CC-Link
OPEN FIELD NETWORK

Applications
From Around
The Globe

CLPA
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**Introduction to CC-Link**

CC-Link is a high speed, high performance industrial network technology that enables devices from numerous manufacturers to communicate resulting in a fast, deterministic control system. CC-Link is an open-architecture network that was originally developed by Mitsubishi Electric, a global leader in automation and motion control products. CC-Link became an open-technology network in 2000 and is now managed by the CC-Link Partner Association (CLPA) with offices throughout the world. By mid-2006 there were more than 3.5 million installed CC-Link nodes and user companies could select from nearly 800 CC-Link compatible products manufactured by hundreds of companies from around the globe. These products include industrial PCs, PLCs, robots, servos, drives, valve manifolds, digital & analog I/O modules, temperature controllers, mass flow controllers, bar code & RFID readers, and many others.

CC-Link (Control & Communication Link) is an industrial field-level network that processes both control and information data at high speed, to provide efficient, integrated factory and process automation. It provides high speed, deterministic communication linking a wide range of multi-vendor automation devices over a single cable. CC-Link is ideally suited for machine, cell or process control in industries ranging from semiconductors to food & beverage, automotive to pharmaceuticals, material handling to building automation. CC-Link is already the dominant open technology network in Asia and is growing fast in North America and Europe.

**CC-Link Features**
- Able to simultaneously handle both control level information and I/O data over the same cable
- Operates at a high-speed communication rate up to 10 Mbps while transmitting large amounts of bit and word data
- Provides outstanding determinism for reliable communication
- Communication cable distances up to 1200 are accommodated
- Longer cable distances up to 4.3km at 10 Mbps are possible by using optical repeaters
- A large variety of CC-Link compatible products are manufactured by hundreds of CLPA partners
- The network supports high-speed cyclic transmissions in addition to large volume transient transmissions

**CC-Link / LT Features**
- Significantly reduces wiring to field devices and within control panels
- Provides high-speed I/O response
- Easy-to-use connector eliminates wiring errors
- Adding I/O drops is extremely easy
- Communication and power wiring is combined in a single cable
- Designed to efficiently handle smaller increments of I/O points

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The AutoAlliance facility in Flat Rock, Michigan manufactures the Ford Mustang and the Mazda6. More than 3,700 employees work at this 2.7 million square foot operation. AutoAlliance makes extensive use of CC-Link networking in the manufacture of approximately 1,200 vehicles per day. This application article describes the body assembly and paint operations. More than 400 robots are used to make over 6,000 body welds on each vehicle. 61 robots and 10 automatic paint machines apply sealants, sound deadening and 19 paint colors.

The ease of assembly line start-up and excellent reliability of CC-Link has translated into a highly productive manufacturing facility. The speed at which these new lines were installed and commissioned resulted in significant savings in comparison to other networked systems used previously. Control engineers at AutoAlliance have commented that they have had no CC-Link network failures but that they have experienced a number of failures with Ethernet networks and with 2 other commonly used fieldbus networks.

**Conveyor System**
A series of conveyors, controlled via CC-Link, move car bodies through the numerous welding, assembly, and painting stations. Each vehicle travels approximately 13 miles in the course of production. Pictured here is a Power and Free (P&F) conveyor. The motors that power the conveyors throughout the facility are controlled by Mitsubishi VFD Drives communicating via CC-Link.

**Body Panel Assembly and Welding Operations**
CC-Link networking is also used to communicate and control the VFD drives that power the motors for moving a JIG bed. A JIG is a large fixture with remote pneumatic I/O that can clamp, fold and hold a section of the auto body.

A CC-Link network handles communication and coordination of the Kawasaki robots within this specific manufacturing cell. Some of these robots move parts within the cell and other robots perform welding of the body panel assemblies. The CC-Link network initiates and stops robot movement and also enables the robots to communicate their positions to each other in order to avoid collisions.

**Conveyor System**
A line of CC-Link connected Kawasaki robots finishes welding the body panels together. There are approximately 400 robots in the Body Assembly portion of the facility. Each robot is connected to a Mitsubishi controller via the CC-Link network. One CC-Link network typically controls between 10 and 12 robots. In addition, Mitsubishi VFD drives control the pumps that provide coolant water to the robot welding guns.

