Development of remote monitoring and control equipment with advanced communication functions

Ayuchi Kurosu, Nobukazu Teraoka, Keiichi Ohama

[Summary] We have developed the NH Telemeter series of equipment for remote monitoring and control systems. The Telemeter series is communications equipment for sending control signals to remote process and control equipment and receiving monitoring signals over communications lines. The NH series has advanced and improved communications functions using various communication lines to monitor and control signals flexibly. This article explains the NH series of products, the technology, settings and maintenance tool.

1 Introduction

Water is essential to human life and water treatment plants must be operated and maintained continuously to assure supply 24 hours a day, 365 days a year.

Remote monitoring and control systems use telemeters as a key device in helping to minimize the operations and maintenance costs of important social infrastructure like water treatment plants.

Telemeters transmit both monitoring signals (voltage, current, and relay signals used in remote monitoring and control systems) handled by the plant equipment and control signals from a control center over communications lines to remote locations.

We have marketed the NH Telemeter series as remote monitoring and control equipment developed as an easy-to-configure telemetry system bearing in mind the communications infrastructure and total cost.

This article introduces the product series, the technology, features, settings and maintenance tool.

2 Development Concept

2.1 Development Background

Anritsu focused its development efforts for more than 40 years on systems for monitoring and controlling social infrastructure, such as water treatment plants. However, the social environment has changed greatly in the 10 years since the release of the previous H-2100 Telemeter series. The change in communications infrastructure, shortage of skilled engineers in remote monitoring and control systems, demand for cost reductions, etc., are becoming key subjects.

In remote monitoring and control systems, communications from remote locations frequently depend on leased lines due to their high reliability, but advances in the switch to IP-based communications are driving an increase in the number of systems using high-speed, high-capacity IP circuits.

In addition, subjects including the shortage of skilled engineers, simplified design, and reduction of initial, operation and maintenance costs, etc., are all becoming increasingly important.

Under these circumstances, we decided to develop the NH Telemeter series as an easy-to-configure remote monitoring and control system supporting the evolving communications infrastructure.

2.2 Product Concept

The product concept was to develop a remote monitoring and control system supporting the evolving communications infrastructure with low total cost of ownership, including design, operation and maintenance, and meeting the following requirements:

(1) All-in-one support for various communications circuits in use with functions for IP, leased and public telephone lines.
(2) Easy extensibility support for communications circuits and monitoring and control signals as well as simple installation.
(3) Efficient configuration and maintenance supported by dedicated tool.
(4) Support basic unit incorporated functions required in remote monitoring and control functions suitable for small and medium systems with simple design, operation and maintenance.

2.3 Key Features

The key features of the NH series design are explained below:

(1) Support for Different Communications Circuits

Because conventional systems use dedicated units matching the types of communications circuits, it is necessary to prepare communications units matching communications circuits.

By incorporating a communications function supporting the various types of communications circuits, the NH series is easily and flexibly tailored to the system design as well as later system updates (relocations, upgrades, etc.).

The communications function supports IP circuits, leased lines (3.4 kHz, 3.4 kHz (S), 50 b/s), public telephone lines, and FL-net all from one unit. Moreover, selection between public telephone and leased lines is supported by software configurations.

(2) Improved Extensibility

Conventional system designs use a bus-connected configuration system and require dedicated cables for connections between equipment pieces. Five meters is the limit to cable lengths.

The NH series uses Ethernet for connections between the base unit and extension units. The extension unit accommodates subunits to extend communications circuits for monitoring and control signals. Using easy-to-obtain LAN Ethernet cables for internal connections between extended units supports connections of up to 100 meters each and increases the setup and layout freedom.

Up to seven extension units can be connected to a base unit and each extension unit can accommodate five communications and I/O subunits.

Both the cascade (no network appliances required) and star (network appliances required but high tolerance to single appliance failure) network topologies are supported by the built-in L2 switching function (Figure 1).

(3) Dedicated Tools

Unit configuration files are created using dedicated setting tools with a simplified GUI.

The NH series has a duplicate address check function so the user can check the settings before configuring the actual hardware. In addition, we have re-examined complex settings and eliminated the need for an expert operator by adding a standard settings mode to improve settability.

Provision of dedicated maintenance tools supporting simulated I/O greatly simplifies maintenance and inspection workloads.

