MITSUBISHI ELECTRIC

AIR CONDITIONING SYSTEMS

Programmable Logic Controller

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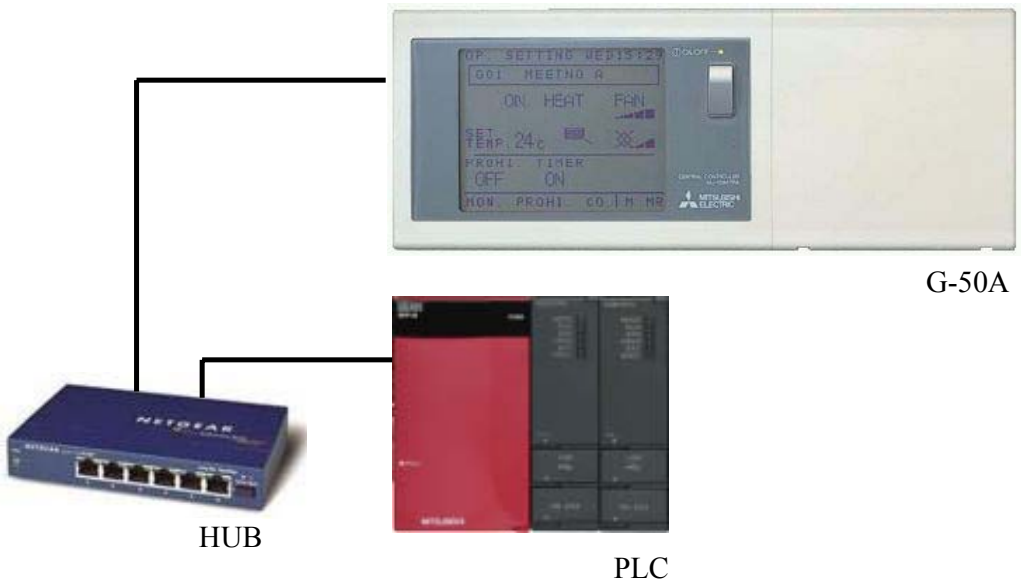
1. PLC overview

1.1. Introduction to the architecture

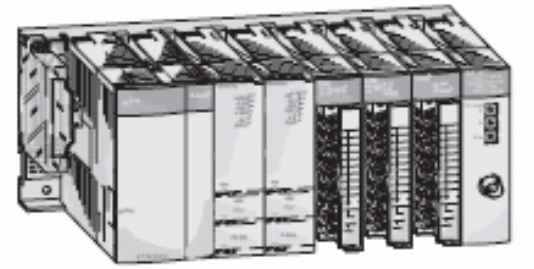
A PLC is a microprocessor-based industrial control system. The PLC talks to the G-50A using the Ethernet Communication and a hub.

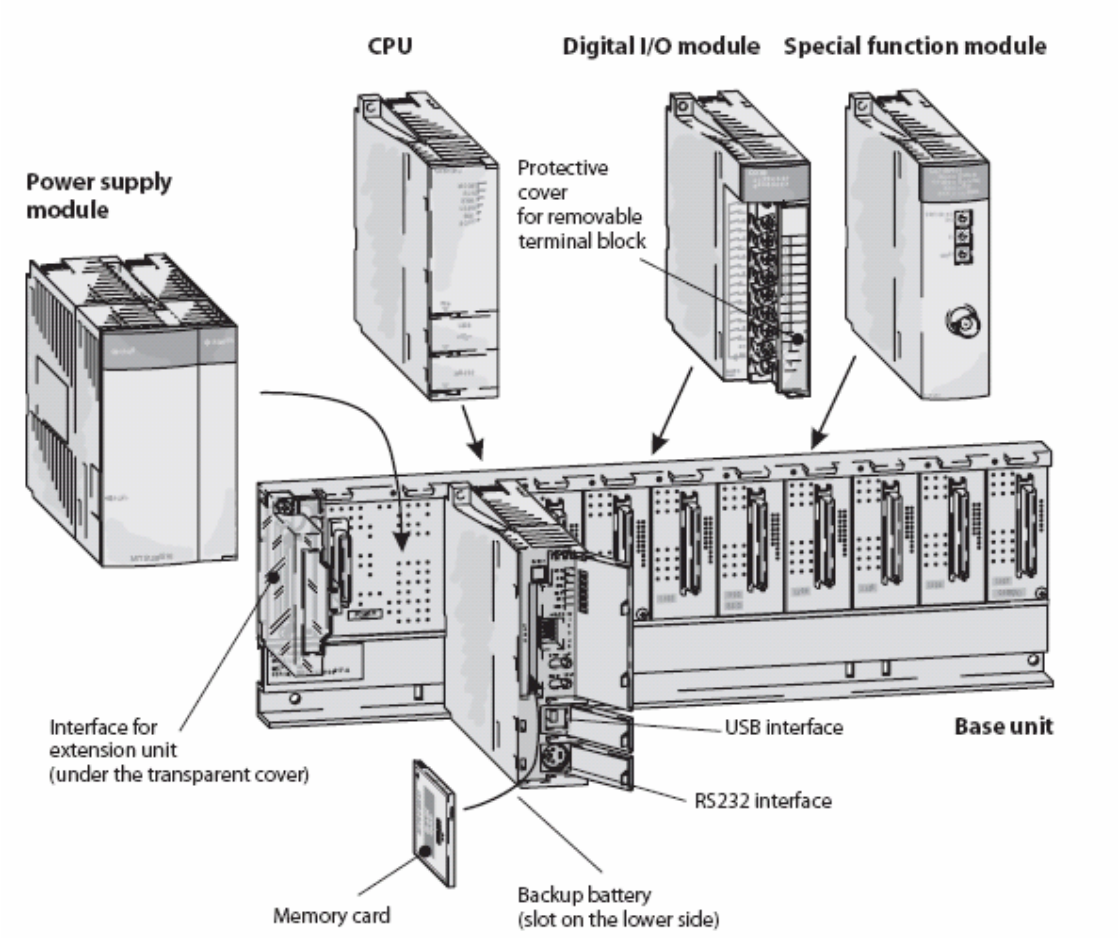


A hub is used to connect several computers and several G-50A together on the same network.

1.2. Introduction to the PLC

The Mitsubishi Electric Q series PLC consists of different modules. Modules are held in the base unit.



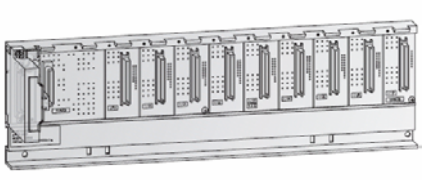


1.3. Modules used with the G-50A

The Q series PLC when used with the G-50A consists of 5 different modules and the base unit:

- Q33B-E Base unit
- Q61P-A2 Power supply
- Q02HCPU High speed CPU
- QJ71E71-100 Ethernet module
- QX40 Input module
- QY40P Output module

Base unit



The main base unit is used for holding and coupling power supply, CPU, Ethernet, input and output modules.

Power supply

The power supply module supply the voltage required for operation to the individual modules.

CPU unit

The CPU unit is the brain of the system. The CPU will link and interlock all inputs and outputs.

Ethernet module

The Ethernet module is used to interface the PLC to an Ethernet network and therefore to the G-50A.

Input and Output module

The digital input signals are converted to different voltage levels.

The PLC output module is used to switch external equipment.

The PLC input module is used to monitor volt-free contact inputs.

1.4. Dimensions

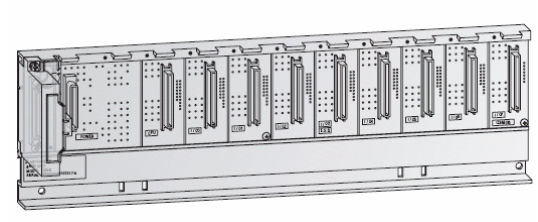
Complete package

Wide: 189

High: 98

Deep: 90

Base unit



Wide: 189

High: 98

Deep: 44

Power supply

Wide: 59

High: 98

Deep: 90

CPU unit

Wide: 27

High: 98

Deep: 90

Ethernet module

Wide: 27

High: 98

Deep: 90

Input and Output module

Wide: 27

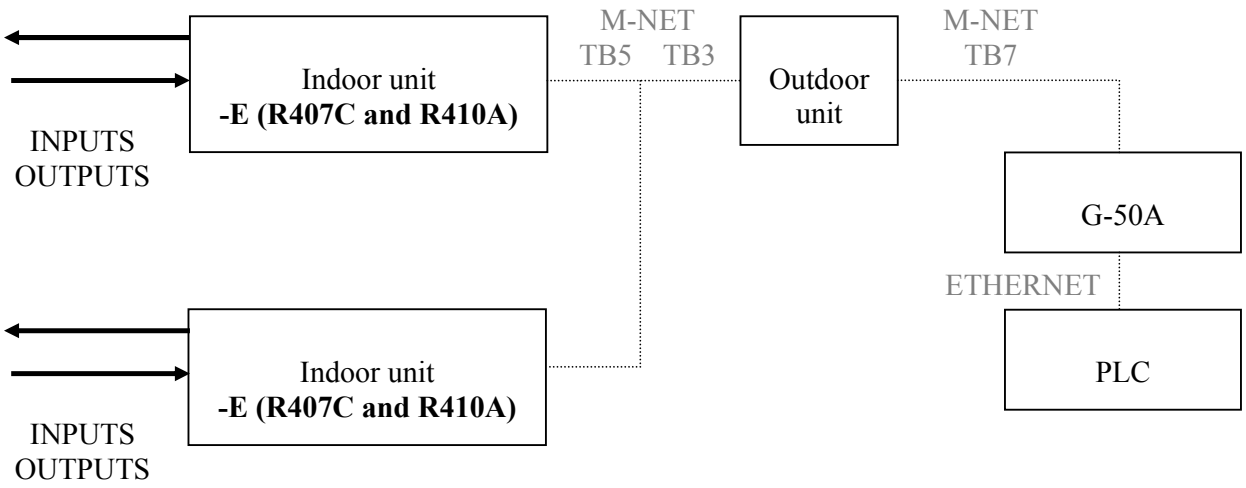
High: 98

Deep: 90

1.5. Introduction to the indoor unit input and output

The main selling point of the PLC application is not only to interlock inputs and outputs but also to interlock local inputs and outputs from the indoor unit.

