Introduction

This document summarizes the essence of the CX1000/CX2000 to help you understand the concept, features, and functions of the product.

The structure of the document is shown below. Please read the appropriate chapters to further your understanding of the product.

In addition, the specifications and the functional details are covered in the following documents. Read them as necessary.

GS:  GS04L31A01-01E  CX1000 General Specifications
     GS04L31A01-02E  CX2000 General Specifications

TI:  TI04L31C01-01E  CX Installation Guidance
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1. About CX

1.1 CX overview

A control station that’s ready to go out of the box, developed from an all-in-one measurement station!

- **PID control function embedded**
- **Easy setup**
- **Ready to go out of the box**
- **Powerful Display, Trending**
- **Less wiring and space**
- **Excellent networking**

The CX control and measurement station contains a PID control (up to six embedded loops and sixteen external control loops) based on Yokogawa’s proven controller technology combined with the power of the DX all-in-one measurement station. The CX station provides quick-start control and management capabilities.

- **Easy Setting - Out of the Box, Ready to go**
  - Set up your system quickly and simply, just connect the cables and enter your settings.
  - Range settings and control parameter settings are easy to enter using menu driven screens.
  - Initial settings are entered on the settings screen. Use the function keys to select input fields.

- **Powerful Display, Trending**
  - The CX station includes standard screens such as faceplates and tuning displays for quick-start control monitoring.
  - The trend and recording functions make it easy to record quality and other management data.
  - External Green Series controller monitoring and data recording are as easy to handle as embedded data.

- **Less wiring and space**
  - The embedded control loops with built-in I/O reduce/eliminate external devices and required installation space.
  - The control data collection function for external Green Series controllers (connected by serial communication) reduces the required cabling.

- **Excellent networking**
  - Ethernet capability is a standard feature.
  - Web and E-mail functions are included to enable remote monitoring and alarm notification.
  - Remote monitoring of controls is easy.
### 1.2 CX development background

**A) The evolution of recorders**

Since it began shipping the ER1 in 1951, Yokogawa has been a global leader in the recording market thanks to numerous technological breakthroughs such as the world's first recorder with a built-in microprocessor, semi-permanent non-contract ultrasonic position converters, and high-withstand-voltage solid-state relays. Beyond the recording field, Yokogawa technology used in the ER (introduced in 1972) and later in the ER180 incorporated an internal PID controller unit, as well as program control technology provided by external units.

- **First digital revolution for recorders: Transition from ER to µR Series**
  
  With the addition of a built-in microprocessor, the range card was eliminated, enabling users to select parameters such as input type and chart speed as desired for greater flexibility. In order to provide the best possible recorders, Yokogawa separated the recording and measurement functions from the controller functions.

- **Second digital revolution for recorders: Transition from µR Series to VR Series**
  
  VR is a paperless recorder that replaced conventional recording methods such as pen on recording paper or intermittent recording with trend displays on a high-resolution TFT color LCD and electronic data recording to semiconductor memory. This made it possible to display and analyze data on a PC, and reduced maintenance such as replacing pens, chart paper, and other consumables.

- **Third digital revolution for recorders: Support for networking**
  
  The spread of networking technologies such as the Internet has extended to recorder field installations. Networking support is an important feature of DAQSTATION DX, the next step in recorder evolution. DX is an all-in-one station that includes the data collection, display, and recording functions of a field recorder, as well as functions for connecting to a data LAN to transmit field monitoring data. Connection to a network enables automatic data transfer, centralized management, and remote data monitoring. This improves reliability through data redundancy, and reduces the cost of data collection.
B) Development of a recorder with all-in-one control functions

DAQSTATION DX is a sophisticated field monitor with recorder functions such as collecting, recording, saving, and monitoring field data. It is also an advanced field data station with functions for connecting to a data network for central/concentrated management of field data. DAQSTATION DX’s functionality expands its usability to a range of field applications.

Applications for DAQSTATION DX as a field data station

One role of DAQSTATION DX in the field is to monitor and adjust temperature in combination with temperature controllers. In this application, the Green Series performs feedback control and field temperature adjustments based on input data from the field. The recorder receives monitoring data from the Green Series through transmission output, or is directly connected in the field like a Green Series and takes measurements. These are displayed and/or recorded, and transmitted to the data LAN as needed.

DX serves to centralize data in a temperature measurement system. In the past, monitoring and adjusting field data with a Green Series and recorder required complex cabling, numerous settings and data adjustments, and a large amount of installation space.

Development of CX control and measurement station, Powerful controller for today’s networking world

The CX control and measurement station was developed as a simple, all-in-one temperature control equipment solution. It represents the integration of DAQSTATION DX’s basic technologies and Green Series controller control algorithms, together with special functions unique to CX. The integration of monitoring functions with temperature control functions and networking functions provides a new platform for the PID control market.
1.3 CX’s market positioning

- **Product positioning in the recorder market**
  
  Like DX, CX is positioned as an open network-oriented, all-in-one station that displays information as a field monitor and transmits that information to a data network.

- **Product positioning in control market**
  
  CX is differentiated from other controllers by differences in field size, its role in the field, and its functions. CX is designed for control application in relatively small-scale (1 to 22 loops) control systems requiring monitor functions and easy setup.
  
  Other systems used in small-scale control applications include recorders combined with controllers, displays combined with PLC, and PC (SCADA) combined with PLC.
CX2000 can be selected with zero to six embedded loops. In addition to use as an all-in-one control and measurement station using the embedded loops, it can also be connected (optional function) with a Yokogawa Green Series. The following notes apply to selections for basic and optional specifications.

**Notes**

1. When using the CX2000 with zero embedded loops, RS232C or RS422/485 must be specified as the communication port, and the Green Series communication (/CM1) option must be selected at the same time.
2. Only one of the following may be selected: measurement alarm (/A6, /A6R, /A4F, /A4FR) and extended control (/CST1).
3. When Green Series communication (/CM1) and Ladder communication (/CM2) are selected, RS232 or RS422/485 must be specified as the communication port. Only an alternative choice is allowed.
4. Program controls (/PG1 or /PG2) apply only to models with embedded loops.

**Hardware resources for controlling CX2000**

<table>
<thead>
<tr>
<th>Model</th>
<th>embedded loops</th>
<th>Control Analog Input</th>
<th>Control DI/DO</th>
<th>Control DI/DO Extension (optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CX20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>CX22</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>Open collectors: 4 Normally open relay contacts: 2</td>
</tr>
<tr>
<td>CX24</td>
<td>4</td>
<td>10</td>
<td>12</td>
<td>Di: 12, DO: 12 (open collector)</td>
</tr>
<tr>
<td>CX26</td>
<td>6</td>
<td>10</td>
<td>18</td>
<td>Di: 12, DO: 12 (open collector)</td>
</tr>
</tbody>
</table>
1.5 CX model numbers and basic specifications (CX1000)

CX1000 can be selected with zero to two embedded loops. In addition to use as an all-in-one control and measurement station using the embedded loops, it can also be connected (optional function) with a Yokogawa Green Series. The following notes apply to selections for basic and optional specifications.

**Notes**

1. When using the CX1000 with zero embedded loops, RS232C or RS422/485 must be specified as the communication port, and the Green Series communication (/CM1) option must be selected at the same time.
2. Only one of the following may be selected, and for CX1006 only: measurement alarm (/A6, /A6R, /A4F, /A4FR).
3. When Green Series communication (/CM1) and Ladder communication (/CM2) are selected, RS232 or RS422/485 must be specified as the communication port. Only an alternative choice is allowed.
4. Program controls (/PG1 or /PG2) apply only to models with embedded loops.

### Hardware resources for controlling CX1000

<table>
<thead>
<tr>
<th>Model</th>
<th>embedded loops</th>
<th>Control Analog Input</th>
<th>Control DI/DO</th>
<th>Control DI/DO Extension (optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>DI</td>
<td>DO</td>
</tr>
<tr>
<td>CX10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>CX12</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>
## 1.6 Control specifications

<table>
<thead>
<tr>
<th>PID control embedded Monitoring</th>
<th>CX1000</th>
<th>CX2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control period</td>
<td>250/500/1000 ms</td>
<td></td>
</tr>
<tr>
<td>Control loops</td>
<td>0/2 loops</td>
<td>0/2/4/6 loops</td>
</tr>
<tr>
<td>Measurement period</td>
<td>1/2 seconds</td>
<td></td>
</tr>
<tr>
<td>Measurement channels</td>
<td>6 channels</td>
<td>10/20 channels</td>
</tr>
</tbody>
</table>

| Internal control functions     | Single loop control, cascade control, loop control with PV switching, overshoot prevention function (Super) |
| Control module                 | Control output for two control loops and DIO for each module |
| Output (universal)             | Traster contact (NO-C-NC), 4-20 mA current output, voltage pulse |
|                                | * Selected and set for each loop. |
| DIO                             | For each module: |
| DIO extended module            | D: 6 points |
|                                | DO: 6 points (4 open collector and 2 normally open relay contacts) |
| Communication interfaces       | Ethernet interface |
|                                 | Standard feature |
|                                 | RS422A/485 interface |
|                                 | One or the other |
| Optional functions             | Green Series communication |
|                                 | Maximum 4 external controllers control points |
|                                 | Maximum 16 external controllers control points |
|                                 | Program control |
|                                 | Maximum 30 program patterns |
|                                 | Maximum 99 segments per pattern |
|                                 | Maximum 300 segments total |
|                                 | Computation function |
|                                 | 12 channels |
|                                 | 30 channels |
|                                 | Ladder communication |
|                                 | Capable |
|                                 | Capable |
1.7 Control hardware

CX1000
- Control output/contact I/O
- Control output unit 1
  - Loops 1-2
- Input unit
  - Loops 01-02
  - Channel 01-06
- Control inputs (5)
- Measurement channel input
  - (6 channels)
- Option attachment area
- /CST1: Extended control DIO
  - /A6, /A6R, /A4F, /A4FR: Measurement alarms
- TPS: 24 V DC transmitter power output

CX2000
- Control output/contact I/O
- Control output unit 1
  - Loops 1-2
- Control output unit 2
  - Loops 3-4
- Control output unit 3
  - Loops 5-6
- Option attachment area
- Measurement channel input unit
  - Channel 01-10
- Measurement channel input unit
  - Channel 11-20
- Control inputs
  - (2 loops, 4 loops, 6 loops)
- Control input
  - (2 loops, 4 loops, 6 loops)
1. About CX

### Types of Rear Terminal Arrangements for CX Series

- **Control Inputs**
  - (Control Inputs for Loops 1 to 2)
  - (Control Inputs for Loops 1 to 4)
  - (Control Inputs for Loops 1 to 6)
  - (Control/Measurement Inputs for CX1000 only)

- **Control Outputs and Contact Input/Outputs for 2 Loops**

- **Measurement Alarms**
  - A6 (DO 6 points)
  - A6R (with remote control, DI 8 points, DO 6 points)
  - A4F (DO 4 points, with Fail end memory and relay contact outputs)
  - A4FR (with remote control, DI 8 points, DO 4 points, with Fail and memory end relay contact outputs)