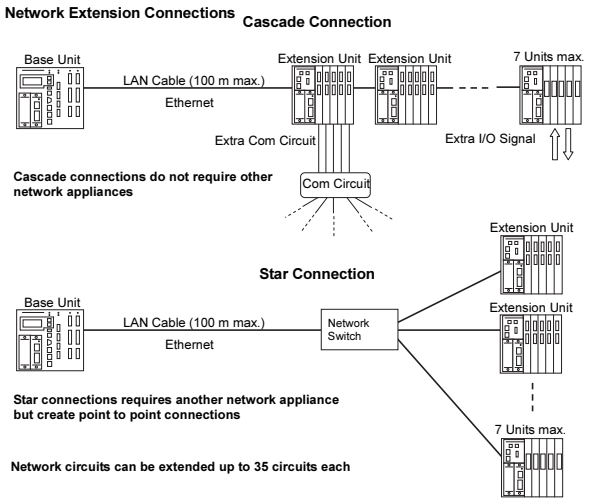

Figure 1 Example of Unit Extension Setup

(4) Shorter Equipment Selection Times

Previous systems placed a heavy burden on designers as well as a lot of time in configuring equipment combinations matching the monitoring and control signals to the system scale and installation requirements.

To improve this situation, we have designed a base unit that incorporates all the required functions for a small-to-medium scale monitoring and control system in one unit.

Using this base unit in system configuration simplifies the design and setup times and because it also reduces the number and variety of other equipment and units, it also cuts inventory and management costs too.

(5) Labor Saving Operation and Maintenance

Using a system configuration with a base unit reduces the number different types of units in the system, helping reduce the operation and maintenance workloads through work standardization.

3 Design Requirements

This section explains the NH series design requirements.

3.1 System Architecture

The architecture of remote monitoring and control systems continues to use the Wide Area Pseudo Shared Memory Method pioneered by Anritsu and assuring good connection compatibility with previous equipment. This method performs communications with each piece of equipment to share necessary information (monitoring and control signals) being updated continuously. Instead of merely reporting data, this architecture offers the merit that data sharing can be handled by any equipment in the entire system. Since the architecture can handle any information irrespective of the system configuration, it is easy to configure a flexible system for monitoring and control from multiple locations (Figure 2).

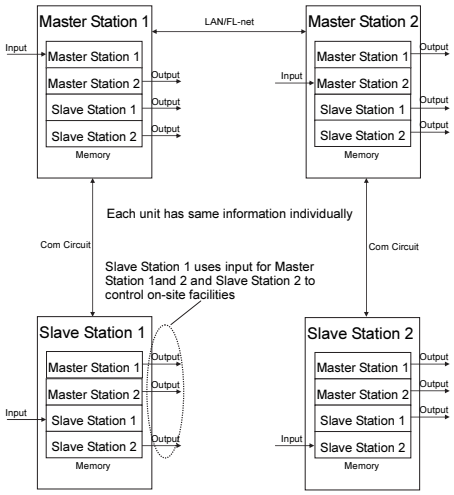

Figure 2 Wide Area Pseudo Shared Memory Method

3.2 Equipment Architecture

In previous systems, a faulty unit could impact the entire system, so the bus connection method was changed to a point-to-point method.

In the NH series with improved RAS (Reliability/Availability/Serviceability), independent operation using point-to-point connections strengthens the system fault tolerance by preventing one faulty unit having an impact on the entire system and ensures increased reliability by supporting a dedicated surveillance function (Figure 3).

This high unit fault tolerance also helps easy maintenance parts exchange and high degree of extensibility. In addition, the extension unit has a dedicated management CPU to monitor status, and auto-recovery offers an unparalleled level of reliability.

3.3 WAN Communications Function

Previous systems required dedicated communications units supporting communications lines (3.4 kHz, 50 b/s) and speeds (1200 bit/s, 9600 bit/s, etc.) but the NH series has a single unit handling the circuits, speeds and methods via software configurations. As shown in Figure 4, each communications function and its corresponding switching hardware is controlled by software.

Since dedicated communications units are no longer required, there are no problems with circuit upgrades and service parts exchange, cutting the burdens of system design, setting, and verification.

Moreover, older systems suffered communications faults due to unforeseen degraded circuit quality, whereas the NH series has constant circuit quality monitoring functions and auto-adjustment of communications speeds to avoid communications faults and recover as fast as possible when errors occur.