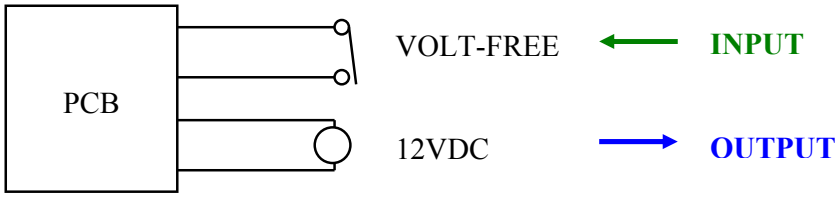
The –E version of the indoor unit (R407C and R410A) are compatible with the PLC.



1.6. Type of input and output

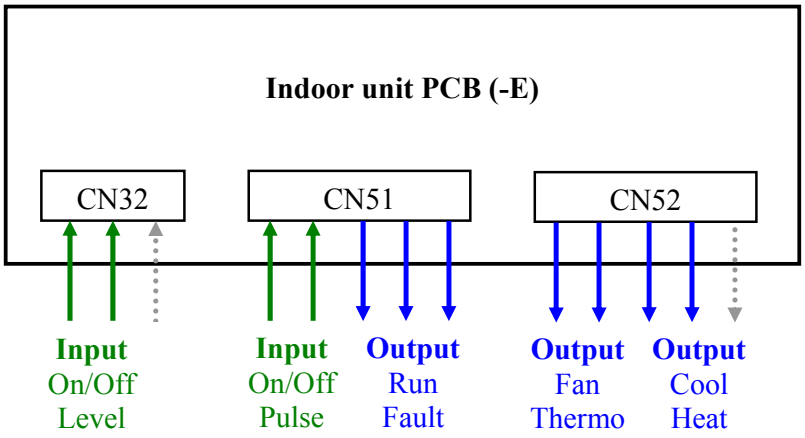
Types of inputs and outputs are:

- Input: volt-free contact
- Output: 12VDC

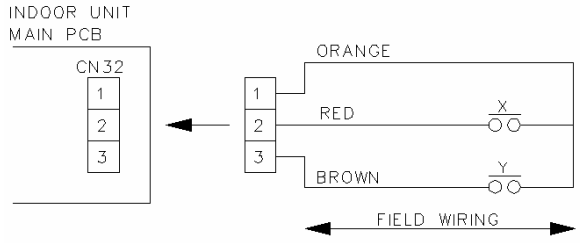


1.7. Diagram of the indoor unit input and output

CN32, CN51 and CN52 are normally used for inputs and outputs.



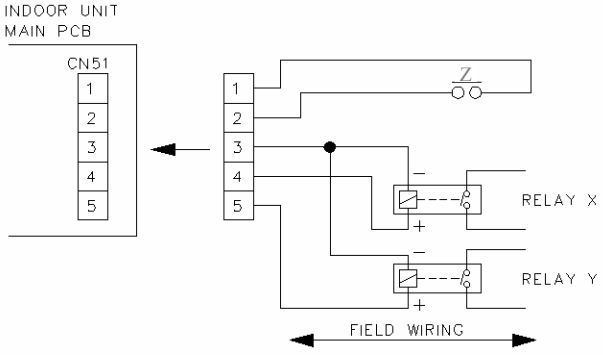
1.7.1. Wiring diagram of CN32



Volt-free contacts X and Y are used to switch On/Off the indoor unit (level signal).

Remote controller On/Off button "Centrally Controlled".

1.7.2. Wiring diagram of CN51

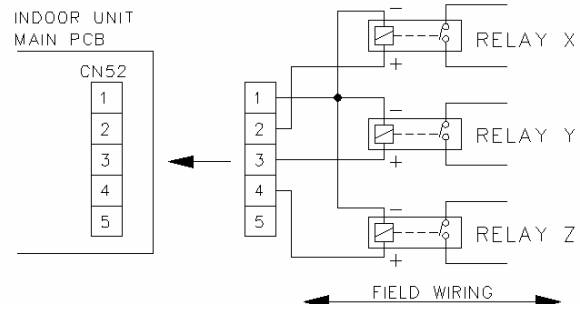


Volt free contact Z is used to switch On/Off the indoor unit (pulse signal).

Remote controller On/Off button not "Centrally Controlled".

Relay X is used to monitor when the unit is On or Off and Y is used to monitor when the unit is in fault.

1.7.3. Wiring diagram of CN52



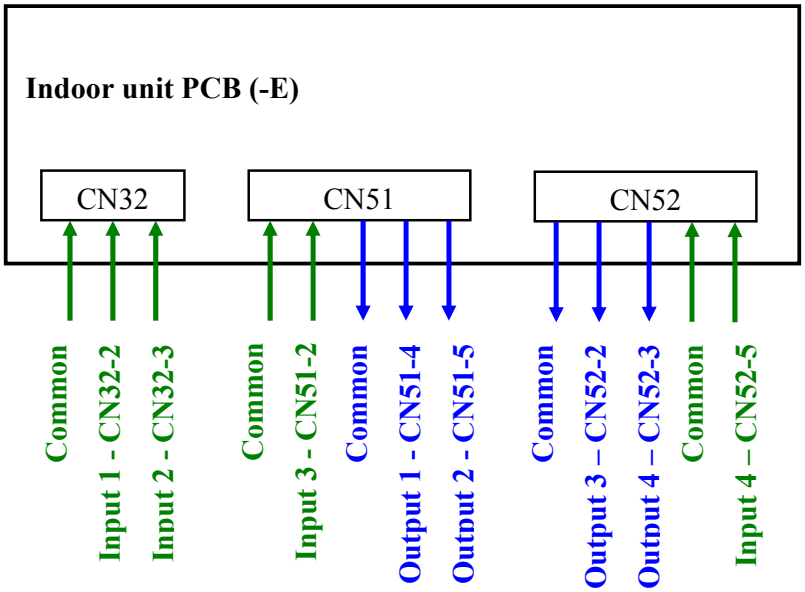
Relay X is used to monitor when the fan is running.

Relay Y is used to monitor when the indoor unit is in cooling mode (On or Off).

Relay Z is used to monitor when the indoor unit is in heating mode (On or Off).

1.8. Diagram of the indoor unit input and output using PLC

To enable the PLC, two dipswitch need to be changed on each indoor unit (SW1-9 and SW1-10 set to ON). CN32, CN51 and CN52 will then be controlled by the PLC.



1.9. Input and output - Interlocking strategy

Different types of inputs and outputs are available:

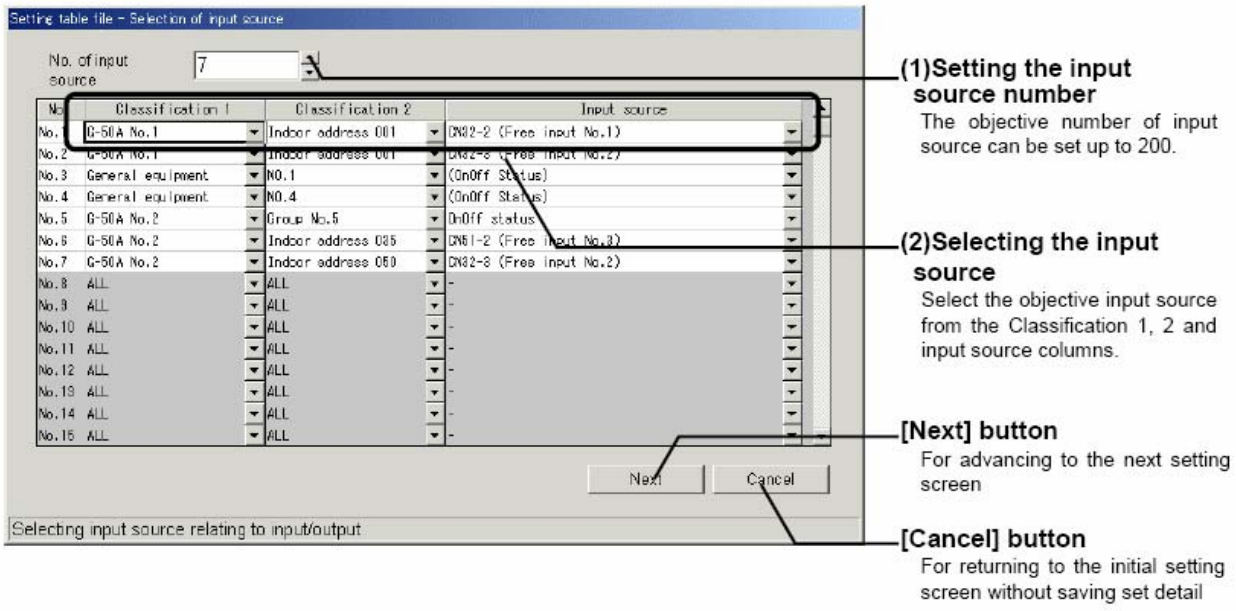
- Software input Air Conditioning settings: On/Off
- Hardware input physical input: input 1 - CN32-2, input 2 – CN32-3, input 3 – CN51-2, input 4 – CN52-5
- Software output Air Conditioning settings: On/Off, Mode, Fan Speed, Setpoint, Prohibit On/Off, Prohibit Mode
- Hardware output physical output: output 1 – CN51-4, output 2 – CN51-5, output 3 – CN52-2, output 4 – CN52-3

Each software and hardware input may be interlocked to software and hardware outputs.

