Power Meter PM-2104-3 Specification and User Manual

1. Overview

Power Meter PM-2104-3 v6 is designed by Intech 21, Inc. for the purpose of accurate metering of electrical power, voltage, consumed active energy, and demand in a two- or three-phase power distribution system, particularly in apartment or commercial buildings. The Power Meter designed to meet the .5% accuracy class requirements in accordance with ANSI C12.1 & ANSI C12.20.

The PM2104-3 (PM) is a multifunctional device featuring configurable electrical energy meter, two configurable isolated input/output channels, a choice of temperature sensors, built-in radio communication interface, LCD display and three different color LED indicators. External extension boards provide additional functionality.

The PM can be configured to work with different types of Current Transformers. This feature allows to measure electrical currents in the wide range: from tens milliamperes to thousands of amperes, depending on application (e.g. apartment meter 100A, commercial space meter 800A and the building master meter 10.000A).

Each of two multipurpose I/O channels can be configured independently to perform one of the following functions:

Digital Output:

- Temperature Control Output: Thermostat Heater/Cooler, Day/Night Settings (Two Zone Thermostat). The Thermostat function can be disabled to allow Remote Direct Load Control.
- Curtailment Program:
  Programmable Load Curtailment or Direct Load Control outputs for Demand Management.
- Shunt trip breaker activation
- Pulse Output. A dry contact with programmable pulses/kWh rate.

Digital Input:

- Smoke Detector, Tamper Switch, Time duration counter.
- Pulse Counter inputs. Counts pulses from external standard Gas, Water, BTU and similar meters with dry-contact or active outputs.

Up to two external temperature sensors can be connected to the PM. Customer has a choice of daisy-chained wired sensors (up to 100ft), or attached wireless Intech21 sensors, or internal sensor, or their combination. The temperature sensors can be used for automatic Thermostat operations and/or supplying information to a Building Monitoring and Control System for more efficient heating/cooling control.

Extension Relay Board PM2104-3-RB has five relay outputs and provides a set of standard commercial thermostat configurations (e.g. fan control, two stages cooling, and two stages heating). The board needs 24VAC power. The board should be placed on the common line with the wired temperature sensors to be controlled by the Power Meter. Up to two dry-contact sensors can be connected to the board (push buttons, alarm detectors etc).

Embedded Radio Communication Device is configured as a Wireless Network Node, allowing the Power Meter to participate in the Intech21 Wireless Control Network.

The Wireless Control Network is designed to simplify deployment and reduce cost of installation of the Building Monitoring and Control System, which standard operation is to perform a variety of Data Acquisition and Control functions, e.g. Power Meter reading, Smoke Detector monitoring, Temperature Sensor reading, Electrical Heating/Cooling control, and operating the Electrical Power Load Control devices for power savings

etc. The system is WEB-enabled, with the purpose of easy user access via the Internet to the building's real-time data, to the information stored in the Central Database as well as to the Power Meter outputs.

As the Wireless Network has self-configuring self healing features with an intrinsic structural hierarchical organization, the network units do not require hardware preprogramming prior to or during installation and the units are easily interchangeable, which reduces the possibility of installation errors by personnel.

When the PM-2104 meter installed it's automatically registers itself, using the wireless mesh network, to the local Energy Management System provided by Intech 21, Inc.

The Energy Management System are WEB-enabled, with the purpose of easy user access via the Internet to the building's or individual apartment's real-time data as well as to the historical information stored in the Central Database. The user, the property manager will have secure access to the entire system. The individual tenants will have secure access to their apartments only.

The Wireless Network operates in 902-928MHz frequency band dedicated for non-licensed Industrial Scientific Medical (ISM) applications in the USA. Versions for other frequency bands are also available.

The Power Meter's LCD display shows measured real-time data and capable of displaying text messages provided by the System, e.g. billing information to the tenants. The LCD backlight can be turned on/off remotely to attract attention to a new message.

Green, Yellow, and Red LED annunciators on the PM's front panel are remotely controlled. Each of the LEDs can be independently set to Off, Steady On, or Blinking state. This feature can be used to announce special conditions (e.g. the cost of electricity at the moment (TOU): high [red], medium [yellow] and green [low]).

Fig 1. PM-2104-3 v6. Front view. Surface mount version.

Fig 1.1. PM-2104-3 v6. Front view. Flush mount version.

