setting

The operating temperature range is 16 °C to 30 °C, both inclusive. Temperature setting is allowed in COOL, DRY, HEAT and AUTO modes.

Sleep Function

This function will increase or decrease the set temperature with time. The COOL mode SLEEP profile is as follows:-

The HEAT mode SLEEP profile is as follows:

The SLEEP option is only available for COOL, HEAT and AUTO modes.

This option is set/reset by on the LCD remocon.

Protections

- **3-Minutes Minimum OFF Time for Thermostat**

For thermostat cycles, the compressor can only cut in after a minimum period of 3 minutes from the time it cuts off.

- **140 seconds Minimum Run Time for Thermostat**

For thermostat cycles, the compressor can only cut out after minimum 140 seconds of running in the current mode. The compressor can be cut out at any time if the system is switched to other modes or in any other protection sequences.

- **Compressor Overload Protection**

There are two methods to detect the compressor overload; namely by the coil sensors and the hardware overload (normally close) switch.

   a) Coil Sensors Detection

This protection is only available in:

UNIT	MODE
Multisplit	HEAT

When the Indoor Coil temperature exceeds 68°C in heating cycle, the compressor and outdoor fan will stop operating accordingly.

The unit will auto reset if the temperature goes below 50°C. This is allowed once every power on reset. If the unit is required to auto reset every time the overload occurs, a diode (1N4148 or equivalent) is required to insert into DOV.

If the temperature goes below the permissible limit, the overload protection can be reset manually by triggering the ON/OFF key.

b) Hardware Switch Detection

This is a normally close switch. It is connected in series with the power supply to the controller. Once there is overload, the switch will open and power supply to controller will be cut off.

During the first cycle of thermostat on since power on reset, a counter is increased by one and a timer starts to run. If the timer exceeds 3 minutes or the unit is turned off, the counter is reset to 0. During the increment, if the counter is > 5, the unit will declare compressor overload protection. This fault is manual resettable.

The counter is saved in the non-volatile memory. If memory backup option is not selected, the counter is always set to 0 during power on reset. It is selectable if diode is inserted into DOV.

- **Outdoor fan speed control**

  a) Heat mode

  The outdoor fan will:-

    i) cut off when the indoor coil temperature exceeds 57°C.
    ii) resume at high fan when indoor coil temperature is lower than 50°C.

  b) Cool mode

  Only outdoor high fan is available.

- **Indoor Anti Freeze**

  This protection is only available in cooling cycle.

  The system will be in the Frost Prevention Mode if the Indoor Coil temperature reaches 1°C and cooler for at least 4 minutes. Upon confirmation, the compressor and the outdoor fan must be stopped. The compressor and the outdoor fan can only be restarted when the Indoor Coil temperature reaches 10°C and above for at least 1 minute.

Fan Speed Selection

The indoor fan speeds are LO, MED, HIGH or AUTO FAN in COOL, HEAT and AUTO modes.

In FAN mode, only HI, MED and LO speeds are allowed.

Air Louvre And Air Swing

In ac swing option, the swing will run if indoor fan is on and vice versa.

In the air louvre option, the stepper motor will only run when the indoor fan runs. The louvre will be set at the maximum closing position when the unit is turned off. The swing angles of all operating modes (when swing option is activated) are as follow:

RSWG	REMARK	MODE	SWING ANGLE
3K	WM10F	COOL/DRY/FAN	$100° <= X <= 140°$
		HEAT	$80° <= X <= 110°$
220R	WM20F, WMXX1	COOL/DRY/FAN	$120° <= X <= 160°$
		HEAT	$100° <= X <= 140°$

where 0° is referred to as air louvre maximum closing point.

Operating Modes

The system mode is set by the LCD remocon. The actual mode will be shown on the mode LEDs. Mode changes respond 2 seconds after data reception.

Cold Start

When the unit restarts 2 hours after it has stopped or during power-on-reset start, it is considered a cold start.

Cool Mode

In Cool mode, the compressor will be cut in if the $Tr - Ts > 0.5°C$ and the compressor will be cut out if the $Tr < Ts - 1.0°C$, subject to timing protections.

In this mode, the indoor fan is always running. For manual speed, the indoor fan will run as per user set speed. In AUTO FAN speed, the indoor fan speed will run as follows:

HIGH FAN : $Tr > Ts + 0.5°C$
MEDIUM FAN : $Ts + 1.5°C > Tr > Ts - 0.5°C$
LOW FAN : $Ts + 0.5°C > Tr$

Dry Mode

During the first 12 minutes of the DRY mode run from:

    a) Cold Start **OR**
    b) Mode change from HEAT, FAN or AUTO HEAT

Dry mode must run under cool mode with AUTO indoor fan for 12 minutes or until
$$Tr < Ts - 1°C.$$

After this, the dry mode may run under either Zone A, B, C or D as below:

    a) if $Tr - Ts > 2°C$, the operation is in Zone A
    b) if $1°C < Ts - Tr < 2°C$, then the operation is in Zone C.
    c) if $0°C < Tr - Ts < 1°C$, then the operation is in Zone B.
    d) if $Ts - Tr > 3°C$, then the operation is in Zone D.

e) the other temperature ranges are dead bands for zone stability.

The sequence for the various zones are as shown:

a) ZONE A

COMPRESSOR
ON
OFF
t

LOW FAN
ON
OFF
12 mins   t

b) ZONE B

ON
COMPRESSOR
OFF
8 mins   4 mins   t

ON
LOW FAN
OFF
t

30 secs   30 secs

c) ZONE C

ON
COMPRESSOR
OFF
6 mins   6 mins   t

ON
LOW FAN
OFF
t

30 secs   30 secs
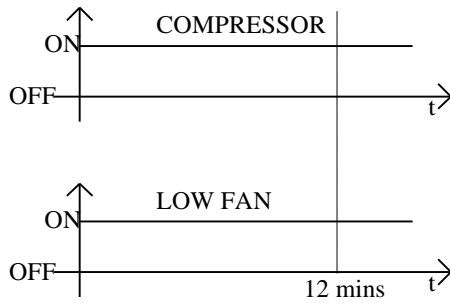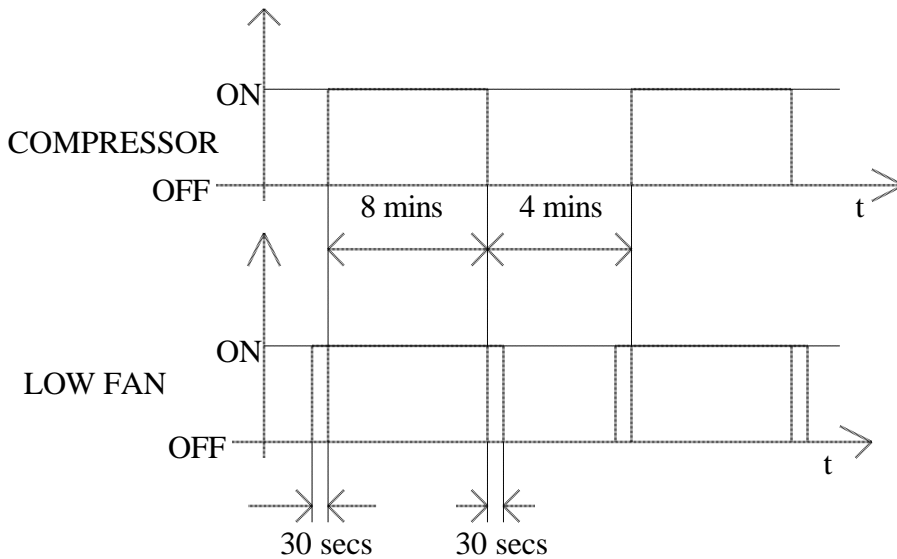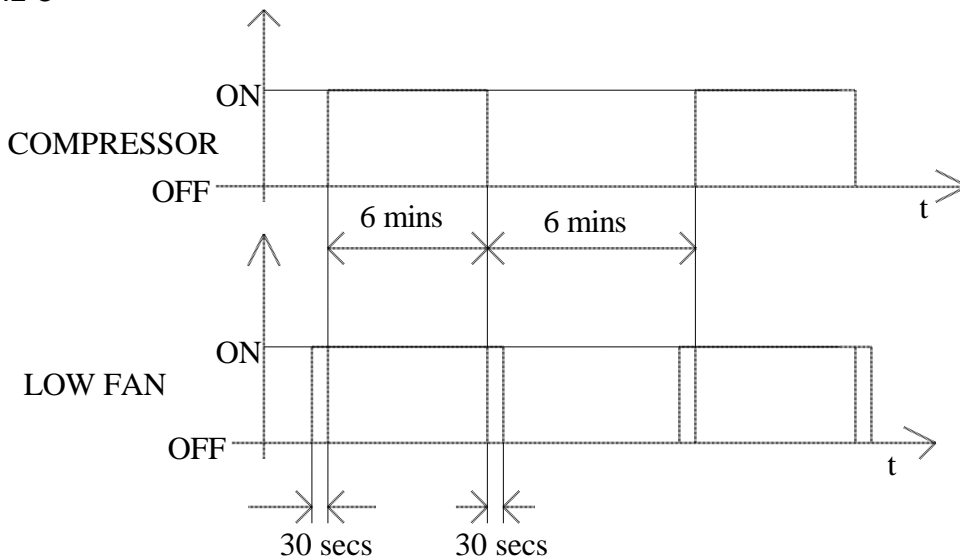
d) ZONE D

Heat Mode

- **Heat Pump Model**

The compressor will be cut in if the $Tr < Ts - 1.0°C$ and it will be cut out if $Tr - Ts > 1.5°C$, subject to timing protections.

For manual speed, the indoor fan will run as per user set speed. In AUTO FAN speed, the indoor fan speed will run as follows:

    HIGH FAN : $Tr < Ts - 1°C$
    MEDIUM FAN : $Ts - 2°C < Tr < Ts + 1°C$
    LOW FAN : $Ts < Tr$

These fan speeds are subjected to the following Hot start and Hot keep features:

a) Hot Start

During the cut in cycle, the indoor fan speed will modulate according to the indoor coil temperature:

i) if the indoor coil temperature > 40°C, the indoor fan will run at user set fan speed.
ii) if the indoor coil temperature:
        < 25°C
   the indoor fan speed will stop.
iii) if the indoor coil temperature crosses the 30°C mark, the indoor fan speed will be changed to low.

b) Hot Keep

When the compressor cuts out, the unit is in hot keep mode. There are 3 options of Hot Keep:-

i) Fan On Option

This option is selected if a 110k ohm resistor is inserted into RFAN.

- if the indoor coil temperature > 40°C, the indoor fan will run at set speed.
- if the indoor coil temperature crosses 37°C, the indoor fan will run at low speed.
- if indoor coil temperature:
        < 27°C
   the indoor fan will stop.

ii) Fan OFF option

This option is selected if a 7k5 ohm resistor is inserted into RFAN.

- if the indoor coil temperature > 40°C, the indoor fan will run at set speed.
- if the indoor coil temperature crosses 37°C, the indoor fan will run at low speed.
- if indoor coil temperature < 30°C, the indoor fan will stop.

iii) Fan low cycle on & off option

This option is selected if a 22kohm resistor is inserted into RFAN.

- If the coil is > 30°C, the low fan will cut in for 30 seconds and subsequently off for 120 seconds. These cycleS of on and off will repeat.
- If indoor coil temperature < 27°C, the fan will stop.

c) 4-way valve changing

The 4-way valve must turn ON when the unit is running heating cycle. When the unit is running non-heating cycle, the 4-way must turn OFF.

Auto Mode

Under AUTO mode, the mode can be selected automatically between Heat and Cool mode, depending on the room temperature and Set Temperature.

Fan Mode

Only HI, MED and LO speeds are allowed. When changing to FAN mode using the emergency switch from COOL, HEAT or AUTO modes in any user set speed, the current running speed will be maintained. Should the mode return to COOL, HEAT or AUTO, then the user set speed will be restored.

The compressor and the outdoor fan will stop. Similarly, the 4-way valve will turn off.

Defrost Mode

No defrost mode for indoor unit.

Off Mode

When the unit is off, no indication will be provided. All relays will be turned off immediately after the ON/OFF triggering.

Diagnostics

Error	OPERATION LED	Other LEDs	Seven Segments
Room Sensor missing	blinks 4 times	Fan blinks	E1 blinking
Indoor coil sensor missing	blinks 4 times	Sleep blinks	E2 blinking
Compressor overload	blinks 1 time	Cool blinks	E4 blinking
Indoor deice	-	Iddeice & Comp blink	-
Outdoor coil sensor exist	-	Cool & Heat blinks	E7 blinking

Selections

- **RMODE**

This is used to configure the board's models :-

110k	-	EC
22k	-	AT
7k5	-	AHP
3k	-	AHP

- **RSWING**

This is used to configure the board's DC swing angles :-

3k	-	WM10F
220r	-	WM20F, WMXX1

- **RFAN**

This is used to configure board's hot keep specifications :-

110k	-	Fan ON option
22k	-	Fan low cycle ON & OFF option
7k5	-	Fan OFF option

- **DOV**

This is used to configure the board's compressor overload options :-

with DOV	-	auto(temperature) and manual resettable
	-	hardware overload detection on
without DOV	-	manual resettable
	-	hardware overload detection off

- **On line testing activation (OnTac)**

This feature is to force the compressor on for approximately 10 minutes irrespective of room temperature and compressor minimum off time protection. Besides the compressor minimum off time, other protections are still available. This feature is allowed to be activated once every power on reset and is activated by pressing the emergency on/off button for more than 5 seconds.

For instance, to activate OnTac in cooling cycle, ensure the unit to off mode first. Then press the button for more than 5 seconds.

To activate the OnTac in heating cycle, set the unit to cool mode first before pressing the button for more than 5 seconds.

Section A – 5
Direct Expansion System – Multi Split

Outdoor Controller (MS5)

Features

This outdoor controller must be used in conjunction with indoor multisplit heatpump indoor controller board .

- Couple to maximum three indoor units
- 4 Master selection options
- Cooling & Heating operation
- Outdoor Defrost
- Compressor anti short cycle protection
- LED display for defrost & sensors missing

Functions

Couple To 3 Indoor Units

MS5 can couple to a maximum of three indoor units . There are three AC input signals from each unit, namely Compressor (COMP), Four way valve (4WV) and Outdoor fan (OF).

