Implementation of Monitoring and Control Systems for 50KW PV Systems Using the Wire-Wireless Network

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Abstract

This paper deals with the efficient management for the intelligent distribution system related with the renewable energy sources, using the wire-wireless monitoring and control device. This device is mainly composed of two sections. One is monitoring device using the Autobase Software and the other is control device using PLC. This paper proposes a wire and wireless monitoring and controlling device which can monitor and control the 50Kw PV system installing remotely (about 1Km) in campus of the Korea University of Technology and Education. By the analysis of PV output characteristic using the device proposed in this paper, it is confirmed that the device can contribute the establishment of Smart Grid.

Keywords: *Wire and wireless communications, 50KW PV monitoring and control, PLC, Autobase Software*

1. Introduction

Globally, Green-Energy industry has already been expected to trigger the cascade effect which leads the change of society and culture as other industries go green. Accordingly, the developing nations have arranged an active plan to promotion, and have continuously supported and invested money for a long time. A well-established research institution in USA expects the Green energy to be highly developed that the growth of Green energy market would be up to 15.1% as much as the IT Industrial Revolution (growth in early 2000, 17%) [1, 2]. Under these backgrounds, this paper proposes one of several solutions that collect and analyze the real time output data from solar power system by using the wire-wireless monitoring and controlling device. It is expected to overcome the operating system problems caused by the installation of remote locations like mountain and sea sides.

2. Concept for Proposed System

Large scale of renewable energy power complexes are now being introduced actively under the conditions of national projects sponsored by green growth policy of government. However, there are many technical problems on the maintenance and management for large renewable complex cases. Specially, PV systems interconnected with distribution systems, may cause a huge change of power output under the conditions of weather (windy, rainy), and lead to some problems with voltage management of system operation of the distribution system and quality of power [3, 9]. Therefore, this paper proposes a wire and wireless monitoring and controlling device which can monitor and control the 50Kw PV system that installed remotely (about 1Km) in campus of the Korea University of Technology and Education as shown in Figure 1.

Figure 1. Concept of 50Kw PV System

3. Configuration of Wire-wireless Monitoring and Control System for PV Systems

The wire-wireless monitoring and control system is mainly consist of two sections as shown in Figure 2. One is the monitoring and controlling section for receiving data and the other is transmitting section for collecting and sending data. The former is made up of HMI(Human Machine Interface) software and router, and the latter is made of 50KW inverter, PLC(Program Logic Controller), Relay and MC elements.

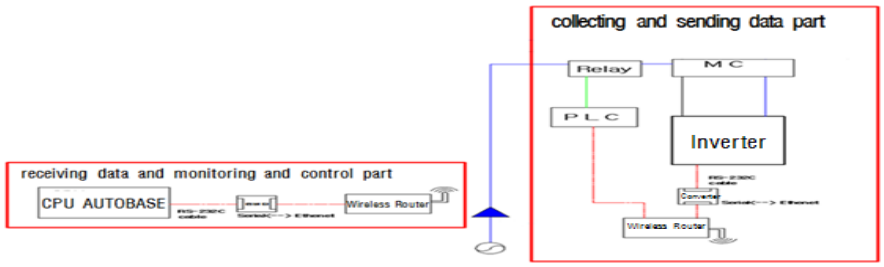

Figure 2. Configuration of Wire-wireless Monitoring and Controlling Device

3.1 Monitoring Device using HMI Program

As shown in Figure 3, the monitoring device using HMI program is designed to communicate the protocol of components which are wire-wireless converter and router and Autobase software.