**Typical Control Panel**
Shown here is one of the control panels for the Mustang sub-assembly within the Body Shop portion of the AutoAlliance facility. It handles the control for the assembly of the driver’s side panel of the Mustang auto body. This panel includes a Mitsubishi Automation Controller with five CC-Link network masters. One of the five networks provides communication between other control panels within the body shop. The other CC-Link networks handle control of the material handling equipment, robots and welding operations described below. There are approximately 125 control panels of this type within the Mustang Body Shop. The Mazda Body Shop in this Auto-Alliance facility also uses approximately 125 control panels of this type to provide similar control functions for Mazda assembly.

**Paint Line**
Mitsubishi PLCs control the paint line where state-of-the-art Fanuc P500 robots apply the finish color. These robots can apply 24 different paint colors.

After the finish color has been applied, another line of robots sprays two coats of clear paint over the vehicle body.

**Pollution Abatement**
The AutoAlliance facility also uses the latest in pollution abatement equipment. The strong fumes generated during the body paint process are incinerated to neutralize harmful compounds before being vented to the atmosphere. The process is called RCD for Regenerative Catalytic Oxidizer.

A Mitsubishi PLC controls the RCD process and communicates, via CC-Link, to 5 Mitsubishi VFD drives.

Each VFD drive controls a 500 HP fan. The process involves exhausting the fumes from the paint line and passing the fumes through a catalytic oxidizer. There are 6 oxidizer beds (2 incinerators, 2 regeneration, 2 standby).

**Typical Operator Interface Panel**
Numerous Mitsubishi GOT Operator Interface Panels are used to depict production information and status on their LCD screens. The VFD drives and Operator Interface Panels communicate to the PLC controllers via CC-Link. Upwards of 95% of the controls within the Body Assembly portion of the facility are connected via CC-Link.

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Hyundai Kia Motor Company (Korea)

Hyundai Kia Automotive Group, of Korea, is one of the world’s major automotive manufacturers. The Kwangju factory of Kia Motors Company is a group of specialized assembly plants for small-sized commercial vehicles of Hyundai Kia Automotive Group. These include plants for press operations, auto body assembly and painting, and material plants. An important capability of the factory is to build limited-production diversified products in order to manufacture many different types of vehicles to quickly meet market demand.

CC-Link networking is widely used in the body shop for the assembly lines of the front floor, roof side panels, rear & roof panels and others. Control equipment, such as interlocking signal control panels for robots and shuttle control panels, are connected to the upper level PLC Controller through the CC-Link network.

According to Kwangju factory personnel, the main reason CC-Link was adopted is easy wiring of control devices and easy maintenance of facilities and lines. And CC-Link can be widely used throughout the facility for effective distributed control. CC-Link can be applied to any production line for automobiles and any other operation, which is a very big advantage. Furthermore, when I/O update speed and the speed of the CC-Link network is compared to other field bus networks, CC-Link proves capable of handling more control points in shorter time-frames than other field bus networks.

A manager from the maintenance section in the factory has commented, “I am very satisfied with CC-Link because of the high reliability of I/O communication and CC-Link is easier to use and maintain than other field bus networks. I also need detailed diagnostics beyond just the indication of ‘normal’ or ‘error’ station status.”

Beijing Hyundai Motor Company (China)

In recent years, the Chinese auto industry has attracted significant capital investment due to the expanding consumer demand for automobiles. Beijing Hyundai Motor Company produces four types of vehicles including the SONATA, ELANTRA and TUCSON. This production facility was established in 2002 and is now undergoing an expansion project. Now, 300,000 cars and engines are manufactured per year by Beijing Hyundai Motor Company. With an eye to future expansion and improvement of the production facility, the CC-Link open network has been adopted in this plant to provide a more stable production line, quick failure recovery, a simple and easy-to-use control system, while guaranteeing future expandability. In the body welding and painting lines where the “Sonata” is produced, many CC-Link compatible products are used including PLCs and robots. High-speed and large volume communication between CC-Link compatible devices is realized. CC-Link easily supported a major increase in the number of robots needed to expand production. Plant production data is gathered and transmitted to upper level control systems through the CC-Link network in order to monitor the current operational status of the production line. The world’s most advanced press, welding and engine production lines are made possible by CC-Link networking. CC-Link high-speed and large volume communication enables significant increases in productivity and avoids costly production line stoppages.

A key maintenance person at Beijing Hyundai Motor Company commented that he is very satisfied with the reliability of the CC-Link network: “It is very convenient from the viewpoint of maintenance. CC-Link is so stable that it does not require maintenance except for periodically checking communication cables to ensure that they have not become loose.”