Following are the system operation with respect to the 3 input signal :-

4WV	OF	COMP	OPERATION STAGE
OFF	OFF	OFF	Unit off
OFF	ON	OFF	Cooling cycle thermostat off
OFF	ON	ON	Cooling cycle thermostat on
OFF	OFF	ON	Unit off
ON	OFF	OFF	Heating cycle thermostat off
ON	ON	OFF	Heating cycle thermostat off
ON	OFF	ON	Heating cycle thermostat on, outdoor fan off cycle
ON	ON	ON	Heating cycle thermostat on, outdoor fan on cycle

Master Selection

Master is defined as the one which is controlling the operations of the controller. Controller operations include heating ,cooling and defrost.

By configuring the jumper headers JH1, JH2 and JH3, user can select the master as per following table :-

OPTION	JH1	JH2	MASTER
1	Y	N	Unit 1
2	N	Y	Unit 2
3	Y	Y	Unit 3
4	N	N	HEAT mode as master mode

note   : Y = shunt jumper present   N = no shunt jumper

- **Mode Determination**

The system operation mode: Cooling or Heating is decided by the mode of the master unit. Other units which are operating in different modes from the master unit will be forced to off mode.

If the master unit is off , the system mode is decided by unit which is turned on first after master unit is off.

- **Heating Cycle Outdoor Fan Control**

During heat mode thermostat cut in cycle, the outdoor fan will cut out if either one of the three units outdoor fan input signals are off.

Outdoor Defrost Cycle

Defrost mode can only be entered from heat mode (not selectable by user). If either one go into defrost mode, all units which are currently in Heat mode will be forced into defrost mode irrespective if the defrost conditions are met.

During defrost, if the unit is set to off mode or cooling operation, the unit will continue the defrost cycle until end.

- **Pre-Defrost**

A defrost timer will start counting when the outdoor heat exchange thermistor is below +3°C.

Defrost mode will be activated if the accumulated compressor run time is:

a) 1 hour to 2 hours from +3°C reference point, if the outdoor coil temperature is <=-4°C, then defrost mode can be started.

b) more than 2 hours from +3°C reference point, if the outdoor coil temperature is <=-2°C, then defrost mode can be started.

- **Defrost Cycle**

Once defrost started, the 4 way valve and outdoor fan will cut out immediately while compressor remains on. The Compressor runs with the outdoor fan off until :-

a) temperature of outdoor exchange coil exceeds +12°C or
b) a maximum of 12 minutes continuous compressor run time is achieved;

after which the compressor must cut out, and the defrost cycle is completed.

Compressor Anti Short Cycle Protection

- **Compressor Minimum Off Time**

The compressor will stop for at least 3 minutes once it is cut off.

- **Compressor Minimum On Time**

No compressor minimum run time is incorporated.

Four Way Valve Changing Cycle

To run the heat pump cycle , the 4-way valve must turn ON.

Upon return to non-heat pump modes, the 4-way valve must turn OFF. The 4-way valve can only be changed 55+/- 5 seconds after the compressor has cut out. Then the compressor may cut in 4 seconds later.

Schematic Diagram

MSD

MST

MSH8K66

TO SOLENOID VALVE SVA1

TO SOLENOID VALVE SVA2

TO SOLENOID VALVE SVB1

TO SOLENOID VALVE SVB2

TO LIVE

TO COMPRESSOR B
TO COMPRESSOR A

TO OUTDOOR FAN

TO NEUTRAL

TO SOLENOID
VALVE NEUTRAL

TRANSFORMER

TO INPUT SIGNAL IA1

TO INPUT SIGNAL IA2

TO INPUT SIGNAL IB1

TO INPUT SIGNAL IB2

MSH66K66

TO SOLENOID VALVE SVA1

TO SOLENOID VALVE SVA2

TO SOLENOID VALVE SVA3

TO SOLENOID VALVE SVB1

TO SOLENOID VALVE SVB2

TO LIVE

TO COMPRESSOR B
TO COMPRESSOR A

TO OUTDOOR FAN

TO NEUTRAL

TO SOLENOID
VALVE NEUTRAL

TRANSFORMER

TO INPUT SIGNAL IA1

TO INPUT SIGNAL IA2

TO INPUT SIGNAL IA3

TO INPUT SIGNAL IB1

TO INPUT SIGNAL IB2

MSH66K555

Section B – 1
Chilled Water System – Fan Coil Unit

Fan Coil Controller (W1V3)

Features

- HEAT/COOL/DRY/FAN system control.
- AUTO/HIGH/MED/LOW indoor fan speed control.
- DC motor and AC motor swing control option.
- LCD remote control reception.
- Wired (UNI system) control reception.
- Pipe water temperature sensing
- SLEEP function for COOL and HEAT mode.
- Cold start.
- Sensors missing detection.
- Memory (non volatile) backup for last state settings option.
- Water Valve 9 minutes force on (Cool mode only) option.
- Valve or valveless control options.
- Capable to control Minichiller operating modes.
- Waterpump and water overflow protection control.

Functions

Mode Selection

The system has 2 modes selection to be selected via the OD connector. The following notations are used to represent the various modes selected:

MODES	COOL	DRY	HEAT	FAN	OD
AP	X	X	X	X	SHORTED
EC	X	X		X	OPEN

Where X denotes modes available.

Power Up Settings

During power up, the system can be configured to memorised the settings prior to power down. This is done by shorting the 2 way straight header JP1/JH. The settings that are memorised are :-

a) Mode & On/Off status
b) Set Temperature
c) Fan Speed
d) DC swing
e) AC swing
f) Flap stop coordinate (for DC swing off mode)

These data or settings are save in non-volatile memory.

The CPU will save the updated settings into the memory10 seconds after changes are confirmed. However, it will take 3 seconds to update the memory if the unit change from on to off state.

If the JP1/JH is not shorted, the power up setting is OFF mode, temperature setting is 24°C, indoor fan speed is high and swing mode is off.

Unit ON/OFF

- **ON/OFF triggering**

ON/OFF triggering can be achieved by pressing the emergency ON/OFF button or the LCD remote controller ON/OFF button.

When the emergency ON/OFF button is pressed, the system mode setting will rotate in the following sequence :-

MODEL	SEQUENCE
AP	---------- > COOL > HEAT > OFF > ------------
EC	--------------->COOL > OFF >-------------------

The corresponding LEDs will also follow suit.

Pressing the remocon ON/OFF will toggle the system status either from ON to OFF or from OFF to ON.

Temperature Range And Setting

The operating temperature range is 16 °C to 30 °C, both inclusive. Temperature setting is allowed in COOL, DRY, and HEAT modes.

Sleep Function

This function will increase or decrease the set temperature with time. The COOL mode SLEEP profile is as follows:-
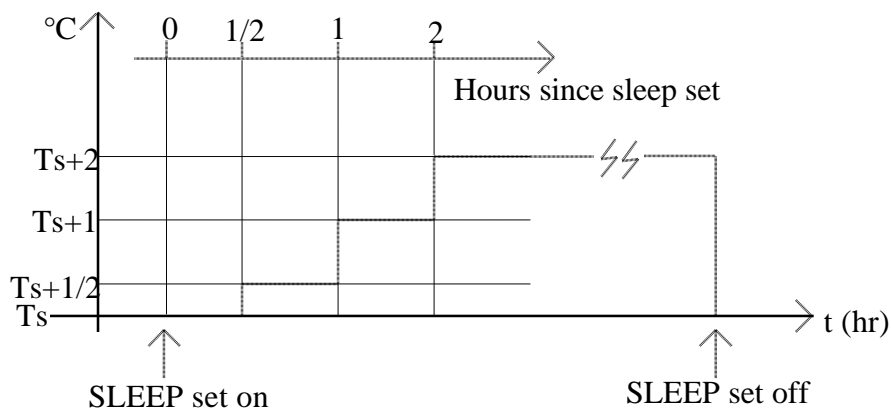
The HEAT mode SLEEP profile is as follows:
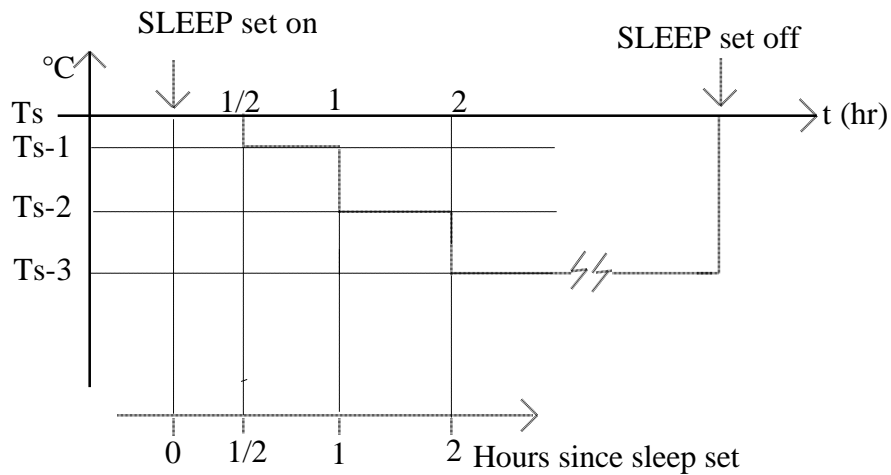
The SLEEP option is only available for COOL, and HEAT modes.

This option is set/reset by on the LCD remocon.

Fan Speed Selection

The indoor fan speeds are LO, MED, HIGH or AUTO FAN in COOL and HEAT.

In FAN mode, only HI, MED and LO speeds are allowed.

Air Louvre And Air Swing

In AC swing option, the swing will run if indoor fan is on and vice versa.

In the air louvre option, the stepper motor will only run when the indoor fan runs. The louvre will be set at the maximum closing position when the main power is just turned on or when the unit is turned off. The swing angles of all operating modes (when swing option is activated) are as follow:

RSWG	REMARK	MODE	SWING ANGLE
3K	WM10F	COOL/DRY/FAN	100° <= X <= 140°
		HEAT	80° <= X <= 110°
220R	WM20F, WMXX1	COOL/DRY/FAN	120°<= X <= 160°
		HEAT	100°<= X <= 140°

where 0° is referred to as air louvre maximum closing point.

If unit change from OFF mode to ON mode , the flap will stop at the last position when it go from on to off mode.

Operating Modes

The system mode is set by the LCD remocon. The actual mode will be shown on the mode LEDs. Mode changes respond 2 seconds after data reception.

Cold Start

When the unit restarts 2 hours after it has stopped or during power-on-reset start, it is considered a cold start.

Cool Mode

- **With Water Valve**

The water valve will cut in if the $Tr >= Ts + 1°C$ and the water valve will cut out if the $Tr =< Ts$. The thermostat cut in or out decision is made every 30 seconds.

In this mode, the indoor fan is always running. For manual speed, the indoor fan will run as per user set speed.

In AUTO FAN speed, the indoor fan speed will run as follows:

High :	$Tr > Ts + 1°C$
Medium :	$Ts + 1°C > Tr > Ts$
Low :	$Ts > Tr$

The fan speed decision is made every 30 seconds.

- **Without Water Valve**

The fan speed decision is made every 30 seconds.

In manual fan speed, the indoor fan speed will run as follows:

User set speed (H/M/L) :	$Tr > Ts - 1°C$
SLo (Super low) :	$Ts - 0.5°C > Tr > Ts - 2°C$
OFF :	$Tr < Ts - 1.5°C$

In auto fan speed, the indoor fan speed will run as follows:

High fan :	$Tr > Ts + 0.5°C$
Medium fan :	$Ts + 1°C > Tr > Ts - 0.5°C$
Low fan :	$Ts > Tr > Ts - 1°C$
SLo :	$Ts > Tr > Ts - 2°C$
OFF :	$Tr < Ts - 1.5°C$

Dry Mode

During the first 12 minutes of the DRY mode run from:

    a) Cold Start or
    b) Mode change from HEAT or FAN

Dry mode must run under cool mode with AUTO indoor fan for 12 minutes or until

$$Tr =< Ts.$$

After this, the dry mode will operate like cooling cycle. However, only low fan is allowed to cut in.

Heat Mode

- **With water valve**

The thermostat cut in or out decision is made every 30 seconds.

The water valve will be cut in if the $Tr =< Ts + 1°C$ and it will be cut out if $Tr >= Ts + 2°C$.

For manual speed, the indoor fan will run as per user set speed.

In AUTO FAN speed, the indoor fan speed will run as follows:

High Fan :	$Tr < Ts + 1°C$
Medium Fan :	$Ts + 1°C < Tr < Ts + 2°C$
Low Fan :	$Ts + 2°C < Tr$

The fan speed decision is made every 30 seconds.

- **Without water valve**

The fan speed decision is made every 30 seconds.

In manual fan speed, the indoor fan speed will run as follows:

User set speed (H/M/L) :	$Tr < Ts + 1.5°C$
SLo (Super low) :	$Ts + 1°C < Tr < Ts + 3°C$
OFF :	$Ts + 2.5°C < Tr$

In auto fan speed, the indoor fan speed will run as follows:

High fan :	$Tr < Ts - 1°C$
Medium fan :	$Ts - 2°C < Tr < Ts + 1°C$
Low fan :	$Ts < Tr < Ts + 2°C$
SLo :	$Ts + 1.5 °C < Tr < Ts + 3°C$
OFF :	$Ts + 2.5°C < Tr$

Fan Mode

Only HI, MED and LO speeds are allowed.

- **With Water Valve**

Indoor fan will run at user set speed.

- **Without Water Valve**

No fan mode is allowed. The unit will not give any response to the fan mode setting.

Off Mode

When the unit is off, no indication will be provided. All relays will be turned off immediately after the ON/OFF triggering .

Water Pump

The water pump will on if the water valve is on during cooling cycle. The pump will remain on for at least 5' after the water valve is off.

During mode change from cooling to non cooling mode, the pump will on for minimum 5'.

Water Level Switch

This normally close switch is to detect faults in water pump system. It will confirm for 30" for switch open and 60" for switch close.

Once switch is confirmed open, it will force the water valve to cut off . If the switch is closed within 5', the water valve is allowed to cut in. If the switch does not close for more than 5', the system will warn user regarding this fault. The water valve is not allowed to cut in.