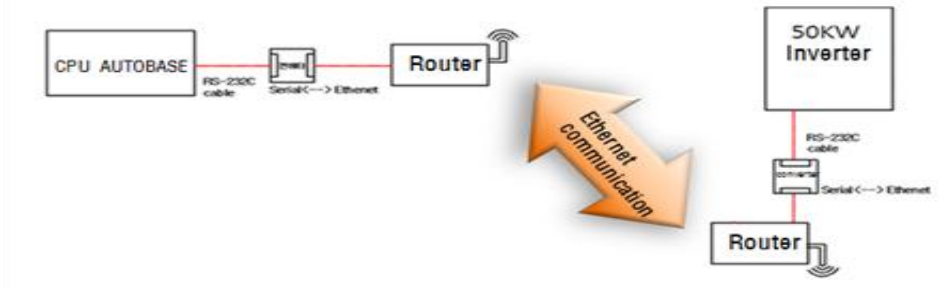

Figure 3. Concept of Monitoring Device

3. 2. Control Device using PLC

Figure 4 shows the control device is made of PLC (Program Logic Controller), Relay and MC elements for 50KW PV system. PLC plays a main role at the control device, which turns on the output contact of LADDER by operating internal contact of PLC from the control signal of the Autobase Software.

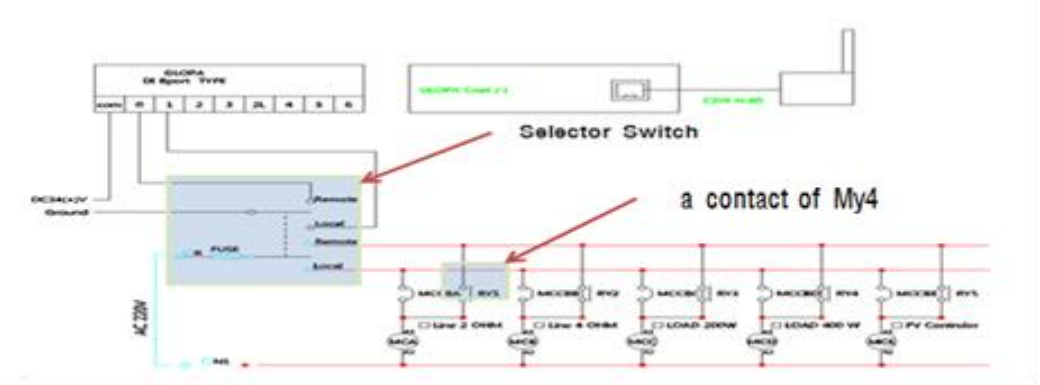

Figure 4. Concept of Control Device

3. 3. 50Kw PV System with 3 Phase Inverter

As shown in Table 1, the input and output data which of PV inverter used in this test for grid connection is transferred by using the RS232 serial communication and itself protocol

Table 1. Contents of 50KW Inverter Protocol

Photovoltaic Battery Voltage		0x0020	32	1	V	300	0X012C	1	300V
Photovoltaic Battery Current		0x0021	33	SCALE	A	300	0X012C	SCALE	30A
Photovoltaic Battery Power		0x0022	34	1	W	55000	0XD6D8	1	55000W
28-31	PV_VOLT	Photovoltaic Battery Voltage		0A00A0	160	1	Vdc	160[Vdc]	
32-35	PV_AMP	Photovoltaic Battery Current		0A006B	107	0.1	A	10.7[A]	
36-39	PV_KW	Photovoltaic Battery Power		0A080D	2061	0.01	kW	20.61[kW]	

4. Implementation of Monitoring and Controlling Device using Wireless-Network

4.1. 50Kw PV System with 3 Phase Inverter

The concept for data flow of monitoring device is shown in Figure 5. First, the data of the 50Kw solar power system is transferred by wire to the wireless converter of CSW-H80 by transforming into Serial communication. This serial communication collecting data from PV system is transferred by wireless converter to the monitoring place where TCP/IP exists. The data is received by the router at the monitoring place and then it is transferred in form of Ethernet by wireless router and it is sent into wire converter of CSW-H20-2. After that, it is transferred as serial data to PC.