Office/Condominium Automation (China)

In China, the construction industry is highly active. CC-Link is being adopted for the building automation system in intelligent office buildings and condominiums, particularly in East China including Shanghai. The CC-Link building automation system controls a wide range of equipment in these buildings. This new system improves energy savings and reduces operating costs, while still providing a comfortable working environment and living environment. The CC-Link network controls the electrical distribution system and air-conditioning subsystem, the boiler and plumbing control systems, the lighting control subsystem and several other subsystems.

CC-Link networking also enables remote monitoring and operation of the water supply and plumbing system, and lighting. In one of the applications, it allows three settings for the air-conditioning subsystem: fully automatic, semi-automatic, and manual. Furthermore, utilizing a unique CC-Link feature allows the system to easily accommodate expansions. This CC-Link special feature provides for the addition of remote scanning of water and electric meters. The CC-Link network is low in cost, provides high performance, flexible features and functions, and is easy to adapt to previously installed low-rise and middle rise intelligent building systems. The result is an improved, low cost building management system.
**Koujimachi Diamond Building (Japan)**

CC-Link features, such as high-speed, easy expansion and a wide range of products by numerous manufacturers, make it the logical choice for a building automation network.

There is a new type of urban office building in Tokyo designed for comfort and security. This particular building rises 11 stories above the ground and one level underground. It not only has a beautiful green roof terrace, it incorporates public use facilities such as a subway entrance, and features a large glass curtain wall that has sophisticated energy-saving properties in addition to its beautiful appearance. In addition, the CC-Link based system has provided a cost-effective way to upgrade to the most advanced facilities management system; the Building Management Assistance and Solution System (“B-MASS”).

Similar to BACnet and B/Net networks that have been previously used in building automation systems, CC-Link is being adopted as the network of choice to connect PLC controllers to the total building automation system.

In this building, the process automation system is controlled by a PLC. Sensors and other equipment are installed at each floor and are connected to a PLC controller by the CC-Link network. The heat source controller of the Crystal Liquid Ice Heat Storage System (CLIS) is directly connected to a PLC Controller. CLIS is a part of the heat storage system responsible for substantially reducing carbon dioxide and the total running/operating costs for the air conditioning subsystem. The Vapor Cycle Air Conditioning System (VCS) is directly connected to a PLC as well. CC-Link makes it easy to install equipment and devices and to wire the entire building automation system.

It is necessary to install the network wiring across several floors of this building. CC-Link networking is particularly suitable because it allows long cable runs which can be extended by using anti-noise optical repeaters.

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**Nanyang Architect of Fine Art (Singapore)**

The CC-Link network has been selected for the Intelligent Building Management System in Singapore.

Within educational facilities in Singapore, a clean, green and comfortable environment for learning must be provided. At the same time precious energy resources must be conserved while providing cost-effective construction and long-term facilities efficiency. In order to satisfy these requirements, CNA, a famous system house in Singapore, was selected to provide integration of a wide spectrum of services including HVAC, Electrical, Plumbing, Sanitation, and Lighting Automation.

For the Nanyang Architect of Fine Arts project, CNA decided that high-speed PLCs were to be installed throughout the facilities in order to accomplish an intelligent building management system and to provide around-the-clock monitoring and control of security, energy conservation and indoor comfort.
Building Automation Applications

Multi-Facility and Office Building Integration (Germany)

AGSY TEC is a specialist building Technology Company. They are based in the picturesque town of Neuenstadt, Baden Württemberg, and have utilized the power of the latest Open fieldbus CC-Link to totally automate and link a customer’s four factories and one office building together on a single Building Management System.

Before the new Building Management System (BMS) was used on-site, all the building facilities had to be operated by hand. These facilities included lights, heating, windows, window blinds, presentation screens and a host of other functions.

Most people do not appreciate that using a manually operated building facilities system can at times be more expensive to operate than a totally automated one. But when viewed from an energy management perspective the long term cost savings of using an automated BMS system can be considerable. The use of the new BMS system apart from giving precise facility control also enhances security of the buildings, as it can indicate immediately if windows are left open.

Old BMS systems used on buildings are very energy expensive and do not allow energy efficient heating of the rooms, and/or compensation for hot spots created by other factors such as sunlight.

The new building management system from AGSY TEC changes all this with a new approach to the technology, that uses the latest in high speed automation to ensure precise real-time control of all building facilities.