2. Specifications

Power Meter Type (Configurable)	Solid-State Meter with External Current Transformers: • Three-Phase Four Wire, Three-Element meter • Two-Phase Three Wire, Two-Element meter
Baseline Standards and Approvals	ANSI C12.1, ANSI C12.16, ANSI C12.20, UL3111-1, UL 61010-1 release 3, CSA22.2 No. 1010-1, UL Listed Power Meter 36NB; FCC part 15, class B.
Voltage and Frequency Rating	120 V, 60 Hz
Test Current for Base Configuration	15 A RMS
Voltage Input Configurations	• Three-phase, 4-wire: Line A, Line B, Line C and Neutral • Two-phase, 3-wire: Line A, Line B and Neutral
Voltage Input	120 V RMS +30%, -50% Connection type: 20AWG to 16AWG wires, color coded
Transient Overvoltages	According to ANSI standard INSTALLATION CATEGORIES II
Current Inputs (Configurable)	• 100 A RMS max per element. External Current Transformers, choice of 2000:1 or 1000:1 • 200 A RMS to 10.000 A RMS. External Standard Current Transformers 5A secondary. Intech21 CT interface board PM2104-3TB must be used. Connection: two wires per phase, color coded
Load Power Factor	-0.5 to +0.5

Measured Parameters	• Accumulated Active Energy in the range from: 000000.000 kWh to 999999.999 kWh for 100A configuration 00000000.0 kWh to 99,999,999.9 kWh for 200A and higher • Lines A,B(C) Voltage in the range from 0 V RMS to 255 V RMS • Lines A,B(C) Active Power in the range from 0 W to 2000 kW • Temperatures in the range: 13°F to 185°F (-10°C to +85°C). Accuracy: ±0.5°F (±0.25°C)
Energy Measurement Accuracy	<0.2% at Test Current (Active Load), other Loads in accordance with ANSI C12.1 & C12.20
Internal Temperature Sensor	Digital. Accuracy ±0.5°F.
External Wired Temperature Sensors	Up to two Digital Sensors on common 2-wire bus. Wire length up to 100 ft. Accuracy ±0.5°F. Connection: two wires, color coded
External Wireless Sensors	Up to two Intech21 Wireless Temperature Sensors TS2100 (powered from 120VAC mains) and/or TS2100B (battery powered). Must be logically attached to the particular PM. Provides temperature data directly to the PM regardless the Wireless Network presence and state.
Extension Relay Board PM2104-3-RB	• Five relay outputs 5A 250VAC • Two dry-contact inputs • Digital communications interface compatible with the 2-wire bus of the External Wired Temperature Sensors • Standard Commercial Thermostat contacts: G, Y1, Y2, W1, W2, R, C • Status LEDs • 24VAC powered
Data Retention	During a Power Outage the Measured Energy and Settings are stored in EEPROM
Power Consumption	< 0.6W (<0.9VA)
Display	LCD alphanumeric display 16x2 characters with optional remotely controlled backlight. Displays Measured Parameters, status information and text messages.
LED Annunciators	Red, Yellow, and Green LEDs on the PM's front panel. Independently remote-controlled. States: On, Off, Blink.
Wireless Interface	Built-In Wireless Network Communication Device. ISM License-Free Frequency Band: 902 MHz - 928 MHz This device contains transmitter module with FCC ID: P8A-I21RU4. RF Transmitted Power: <0dBm
Control Channels' Outputs (Configurable)	Two normally opened solid state relays (dry contacts equivalent). Rating 300V, 40mA. Connection: two wires, color-coded
Control Channels' Pulse Counter Inputs (Configurable)	Two optically isolated inputs. ON voltage: 5VDC to 26VDC Connection: two wires, color-coded
Isolated General Purpose Power Supply	10VDC, 40mA. Can be used e.g. for the Pulse Inputs powering.
Size	5 x 5.7 x 1.4 inches
Weight	< 10 oz

Environmental Conditions	• Indoors use. • Placement: Power Distribution Panel, Wall-Mount, Flush-Mount • Temperature Range: 0°C to +50°C • Altitude up to 2000m • Maximum relative humidity 95% for temperatures up to 31°C decreasing linearly to 50% relative humidity at 40°C • POLLUTION DEGREE 2 in accordance with IEC664

3. PM2104-3 Installation

The Power Meter can be installed inside a power distribution panel or wall-mounted by a qualified technician. After being energized the Power Meter needs no maintenance. Following examples illustrate installation steps for the most common PM configurations. Make sure the Power Meter works properly after installation (see Intech21 Document "PM2104-3 v6 Installation Mistakes").