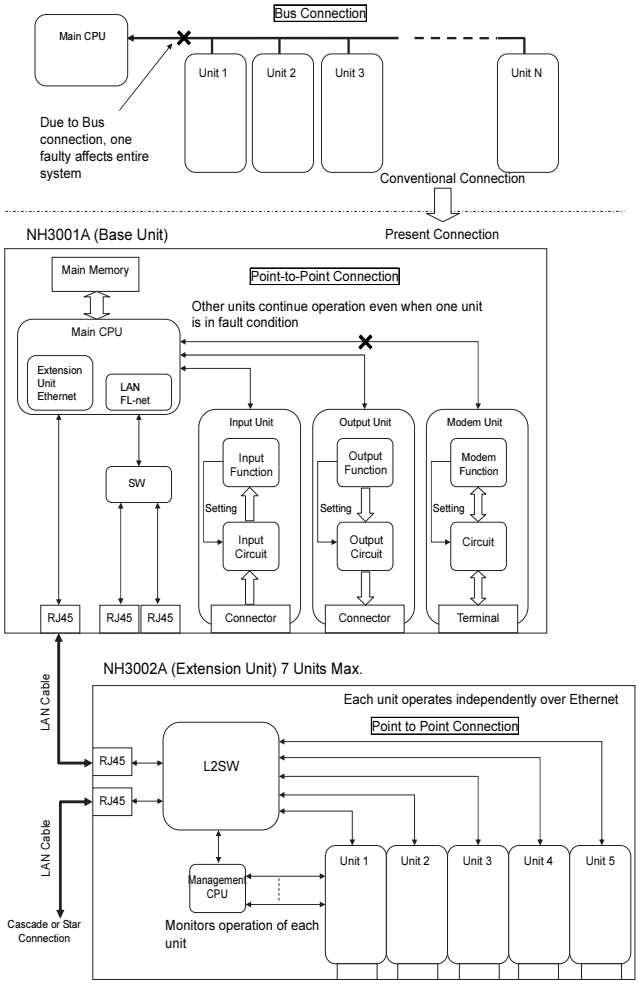

Figure 3 Equipment Architecture

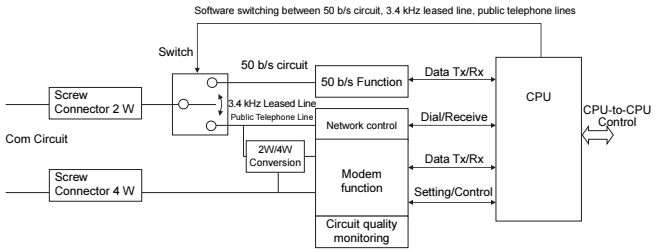

Figure 4 Communication Line Block Diagram

3.4 FL-net Communications Function

The FL-net communications network requires real-time communications processing. Previous systems used separate units with a dedicated CPU with sufficient power to support the required real-time processing performance. The NH series supports IP and FL-net communications functions using a single unit with one CPU with the required performance. Since no other separate units are required, it not only saves space, but also cuts costs.

In addition to giving higher priority to FL-net communications processes over other processes so as to assure FL-net real-timeness, the OS built-in timer has a precision of better than 1 ms, supporting real-time scheduling.

3.5 I/O Function

The analog I/O functions of previous equipment combined voltage, current, etc., with required hardware settings (jumper settings), but the new NH series supports settings entirely via software.

This eliminates the need for complex hardware settings, allowing the operator to check the settings easily via software.

3.6 Power Supply Function

(1) Redundant Power Supply Function

(See Table 1 for supported products.)

The NH series incorporates a redundant power supply to assure continuous operation 365 days a year. The power supply unit (PSU) supplies both 100 Vac and 24 Vdc and can be implemented freely to support parallel operation. In addition, use of the 24 Vdc commonly found in equipment rooms as a backup power supply improves system reliability at power cuts.

(2) Power Cut Notification

(See Table 1 for supported products.)

If a power cut occurs at a remote location without backup power, although the interrupted communications can be detected from the lost communications, the lost communications cannot be distinguished from a power cut.

However, the NH series has power supply monitoring and power cut notification functions for rapidly distinguishing the cause of the fault.

Since operation must be maintained for several 100 ms after power cut detection because the power cut is notified over the communications lines, an adequate backup time is assured using a booster circuit with small-volume capacitors (Figure 5).

