Specifications

Power Supply

Model Option	Power Voltage	Usage	OVP Category
24U	24 VAC/VDC (+/-10%) 50/60 Hz AC power	180 mA	II
120	120 VAC (+/-10%) 50/60 Hz	50 mA	II
240	240 VAC (+/-10%) 50/60 Hz	25 mA	II

Current Input	RC Type Rogowski Coils
Coils Aperture	RC1 - 0-500 A, 4.5” (11.5 cm) ID 2 meter (80 in) long leads RC2 - 0-2000 A, 4.5” (11.5 cm) ID 2 meter (80 in) long leads
Voltage Input	347/600 VAC 3-Phase Wye system with earthed neutral max 600 VAC 3-Phase Delta Measurement Category III (either wye or delta)
Output	Modbus RTU (RS485) KWH pulse contact, 40 mA 50 VDC max
Accuracy	< 1% (10-100% of range)
Linearity	< 0.5%
Response Time	120 mS
Isolation Voltage	UL listed to 5400 VAC
Frequency Range	50 or 60 Hz auto select
Enclosure	UL94 V-0 Rated
Operating Temp	14-122°F (-10 to +50°C)
Environmental	0–95% RH Non-condensing Altitude to 2000 meters (6561 ft) Pollution Degree 2 Indoor use
EMC/Immunity	EN50081-1, EN50082-2
Listings	UL/cUL

Model Number Key

APN - 600 - RC1 - 120 - MOD

OUTPUT TYPE:
MOD - Modbus RTU (RS485)

POWER SUPPLY:
24U - 24VAC/VDC
120 - 120VAC
240 - 240VAC

CURRENT INPUT:
RC1 - Rogowski Coils 0-500 A
RC2 - Rogowski Coils 0-2000 A

VOLTAGE INPUT RANGE:
600 - Line voltage 0 - 600 VAC

POWER MONITOR TYPE:
APN - AC Power Monitor, Digital Output

Know Your Power

Other NK Technologies Products Include:
AC & DC Current Transducers
AC & DC Current Operated Switches
1ϕ & 3ϕ Power Transducers
Current & Potential Transformers (CTs & PTs)

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NK Technologies

INSTRUCTIONS

APN SERIES

AC Power Monitor
RC Type Current Sensors
Modbus RTU Output

Quick “How To” Guide

1. Current sensing coils are matched with monitor.
2. Mount the monitor to a DIN rail using integrated mounting clips on backside of power monitor.
3. Connect non-energized 3 phase input voltage (terminals 2-4, neutral 1 if used) using 22-12 AWG copper conductors rated 75°C minimum. 1 amp fuses are recommended. All terminals to be tightened to 6 inch-pounds torque.
4. Connect Current Coil (RC) Inputs (terminals 5-10). The white wire from a coil is positive or phase indicator (6-8-10). Be certain the RC coil label faces the source power.
5. Select baud rate, network address.
6. Connect network output (terminals 11-13).
7. Connect power supply (terminals 16-17).
8. Connect kWH pulse output if needed (terminals 4-15).
9. Energize the monitor and primary circuit.

791000007 Rev 8

Description

APN Series Power Monitors are designed to monitor AC loads and provide data points displaying line voltage, current, instantaneous wattage, accumulated watt-hours and power factor. The APN is available with a Modbus RTU (RS485) output as standard, and also provides a configurable pulsed contact representing accumulated watt hours.

Installation

APN Power Monitors feature a 35 mm wide DIN rail compatible housing. It should be installed in a UL listed fire/electrical enclosure certified under NRTL, or similar.

If the equipment is used in a manner not specified by Neilsen-Kuljian, Inc., the protection provided by the equipment may be impaired.

To mount on DIN rail: Orient transducer so that line voltage terminals (1) neutral if used, (2) phase C, (3) phase B and (4) phase A are upright/at the top of unit and snap securely onto DIN rail.

To remove, press upward on the tabs on the monitor underside, on the left and right corners.

De-energize the monitored circuit. It is **not recommended** to install the current sensors over an energized conductor. If unavoidable, adopt safe operating procedures when working on hazardous live installation during application and removal to the current sensors. Identify the monitored circuit phases as A, B and C, in no particular order. Connect the primary voltage using 22-12 AWG rated 75°C minimum, to terminals 1-4, A to 4, B to 3, C to 2 and the neutral (if used) to 1, and torque to 6 inch-pounds. Adding one amp fuses to the voltage input leads will protect the power monitor. Equipment can be used to monitor either Wye or Delta systems.