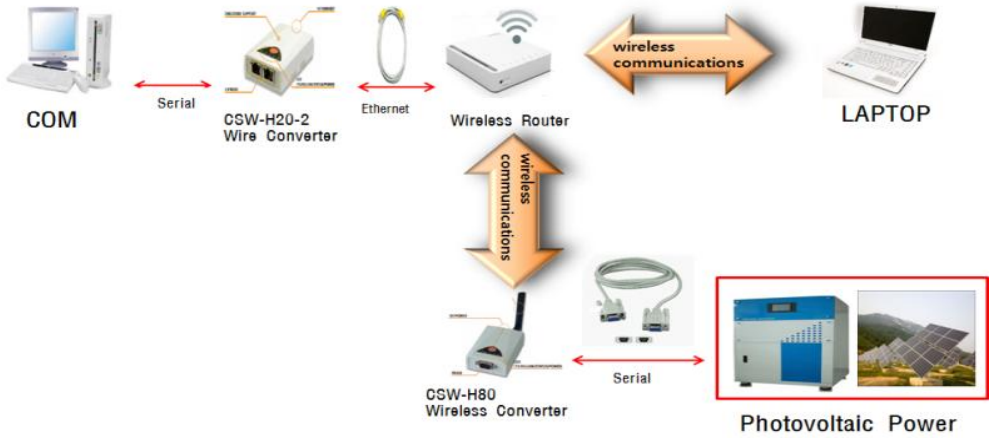

Figure 5. Algorithms of Monitoring Device using Wireless-network

4.2. Real time remote control device

The concept for data flow of control device is shown in Fig. 6. At first, the signal to control ON/Off switch of the 50Kw solar power system is produced by HMI Software. The control signal is transformed from Serial communication into Ethernet communication with CSW-H80, and is sent the transformed signal to the PV system in a wireless manner. And the signal is transferred to PLC to control the ON/OFF switch like MC. Then the 24V of output voltage by using LADDER program of PLC is sent into the power of relay.

Figure 6. Algorithms of Controlling Device using Wireless Network

5. Analysis of Simulation

Figure 7 shows the main menu of remote monitoring and controlling system using HMI Software. The panel can monitor the weather conditions and the 3-phase voltage and current from 50Kw solar power system, and also, monitor the frequency and power factor of each phase. The panel can also control the ON/OFF switch of PV system to solve the maintenance and management problems.

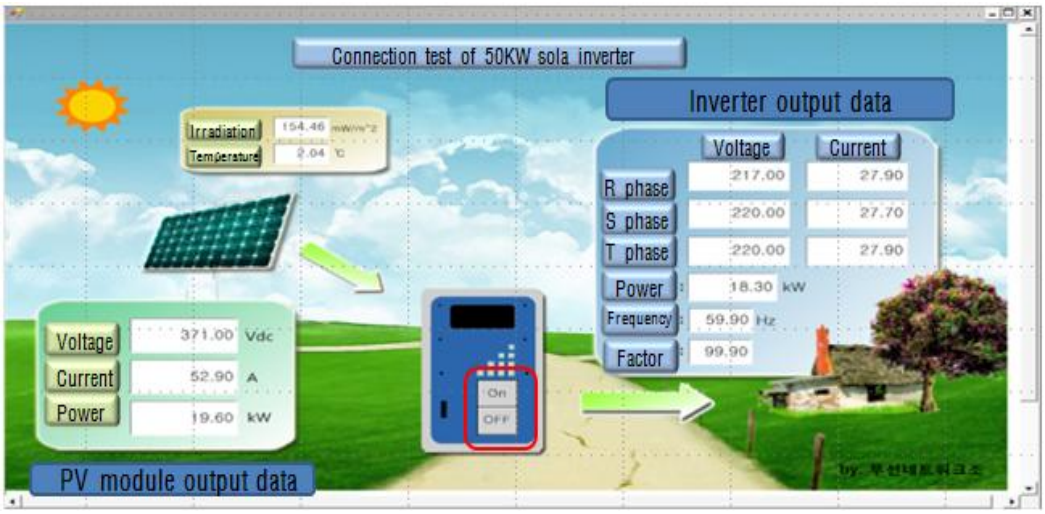

Figure 7. Monitoring Panel using HMI S/W

Figure 8 shows that the measured data from 50KW inverter of PV systems is equals to the data from monitoring system proposed in this paper. Therefore it is verified that the monitoring and control system is practical system.