3.1 Two-phase installation (100A configuration)

1. Switch off all circuit breakers in the panel.
2. Put on the external current transformers (CTA and CTB on Fig 2) on the power line cables.
3. Remove the lid of the Power Meter's junction compartment.
4. Pull the Current Transformers' and three AWG18 wires (White, Black, Blue) through the 1/2" conduit. Insert and secure fitting of the conduit in the backside opening of the PM's junction compartment.
5. Secure the Power Meter using the mounting holes located inside the junction compartment.
6. Connect the current transformer wires (twisted pairs) to the appropriate current sensor wires of the Power Meter: AWG18 black-white pair for CTA, AWG18 orange-blue pair for CTB.
7. Connect White, Black, Blue wires to the corresponding Power Meter's voltage input wires.
8. Put the wires inside the junction compartment and cover it with the lid.
9. Connect wires in the panel: White to Neutral, Black to the Line A voltage through the 3A in-line fuse, Blue to the Line B voltage through the 2A in-line fuse.
10. Turn on the circuit breakers.

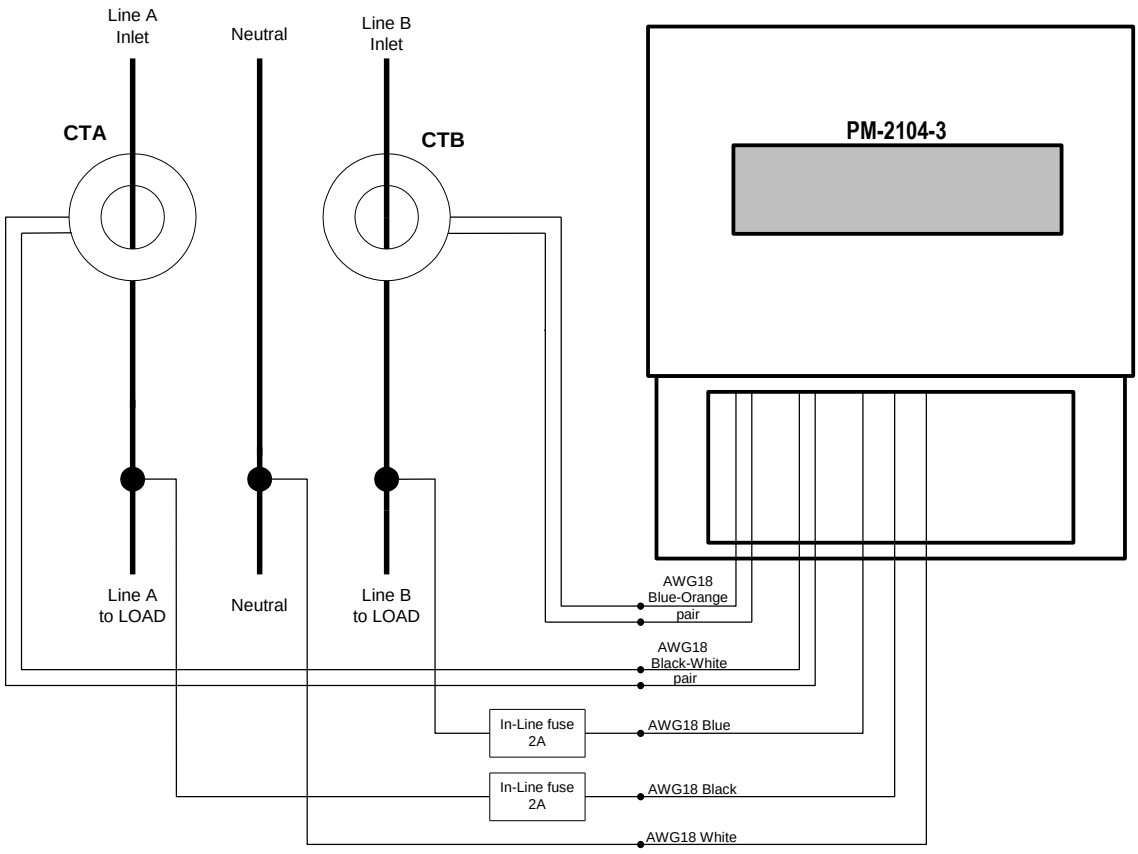

Fig 2. PM-2104-3 Two-phase Connection Diagram.

Solid-core CTA and CTB 2000:1 or 1000:1

3.2 Three-phase installation (5A split-core CTs)

1. Installation can be made on live power lines.
2. Connect the Power Meter wires to the Terminal Board.
3. Connect the Current Transformers' wires (twisted pairs) to the appropriate terminals of the Terminal Board.
4. Install and lock split core CTs on the corresponding power lines (bus bars).
5. Connect to the appropriate terminals of the Terminal Board the Neutral wire first, then Line A and Line B voltage wires through the 2A in-line fuses.