Diagnostics

Error	OPERATION LED	Other LEDs	Seven Segments
Room Sensor missing	blinks 4 times	Fan blinks	E1 blinking
Indoor coil sensor missing	blinks 4 times	Sleep blinks	E2 blinking
Pump fault	blinks 2 times	Cool & Fan blink	E6 blinking
Pipe water temperature poor	blinks 3 times	Cool & Dry blink	E4 blinking
Pipe water temperature fault	blinks 1 time	Cool blinks	E5 blinking

Selections

- **RSWING**

This is used to configure the board's DC swing angles :-

```
3k      -       WM10F
220R    -       WM20F
```

- **RLED**

This is used to configure the board's control modes :-

110k	-	Valve control
22k	-	Valveless control
7k5	-	Valve control
3k	-	Valveless control

- **RGL**

This is used to configure the board's 9 minutes valve force on feature :-

110k	-	Water valve force on option not available
22k	-	Water valve force on option available
7k5	-	Water valve force on option not available
3k	-	Water valve force on option available

9 Minutes Water Valve Force On.

If the water valve is idle for more than 9 minutes during cool mode and room temperature is Ts (Ts = Set temperature)or warmer, the water valve is forced to cut in and this cycle is subjected to cool mode thermostat cut in/out condition.

Schematic Diagram

TO AC SWING
TO VALVE
TO WATER PUMP
TO LIVE

TO HIGH FAN
TO MEDIUM FAN
TO LOW FAN

TO NEUTRAL

TO WIRED CONTROLLER
NETWARE 2,SLM 03
TO WIRELESS
2030000052

TO LOW FAN 2

TO MED FAN 2

TO HIGH FAN 2

TO LIVE

TO INDOOR SENSOR
TO ROOM SENSOR
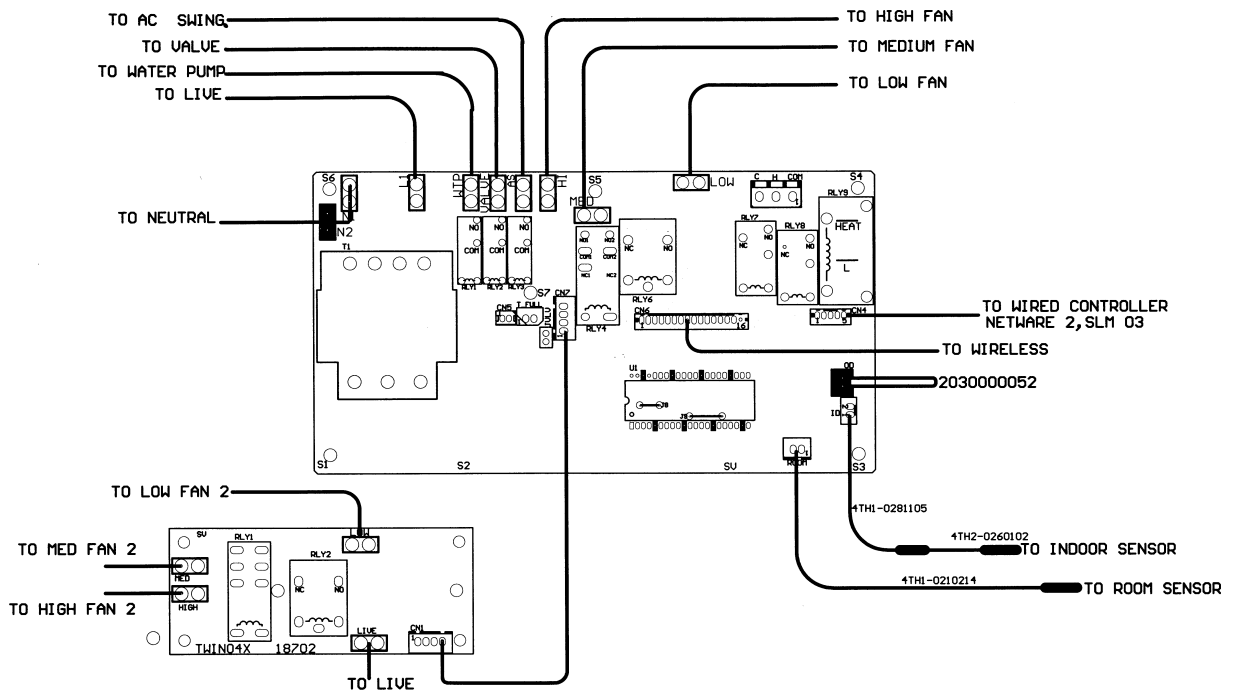
Section B – 2
Chilled Water System – Mini Chiller

Mini Chiller Controller (MCH1)

Features

- HEAT/OFF/COOL outdoor system control.
- Compressor recycle protection (Anti short cycle timer).
- Frost/ice prevention in the chilled water.
- Compressor overload, water pump overload, high/low pressure and flow switch protections.
- Defrosting for outdoor coil during heat pump mode.
- LEDs indication for system condition and system temperatures.
- Separately adjustable cool mode & heat mode water-in (entering water) temperature.
- Auto pump run during standby mode.

Functions

System ON/OFF And Mode Setting

The system mode is determined by two contacts i.e. contact 1 & contact 2.

Mode	Contact1	Contact2	Green LED	Red LED
System OFF (standby)	OFF	OFF	OFF	OFF
Heat Mode	OFF	ON	OFF	ON
Cool Mode	ON	OFF	ON	OFF
System OFF - Error	ON	ON	OFF	OFF

Entering water temperature.

This temperature setting for the entering water temperature is as follows:-

Mode	Minimum	Maximum	Step	Factory Setting
Cool	3°C	15°C	1°C	12°C
Heat	35°C	50°C	1°C	40°C

- **SW2 Factory Setting (for COOL mode)**

Set Temperature °C	SW2		
	SW2-3	SW2-2	SW2-1
Set by VR3	0	0	0
3	0	0	1
4	0	1	0
5	0	1	1
6	1	0	0
7	1	0	1
8	1	1	0
9	1	1	1

1 = ON
2 = OFF

If this DIP switch setting is set to (0,0,0), the set temperature will be determined by the VR3 setting. Otherwise, this setting will override the VR3 setting.

- **Cool Mode User Set Temperature**

This is the setting of the entering water temperature during cool mode. The setting range is 10 °C to 15 °C. Setting is done by trimmer VR3 and the value will be shown on the 7-segment LED display. The set value can be read by adjusting the trimmer or by pushing the tact switch SW1. When reading this value, the green LED and the 7-segment display will flash.

- **Heat Mode User Set Temperature**

This is the setting of the entering water temperature during heat mode. The setting range is from 35 °C to 50 °C. Setting is done by trimmer VR1 and the value will be shown on the 7 segment LED display. The set value can be read by adjusting the trimmer or by pushing the tact switch SW1. When reading this value, the red LED and the 7-segment display will flash.

Initial System Power Up Condition

When the system is first power up, the water pump will run and the flow switch condition is checked. If the flow switch contact is closed within 3 minutes after the water pump run, operate the system as normal. Otherwise, shutdown the system as according to section 2.5.

Thermistor Sensor Inputs

- **Entering water (water-in) temperature sensor (B1).**

This sensor measures the temperature of the returned water from the indoor chilled water fan coil. When the temperature reaches the set temperature as determined by DIP switch SW2 or trimmer VR3, the compressor will either cut in or cut out.

- **Leaving water (water -out) temperature sensor (B2)**

This sensor measures the leaving water temperature (T_{B2}) for anti-freeze protection. Therefore, it is only applicable for cooling mode only.

State	Temperature TB2	Time Delay	System Status
1	> X °C	Not Applicable	i) System run as normal
2	< X °C	< 20 secs	i) System run as normal
3	< X °C	> 20 secs	i) OFF compressor ii) OFF condenser fan iii) Water pump continue running iv) On antifreeze heater v) Green LED blinking to indicate fault condition vi) System reset by power supply ON/OFF only vii) Antifreeze heater will turn OFF if temperature TB2 . 4°C viii) Display show error code E3

The temperature *X* °C is set by trimmer VR2 and the setting range is from +3 °C to -4 °C. The factory setting is +3 °C. This setting can be read by pushing the tact switch SW1 or by simply adjusting the trimmer position. When display the set temperature, both the green and red LED and the 7-segment LED will blink.

- **Air temperature sensor (B3)**

This sensor measures the outdoor air temperature T_{B3}. This sensor is used for standby auto-pump run feature. This mode is only active during power standby mode.

Defrost sensor (B4)

This sensor is for the purpose of defrost during heat pump mode.

Digital Alarm Inputs

Input	Description	Contact Status	Comp.	Condenser Fan	4WV	Water Pump	LED *Note 3	7 segment Diaplay	System Code	
A1	Compressor overload	Open	X	X	X	O	B	CO	Fault	
A1	Compressor overload	Closed	-	-	-	-	-	-	Normal	
A1	Condenser fan overload	Open	X	X	X	O	B	CO	Fault	
A1	Condenser fan overload	Closed	-	-	-	-	-	-	Normal	
A2	Water pump overload	Open	X	X	X	X	B	PO	Fault	
A2	Water pump overload	Closed	-	-	-	-	-	-	Normal	
A3	Flow switch	Open	X	X	X	X	B	FL	Fault	*Note 1
A3	Low switch	Closed	-	-	-	-	-	-	Normal	
A4	High pressure cut-off	Open	X	X	X	O	B	HP	Fault	
A4	High pressure cut-off	Closed	-	-	-	-	-	-	Normal	
A5	Low pressure cut-off	Open	X	X	X	O	B	LP	Fault	*Note 2
A5	Low pressure cut-off	Closed	-	-	-	-	-	-	Normal	

X = Stop
- = ON or OFF as according to normal system requirement.
O = Run
B = Blink

*Note 1 :
Flow switch contact will only be sensed with 3 minutes timeout after the water pump is activated.

*Note 2 :
i)   After power on unit, before compressor cut in, LP fault requires manual reset.
ii) At first compressor cut in after power on unit, LP fault will be ignored for first 3 minutes.
iii) For subsequent compressor cut in cycle, the LP fault will be ignored for the first 30 seconds.
iv) After each LP fault, the LP contact will be rechecked after 10 seconds, in case the contact is closed, the fault will be reset automatically.
v)   The unit can only be reset manually after the 6th LP trip.

*Note 3 :
Fault condition can only be reset by switching OFF and ON of the system power supply, except LP fault.

Digital Outputs

- **Compressor**

Minimum compressor ON time = 2 minutes.
Minimum compressor OFF time = 4 minutes

- **Outdoor Fan**

The outdoor fan is switched ON when the compressor is ON. The only exception is when the unit is in defrost mode. In this mode, the outdoor fan remain OFF when the compressor is ON.

- **Water Pump**

The water pump will run when the system is switched ON except under condition as stated in section **Digital Alarm Inputs**. The water pump may also operate when the system is on standby mode. Please refer to section **Air temperature sensor (B3).**

- **Standby Auto Pump**
 i.   During standby mode, if outdoor air <= 5 °C, water pump runs 5 to 6 minutes every hour. Antifreeze heater will turn on and off together with the water pump. 7 segment displays "AP"
 ii.   If entering water > 6°C, water pump and antifreeze always stops.
 iii. If outdoor air <= 2°C and entering water <= 2°C, system enters heat mode.
 iv.   If entering water > 15°C, system returns to standby mode. Water pump and antifreeze heater off 30 seconds after compressor off.

- **4-way valve (4WV)**

The 4WV relay will be activated once the system enter into heat pump mode except during heat pump defrost cycle. If the system changes from cooling mode to heat pump mode or vice versa, the 4WV changes immediately.

- **Antifreeze heater**

The antifreeze heater will be switched on if the leaving temperature (T_{B2}) is less than or equal to X°C. It will be switched off if T_{B2} is greater than X°C.

- **Second stage electric heater**

This heater serves as the auxiliary heater for the heating mode if the temperature between the set temperature and the entering water temperature is too great.

- **Fault relay output**

This relay will be activated when a fault condition as mentioned in Section 2.5 occurs or the system enter into anti-freeze alarm mode.

- **Defrost mode**

 Start Defrost Conditions
 a)   Defrost timer start counting when Defrost Sensor (DS) <= 0°C
 b)   45 minutes later and DS <=-3°C, defrosting start.
 c)   At any time if DS > 2°C for more than 150 seconds, defrost timer reset to 0.

 Defrost Cycle
 4WV, outdoor fan, electric heater off, compressor still running. 7 segment display "df"

Defrost Termination

a) DS > 14°C
b) After defrosting for 10 minutes **OR**
c) High pressure contact open

For defrost termination, HP contact open, the compressor will stop, but no error indication. The HP switch will be bypassed for 3 minute. If contact not closed compressor will not run. If contact closes at any time, no more bypass. After 3 minute if the high pressure switch is still open, "HP" error will be shown.

Defrost Termination Cycle

Compressor stop, outdoor fan on, 15 second later 4WV on, 20 second later compressor on. If compressor not allowed to on, outdoor fan will off after it is on for 35 seconds. Second stage electric heater will on/off accordingly.

Cool Mode Temperature Regulation

In Cool mode, the compressor will cut in if the entering water temperature is higher than the set temperature by 2 °C. The compresor will cut out if the entering water temperature is equal to set temperature. The above are subjected to timing protections of the compressor. The outdoor fan must run when the compressor is ON except during defrost mode.

Heat Mode Temperature Regulation

In Heat mode, the compressor will cut in if the entering water temperature is lower than the set temperature by 3 °C. The compressor will cut out if the entering water temperature is equal to set temperature. The above are subjected to timing protections of the compressor. The 2nd. stage electric heater is switched on if the entering water temperature is lower than the set temperature by 5 °C and is switch off when the difference is reduced to 2 °C. The outdoor fan must run when the compressor is ON except during defrost mode.

Calibration and test mode

The unit can enter into calibration and test mode by adding 10K resistor across calibration jumper during power up. The red and green LEDs will turn on if the tolerance of the thermistors are within the specification else both the LEDs will blink. The relay will also turn one by one.