- **Extended module**
### 1.8 Differences between CX and DX

<table>
<thead>
<tr>
<th>Function</th>
<th>DX</th>
<th>CX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control functions</td>
<td>None</td>
<td>Max. 2 loops</td>
</tr>
<tr>
<td>Measurement inputs</td>
<td>Max. 12 channels</td>
<td>Max. 30 channels</td>
</tr>
<tr>
<td>Display functions</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Simultaneously displayed channels</td>
<td>Max. 24 channels</td>
<td>Max. 60 channels</td>
</tr>
<tr>
<td>Control groups</td>
<td>None</td>
<td># #</td>
</tr>
<tr>
<td>Measurement period</td>
<td>Max. speed 125 ms</td>
<td>Max. speed 1 second</td>
</tr>
<tr>
<td>Communication functions</td>
<td>Ethernet</td>
<td>Standard</td>
</tr>
<tr>
<td>RS232C</td>
<td>Optional</td>
<td>Select in basic specs</td>
</tr>
<tr>
<td>RS422-A/485</td>
<td>Optional</td>
<td>Select in basic specs</td>
</tr>
<tr>
<td>FOUNDATION Fieldbus</td>
<td>Optional</td>
<td>None</td>
</tr>
<tr>
<td>Green Series communication</td>
<td>None</td>
<td>Optional</td>
</tr>
<tr>
<td>Ladder communication</td>
<td>None</td>
<td>Optional</td>
</tr>
<tr>
<td>Consumed power</td>
<td>100 V AC With LCD saver</td>
<td>30 VA</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>32 VA</td>
</tr>
<tr>
<td></td>
<td>Max.</td>
<td>45 VA</td>
</tr>
<tr>
<td></td>
<td>240 V AC With LCD saver</td>
<td>42 VA</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>47 VA</td>
</tr>
<tr>
<td></td>
<td>Max.</td>
<td>62 VA</td>
</tr>
</tbody>
</table>

- **New Functions provided with PID Control**
  - Functions for control-related setting and display
  - Control analog input (1-5 V DC), etc.
  - More trend groups (10 instead of 4)
  - New control groups (4 or 8)

- **Other differences from DX**

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**Network Solutions Division**

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2. CX features and functions

2.1 CX embedded control features

GREEN Series control algorithm
- Includes a Green Series control algorithm with a proven track record

Built-in PID control
- Embedded control for up to six loops

Multiple PID parameter sets and auto-tuning function
- Eight sets of PID parameters for each loop
- Automatic PID setting based on limit cycle method

Control output prevention function
- Includes control functions for preventing overshooting, such as Super function and anti-reset windup function

Program control
- Control based on up to 30 different program patterns

2.2 CX embedded control functions

Control modes:
- Single loop control
- Cascade control
- Loop control with PV switching

Control operation modes:
- Fixed point control mode
- Program control mode

PID control types and control output types:
- Time proportional PID control: Voltage or relay contact output
- Continuous PID control: Current output
- ON/OFF control: Relay contact output

PID control action:
- Direct action
- Reverse action

PID control modes:
- Standard PID control mode
- Fixed point control mode

PID control methods:
- PV derivative type PID
- Deviation derivative type PID

PID parameters:
- Eight sets per loop

PID parameter selection methods:
- Zone PID selection
- Segment PID selection
- Target setpoint number selection

Auto-tuning function:
- Limit cycle method

Control output prevention functions:
- Super overshoot prevention function
- Anti-reset windup
- Control output limiter
- Shutdown function
- Output rate-of-change limiter
- Preset output function
- PS rate-of-change limiter
- Setpoint limiter

Tracking:
- Target setpoint (SP) tracking
- Process value (PV) tracking

Alarm types:
- Process value (PV) high/low limits
- Deviation value (DV) high/low limits, deviation value high and low limits, within deviation value high and low limits
- Setpoint (SP) high/low limits
- Output value (OUT) high/low limits

Alarm operation conditions selection
- Stand-by action
2.3 CX embedded controls

<table>
<thead>
<tr>
<th>Control modes</th>
<th>Loop number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 or 2</td>
</tr>
<tr>
<td>Single loop control</td>
<td>×</td>
</tr>
<tr>
<td>Cascade control</td>
<td>×</td>
</tr>
<tr>
<td>Loop control with PV</td>
<td>×</td>
</tr>
</tbody>
</table>

- Single loop control: This mode provides basic functions including one control computation unit.
- Cascade control: This mode executes a single cascade control through two control computation units. Continuous PID control is the only control computation that can be used on the primary side of the cascade.
- Loop control with PV switching: This mode provides control functions for switching between two PV inputs according to a contact signal or PV range. One of the following three PV switching modes can be selected:
  - Mode 1: Switching according to set range value
  - Mode 2: Switching according to PV high limit
  - Mode 3: Switching according to contact input state

Control operation mode

CX has two control operation modes for each control mode (Single loop control, Cascade control or Loop control with PV switching). A control operation mode is specified for every two loops with a common control output module.

- Fixed point control: Sets the target setpoint (SP) as local or remote.
- Program control: Sets the target setpoint (SP) as local or a program pattern.
Control computation and control output types

CX can perform the following control computations:

- **Time proportional PID control**: PID computation results are output in an ON/OFF signal pulse width proportional to the time. The pulse width is output by a relay or voltage pulse, with the cycle time (control output period) set to 100%.
- **Continuous PID control**: PID computation results are output as a current value (analog signal) proportional to the PID computation value.
- **ON/OFF control**: The target value and process value are compared, and an ON/OFF signal is relay-output according to whether the deviation is positive or negative.

PID control action: Direct/reverse action

PID control output operations have two directions: direct and reverse. This defines the directions of increase and decrease for changes in the control output value according to whether the deviation between the target setpoint (SP) and process value (PV) is positive or negative. The following table summarizes the relationships between the different types of control computation and the output directions.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Reverse action</th>
<th>Direct action</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV &gt; SP</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>PV &lt; SP</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>Current output</td>
<td>Current decreases</td>
<td>Current increases</td>
</tr>
<tr>
<td>Time proportional output</td>
<td>ON time decreases</td>
<td>ON time increases</td>
</tr>
</tbody>
</table>

Minimum value (low PV) 20 mA (increase) 4 mA (decrease)
Maximum value (high PV) 20 mA (increase) 4 mA (decrease)
2.4 CX PID control

2.4.1 PID control modes and control methods

■ PID control modes
CX has two different PID control modes, either of which can be selected.
- Follow-Up control mode: This mode gives priority to providing output with respect to the deviation and quickly reaching the target value when the target setpoint is changed.
- Fixed point control mode: This mode gives priority to providing stable output while minimizing excessive reaction when the target setpoint is changed.

■ PID control methods
CX controls by the following either with two PID control methods. By which control method to control is decided by the PID control mode and the operation mode which was chosen by the setup.
- Deviation derivative type PID: This control method is immediately responsive when the setting is changed, because the derivation operation is performed with respect to the change in the control deviation (the difference between the process value and the setpoint). It is effective when setpoint tracking is given priority.
- PV derivative type PID: This control method enables stable control output because the derivation operation is performed only on the process value. Even if the target setpoint is changed by a large amount, the control output will gradually eliminate the deviation without rapid changes.

■ Bumps in control output
The operation mode and PID control mode are used to determine whether or not there are bumps in the control output value at the point in time when the target setpoint is changed.
### PID control methods for different PID control mode and operation mode combinations

<table>
<thead>
<tr>
<th>PID control mode</th>
<th>Operation mode</th>
<th>Operating condition</th>
<th>PID control method</th>
<th>Control output bump</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Follow Up control mode</strong></td>
<td>Fixed point control</td>
<td>Local and not on secondary side of cascade connection.</td>
<td>PV derivative type PID</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remote or on secondary side of cascade connection.</td>
<td>Deviation derivative type PID</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Program control</strong></td>
<td></td>
<td>Local and not on secondary side of cascade connection. Or hold or soak.</td>
<td>PV derivative type PID</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>During program operation (excluding hold and soak), or on secondary side of cascade connection.</td>
<td>Deviation derivative type PID</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Fixed point control mode</strong></td>
<td>Fixed point control</td>
<td>Local and not on secondary side of cascade connection.</td>
<td>PV derivative type PID</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remote or on secondary side of cascade connection.</td>
<td>PV derivative type PID</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Program control</strong></td>
<td></td>
<td>Local and not on secondary side of cascade connection. Or hold.</td>
<td>PV derivative type PID</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>During program operation (excluding hold), or on secondary side of cascade connection.</td>
<td>PV derivative type PID</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*1) “On secondary side of cascade connection” refers to a secondary loop where cascade is selected from among the “Auto”, “Manual”, and “Cascade” cascade control mode settings.
The CX PID parameters and the auto-tuning function which automatically sets the PID parameters are described below.

**PID parameters**

Eight sets of PID setpoints and target setpoints for operation can be set for each loop in CX.

**PID parameter selection methods**

The following methods can be used to select PID parameters:

- **Zone PID selection:** This method provides a function that automatically switches PID setpoints according to the process value. This function can be used to set PID constants divided into as many as seven zones with set reference points. Within a given process value band, the same PID constant is used, regardless of whether the program control is ramping up or down.

- **Segment PID selection:** This method provides a function for switching the PID setting one segment at a time to match the program pattern during program control. Changing the PID constant during ramp up and ramp down even within the same process value band is appropriate for good control.

- **Target setpoint (SP) number selection:** This method provides a function for selecting a PID constant in an SP group according to the target setpoint number selection. It can be used during fixed point control operation and program control with local control.
Auto-tuning

This function automatically measures the process characteristics for the item being controlled, and automatically sets the PID constant to the optimum value. It should be noted that auto-tuning does not function during ON/OFF control.

CX uses the limit cycle method to calculate the PID setpoint. This method performs step-form control output when auto-tuning starts and calculates the appropriate PID setpoint from the response data. It should be noted that some applications are not suitable for the limit cycle method because the output fluctuates between 0% and 100%. Avoid using the auto-tuning function with processes such as those shown below.

Processes not suitable for auto-tuning

- Control processes with fast response, such as pressure control and flow rate control
- Processes that do not allow output to be turned ON/OFF even temporarily
- Processes that do not allow large stresses to be applied to the final control device, etc.
- Processes in which product quality may be adversely affected if the process value fluctuates outside the allowed range
2.4.3 Control output suppression functions

CX has numerous control output suppression functions to prevent excessive increases or decreases in control output. These excellent functions are described below.

- **Super overshoot prevention function**
  The Super function is an overshoot prevention function that uses fuzzy logic. It is useful in cases such as the following:
  - To prevent overshooting
  - To reduce startup time
  - In cases where there are large load fluctuations
  - In cases where the setpoint changes frequently
  * Note: CX1000 and CX2000 do not include the Super 2 function which is included in the Green Series.

- **Anti-reset windup over-integration prevention function**
  If a large deviation between the target setpoint (SP) and the process value (PV) continues for a long time, control output reaches the output limit high limit and becomes saturated due to the integration operation. In some cases, overshooting may occur if it is not possible for the control output to leave the saturated state even when the process value exceeds the setpoint. This function prevents this from happening by temporarily stopping the integration operation when the manipulated output reaches the output limit high limit.