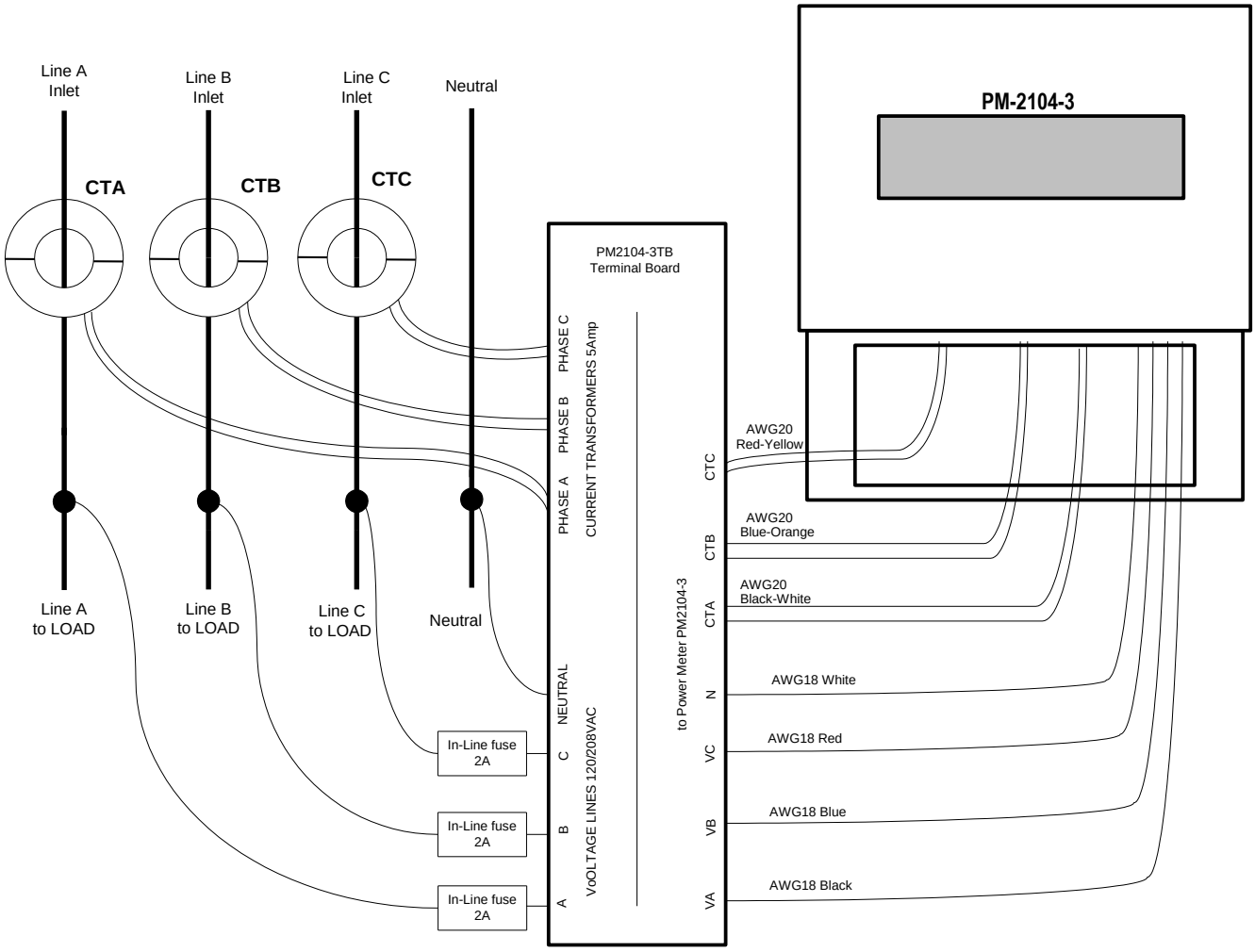

Fig 3. PM-2104-3 Three-phase Connection Diagram.
Split-core CTA, CTB, CTC 200:5 and higher ratios

3.3 Temperature Control
Internal Relays

In this example both Channels are configured for the Temperature Control of the electrically heated two-zone space. Two Wired Temperature Sensors are connected to the PM (Fig 4). Intech21 Wireless Temperature Sensor(s) could be used instead of one or both wired sensors. To close temperature control loop the channels should be set to Thermostat Heating control mode.

For a simple single zone installations the system can do without the external Temperature Sensors - an internal PM temperature sensor can be used as well.

