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WHITE PAPER: Data Center Monitoring: Flexibility, Scale and Accuracy for the 21st Century

Rittal Computer Multi Control monitoring evolves with the rapidly changing demands of technology and the market.

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Executive summary

Today's data centers are incorporating more and more sophisticated monitoring systems to enable managers to not only maintain an overview of ambient conditions, but to keep a watchful eye on a host of parameters from a central office, a remote location or even a "smart" phone.

As today's installations increase in scale and complexity, and the expectations for monitoring expand, so do the cabling requirements for cabling individual components – including monitoring systems. More components, often in less space, can make tackling this challenge even more demanding. The latest version of Rittal's access control and environmental monitoring solution Computer Multi Control (CMC) system – the CMC III – addresses these concerns using a Control Area Network Bus (CAN-Bus) that permits interconnections between various monitoring sensors and a central controller. The successor to Rittal's proven CMC-TC system, the CMC III offers innovative improvements and additional functions while making installation even quicker and cabling more efficient. The CAN-Bus and available redundant power supply provide a new standard for measuring security, reliability and fault detection.

While the previous series was designed specifically with large IT facilities in mind, the compact version of CMC III can be deployed in smaller installations and even single-enclosure applications. Its reduced demand profile allows for a narrower scope of functionality and optimization of its price-performance ratio. Via its Object Linking Controls (OPC) the CMC III can be integrated into virtually any supervisory control system making its data available to an assortment of users from an equally diverse assortment of locations.

Introduction

Today's data center is the heart of most IT installation, especially in medium- to large-size companies. It's where irreplaceable data is stored and collected. Where access is granted to authorized personnel at any time if the day or night. It's a place where components have to be safe and operating without fear of failure – failure in any form can have disastrous consequences.

In addition to a temporary interruption in workflow, the possible data losses from a failure can place enormous cost burdens on the company, especially of the work from a week, a few weeks or months has gone to waste. If for no other reason, the data center must be monitored to permit timely response to any number of potential problems and concerns. In a modern, multi-faceted facility, technical aids have become indispensable to IT managers.

Around the world, data center managers have put their trust in Rittal's CMC-TC (Computer Multi Control – Top Concept) system. Its sensors have monitored a variety of vital functions, including such basics as temperature and humidity. These findings are continually sent to a central evaluation unit for processing. If anything exceeds a defined threshold the system sends a text message to a technician so that appropriate actions can be taken to avert a threat to the center.

As data centers expand and components become more and more complex – with more units in less space accompanied with even more cables – monitoring all these vital elements has become an even greater challenge. With this in mind, Rittal has developed its CMC III series, incorporating all the established features of its predecessor while incorporating innovations taking it into the 21st century.

Objective and requirement

IT components of the 21st century continue to pack more power, more capacity and more performance into smaller and smaller units. These compact units are expanding the capacity of data centers and entire network systems. These advances in server and component technology have not come without attendant concerns – with more powerful equipment comes additional needs for monitoring and additional concerns with cabling demands. More “boxes” in the same sized enclosures means more wires and cables in even less space.

The CMC III system is designed to not only provide additional monitoring capacity but to reduce the complexity of cabling while providing clearer cable routing between sensors within enclosures and the central processing unit. A redundant power supply guarantees reliable operation to provide fast and secure data communication without downtime. An ability to tap into Power Over Ethernet (PoE) technology further enhances the speed and ease of installation. All in a reduced footprint to make the most of a minimum amount of space.

Conceived to facilitate the needs of IT departments with multiple enclosure suites, the new CMC III goes well beyond those limitations and can be optimized for single-enclosure installations, building services applications and many industrial operations. While industrial applications may rely upon facilities infrastructure for many of its monitoring requirements, the CMC III is available in a compact version where the full-function model may be “over-qualified.” The CMC units are capable of communications with an assortment of facilities systems via a common protocol – Object Linking and Embedding for Process Control (OPC).

Many complex systems require a significant investment and a long learning curve when it comes to installation of a new monitoring system providing higher levels of technology and proficiency, but CMC III provides a simpler, less complicated installation that not only saves time and money, but permits faster, more efficient deployment of the system and its sensors.

The CAN-Bus

CMC III uses a Controller Area Network Bus (CAN-Bus) for integration of is sensors. Developed by the Bosch Company in 1991, it was originally developed for the automotive industry and is widely used in automotive applications. The CAN protocol is standardized in the international ISO 11898 standard.