- **Control output limiter**
  This function can be used to set a high limit and low limit for the control output operation range, regardless of the operation mode. Up to eight sets of limits may be set to match the PID parameters.

- **Shutdown function**
  This function fully closes the adjusting valve (sets the 4-20 mA current output to 0) outside the positioner dead band. However, in automatic mode operation, the output lower limit value is -5.0%; it does not fall all the way to 0.0 mA. In manual mode operation, the shutdown output (approximately 0.0 mA) is reached.
- **Output rate-of-change limiter**
  This function prevents abrupt changes in the control output.

- **Preset output function:**
  This function outputs a preset output value as the control output when the operation mode is changed from operating status to stopped status. Values can be set in the range of -5.0% to 105.0%.

- **SP rate-of-change**
  This function changes the target setpoint at a fixed change rate in cases where it should not be changed abruptly or when it should be changed at a certain fixed rate ramp grade. This function is useful in cases such as the following:
  - When the target setpoint is changed and when the target setpoint number has been changed
  - When the power is turned on (or restored after a power outage)
  - When operations are changed from manual to automatic

- **Setpoint limiter**
  This function can be used to establish H/L limits for a target setpoint.
2.4.4 Tracking functions

CX has a number of output suppression functions to provide stable control without abrupt changes in the control output from PID control. In addition, a number of alarms are provided as notifications of control output statuses.

- **Tracking functions**
  - Target setpoint (SP) tracking: In cases where the mode is changed from remote to local operation, this function tracks the local target setpoint to the remote target setpoint preceding the mode change in order to prevent abrupt changes in the output value.
  - Process value (PV) tracking: This function matches the target setpoint to the current process value and then restores the original target setpoint in order to prevent abrupt changes in the process value.
2.4.5 Control Alarms

There are four instrument alarm outputs per loop. Alarm hysteresis can be set for each alarm.

### Control alarm functions
- Process value (PV) high/low limits
- Deviation value (DV) high/low limits, deviation value high and low limits, within deviation value high and low limits
- Setpoint (SP) high/low limits
- Output value (OUT) high/low limits

### Fault diagnosis output
FAIL output: Alarms are output in the following cases:
- Program failure
- ROM failure
- RAM failure
- Power outage detected

### Standby operations
This function turns off alarms until stable conditions are restored. Alarms are not output in the following cases until normal ranges are reached:
- When power is turned on
- When power is restored after power outage
- When target setpoint is changed
- When target setpoint is switched (except in cases where SP values are equal)
- When alarm types are changed

### Alarm operation conditions
- Enable alarms at all times
- Disable alarms when operations are stopped (STOP)
- Disable alarms in manual (MAN) mode or when operations are stopped (STOP)

### Stand-by operations
This function turns off process value alarms and deviation value alarms in the startup interval between when controls are started and when stable conditions are reached. Alarms are not output in the following cases, even if there is a failure, until normal ranges are reached:
- When power is turned on
- When target setpoint is changed
- When target setpoint is switched (except in cases where SP values are equal)
- When alarm types are changed

### Fault diagnosis output
Alarms are output when a measurement input wire line is cut (input burnout), and in cases of A/D converter failure, improper reference contact correction, etc. When an alarm turns ON, if the reference contact correction is undetermined, control operations are continued with RTC 0(%).

### FAIL output
When FAIL output turns OFF, control output is set to a preset output value (except if FAIL occurs at power-on, in which case it is turned off or 0% is set). In addition, alarm output is turned off and control output is stopped.
2.5 CX Program Control

2.5.1 CX Program Control Features

---

The CX can perform up to six loops control programs! The embedded loops are made best use for CX control functionality.

- **Synchronized control**
  - Set the ramp-rate of multiple loops in a single segment

- **Program setting of up to 6 loops and temp. control using a single unit.**

- **Excellent progress status indication**
  - Pattern and PV simultaneously
  - Position of the pattern in execution

- **Smooth process transition by setting the high and low limits of the wait zone width individually**

- **Supports SP control during ramp/soak**

- **Easy setup using PC software application**
  - Initial setting, loop setting
  - Segment setting
  - Event output setting

---

Program control is a function used to change the SP according to a preset program pattern. During program control, the internal control loops carry out control concurrently with the SP changes. The CX supports multiple program patterns, and execute program control appropriate for your application.

The CX has a program control function for up to six loops and provides functions that exploit this architecture. The features are described below.

- **Synchronized program control**
  It is generally believed that achieving synchronization between conventional single-loop controllers when carrying out pattern control among multiple loops is difficult. However, a single internal program control function of the CX supports multiple loops enabling program control that achieves synchronization among multiple loops.
  Up to 6 loops can be set for a program pattern.

- **Supports multiple loop settings with different target SPs using a single segment**
  The CX allows pattern settings of up to six loops for each segment. You can use a single segment to set a pattern of a same ramp-rate even if each loop has different final SP. (See the figure below); it is very effective way to use segments.
2. CX features and functions

Smooth process transition by setting the high and low limits of the wait zone width individually

Since up to 5 groups of high and low limits can be specified for the wait action, you can construct a program control pattern that matches the control characteristics. (Example: If you wish to move to the next process when the temperature settles within a certain amount (even if the measured value is not constant), you can set the high limit of the zone width to a large value and the low limit to a small value.)

Excellent display functions

- **Program control display**
  A highly important control display function is the “simultaneous display of patterns and PVs” and the “position indication of the pattern in execution.”
  This display function was made possible as a result of combining the control and measurement functions into a single unit.
  This display function enables you to confirm the follow-up control against the program pattern and the progress. This, in return, achieves a stable program operation.

- **Program selection display**
  The CX provides a display function that enables you to select the program while viewing the program pattern.
  You can also view the overall program pattern using the overview function.
  You can check the program pattern even during operation. You can easily confirm segment information as well as program pattern information on this display.

Easy setup using a PC software

By using the PC software that comes standard with the product, you can easily set program patterns (which may appear complicated) using a user-friendly interface. The software provides an optimum environment for system configuration through colorful and easy-to-view setup windows.

Supports SP control during ramp/soak operation

The CX program control allows the pattern data of the current segment to be changed temporarily by being in HOLD during ramp/soak. Therefore, you can make necessary adjustments according to the progress of the program.

Controllable settings: segment time, target SP

In addition, the settings of segments after the current segment can be changed even while program control is in progress. This gives you the flexibility to change the settings of the succeeding process while viewing the progress of the pattern.
Below is an overview of the CX program control.

**Program control specifications**

Each program pattern consists of multiple segments. You can set parameters such as the segment time, target SP, PID parameter, and event output for each segment. The CX enables you to switch the pattern that is actually used in the operation out of multiple program patterns.

- **Program pattern specifications**
  - Number of program patterns: Up to 4 (/PG1) or up to 30 (/PG2) patterns
  - Pattern name: Up to 16 characters
  - Number of segments: Up to 99 (per pattern)
  - Total number of segments: Up to 300
  - Segment time: 1 s to 99 hours 59 minutes 59 seconds

- **Program control functions**

  Below are the functions provided by the CX program control.

  - **Wait action**
    
    Function for delaying the progress of the program if the PV cannot follow the SP.
    
    Wait action is performed in switching segments or within a segment. The wait action is specified by setting the wait zone and the wait time individually for high and low limits.
    
    - Number of settings: 5 groups (wait zone and wait time)
    - Wait zone selectable range: 0 to 100% of the measurement input span
    - Wait time: Off (0 s) to 99 min 59 s
      
      (No limit for wait within a segment)
Repeat action
Function for repeating a given segment (multiple consecutive segments also possible) within a program pattern.
Repeat frequency: Up to 999 or infinite

Hold function
Function for temporarily holding the program pattern operation during program control.
You can hold the program control by a key operation or by a contact input.
The time event and segment time counts are also held while the program control is held.

Advance function
Function for advancing the program pattern to the next segment during program control.
You can advance the program control by pressing a key or by using a contact input.

Event function
Function that outputs alarms according to progress of the program control and turns ON/OFF the contact output after a given time elapses.
There are two types of event actions: time event and PV event.
  Total number of events: Up to 800
  Time event: 16 points/segment
  PV event: 16 points/segment

[Time event]
Function that turns ON or OFF the contact output after a specified time elapses from the start of the segment operation.
  Time event setting range: 0 second - 99 hours 59 minutes 59 seconds
  Setting kinds: OFF : Not available
                ON1 : Time event ON/OFF
                ON2 : Time event ON
                ON3 : Time event OFF

[PV event]
Function that outputs alarms according to the progress of the program. The event operates only within the specified segment. The following types of alarms are available.
  PV high/low-limit, Deviation high/low-limit, Deviation high & low limit,
  Deviation within high & low limits alarm, SP high/low-limit, Output high/low-limit

Local (fixed-point) operation
Function that stops the program control and carries out fixed-point operation irrespective of the elapsed time of control operation.

Control mode
Single loop control and cascade control can be selected.

PID parameter selection method
Zone PID and segment PID can be selected.
Segment setting method (method of setting the operation of the SP within the segment)

A program pattern consists of multiple segments. The program pattern that represents the changes in the SP within each segment is automatically created by the segment setting method. The CX has the following two setting methods from which you select one in creating the program pattern. The segment setting method applies to all segments that make up the single program pattern.

- **Segment time method**
  This method sets the program pattern of the SP within the segment using the target SP, “TSPn” at the segment end and the segment time, “TIME.” The ramp rate (RT) of the graph within the segment is derived from the following equation.

\[
RT = \frac{(TSP - SP \text{ at start})}{TIME}
\]

- **Segment time ramp-rate method**
  This method sets the operation within the segment using a ramp rate “RT (per hour or min).” When the SP is constant (soak), the time of the segment is set using segment time. When the SP is changing (ramp), the graph is set using the target SP, “TSPn” at the segment end and the ramp grade of the ten-segment linearizer graph “RT.” In this case, the segment time (time needed to reach the SP) is derived from the following equation. The ramp rate “RT” is common to all program control loops.

\[
TIME = \frac{(TSP - SP \text{ at start})}{RT}
\]
Multi loops action within a segment>

Ramp rate, “RT” is common ramp rate to the loops within the segment. In setting the patterns of multi loops, find out “TIME” for each pattern by a calculation and the biggest “TIME” will be used as segment time. The patterns for each loops are set by following the segment time. In this case, program loop patterns are descended (ascended) by ramp rate, RT. After reaching TSPn, the pattern is kept at the value of “TSPn”.

<table>
<thead>
<tr>
<th>1st loop</th>
<th>2nd loop</th>
<th>3rd loop</th>
<th>4th loop</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSP1</td>
<td>TSP2</td>
<td>TSP3</td>
<td>TSP4</td>
</tr>
<tr>
<td>SEG1</td>
<td>SEG2</td>
<td>SEG3</td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>T2</td>
<td>T3</td>
<td></td>
</tr>
</tbody>
</table>

**TSP holding status**

- **Precautions in using the segment time ramp grade setup method**

In the segment ramp-rate method, if the segment time is beyond maximum value, the error process will be carried out. Please set ramp rate to prevent such error process.