Solid-State Relay type selection is based on heaters' power rating. More than one SSR relay may be installed and controlled by a channel if a zone has more than one heater and total heaters' power exceeds relay's maximum controlled current. In this case the control circuits of all zone's relays must be connected in parallel.

In this example an external Power Supply is used to power SS relays' control circuits. If total control current for all turned on SS relays is no more than 40mA, then internal DC power supply of the PM can be put to use.

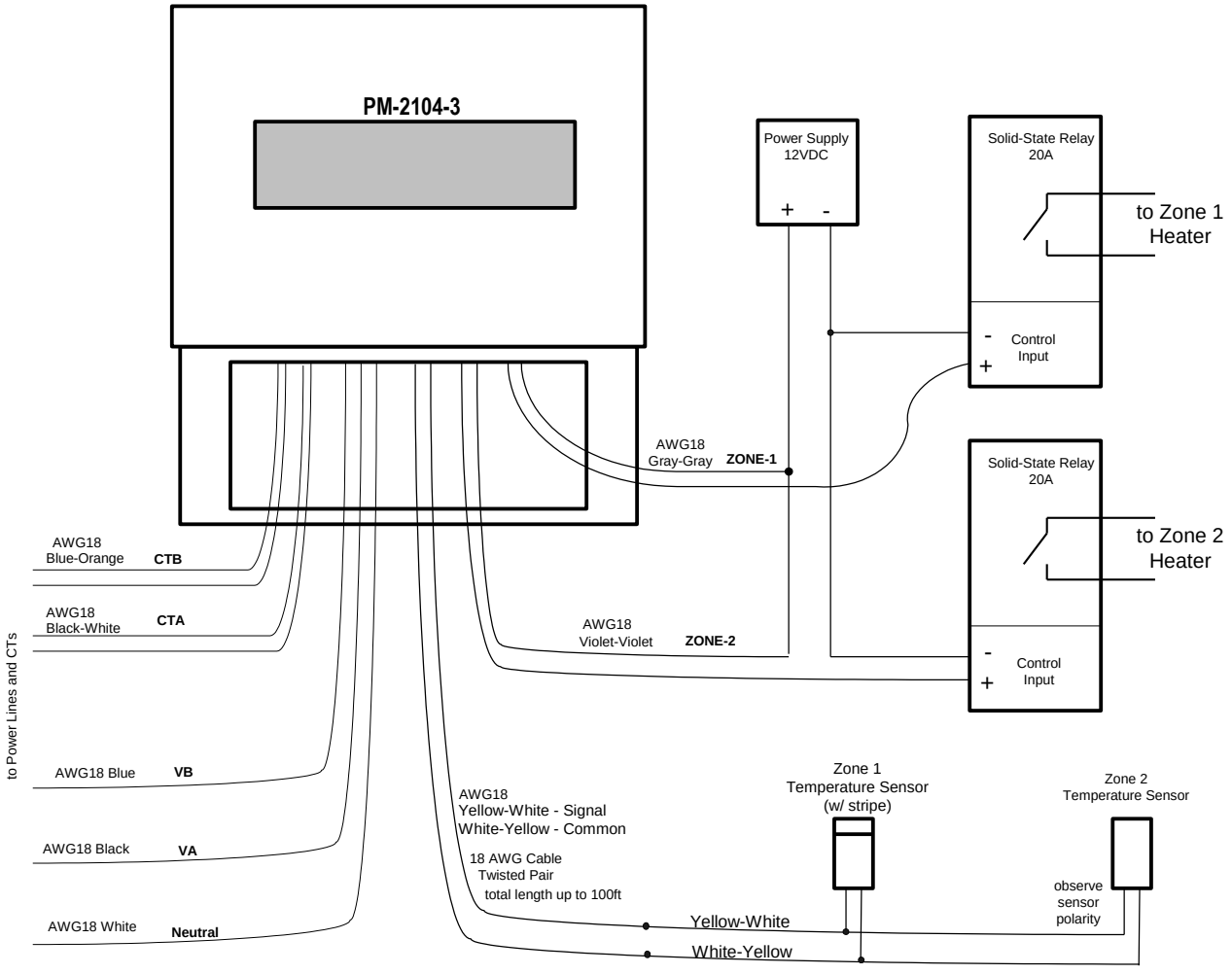

Fig 4. PM-2104-3 Electrical Heating Control application.