Schematic Diagram
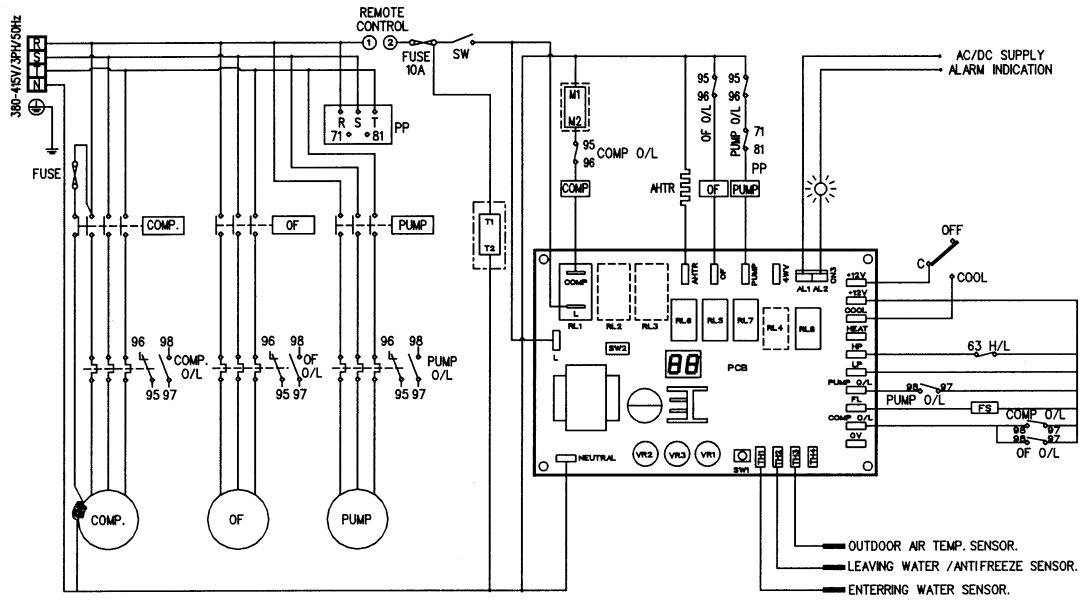
Cooling Only
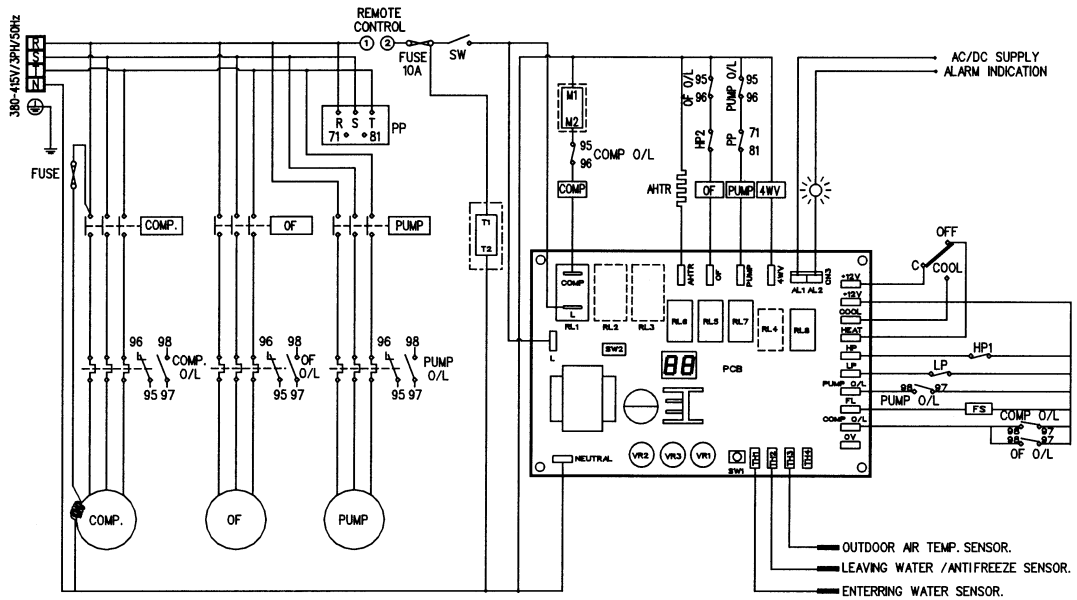
Heatpump

Section C – 1
Networking For Fan Coil Unit

Network Interface Module (NIM1.1)

Main Board Controller

The NIM 1.1 system can only be used in conjunction with universal board U1.4 and above.

Display Control Panel
The NIM 1.1 system can be used in conjunction with Netware 2, and SLM3 display control panel. Each unit can operate *with* or *without* display control panel. Display control panel used in conjunction with master unit of each group will be able to display the error type of itself as well as its own slave units (Only available in Netware2).

Example of error message : **E$n_1 n_2$**
E : Error
n_1 : Unit ID (0 for master, 1 – F for slaves)
n_2 : Error type

Supported Configuration:

	Master	Slave
Netware 2	Yes	Yes
SLM 3	No	Yes
IR Remote	No	Yes
None of the above interface	No	Yes

NIM Controller
NIM, version 1.1 is the data communication controller among the main board controller, display control panel and communication bus.

> Connecter CN1 → Main Board Controller
> Connecter CN2 → Display Control Panel
> Connecter CN3 → Communication Bus

Installation

Confirmation Of Parts

The following parts are contained in the carton box together with this manual.
Please check to make sure that everything is included.

1. NIM controller
2. PCB casing (top & bottom)
3. 5-way shield wire (1000mm) to/from main board controller.
4. Screws (for installing unit directly on wall)

Procure the following parts locally:
    Communication bus. (Shielded and twisted pair wire, refer to bus cable)

Parts drawing
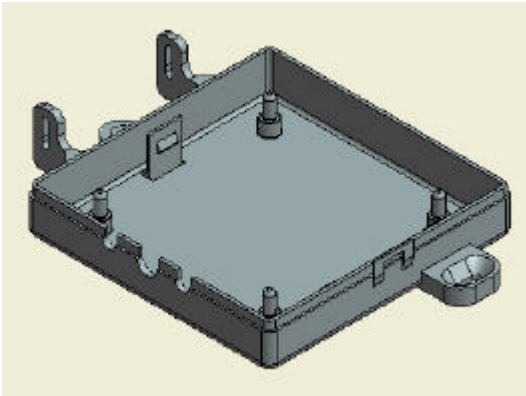
Bottom Casing
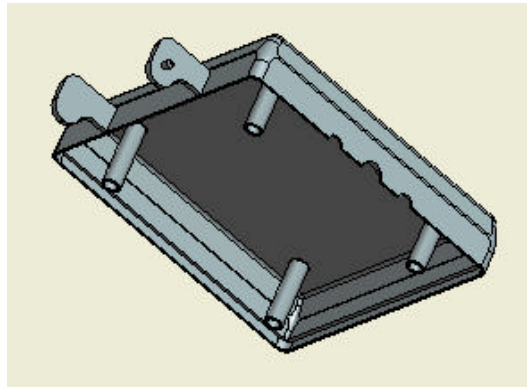
Top Casing
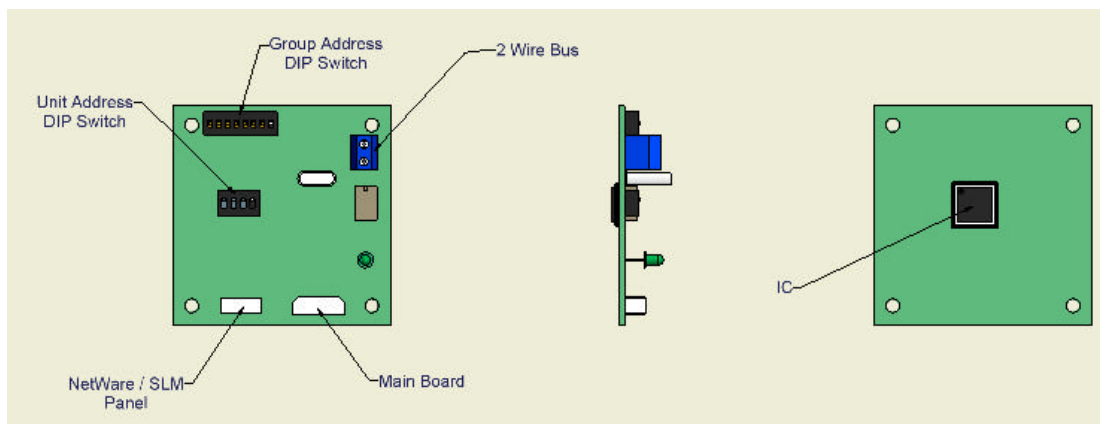
NIM Controller

Mounting

Decide where you want to install the unit (Plastic casing). Avoid installation at location such as :
- Expose to direct sunlight.
- Susceptible to humidity and moisture.
- Near a source of heat.
- Near machines emitting high frequency waves.

Caution: Over-tightening the screws can cause deformation or/and crack at the casing. Mount the bottom casing on the wall with flat surface. Mounting on an uneven surface can cause cracks at the casing.

Installation Procedure

Firstly, adjust the group address and unit address via the dip-switch to the required setting.
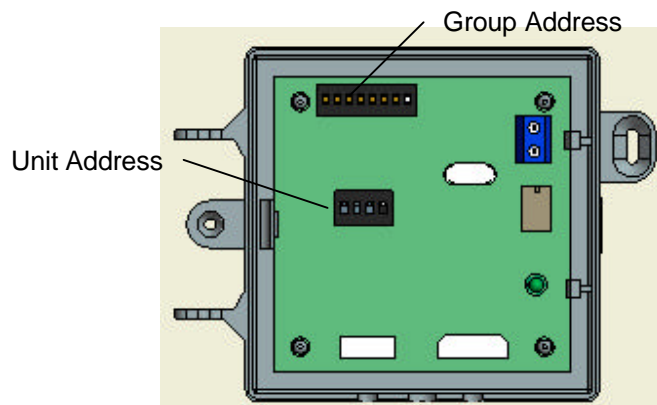
Group And Unit Address Setting Via Dip Switch

- Group Address (DSW1)
  - Dip Switch turn to 'ON' represent '1' in settings.
  - Please note that group address '255' is reserved for PC Operation.
  - Please refer to the Dip Switch Setting Look Up Table for details.
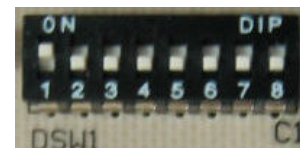
Example: Group address 5 => Settings = 10100000
Group address 20 => Settings = 00101000
Group address 100 => Settings = 00100110

*** Please note that, NIM system can only support up to 256 units of air conditioners.**

- Unit Address (DSW2)
Dip Switch turn to 'ON' represent '1' in settings.
Please note that unit address '0' is reserved for MASTER Configuration.

Example: Unit address 0 => Settings = 0000 (Master)
Unit address 5 => Settings = 0101 (Slave 5)
Unit address 15 => Settings = 1111 (Slave 15)

- Plug in both 5-way harness wires to the connectors on NIM accordingly.

- Plug in the communication wires to CN3 connector. (Take note that the same polarity has to be connected the other units)
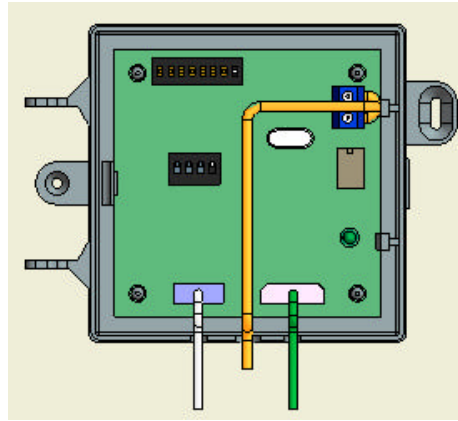
Plug In Wires

- Align the wires with the holes at the casing accordingly.
- Snap the top casing into place. Hook the claws into their slots by pressing it hard. Make sure that the wires are properly covered in the holes.
- Screw the casing on the wall with screws provided.
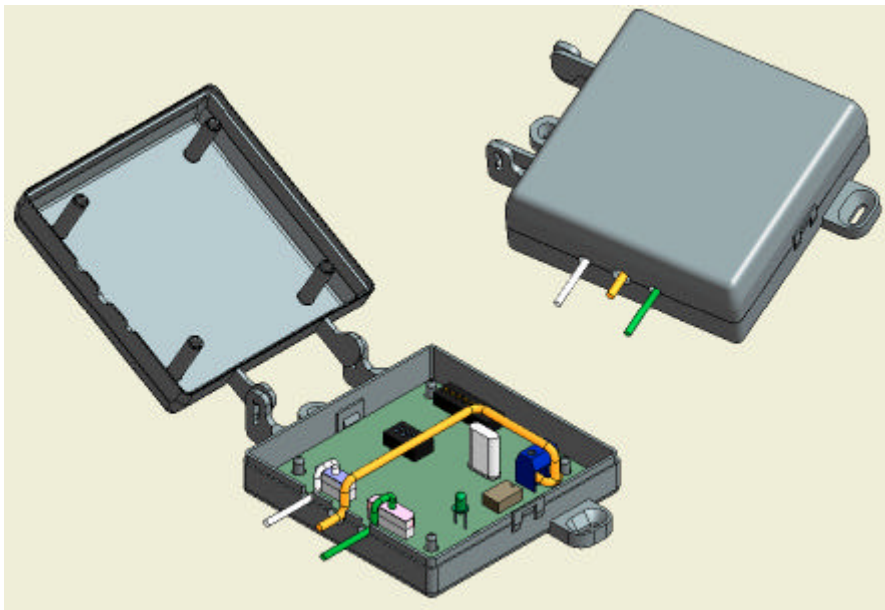
Completed NIM Installation Figure

Bus Cable

Description
The bus cable is a screened cable, with twisted pair. The electrical and mechanical characteristics are as follows:

- Bus cable characteristics

No	Topic	Requirements
1	Specification	The wire shall comply at least with IEC 189-2 or equivalent national standard unless otherwise specified below.
2	Bus wire diameter	Min. : 0.8mm Max. : 1.0mm
3	Bus wire material	Copper and solid wires
4	Bus cable structure outer sheath	Required
5	Bus cable screened	Required
6	Bus cable structure cores	One twisted pair. Colors of cores shall be different.
7	Bus cable structure twist	Min. 5/m
8	Tensile strength	2 core cable: min. 50N