<Example of error process>:

In setting the program pattern using the segment time ramp rate method, if the ramp rate (RT) is set extremely small with respect to the difference between the start SP and the final SP (TSP - SP at start), the calculated segment time may exceed the maximum value of 99 h 59 min 59 s. In such case, the program pattern loops back as shown in the following figure and moves to the next segment.
Program starting condition

The CX program control allows you to select the operation at the start of the control from the following. This determines the ramp grade and the start point of the start segment. Below is an overview of the various start conditions and the operations.

- **Starting target setpoint (SSPn)**
  The operation starts according to the pattern created by the starting target setpoint (SSPn) and the final target setpoint (TSPn) of the first segment regardless of the PV at start. If you specify the start segment, the SP at start is the final SP (TSPn-1) of the previous segment.
  When started, the SP is changed according to the ramp grade defined by “(TSPn-SSPn)/segment time.”

- **Starting with priority assigned to the segment time (can be selected in segment time method)**
  The operation starts according to the pattern created by the starting PV and the final target setpoint (TSPn) of the first segment regardless of the SP at start (SSPn).
  When started, the SP is changed according to the ramp grade defined by “(TSPn-PVn)/segment time.”
  If the start segment is soak, the operation is equivalent to starting target setpoint start.

- **Starting with priority assigned to PVn ramp rate (n: 1-6)**
  This method determines the start point by comparing the PV at start of the nth loop and the program pattern.
  Other unspecified loops start according to pattern of the specified nth loop.
  In this case, the program start point varies depending on the start segment pattern (soak, ascending ramp, or descending ramp). (See the table below.)

### Starting segment: starting point of ascending-segment ramp

<table>
<thead>
<tr>
<th>Process value (PV)</th>
<th>Starting point</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascending-segment ramp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(SSP&lt;TSP)</td>
<td>PV&lt;TSP</td>
<td>PV&lt;TSP</td>
</tr>
<tr>
<td></td>
<td>PV&lt;SSP</td>
<td>Same as SSP</td>
</tr>
<tr>
<td></td>
<td>PV&gt;SSP</td>
<td>Intersection between PV and pattern</td>
</tr>
<tr>
<td></td>
<td>PV&gt;TSP</td>
<td>will be decided by segment</td>
</tr>
</tbody>
</table>
### Starting segment: starting point in descending-segment ramp

<table>
<thead>
<tr>
<th>Process value (PV)</th>
<th>Starting point</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV&gt;TSP</td>
<td>PV&gt;SSP</td>
<td>Same as SSP</td>
</tr>
<tr>
<td>PV&lt;SSP</td>
<td>Intersection between PV and pattern</td>
<td>Figure B-2</td>
</tr>
<tr>
<td>PV&lt;TSP</td>
<td>will be decided by segment</td>
<td>Figure B-3, B-4</td>
</tr>
</tbody>
</table>

#### Figure B-1
![Diagram B-1](image1.png)

#### Figure B-2
![Diagram B-2](image2.png)

### Starting segment: starting point in soaking segment ramp

<table>
<thead>
<tr>
<th>Process value (PV)</th>
<th>Starting point</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>A value</td>
<td>Same as SSP</td>
<td>Figure C-1</td>
</tr>
</tbody>
</table>

#### Figure C-1
![Diagram C-1](image3.png)
Like the settings of other control items, you can set program control in the Setting mode (Control).
You can make changes while program control is in progress. The changes are applied to the next segment of
the program pattern operation.

- **Program pattern settings**
  The program pattern setting displays are divided into the following items. You can enter settings on a display
  that is provided for each item.
  - Pattern initial setting: Pattern initial setting (Items common to all segments such as the segment setting
    method)
  - Wait action setting: Sets the wait action of each program control loop
  - Pattern start setting: Sets the start SP.
  - Program pattern setting: Sets the segment operation.
  - Event setting: Sets PV events and time events.
  - Repeat action setting: Sets the repeat action segment.

- **Event output setting**
  Sets the terminal for outputting relay signals and behavior in relation to event output.

- **AUX (Auto message, Display position)**
  Sets the auto message printing function, the program display position, etc.
  - Auto message printing: Turns ON/OFF the function that automatically records the start and end
    points of program control on the trend as messages. When this function is
    ON, the start/stop information is also recorded in the message summary.
  - Program display position: Sets the displayed position of the program pattern.
2.5.4 CX Program Control Display Function (Program Selection Display)

The program selection display is used to select the program while viewing the program pattern. The pattern, the digital display of the SP, and the pattern information on this display helps you to select the program to be started. The features are described below.

■ Easy-to-view waveform display
- All display: Displays the patterns of all loops on the entire screen. (The span of the smallest numbered loop is used to display the patterns.)
- Division display: The screen can be divided into up to six sections. This is useful when the span of the displayed loops is different or when you wish to display the pattern individually or in groups. The display position for each loop is set beforehand.
- Overview display: You can view the overall pattern by turning ON the overview display. You can view the details in a partially expanded display by turning OFF the overview display.
- Waveform display ON/OFF: You can turn ON/OFF the loop display on the waveform section. The display ON/OFF status is indicated by the background color of the tag name.
- Scroll function: You can easily scroll the screen by key operation. The left and right arrow keys scroll the screen in units of segments; using the function key along with the left and right arrow keys scrolls the screen in units of 10 segments.

■ Segment information display
Shows information about the left-most segment on the waveform display. The displayed information is as follows:
- Pattern number, pattern name
- Segment number corresponding to the displayed information (left end)/total number of segments
- Segment time corresponding to the displayed information (left end)
- Program control start segment, program control delayed time
- Repeat frequency, repeat start/stop segment number, etc.

■ Digital display
The tag name, the tag comment, the SP of the segment and the corresponding unit are displayed numerically. In addition, you can check the ON/OFF status of the loop waveform display by the background color (ON/OFF) of the tag name.

■ Program control start and switching to the control display
The program control starts when you select a pattern and press the (RUN/RST) function key. When the program control starts, the display automatically switches to the program operation display.
2.5.5 CX Program Control Display Function (Program Control Display)

The program control display is provided for monitoring the operation status of the control operation that is carried out according to the program pattern. Versatile display function is achieved also on the control display as a result of fusing the control and measurement function. The features are described below.

- **Waveform display**
  - **Easy-to-view waveform display**
    Like the pattern selection display, the switch functions between all display/division display and ON/OFF of the loop display allow effective monitoring according to various conditions.
  - **Current PV is displayed on the program pattern**
    You can view the progress of the program on a display that the current program pattern and the measured PV waveform are displayed one on top of the other. The program pattern is displayed with a dotted line and the trend of the actual PV value is displayed with a solid line.
  - **Indication of the pattern proceeding position**
    Displays a cursor at the current pattern position. The waveform area displays “past data,” which shows the pattern that has been through along with the PV value, and “future data,” which shows the program pattern to be executed.
  - **Waveform display updating**
    The waveform area is updated at the waveform display update rate.

If you move to another display and redisplay the control display again, the past data section is reverted and displayed.

**Note:**
Because PV is displayed by using recorded “display data” PV can not be displayed in case of not starting record and setting “Record OFF”. Also, in Hold or Wait, the segment and pattern proceeding stop, but PV will be continuously displayed.
2. CX features and functions

■ Digital display
The data of each loop is displayed numerically giving you the exact value. In addition, you can check the ON/OFF status of the loop waveform display by the background color (ON/OFF) of the tag name.
Display items: Tag name or tag comment, PV & unit, SP & unit, OUT & unit, STOP/RUN status, and PROGRAM/LOCAL status

■ Program Pattern Information Display
Displays the program control information in progress.
Display items: Control status, pattern number (1 to 30) and pattern name (displayed at the top section of the screen),
current segment number (1 to 99)/total number of segments,
Current remaining segment time, wait status and wait time, hold status, and repeat status

■ Program control operation
You can change the pattern progress and the pattern setpoints during program control to accommodate the actual condition.
● Program control operation
 [Control function]: Start/Reset operation, advance, HOLD, and move to the program pattern selection display
● SP manipulation in HOLD
You can temporarily change the pattern setting of the current segment in HOLD.
[Changeable items]: Change the SP when in HOLD, change the segment time when in HOLD, etc.
● Change the future pattern setpoints
You can also change the program pattern on the setting display even during program operation.
In this case, the pattern changes are applied only to the segments succeeding the current segment.

■ PV display when in HOLD or WAIT
When the program control is held or is in a WAIT condition, the progress of the segment time and the pattern is stopped. However, PV is continuously displayed because recording is still in progress.
2.5.6 PC Software

Set patterns with easy using the PC software that comes standard

User-friendly window design arranged by setup items  Colorful displays  Easy and user-friendly operationally

In addition to the setup functions provided on the CX, you can also use PC software that comes standard with the product for setting the CX program control. The software allows complicated program patterns to be entered very easily through a user-friendly interface. The features of the software are described below.

- **Easy-to-use screen design**
  - **Setting display construction**
    The setting screen related to the program control consists of “Default setting,” “Segment setting,” “Event output,” and “AUX.” The setup items are organized on a single screen in an easy-to-understand window design.
  - **Setting and viewing of patterns on a single screen**
    The Segment setting window consists of the setup section and the pattern display section. Because the pattern display section is updated when you change a setting such as a SP, you can verify the changes immediately.
    In addition, PV event and time event settings are arranged in a way so that you can verify the settings along with the pattern.

- **Graphical screen design**
  The various colors used on the window facilitate the identification of the selected condition of items and settings.

- **User-friendly GUI**
  Remarkable features of program setting function by PC application are the functions and operationality. It provides easy and user-friendly setting environment by entering with mouse and keyboard operation.
  - **Easy Mouse operation for switching screens and setting items**
    Simply click the item buttons to switch between screens.
    Select settings from a selection list, except for numeric entry items.
2. CX features and functions

- **Resizable display area**
  On the Segment setting window, you can change the size of the display area. For example, you can expand an area where you wish to view in detail.

- **Tool buttons**
  Abundant tools convenient for setting patterns and display are provided. Simply click on the tool button to use the function.
  - Example: Copy, paste, initialize, segment design (insert, add, and delete), expand/reduce the display, realtime display (uniform/time proportional), all display/divided display, SP display (ON/OFF), etc.

**Original function of PC application**

The original functions of PC software are introduced regarding of program pattern setting.

- **Program patterns copy and paste**
  The program patterns' copy and paste are available. The initial setting of original copy program pattern and segment setting can be copied. Because of this function, repetition of same settings can be eliminated.
  - Ex.: In case of preparing a little different settings for many segments.

- **Initialization of program pattern**
  The segment setting of program pattern can be reset to the initial status.

- **Real time display function**
  The segment display can be switched to “uniform width” and “Real time display”. This function enables to see from two point of views.
  - “Uniform width” : good to understand setting for each loops.
  - “Real time display” : good to understand program pattern action.

- **Expansion/reduction of segment display**
  A part of segment can be displayed by expanded size or reduced size.