CAN manages access to the common medium (the bus) and insures the correct transmission of messages. Network users on a CAN-bus are arrayed in a line topology. In an Open Systems Interconnection (OSI) model, the reference model for manufacturer-independent communications systems, it represents Layers 1 and 2.

For physical interconnections between users, either copper cables or media such as fiber optics or wireless transmission may be used. All network users are treated as equal and permitted to transmit and receive as long as the bus is free. Message frames are not addressed directly to an individual node. A message is sent to all users. Each user then determines the relevance of the message independently and either processes or discards its content.

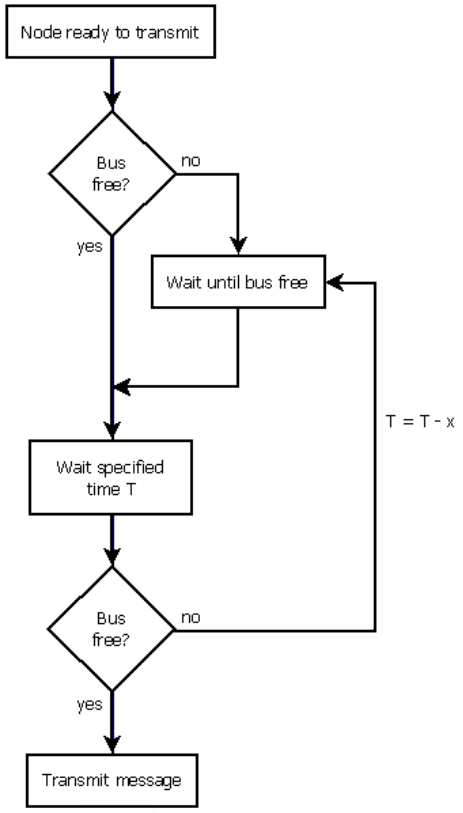

Figure 1: Bus access method

To avoid collisions on the bus, a method known as CSMA/CD+CR (**C**arrier **S**ense **M**ultiple **A**ccess/**C**ollision **D**etection + **C**ollision **R**esolution) is implemented (Figure 1). If one of the users wants to transmit a message it first listens for traffic on the common medium. If the bus is not in use, it waits for a further specified time and verifies that the bus is still free before commencing the transmission. If, in the meantime, another user has begun transmitting and has occupied the channel, the delay is extended until this transmission is complete. Called “back-off” this procedure will be repeated as often as required until the medium is free. The specified waiting time is reduced after each unsuccessful attempt, thus increasing the probability of the channel being free.

Since the system cannot completely eliminate collisions, the CAN-bus protocol also specifies the appropriate reaction should two users transmit at the same time. On the common bus, a logical “0” is always dominant, and a logical “1” always recessive. If two users transmit different messages simultaneously, the first “1” of the first user will be overwritten by a “0” from the second user. As both users are monitoring the channel, the first user detects a “0” instead of its “1” and stops its transmission. The second user will detect no error and keep transmitting. At this time the first user waits for the channel to clear so it can attempt to transmit again.

The CAN-bus is capable of transmission rates of 1 Mbit/s over a distance of 40 meters. If a cable is longer, the bit rate is reduced. Figure 2 shows attainable transmission rates for varying cable lengths. There is, theoretically, no limit to the number of potential users. The connection components of individual systems, however, normally provide for 32, 64 or up to 128 users. The CMC III provides for 32 users to connect to the bus.

Bit rate	Cable length
10 kbits/s	6,7 km
20 kbits/s	3,3 km
50 kbits/s	1,3 km
125 kbits/s	530 m
250 kbits/s	270 m
500 kbits/s	130 m
1 Mbits/s	40 m

Figure 2: Bit rates and cable lengths

Source: IT-Wissen

With its various control mechanisms, the CAN-bus features both a high level of fault tolerance and extensive fault detection – making the system especially reliable and suitable for environments subject to interference.

The CAN protocol defines bus access and message transmission, but contains no specifications regarding interpretation of actual user data. For this reason, CMC III uses the CANopen protocol where data is assigned to different types and arranged by order of importance. This permits prioritizing messages, so data flagged as important gets transmitted first and is available faster on the receiver side for time-critical applications.

CMC III

The structure of the CMC III system is similar to its predecessor – maintaining many of its proven functions and features while enhancing others and bringing new technology into play.