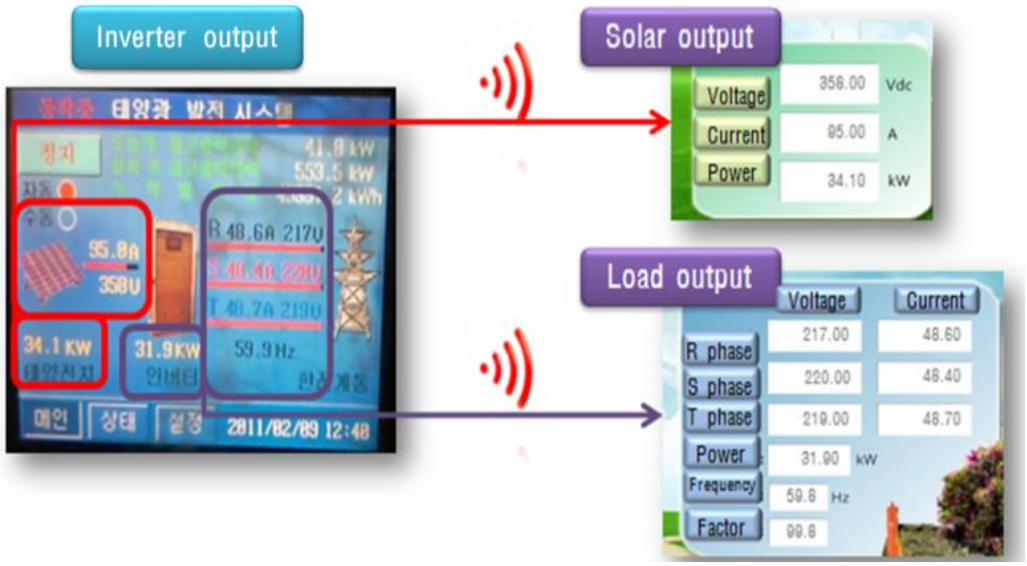

Figure 8. Comparison of Monitoring Data between Data of Inverter and Proposed Method

Figure 9 shows the daily output pattern of PV systems by using HMI Software. the output power of PV system is analyzed as the highest value from 12 PM to 3 PM, by using the saving data function of HMI Software. Finally it is confirmed that, predicting the output pattern of PV system through the proposed system can be effectively performed.

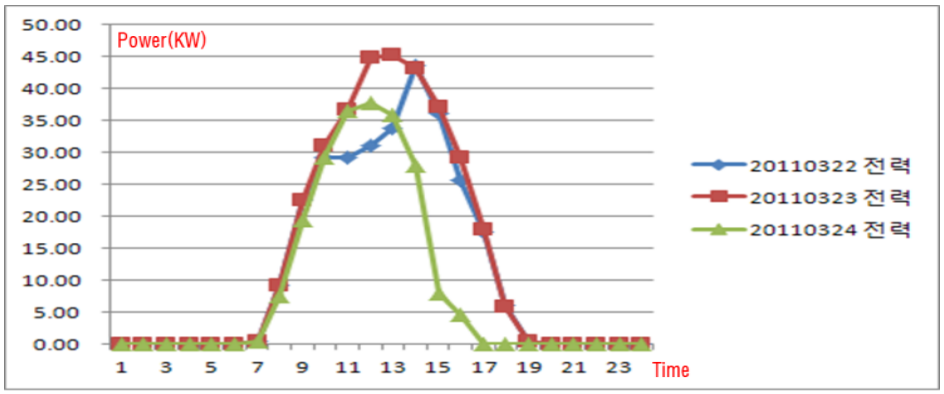

Figure 9. Daily Output Pattern of Solar Power System

6. Economical Evaluation

Until now the IPv6 has not been commercialized. In this situation, if the remote monitoring and control system has been commercialized, all of the measuring devices must have their own IP addresses as shown in Figure 10 [10, 16]. So the problem of IP exhaustion could happen in global size. However, if the wire-wireless monitoring and controlling device proposed in this paper is used in independent network, it is unnecessary to consider of the IP exhaustion. Therefore it is verified that the proposed system can be practical and competitive.