Install **supplied coils** over each identified phase conductor. Connect the secondary using supplied secondary leads. Phase A to terminals 9-10, B to term. 7-8, and C to term. 5-6. The coil lead marked X1 (the white lead) connects to the positive and the brown lead goes to negative. It is essential that the phase relationships be matched. Phase A voltage is connected to terminal 4, coil over phase A connects to terminals 9 & 10, so on for all three phases as labeled.

The H1 side of the coil must face the source.

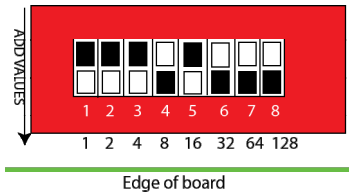
The output will not be correct if there are any mismatched phases. The current sensors may not be installed in a panel where they exceed 75% of the wiring space of any cross-sectional area of the panel.

Separate Class 1 and non-Class 1 conductors per NEC.

Power Supply Wiring Connection

Connect correct power supply voltage to terminals 16 & 17 on transducer using 22-12 AWG copper wires rated 75°C minimum and tighten terminals to 6 inch-pounds torque. Use 20A branch circuit protection against the remote possibility of a short.

Modbus Address and Baud Ra-



The node address is set through a series of eight dip-switches allowing a possible address range of 1-247. After converting your decimal address to binary either by hand or with a calculator you can set the dip-switches by flicking the operating lever toward the edge of the board. As an example, the illustration above shows the address set at the decimal value of 23. Switch 1=1, 2=2, 3=4, 5=16. 1+2+4+16=23

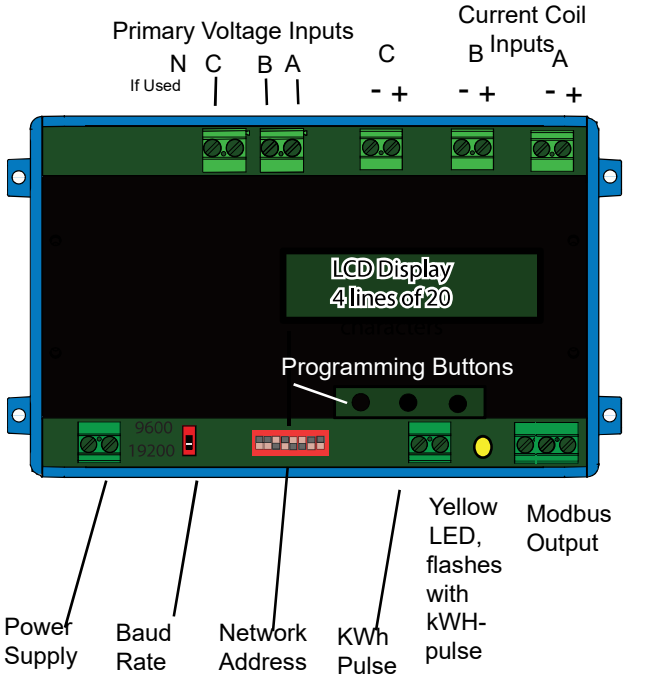
Note that switch 8 has the largest value.

Cycle power to the unit after changing the network address.

The baud rate can be set for 9600 or 19200 bps by placing the switch to the left of the node address block, in the appropriate position.

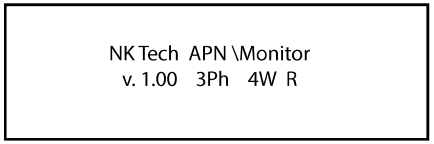
There are two LEDs under the cover between the network connection terminal block and the pulse LED. The one on the right (red) will light when there is a fault in the output, and the one on the left (yellow) will flash to indicate network data communication.

Input Wiring



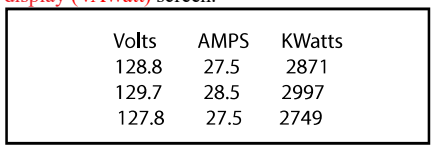
Set up Screens

When the field input connections have been made (Rogowski coils and line voltage), and the monitor is powered up, the LCD will display the following screen:



Product series, firmware version, and meter configuration (three phase, four wire). "R" refers to RC current inputs

1. After approximately two seconds, the display will show the default data display (VAWatt) screen.

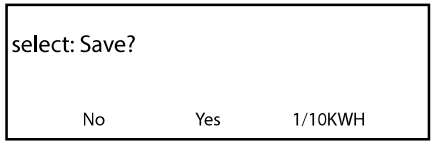


Voltage and current are RMS values, the watts displayed are active power.