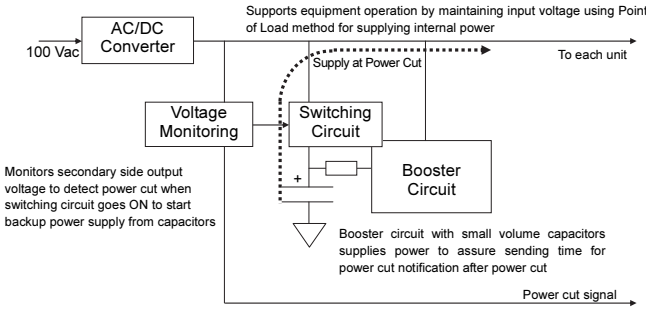

Figure 5 Backup Circuit Implementation

3.7 Weight Reduction

The cabinet of the NH series is all aluminum to help cut equipment weight and assure safe and easy handling in the equipment room. As well as safer work resulting from the reduced weight, the lower weight supports a greater degree of design freedom at equipment installation without needing strong walls and racks, etc.

3.8 Configuration Auto-download

To support on-site configuration changes without using a personal computer, the NH series has a function for automatically downloading a configuration file from the USB port. When a USB memory stick containing a configuration file is connected at system startup, the configuration file is downloaded automatically and the equipment is updated for smooth on-site operation.

3.9 System Monitoring Function

Since remote faults can stop system operation for long periods, the NH series monitors internal operations for abnormalities using software and has a function for performing auto-recovery if an abnormality is discovered. To assure short recovery times, processes are monitored by software and when an abnormality is detected, only that abnormal process is restarted. In the unlikely event that the monitoring function process itself stops, the device is restarted using a hardware watchdog timer to assure continued operation.

4 Small to Large System Scalability

To support design of scalable systems, the NH series has a wide range of models (NH3001A, NH3002A, NH2501A, NH2502A, NH6001A) matching the system scale. Figure 6 shows the product line and Figure 8 shows a usage example.

4.1 NH3001A (Remote Monitoring and Control Equipment Base Unit)

The NH3001A is the all-in-one base unit incorporating the required remote monitoring and control functions for supporting IP, leased line and general public telephone line as well as both analog and digital I/O functions. The base communications circuit and I/O functions are extended using extension units (NH3002A).

It has a built-in LCD for displaying both its own status and the status of any subordinate NH3002A extension units to perform distributed monitoring and control of all extension units in the system from one screen.

4.2 NH3002A (Remote Monitoring and Control Equipment Extension Unit)

The NH3002A extension unit is connected to the NH3001A base unit to extend functions. Up to seven NH3002A units can be connected to one NH3001A.

Up to five other types of subunit can be installed in the NH3002A. Since connections are via common LAN Ethernet cable, connections can be extended up to 100 meters at low cost, supporting easy installation at separate locations. Moreover, with its built-in 2-port network switch function, the NH3002A supports cascade network topologies without needing other network appliances (Figure 3).

4.3 NH2501A/NH2502A (Input/Output Unit)

The NH2501A and NH2502A units have been designed to emulate the functions and performance of the NH3001A on a smaller scale. The NH2501A is dedicated to input and the NH2502A is dedicated to output. The communications functions are the same as the NH3001A and both units can be used for configuration of an effective smaller-scale remote monitoring and control system.

4.4 NH6001A (Gateway Unit)

The NH6001A has been developed as a specialized communications unit that omits the I/O functions. It has the same communications functions as the NH3001A but the license for the FL-net communications function is free.

It can be used as a gateway for sending monitoring and control signals from monitoring and control devices scattered around an FL-net to other remote locations.

5 System Design/Service Support

The NH series uses the dedicated tools described in section 2.3 to support every stage from system design through to operation and maintenance.

The NH series dedicated tools are split into setting tools for simply and accurately setting equipment as well as maintenance tools for supporting on-site equipment maintenance and inspection.

The setting tools have standard and detailed modes matching the setting detail degree, plus a configuration mode for visualizing the system configuration, and a verification mode for verifying settings.

The standard mode supports standard usage methods so it is used to operate equipment simply by selecting a small number of items.

Figure 6 External View of NH series

The standard mode setting window is shown in Figure 7.

The detailed mode makes detailed settings using the built-in equipment functions.

The configuration mode visualizes the configuration of the remote monitoring and control system such as the master, slave and subunits and supports centralized management using settings files for each unit.

The verification mode handles detection of duplicate addresses for analog and digital inputs, modem Rx, FL-net Rx, etc., at units managed by the configuration mode. As a result, it can help preempt troubles resulting from remote monitoring and control system setting mistakes.

The maintenance tools are used to generate data simulating local operations to perform analog and digital I/O tests, sending of modem pattern signals, etc., for verifying, servicing, and inspecting systems before and after installation.