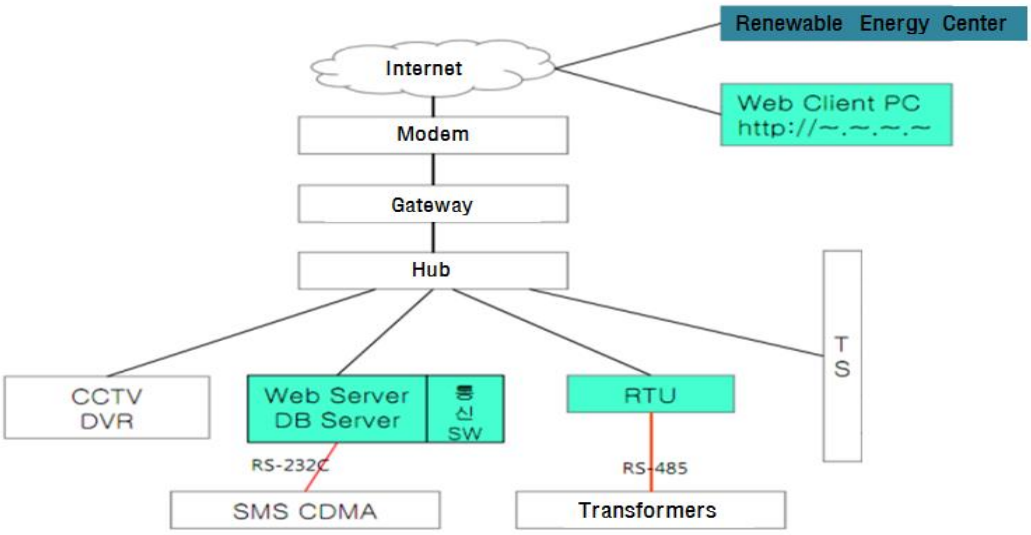

Figure 10. Internet Based PV System and the Configuration

Table 2 is the maintenance cost of PV systems according to the minimum wage in South Korea and Table 3 shows the installation cost of wire-wireless monitoring and control device proposed in this paper [16]. It is found that the wire-wireless monitoring and controlling device could be economical and practical because labor costs can be saved dramatically.

Table 2. Maintenance Cost of PV Systems

	Period	Salary(won)
Per a day	4,320 X 24hour	103,680 won
Per a week	103,680 X 5day	518,400 won
Per a month	518,400 X 4week	2,903,040 won
Per a year	2,903,040 X 12month	34,836,480 won

Table 3. Cost of Wire-wireless Monitoring and Control Device Installation

Component list	UNIT	
Csw-H80	2ea	374,000 won
Csw-H20-E	1ea	176,000 won
Cable	4ea	8800 won
HMI S/W	1ea	1,500,000 won
RM6017	1ea	200,000 won
Wire-Wireless Router	2ea	116,000 won
PLC	1ea	800,000 won
Relay	2ea	100,000 won
Total		3,274,800 won

7. Conclusions

This paper proposes a wire-wireless monitoring and controlling device which can monitor and control the 50KW solar power in a remote manner. In purpose of remote communication, by using directional and omnidirectional antenna it can be monitored and control the PV source which is 1KM away.

(1) It is found that the wire-wireless monitoring and controlling device could be economical and practical in both sides of the IP exhaustion and maintenance cost of PV systems which is located at remote areas.

(2) It is confirmed that predicting the output pattern of PV system through the proposed system can be effectively performed and this system can contribute to the infra construction of Smart Grid.

Acknowledgement

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