STOCKING DISTRIBUTOR
Esys The Energy Control Company™
4520 Stine Road, Suite 7
Bakersfield, CA 93313
Office: (661) 833-1902
Fax: (661) 833-4008

Chapter 4 Description

Summarizes the Colormetry system and explains the monitoring methods, functions, remote signal applications and evaluation method. It answers the question “What is the Colormetry system?”

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4-1 Outline

4-1-1 Summary of Colormetry system

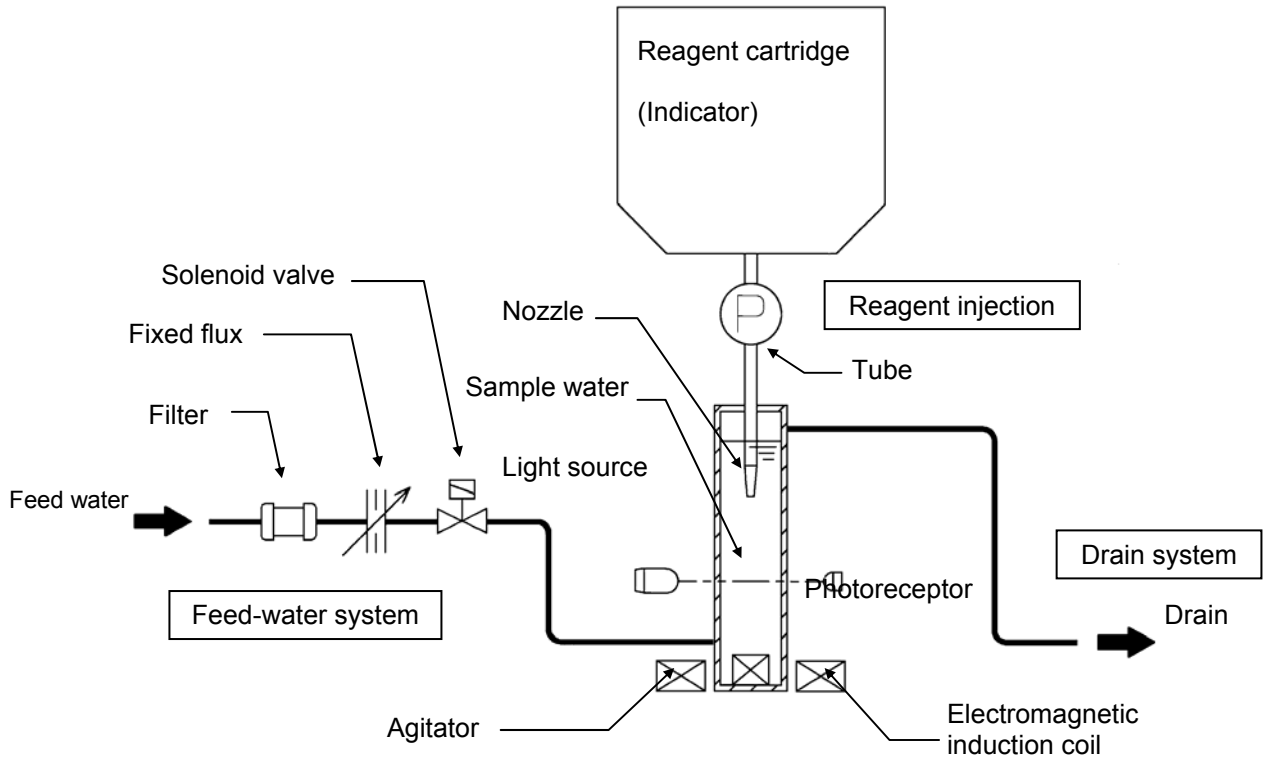
The Colormetry system monitors the concentration of calcium ions and other particles in water through the use of colormetry.
In a colormetry process the ionic calcium and other concentration in water is monitored by allowing a reagent to react against the target ions and others, and monitoring the transmissivity of the resultant coloration for light by a specific wavelength. An example procedure is to check for hardness leakage via the coloration of a hardness indicator. The Colormetry system electronically automates the entire process.
Basically, the system has been developed as part of a processing system for boiler water.
Colormetry automatically and regularly implements the process of sampling water, injecting the reagent, stirring and evaluating the result, thereby obviating the conventional manual procedure.
The system allows the detection of low-level ionic concentrations, reducing maintenance to a minimum. The system has been designed with emphasis on reliability of monitoring results. The manually selectable conditions--for instance, verifying monitor upon the detection of hardness leakage--prevent temporary fluctuations from triggering alarms.
Other features include the external alarm output, DDI-compatible, self-diagnostic function, and message display, as well as the suspension (by remote signal input) of monitoring while the water softener is regenerating or the water feed is stopped.