Figure 3: The Processing Unit PU III

The system operates with a central controller, the PU III (Processing Unit) shown in Figure 3. Sensors communication with this unit via interconnected links in series rather than in star topology via an I/O (input/output) Unit. In the previous models it was always necessary to have an I/O Unit between the sensors and the processor but in the CMC III they can be connected directly – saving space for other installations.

In addition to its refined appearance, the new unit also incorporates improved functionality. First access to the unit is immediately more convenient. A standard mini-USB port, compatible with practically every PC today, makes the connection between the PU III and PC so the user can quickly enter the settings required for initial configuration of the processing unit.

An additional USB port is provided on the rear of the unit so data from the PU III can be saved to an external data carrier. There's also an SD card slot in the front panel that can be used for the same purpose.

Rittal offers a diverse selection of sensors to be used with the CMC III system, significantly expanding the scope over what previous models offered. In addition to standard parameters such as temperature, humidity, voltage and current, it is now possible to measure values for such things as active power, apparent power and supplied energy. And, an interface module permits CMC-TC sensors to connect to the new PU III as well – making it much easier for users to up-grade to the new system without replacing all the sensors already in position.

Two in important sensors come built into the PU III as standard features. The infrared sensor on the front of the unit monitors the enclosure door, and a temperature sensor located behind the front panel to measure temperature of in inflowing ambient air. By integrating these two into the main unit, users may eliminate installation of external infrared and temperature sensors near the PU III.

The PU III acts as a central controller and is the interface between the CMC and end-user or he CMC and a higher level management system. Through a standard network port, the CMC system can be linked into a company network enabling administrator to access an integrated Web interface from their office PC via an IP address or a name assigned to the processing unit. Once an approved user name and password is entered, users may view currently measured values or modify settings from their remote location. Figure 4 shows a typical Web interface with a list of several sensors. Thresholds for these levels may be defined for each sensor.

When integrated into Rittal's management software, RiZone, and in combination with System Center Operations Manager (SCOM) software from Microsoft, it is possible to trigger automatic countermeasures should a critical state be detected through the CMC. These measures can avert a failure or data loss without direct action from the IT staff.

The interface to a company LAN, in addition to providing data communications, allows the PU III to draw power from the network via Power Over Ethernet (PoE) so an independent power source is not required. Nevertheless, two additional power supply connections are available at the rear of the unit. In addition to the standard CMC III power pack, terminals can be used to connect a redundant power supply; providing even more flexibility in powering the PU III. And the facility for redundant installation enhances reliability and reduces the risk of system failure.