- **Numerical display of setpoints**
  The setpoints can be displayed with numerical value in program pattern area.

- **Emphasis display of a control loop pattern (active button of each loop)**
  In case of multi number of program patterns, a control loop pattern can be picked up and displayed in the front.
2.6 Setting functions

Another feature of CX is how easy it is to set control items. These setting functions are described below.

- **Changing modes from the operating display to the setting display**
  The displays related to CX settings are broadly divided into three categories according to the type of settings. The mode changes from the operating display are done using the MENU keys and function keys (see the diagram above).
  - Set mode display (common menu display)
    The settings on this screen are equivalent to the DX set mode items.
  - Set mode display (control-menu display)
    These settings are related to controls.
  - Basic setting display
    These are the basic system settings.

- **Easy switching to detailed displays from menu display using soft keys**
  Using the menu display as an entryway from the setting display, it is possible to access detailed setting displays in more detailed categories. This is easy to do using soft keys for quick access to the desired setting display.

- **Detailed display design with easily understood categories makes it easy to enter and check settings**
  Numerous settings are shown on a single screen in the individual detailed setting displays. This makes it easy to enter and check settings. There are even setting displays for the Green Series controller basic settings. These displays, which have the same design as the displays for the embedded loops, make it easy to enter the relevant settings.
2.7 Display functions
2.7.1 Operating display (control groups)

- Three different display styles provide familiar-looking instrument images
  - Controller display: Same image as Green Series controller
  - Faceplate display: Instrument image
  - Hybrid display: Combination of instrument image and Green Series controller image

- Simultaneously monitor multiple loops on a variety of operating displays
  - As many as six loops can be monitored simultaneously, and up to eight control groups can be set as display groups. The displays for the operating statuses of individual loops are informative and easy to view.
  - Measurement input channel data and external Green Series controller operating statuses can be displayed on the same screen as embedded loops.
    - Screen updating interval: 1 second
    - Maximum number of displayed loops: 4 for CX1000, 6 for CX2000
    - Number of control groups: 4 for CX1000, 8 for CX2000
    - Displayed information: PV, SP, OUT, mode status, alarm status, start/stop, remote/local status, etc.
    - Available actions: Mode switching, remote/local switching, start/stop, changes to SP value and OUT value, etc.

- Access the tuning display with a single touch
  - The soft keys provide one-touch access to a display for tuning any loop.

- Control and monitor embedded and external loops over the same interface
  - Green Series controllers on external loops can be controlled and monitored just like embedded loops. A single CX unit can centrally monitor the operating statuses of as many as 16 external Green Series controllers.
2. CX features and functions

2.7.2 Operating display (tuning display)

This screen contains a faceplate display, trend display, and parameter display. It can be used to tune for optimal control while monitoring the operating statuses of the embedded and external loops.

- **Parameters can be customized by the user. Up to 21 different parameters can be displayed.**
  The displayed parameters can be customized by the user, and up to 21 different parameters can be displayed. It is also possible to reduce the number of parameters and display only the minimum number required for your work.

- **Trend display of control operations**
  PV, SP, and OUT trends are displayed as indications of control operating statuses.

- **External Green Series controllers also supported**
  CX provides the same function support for external Green Series controllers as for embedded loops.

- **Entering and changing data**
  Function keys are assigned for data entry and changing for frequently used items. When a function key is pressed to change a parameter value, the data entry window is displayed.
2. CX features and functions

2.7.3 Operating display (other)

CX has a variety of standard displays for monitoring operating statuses. It also has display functions that are useful for remote monitoring.

- **Overview**
  This display presents an overview of the alarm occurrence status of each loop. It can also be used to monitor Green Series controller alarm statuses.
  Loops with alarms: Red
  Normal loops: Green
  Display functions: Mode status, PV values, SP values, and OUT values are displayed.
  Action functions: Mode switching, SP value changing, OUT value changing, start/stop, remote/local switching
  Display access: The tuning display or control group display can be accessed from a loop.

- **DI/DO status display**
  This display shows the current DI/DO operating statuses (ON/OFF).

- **Alarm summary**
  This shows a list of alarm occurrence statuses.
  Display access: The tuning display or historical display can be accessed from the alarms.

- **Information display (control event summary, control action summary, memory summary)**
  Control event summary: Displays a summary of events (PV events, time events) occurring during program control.
  Control action summary: Displays a summary of operating statuses related to control operations.
  Memory summary: Displays program names in memory block information.

- **4-Panel display (CX2000 only)**
  Overview, DI/DO status display, alarm summary, control event summary, control action summary
2.7.4 Trend display

CX can display and record embedded and external loop control status trends just like measurement channels.

- **Display all data together using the all-channel display function**
  CX1000 can simultaneously display data for 36 channels, and CX2000 can simultaneously display data for 116 channels.

  **Breakdown of displayed channels for CX1000**
  - Embedded loop channels (PV, SP, OUT): Channels 101-106
  - External Green Series controller channels (PV, SP, OUT): Channels 201—212
  - 6 measurement channels, 12 computation channels

  **Breakdown of displayed channels for CX2000**
  - Embedded loop channels (PV, SP, OUT): Channels 101—118
  - External Green Series controller channels (PV, SP, OUT): Channels 201—248
  - 20 measurement channels, 30 computation channels

- **Numerous group screens**
  CX has a number of display groups. The user can assign the desired channels (embedded/external loop data channels, measurement channels, computation channels) to each group.

  **CX1000**
  - 6 group screens capable of displaying trends for a maximum of 6 channels per group

  **CX2000**
  - 10 group screens capable of displaying trends for a maximum of 10 channels per group
2.7.5 Other display functions

With a variety of display features, CX can display needed information in the optimum format.

- **Digital display**
  Accurate current values are displayed in large fonts.

- **Bar graphs**
  Bar graphs make it possible to check current process value levels and alarm information at a glance.

- **Overview**
  The overview display shows current values and alarm statuses for all channels on a single screen.

- **Information display**
  A variety of information, including alarms, messages, and internal memory data is displayed.

- **4-Panel display**
  The screen can be split into four windows to show four separate displays. Display screens related to measurement data, information display, and controls (overview, DI/DO status display, alarm summary, control event summary) can also be shown in a 4-Panel display.

- **Snapshot function**
  This function can be used to save the currently displayed CX screen as an image in storage media. The data is saved in PNG format, so it can be used in ordinary word processor files and the like.
2.8 Recording methods

Flexible recording methods make it possible to save required data efficiently in the optimum format. The wide variety of recording methods greatly improves the efficiency of subsequent processing of recorded data, and the efficiency of work in the field.

- **CX recording methods**

  CX saves measurement data to internal memory, then saves the data to external storage media according to whether auto mode or manual mode is used. The internal memory is a nonvolatile flash memory that requires no battery backup, so data will not be lost in events such as a power outage.

  - **External storage media**

    | Storage media     | Capacity | Features                                      |
    |-------------------|----------|-----------------------------------------------|
    | 3.5 inch floppy disk | 1.4 MB   | Inexpensive and widely available.            |
    | ZIP disk          | 100 MB   | The recording head is non-contact, so reliability is better than that of floppy disks. |
    | ATA flash memory card | Up to 440 MB supported | Expensive, but contains no moving parts and has high reliability. Ideal for data collection over extended time periods. |

  - **Recording modes**

    There are two different CX recording modes: auto and manual.

    - **Auto mode**
      
      In this mode, data is saved automatically at set intervals to external storage media inserted in advance. This recording mode is well-suited to automated recording over extended periods of time using an ATA flash memory card or ZIP disk.

    - **Manual mode**
      
      In this mode, data in the internal memory is saved to an external storage medium when one is inserted in the appropriate drive. This recording mode is suitable for cases where the user wants to be able to immediately check data covering a relatively short time period using floppy disks.
### Types of recorded data

<table>
<thead>
<tr>
<th></th>
<th>CX1000</th>
<th>CX2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement data</td>
<td>Max 6CH</td>
<td>Max 20CH</td>
</tr>
<tr>
<td>Computation data</td>
<td>12CH</td>
<td>30CH</td>
</tr>
<tr>
<td>Embedded control loop data (PV, SP, OUT)</td>
<td>101–106CH (2 loops*PV, SP and OUT readings)</td>
<td>101–118CH (6 loops*PV, SP and OUT readings)</td>
</tr>
<tr>
<td>External Green Series loop data (PV, SP, OUT)</td>
<td>201–212CH (4 loops*PV, SP and OUT readings)</td>
<td>201–248CH (16 loops*PV, SP and OUT readings)</td>
</tr>
</tbody>
</table>

### File types

The following file types can be saved to external storage media.

<table>
<thead>
<tr>
<th>File type</th>
<th>Data contents</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement data files</td>
<td>Measurements sampled in the measurement period, computations, embedded controls, and Green Series controller communication data maximum and minimum values within the waveform update period</td>
<td>Binary</td>
</tr>
<tr>
<td>Event data</td>
<td>Instantaneous values sampled in the specified sampling period</td>
<td></td>
</tr>
<tr>
<td>Alarm summary data</td>
<td>Alarm occurrence/clearing information for the observed channel</td>
<td></td>
</tr>
<tr>
<td>Event summary data</td>
<td>Time/PV event occurrence/clearing</td>
<td></td>
</tr>
<tr>
<td>Control mode summary data</td>
<td>Start/Stop, Local/Remote, Manual/Auto/Cascade switching, program Hold/Clear</td>
<td></td>
</tr>
<tr>
<td>Manual sampling data files</td>
<td>Instantaneous values at each key input or contact input</td>
<td>ASCII</td>
</tr>
<tr>
<td>Statistical computation (TLOG) data files</td>
<td>Data at TLOG time-up</td>
<td>Binary</td>
</tr>
<tr>
<td>Report files *1</td>
<td>Hourly reports, daily reports, weekly reports, monthly reports</td>
<td>ASCII</td>
</tr>
<tr>
<td>Settings files</td>
<td>Set mode/setup mode settings</td>
<td>ASCII</td>
</tr>
<tr>
<td>Information</td>
<td>Login user names</td>
<td>Binary</td>
</tr>
<tr>
<td></td>
<td>When the login function is ON, login user names executing Start/Stop and message inputs are stored in a measurement data file.</td>
<td></td>
</tr>
</tbody>
</table>

*1: When computation option is installed.

Snapshot data on the display screen are output to external storage media or online communication.

<table>
<thead>
<tr>
<th>File type</th>
<th>Data contents</th>
<th>Output to</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snapshot data files</td>
<td>Snapshot images</td>
<td>External storage media or online communication output</td>
<td>PNG</td>
</tr>
</tbody>
</table>

### Number of events

“Number of events” refers to the number of recording operations (from start to stop). The CX internal memory can store a maximum of 16 display data file events. When the 17th recording event is started, overwriting of the display data file begins. During recording operations involving Start/Stop (e.g., batch processes), there are two limits on the number of data files that can be stored in CX: the memory capacity and the number of events.