2. Press one of the three buttons below the display and the display will change to:

Press the button below "Set-Up" and the display will change:

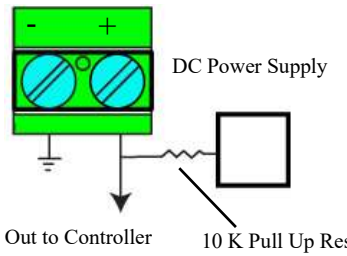
3. Select "Store KWHr" to save the accumulated watt hour value to flash memory. The count will be restored after a loss of power. S elect "KWHr Pulse" to save the counts to the Energy display only (lost is power is interrupted). Select either to set the pulse interval for watt hour counting. Pressing "KWHr Pulse" before "Store KWHr" will clear any previously accumulated watt hour value from memory.



Press the "Yes" button to set the pulse rate (1/10 KWH) one pulse per ten kilowatt hours. This is the available option with this model. The solid state N.O. voltage contact will open and close when 10 kilowatt hours have accumulated.

Press the "No" button will return the screen to data display (VAWatt) screen (Step1).

Pulse Contact Connection



Use an external resistor of 10 KΩ from the DC power to the pulse output contact (+) and out to the controller input. Ground the (-) terminal of the pulse contact. This will allow voltage to pass when the output is open, and block when closed. One kwh value is represented with an open and closed output cycle.

The APN-RC can be used only with the flexible coils supplied with the device. The standard ID is approximately 4.5 inches ("RC1" designation) or 4.5 inches ID ("RC2" designation). The lead length is two meters (80 inches).
It is not recommended to extend the secondary leads in the field.

After completing the set up programming, the LCD display can be changed to show several data groups. Press any button, and the display will show the following:

select:		
Energy	PwrFtr	VAWatt

Press the button below "Energy" and the display will change to show the following:

	Energy
sum KWatts	3,480
KWHr	00000127
Pwr Ftr	+0.68

Sum KWatts shows the active power being used at any time.
KWHr increases as kilowatt hours are accumulated.
Pwr Ftr shows the average power factor of all three phases.

Press any button to show your display options again. Press the button below "PwrFtr" to display the power factor of each phase.

select:		
Energy	PwrFtr	VAWatt

The power factor is shown with a (+) positive notation for inductive loads, and a (-) notation for loads which are capacitive. If the monitored load is inductive, all three phases should show power factor as positive. A negative value will be displayed if the load is capacitive.
If you see **0.01**, there is **no input** from the current sensor, the coil is reversed (label should face the source), the power **frequency** is out of bounds (frequency less than 48 Hz on a 50 Hz circuit or less than 58 Hz on a 60 Hz circuit; or **power factor** lower than 0.10.

	Power Factor
A	+0.70
B	+0.71
C	+0.68

Press any button to show your display options again. Press the button below "VAWatt" to display the voltage, current and watts being used for each phase.

select:		
Energy	PwrFtr	VAWatt

Volts	Amps	Watts
128.8	27.5	2871
129.7	28.5	2997
127.8	27.5	2749

This is generally the last screen viewed, and will be the default screen shown. Press any button to return to set up or display other values.

About MODBUS and the APN Power Monitor

MODBUS® Protocol is a messaging structure, widely used to establish master-slave communication between intelligent devices. A MODBUS message sent from a master to a slave contains the address of the slave, the 'command' (e.g. 'read register'), the data, and a check sum (CRC). Since MODBUS protocol is just a messaging structure, it is independent of the underlying physical layer. The interface used by the Monitor is RS-485.

The Query

The function code in the query tells the addressed slave device what kind of action to perform. The data bytes contains any additional information that the slave will need to perform the function. Only function code 03 HEX (Read Holding Registers) is supported by the Monitor, other codes will not be responded to and the red FAULT LED will turn on. The Monitor will read the requested registers and return their values. The data field will contain the information telling the slave which registers to read. The error check field (CRC) provides a method for the slave to validate the integrity of the message contents.