- Bus Length

Connection	Recommended Maximum Bus Length (M)
NIM to NIM Controller	1000
NIM to Main Board	10
NIM to Wired Controller	10
NIM to NIM PC Gateway	10
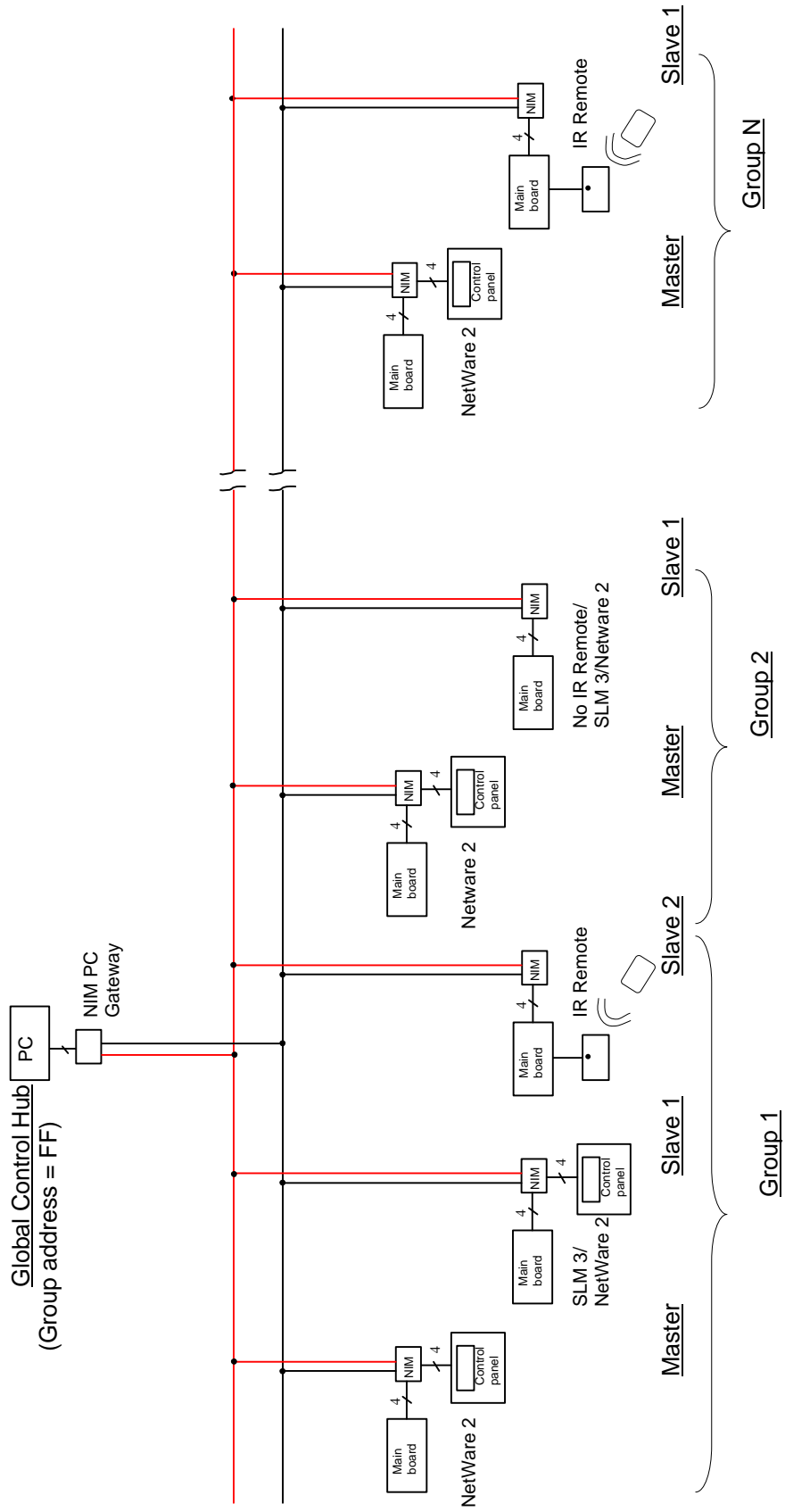
TYPICAL BUS STRUCTURE FOR NIM NETWORK

Global Control Hub
(Group address = FF)

PC

NIM PC
Gateway

Group 1

Master

NetWare 2

Main board

4

NIM

Control panel

4

Slave 1

SLM 3/
NetWare 2

Main board

4

NIM

Control panel

4

Slave 2

IR Remote

Main board

4

NIM

Group 2

Master

Netware 2

Main board

4

NIM

Control panel

4

Slave 1

No IR Remote/
SLM 3/Netware 2

Main board

4

NIM

Group N

Master

NetWare 2

Main board

4

NIM

Control panel

4

Slave 1

IR Remote

Main board

4

NIM

- Dip Switch Setting Look Up Table

Dip Switch turn to 'ON' represent '1' in settings.
Please not e that group address '255' is reserved for PC Operation.
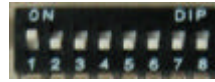
GROUP ADDRESS	Settings 12345678	GROUP ADDRESS	Settings 12345678	GROUP ADDRESS	Settings 12345678	GROUP ADDRESS	Settings 12345678
0	00000000	64	00000010	128	00000001	192	00000011
1	10000000	65	10000010	129	10000001	193	10000011
2	01000000	66	01000010	130	01000001	194	01000011
3	11000000	67	11000010	131	11000001	195	11000011
4	00100000	68	00100010	132	00100001	196	00100011
5	10100000	69	10100010	133	10100001	197	10100011
6	01100000	70	01100010	134	01100001	198	01100011
7	11100000	71	11100010	135	11100001	199	11100011
8	00010000	72	00010010	136	00010001	200	00010011
9	10010000	73	10010010	137	10010001	201	10010011
10	01010000	74	01010010	138	01010001	202	01010011
11	11010000	75	11010010	139	11010001	203	11010011
12	00110000	76	00110010	140	00110001	204	00110011
13	10110000	77	10110010	141	10110001	205	10110011
14	01110000	78	01110010	142	01110001	206	01110011
15	11110000	79	11110010	143	11110001	207	11110011
16	00001000	80	00001010	144	00001001	208	00001011
17	10001000	81	10001010	145	10001001	209	10001011
18	01001000	82	01001010	146	01001001	210	01001011
19	11001000	83	11001010	147	11001001	211	11001011
20	00101000	84	00101010	148	00101001	212	00101011
21	10101000	85	10101010	149	10101001	213	10101011
22	01101000	86	01101010	150	01101001	214	01101011
23	11101000	87	11101010	151	11101001	215	11101011
24	00011000	88	00011010	152	00011001	216	00011011
25	10011000	89	10011010	153	10011001	217	10011011
26	01011000	90	01011010	154	01011001	218	01011011
27	11011000	91	11011010	155	11011001	219	11011011
28	00111000	92	00111010	156	00111001	220	00111011
29	10111000	93	10111010	157	10111001	221	10111011
30	01111000	94	01111010	158	01111001	222	01111011
31	11111000	95	11111010	159	11111001	223	11111011
32	00000100	96	00000110	160	00000101	224	00000111
33	10000100	97	10000110	161	10000101	225	10000111
34	01000100	98	01000110	162	01000101	226	01000111
35	11000100	99	11000110	163	11000101	227	11000111
36	00100100	100	00100110	164	00100101	228	00100111
37	10100100	101	10100110	165	10100101	229	10100111
38	01100100	102	01100110	166	01100101	230	01100111
39	11100100	103	11100110	167	11100101	231	11100111
40	00010100	104	00010110	168	00010101	232	00010111
41	10010100	105	10010110	169	10010101	233	10010111
42	01010100	106	01010110	170	01010101	234	01010111
43	11010100	107	11010110	171	11010101	235	11010111
44	00110100	108	00110110	172	00110101	236	00110111
45	10110100	109	10110110	173	10110101	237	10110111
46	01110100	110	01110110	174	01110101	238	01110111
47	11110100	111	11110110	175	11110101	239	11110111
48	00001100	112	00001110	176	00001101	240	00001111
49	10001100	113	10001110	177	10001101	241	10001111
50	01001100	114	01001110	178	01001101	242	01001111
51	11001100	115	11001110	179	11001101	243	11001111
52	00101100	116	00101110	180	00101101	244	00101111
53	10101100	117	10101110	181	10101101	245	10101111
54	01101100	118	01101110	182	01101101	246	01101111
55	11101100	119	11101110	183	11101101	247	11101111
56	00011100	120	00011110	184	00011101	248	00011111
57	10011100	121	10011110	185	10011101	249	10011111
58	01011100	122	01011110	186	01011101	250	01011111
59	11011100	123	11011110	187	11011101	251	11011111
60	00111100	124	00111110	188	00111101	252	00111111
61	10111100	125	10111110	189	10111101	253	10111111
62	01111100	126	01111110	190	01111101	254	01111111
63	11111100	127	11111110	191	11111101	255	RESERVED

Unit Address (DSW2):

Dip Switch turn to 'ON' represent '1' in settings.
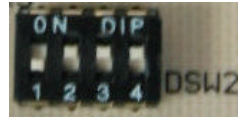Please note that unit address '0' is reserved for MASTER Configuration.

UNIT ADDRESS	Settings 1234
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

Section D – 1
Handsets

Sequential LCD

Features

The controller has a LED indicator, a LCD display panel, 5VDC power supply input, and two communication input/output port.

Features of controller :
- Cool/Heat/Fan/Dry/Auto modes.
- Single fan speed (High speed).
- Set temperature in $^{\circ}$C or $^{\circ}$F.
- Save function.
- Test run function.
- 7 days programmable timer (option).
- Compressors Run/Error status
- Compressors Defrost status
- Heater enable control
- Error indicator
- Keylock function
- Last state memory (battery backup or backup setting from main board)

Hardware Setting

The system has a 2 jumper setting to control the board function. (Jumper H and jumper D are not used.)

The jumper NODRY is used when the Dry mode is not needed.

The jumper RTC is used to determine whether real time clock and timer functions are used.

Jumper RTC	Clock/Timer function
no	no
yes	yes

Functions

Power Up Settings
During power up, the controller will start up with default setting or battery backup setting or last state setting from the EEPROM on the main board. The default setting is as below:

Mode	: Cool
Set temperature	: 25°C
Fan speed	: High

Unit ON/OFF

There are 2 ways to turn on or off the system:

i) via 7 days programmable timer or
ii) via ON/OFF key.

When the unit is OFF, the LED is light off. When the unit is turned ON, the LED will light up.

Temperature Range and Setting

The temperature setting range is 16°C to 30°C (61°F to 86°F). Temperature setting is performed via pressing TEMP DOWN key or TEMP UP key. Pressing both the TEMP UP and TEMP DOWN keys simultaneously will toggle the temperature setting between $^{\circ}$C and $^{\circ}$F.

Mode Function

Mode setting can be changed via MODE key. There are 5 modes selectable in following sequence :

Cool > Heat > Auto > Dry > Fan

Availability of the modes are determined by the main board. All modes except Fan mode can be disabled.

Save Function

To activate Save function, press the SAVE key once. To disable Save function, press the SAVE key once again.

Test Run Function

Test Run function is available in Cool and Heat modes. To activate Test run function, press the TEST RUN key twice. 'TEST RUN' symbol is turned on with 'COOL' or 'HEAT' symbol blinking. The function will last for 2 hours and could be manually disabled by pressing ON/OFF key once.

Real Time Clock

Press the CLOCK key one time will activate set clock mode. Press the CLOCK key again will disable set clock mode.

Under set clock mode, a word 'SET CLOCK' on LCD will blink at 0.5 seconds interval and the real time clock and day setting can be changed by pressing DAY key, HOUR key or MINUTE key.

The unit will also automatically disable set clock mode after 15 seconds if none of the DAY, HOUR or MINUTE key is pressed.

Seven Days Programmable Timer

There are two 7 days programmable timers namely On Timer and Off Timer.
Press the timer key once will activate set timer mode. Press the same timer key again will disable set timer mode.

Under set timer mode, a word 'SET TIMER' on LCD will blink at 0.5 seconds interval and the timer setting can be changed by pressing the DAY key, HOUR key or MINUTE key.

The unit will also automatically disable set timer mode after 15 seconds if none of the DAY, HOUR or MINUTE key is pressed.

Whenever there is any timer setting in the program, the LCD displays a word 'TIMER ACTIVE' to indicate the 7 days programmable timer is active. To deactivate the timers setting temporary, press the HOLD key for 2-3 seconds until the word 'TIMER ACTIVE' disappears. To recall back the timer setting, it could be done by

pressing the HOLD key again for 2-3 seconds or press once the timer key. The word 'TIMER ACTIVE' will appear.

Another way to cancel the timers setting is to change all the hour setting of the timers to null one by one. When the setting is null, the LCD display --:--.
Battery backup is used to keep the real time clock operating if power failure occur.

Compressor Run/Error Status
Compressors running status is indicated on the LCD panel. When compressor 1 is running, symbol 'COMP 1' will turn on. If there were error conditions (for examples: overload, high pressure trip and gas leak) detected on compressor 1, symbol '1' will blink. Error code will be shown as well.

Compressor Defrost Status
Compressor defrost status is indicated on the LCD panel. When compressor 1 is running defrost cycle, symbol 'DEFROST 1' will be shown and etc.

Heater Enable Control
When HEATER key is pressed, the display will rotate in following sequence :

   'HEATER 1' > 'HEATER 1 2' > '   ' > 'HEATER1'

The main board controls the availability of the heaters. When heater 1 and/or heater 2 is disabled, the LCD panel will response accordingly.

Error Indicator
If there were abnormal condition detected, the error code will be shown with the LED blinks. Refer to main board error code for detail. The format of error code is as following.
"E01", "E02", "E03", "E04",... etc.

Keylock Function
The controller has a keylock function to prevent unauthorized changing of the unit's operating settings. Press the MINUTE key 3 times consecutively will activate the keylock function. 'KEYLOCK' symbol will turn on. Upon keylock, all key pressing except ON/OFF and FAN keys will be ignored. To cancel the keylock function, press the MINUTE key 3 times consecutively, symbol 'KEYLOCK' will disappear.

Last State Memory
For 7-days programmable timer option, battery backup is used to retain the last stage data. For unit without battery backup, the last stage memory backup will base on the EEPROM data from the main board. If last stage information is not available, the unit will use default setting during next power up.

Sequential Controller LCD Operating Instructions

Sequential Controller LCD Display
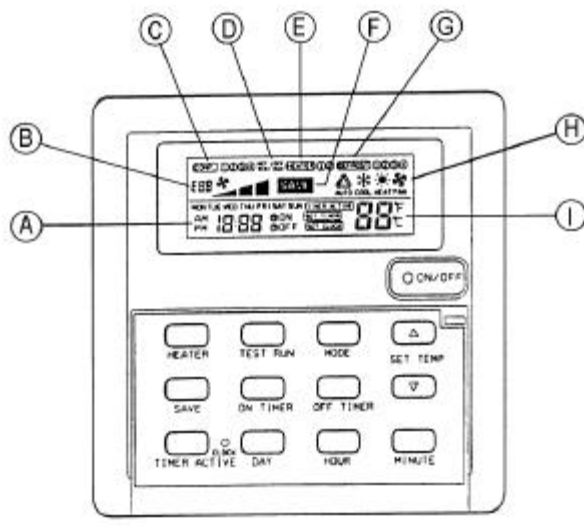
A : Time display
B : Error indication
C : Compressor running display (up to 4 compressors)
D : Key lock display
E : Heater display (up to 2 heaters)
F : Energy saving mode display
G : Compressor defrost cycle display (up to 4 compressors)
H : Operation mode display
I : Temperature set display

Operating Guide

- **ON/OFF key**
  Press once to start the air conditioning unit.
  Press again to stop the unit.
  The operation lamp next to the key lights up and goes off respectively when the unit is running or not running.
  Caution : In the case when the **ON/OFF** key is pressed immediately after the operation is stopped, the unit will not restart until 3 minutes later to protect the compressor.