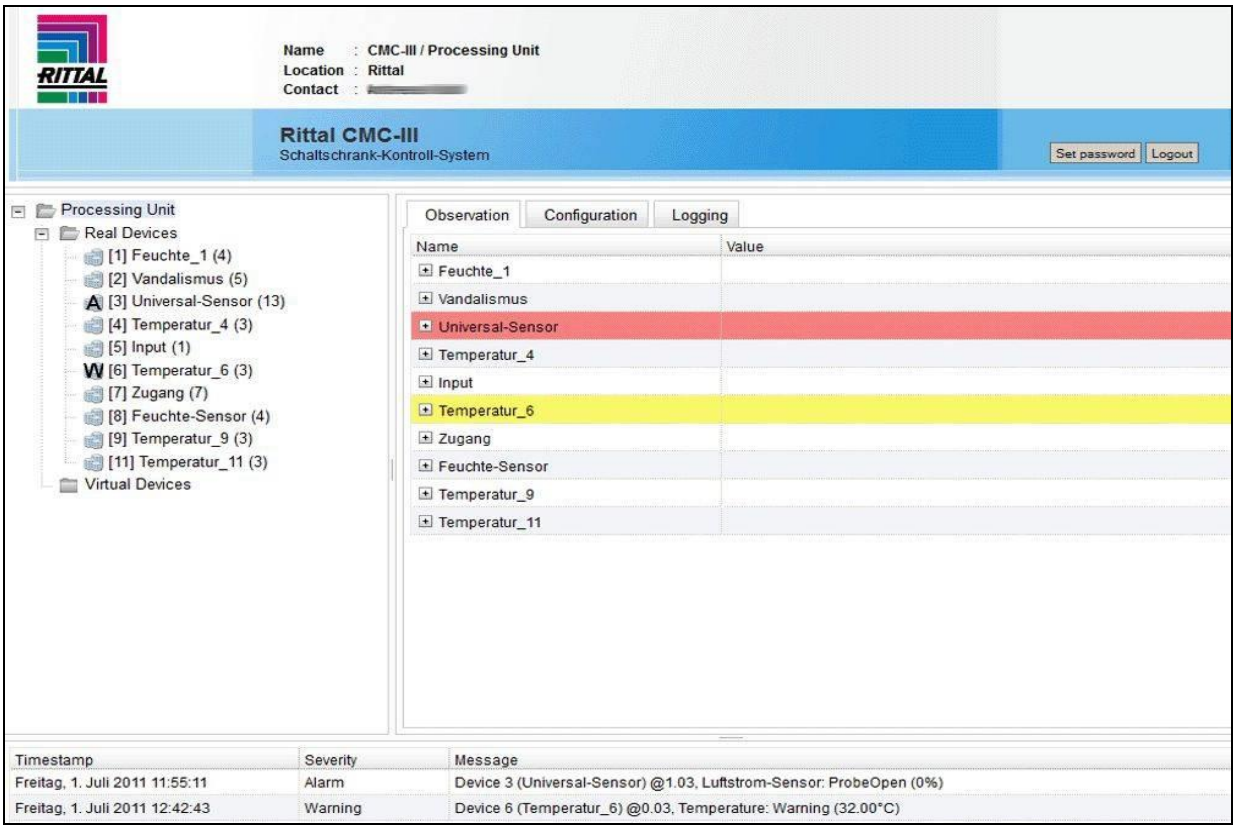

Figure 4: Web interface

Test setup

The CAN-bus with its high degree of fault tolerance and extensive fault detection capability provides numerous benefits. It can be used in environments where potential interference exists and provides for much easier cable distribution and management than with previous installations. Where the CMC-TC often required complex installations, connections with the PU III are straightforward.

To connect a sensor to the previous versions, it was necessary to connect an I/O unit at one of four inputs. Each I/O included four sensor inputs so 16 sensors could be installed on the PU II models.

Figure 5 illustrates a test where eight racks are to be monitored with the CMC-TC system. Four sensors are placed in each rack – 32 sensors are incorporated into this enclosure suite and connected to a PU II via I/O units.