Refer to 4-2, “Features” on page 22.

4-1-2 Colormetry layout

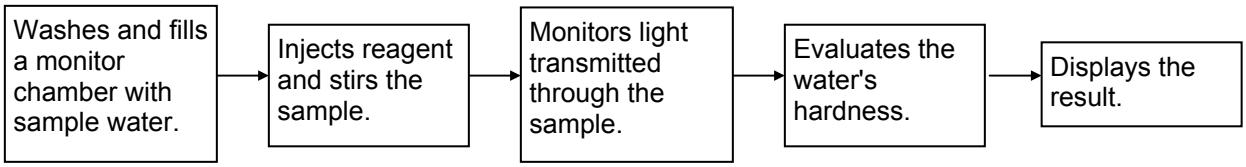
Colormetry consists of the reagent cartridge (the indicator), reagent injector mechanism, monitoring system and water-feed and drainage systems.

Colormetry layout



4-1-3 Operating principles of Colormetry

The Colormetry system operates as follows:



[1] Washing and filling the monitor container with sample water
A solenoid valve opens, filling the monitor container with sample water. The old sample water remaining in the container is pushed out, and the container is washed at the same time.

[2] Injecting reagent and stirring sample water
The solenoid valve closes, and the injection pump injects the reagent into the sample water. The stirrer coil, activated at the same time, mixes the water and reagent.
The reagent causes coloration of the sample water in accordance with the hardness components of the water.

[3] Monitoring the sample water
A light source is activated to project light into the sample water. The light receptor electronically monitors the light transmitted through the sample water. The intensity of the transmitted light varies, depending on the color of the sample water. These variations are caused by light absorption in the water, which varies with the color of the water.

[4] Evaluating the concentration and displaying the result
The concentration is evaluated from the monitoring value, and the results are indicated on the LCD display.

4-2 Features

The Colormetry system has the following features:

[1] Monitors hardness leakage automatically

- The monitoring process is fully automated, saving a significant amount of work by eliminating the need for complicated manual procedures.

[2] Requires no periodic calibration

- The system needs no cumbersome periodic calibrations.

[3] Includes a built-in timer
(Refer to the setting instructions in Section 6-3, “About items to be set in Setting mode,” on page 60.)

- Monitoring period may be set as desired (e.g., daily between 9 a.m. and 5 p.m.).
- Interval for each monitoring may set as desired.
  (The interval is selectable in 30-minute increments between 30 and 180 minutes.)

[4] Detects low hardness leakage
(Refer to Section 4-5, “Evaluation method,” on page 31 for details.)

- The evaluation ranges are 0 – 1 mg/L, 1 – 2 mg/L and over 2 mg/L.

[5] Evaluates hardness leakage with higher accuracy
(Refer to Section 4-5, “Evaluation method,” on page 31 for details.)

- The alarm set point may be set to activate either on “1 mg/L and over” or “2 mg/L and over.”
- When an abnormal condition is detected, monitoring is repeated a number of times (called abnormal-condition retries; selectable between one and three times) to prevent a temporary fluctuation from triggering an alarm. In addition, such an abnormality must be repeated in a series of monitoring at a preset interval for a number of times (called response (alarm) cycle; also selectable between one and three times). When all of these monitoring results indicate an abnormal condition, it is evaluated that hardness leakage exists and the alarm is set-off.

[6] Indicates data on the display screen
(Refer to Chapter 7, “Digital display description,” on page 65 for details.)

- The display indicates the abnormality, as evaluated, and the causes of major system problems.

[7] Offers a self-diagnostic function
(Refer to Section 4-5-2, “How the system operates in evaluating an abnormal condition,” on page 32 for details.)

- When it is evaluated that there is a leakage of hardness, the buzzer sounds. SPDT contact may also be used to send an alarm remotely.
- If a problem occurs in the system, a typical cause will be displayed in the same manner as the hardness leakage.

[8] Stores historical records of hardness leakage
(Refer to Section 9-3, “Verifying error records,” on page 93.)

- The system stores the records of occurrence date and time, duration, and recovery date and time for each of the three latest incidents of hardness leakage. These records may be utilized to analyze the causes of hardness leakage.