Mr. Heuchemer, product manager for AGSY TEC states “We choose to use CC-Link at our customer site as it has a remarkable tolerance to electro-magnetic noise. We have used other networks, but always had noise problems, but with CC-Link it worked without expensive cabling and expensive earth grounding precautions. Another reason we used CC-Link was that it is very low cost, and extremely fast, not just in network speed, but actual speed of response due to its low overhead protocol. This high speed allows us to expand the system at a later date without having to slow down or reconfigure the network. A major advantage for us is that it allows us to offer customers connection of building control and machines over the same network, dramatically reducing installation costs.”

The site system consists of 4 micro PLCs connected back to a central modular PLC via CC-Link running at 10 mega bits per second. The central PLC takes care of all coordination, monitoring and reporting for the overall system. Each building has its own independent PLC giving localized intelligent control, which is needed to ensure the system operates even if network communication gets interrupted between buildings.

Every room has a dual temperature sensor, with one in the north and one in the south. The system compensates for area temperature changes due to sunlight heating through the windows, again increasing energy savings.

To avoid unnecessary network traffic, the remote stations send back digital data when states have changed, but all analog data such as temperature etc. is reported back on a real-time basis to the central master. Christoph Lohm, installation and service manager for AGSY TEC comments “With CC-Link we can remove station cabling when the system is running without shutting down the entire network. What we liked about CC-Link from a maintenance point of view is that we can program the network and connect stations via a modem connected to the master PLC. This allows us to offer the customer a very competent after-sales maintenance and service program, and to diagnose problems remotely before going to the site”.

Using intelligent building management systems does require an initial expenditure, but with energy savings of up to 30% not uncommon, the payback period on a building can be as short as two years.
The data link should operate normally even when an error occurs in one of the network devices. Each network device should be capable of being replaced online. Each solenoid valve should be capable of being replaced online. CC-Link was chosen as the field bus system that met the above requirements.

In this system, the control station of the DCS is connected to the PLC Controller by a PLC Controller level network system. CC-Link is controlled through this PLC and all of the solenoid valves and digital inputs are connected to the PLC by the CC-Link network. The solenoid valves and other digital I/O are installed in a wall-mounted panel and are connected to the process valves by pneumatic piping and cables. The power supply circuit of the solenoid valves has been simplified in the new paper machine by using CC-Link networking. Wiring in the panel has been sharply decreased because the individual interface boards (previously required) are no longer necessary. This reduces the number of components. Each solenoid valve wiring panel is now connected to the controller by a single CC-Link network cable which dramatically reduces wiring costs. Oji Paper can also expect increased reliability due to fewer I/O connections. By utilizing the CC-Link fieldbus network, it is also easy to collect and compile process information that is useful for preventive maintenance. As a result, Oji Paper expects a reduction in overall operation costs.

As with other CC-Link installations, this network approach eliminates the wiring mistakes so common with non-networked systems. Thus, field installation requires far less time and system start-up is considerably more efficient with less downtime for the end-user.

The speed of the CC-Link network (10Mbps) and the fast update time allows quick response in the control of the ink and water motors thus reducing the paper waste that would occur during start-up and after plate changes. Also, the fast speed of CC-Link enables quick system response in the event of a web break or when a paper jam is detected. The effectiveness of CC-Link accuracy, speed and durability provides conditions that reduce paper waste, offers safer operating conditions and reduces damage to the press units and folders due to paper wrap-ups.

The open-technology aspect of CC-Link allows a wide variety of automation equipment from numerous manufacturers to be integrated for fast and effective control. PLCs, Motion Controllers, Pneumatic valve manifolds, Variable Frequency Drives (VFDs), Digital I/O, and Analog I/O are all connected via CC-Link for reliable control of the printing process.

Description of the CC-Link Based Printing Press

The press units are designed with a separate CC-Link network for each press unit for a modular, expandable design concept. Each press unit produces a single color. Four individual press units may be connected together to operate as a four-color press. The separate network feature allows the separate startup of each unit, and thus a separate startup of each color. An additional advantage of the separate network design is that it allows for easy expansion of the press in the field.
Machine Control Applications

Becatron Mecatronica (Germany)

Becatron Mecatronica B.V. of Apeldoorn have been specialists in the mechatronics industry for 15 years. Based on their extensive technical experiences they decided to install a CC-Link system to manage energy saving and machine safety for ITS, Europe's largest rewinder of aluminum foils and cling films.

ITS makes over 7,000 tons of foil per year, produced on over 40 machines in their factory in Apeldoorn. Production at ITS has increased by over 20 fold in the last 15 years but they have managed to keep staffing levels the same and overhead to a minimum by investing in the latest automation technologies.