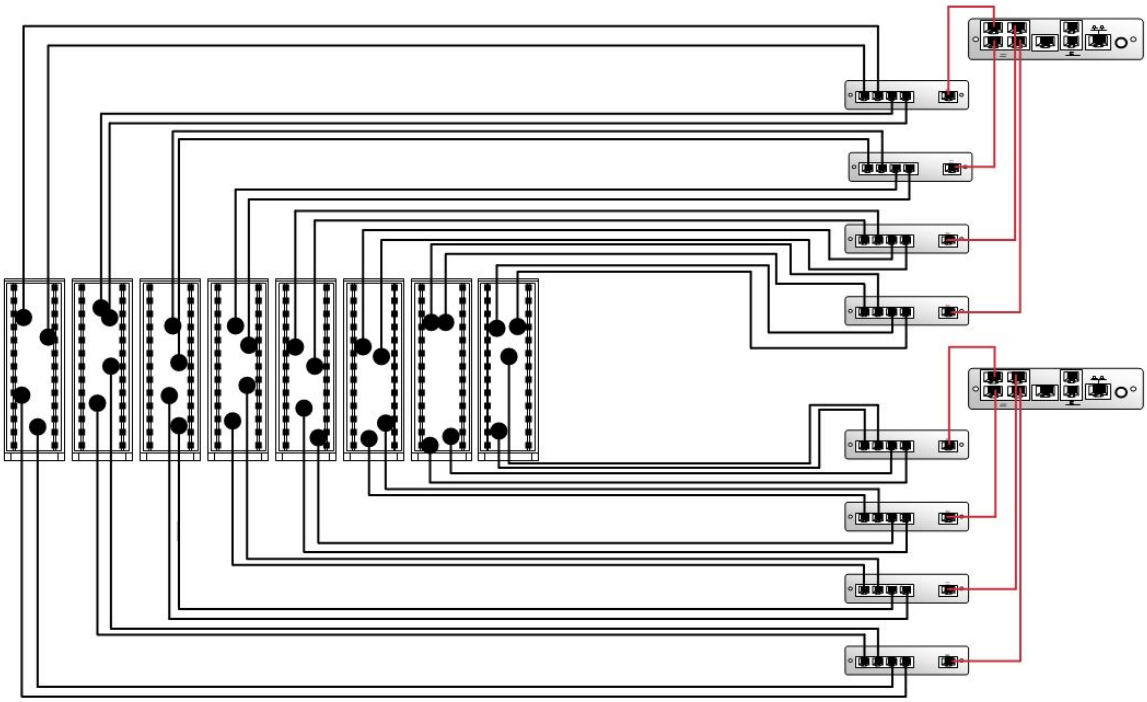

Figure 5: Test setup with CMC-TC

Table 1 lists the components required for this configuration.

Component	Number required
Processing Unit	2
I/O Unit	8
Sensors	32
Connecting cables	40

Table 1: Components for test setup with CMC-TC

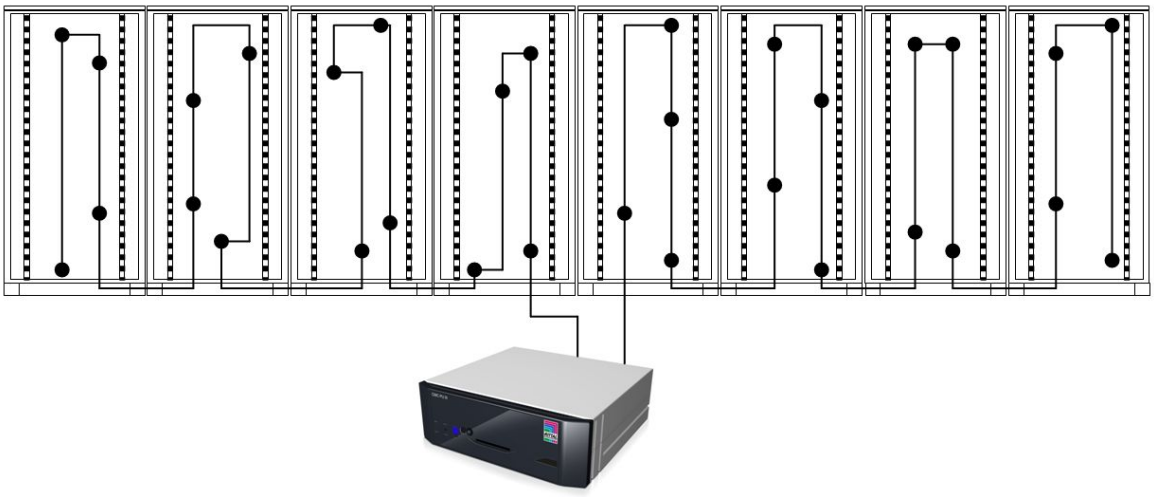

Figure 6: Test setup with CMC III

Figure 6 depicts the same enclosure monitoring configuration using the new CMC III. There are two ports on the rear of the PU III, each available to connect 16 sensors. Individual sensors are connected in series.

Table 2 lists the components required for use with the CMC III. A number of differences can be readily seen when comparing the two setups.

Component	Number required
Processing Unit	1
I/O Unit	0
Sensors	32
Connecting cables	32

Table 2: Components for test setup with CMC III

First, the list of required components (Table 3) shows a definite advantage for CMC III – fewer devices and accompanying cables.

And, as shown in Figures 5 and 6, the actual installation in the racks is far less complicated with the CMC III system – fewer cables and devices means it is easier to identify individual cables and helps avoid “cable clutter.”

Component	Number required for CMC-TC	Number required for CMC III
Processing Unit	2	1
I/O-Unit	8	0
Sensors	32	32
Connecting cables	40	32

Table 3: Comparison of components for test setups with CMC-TC and CMC III

CMC Compact

The PU III is available in two versions; the Standard version supports up to 32 sensors with full functionality, and the Compact configuration supports up to four sensors with a reduced menu of features. The Compact model is ideal for smaller installations and industrial applications.

Smaller monitoring systems often serve a few racks or control enclosures, many of which stand alone in a production environment. In most cases, these installations are less complex than those found in large data centers with multiple enclosure suites. In these more condensed, less demanding installations, many of the functions of the standard CMC III are not required. It can be considered “over-engineered.”