- Two zones, solid-state relays, external power supply, two wired sensors

3.4 Temperature control
Extension board

In this example the Extension Relay Board PM2104-3-RB is used to control two-stage heat and two-stage cool heat pump system. Two Wired Temperature Sensors are connected to the PM (Fig 5). Intech21 Wireless Temperature Sensor(s) could be used instead of one or both wired sensors. One sensor can be used for the ambient temperature measurements, while the other for other purposes (like air intake temperature etc.)

The board and the system relays are powered from an external 24VAC transformer. The board shares its communication interface with the external temperature sensors.

Two dry-contact alarm sensors are connected to the board.

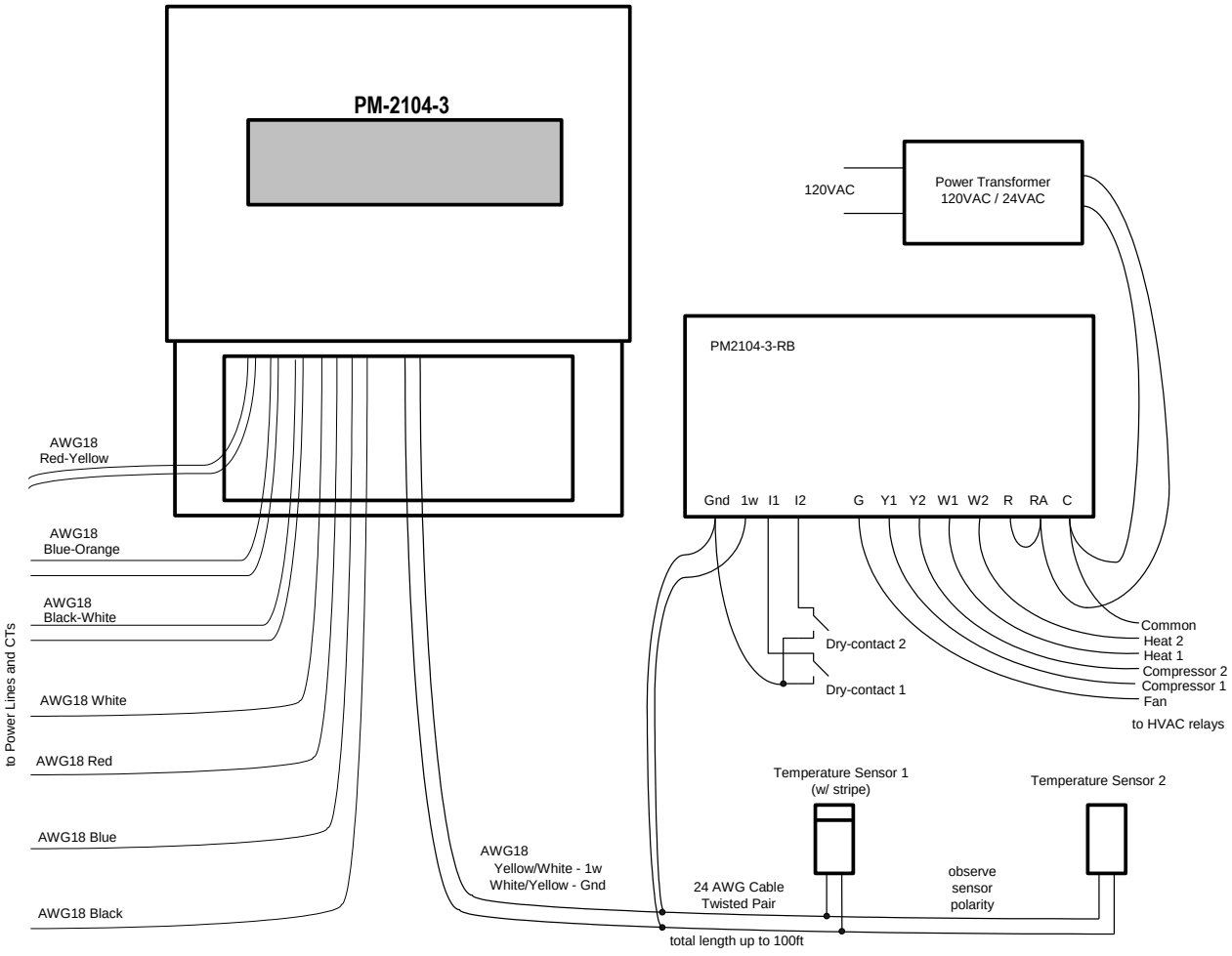

Fig 5. PM-2104-3 controls two-stage heat and two-stage cool heat pump system.
external Relay Board, single power transformer, two wired sensors, two dry-contact alarms

3.5 Pulse Counter

Both Channels are configured as Pulse Counters to count pulses from Gas (Channel 1) and Water (Channel 2) meters equipped with isolated dry contact outputs (Fig 5). A counter increments on every change of contact state: from closed to open as well as from open to closed.