Before the new energy saving system was installed all the machines were stand alone, and every machine needed an operator to start and stop it. With the new CC-Link control system ITS can utilize staff more effectively and now one member of staff looks after a production process, rather than an individual machine.

Before starting production the rewinding machines need to attain their operating temperature. This can take up to 5 minutes per machine. To prevent energy demand peaks the machines must be started consecutively.

Totally Automated Procedure

The start up sequencing of all the machines in the factory was quite complicated, but with a totally automated procedure any operator errors can be shut down if it is idling too long. A powered up machine needs to be periodically shut down for scheduled maintenance, and the CC-Link system is flexible enough to incorporate this into the control philosophy by using its unique station offline feature. The master for the overseeing system is a micro modular PLC, connected to a 4 line test HMI. The HMI allows the maintenance operators to alter any of the switching times of the production machines from a central location.

50 I/O Stations on a Single 4-Wire Network

For the entire factory 15 systems are connected to CC-Link, using 50 I/O stations on a single 4-wire network. CC-Link was chosen as it is very fast in its reaction compared to other fieldbus networks, and Becatron are more confident of a CC-Link integrated solution than Profibus DP, due to the local noise problems which can occur from the high energy rewinding machines.

Gertt Beking, Managing Director of Becatron says of the CC-Link system "ITS is a very special customer of ours and we wanted to install a system that would give them a trouble free solution. Since we installed CC-Link it has never stopped working and is extremely reliable. The configuration and start up of the system was very simple, with CC-Link's unique station offline feature. Facility machines on the factory floor also need to be periodically shut down for scheduled maintenance, and the CC-Link system is flexible enough to incorporate this into the control philosophy by using its unique station offline feature. The master for the overseeing system is a micro modular PLC, connected to a 4 line test HMI. The HMI allows the maintenance operators to alter any of the switching times of the production machines from a central location."

The increased efficiencies that have been achieved over 12 months of running the system are staggering. Dawson, working in partnership with Longslow Dairies, is now due to expand the system by installing remote maintenance and diagnostics tools, giving Longslow even more control of their plant and further reducing downtime.

Longslow Dairies, Packaging (UK)

Consumers are increasingly buying milk in plastic bottles rather than the traditional glass, but Longslow Dairies Group believes that glass is better in the current age of environmental friendliness and recycling. Supplying product in glass bottles gives consumers a cost-effective solution to refillable milk packaging that is also kind to the environment. To meet this demand Longslow has installed the UK's first totally automated milk bottling plant at their Central Dairies factory at Colwyn Bay.

The project was awarded to Dawson, a specialist fitting, cleaning and handling systems manufacturer based at Heckmondwike, with the desire that the plant be easy to use and maintain. Dawson designed, built and installed a complete, but simple solution that requires no manual interaction to run the plant. Although the initial order was only to automate parts of the system, as installation proceeded Longslow Dairies was so impressed with early results, that they extended their requirements to automation of the whole plant.

To enable modular construction of the plant, Dawson chose to use Mitsubishi Electric automation equipment, creating a prime example of the company’s MELSMART integrated automation engineering environment.

Mitsubishi Electric’s products are also easy to install, are highly immune to noise and – critically in the tough environment of a dairy – extremely reliable.

At the hub of the plant system is a Mitsubishi Master PLC that coordinates all communications via a CC-Link fieldbus. The 7 basic sections of the plant, each controlled by a Mitsubishi Micro PLC. These control all local operations and connect back to the Master PLC using CC-Link. Utilizing intelligent slave PLCs rather than one large PLC to control the whole plant allows sections to continue operating even if there are problems in other plant areas, ensuring high throughput and increased section efficiency.

The success of the project highlights the benefits of Mitsubishi Electric's MELSMART concept in action, providing a modular approach for managed investment and return. Based on 'best in class' solutions, including an integrated automation hardware platform and software, MELSMART is supported by Mitsubishi's Hatfield Customer Technology Centre and a nationwide group of accredited MELSMART partners.
CC-Link provides the “open” network backbone for a high-pressure gas filling system at ILL-MO in their Jacksonville, Illinois facility. The compressed gases handled at this facility are Oxygen, Argon, Nitrogen, Carbon Dioxide and Helium. This system was designed and installed by Computer Integrated Automation, Inc. of Carol Stream, Illinois. The CC-Link network enables communication between PLCs, motion controllers, pneumatic valve manifolds, variable frequency drives (VFDs), digital I/O, and analog I/O devices. CC-Link handles remote device interfacing, integrating equipment from different manufacturers, data collection, information handling, and data exchange between PLCs and machine control elements.