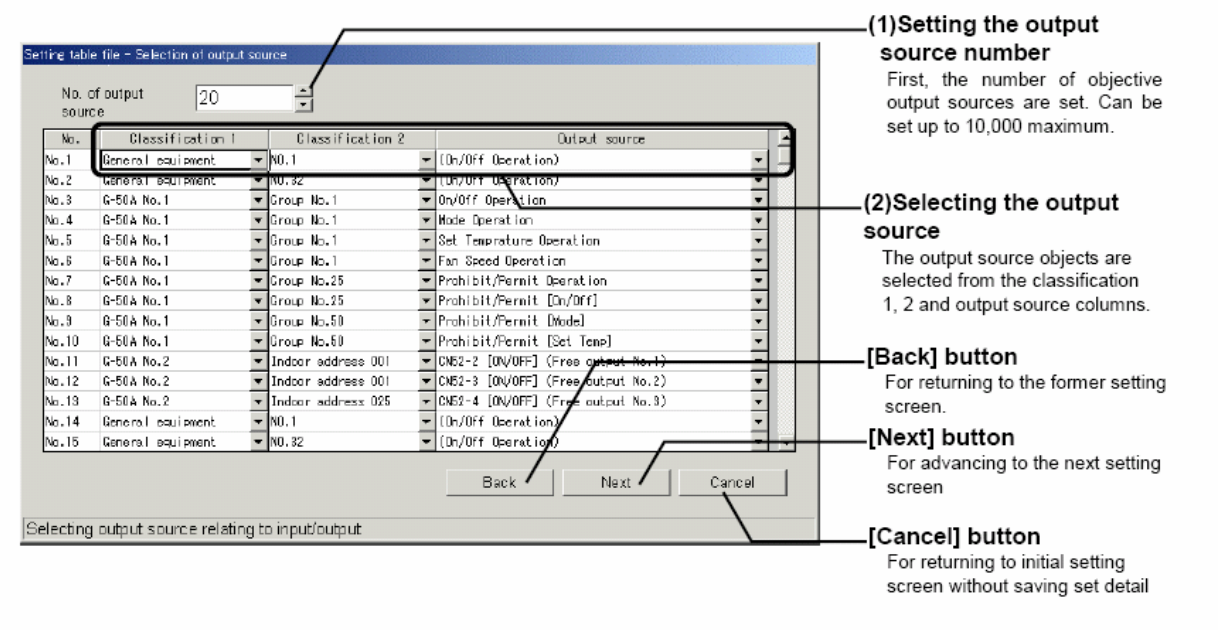
1.10. Input and output - Examples

A PLC tool software is used to set the inputs, outputs and the strategy.

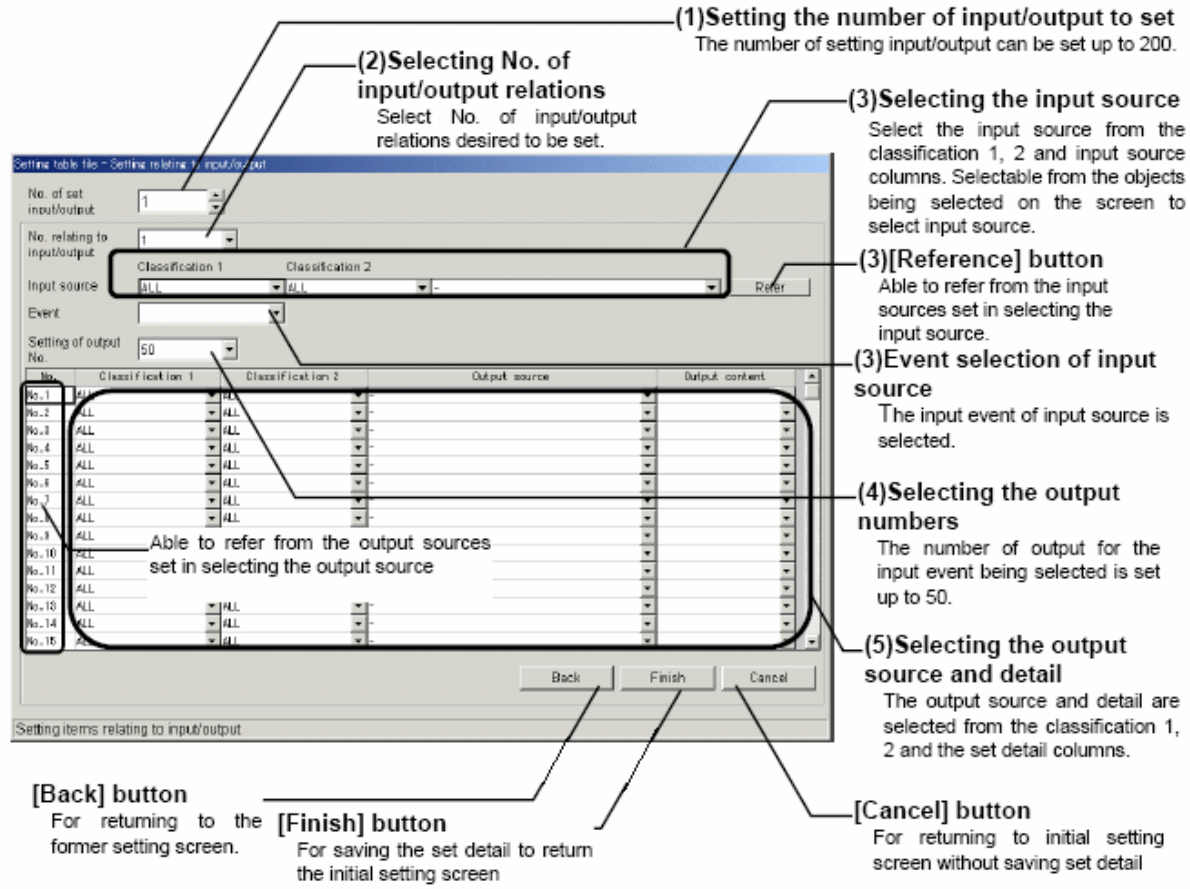
1.10.1. Step 1: Set input



1.10.2. Step 2: Set output



1.10.3. Step 3: Set logic



2. PLC option 1 – Hotel application

2.1. Specifications

Entry to each room will be via a card key activated door lock. A volt-free contact shall be monitored via the appropriate indoor unit's CN32 (PIN 1 and 2) contact to determine when the lock has been activated i.e. the room is occupied.

When the card key has been activated i.e. when the volt-free contact is closed (card key located within door lock) the room will be deemed to be in an "occupancy" status.

When the card key is de-activated i.e. when the volt-free contact is opened (card key removed from door lock) the room will be deemed to be in an "out-of-occupancy".

(a) Occupancy. Units should be set to the following status: **ON**, mode: **AUTO**, setpoint: [**22**]ºC.

(b) Out of occupancy. Units should be set to night set back.

Should the space temperature drop below [**16**]º C the PLC shall command the indoor unit to operate in "HEATING" mode at "setpoint" [**19**]º C. The unit will continue to operate in this mode until the space temperature reaches [**18**]º C.
Should the space temperature raise below [**26**]º C the PLC shall command the indoor unit to operate in "COOLING" mode at "setpoint" [**21**]º C. The unit will continue to operate in this mode until the space temperature reaches [**22**]º C.

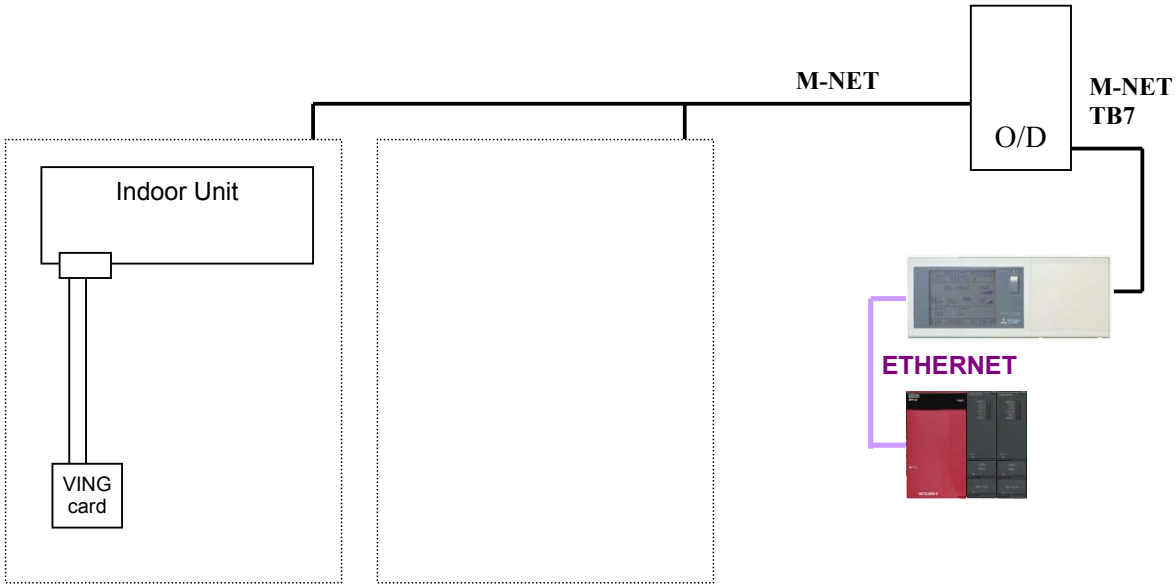
The temperature sensor located within the PAC-SE51CRA remote controller will measure its associated room space temperature condition.