In auto mode, files are saved automatically to computations each time recording is stopped. Auto mode is appropriate for batch processes. During continuous recording, the display data is overwritten starting with the oldest data once the internal memory becomes full.
Sampling time (maximum recording time)

Sampling time (maximum recording time) is determined by the number of control data records, the number of measurement channels, the number of computation channels, and the combination of file types. Sampling time (maximum recording time) is calculated according to the following equation:

Sampling time = Maximum number of data records × Sampling period

Maximum number of data records = Internal memory capacity / Data capacity per sampling

- **Internal memory capacity**
  Internal memory capacity is defined as shown below according to the combination of files.

<table>
<thead>
<tr>
<th>File type</th>
<th>Memory capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display data files only</td>
<td>1.2 MB</td>
</tr>
<tr>
<td>Event files only</td>
<td>1.2 MB</td>
</tr>
<tr>
<td>Display data files and event files</td>
<td>900 KB for display data files</td>
</tr>
<tr>
<td></td>
<td>300 KB for event files</td>
</tr>
</tbody>
</table>

- **Data capacity per sampling**
  Data sizes per sampling per channel are as shown below.

<table>
<thead>
<tr>
<th>Display data</th>
<th>Control data (PV, SP, OUT) 4 bytes each</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Measurement data 4 bytes</td>
</tr>
<tr>
<td></td>
<td>Computation data 8 bytes</td>
</tr>
<tr>
<td>Event data</td>
<td>Control data (PV, SP, OUT) 2 bytes each</td>
</tr>
<tr>
<td></td>
<td>Measurement data 2 bytes</td>
</tr>
<tr>
<td></td>
<td>Computation data 4 bytes</td>
</tr>
</tbody>
</table>

Given the above data sizes, the data capacities per sampling of display data and event data are calculated according to the following equations:

Display data capacity = Number of control groups × 3 × 4 bytes + Number of measurement channels × 4 bytes + Number of computation channels × 8 bytes

Event data capacity = Number of control groups × 3 × 2 bytes + Number of measurement channels × 2 bytes + Number of computation channels × 8 bytes

- **Maximum number of data records**
  The maximum number of data records that can be recorded in internal memory varies according to the combination of file types, and is calculated as shown below.

  - **Display data only**
    Maximum number of data records: 1.2 MB / (Number of controls loops × 3 × 4 bytes + Number of measurement channels × 4 bytes + Number of computation channels × 8 bytes) .... 1; note: maximum 100,000 data records

  - **Event files only**
    Maximum number of data records: 1.2 MB / (Number of controls loops × 3 × 2 bytes + Number of measurement channels × 2 bytes + Number of computation channels × 8 bytes) .... 2; note: maximum 120,000 data records

  - **Display data and event files**
    - **Display data**
      Maximum number of data records = 900 KB / (Number of measurement channels × 4 bytes + Number of computation channels × 8 bytes) .... 3; note: maximum 75,000 data records

    - **Event data**
      Maximum number of data records = 300 KB / (Number of measurement channels × 2 bytes + Number of computation channels × 4 bytes) .... 4; note: maximum 30,000 data records
Examples: (1) Display data files only (calculated according to Equation 1)

- 2 control loops, 6 measurement channels, no computation channels
  Maximum number of data records = 1.2 MB / (2 \times 3 \times 4 \text{ bytes} + 6 \times 4 \text{ bytes} + 0 \times 8 \text{ bytes}) = 25,000 data records
  For display updating interval of 30 minutes/div (data saving interval: 60 seconds)
  Sampling time = 25,000 data records \times 60 \text{ seconds} = 1,500,000 \text{ seconds} (approximately 17 days)

- 6 control loops, 10 measurement channels, 10 computation channels
  Maximum number of data records = 1.2 MB / (6 \times 3 \times 4 \text{ bytes} + 10 \times 4 \text{ bytes} + 10 \times 8 \text{ bytes}) = 6250 data records
  For display updating interval of 30 minutes/div (data saving interval: 60 seconds)
  Sampling time = 6250 data records \times 60 \text{ seconds} = 375,000 \text{ seconds} (approximately 4 days)

Examples: (2) Event data files only (calculated according to Equation 2)

- 2 control loops, 6 measurement channels, no computation channels
  Maximum number of data records = 1.2 MB / (2 \times 3 \times 2 \text{ bytes} + 6 \times 2 \text{ bytes} + 0 \times 4 \text{ bytes}) = 50,000 data records
  For event file sampling interval of 1 second
  Sampling time = 50,000 data records \times 1 \text{ second} = 50,000 \text{ seconds} (approximately 13 hours)

- 6 control loops, 10 measurement channels, 10 computation channels
  Maximum number of data records = 1.2 MB / (6 \times 3 \times 2 \text{ bytes} + 10 \times 2 \text{ bytes} + 10 \times 4 \text{ bytes}) = 12,500 data records
  For event file sampling interval of 1 second
  Sampling time = 12,500 data records \times 1 \text{ second} = 12,500 \text{ seconds} (approximately 3 hours)

Examples: (3) Display data files and event data files (calculated according to Equations 3 and 4)

- 2 control loops, 6 measurement channels, no computation channels
  - Display data
    Maximum number of data records = 900 KB / (2 \times 3 \times 4 \text{ bytes} + 6 \times 4 \text{ bytes} + 0 \times 8 \text{ bytes}) = 18,750 data records
    For display updating interval of 30 minutes/div (data saving interval: 60 seconds)
    Sampling time = 18,750 data records \times 60 \text{ seconds} = 1,125,000 \text{ seconds} (approximately 13 days)
  - Events
    Maximum number of data records = 300 KB / (2 \times 3 \times 2 \text{ bytes} + 6 \times 2 \text{ bytes} + 0 \times 4 \text{ bytes}) = 12,500 data records
    For event file sampling interval of 1 second
    Sampling time = 12,500 data records \times 1 \text{ second} = 12,500 \text{ seconds} (approximately 3 hours)

- 6 control loops, 10 measurement channels, 10 computation channels
  - Display data
    Maximum number of data records = 900 KB / (6 \times 3 \times 4 \text{ bytes} + 10 \times 4 \text{ bytes} + 10 \times 8 \text{ bytes}) = 4687 data records
    For display updating interval of 30 minutes/div (data saving interval: 60 seconds)
    Sampling time = 4687 data records \times 60 \text{ seconds} = 281,250 \text{ seconds} (approximately 3 days)
  - Events
    Maximum number of data records = 300 KB / (6 \times 3 \times 2 \text{ bytes} + 10 \times 2 \text{ bytes} + 10 \times 4 \text{ bytes}) = 3125 data records
    For event file sampling interval of 1 second
    Sampling time = 3125 data records \times 1 \text{ second} = 3125 \text{ seconds} (approximately 52 minutes)
2.9 PC application software

- **DAQSTANDARD for CX (standard)**
  
  DAQSTANDARD for CX is a software package that is provided as a standard feature with the CX Series. It can be used for file conversion and to open and display data files (event data, display data, TLOG data files) saved on CX as well as data transferred to a file server using a protocol such as FTP. File conversion can be used to convert CX data files to ASCII format or formats compatible with popular spreadsheet programs like Lotus 1-2-3 and Microsoft Excel. The settings software can be used to enter various CX settings either online or using external storage media.

- **DAQLOGGER (Due out spring, 2002)**
  
  DAQLOGGER is a data logging program that allows simultaneous use of RS-232, RS422-A/485, or an Ethernet connection. Up to 32 units can be connected at the same time in a heterogeneous environment, including CX Series as well as DX Series, µR Series industrial recorders, VR Series view recorders, and DARWIN Series. Collected data can be converted to ASCII, Lotus 1-2-3, and Microsoft Excel formats. In addition, reports such as hourly reports, daily reports, and monthly reports can be created on a PC during data collection.

- **DAQEXPLORER (Due out spring, 2002)**
  
  DAQEXPLORER is a software package for DAQSTATION that includes functions such as Desktop and Remote Monitor as well as standard software functions. DAQEXPLORER provides a user-friendly GUI interface that makes it easy to use CX's Ethernet-based networking functions such as file transfers and real-time monitoring.
Application Software Specifications

- **CX standard software**

  **System Requirements**
  - Operating system: Microsoft Windows 98/NT4.0/2000/Me
  - Microprocessor: MMX Pentium 166 M-Hz or faster (266 MHz or faster recommended)
  - RAM: 32 MB or more (64 MB or more recommended)
  - CD-ROM drive: Required
  - Free hard drive space: 10 MB or more (100 MB or more recommended)
  - Video card: Video card compatible with Windows 98/NT4.0/2000/Me and capable of displaying 32,000 or more colors (64,000 or more colors recommended)
  - Printer: Printer and driver compatible with Windows 98/NT4.0/2000/Me

  **Main functions**
  - CX settings (online or via external storage media)
  - Data redisplay
  - Printout of displayed data
  - File conversion (ASCII, Lotus 1-2-3, Microsoft Excel)

- **DAQLOGGER**

  **System requirements**
  - Operating system: Microsoft Windows 98/NT4.0/2000/Me
  - Microprocessor: MMX Pentium 166 MHz or faster (266 MHz or faster recommended)
  - RAM: 64 MB or more (128 MB or more recommended)
  - CD-ROM drive: Required
  - Free hard drive space: 30 MB or more (100 MB or more recommended)
  - Video card: Video card compatible with Windows 98/NT4.0/2000/Me and capable of displaying 32,000 or more colors (64,000 or more colors recommended)
  - Printer: Printer and driver compatible with Windows 98/NT4.0/2000/Me

  **Main functions**
  - Online connection of up to 32 units ([μR, VR, DARWIN, DX, CX](https://example.com))
  - Multiport support for a mixture of RS422-A/485, RS-232C, and Ethernet connections
  - Data logging on up to 1000 channels
  - Data redisplay
  - Printout of displayed data
  - File conversion (ASCII, Lotus 1-2-3, Microsoft Excel)

- **DAQEXPLORER**

  **System requirements**
  - Operating system: Microsoft Windows 98/NT4.0/2000/Me
  - Microprocessor: MMX Pentium 166 MHz or faster (266 MHz or faster recommended)
  - RAM: 64 MB or more (128 MB or more recommended)
  - CD-ROM drive: Required
  - Free hard drive space: 10 MB or more (100 MB or more recommended)
  - Video card: Video card compatible with Windows 98/NT4.0/2000/Me and capable of displaying 32,000 or more colors (64,000 or more colors recommended)
  - Printer: Printer and driver compatible with Windows 98/NT4.0/2000/Me

  **Main functions**
  - CX Desktop (for performing actions such as file transfer and entering CX settings on a PC desktop)
  - Remote monitor
  - CX settings (online or via external storage media)
  - Data redisplay
  - Printout of displayed data
  - File conversion (ASCII, Lotus 1-2-3, Microsoft Excel)
2.10 Communication functions
2.10.1 Ethernet (E-mail sending function)

CX is standard-equipped with an Ethernet port so it can exchange information over a network. It also has excellent functions to support remote monitoring. One of these functions is the E-mail sending function. This feature makes it possible to monitor data anywhere and anytime, so just a few people can effectively monitor a wide area.