The control system and CC-Link network assure gas purity, filling accuracy, and handles all operational functions of the gas filling controls. In this application, CC-Link enabled equipment from these different manufacturers to communicate over the same network:

- WAGO Corp. – I/O modules
- SMC Corp. – Pneumatic valve manifolds
- Mitsubishi Electric Co. – PLCs, HMIs, VFDs, I/O modules

**Additional Benefits**

The use of the CC-Link network results in significant reductions in conduit and wiring expenses. Instead of long wire runs from each field device back to a central controller, now a simple communication cable interconnects all gas-filling devices on the network. Also, this approach eliminates the wiring mistakes so common with non-networked systems. Less skilled personnel can be utilized for the field-wiring task. Thus, field installation requires far less time and system start-up is considerably more efficient with less downtime for the end-user.

From the designer’s perspective, a CC-Link networked system requires less engineering time, fewer CAD hours, less installation production, and enables simplified panel layout and design, and the use of space saving components. CC-Link also allows easy future expansion of the system, which in today’s rapidly changing environment is an important benefit.

**Description of the CC-Link Based System**

One CC-Link Master controls a single gas-filling island where a variety of I/O devices transmit thermocouple, digital, and analog information.

**Mix Gas Filling Station**

As the name implies, the Mix Station fills gas tanks with a mixture of different gases. An operator determines the portions and types of gases to be mixed through a touch panel HMI (Human Machine Interface) located on the front panel of the control enclosure. In this photo, the back of the HMI can be seen in the open panel door. The CC-Link Master module is located in the backplane of a Mitsubishi PLC rack. Information is transmitted via CC-Link to control the pumps and valves to provide the proper gas mixture requested by the operator.

**Inert Gas Filling Station**

At this station gas tanks are filled with the selected Inert gas. The front of the Inert Gas Filling control panel contains numerous gauges and valves as well as another Human Machine Interface (HMI) device. Inside the control panel is a Mitsubishi Micro PLC. This PLC integrates the numerous gauges, valves, push buttons, and HMI onto the CC-Link network.

**Oxygen Gas Filling Station**

At this station gas tanks are filled with oxygen. The front of the Oxygen Filling control panel contains several gauges and valves as well as another Human Machine Interface (HMI) device. Inside the control panel is a Mitsubishi Micro PLC. This PLC integrates the numerous gauges, valves, push buttons, and HMI onto the CC-Link network.

**The final part of the system is the Pump and VFD control system. The VFD Control cabinet houses three Variable Frequency Drives (VFDs), each communicating on the CC-Link network. The VFDs control the pumps for filling the gas containers. A single pump may be used at several different gas-filling stations at different times, therefore the pump control needs to know which pump is operating at all times. This information is obtained through the use of the CC-Link network. Also in that cabinet is an I/O module for controlling the pump starters and various other I/O devices.**
Klinting Vandvaerk Facility (Denmark)

Since 1979 the Klinting Vandvaerk water company in Denmark has been a supplier of the highest quality drinking water for the western region of West Jutland. The normal population of the picturesque part of Denmark is 3000 households, but as tourism has increased in the region of West Jutland. The normal population of this picturesque part

has increased to 4500 users, the water station has had to increase production drastically to keep pace with new current and future demands. The challenge set to the engineers involved with the project was not only to increase the output capacity, but also how to increase the number of boreholes which provide the water, and to increase the whole system including the reservoir capacity (from 700 to 2200 m³) without affecting supply to existing customers.

The existing water system consisted of 5 remote boreholes, a 700 m³ reservoir, green sand filter system and an outlet pipeline. The boreholes are located 1.2km from the main pumping station (in the middle of a local forest) with each borehole able to extract up to 30 m³ of water per hour, with the boreholes going down to a depth of 100 meters.

Interactive Control Is a Must

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The first part of the project tackled was the reservoir, and a new 2200 m³ capacity tank was installed at the station site. The next step was to increase the number of boreholes from 5 to 11. After the mechanical elements were installed the engineers involved set about the task of updating and connecting the new system together. When the overall concept was decided, specialist automation system supplier PRO/AUTOMATIC were called in to manufacture the control system panels and program the newly chosen PLC controlled solution.

