Development of *San Ace Controller*, an IoT Product for Remote Fan Control and Monitoring

Naoki Murakami Hironori Ogihara Soma Araki Masashi Murakami

Hikaru Urushimoto Masahiro Minamoto Honami Osawa

1. Introduction

In recent years, IoT (Internet of Things) has spread throughout many fields. IoT-enabled devices can be operated and monitored remotely via the internet, offering customers and users many benefits such as accumulating operating data on a cloud server to use for purposes such as preventive maintenance and product development.

Fans are a vital part of the devices in which they are used, as they enable stable operation. As such, IoT products that enable remote monitoring and preventive maintenance of fans are required.

Moreover, high energy efficiency and low SPL (sound pressure level) are always important concerns for devices. To achieve even higher energy efficiency and lower SPL, a device that can automatically control fans to operate at the proper speed for a given situation is required.

To satisfy these requirements, we developed the *San Ace Controller*, an IoT product that enables remote control and monitoring of fans with the PWM control function (hereinafter "fan").

This article will provide an overview and introduce the features of the *San Ace Controller*, it's dedicated sensors, and the *San Ace NET* cloud service.

2. Outline of the New Product

2.1 Appearance and Dimensions

Figures 1 and 2 show the appearances of the *San Ace Controller* and its dedicated sensor respectively, while Figures 3 and 4 provide the respective dimensions of the *San Ace Controller* and its dedicated sensor.

San Ace Controller can be installed sideways, vertically, or mounted on walls. Moreover, all connectors are positioned in the front for easy wiring.

Fig. 1 San Ace Controller

Fig. 2 Dedicated sensor

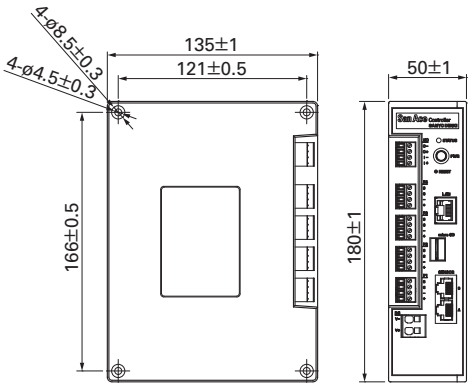

Fig. 3 San Ace Controller dimensions

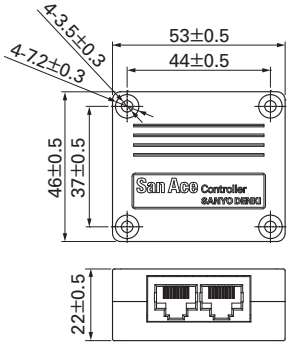

Fig. 4 Dedicated sensor dimensions

2.2 Specifications

Tables 1 and 2 show the respective specifications of *San Ace Controller* and the dedicated sensor.

It can control and monitor SANYO DENKI's fans via a network.

Table 1 San Ace Controller specifications

Model		9CT1-001
Rated voltage [V]		12/24/48 DC
Power consumption [W]		3.1(1)
Operating voltage range [V]		7 to 60 DC
Operating temperature range [˚C]		-20 to +70
Control function		Manual/Automatic
Control signal		PWM signal High-level voltage (V_{OH}): 3.3/5 V Frequency: 25 kHz
Monitoring criteria		Fan speed, fan current, fan operation time, sensor detection value, external input
No. of connectable fans		Max. 4
Allowable fan connection terminal current		5 A (per terminal)
No. of connectable sensors		Max. 4
Supported sensors		Temperature/humidity, barometric pressure, acceleration(2)
External I/O	**Input**	Photocoupler-isolated input, ON: 15 to 28.8 VDC, OFF: 0 to 5 VDC
	Output	Photocoupler-isolated open-collector output, load voltage: 28.8 VDC or less, output current: 0.1 A or less
Communication	**Wireless**	IEEE802.11b/g/n, frequency 2.4 GHz(3)
	Wired	Ethernet 10BASE-T, 100BASE-TX
Size [mm]		50 (W) × 135 (D) × 180 (H)
Mass [g]		450
Material		Case: Plastic