The CMC III Compact is tailored specifically to the demands and challenges of these smaller systems. In the compact, for example, the SD card slot and USB port for saving data and exporting information have been omitted. And, the Compact only connects four CAN-bus sensors – but there’s still built-in temperature and infrared sensors and a host of external sensors can be used. There’s plenty of power available for small systems or single enclosure applications. And, compared to the standard version the compact is more cost-effective in smaller scale installations. Intelligent networking makes it possible to program additional energy-saving and convenience tools in the field.

Since stand-alone enclosures usual include their own cooling – via a Rittal wall- or roof-mounted cooling unit – CMC III can control and monitor these as well. Incorporating such features as being able to shut down the unit as soon as the door is opened to conserve cooling energy.

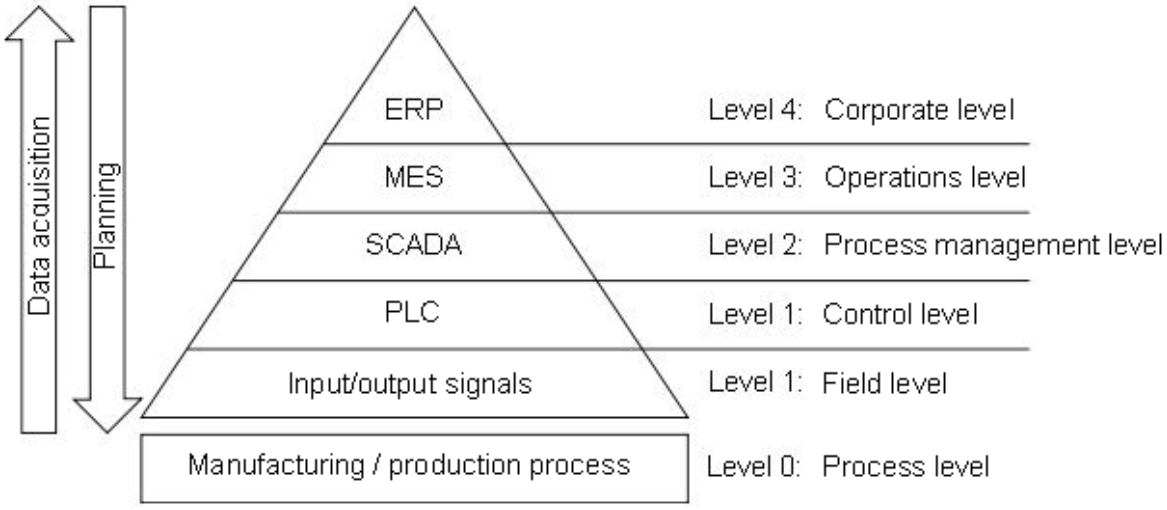

Figure 7: Automation pyramid

Source: Wikipedia

In many cases, a single enclosure will contain a Programmable Logic Controller (PLC) to manage the production machine. The PLC and other components is usually linked to a higher level management system. In the automatic pyramid shown in Figure 7, this kind of control system is seen at Level 2, If the CMC system is assigned to this same chart, the PU III, as the central processing unit, would be assigned to Control Level 1 and sensors to the Field Level.

To network between the CMC III and a higher level requires a common protocol understood by as many supervisory control systems as possible. To accomplish this, CMC III supports the OPC (Object Linking and Embedding for Process Control) protocol in addition to its standard SNMP protocol. OPC is available to nearly 99 percent of all control systems and permits direct communications from CMC to the control system.

In many industrial settings, enclosures that incorporate a PLC or similar units do not include a monitoring system. So, and excessive rise in temperature, for example, may not be caught until the first component fails. But, since a PLC should not be modified it is difficult to integrate monitoring into a running system. Or it was until the development of CMC III