Remote Borehole Connectivity Was a Problem

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The first problem to overcome was how to connect the remote boreholes pumps (up to 1.2km away) back to the water station's new PLC control system. After looking at many network solutions, the specialist automation equipment supplier, Louis Poulsen proposed the latest in fieldbus technologies, CC-Link. CC-Link can use standard cabling up to 1200 meters, but on this system the area is very flat and lightning can cause transients in communications, so a fiber-optic system with repeaters was chosen to avoid any possible network errors.

Wago Remote I/O Used On CC-Link

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The master of the CC-Link network is a Mitsubishi Electric PLC which resides at the main water station. This connects via the fiber-optic cable to remote Wago CC-Link I/O modules which are connected directly to the borehole pump controllers.

On each of the remote WAGO CC-Link I/O is a 4-20mA analog input connected to every borehole, which is used to measure borehole pressure using pressure sensors (at the level of the ground-water). This allows the system to detect level changes of the ground-water when a borehole is pumping. Every month each borehole is tested.

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The use of VSDs has the additional effect of saving large amounts of energy over the old direct on line (DOL) pump starting system. They do this by optimizing energy usage by reducing the frequency to match instantaneous changes in pumping pressures. Using VSDs also has the advantage of extending considerably the pump’s life expectancy, and are under the real-time control of the central PLC via the CC-Link’s 10MBit network.

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The advantages of the new system are huge. Now the entire site can be controlled remotely. The new system has improved the safe operation of the overall system, with the new system having duplex backup control of all major water pumping elements. The system is also designed to be very flexible and can be expanded without any fuss, and allows for any changes in legislation and needs that may arise from local authorities without having to renew the control system.

Jens Kruse Madsen of Klinting Vandvaerk is rightly proud of his new Water station which is extremely clean and very well managed. “Water is food” he says and insists that only the highest standards of cleanliness are used in the station, and that the control equipment is installed to the same levels as any food factory. He continues “We started the project in February 2003 and everything was completed without any hitches by the official opening on the 1st of October 2003, with all work completed and without any noticeable water supply stoppages to the served communities”.

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CC-Link was chosen as the site fieldbus standard for a few reasons. The main reason is that it was very easy to set up and install and extremely noise resistant and robust. Another reason is its unique I/O disconnect mode allowing stations to be removed from the network without affecting network performance or data loss.

PRO/AUTOMATIC says of using CC-Link “It was wonderful to use such a simple but powerful fieldbus solution. It was so easy to create the network systems and it has some very powerful and unique features such as the station removal. Another aspect we liked was that there are a growing number of automation manufacturers that now offer CC-Link connectivity and we know that by installing this network solution we are using cutting edge fieldbus technology that is supported worldwide”.

Large energy saving was a bonus as the VSDs used the new system is so flexible it can now easily accommodate the variable supply requirement. Now average water consumption ranges from 1500 to 2000 m³ per day in winter and soars up to 4-5000 m³ in the summer (due to tourism), with the CC-Link controlled system easily able to respond to realtime demands.
Changi Water Reclamation Plant (Singapore)

CC-Link Network is used in the Changi Water Reclamation Plant (CWRP) in Singapore. The Changi Water Reclamation Plant will transform the management of waste water and provide high sanitation standards in Singapore for generations to come. Company CNA, a famous systems integration house in Singapore, has supplied numerous integrated facility management systems and was involved in the implementation of the waste water control and automation systems for the CWRP. This water facility is one of the largest in the world. Company CNA has decided to use the CC-Link network for controlling the Temperature and Ventilation Control Systems.

There are numerous control rooms in this plant and one or more panels are installed in each control room. As this plant is located near the sea, it is necessary to install the control equipment inside a panel in order to protect these devices from corrosion.

The entire control system is divided into two layers as shown in the drawings. This system utilizes the transient communication function of CC-Link rather than the standard cyclic communication function. One of the advantages of the CC-Link network is that there is no effect on the total link scan time of the cyclic communication cycle even though transient communications are conducted. All of the Discrete Inputs and Outputs and Analog Inputs and Outputs were installed through a Local station. Another advantage of the CC-Link network is that a Local station can be set up as a Stand-by Master and take on the Master station functions if necessary. This important function provides back-up control and communication capability.

CC-Link Master using transient communications. The CC-Link network is used to exchange data between all CC-Link Local stations; therefore there is no need for the installation of Remote I/O or Remote Device stations. Another advantage of the CC-Link network is that a Local station can be set up as a Stand-by Master and take on the Master station functions if necessary. This important function provides back-up control and communication capability.