Sending alarm information and other data as Internet mail (E-mail)

CX has two addressee groups. Multiple addressees can be registered in each of these groups (maximum 150 alphanumeric characters). The user can select whether or not to send notifications to each addressee group.

Transmitted information:
- Alarm notifications: Notifications provided when an alarm occurs or is cleared. The user can select whether or not to send this type of notification to each addressee group (the selection applies to all channels). In addition, the user can select whether or not to send notifications of the instantaneous values for all channels.
- System notifications: Power outage notifications, memory end notifications, error notifications
- Periodic notifications: E-mail notifications provided at specified intervals from specified times
- Report notifications: Notifications of report computation results provided when reporting time ends (when computation option /M1 is installed)

Enabling information exchanges through E-mail

Methods such as the following can be used to send E-mail from remote sites to monitoring sites:
- Connection to an existing E-mail system
- Notification using ISP (Internet Service Provider) connection via PSTN line
- Notification using ISP (Internet Service Provider) connection via ISDN line
- Notification using ISP (Internet Service Provider) connection via remote cellular phone
2.10.2 Ethernet (Web server function)

Display CX screens on a Web browser for remote monitoring and wide-area monitoring using the included Web server function

- CX screen display: Displays CX screens on a Web browser
- Alarm information display: Displays the most recent 120 events in a separate window
- All-channel display: Displays instantaneous values/alarm statuses for all channels in a separate window
- History display: Displays a history of errors, communications, FTP, E-mail and Web activity in a separate window
- Message input function: Inputs messages to CX through the Web browser screen

The function for displaying CX screens on an ordinary Web browser enables data monitoring on any PC, not just a special administrative PC. This means users can monitor in any location, and is effective in reducing maintenance labor costs.

Main specifications of Web server function

- Applicable Web browsers: Microsoft Internet Explorer versions 5.0 and 5.5
- Security: User authentication function (user name and password)
- Access levels
  - Operator: Can change display screens and enter messages
  - Monitor: Can change display screens but cannot enter messages
- Screen refreshing: Select automatic (every 30 seconds) or manual in the Web browser.
- Display types
  - CX screen display: Displays CX screens in a Web browser
  - Alarm information display: Displays the most recent 120 events in a separate window
  - All-channel display: Displays instantaneous values/alarm statuses for all channels in a separate window
  - History display: Displays a history of errors, communications, FTP, E-mail and Web activity in a separate window
- Message input function: Enables message input to CX through the Web browser screen
2.10.3 Ethernet (FTP function)

- **FTP server function**: Supports up to 7 clients. Transfers data files to client PCs when needed.

- **FTP client function**: Works with up to 2 servers. Automatically and periodically transfers internal memory data to servers.

**FTP server function**
The FTP server function allows client computers to download data files saved to the CX's storage media. Ordinary FTP client tools can be used to download files. DAQEXPLORER, the special CX application software, can be used for real-time monitoring on a single host computer of measurement data from as many as 16 CX units installed in different locations. In addition, the user-friendly icons make it easy to download CX files to a computer.

**FTP client function**
The FTP client can be used to periodically and automatically download CX internal memory data to a file server. This function supports up to two servers (primary and secondary), so if the primary server fails, the files will be automatically transferred to the secondary server. Files stored on a server can be opened and worked on using a PC and special application software.
2.10.4 Modbus communication

CX has the same Modbus communication function as DX. A serial communication interface must be specified and computation option (/M1) must be installed.

- **CX has the same Modbus communication function as DX**

  This function enables Modbus (RTU protocol) communication with slave devices. DARWIN can be connected as a slave device to increase the number of input channels. Other Modbus-compatible devices can be connected for effective use of measurement data on the slave devices.

- **Collecting, saving, and using measurement data from slave devices as a Modbus master device**

<table>
<thead>
<tr>
<th>Model</th>
<th>Maximum number of inputs</th>
<th>Maximum number of recording points</th>
</tr>
</thead>
<tbody>
<tr>
<td>CX1000</td>
<td>12: (C1–C12)</td>
<td>12: (31–42)</td>
</tr>
<tr>
<td>CX2000</td>
<td>30: (C1–C30)</td>
<td>30: (31–60)</td>
</tr>
</tbody>
</table>
### 2.10.5 Green Series controller communication

The Green Series communication function makes it easy to monitor external Green Series controllers just like embedded loops.

- **Automatic parameter acquisition-no complex setup process**
  - There is no complex setup process to establish a connection. The Green Series controller parameters are acquired automatically simply by setting the station number.
  - **Automatically acquired parameters:** Model, control mode, span, units, decimal point position, output type, alarm-related (type)

- **Combined monitoring of multiple Green Series controllers in different locations**
  - This function lets you centrally monitor the control operation statuses of Green Series controllers on the operating display. The operating statuses of Green Series controllers in different locations can be monitored at one location.
  - Maximum display loops: 4 for CX1000, 6 for CX2000

- **Alarm statuses shown on a single screen**
  - The overview display shows PV, SP, and OUT values, as well as alarm occurrence statuses for all loops on a single screen.

- **Controlling Green Series controllers on the tuning display**
  - The tuning display can be used to control a Green Series controller or change its parameters remotely. The user can set the desired parameter types to be displayed on the tuning display.
Green Series controller communication specifications

- Maximum number of connected units
  Green Series controllers and:
  - CX2000: 16 units
  - CX1000: 4 units
  (Note that two-loop Green Series controllers are counted as two units.)
- Supported models: UT320/350, UT420/450, UT520/550, UT750, and more
- Monitoring and operation functions

<table>
<thead>
<tr>
<th>Function</th>
<th>UT</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring and recording PV, SP, and OUT</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Monitoring and recording alarms</td>
<td>×(*)</td>
<td></td>
</tr>
<tr>
<td>Monitoring and recording modes</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Changing modes</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Changing SP settings</td>
<td>×</td>
<td>×(*)</td>
</tr>
<tr>
<td>Changing PID parameter settings</td>
<td>×</td>
<td>×(*)</td>
</tr>
<tr>
<td>Changing output during manual operation</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Switching between REMOTE and LOCAL</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Switching between RUN and STOP</td>
<td>×</td>
<td></td>
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<tr>
<td>Changing SP numbers</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Executing auto-tuning</td>
<td>×</td>
<td></td>
</tr>
</tbody>
</table>

(*1) Alarm types are acquired once only during automatic acquisition. If they are later changed, the data will not be updated unless automatic acquisition is performed again. Furthermore, flags for the alarm setpoints will not be displayed in bar graphs and on faceplate displays.

(*2) Range checks cannot be performed.
2.10.6 Ladder communication

The Ladder communication function makes it possible to build a system combined with PLC. CX temperature control data can be used by the PLC sequence control function to broaden the range of controls and make the controls more advanced.

- **Ladder communication from Host (PLC) Ladder program to CX**
  A host conforming to the Ladder communication protocol can read/write CX data through Ladder communication.

- **Supported features**
  - Communication register data
  - Memory Start/Stop
  - Alarm ACK
  - Centralized monitoring Start/Stop/Reset
  - Alarm settings
  - Program control Stop/Hold, pattern switching
  - Control operation Start/Stop
  - Various parameters for each loop
  - PID parameters for each loop
  - Target setpoint (SP) number
  - Other data assigned to D register
### Differences between CX and UT (Green Series)

<table>
<thead>
<tr>
<th>Control modes</th>
<th>CX</th>
<th>UT350</th>
<th>UT450</th>
<th>UT550</th>
<th>UT750</th>
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<tbody>
<tr>
<td>Single loop control</td>
<td>×</td>
<td>×</td>
<td>×</td>
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<tr>
<td>Cascade</td>
<td>×</td>
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<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Loop control with PV switching</td>
<td>×</td>
<td>×</td>
<td></td>
<td>×</td>
<td></td>
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<tr>
<td>Loop control for backup</td>
<td>×</td>
<td>×</td>
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<td></td>
<td></td>
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<tr>
<td>Loop control with PV auto-selector</td>
<td>×</td>
<td>×</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Loop control with PV-hold function</td>
<td>×</td>
<td>×</td>
<td></td>
<td></td>
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<tr>
<td>Dual loop control</td>
<td>×</td>
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<tr>
<td>Temperature and humidity control</td>
<td>×</td>
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<td></td>
</tr>
<tr>
<td>Cascade control with two universal inputs</td>
<td>×</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Loop control with PV switching and two universal inputs</td>
<td>×</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Loop control with PV auto-selector and two universal inputs</td>
<td>×</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Custom computation control</td>
<td>×</td>
<td></td>
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<table>
<thead>
<tr>
<th>Control computation functions</th>
<th>Continuous PID control</th>
<th>Time proportional PID control</th>
<th>Heating/cooling control</th>
<th>Relay ON/OFF control</th>
<th>Auto-tuning</th>
<th>Super</th>
<th>Super 2</th>
<th>Anti-reset windup</th>
<th>Zone PID switching</th>
<th>Reference point</th>
<th>Preset output function</th>
<th>Control interval</th>
<th>Parameter sets</th>
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<tbody>
<tr>
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<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>6</td>
<td>2 or 4</td>
<td>≥ 250 ms</td>
<td>8 sets</td>
</tr>
<tr>
<td>UT350</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>2</td>
<td>2 or 4</td>
<td>≥ 250 ms</td>
<td>4 sets</td>
</tr>
<tr>
<td>UT450</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>2</td>
<td>2 or 4</td>
<td>≥ 250 ms</td>
<td>8 sets</td>
</tr>
<tr>
<td>UT550</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>2</td>
<td>2 or 4</td>
<td>≥ 250 ms</td>
<td>8 sets</td>
</tr>
<tr>
<td>UT750</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>2</td>
<td>2 or 4</td>
<td>≥ 50 ms</td>
<td>8 sets</td>
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<tr>
<th>Operation mode switching</th>
<th>Auto/Manual switching</th>
<th>Run/Stop switching</th>
<th>Remote/Local switching</th>
<th>Cascade/Auto/Manual switching</th>
<th>Output tracking ON/OFF switching</th>
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<tbody>
<tr>
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<td>×</td>
<td>×</td>
<td>×</td>
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<tr>
<td>UT450</td>
<td>×</td>
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<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
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<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
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<thead>
<tr>
<th>Measurement input computation</th>
<th>Bias calculation</th>
<th>Input processing</th>
<th>First-order lag computation (filtering)</th>
<th>Square-root computation (extraction)</th>
<th>Ten-segment linear approximation</th>
<th>Ten-segment linear biasing</th>
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<tbody>
<tr>
<td>CX</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>UT350</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>UT450</td>
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<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
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<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>UT750</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
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<table>
<thead>
<tr>
<th>Supplemental input computation</th>
<th>Input processing</th>
<th>Square-root computation (extraction)</th>
<th>First-order lag computation (filtering)</th>
<th>Ratio multiplication</th>
<th>Bias addition</th>
</tr>
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<tbody>
<tr>
<td>CX</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
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<tr>
<td>UT350</td>
<td>×</td>
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<tr>
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<td>UT550</td>
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<tr>
<td>UT750</td>
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<table>
<thead>
<tr>
<th>Alarm information functions</th>
<th>Alarm output: Relay</th>
<th>2 per 2 loops</th>
<th>3</th>
<th>3 or 4</th>
<th>3</th>
<th>Transistor</th>
<th>4 per 2 loops</th>
<th>1</th>
<th>4</th>
<th>4</th>
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<tbody>
<tr>
<td>CX</td>
<td>Relay</td>
<td>2 per 2 loops</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4 per 2 loops</td>
<td>1</td>
<td>4</td>
<td>4</td>
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<tr>
<td>UT350</td>
<td>Relay</td>
<td>2 per 2 loops</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4 per 2 loops</td>
<td>1</td>
<td>4</td>
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</tr>
<tr>
<td>UT450</td>
<td>Relay</td>
<td>2 per 2 loops</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4 per 2 loops</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>UT550</td>
<td>Relay</td>
<td>2 per 2 loops</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4 per 2 loops</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>UT750</td>
<td>Relay</td>
<td>2 per 2 loops</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4 per 2 loops</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