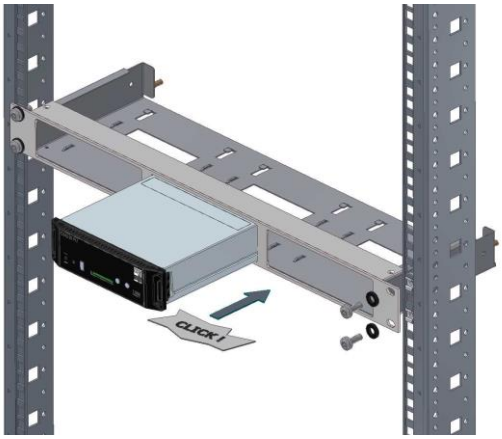

Figure 8: Mounting on 19" mounting frame

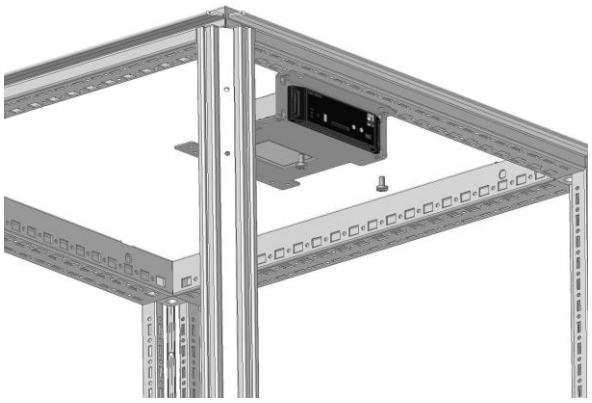

Figure 9: Mounting on enclosure frame

Compact. This development is suited to a retrofit installation in many cases. Relatively simple installation requirements and the ability to communicate via OPC make it possible to add the system without a production shutdown, modifications to the PLC software or other interruptions to operations.

The PU III can be mounted either directly on the enclosure frame (Figure 9) or in a 19-inch mounting frame (Figure 8).

Its uncomplicated plug-in technology not only reduces installation time it simplifies maintenance and retrofitting.

Summary

Electronic components, even the most innovative state-of-the-art units, are susceptible to failure caused by water, heat and a host of outside influences. A failure and resulting interruption in operations can mean high losses –in terms of cost, data recovery and downtime.

Can these threats be eliminated? Try as one might, the answer is still no. With that in mind, data centers and vital components in a variety of environments must be monitored permanently.

A reliable, flexible method of monitoring sensitive equipment revolves around the CMC III from Rittal where a selection of sensors can be, tuned to monitor vital functions within a data center or lone installation. Connected to a central controller, the PU III, data is evaluated and relayed to its user at any of several locations. Combined with appropriate software – Rittal's RiZone and Microsoft's SCOM – it is possible to automatically trigger countermeasures to thwart failures and downtime without the intervention of a technician. Two of the most important sensors are built into each PU III. Temperature and infrared sensors are integrated into each basic unit.

Tied directly to its ease of installation and use, the CMC III provides much simpler and more compact cabling solutions. And the cabling requires less space within the installation, freeing up more useable space for ever-expanding components and making retrofitting easier.

Power to the PU III can be supplied via a CMC power pack, through terminals and from PoE to added versatility and providing an easy way to provide redundancy and backup.

A simple USB port configuration makes deploying, commissioning and retrofitting easier, as well.

One size does not fit all – there's a CMC III Compact version designed specifically for smaller installations where space is at a premium and not every bell or whistle is required. For small operations or single enclosures the compact can be the most cost-effective answer.

With the aid of OPC protocols, the CMC III power unit can communicate with virtually any supervisory control system to make data available to almost any higher level management system – making interfacing the system with existing components easier and providing quicker access to data for IT managers in remote locations.

CMC III is more than a new generation of Rittal's proven technology, it's a 21st century answer to the demands of the IT industry and industrial operations today and well into the future.

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List of abbreviations

CAN	-	Controller Area Network
CMC-TC	-	Computer Multi Control - Top Concept
CSMA/CD	-	Carrier Sense Multiple Access / Collision Detection
CSMA/CR	-	Carrier Sense Multiple Access / Collision Resolution
I/O Unit	-	Input/Output Unit
IP	-	Internet Protocol
ISO	-	International Organisation for Standardisation
IT	-	Information Technology
LAN	-	Local Area Network
OPC	-	Object Linking and Embedding for Process Control
OSI	-	Open Systems Interconnection
PC	-	Personal Computer
PLC	-	Programmable Logic Controller
PoE	-	Power over Ethernet
PU	-	Processing Unit
SCOM	-	System Center Operations Manager
SD	-	Secure Digital
SNMP	-	Simple Network Management Protocol
USB	-	Universal Serial Bus

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Faster – better – worldwide.

Rittal Corporation
1 Rittal Place • Urbana Ohio 43078 • USA
Woodfield Corporate Center • 425 North Martingale Road, Suite 400 • Schaumburg Illinois 60173
Phone: 937-399-0500 • Fax: 800-477-4003 • Toll-free: 800-477-4000
Email: rittal@rittal.u • Online: www.rittal.us