Milklink Dairy (UK)

Milklink Dairy’s engineering team in Crediton, Devon, prides itself on constantly improving efficiency. Their latest energy saving project, involving the site’s water management system, has shown what careful planning and implementation can achieve.

The site has its own two bore-holes that can produce all their water requirements, but can also connect onto mains water if necessary. Water is an essential commodity at the dairy and is used for a host of water services such as wash downs, cooling etc. The water is softened before use, to avoid leaving any residue on the production surfaces.

The old water control system had inherent problems, such as water wastage due to leaks in the old system, lack of capacity to meet new production demands (the dairy produces 2 million liters of UHT milk per week), high energy expenditure and no centralized control and monitoring.

Raw water was stored in a large 38k liter Brailthwaite tank and led via a water softening system to two other tanks for use by the boiler house and the factory production lines (with 38k liters and 135k liters capacity). The water pressure to control the whole operation.

All the pump speeds are controlled by PID loops in the PLC with data sent to the VSDs via the 10MB high speed CC-Link connection. The reaction time of the entire CC-Link network is a mere 15mS, giving instantaneous control of the entire water management system. Due to the fast control of the VSDs, and high speed matching of pumping requirements via CC-Link, the pump motor frame sizes were reduced from 15kw to 7.5kw providing a considerable saving in energy costs.

The actual changeover from the old to the new water management system took only three months, with all panel building and installation being done on site by the Milklink engineering team. John Bater assistant project engineer said, “Using CC-Link on this system made the whole installation much easier. We now have remote control and programming of the entire system and were pleasantly surprised how quickly we managed the entire changeover”.

The power requirement for the water management system has now been reduced by up to 173kw per hour, giving a pay back period of only 19 months for the entire system. Additional benefits include reduced water costs, less actual water waste and increased ease of maintenance.

Ken Mason says of the chosen Fieldbus technology “CC-Link is now the preferred site standard. It was chosen because it is fast, easy to configure and has never failed to operate correctly, even in the most testing of environments”.

The PLC automatically controls all aspects of the new water management system. It measures water demand points, takes this collated data and works out appropriate pumping solutions. It then communicates to the VSDs and line PTY pressure transmitters (used to measure water pressure in the pipes) over CC-Link. The water pressure of the system is optimized at 3 bar to an accuracy of 0.1 bar via the efficient fieldbus network.
In South Korea one of the world’s largest liquid crystal display manufacturers produces and sells LCD panels and LCD modules used not only for television sets, computer monitors, laptop PCs, but also for other applications such as car navigation displays and E-book displays. The sizes of the LCD panels and the LCD modules range from 15 inches to 47 inches wide. This manufacturing facility operates 24 hours/day to serve the rapidly expanding global demand for LCD panels.

The CC-Link network is utilized in this facility by the TAB Bonder equipment. The TAB Bonder is used in the LCD module process, specifically the post-process portion in the production line of TFT-LCD modules.

In TAB Bonder equipment, proximity sensors and relays are connected to the upper-level PLC controller through the CC-Link network. CC-Link makes it possible to reduce the amount of wiring and the size of the TAB Bonder equipment.

A company representative commented that “CC-Link has made it easier to place I/O and install wiring. In addition, the number of empty PLC stations has been reduced and the CC-Link network is very easy to maintain.” He also hopes that CC-Link compatible products are further expanded. He wishes to upgrade intelligent positioning modules, add a graphic-based configurator, include detailed diagnostic functions, and use a PCMCIA Card for CC-Link in order to use his laptop PC.

The CC-Link Partner Association (CLPA) is an organization of manufacturers of CC-Link compatible products and users of CC-Link technology. The global CLPA support offices provide a range of services to its members. These services include:

- Distributing the CC-Link protocol specification
- Providing technical support during the design phase to members who incorporate CC-Link compatibility in their products
- Conducting CC-Link educational seminars
- Providing CC-Link conformance-testing of member products
- Issuing conformance certificates for successfully-tested products
- Listing and promoting CC-Link compatible products on the CLPA web site, in the product catalog and other publications
- Organizing task forces to improve functionality and acceptance of CC-Link technology – task forces include:
  - Technical Task Force
  - Marketing Task Force
- Promoting CC-Link and CLPA partners and products via trade shows, publications, seminars and the worldwide web
- Assisting potential members in the CLPA admission process

The CLPA has offices in Japan, North America, Europe, China, South Korea, Taiwan and Singapore. CLPA operates conformance test facilities in Japan, North America, Korea and will soon add a test facility in China.
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