(1) For use of this product alone, at 20˚C ambient temperature, (2) Dedicated sensor, (3) Supports channels 1 to 11

Table 2 Dedicated sensor specifications

Sensor type	Temperature/humidity	Barometric pressure	Accelerometer
Model	9CT1-T	9CT1-P	9CT1-A
Measurement range	Temperature: -20 to +70°C Humidity: 20 to 85% RH(1)	Barometric pressure: 800 to 1100 hPa	Acceleration: 0 to 60 m/s^2 (2)
Operating temperature range [˚C]	-20 to +70		
Operating humidity range [% RH]	20 to 85(1)		
Size [mm]	53 (W) × 46 (D) × 22 (H)		
Mass [g]	35		
Material	Case: Plastic		

(1) Non-condensing (2)Total acceleration from 3-axes

3. Product Features

3.1 Network connection function

San Ace Controller can be connected to a network either by wired or wireless connection. Figure 5 shows an example of system configuration when connected to a network.

Through its network connection function, San Ace Controller can be accessed from a device such as a computer or smartphone on a network to perform settings, control, and monitoring. Moreover, detected alarms can be received, and stored measurement data and alarm history can be downloaded. The Ethernet 10BASE-T and 100BASE-TX (wired) and IEEE802.11b/g/n (2.4 GHz) (wireless) communication standards are supported.

3.2 User interface

San Ace Controller can be operated using the regular web browser installed in devices such as computers or smartphones. The user interface is designed to be user-friendly, and a validation function prevents input and selection errors, making San Ace Controller easy to operate even for first-time users. Figure 6 shows an example of a settings screen.

3.3 Measuring and monitoring function

Regarding the connected fan and dedicated sensors, it is possible to measure and monitor the below criteria.

Fan: Speed, current value, operation time
Dedicated sensors: Temperature, humidity,
barometric pressure, acceleration

The threshold of each monitoring criterion can be set arbitrarily by the user. If measurement values deviate from these thresholds, the user is alerted of an abnormality via email, a notification on a browser screen, an LED on the main unit, and an external output. Measurement data and alarm history are stored in the internal memory, and can be checked through a web browser. Moreover, measurement data and alarm history can be downloaded from a computer as a csv file, then used for preventive maintenance, new product development, and problem analysis. Figure 7 is an example of a measurement data screen.

Furthermore, an input signal from an external device enables monitoring of the external device's status, and there is a function to notify users with an alarm in the event of an abnormality.