Value marked in bold shall be set-up during commissioning.

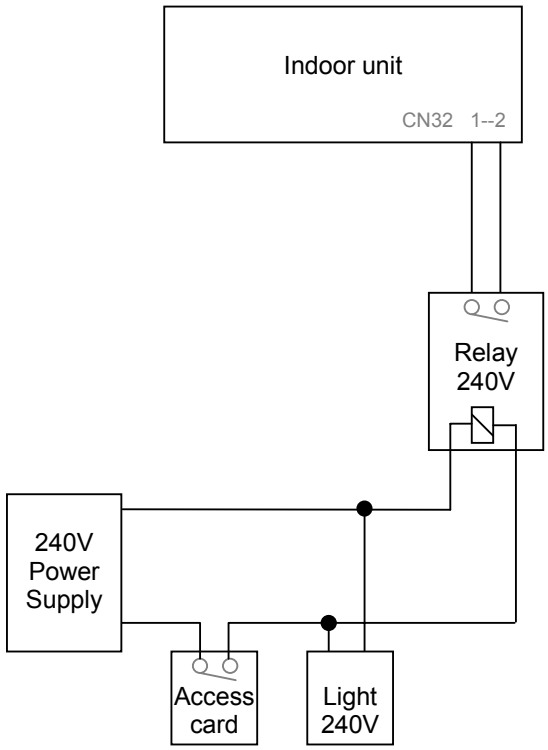
One PLC can control up to 100 indoor units i.e. 2 G-50A.

It may take up to 5 minutes for the PLC to switch ON the unit to AUTO, [22]º C. This time delay depends on how many indoor units are connected to the PLC.

2.2. Installation diagram



2.3. Installation diagram (key card)



2.4. Equipment list

Model	Details	Supplier
G-50A / GB-50A	Centralised controller	Mitsubishi Electric
PAC-SC50KUA	Power pack	Mitsubishi Electric
PLC-QSERIES-LSPD	Q series low speed PLC	Mitsubishi Electric
TG-2000A **(Note 1)**	Software package (CD)	Mitsubishi Electric
TG-2000A GRAPHICS **(Note 1)**	Graphical page (1 per 30 indoor units)	Mitsubishi Electric
TG-2000A PC **(Note 1)**	High specifications PC running Windows XP Pro	Mitsubishi Electric **(Note 2)**
PAC-SA89TA-EP	3 wire adaptor (1 per indoor unit)	Mitsubishi Electric

Note 1: Optional.

Note 2: PC may be supplied by others. The minimum specification required is: PIII, 256 Mb of RAM running Windows XP SP2 Professional or Windows 2000 SP5 Professional.

2.5. Prior to site commissioning

4 weeks-notice are required prior to going on site.

Details of the specification and units schedule must be sent 4 weeks prior to site visit.

Dipswitch must be set on all indoor units (SW1-1, SW1-9 and SW1-10 set to ON).

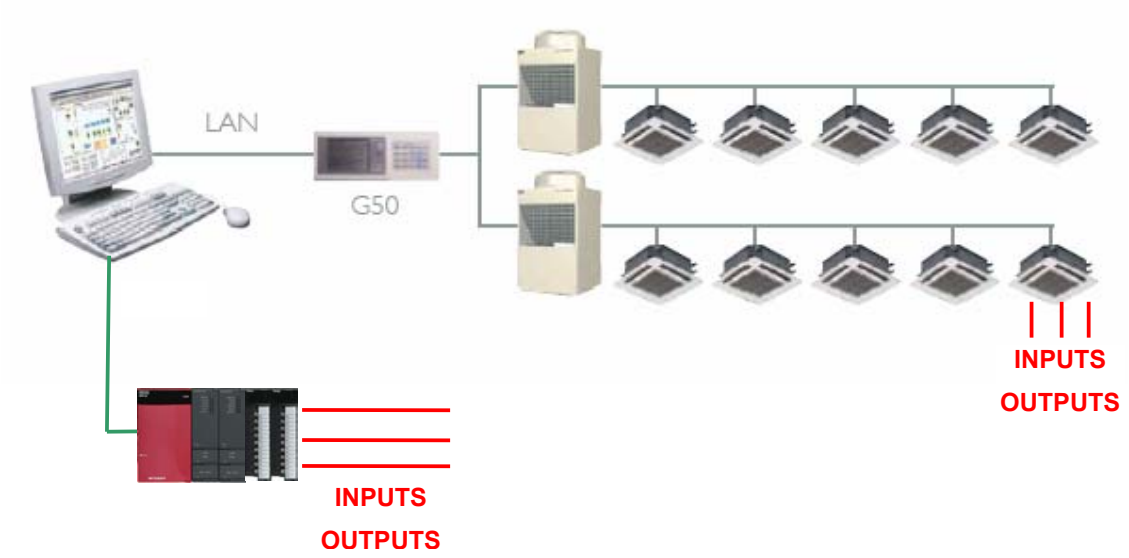
3. PLC option 2 – Control general equipment

3.1. Introduction

A Mitsubishi Electric programmable logic controller can be connected to the G-50A to provide remote I/O capability to the indoor unit. Key card access, window locking, lighting, infrared detectors can be connected locally to the indoor unit to be interlocked with the Air Conditioning.

For instance, the Air Conditioning can be interlocked with a card key system. During occupancy, the lights will be turned on and the Air Conditioning set to AUTO, 22°C. Out of occupancy, the lights will be turned off and the Air Conditioning set to HEAT, 12°C (night set back).

3.2. System Overview



G-50A:

- connected to the outdoor unit using TB7 (M-net) and the power pack PAC-SC50KUA
- connected to the Ethernet network connection (LAN)

PLC:

- connected to the Ethernet network connection (LAN)

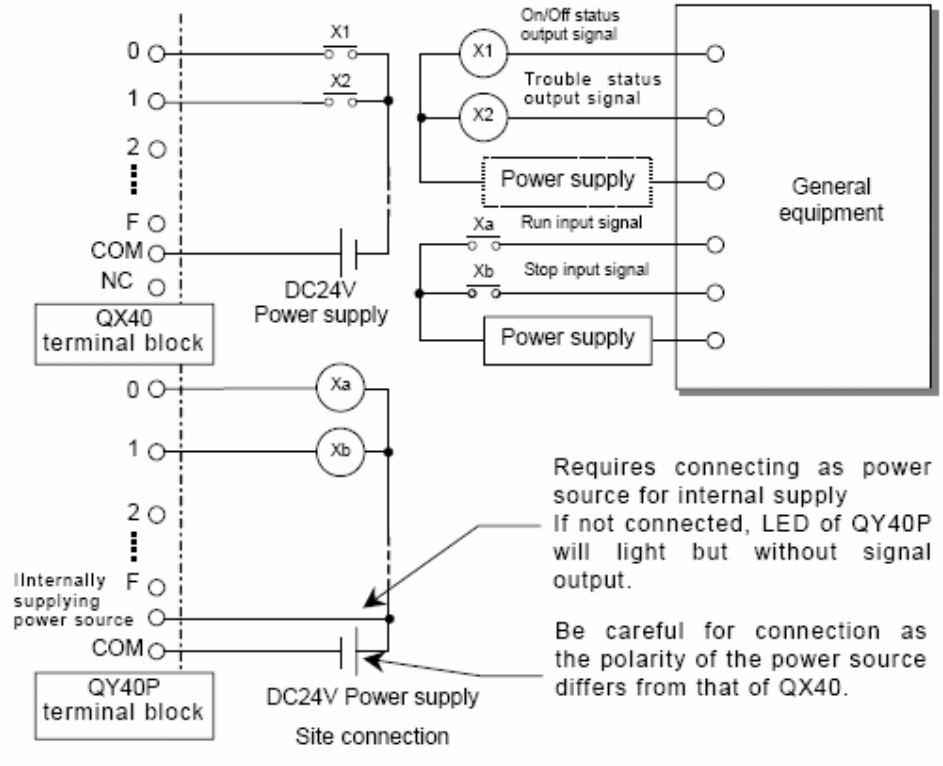
Input/Outputs:

- input: volt-free contact
- output: 12VDC

3.3. General equipment connection

Each general equipment requires:

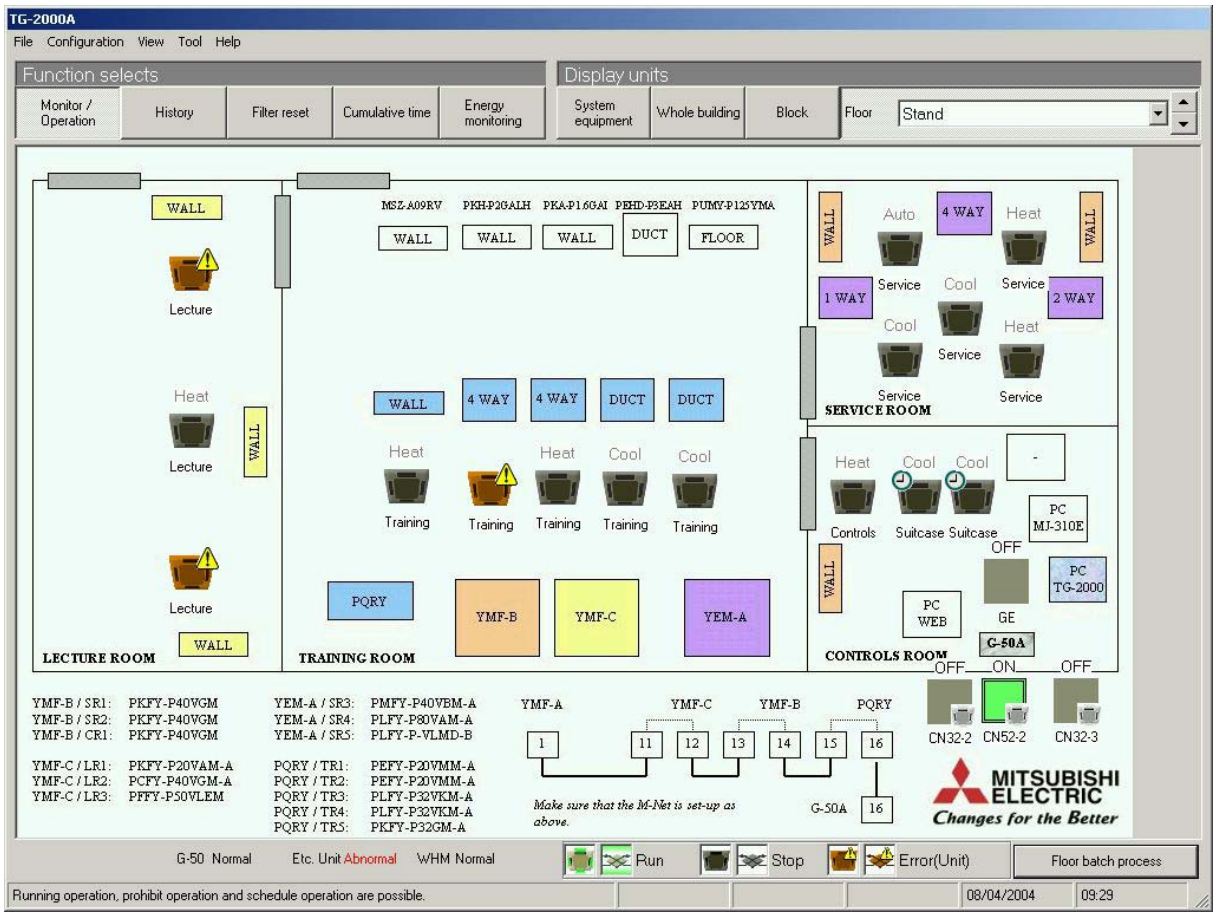
- one input for RUN
- one input for FAULTS
- one output for ON
- one output for OFF



Each input and output module will monitor and control up to 8 general equipment. Each PLC can control up to 4 input and output module which means 32 general equipment in total.

3.4. TG-2000A

TG-2000A is a software package that controls up to 40 G-50A i.e. 2000 indoor units.



General equipment may be controlled from TG-2000A. General equipment connected to the programmable logic controller may be controlled under schedules (today, weekly and annual).

TG-2000A can control up to 20 general equipment PLC and therefore 640 general equipment.

3.5. Interlocking

A software and hardware input can trigger up to 50 software and hardware outputs.

For example:

A software output could be: - TURN 'ON' UNIT 1 and UNIT 2
- SWITCH UNIT 1 mode to AUTO

A hardware output could be: - SWITCH digital output (CN52-2) 'ON'

Settings changeable via a software output are: On/Off, Mode, Fan speed, Setpoint (19ºC to 28ºC or 12ºC in Heating mode), Permit / Prohibit

3.6. Equipment list

Model	Details	Supplier
G-50A / GB-50A	Centralised controller	Mitsubishi Electric
PAC-SC50KUA	Power pack	Mitsubishi Electric
PLC-QSERIES-HSPD	Programmable logic controller high speed CPU	Mitsubishi Electric
PLC-IO-QX40-QY40	Input and output module for the PLC (general equipment)	Mitsubishi Electric
TG-2000A	Software package (CD)	Mitsubishi Electric
TG-2000A GRAPHICS	Graphical page (1 per 30 indoor units)	Mitsubishi Electric
TG-2000A PC	High specifications PC running Windows XP Pro	Mitsubishi Electric **(Note 1)**
Power supply	24VDC power supply	Others

Note 1: PC may be supplied by others. The minimum specification required is: PIII, 256 Mb of RAM running Windows XP SP2 Professional or Windows 2000 SP5 Professional.

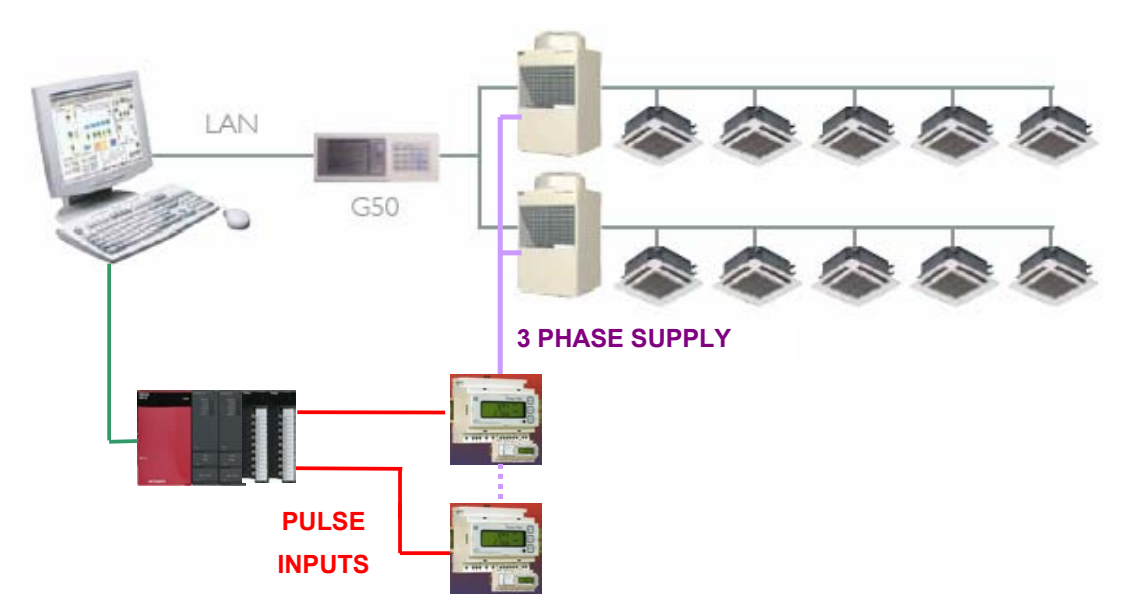
Note 2: 3/5 wire adaptor may be required to connect general equipment to the indoor unit.

4. PLC option 3 – Energy monitoring

4.1. Introduction

Pulses power meters can be installed to a group of outdoor units to monitor the energy consumption. Power meters are connected to TG-2000A via a PLC to provide individual billing. TG-2000A reads the total energy consumption from the PLC and distributes it across the indoor units using indoor unit factors. Indoor unit factors are dependent of the running time of the unit, the size of the unit and the load of the unit.

4.2. System Overview



G-50A:

- connected to the outdoor unit using TB7 (M-net) and the power pack PAC-SC50KUA
- connected to the Ethernet network connection (LAN)

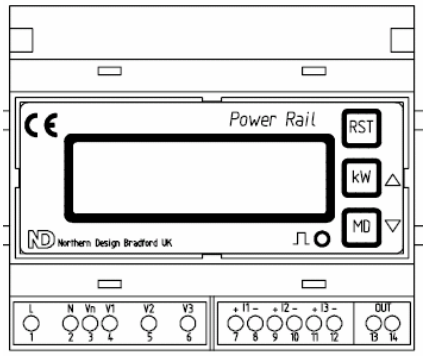
PR323:

- connected to the outdoor unit power supply using current clamps
- able to connect up to 5 outdoor units to one single meter
- connected to the PLC using 2 cores cable (pulse signal)

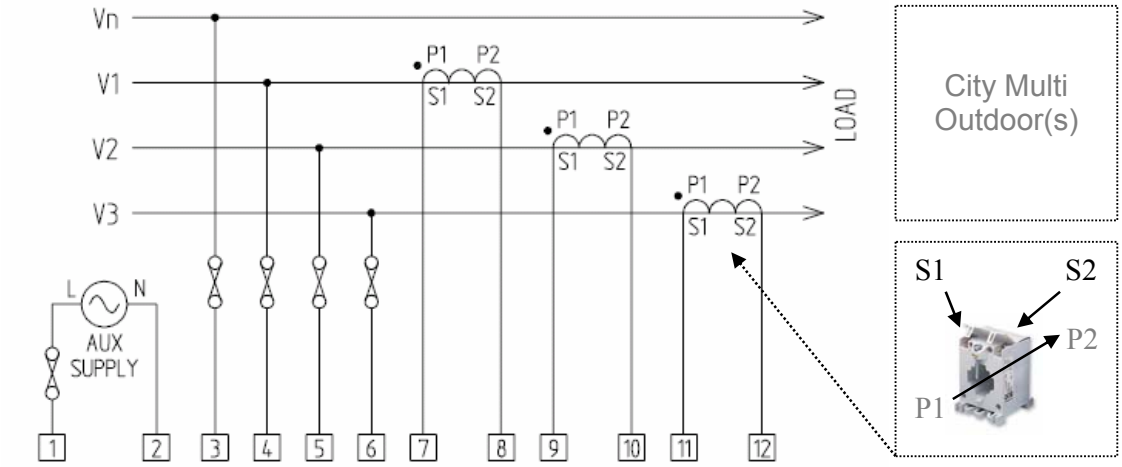
PLC:

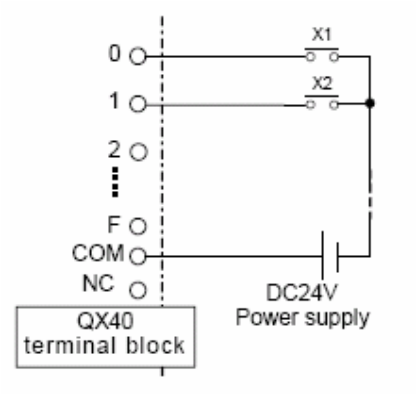
- connected to the Ethernet network connection (LAN)

4.3. Meters installation



Meters must be installed using current clamps.
Meters will be connected to the PLC via a 2-core cable (pulse signal). Each meter will use on input of the PLC.





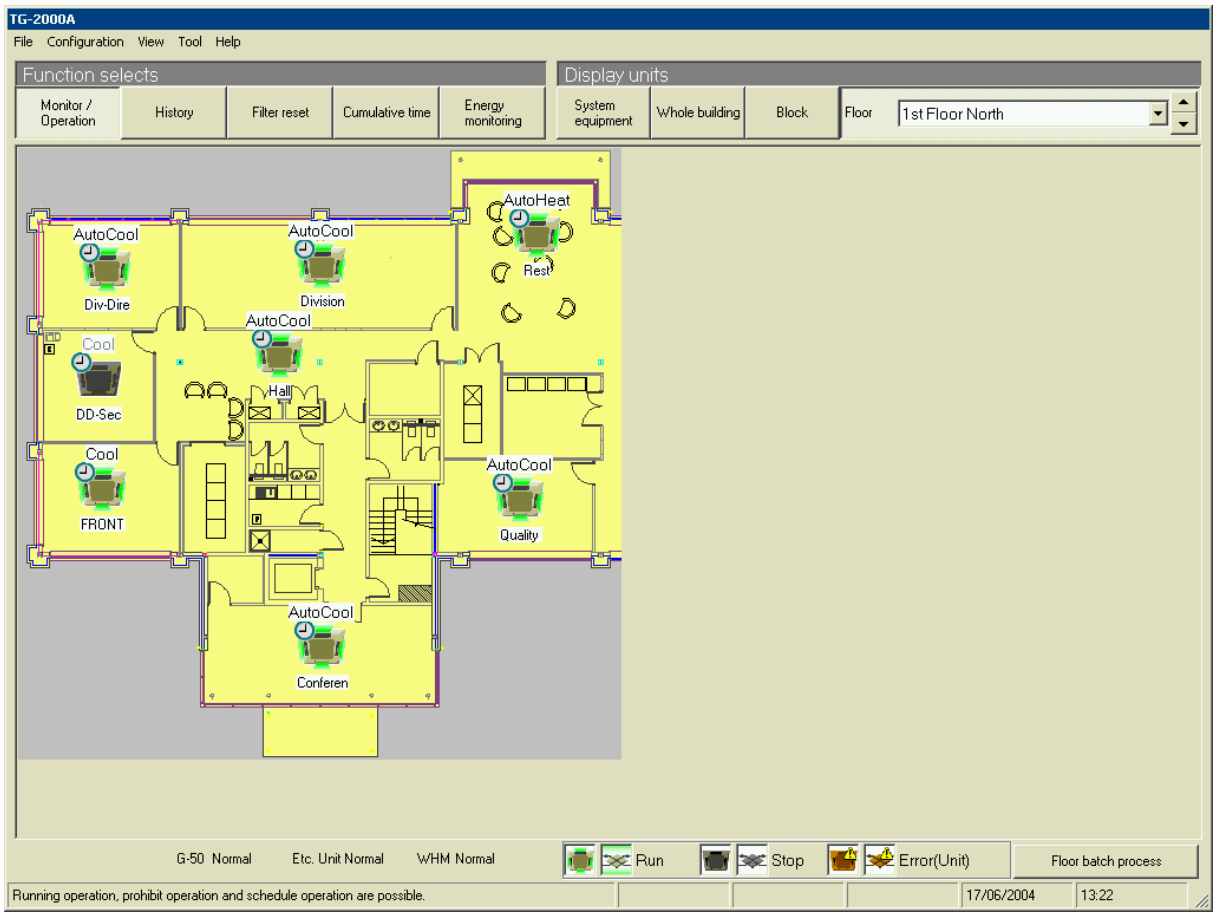
One input monitors one meter pulse signal.

Each QX40 input module includes 16 inputs and therefore can monitor up to 16 meters.

2 QX40 input modules may be connected.

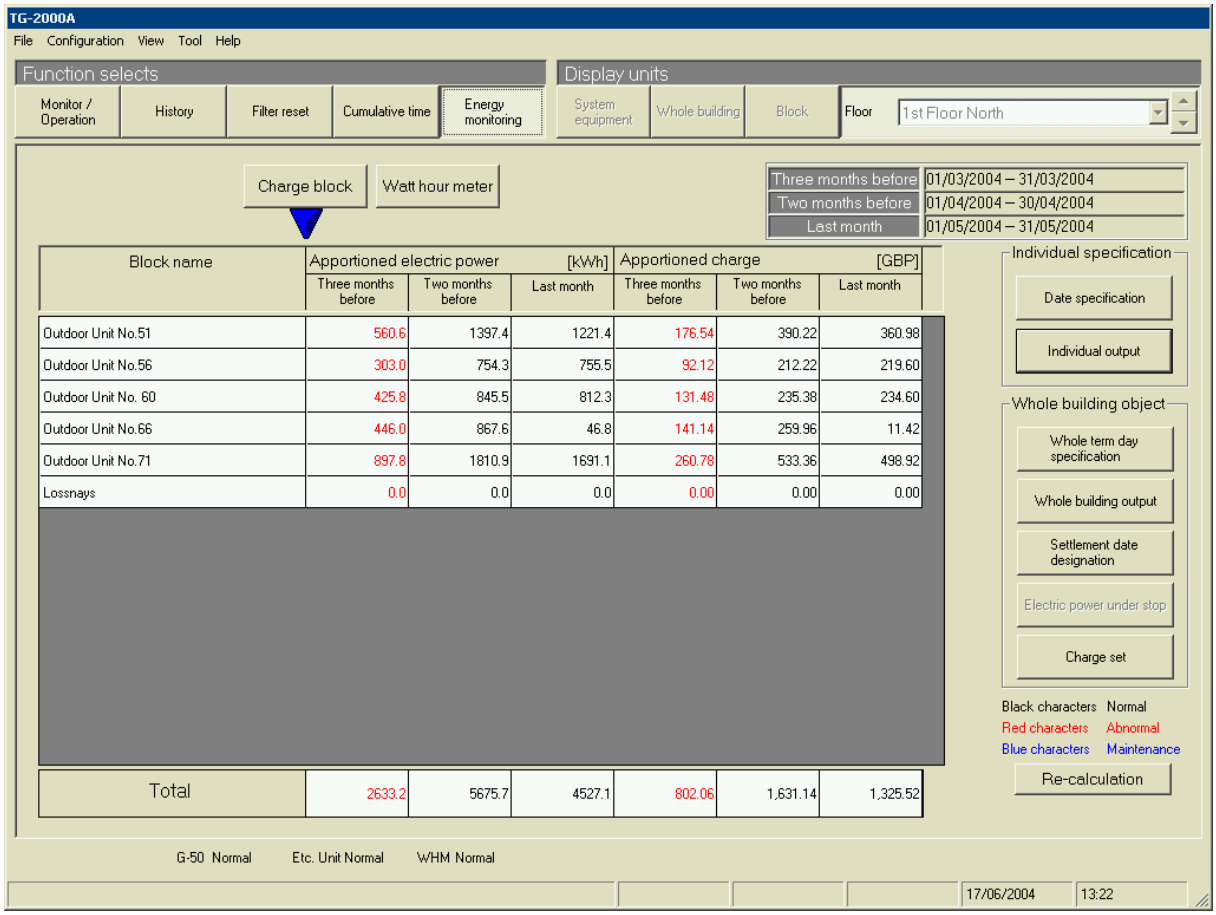
4.4. TG-2000A

TG-2000A is a software package that controls up to 40 G-50A i.e. 2000 indoor units.



TG-2000A can monitor up to 5 energy monitoring PLC and therefore 160 energy meters (16 INPUTS x 2 QX40 x 5 PLC).

To access the Energy Monitoring data, click on Energy Monitoring button.



Block will be displayed with the energy consumption in kW.