- **Selecting Operation Mode**
  Press the **MODE** key to select the type of operating mode. Consecutive press of the key switches the operation over *"COOL", "HEAT", "AUTO" and "FAN"*

- **SAVE Mode**
  Press the **SAVE** key to select the energy saving function. This option is only available for "COOL", "HEAT" and "AUTO" modes.

- **Auxiliary Electric Heater**
  If the "HEAT" mode provides insufficient heating to a room even at the highest temperature setting (30°C), press the **HEATER** key to activate the auxiliary electric heater. For models with two heaters, consecutive press of the key allows the selection of one or both heaters active.

- **Temperature Setting**
  To set the desired room temperature, press ⬛▲ or ⬛▼ to increase or decrease the set temperature in the range of 16°C to 30°C.
  Press both ⬛▲ and ⬛▼ simultaneously to toggle between °C and °F setting.

- **Time Setting**
  Real time Clock
  Press the **CLOCK** key once to activate set clock mode.
  Press again to disable set clock mode.
  Under set clock mode, the time of the present day can be set by pressing the respective **MINUTE, HOUR** and **DAY** key.

_

7-days timer
Press the **ON TIMER** key to activate auto-ON timer mode. Under this mode, press the respective **MINUTE, HOUR** and **DAY** key to select the time of the week when the air-conditioning unit is to automatically start running. Press the **ON TIMER** key again to save the setting.

Press the **OFF TIMER** key to activate auto-OFF timer mode. Under this mode, press the respective **MINUTE, HOUR** and **DAY** key to select the time of the week when the air-conditioning unit is to automatically stop running. Press the **ON TIMER** key again to save the setting.

Then to activate the 7-days timer, press and hold the **TIMER ACTIVE** key until the word "TIMER ACTIVE" appears on the LCD screen. Repeat the same step to disable the 7-days timer.

- **Other Function**
  Key Lock
  Press the **MINUTE** key 3 times consecutively to activate the key lock. A *"KEY LOCK"* symbol will appear on the LCD screen. At this point, only the **ON/OFF** key is valid.
  To disable the key lock, again press the **MINUTE** key 3 times consecutively.

  Test run
  Press the TEST key 2 times consecutively to test run the unit.

Error Code

Error code	Possible fault	Error code	Possible fault
E01	Require manual reset (possible causes)	E19	Indoor coil sensor 4 short
E02	Compressor 1 high temperature (overload)	E20	Indoor coil sensor 1 open
E03	Compressor 2 high temperature(overload)	E21	Indoor coil sensor 2 open
E04	Compressor 3 high temperature(overload)	E22	Indoor coil sensor 3 open
E05	Compressor 4 high temperature(overload)	E23	Indoor coil sensor 4 open
E06	Compressor 1 high pressure trip / contact open	E24	Outdoor coil sensor 1 short
E07	Compressor 2 high pressure trip / contact open	E25	Outdoor coil sensor 2 short
E08	Compressor 3 high pressure trip / contact open	E26	Outdoor coil sensor 3 short
E09	Compressor 4 high pressure trip / contact open	E27	Outdoor coil sensor 4 short
E10	Compressor 1 trip / low R-22 / outdoor abnormal	E28	Outdoor coil sensor 1 open
E11	Compressor 2 trip / low R-22 / outdoor abnormal	E29	Outdoor coil sensor 2 open
E12	Compressor 3 trip / low R-22 / outdoor abnormal	E30	Outdoor coil sensor 3 open
E13	Compressor 4 trip / low R-22 / outdoor abnormal	E31	Outdoor coil sensor 4 open
E14	Room sensor short	E32	Compressor 1 de-ice
E15	Room sensor open	E33	Compressor 2 de-ice
E16	Indoor coil sensor 1 short	E34	Compressor 3 de-ice
E17	Indoor coil sensor 2 short	E35	Compressor 4 de-ice
E18	Indoor coil sensor 3 short		

When the system is on and an error occurs, the **ON/OFF** LED on the LCD panel will blink and an error code is shown. When the system is off and there is a thermistor error, the **ON/OFF** LED is off but the error code is still displayed. Each error code represents different message as below

Installation Of LCD Remote Controller

- **Accessories**

  The following accessories are included. If any part is missing, contact your dealer immediately.

  ① Remote controller
  ② Wooden screw 4.1 x 16 (2 pieces)
  ③ Instruction manual

- **Step-By-Step Guide**

  i) First, open up the casing of the LCD remote controller **into its top and bottom** case using a screwdriver. To do this, insert the screwdriver into the lower slot and slide it in the outward direction.

  ii) Fix the bottom case onto the wall with the 2 wooden screws provided. Then, insert the 4 connecting wires (from the main board) through the slot on the lower right.

  iii) Connect one end in each of the 4 wires to the terminal block behind the top case as shown below. The wire that goes into the "GND" terminal at the top case must be connected at the other end to the "GND" terminal at the main board. The same goes for the "+5V", "B" and "A" connection.

  iv) Fasten back the top and bottom case into place. Hook the two upper claws into their respective slots and snap the lower part shut.
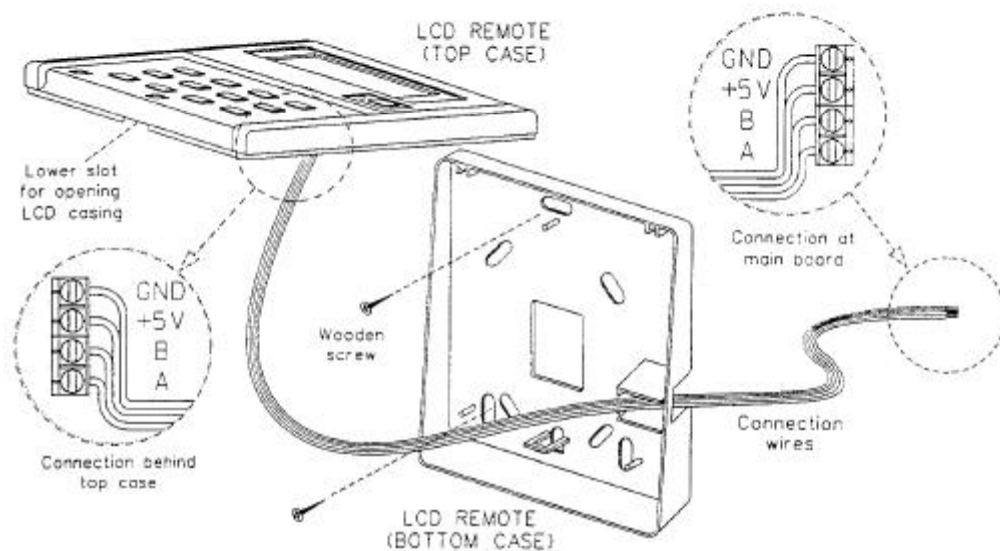
Section D – 2
Handsets

Netware 2

Features

The controller has a LED indicator, a LCD display panel, 5VDC power supply input, and one or two communication input/output port.

- Cool/Heat/Fan/Dry/Auto modes.
- High/Med/Low fan speed.
- Temperature operate in ^{o}C or ^{o}F.
- Room temperature indicator.
- Swing function.
- Sleep function.
- 7 days programmable timer (option).
- Error indicator.
- Keylock function
- Last state memory (battery backup or backup setting from main board)
- k)A test bit that will force the compressor to turn on without delay

Hardware Setting

The system has 4 jumpers setting to control the board function.

Jumper H	Jumper D	Model/Remark
no	no	N/A
no	yes	export cool (EC)
yes	no	heatpump (HP)
yes	yes	auto heatpump (AP)

The jumper NODRY is used when the Dry mode is not needed.

The jumper RTC is used to determine whether real time clock and timer functions are used.

Jumper RTC	Clock/Timers function
no	no
yes	yes

Section D – 3
Handsets

G6 Remote Controller

Operation Guide

1. ON / OFF SWITCH
- Press to start the air conditioner unit.
- Press again to stop the unit.

2. TEMPERATURE SETTING
- Set the desire room temperature.
- Press button to increase or decrease the set temperature. Setting range are between 16°C to 30°C setting (60°F to 80°F) (Optional setting from 20°C to 30°C).
  Press ▲ or ▼ button simultaneously will toggle the temperature setting between °C and °F.

3. AUTOMATIC AIR SWING
- Press the button to activate the automatic air swing function. The swing angle ranging from horizontal to 25° to bottom.

4. SLEEP MODE
- Press the button to activate sleep mode. This mode can only be activated while in cooling or heating mode operation. If it is activated in "COOL" mode, the set temperature will be increase 0.5°C after 30 minutes, 1°C after 1 hour and 2°C after 2 hours. Whereas in "HEAT" mode, the set temperature will decrease by 1°C after 30mins, 2°C after 1 hour and 3°C after 2 hours.
- This function is available under COOL, HEAT & AUTO mode.

5. TIMER SETTING
- Press set button to activate the timer setting (from 1 hour to 15 hour) of the air conditioning unit. It will be in "On" or "Off" condition after the set time depending to the current condition (either from "On" to Off" or vise versa)
- To cancel the timer setting, press the button continuously until the timer display goes off.

6. OPERATION MODES
- Press the "mode" button for select the type of operating mode.
- Cooling only unit:
    Cool → Dry → Fan.
- Heatpump unit :
    Auto → Cool → Dry → Fan → Heat

7. FAN SPEED AND VENTILATION MODE SELECTION
Press the button until the desired fan speed is achieved.

8. SIGNAL TRANSMISSION INDICATION
Blink to confirm the last setting has been send to the unit.

Functions

Power Up Settings

During power up, the controller will start up with default setting or battery backup setting or last state setting from the EEPROM on the main board. The default setting is as below:

      Mode   : Cool
      Set temperature   : 19°C (66°F)
      Fan speed   : Low

Unit ON/OFF

There are 2 ways to turn on or off the system:

           i) via 7 days programmable timer or
           ii) via ON/OFF key.

When the unit is OFF, the LED is light off. When the unit is turned ON, the LED will light up.

Temperature Range And Setting

The temperature setting range is 16°C to 30°C (61°F to 86°F). Temperature setting is performed via pressing TEMP DOWN key or TEMP UP key. Pressing both the TEMP UP and TEMP DOWN keys simultaneously will toggle the temperature setting between $^{\circ}$C and $^{\circ}$F.

Mode Function

Mode setting can be changed via key press on MODE key.

      Export Cool (EC)   Cool > Dry > Fan > Cool >
      Heatpump (HP)   Cool > Heat > Dry > Fan > Cool >
      Auto Heatpump (AP)   Cool > Heat > Auto > Dry > Fan > Cool >

Fan Speed Function

Fan speed can be changed via key press on FAN key.

      Fan speed operation   Low > Med > High > Auto > Low >

Room Temperature Function

Room temperature is displayed all the time. If set temperature key is pressed, then the set temperature will be displayed for 5 seconds. Then the LCD will display room temperature again.

The LCD displays room temperature from 8°C to 37°C (46°F to 99°F). If room temperature below 8°C (46°F), a word "LO" will be displayed. If room temperature above 37°C (99°F), a word "HI" will be displayed. There will be no display on room temperature if the thermister is in open or short circuit condition.

Sleep Function

To activate Sleep function, press the Sleep key once. To disable Sleep function, press the Sleep key once again.

Swing Function

To activate Swing function, press the Swing key once. To disable Swing function, press the Swing key once again.

Real Time Clock

Press the CLOCK key one time will activate set clock mode. Press the CLOCK key again will disable set clock mode.

Under set clock mode, "SET CLOCK" symbol will blink at 0.5 seconds interval and the real time clock and day setting can be changed by pressing DAY key, HOUR key or MINUTE key.

The unit will also automatically disable set clock mode after 15 seconds if there is no further time related (DAY, HOUR and MINUTE) key is pressed. Refer to attached flow chart for clock setting.

Seven Days Programmable Timer

There are two 7 days programmable timers namely On Timer and Off Timer.

Refer to attached flow chart for On Timer setting and Off Timer setting.
Press the timer key one time will activate set timer mode. Press the same timer key again will disable set timer mode.

Under set timer mode, "SET TIMER" symbol will blink at 0.5 seconds interval and the timer setting can be changed by pressing the DAY key, HOUR key or MINUTE key.
The unit will also automatically disable set timer mode after 15 seconds if there is no further time related (DAY, HOUR and MINUTE) key is pressed.

Whenever there is any timer setting in the program, the LCD displays "TIMER ACTIVE" to indicate the 7 days programmable timer is active. To cancel the timers setting temporary, press the HOLD key for 2-3 seconds until "TIMER ACTIVE" symbol disappears. To recall back the timer setting, press the HOLD key again for 2-3 seconds until "TIMER ACTIVE" symbol appears. To view the setting of the timer , press the TIMER KEY , whenever the HOUR key or MINUTE key are press the timer will be activated & " TIMER ACTIVE " display.

Another way to cancel the timers setting is to change all the hour setting of the timers to null one by one. When the setting is null, the LCD display --:--.
Battery backup is used to keep the real time clock operating if power failure occur.

Keylock Function

The controller has a keylock function to prevent the changes of the unit operating setting by unauthorized person. Press the MINUTE key 3 times consecutively will active keylock function, 'KEYLOCK' symbol will turn on. Upon keylock, all the keys press except ON/OFF key and Fan key will be ignored. To cancel the keylock function, press the MINUTE key 3 times consecutively, 'KEYLOCK' symbol will disappear.

Last State Memory

For 7-days programmable timer option, battery backup is used to retain the last stage data. For unit without battery backup, the last stage memory backup will depend on the EEPROM on the main board. If last stage information is not available, the unit will use default setting during next power up.

Error Indicator

If there were abnormal condition detected, the error code will be shown. Refer to main board error code for detail. The format of error code is as following.
"E01", "E02", "E03", "E04",.....etc.