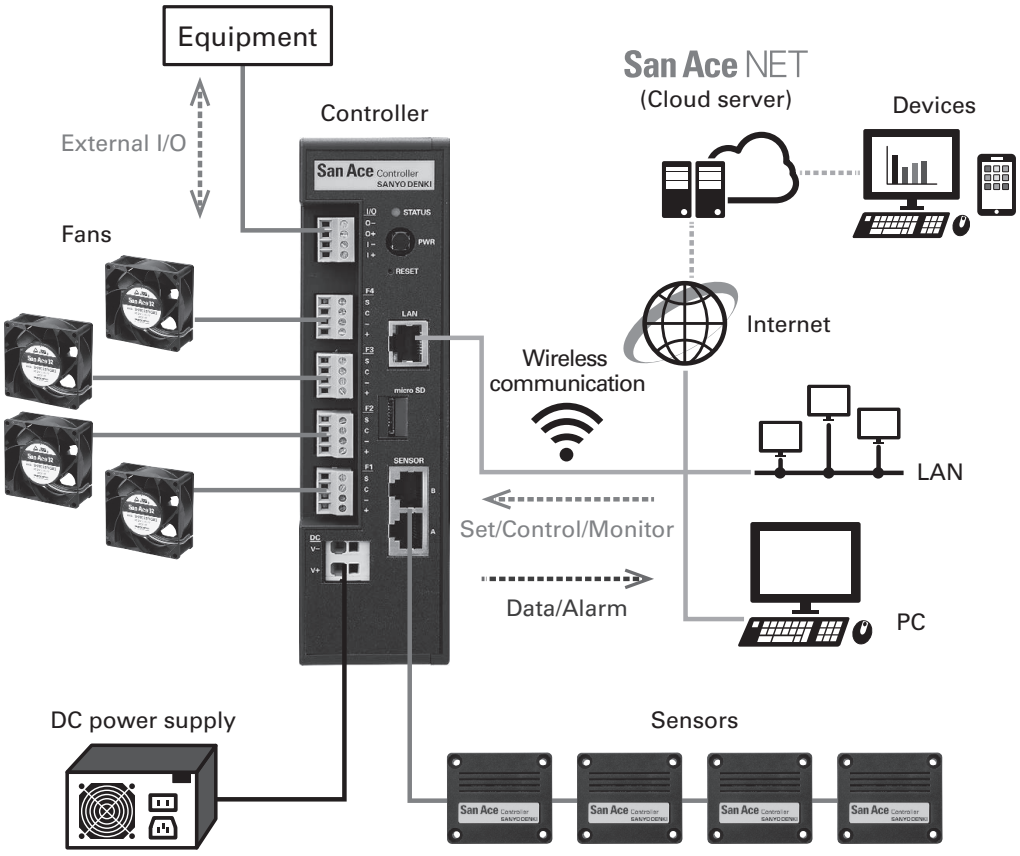

Fig. 5 Example of system configuration

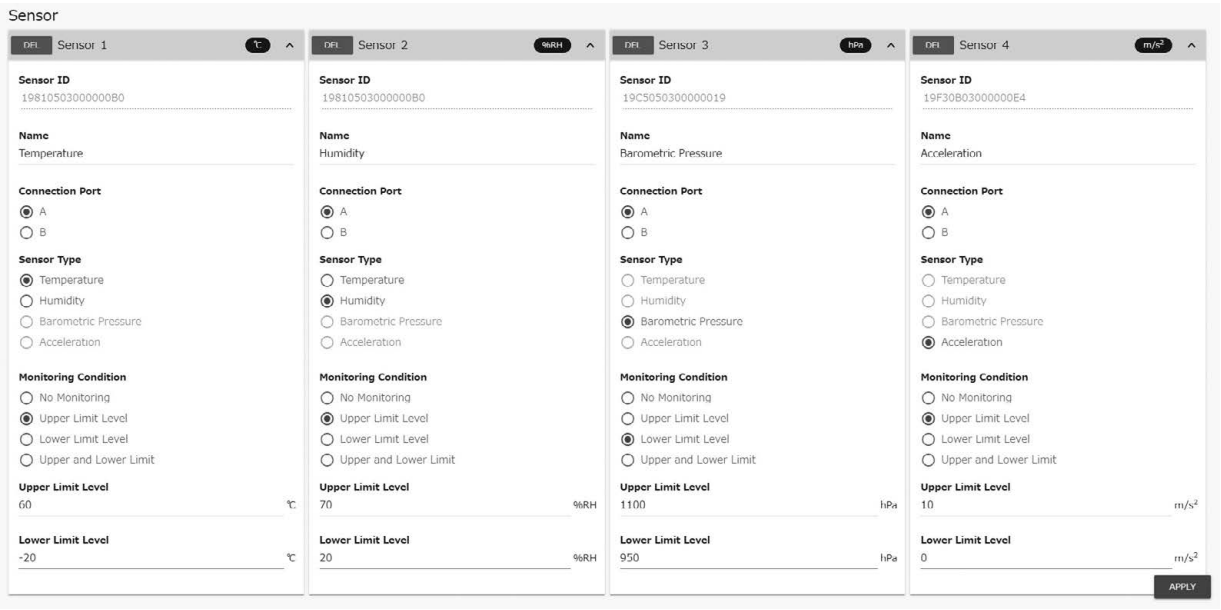

Fig. 6 Example of a settings screen

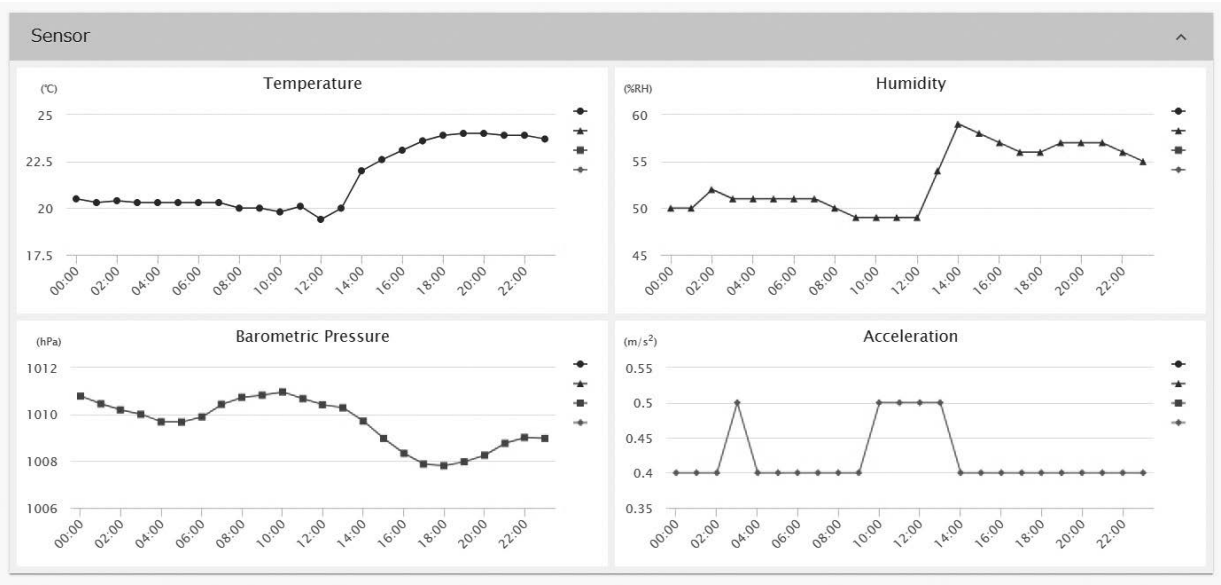

Fig. 7 Example of a measurement data screen

3.4 Fan control function

San Ace Controller can control up to four fans. Both manual control and automatic control methods are options.

3.4.1 Manual control

Manual control is a function to control fan speed by inputting an arbitrary PWM signal duty value into the connected fan. PWM signal duty can be set in increments of 1%, so users can adjust to their desired fan speed.

3.4.2 Automatic control

Automatic control is a function to automatically adjust fan speed in line with the measurement values of the connected sensor. Automatic control is achieved using either a dedicated temperature/humidity sensor or barometer. Figure 8 shows connection and operation examples of automatic fan control using temperature/humidity sensors. In this example, fans 1 and 2 are automatically controlled in accordance with the measurement values of temperature/humidity sensor A, while fans 3 and 4 are automatically controlled in accordance with the measurement values of temperature/humidity sensor B. The speeds of the fans are

automatically adjusted so that the measurement values of temperature/humidity sensors A and B reach the preset target values. Because automatic control enables users to operate fans at the optimal speed, it is possible to suppress SPL and power consumption caused by excessive fan speed.

Figure 8 is an example of using two sensors for the automatic control of four fans, but it is also possible to automatically control four fans with their own individual sensor at a different target value. It is also possible to automatically control our Counter Rotating Fan and Reversible Flow Fan.