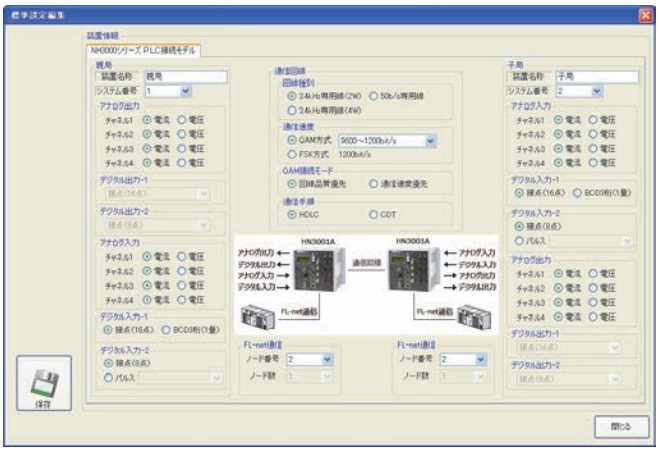

Figure 7 Standard Setting Window

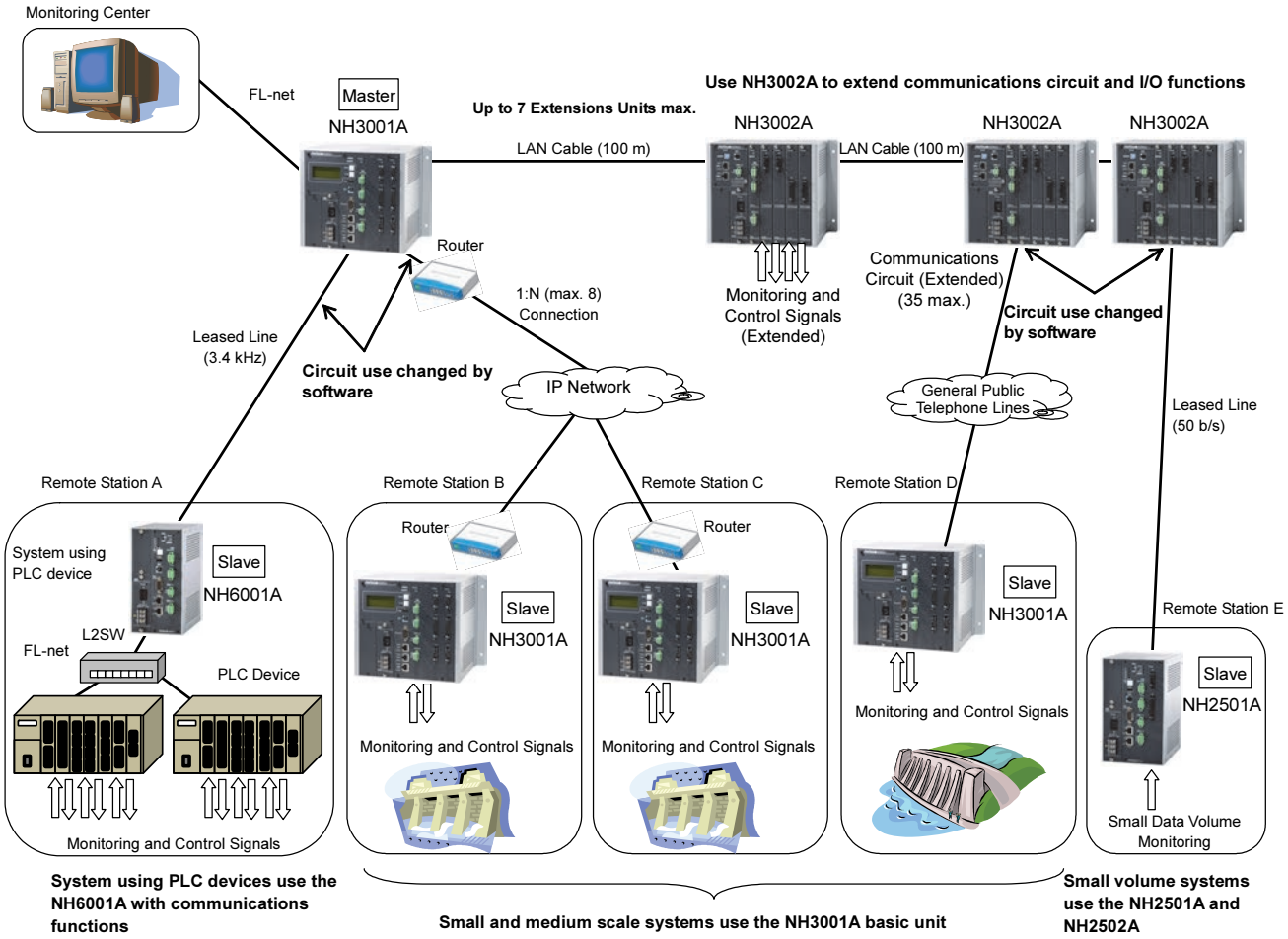

Figure 8 System Configurations using NH Series

6 Summary

This article describes the technologies and features of the new NH Telemeter series of remote monitoring and control equipment.