If the Transmit wire (D7) of Microdp2 handset is not connected or broken, LCD will display error code 'EOP'.
If the receive wire(D8) is not connected or broken, the handset will go to power down mode.

Test Mode Function

When "MODE" key & TEMP DOWN key are press simultaneously, the compressor will force to turn on. This feature only function once for every power on or reset of the main board.

Section D – 3
Handsets

G6 Remote Controller

Operation Guide

1. ON / OFF SWITCH
- Press to start the air conditioner unit.
- Press again to stop the unit.

2. TEMPERATURE SETTING
- Set the desire room temperature.
- Press button to increase or decrease the set temperature. Setting range are between 16°C to 30°C setting (60°F to 80°F) (Optional setting from 20°C to 30°C).
  Press ▲ or ▼ button simultaneously will toggle the temperature setting between °C and °F.

3. AUTOMATIC AIR SWING
- Press the button to activate the automatic air swing function. The swing angle ranging from horizontal to 25° to bottom.

4. SLEEP MODE
- Press the button to activate sleep mode. This mode can only be activated while in cooling or heating mode operation. If it is activated in "COOL" mode, the set temperature will be increase 0.5°C after 30 minutes, 1°C after 1 hour and 2°C after 2 hours. Whereas in "HEAT" mode, the set temperature will decrease by 1°C after 30mins, 2°C after 1 hour and 3°C after 2 hours.
- This function is available under COOL, HEAT & AUTO mode.

5. TIMER SETTING
- Press set button to activate the timer setting (from 1 hour to 15 hour) of the air conditioning unit. It will be in "On" or "Off" condition after the set time depending to the current condition (either from "On" to Off" or vise versa)
- To cancel the timer setting, press the button continuously until the timer display goes off.

6. OPERATION MODES
- Press the "mode" button for select the type of operating mode.
- Cooling only unit:
  Cool → Dry → Fan.
- Heatpump unit :
  Auto → Cool → Dry → Fan → Heat

7. FAN SPEED AND VENTILATION MODE SELECTION
Press the button until the desired fan speed is achieved.

8. SIGNAL TRANSMISSION INDICATION
Blink to confirm the last setting has been send to the unit.

Section D – 4
Handsets

SLM Wired Controller

Operation Guide
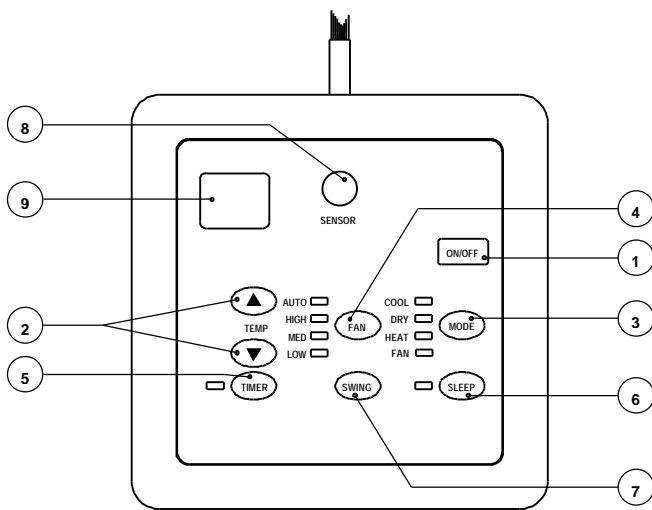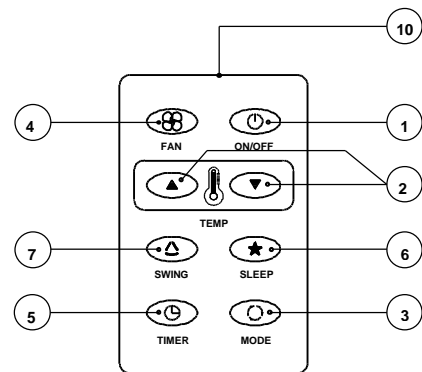
SLM   **AC-5300 (OPTIONAL)**

1. **"ON/OFF" switch**
   - Press to start the air conditioner unit.
   - Press again to stop the unit.

2. **Temperature setting**
   - Set the desired room temperature.
   - Press button to increase or decrease the set temperature. Setting range are between 16°C to 30°C (60°F to 80°F).

3. **Operation Modes**
   - Press the "mode" button for select the type of operating mode.
     - Cooling Only :
       COOL, DRY, FAN
     - Heat Pump :
       AUTO, COOL, DRY, HEAT, FAN
       (AUTO mode is represented by both COOL and HEAT LED light on)

4. **Fan Speed selection.**
   - Press the button until the desired fan speed is achieved.

5. **Timer.**
   - Press the set button to select the switch timer of the air conditioner unit (the setting range is between 1 to 10 hours).

6. "SLEEP" MODE

- Press button to activate the sleep function. This function can only be activated under "cool" or heating mode operation. When it is activated under "cool" mode operation, the set temperature will increase $0.5^{o}C$ after 30 minutes, $1^{o}C$ after 1 hour and $2^{o}C$ after 2 hours. If it is activated under "HEAT" mode operation, the set temperature will be decreased 0.5° C after 30 minutes, 1° C after 1 hour and 2° C after 2 hours.

7. AIR SWING

- Press button to activate the automatic air swing function.

8. SENSOR

- Infra red sensor to receive signals from wireless controller.

9. LED DISPLAY

- To display the set temperature (in º C) and timer delay setting (in hours).

10. TRANSMISSION SOURCE

- To transmit signals to the air conditioner.

Section D – 5
Handsets

G7 Remote Controller

Operation Guide
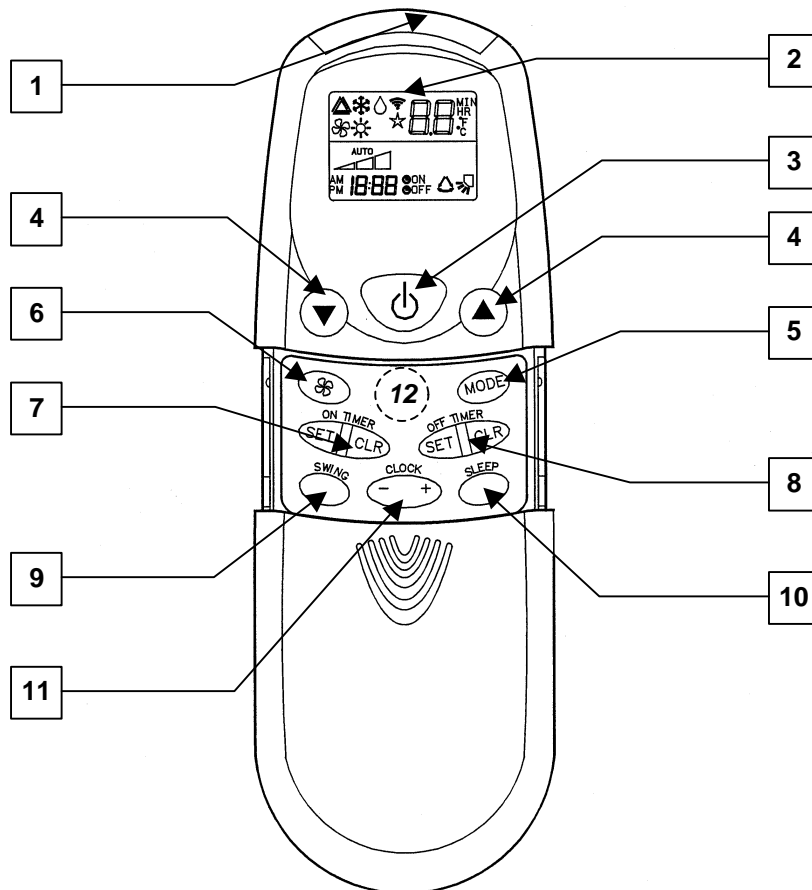
1. .**TRANSMISSION SOURCE**
- The source where the signal will be transmitted.

2. SIGNAL TRANSMISSION INDICATION
- Blink to confirm the last setting has been send to the unit.

3. ON/OFF BUTTON
- Press once to start the air conditioner.
- Press again to stop the unit.

4. TEMPERATURE SETTING
- To set the desired room temperature, press the button to increase or decrease the set temperature.
- The temperature setting range is from 16°C to 30°C (Optional setting 18°C to 30°C).
- Press both buttons simultaneously to toggle the temperature setting between °C and °F.

5. OPERATION MODE
- Press the MODE button to select the type of operating mode.
- For cooling only unit, the available modes are : COOL, DRY & FAN.
- For heat pump unit, the available modes are : AUTO, COOL, DRY, FAN & HEAT.

6. FAN SPEED SELECTION
- Press the button until the desired fan speed is achieved.

7. ON TIMER SETTING
- Press the SET button will activate the on timer function.
- Set the desired on time by pressing the SET button continuously. If the timer is set to 7.30am, the air conditioner will turn on at 7.30 sharp.
- Press the CLR button to cancel the on timer setting.

8. OFF TIMER SETTING
- Press the SET button will activate the off timer function.
- Set the desired off time by pressing the SET button continuously.
- Press the CLR button to cancel the off timer setting.

9. AUTOMATIC AIR SWING (OPTIONAL)
- Press the SWING button to activate the automatic air swing function.
- To distribute the air to a specific direction, press the SWING button and wait until the louver move to the desired direction and press the button once again.

10. SLEEP MODE SETTING
- Press the button to activate sleep mode. This function is available under COOL, HEAT & AUTO mode.
- When it is activated in COOL mode, the set temperature will be increased 0.5°C after 30mins, 1°C after 1 hour and 2°C after 2 hours.
- When it is activated in HEAT mode, the set temperature will be decreased 1°C after 30mins, 2°C after 1 hour and 3°C after 2 hours.

11. CLOCK TIME SETTING
- Press button + or - to increase or decrease the clock time.

12. TURBO FUNCTION (OPTIONAL – ONLY APPLICABLE TO INVERTER UNIT)
- Press button for fast cooling or heating operation.
- The temperature will be increased internally if it is in the HEAT mode, decreased if in COOL or DRY mode. Fan speed will be increased if it is not at maximum speed.
- The temperature & fan speed will resume to user setting if the button is pressed again or after 20mins.
- Available under HEAT, COOL & DRY modes only.

Appendix 1
Controllers' Development

History Of Controllers

YEAR	SOFTWARE USED IN MAIN BOARD	HANDSET		MODEL		REMARKS
		WIRELESS	WIRED	COOLING	HEATPUMP	
2001	W1V2	G6	Netware-1	MWM-FW/ MCM-DW/ MCC-CW/ MCK-AW/ MHSB-BW		Convertible PCB
2001	Sequential Controller	-	Sequential Controller	MDB(150-500)B	MDB(150-500)BR	Mutiple compressor
2001	Universal Board D1.0	G6	-	MWM(010-025)F	-	Cooling only
	U1.3	G6	-		MWM(010-025)FR	Heatpump only
	U1.4	G6	SLM (4 core wire)	MCM-D/ MCK-A/ MCC-C	MCM-DR/ MCC-CR/ MCK-AR	Cooling & heatpump
2001	D2.0	G6/G7	-	MWM(010-025)F	-	Cooling only
2001	Mini Chiller SZMC01	-	-	MAC/M4AC (40-58)A; MAC/M4AC75~125B	MAC/M4AC (40-58)AR; MAC/M4AC75~125BR	Cooling & Heatpump
2001	Inverter VA1.0 (indoor) VB1.0 (outdoor)	G7-Turbo	-		MWMV010FR MLCV010BR	In set form only
2001	Rooftop	-	PAC204RC	MRT(80-200) A	MRT (80-200)AR	
2002	Sequential Controller		Sequential Controller, SQ-LCD	MDB(150-500)D	MDB(150-500)DR	Multiple compressor
2002	D2.0	G7		MWM030F		Cooling only
	U1.4	G7	SLM3 / Netware2	MCK (015/020/025/030)B	MWM (010-025)FR; MWM030FR;	Heatpump only
					CK (10/20/25/30)BR	Cooling & heatpump
2002	Chilled Water W1V3	G6	SLM3 / Netware 2	MWM-FW/ MCM-DW/ MCC-CW/ MCK-AW/ MCK-BW		Valveless Application only
2002	Multi Split Indoor, MS10.0	G7	-	-	MWMS (010-020) FR	Auto Random Restart
2003	Mini chiller MCH03A	-	-	MAC/M4AC(80/100/120/150) C	MAC/M4AC(80/100/120/150) CR	Cooling & heatpump
2003	Universal U1SB125	-	SLM3 - Single speed	MDB (125/150) B1/C1/D1 MRT/M4RT (60/80/100/120) A	MDB (125/150) BR1/CR1/DR1 MRT/M4RT (60/80/100/120) AR	Cooling & heatpump
2003	Sequential Controller, SQ	-	SQ-LCD	MRT/M4RT(150/200/250/300) A	MRT/M4RT(150/200/250/300) AR	Cooling & heatpump

Controller Version

Wall Mounted Model

```
MWM010/015D          →   C 2.4
MWM020/025C

MWM010/015DR         →   C 2.4
MWM020/025CR

MWM007/010E          →   C 2.4   →   C 5

MWM007/010ER         →   C 2.4

MWM007/010/015F      →              C 5   →   D1/D2*
MWM020/025F

MWM007/010/015FR     →   C 2.4         →   U1.3* /
MWM020/025FR                               U1.4*
```

* With auto random restart feature

Wall Mounted Model -- Multi Split

```
MWMS010/015D    →   C5    →
MWMS020C

MWMS010E        →   C5    →   D1/D2*

MWMS010/015F    →   C5    →
MWMS020F

MWMS010ER       →   MS7.0 →

MWMS010/015FR   →   MS7.0 →   MS10*
MWMS020FR
```

* With auto random restart feature

Light Commercial Model

```
MCK020-050A
MCK020-050AR    →    C3A    →

MCM020-025C
MCM020-025CR    →

MCM020-050D
MCM020-050DR    →    C3B    →

MCC010-025C
MCC010-025CR    →                    U1.4*

MCM030-050C
MCM030-050CR    →

MCC030-040B
MCC030-040BR    →    C3B CET  →

MCC030-060C
MCC030-060CR    →
```