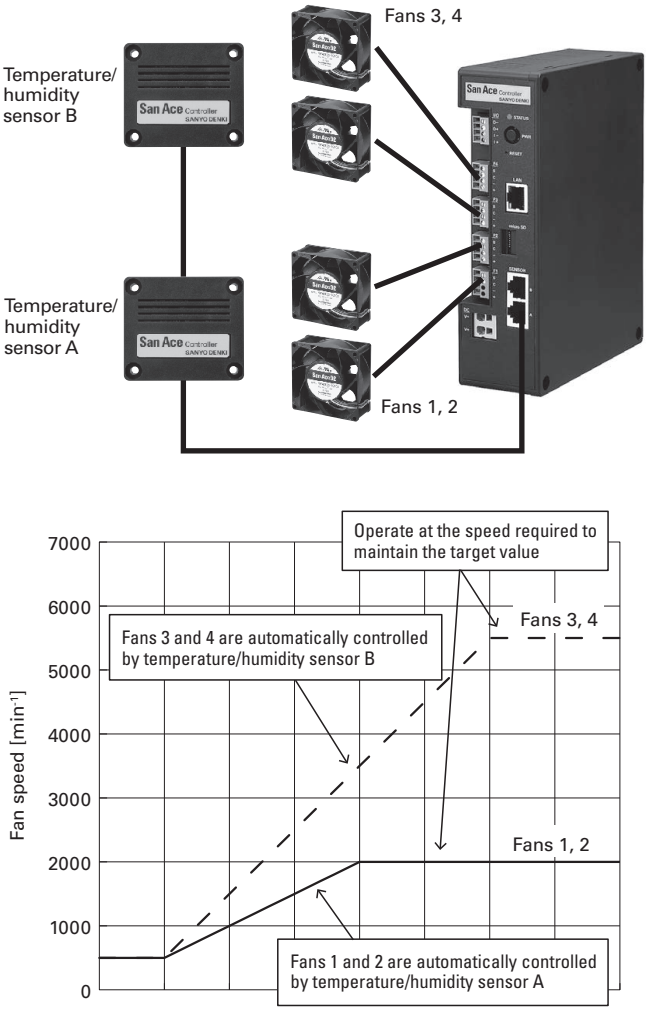

Fig. 8 Example of connection and operation of automatic control

3.5 *San Ace NET* cloud service

By using the *San Ace NET* dedicated cloud service, San Ace Controller can be set, controlled, and monitored on a computer, smartphone, or other device from a remote location as long as there is an internet connection available. Furthermore, San Ace Controller's measurement data is automatically transferred and saved to San Ace NET, meaning it can be used for data backup.

4. Conclusion

This article has given an overview and introduced the features of our *San Ace Controller*.

This is the industry's first(1) IoT product realizing remote control and monitoring of fans. It enables remote monitoring of the fan's operational status and sensor measurement values, and stores the monitoring data in the product or in *San Ace NET*. This enables such data to be used for purposes such as preventive maintenance, new product development, and problem analysis.

Moreover, with the fan automatic control function, excessive increase of fan speed can be prevented, thus significantly contributing to the realization of high energy efficiency and low SPL in our customers' equipment.

We wish to continue engaging in the development of new products to meet new requests of our customers that occur with technological advancements.

(1) Based on our own research as of August 20, 2019.

Authors

Naoki Murakami
Cooling Systems Div., Design Dept.
Works on the development and design of cooling fans.

Hironori Ogihara
Cooling Systems Div., Design Dept.
Works on the development and design of cooling fans.

Soma Araki
Cooling Systems Div., Design Dept.
Works on the development and design of cooling fans.

Masashi Murakami
Cooling Systems Div., Design Dept.
Works on the development and design of cooling fans.

Hikaru Urushimoto
Cooling Systems Div., Design Dept.
Works on the development and design of cooling fans.

Masahiro Minamoto
Cooling Systems Div., Design Dept.
Works on the development and design of cooling fans.

Honami Osawa
Cooling Systems Div., Design Dept.
Works on the development and design of cooling fans.