This work developed dedicated tools and re-examined the unit architecture to create easy-to-use, high-reliability equipment. By incorporating communications functions, the new NH series opens the door to new technologies and services based on new wireless technologies and cloud services, etc.

Future work aims to develop new communications functions, such as wireless and cloud network services for more efficient operation and maintenance of remote monitoring and control systems to support development of new equipment and services for today's network society.

Authors

Ayuchi Kurosu
Anritsu Networks Corporation
Development Section

Nobukazu Teraoka
Anritsu Networks Corporation
Development Section

Keiichi Ohama
Anritsu Networks Corporation
Development Section

Table 1 NH Series Specifications

				NH3001A	NH3002A	NH2501A	MH2502A	NH6001A
Communications Functions	3.4 kHz Leased Line	Speed	1200 to 9600 bit/s	√	√	√	√	√
	50 b/s Leased Line	Speed	50 bit/s	√	√	√	√	√
	Public Telephone Line	Speed	1200 to 14400 bit/s	√	√	√	√	√
	LAN	Circuit	IP Circuit	√	–	√	√	√
		Speed	10 Mbit/s, 100 Mbit/s					
		Method	TCP/IP					
	FL-net	Circuit	LAN (Ethernet)	√Note 2 (Option)	–	√Note 2 (Option)	√Note 2 (Option)	√ (Standard)
		Speed	10 Mbit/s, 100 Mbit/s					
		Method	FL-net (OPCN-2 Ver.2.00) JIS B 3521 Rec.Note 1					
Input Function	Analog	No. of Channels		4	4 subunit	4	–	–
		Voltage	0 to 5 Vdc	√	√	√	–	–
		Current	0 to 20 mA	√	√	√	–	–
	Digital	No. of Points		24	16 subunit	16	–	–
Output Function	Analog	No. of Channels		4	4 subunit	–	4	–
		Voltage	0 to 5 Vdc	√	√	–	√	–
		Current	0 to 20 mA	√	√	–	√	–
	Digital	No. of Points (100 Vdc 50 mA max)		24	16 subunit	–	16	–
Power Supply Function	Redundant Power Supply (100 Vac or 24 Vdc)			√	√	–	–	–
	Power Cut Reporting (50 b/s—public telephone lines not supported)			–	–	√	√	√
Maintenance Function	Status Displays			LCD	–	LED	LED	LED
Dimensions	H × W × D (mm) excl. projections			200 × 220 × 170		200 × 120 × 170		200 × 100 × 170
Operating Environment	Operating Temperature and Humidity			–10° to 50°C 10% to 90% RH				

Note 1: JIS B 3521 standard communications, FL-net approved test certification

Note 2: Set by license key and usable when license canceled

Table 2 NH3002A Extension Function

	Per Subunit	Max. Per Unit	Max. Total Connections
Analog Input	4 channels	20 channels	140 channels
Analog Output	4 channels	20 channels	140 channels
Digital Input	16 points	80 points	560 points
Digital Output	16 points	80 points	560 points
No. of Communications Lines	1	5	35

Table 3 Supported Communications Lines

Communication Line Types		Method	Speed	Format
Code Transmission 50 b/s	2W	Half-duplex	50 bit/s	HDLC
		Full duplex		CDT
Band Items 3.4 kHz	2W	Half-duplex	1200 bit/s (fixed)	HDLC
		Full duplex	1200 to 9600 bit/s	HDLC CDT
	4W	Half-duplex	1200 bit/s (fixed)	HDLC
		Full duplex		CDT
		Full duplex	1200 to 9600 bit/s	HDLC CDT
Band Items 3.4 kHz (S)	4W	Half-duplex	1200 bit/s (fixed)	HDLC
		Full duplex		CDT
		Full duplex	1200 to 9600 bit/s	HDLC CDT
Analog Public Telephone	2W	Full duplex	1200 to 14400 bit/s	HDLC

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