The Response

If the slave detects a transmission error, the message will not be acted upon, but the red FAULT LED will be turned on. If the slave makes a normal response, the function code in the response is an echo of the function code in the query. The data bytes contain the data collected by the slave, with the reading of voltage, current, Watts and Power Factor.

If an out of bounds register is requested , no register or too many registers have been requested, the function code is modified by adding 80 HEX to the function code (returning 83 HEX) to indicate that the response is an error response. There also will be 2 data bytes of zeros returned. The error check field (CRC) allows the master to confirm that the message contents are valid.

RTU Mode

When controllers are setup to communicate on a MODBUS network using Remote Terminal Unit (RTU) mode, each eight-bit byte in a message contains two four-bit hexadecimal characters. Each message is transmitted in a continuous stream.

Coding System

Consists of eight-bit binary, hexadecimal 0 ... 9, A ... F. There are two hexadecimal (HEX) characters contained in each eight-bit field of the message

Bits per Byte:

1 start bit

8 data bits, with the least significant bit sent first
1 bit for even parity
1 stop bit

Errors that occur during a query, such as parity or CRC, will flash the FAULT LED and no response will be sent.

RTU Framing

In RTU mode, messages start with a silent interval of at least 3.5 character times. This time is scaled to BAUD rate with the BAUD selection switch.

The first field then transmitted is the device address. The allowable characters transmitted for all fields are hexadecimal 0 ... 9, A ... F. The Monitor monitors the network bus continuously, including during the silent intervals. When the first field (the address field) is received, the Monitor decodes it to find out if it matches the address set on the switch. If there is a match the following bytes are collected. Following the last transmitted character, a similar interval of at least 3.5 character times, marks the end of the message. The Monitor will collect the data and respond to the master. A new message will begin after this interval

Troubleshooting

1. **No Data on LCD Display.**
   Recheck that all connections are made properly, and the power supply to the unit is energized. Recheck line voltage fuses to be sure they are conducting.

2. **Negative Power Factor when monitoring an inductive load.**
   One or more RC coils are reversed, either the marked H1 side is not facing the power source or the output leads are reversed. The white secondary lead must be connected to the positive input terminal.

3. **Power factor shows 0.01.**
   A. This value is displayed if the frequency of the primary circuit is out of bounds (lower than 48 Hz when monitoring a 50 Hz circuit or lower than 58 Hz when monitoring a 60 Hz circuit).
   B. There may be no current in a phase or the monitored circuit is not energized.
   C. The power factor is lower than **0.10**.

4. **Modbus output is not being received at the Master.**
   Check the slave (APN) network address setting to be sure there are no conflicts with other network nodes. Also recheck the baud rate settings to match the other equipment.

Table 2 Scaling For Watts Data

RC Range	Multiply data by
RC1	100
RC2	100

Table 1 Register Map - Read Only

Address	Register	Type	Description
0	40001	Integer, 16 bit	Volts RMS Phase A
1	40002	Integer, 16 bit	Current RMS Phase A
2	40003	Integer, 16 bit	Watts (active) Phase A
3	40004	Integer, 16 bit	Volts RMS Phase B
4	40005	Integer, 16 bit	Current RMS Phase B
5	40006	Integer, 16 bit	Watts (active) Phase B
6	40007	Integer, 16 bit	Volts RMS Phase C
7	40008	Integer, 16 bit	Current RMS Phase C
8	40009	Integer, 16 bit	Watts (active) Phase C
9	40010	Integer, 16 bit	Watts (active) sum
10	40011	Integer, 16 bit	Energy (active) KWH, MSB, (see Note 1)
11	40012	Integer, 16 bit	Energy (active) KWH, LSB
12	40013	Integer, 16 bit	Power Factor, Phase A (see Note 2)
13	40014	Integer, 16 bit	Power Factor, Phase B (see Note 2)
14	40015	Integer, 16 bit	Power Factor, Phase C (see Note 2)

Notes:

1. Energy is saved in two registers (40011 and 40012) for a maximum total of 4,294,967,295 kWHr. To combine the two registers, multiply MSB by 65,536 and add to LSB.
2. A power factor reading of 70 = +0.70 (inductive). A power factor reading of 198 = -0.70 (capacitive). If the data shows readings greater than 128, subtract 128 from the reading and change the sign to negative. In the case shown as an example, 198 - 128 = 70, but the sign should be changed to negative to represent a leading power factor.