[9] Requires minimal maintenance
(For details, refer to Chapter 8, “Maintenance,” on page 69.)

- The reagent cartridge may be replaced using a one-touch action. The reagent needs no replacement for approximately four months in typical applications.
  (Note that more frequent replacement may be necessary, depending on the application.)

[10] Compact in design, easy to install
(For details, refer to Section 5-2, “How to install the main unit,” on page 39.)

- The main unit is installed easily on a wall.
- Installation is a simple process.
- It is the most compact design ever for a system of this type.

[11] About advanced features
Colormetry offers the following features:

- Remote signal input function (refer to Section 4-3, “Method and examples of utilizing remote signals,“ on page 24.)
  Connecting the remote regeneration signal from water softener prevents a false detection that can occur, for instance, while the water softener is regenerating, thus providing more accurate evaluation.

- External-alarm master contact output
  The alarm’s contact output may be used to transmit a hardness-leakage alarm to a remote location.

- In-monitoring output (DDI compatible)
  A system output is available for monitoring.

(Refer to Section 5-4, "How to wire the system,” on page 45 for functional input.)

4-3 Method and examples of utilizing remote signals

(For specific signal input methods, refer to Section 5-4-3, “Remote signal input,” on page 48.)

4-3-1 About remote signals

Monitoring while the water softener is regenerating may erroneously indicate hardness leakage. An attempt to monitor with the water feed stopped would return either hardness leakage in stagnant water in the plumbing or a system error due to a lack of flow.
Conventional hardness leakage alarm system suffered from such detection errors and required the resulting false alarm to be manually reset. The Colormetry system provides the following two methods, which may be used simultaneously, to avoid false alarms:

<Method No.1: Utilizing the timer function>

Monitor Start time [SStart] and Monitor stop time [SStop] settings limit the period during which monitoring is performed. The provision helps avoid the regeneration time and off-hours of the water softener.
Example

Given the water softener settings of
Regenerating time: 11:00 p.m.
Boiler operating period: 8:00 a.m. through 5:00 p.m.
↓
Set Monitor Start time [SStart] at 8:00 a.m., and stopping time at 5:00 p.m.
(No monitoring by the Colormetry system at 11:00 p.m.)

<Method No. 2: Utilizing the remote signal feature>

Connecting the external contact with voltage may **allow Colormetry monitoring only while the water softener is turned on, or to suspend monitoring while the water softener is regenerating**. (If no voltage is available through an external contact closure, the Colormetry power supply may be utilized.)

The purpose of remote signals: To prevent a false detection while the water softener is regenerating or the feed water is stopped.

4-3-2 Detailed descriptions of remote signals

The remote signal input may be activated to enable monitoring in either of two methods - (1) the “off” state, or (2) the “on” state. The two processing methods are selectable in the Setting mode [Set Mode]. Both methods achieve the same objective (of preventing false detections), though they process the signal differently.

[1] Monitoring is enabled by remote signal being turned “Off” [SRte Sgl Off] (the factory setting)

☆ The off state of the remote signal input; (the external contact is open, giving no voltage input) This permits scheduled monitoring at Monitor intervals [SIntvl] as preset in Setting mode [Set Mode].

☆ Monitor interval [SIntvl] may be set in 30-minute increments up to 180 minutes. (Refer to Section 6-3, “About items to be set in Setting mode,” on page 60.)

Example: Inputting a remote regeneration signal from water softer.

Connecting a water-softener contact, if available, to the Colormetry system as a remote signal input, which turns on (closes) during regeneration, will disable scheduled monitoring. When the softener contact turns off (opens) at the completion of regeneration (that is, the remote signal is off), scheduled monitoring is again enabled.

[2] Monitoring is enabled by Remote-Signal “On” [SRte Sgl On]

The on state of the remote signal input (the external contact closes, inputting a voltage to the Colormetry system) will enable monitoring at Monitor interval [SIntvl].

Example No. [2]-1: Inputting the feed water (to a water softener, etc.) signal

Connecting a contact, if available is being turned a water softener or the like, which turns on (closes) while feeding water, to the Colormetry system as a remote signal input, will enable monitoring only while feeding water. When the feed water stops or the softener regenerates, and the contact turns off (opens), no scheduled monitoring is performed.

Example No. [2]-2: Inputting a control signal of motor valve or solenoid valve

An input signal from a motor valve or solenoid valve that controls the feed water will enable monitoring only while the valve is open and signal is in the “on” state (contact is closed).