* With auto random restart feature

Commercial Model

```
MDB075-100B
MDB075-100BR    →    C3B CCT   →

MDB125B                                U1.4*
MDB125BR        →    SB125 WIRED

MDB150-750B
MDB150-500BR    →    SQ1.0
```
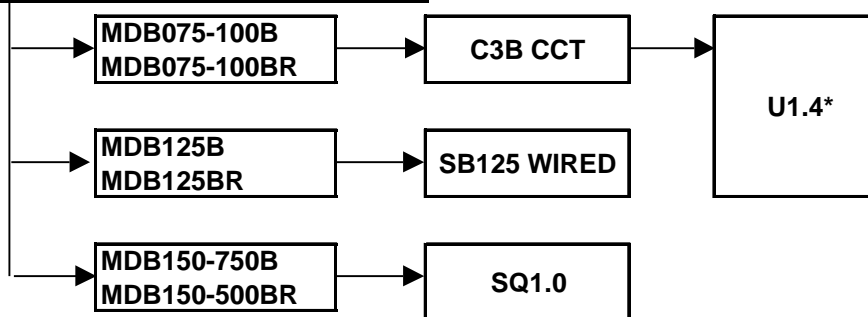
* With auto random restart feature

Mini Chiller & FCU

```
MAC40~58A/AR
MAC75~125B/BR   →   MCH01~07   →   SZMC02

FCU             →    W1V2      →    W1V3
```
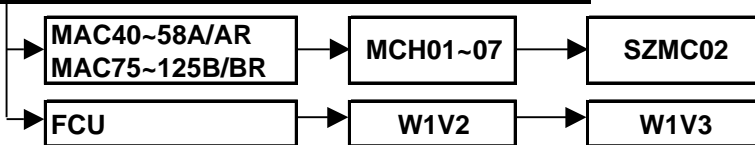
Handset Compatibility

Handset	Communicate with	Main Board								
		OMC - 03	SongJia	Jia Lih	C2	C3	C5	D1.0	U1.3	U1.4
Black Transmitor	=	X	X	X						
V1	=	X	X	X						
V2	=	X	X	X	X	X				
G2 (V1 Code)	=	X	X	X						
G2 (G2 Code)	=				X	X	X			
G3 (V2 Code)	=	X	X	X	X	X				
G3 (G3 Code)	=				X	X				
G6 (V2 Code)	=				X	X	X	X	X	X
G8	=							X	X	X
WIRED CONTROLLER										
SLM (7W)	=	X								
SLM (10W)	=					X				
SLM (4W)	=									X

Appendix 2
PCB Identification

General

To identify a controller, the service personnel must first examine the PCB's (printed circuit board) name and also check the software version printed on the microprocessor. With a same PCB, the software version might be different (due to customization or improvement).
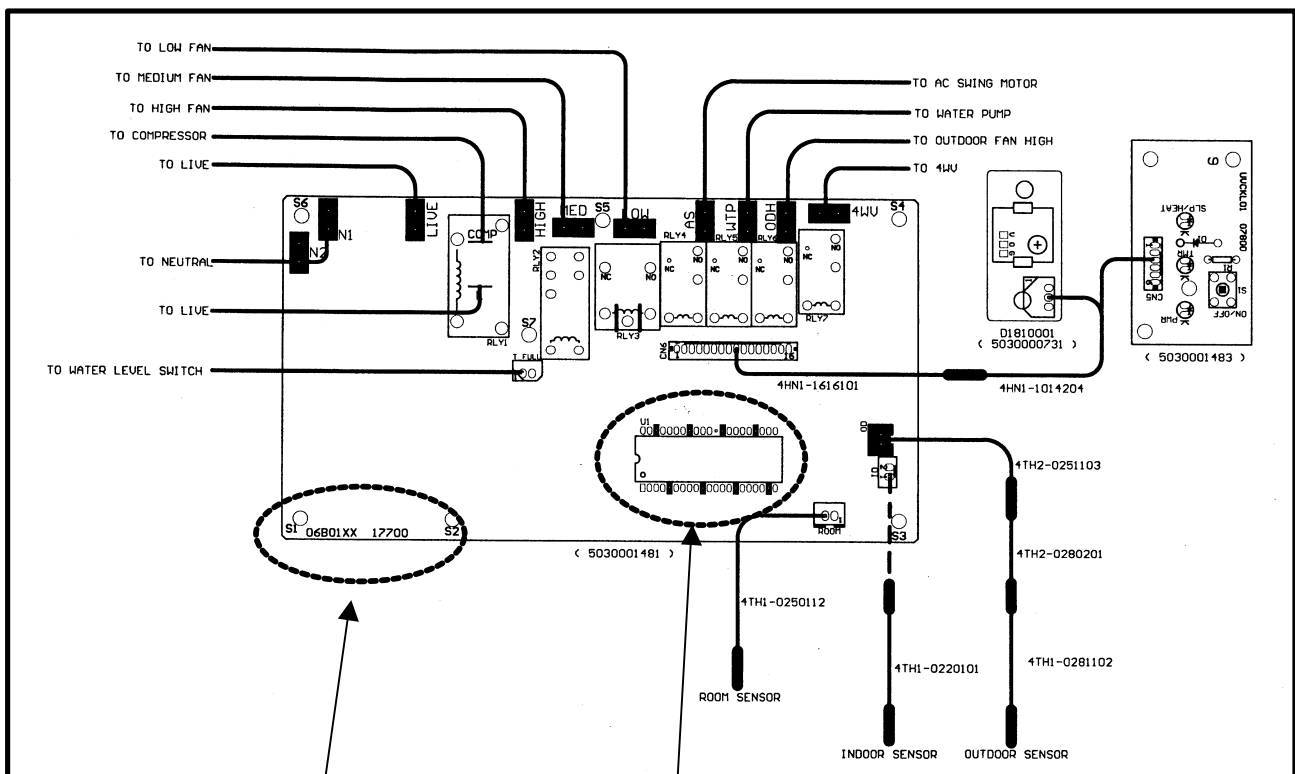
Name of PCB can be read here   **Software version can be read here**

Table Of Identification

Listed in the table below are the name of different PCB used for different air-conditioners.

MODEL	CONFIGURATIN	PCB NAME	SOFTWARE
MCK-AW, MCC-CW, MCM-W	VALVE	06A01	W1V2
MCK-A, MCM, MCC	EC/AP	06B01	U1.4
MCK-C	EC/AP	06B01	U1.4
MCK-CW	VALVE LESS	06C01	W1V3
MCK-B	EC/AP	UNVCK	U1.4
MCK-BW	VALVE	UNVCK	W1V2
MWM-F	EC	WMF05XX	D2.0
MWM-F	EC	WMF04B/05B	L2
MWM-F	AP	WMF04A	U1.4
MWM-F	AP	WMF04B/05B	L2
MWM-FW	VALVE	WMF04A	W1V2
MWM-FW	VALVE LESS	WMF06	W1V3
MWM 030F	EC	WMEXXXX	D2.0
MWM 030FR	AP	WM30E01	U1.4

Appendix 3
Thermistor

Thermistor Resistance Calculation

1) For thermistor, the most important characteristic is the B value.
2) B_{25-50} means the B value between 25°C and 50°C.
3) In order to derive the B value between t_1 and t_2, first, we need to obtain the resistance of thermistor at t_1 and t_2. Lets assume R_1 (at t_1) and R_2 (at t_2).

   Substitute t_1, t_2, R_1 and R_2 into the formula below to obtain the B value:

   B value between t_1°C and t_2°C,

   $B_{t1-t2} = \ln (R_1/R_2) \div [1/(t_1 + 273.15) - 1/(t_2+273.15)]$

   Example :

   B value for copper sensor between 25°C and 50°C,
   $B_{25-50} = \ln (10000/4085) \div [1/(25+273.15) - 1/(50+273.15)]$
   $= 3450$

4) For copper sensor, $B_{25-50} = 3450$

   For silver sensor, $B_{25-50} = 3330$

5) Rearrange the formula, we get

   $\ln (R_1/R_2) = B_{t1-t2} [1/(t_1 + 273.15) - 1/(t_2 + 273.15)]$

   Take reference at 25°C, copper sensor

   $\ln (R_1/10000) = 3450 [1/(t_1 + 273.15) - 1/298.15]$

   Substitute R_1 with R and t_1 with T and rearrange the formula, we get

   $R = 10,000 * e^{3450[1/ (T+273.15) - 1/298.15]}$

   Where,　　R = Resistance at T °C
   　　　　　T = Temperature measured by thermistor

   For Silver sensor,

   $R = 5,000 * e^{3330[1/ (T+273.15) - 1/298.15]}$

Resistance – Temperature Characteristics

TYPE   DTN-C1 03F3H-OYL 1128, 1148, 1158
MATERIAL NAME   3H
RESISTANCE   R25=10.000kO+ 1.0%-1.0%
B VALUE   B25/50=3450K+1.0% -1.0%

t°C	Rmin (kW)	Rnom (kW)	Rmax (kW)	t°C	Rmin (kW)	Rnom (kW)	Rmax (kW)
-10	4.42E+01	4.53E+01	4.65E+01				
-9	4.21E+01	4.32E+01	4.43E+01	41	5.47E+00	5.56E+00	5.64E+00
-8	4.02E+01	4.12E+01	4.22E+01	42	5.28E+00	5.37E+00	5.45E+00
-7	3.83E+01	3.92E+01	4.02E+01	43	5.10E+00	5.18E+00	5.27E+00
-6	3.66E+01	3.74E+01	3.83E+01	44	4.92E+00	5.01E+00	5.09E+00
-5	3.49E+01	3.57E+01	3.65E+01	45	4.75E+00	4.84E+00	4.92E+00
-4	3.33E+01	3.41E+01	3.49E+01	46	4.59E+00	4.67E+00	4.76E+00
-3	3.18E+01	3.26E+01	3.33E+01	47	4.44E+00	4.52E+00	4.60E+00
-2	3.04E+01	3.11E+01	3.18E+01	48	4.29E+00	4.37E+00	4.42E+00
-1	2.90E+01	2.97E+01	3.03E+01	49	4.15E+00	4.22E+00	4.30E+00
0	2.78E+01	2.84E+01	2.90E+01	50	4.01E+00	4.09E+00	4.16E+00
1	2.66E+01	2.71E+01	2.77E+01	51	3.88E+00	3.95E+00	4.03E+00
2	2.54E+01	2.59E+01	2.65E+01	52	3.75E+00	3.82E+00	3.90E+00
3	2.43E+01	2.48E+01	2.53E+01	53	3.63E+00	3.70E+00	3.77E+00
4	2.33E+01	2.37E+01	2.42E+01	54	3.51E+00	3.58E+00	3.65E+00
5	2.23E+01	2.27E+01	2.31E+01	55	3.40E+00	3.47E+00	3.54E+00
6	2.14E+01	2.18E+01	2.21E+01	56	3.29E+00	3.36E+00	3.43E+00
7	2.05E+01	2.08E+01	2.12E+01	57	3.18E+00	3.25E+00	3.32E+00
8	1.96E+01	2.00E+01	2.03E+01	58	3.08E+00	3.15E+00	3.22E+00
9	1.88E+01	1.91E+01	1.94E+01	59	2.98E+00	3.05E+00	3.12E+00
10	1.80E+01	1.83E+01	1.86E+01	60	2.89E+00	2.96E+00	3.01E+00
11	1.73E+01	1.76E+01	1.78E+01	61	2.80E+00	2.86E+00	2.93E+00
12	1.66E+01	1.69E+01	1.71E+01	62	2.71E+00	2.78E+00	2.84E+00
13	1.59E+01	1.62E+01	1.64E+01	63	2.63E+00	2.69E+00	2.75E+00
14	1.53E+01	1.55E+01	1.57E+01	64	2.55E+00	2.61E+00	2.67E+00
15	1.47E+01	1.49E+01	1.51E+01	65	2.47E+00	2.53E+00	2.59E+00
16	1.41E+01	1.43E+01	1.45E+01	66	2.40E+00	2.45E+00	2.51E+00
17	1.35E+01	1.37E+01	1.39E+01	67	2.32E+00	2.38E+00	2.44E+00
18	1.30E+01	1.32E+01	1.33E+01	68	2.25E+00	2.31E+00	2.37E+00
19	1.25E+01	1.27E+01	1.28E+01	69	2.19E+00	2.24E+00	2.30E+00
20	1.20E+01	1.22E+01	1.23E+01	70	2.12E+00	2.17E+00	2.23E+00
21	1.16E+01	1.17E+01	1.18E+01	71	2.06E+00	2.11E+00	2.17E+00
22	1.11E+01	1.12E+01	1.14E+01	72	2.00E+00	2.05E+00	2.10E+00
23	1.07E+01	1.08E+00	1.09E+01	73	1.94E+00	1.99E+00	2.04E+00
24	1.03E+01	1.04E+01	1.05E+01	74	1.88E+00	1.93E+00	1.98E+00
25	9.90E+00	1.00E+01	1.01E+01	75	1.83E+00	1.88E+00	1.93E+00
26	9.52E+00	9.62E+00	9.72E+00	76	1.77E+00	1.82E+00	1.87E+00
27	9.16E+00	9.26E+00	9.36E+00	77	1.72E+00	1.77E+00	1.82E+00
28	8.82E+00	8.92E+00	9.02E+00	78	1.67E+00	1.72E+00	1.77E+00
29	8.49E+00	8.59E+00	8.69E+00	79	1.63E+00	1.67E+00	1.72E+00
30	8.17E+00	8.27E+00	8.37E+00	80	1.58E+00	1.62E+00	1.67E+00
31	7.87E+00	7.97E+00	8.07E+00	81	1.53E+00	1.58E+00	1.62E+00
32	7.58E+00	7.68E+00	7.78E+00	82	1.49E+00	1.53E+00	1.58E+00
33	7.31E+00	7.40E+00	7.50E+00	83	1.45E+00	1.49E+00	1.54E+00
34	7.04E+00	7.14E+00	7.23E+00	84	1.41E+00	1.45E+00	1.49E+00
35	6.79E+00	6.88E+00	6.98E+00	85	1.37E+00	1.41E+00	1.45E+00
36	6.54E+00	6.64E+00	6.73E+00	86	1.33E+00	1.37E+00	1.41E+00
37	6.31E+00	6.40E+00	6.50E+00	87	1.30E+00	1.33E+00	1.38E+00
38	6.09E+00	6.18E+00	6.27E+00	88	1.26E+00	1.30E+00	1.34E+00
39	5.87E+00	5.96E+00	6.05E+00	89	1.23E+00	1.26E+00	1.30E+00
40	5.67E+00	5.75E+00	5.84E+00	90	1.19E+00	1.23E+00	1.27E+00

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