Block can be set-up for:

- single units
- group of indoor units
- outdoor units
- group of outdoor units

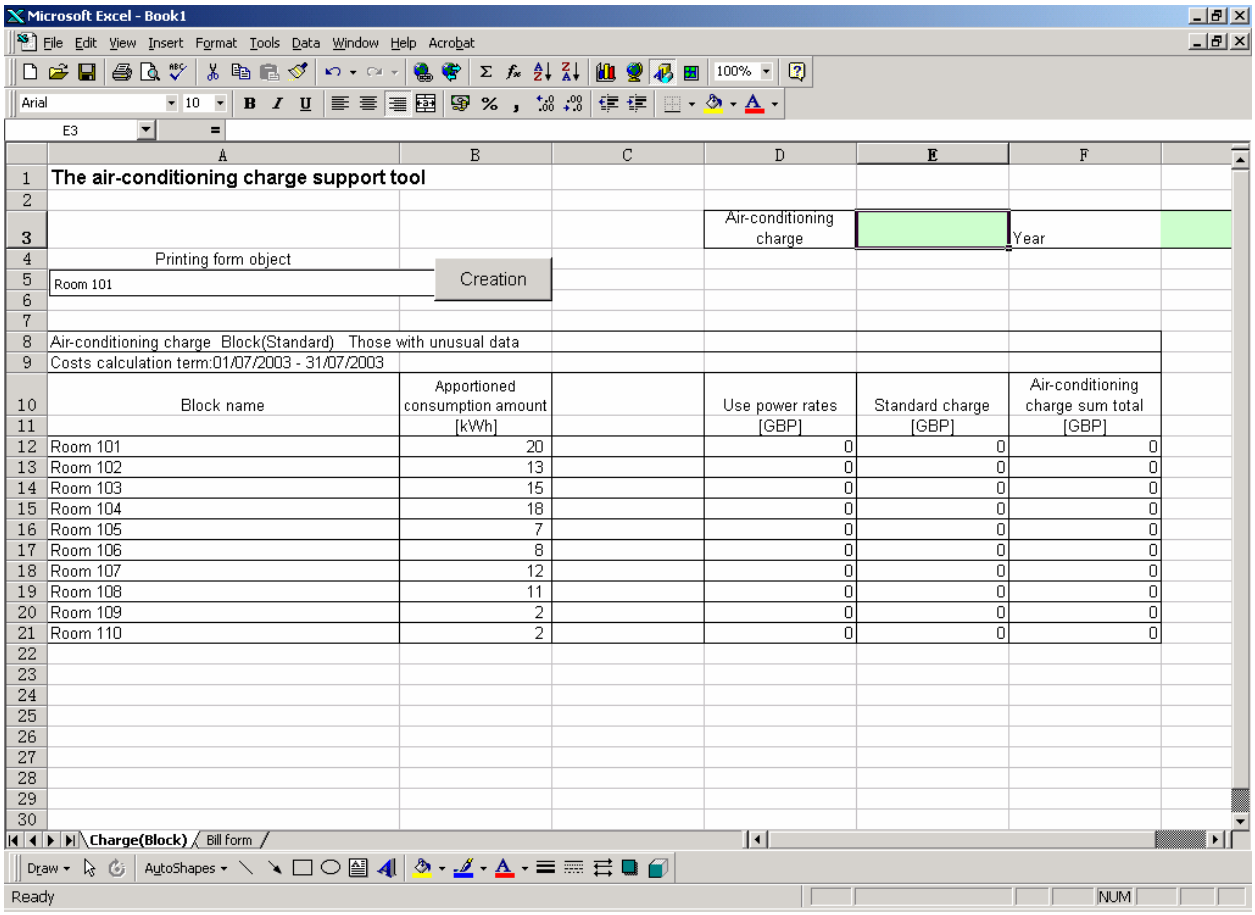
Data will be shown for the last 3 months.

TG-2000A must be running at all time to record the data. If TG-2000A has been switched off or if TG-2000A can not communicate with the power meters, the energy data will then be corrupted. Any corruption of the data will cause the data to be red (error).

The energy data can be exported to Microsoft Excel. A macro supplied with TG-2000A on Excel will be used to display the bill and the cost.

4.5. Bill layout

The macro will generate a standard bill.



4.6. Equipment list

Model	Details	Supplier
G-50A / GB-50A	Centralised controller	Mitsubishi Electric
PAC-SC50KUA	Power pack	Mitsubishi Electric
PLC-QSERIES-LSPD	Q series low speed PLC	Mitsubishi Electric
PLC-IO-QX40-QY40	Input and output module for the PLC (general equipment)	Mitsubishi Electric
G50-EC PIN Code	Software license activation	Mitsubishi Electric
TG-2000A	Software package (CD)	Mitsubishi Electric
TG-2000A GRAPHICS	Graphical page (1 per floor and per 30 indoor units)	Mitsubishi Electric
TG-2000A PC	High specifications PC running Windows XP Pro	Mitsubishi Electric **(Note 1)**
PR323	Powerrail 323 kW demand and kWh	Northern Design (Electronics) Ltd. 228 Bolton Road, Bradford West Yorkshire, BD3 0QW, England Telephone: 01274 729 533
Current Transformer	15 series moulded case current transformers (Hobut)	Northern Design (Electronics) Ltd. 228 Bolton Road, Bradford West Yorkshire, BD3 0QW, England Telephone: 01274 729 533
24 VDC power supply	24 VDC power supply. The PAC-SC50KUA cannot be used	Others

Note 1: PC may be supplied by others. The minimum specification required is: PIII, 256 Mb of RAM running Windows XP SP2 Professional or Windows 2000 SP5 Professional.

5. PLC option 4 – Load shedding

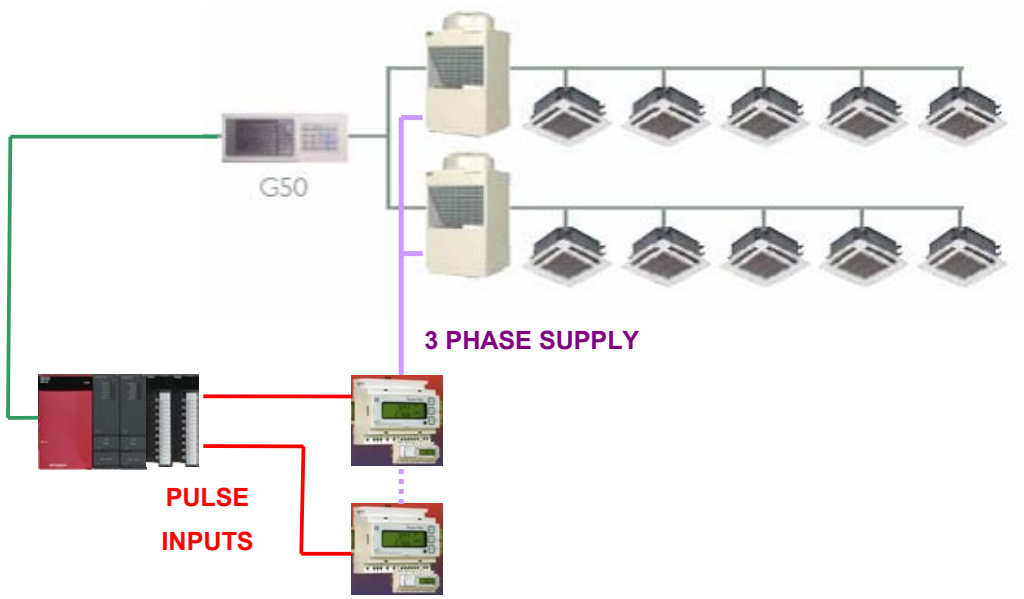
5.1. Introduction

The PLC with the use of G-50A(s) and power meter(s) can monitor the power and limit the maximum energy consumption.

The PLC will read the power consumption using power meter(s) and will reduce the consumption or / and turn off units, group of units or complete system according to the energy consumption limits set-up.

One PLC can control up to 5 G-50As.

5.2. System Overview



G-50A:

- connected to the outdoor unit using TB7 (M-net) and the power pack PAC-SC50KUA
- connected to the PLC using Ethernet connection (LAN)

PR323:

- connected to the outdoor unit power supply using current clamps
- able to connect up to 5 outdoor units to one single meter
- connected to the Programmable logic controller using pulses signal

PLC:

- connected to the G-50A using Ethernet connection (LAN)

5.3. G-50A and PLC

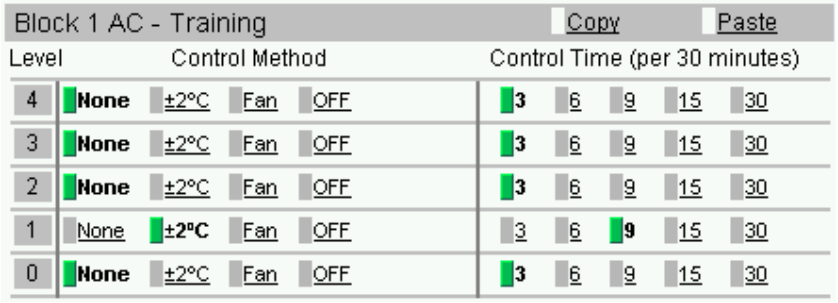
4 different energy consumption limits can be set-up. Some energy saving options can be assigned to each energy consumption limit.