Example No. [2]-3: Inputting a supply tank water-level control signal

When a “Requesting feed water” signal is input from the equipment that controls the water level of a supply tank, monitoring is performed only for the duration of the request (that is, while feeding water).

NOTE

It is recommended to connect a remote signal wherever possible to prevent false detections and avoid recovery operations.
The signal for adding water, if available, should be connected as the first priority.
If only remote regeneration signal from water softer is connected, a false detection of hardness leakage may result from monitoring the stagnant water while the water is stopped, or a system error may occur due to the lack of flow. A remote signal-input arrangement, as shown in examples [2]-1 and [2]-2, is recommended.

⚠ CAUTION

If no remote signal is connected, be sure to set ("the monitoring is enabled by remote signal being turned off") [SRte Sgl Off] mode (which is the factory setting).

4-3-3 About the remote signal delayed time

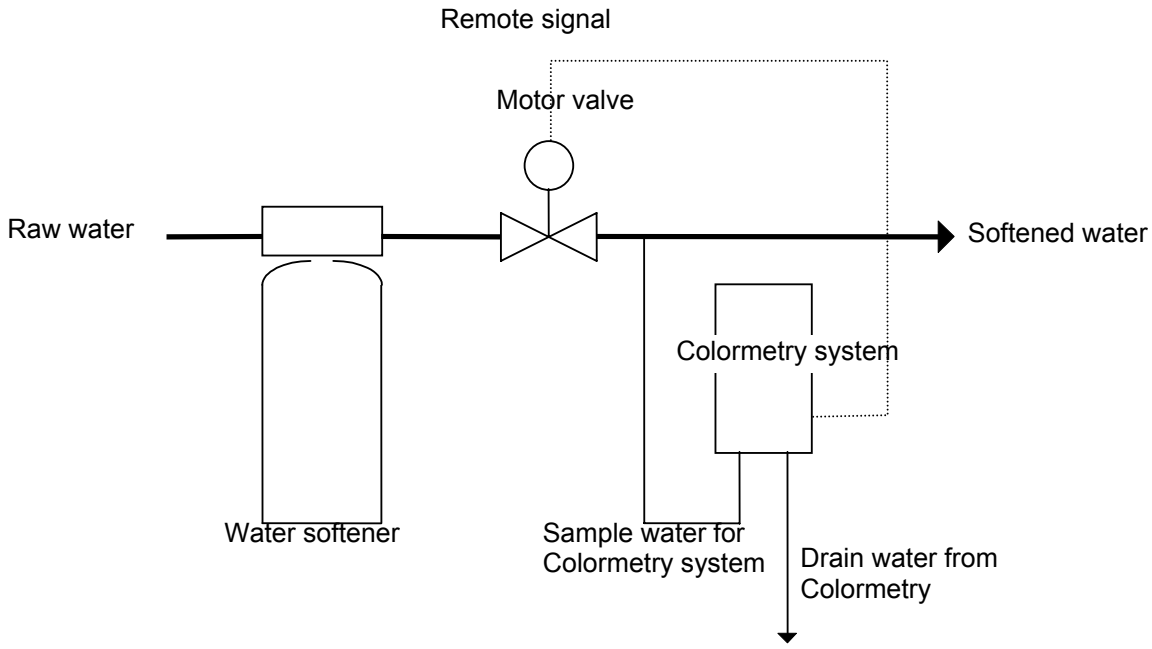
The purpose of Remote-signal delay time [SRte Sgl dl]:

This setting determines the number of seconds the monitoring is to be delayed following the remote signal input.

The delay function is not normally required except for preventing false evaluation, especially in the example shown below.

Example of delay:

It is recommended that the Colormetry sample be taken from as close to the water softener outlet as practical. (Refer to Chapter 5, “Installation,” on page 37 for details.) In the case, however, where a sample is taken, as illustrated, off the secondary of a motor valve or the like, requiring a certain amount of time to open fully, a wash-flow error [Wash Flow F] may occur due to insufficient sample-water pressure when the remote signal is first connected.
(For details on setting the delay, refer to Section 6-3, “About items to be set in Setting mode,” on page 60.)



To prevent such a problem, select Remote signal delay time [SRte Sgl d1] setting and ensure the required pressure (7.1 ~ 71 psi) at the Colormetry inlet (0 ~ 30 seconds).