In this example an internal PM DC Power Supply is used to bias optically isolated PM inputs. An external Power Supply can be used after proper PM inputs hardware reconfiguring as well.

The PM can be configured also to count voltage pulses from active sources capable of 5-24V/10mA output.

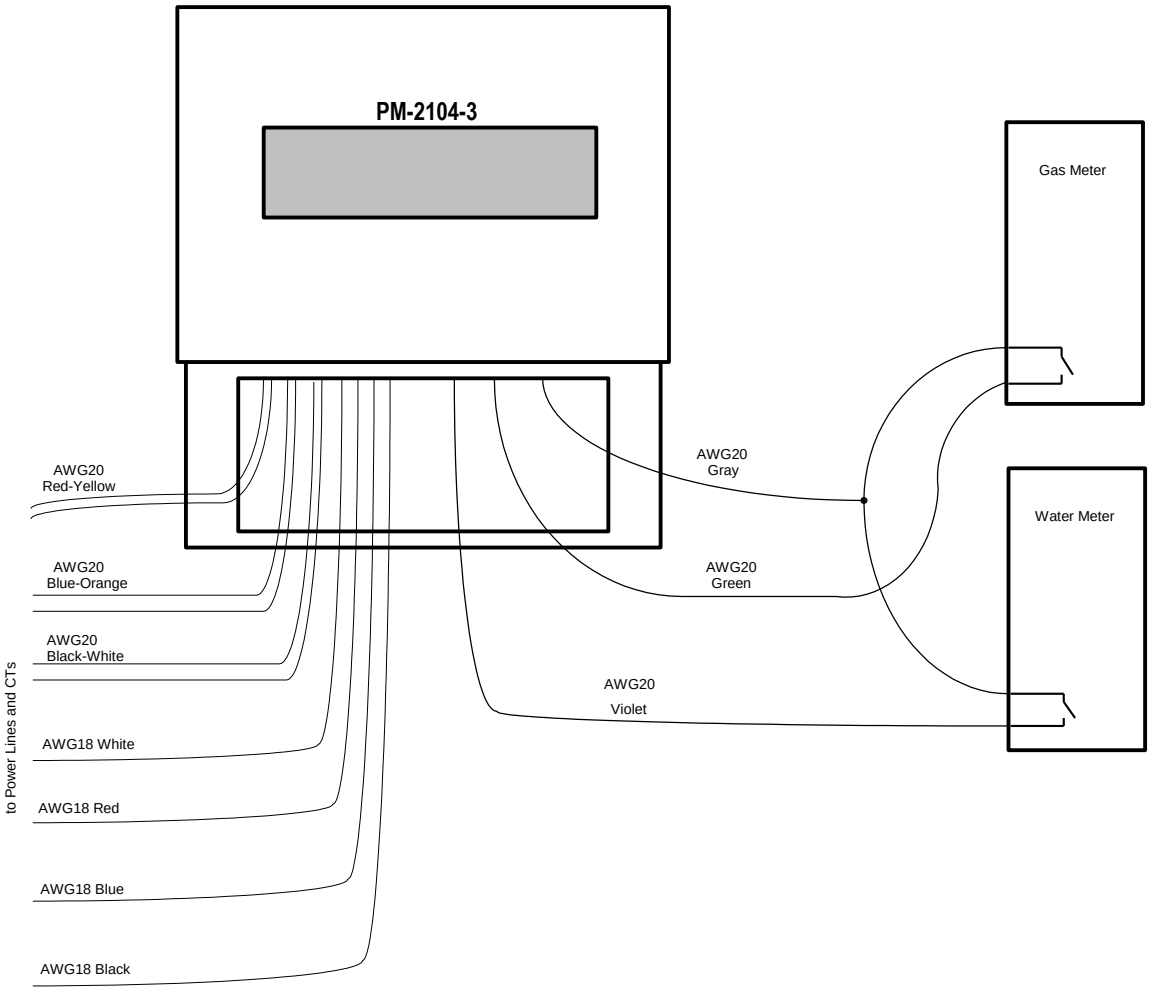

Fig 6. PM-2104-3 Pulse Counter application.
Two internally DC biased inputs for dry-contacts

4. LCD Display Data Representation

Power Meter's two-line LCD Display shows various data depending on the current PM configuration and status of the device.