For example:

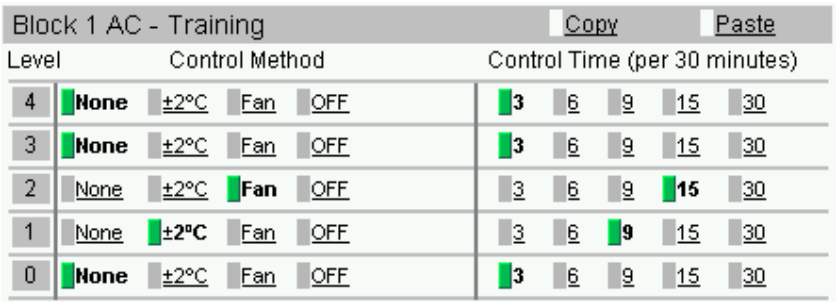
The limit of your building energy consumption is 100 kW.

Level 1: 70 kW **Level 2:** 80 kW **Level 3:** 90 kW **Level 4:** 100 kW

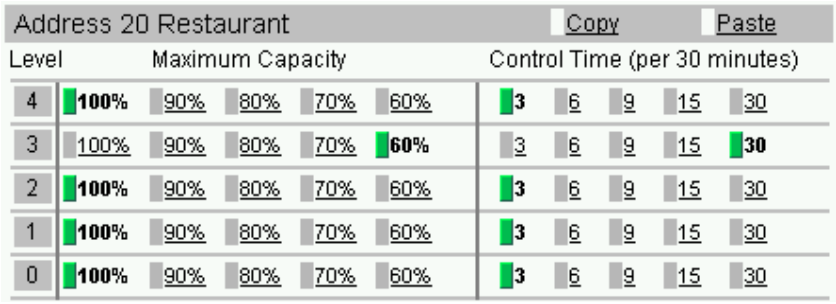
Level 1 (70 kW): Units would be set-up to lower up and down the setpoint by 2°C automatically 9 minutes every 30 minutes.



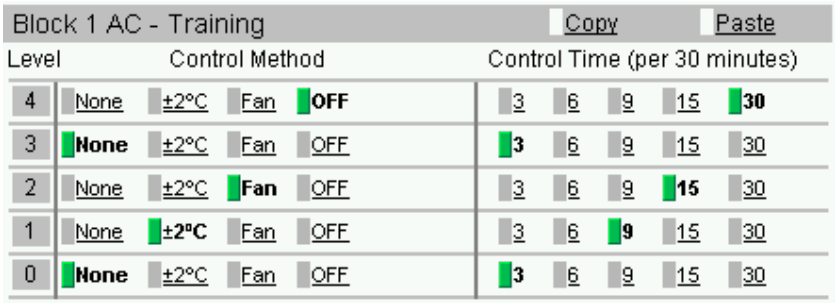
Level 2 (80 kW): Units would be set-up to “fan only” automatically 15 minutes every 30 minutes.



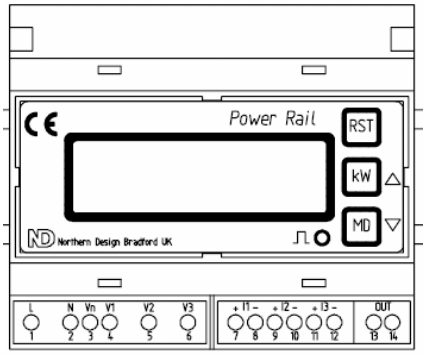
Level 3 (90 kW): Units would be set-up to go to Fan only mode automatically 10 minutes every 30 minutes. Also outdoor units capacity will be reduce to 60% automatically 15 minutes every 30 minutes (10HP becomes 6HP).



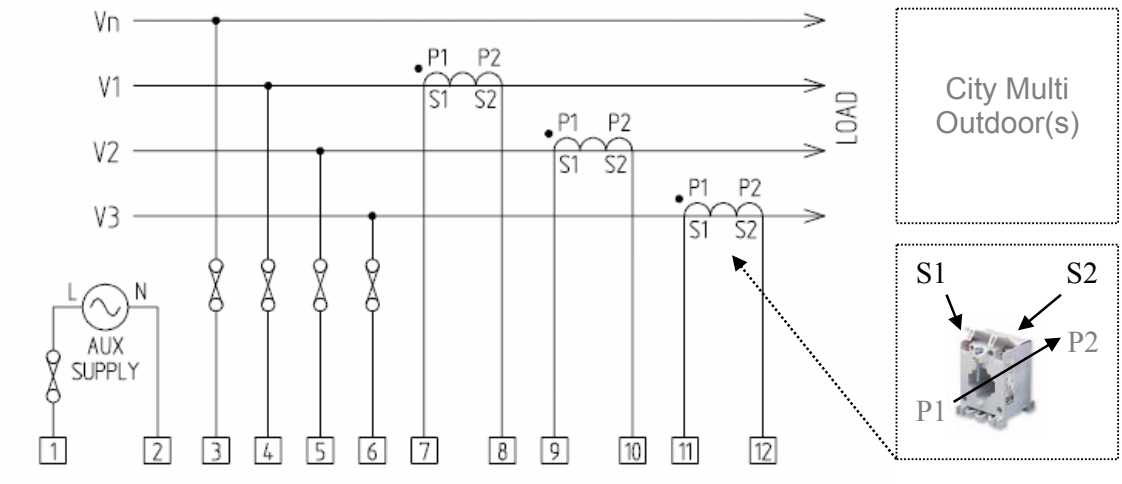
Level 4 (100 kW): Maximum limit reached. All units to be turned off.



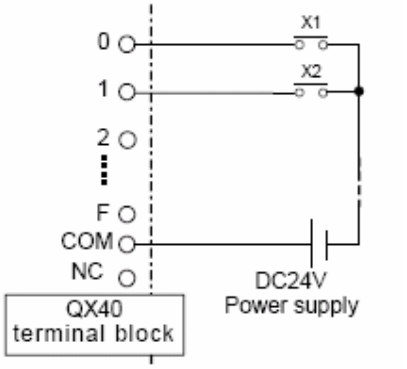
5.4. Meters installation



Meters must be installed using current clamps.



Meters will be connected to the PLC via a 2-core cable (pulse signal). Each meter will use on input of the PLC.

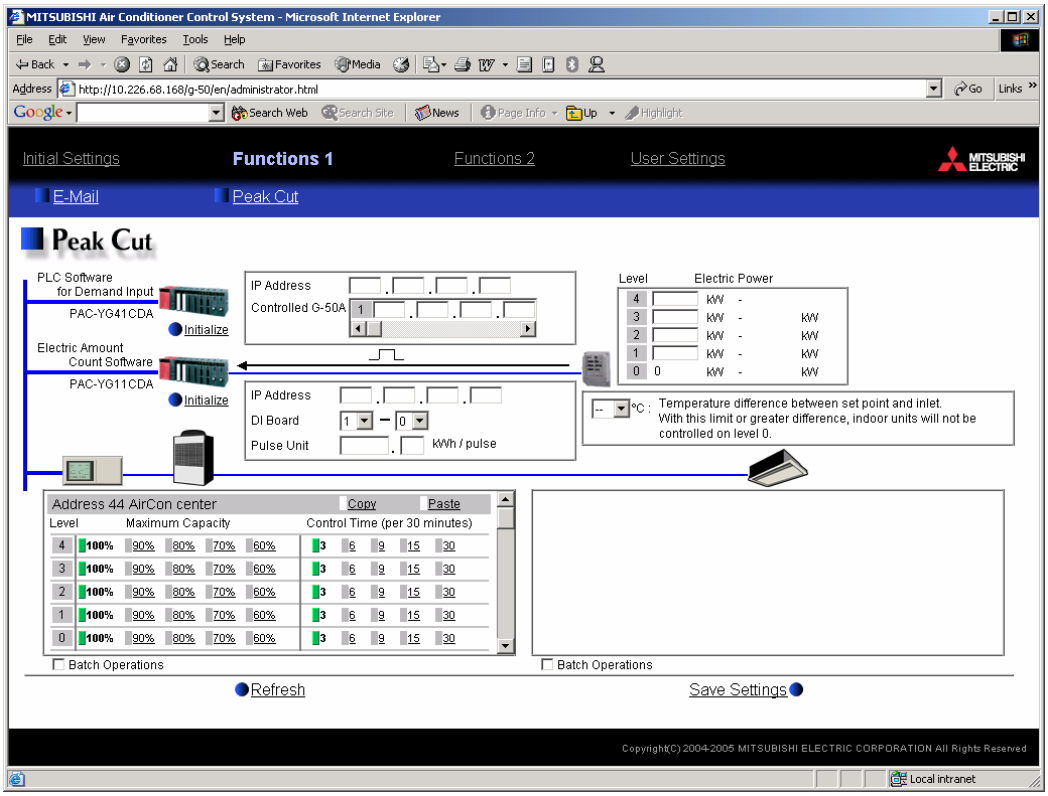


One input monitors one meter pulse signal.

Each QX40 input module includes 16 inputs and therefore can monitor up to 16 meters.

2 QX40 input modules may be connected.

5.5. G-50A set-up



5.6. Equipment list

Model	Details	Supplier
G-50A / GB-50A	Centralised controller	Mitsubishi Electric
PAC-SC50KUA	Power pack	Mitsubishi Electric
PLC-QSERIES-LSPD	Programmable logic controller	Mitsubishi Electric
PLC-IO-QX40-QY40	Input and output module for the PLC (general equipment)	Mitsubishi Electric
G50-PC PIN Code	Software license activation	Mitsubishi Electric
PR323	Powerrail 323 kW demand and kWh	Northern Design (Electronics) Ltd. 228 Bolton Road, Bradford West Yorkshire, BD3 0QW, England Telephone: 01274 729 533
Current Transformer	15 series moulded case current transformers (Hobut)	Northern Design (Electronics) Ltd.