4-4 About Colormetry monitor timing

4-4-1 Automatic monitoring

The basic interval at which the Colormetry system monitors is set in Monitor interval [SLntvl] setting (settable in 30-minute increments over the 0 ~ 180 min. range; refer to Section 6-3, “About items to be set in Setting mode,” on page 60).
Monitor Start time, which occurs at Monitor interval [SIntvl], will be referenced to the occurrence of one of the events listed below. The actual monitor time occurs only after the time set in Setting mode [Set Mode] elapses following the reference event.

a. When the power is first turned on.
b. Upon resetting.
c. When the Monitor interval [SIntvl] setting is changed to a smaller value (a shorter interval) than the current value.

[1] If no remote signal is connected

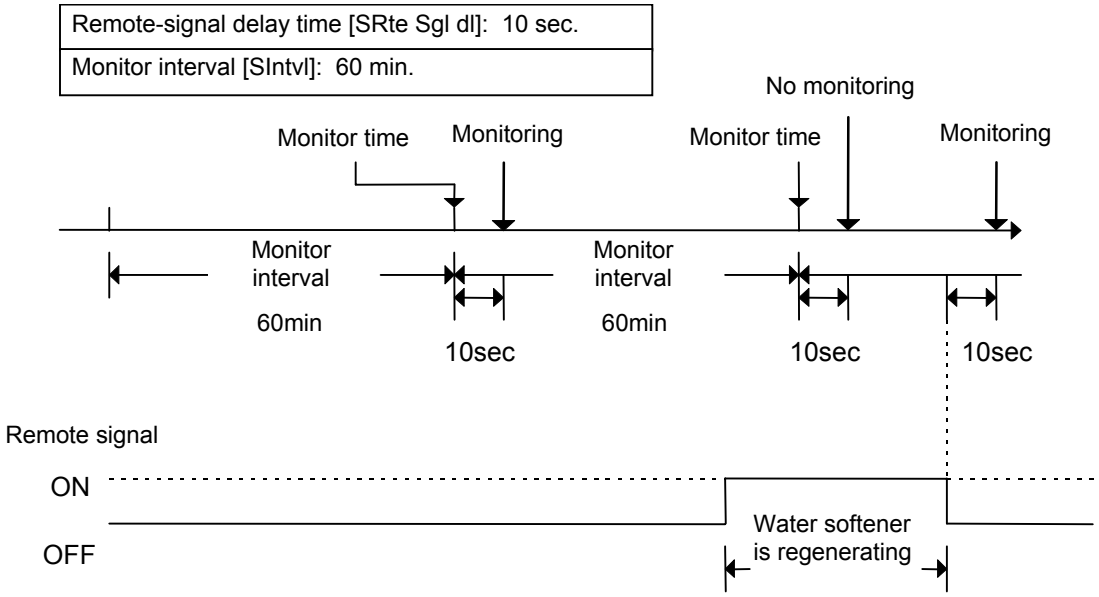
Monitoring is performed at Monitor interval [SIntvl].

[2] If a remote signal is connected

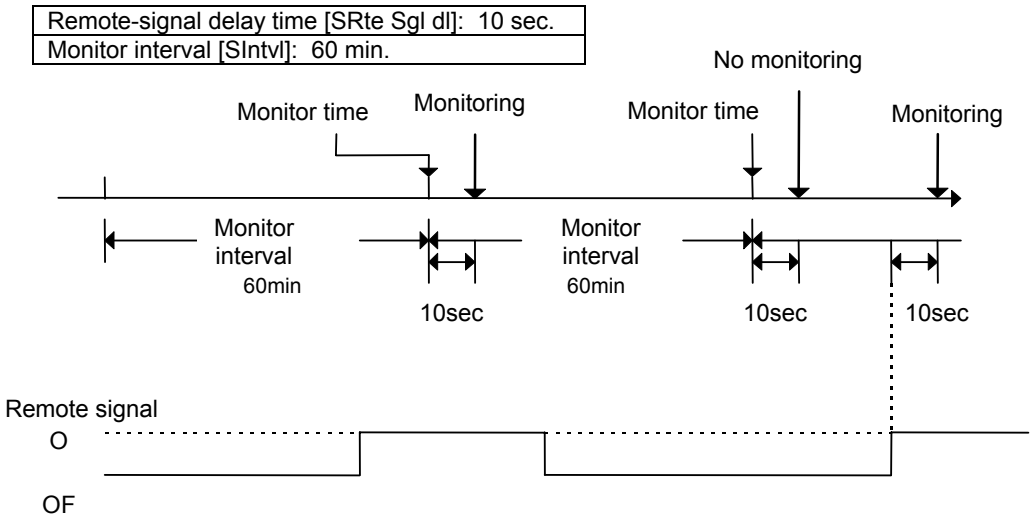
a. *If the remote signal setting is for (Monitoring is enabled by remote signal being turned “off”) [SRte Sgl Off]:*