4.1 Upper Line

- Power Meter model and Company name. Shown once on power-up.

```
PM-2104 Intech21
```

- Current Inputs Configuration. Shown once on power-up.

  Example1: Two-phase meter, 2000:1 CT, Internal burden resistor.

```
2Φ 2000:1  Rint
```

  Example2: Three-phase meter, 800:5 CT, External burden resistor 50 milliohms (standard value for the PM2104-3TB board).

```
3Φ 800:5   R50
```

- Channel 1 and 2 Configuration. Shown once on power-up.

  Example1: Channel 1 - Temperature Control, Channel 2 - Not Used.

```
Ch1:TC Ch2:NA
```

  Example2: Channel 1 - Pulse Input, Channel 2 - Temperature Control.

```
Ch1:PI Ch2:TC
```

Channel Configuration Codes

Code	Channel Configuration
NA	Channel Not Used
TC	Channel configured for Temperature Control
PI	Pulse Counter Input
PO	Pulse Output

- Voltage, active power, and power factor for the phase A.

  Example:

```
A123V 1.23kW .93
```

- Voltage, active power, and power factor for the phase B.

  Example: There's no consumption on phase B, and the Power Factor is not calculated.

```
B121V 0W
```

- Voltage, active power, and power factor for the phase C (if PM configured as 3-phase meter).

  Example:

```
C122V 22.1kW .88
```

- Power Meter Communication ID and Communication Status Code:

  Example:

```
ID:0279/0117 OK
```

Communication Status Codes

Communication Status	Description
OK	This Network Node is registered in the Network. The Power Meter is communicating with the System.
NC	No Communication to the Network, e.g. because of the Network Access Point is off, or due to the radio interference or propagation problems.
NL	Internal Communications Fault. If this code shows up persistently then the device must be replaced.
WD	The Power Meter receives incomprehensible or corrupted data from the Network. Check data communication path.

- A text message(s) may be displayed in the upper line of display when the Building Monitoring and Control System switch PM to the Text Messages Display Mode. The displayed message may consist of up to 16 lines of 16 characters text showing up line by line every second. Then a breaking empty line follows and message displaying cycle repeats.

4.2 Lower Line

- PM Serial Number and firmware version. This line is displayed during first 15 minutes after powering-up. It can be turned on again for another 15 minutes remotely.

  Example:

```
s/n 1573-7C59 6.1
```

- Accumulated Active Energy in kWh

  Example: PM with 100A CT scale

```
000021.684 kWh
```

  Example: PM with 200A and more CT scale

```
00,022,568.3 kWh
```

- I/O channel is configured for Temperature Control.

Example1: Channel2 in **D**irect **L**oad **C**ontrol mode. Relay contacts Closed by remote command. Temperature 76.0°F

```
2 DLC  ⊙ t°=76.0
```

Example2: Channel1 in Thermostat mode, **H**eater control, **D**aytime mode, Setpoint 72°F. Relay contacts Opened (Heater is off). Temperature 74.5°F

```
1HD:72 ✕ t°=74.5
```

Example3: Channel1 in Thermostat mode, **C**ooler control, **N**ighttime mode, Setpoint 70°F. Relay contacts Closed (AC is running). Temperature 77.0°F

```
1CN:70 ⊙ t°=77.0
```

- I/O channel is configured as Pulse Counter.

  Example1: Channel1 is a Pulse Counter.

```
Ctr1: 0000004234
```

- When neither Channel1 nor Channel2 are configured for Temperature Control, and at least one external temperature sensor is connected, then the Lower Line displays current temperature and the Temperature Sensor code. The PM automatically selects one of the present external Temperature Sensors with higher code value:

External Sensor Type	Sensor Code
Wireless Sensor (1 Channel)	7
Server Provided Temperature (1 Channel)	6
Wired Digital Sensor (1 Channel)	5
Wireless Sensor (2 Channel)	4
Server Provided Temperature (2 Channel)	3
Wired Digital Sensor (2 Channel)	2

  Example: Current temperature is 77.0ºF from external wired digital sensor

```
t°=77.0°F   S:5
```

- At the moment when the Power Meter is turned off, the lower line displays "Power Off" for a short period of time. It indicates that current values of the counters and status data are stored in the Power Meter's non-volatile memory. If this message doesn't show up, then the PM needs to be replaced.

```
Power Off
```

5. Technical Support

For technical support please contact Intech 21, Inc. When requesting technical support for the PM-2104-3 please provide following information:

- Power Meter Serial Number and Communication ID.
- Meter's configuration.
- Type of the Current Transformers used.