| Alarm standby operation          | Relay               | 2 per 2 loops | 3 | 3     | 3 | 4 per 2 loops | 1 | 4 | 4 |
|Delay timer                       | Relay               | 2 per 2 loops | 3 | 3     | 3 | 4 per 2 loops | 1 | 4 | 4 |
|Auto-diagnostic alarm             | Relay               | 2 per 2 loops | 3 | 3     | 3 | 4 per 2 loops | 1 | 4 | 4 |
|FAIL output                      | Relay               | 2 per 2 loops | 3 | 3     | 3 | 4 per 2 loops | 1 | 4 | 4 |
|Timer function                    | Relay               | 2 per 2 loops | 3 | 3     | 3 | 4 per 2 loops | 1 | 4 | 4 |
|Sensor contact alarm              | Relay               | 2 per 2 loops | 3 | 3     | 3 | 4 per 2 loops | 1 | 4 | 4 |
3. Benefits of installing CX

3.1 Added value through integration

CX was developed by integrating Green Series controller control algorithms with DX basic technologies, and adding technologies developed in-house to make a simple controller for today’s networked environments. CX includes modern networking technologies and advanced field monitoring functions not seen in conventional Green Series controllers. This integration provides a variety of added values.

- **Easy setup**
  A variety of operating status monitoring displays are standard with CX, eliminating the need for the customer to perform separate engineering work such as screen design. In addition, control-related parameter setting screens are categorized by themes that are easily understood. A single screen lets the user set multiple parameters, so setup is easy.

- **Excellent field display trend function**
  The trend display function is one of the excellent DX basic technologies incorporated into CX. It enables monitoring of measurement data on a variety of displays. Trends for embedded and external loop control operations can be displayed just as easily as measurement data displays. Trends of control values such as PV, SP, and OUT are very useful for monitoring control operations. In addition, the all-channel display lets the user display data for 116 channels on a single screen.

- **Compact wiring and installation space**
  CX contains control functions for up to six loops, so a single unit can handle functions ranging from controls to monitoring, recording, and management for a small-scale site. A single CX unit can thus replace system consisting of a number of conventional units. This significantly reduces installation space requirements and simplifies complex cabling between units.

- **Enhanced networking functions**
  CX is standard-equipped with an Ethernet port and has other networking capabilities such as E-mail sending, Web server, FTP server, and FTP client. These capabilities enable remote data monitoring, wide area management, and centralized monitoring of electronic data. With modern networking functions, CX gives the user remote access to real-time field data. This enables fast response in the control room, and a small number of people can handle monitoring operations.
3.2 Green Series communication

The CX Green Series communication functions integrate control data from multiple remote Green Series controller (up to 16 loops with CX2000, or 4 loops with CX1000) for centralized monitoring. The benefits of these functions include the following.

- **Easy setup**
  When connecting supported Green Series controller models, simply set the station numbers. CX will automatically acquire parameters such as the model, control mode, span, units, and alarms.

- **Operating conditions display**
  The standard display screens can be used without distinguishing whether the data is from an embedded loop. Features like single-screen displays of control groups, single-screen monitoring with the overview display, parameter monitoring with the tuning display, and trend displays allow the user to monitor the operating statuses of multiple Green Series controllers on a single CX unit. This improves monitoring efficiency.

- **Remote control**
  Individual Green Series controllers can be remotely controlled on the control group display and tuning display. Actions such as mode changing, and changing OUT values and PID parameters in manual mode can be performed as necessary. This allows a small maintenance staff to monitor field conditions and quickly take remote actions even when monitoring multiple remote Green Series controllers. In addition, the Web function lets the user monitor Green Series controllers from any location, and to check operating conditions while monitoring sites in the monitoring room.

- **Centralized data management**
  Data from multiple Green Series controllers is transferred using the CX’s networking features to a location such as a managing computer acting as a server for centralized management. In addition, Green Series controller data reports and the like can be easily created using PC application software.
3.3 Centralized monitoring (control groups)

One of CX’s special features is centralized monitoring.

- **Simultaneous monitoring of multiple Green Series controllers**
  With CX2000, up to eight control groups can be set. The user sets the desired control group data according to the monitoring application, choosing from embedded and external Green Series controllers and measurement channel data. This enables centralized monitoring simultaneously on a single screen. Embedded and external Green Series controllers and measurement channel data can be controlled and monitored over the same interface. Monitoring statuses are distinctively displayed on a high-resolution LCD, so conditions are easy to check. Even in setups where a user is already using multiple Green Series controllers, the installation of CX allows the user to use centralized monitoring and improve wide-area monitoring efficiency.

- **Remote control of individual Green Series controllers on tuning display and user-customized screens**
  Another important feature of CX is the ability to monitor multiple Green Series controllers and simultaneously control them. Embedded and external Green Series controllers can be controlled individual on the tuning display. Tuning parameters are customized by the user. By setting the parameters to be controlled in the tuning parameter display fields in advance, the user can easily change their settings. In cases where the user only wants to monitor operations, the display for a site can be set with higher security.

- **Check alarm occurrence statuses at a glance**
  Alarm occurrence statuses are displayed on a single screen, so the user can check the alarm statuses on multiple Green Series controllers at a glance. The tuning display for a loop with an alarm can be accessed through a single touch, so the user can monitor trends on Green Series controllers with alarms and take appropriate action.

- **Maintenance response from any location using Web function**
  Networking functions such as the Web function and E-mail let the user monitor and control Green Series controllers anywhere and at any time. Unit displays can be checked over the Web, thus reducing the need to go out to field sites.
3.4 Benefits of installing controller-integrated recorders

Currently, in the market for small-scale Green Series controllers, there is a shift toward control operation monitoring configurations that use PLC, such as a display combined with PLC or SCADA combined with PLC. However, control monitoring using PLC results in enormous system development costs for system implementation, including programming and the development of display screens.

**Problems at the small-scale sites**
- Our setup is not big enough to justify installing a system.
- It's difficult to set up a system using separate equipment for monitoring, controls, and recording.
- We don't have the installation space for a large number of units.
- Complex cabling is a problem.
- I want to monitor trends in the field.
- I want to save data reports.

These problems can all be solved by installing CX, which integrates control functions and field monitoring functions.

- **As many as six embedded control loops to reduce cabling and installation space**
  A single CX unit can handle multiple functions — controls, monitoring, data recording and data transmission. This reduces installation space and cabling requirements.

- **Powerful monitoring display screens are all standard features**
  A variety of display screens useful for operation monitoring are all standard features with CX. There are even trend display functions.

- **Standard Ethernet port**
  CX also has a standard Ethernet port and many data transmission functions, such as E-mail, Web server, and FTP.

- **Create management data reports using PC software**
  PC application software can be used to easily convert data and create reports, letting the user centralize data management.
3. Benefit of installing CX

3.5 Application models

- Example 1 (sintering parts in electric furnaces or industrial furnaces)

CX's embedded controls are used at control sites consisting of small loops, such as electric furnaces and other industrial furnaces. The main features for these applications are described below.

- **Easy control monitoring and tuning**
  Monitoring is done using the vibrant screen displays. A variety of operation monitoring screens provided as standard features for easy data viewing make it easy to check information. Control operation trends can also be checked. In addition, the user can simultaneously monitor 21 different parameters and take appropriate actions.

- **Easy networking**
  An Ethernet port, which is a standard feature with CX, makes it easy to connect field data to a network. In addition, FTP can be used to centrally manage data. And functions like E-mail sending and Web server can be used to monitor field data in real time.

- **Electronic data for data analysis**
  Data collected by CX is stored as electronic data. Data is recorded to the desired storage media (floppy disk, ZIP, flash memory card) according to the amount of data and the intended use. This makes it possible to record large amounts of data. Because the internal memory is a nonvolatile flash memory, data is not lost if there is a problem such as a power outage. In addition, it is easy to analyze electronic data using PC application software. Application software with report generation and data conversion features further expands the scope of data analysis.

- **Less cabling**
  Because CX contains both display functions and control functions, it requires less installation space, and the required equipment can be put together with less cabling.
Example 2 (temperature management for food and medicine storage facilities)

CX can reduce costs dramatically in systems used to control temperature in food and pharmaceutical storage facilities.

- **Replacing multiple instruments with a single CX unit**
  CX can be installed in temperature control systems containing a combination of multiple control and recording instruments. In such cases, the equipment configuration is simplified, and space and cabling requirements are significantly reduced.

- **Quality control data**
  The use of electronic data means that data formerly stored on recording paper can be kept on an IC card for a paperless system. This reduces running costs.
Example 3 (flow rate control in chemical injection systems)

CX helps reduce costs in many ways in systems that use both recorders and controllers.

- **Replacing control systems consisting of multiple instruments with a single CX unit**
  Building controls systems with multiple instruments is very labor-intensive in terms of setup for the individual instruments. In addition to setup difficulties, it takes a long time to master the procedures for using and setting such instruments. In contrast, CX is standard-equipped with control, recording, and monitoring functions in a single unit. Thus the setup procedure is integrated, reducing the time required for setup.

- **Less panel space**
  Replacing a system containing many instruments with a single CX unit provides a tremendous reduction in the required installation space. CX can even be installed in tight spaces because it is compact in size.

- **Less cabling**
  Because CX does so much in a single unit, it helps simplify cabling arrangements. A messy cable arrangement can easily lead to problems. CX helps by significantly reducing system maintenance costs.
Example 4 (Flow/Level control with reporting)

CX is useful for applications where controls are used over a wide area, such as wastewater treatment systems at plants and the like.

- **Networked remote monitoring and remote control**
  Information from measurement points spread over a wide area can be monitored all at the same time with CX. This means even a small staff can handle and maintain a wide area. In addition, because CX enables remote control, it is not necessary to go into the field to make adjustments. User-friendly networking functions like the Web function make it possible to remotely monitor field data anywhere. In addition, powerful PC application software can be used to create a real-time field data monitoring and management system.

- **Remote alarm notification**
  CX lets the user receive alarm notifications by E-mail even at remote locations. This makes it possible to respond to problems quickly.

- **Data recording and management**
  CX data measurements are transferred through a network to a monitoring center. Large amounts of management data can thus be centrally managed on a dedicated server.
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