(Example of remote signal – Remote regeneration signal from water softener)

- If the remote signal has been off continuously and for longer than specified in the Remote-signal delay time [SRte Sgl dl] setting at the monitor time following Monitor interval [SIntvl], actual monitoring will start.
- If, on the other hand, the remote signal has been on at a monitor time after Monitor interval [SIntvl] lapses, the system will enter monitor standby mode until the remote signal goes off. After the remote signal goes off, actual monitoring will start when the remote signal has remained off as long as set in the Remote-signal delay time [SRte Sgl dl] setting.



b. *If the remote signal setting is for (Monitoring is enabled by remote signal being turned "on") [SRte Sgl On]:*
(Example of remote signal – Remote regeneration signal from water softener)
- If the remote signal has been on continuously and for <u>longer</u> than specified in the Remote signal delay time [SRte Sgl dl] setting at a monitor time following Monitor interval [SIntvl], actual monitoring will start.
- If the remote signal is "off" at a monitor time following Monitor interval [SIntvl], the system enters Monitor standby mode until the remote signal turns "on". After the remote signal switches "on", actual monitoring will start when the remote signal has remained "on" as long as set in Remote signal delay time [SRte Sgl dl] setting.



For details on remote signals and remote signal delay time, refer to Section 4-3, "Method and examples of utilizing remote signals," on page 24.

Precautions on operation

Where a remote signal is connected and, if the remote signal is turned to disable monitoring after the solenoid valve in the Colormetry system turns to closed state from the open state (from water discharging from the drain tube to the stopping of drainage), the monitoring results will remain valid. The monitoring results before the solenoid valve enters the closed state (stopping water discharge from the drain tube) will be processed as follows:
(If the remote signal turns to disabled monitoring, the monitoring process will still be carried out to completion.)

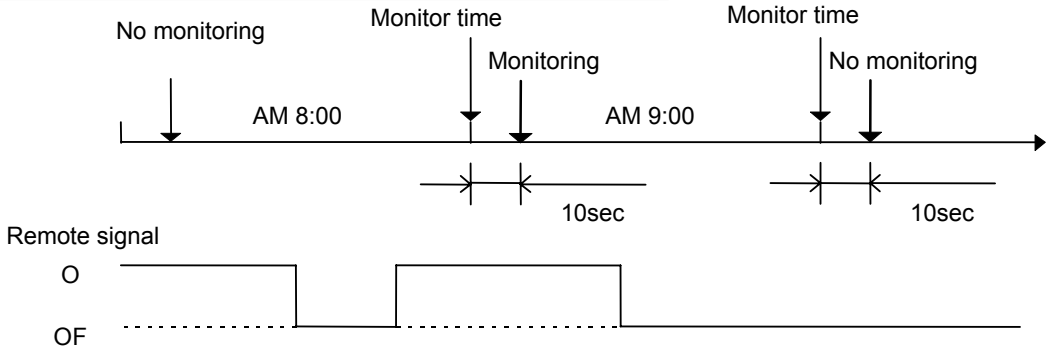
a. If the concentration is evaluated as being lower than the Alarm set point (setting):
The result will be displayed as usual.
b. <u>If the concentration is evaluated as being higher than the Alarm set point (setting):
The evaluation is invalidated and a blank bar ("Result: -----") is displayed.</u>

[3] If the Monitor Start time [SStart] and Stop time [SStop] are set up (when the timer function is used)

a. If it becomes the Monitor time after the Monitor interval [SIntvl] has elapsed, but it is not Monitor Start time yet, the system will enter Monitor standby mode until Monitor Start time, at which point monitoring will be performed.
b. If no remote signal is connected, monitoring will be performed at Monitor interval [SIntvl] only during the period between Monitor Start time [SStart] and Stop time [SStop].
c. If a remote signal is connected, monitoring will be performed in the same manner as in paragraph 2 above, “If a remote signal is connected,” only during the period between Monitor Start time [SStart] and Stop time [SStop].

Example:

Monitor start time [SStart]	AM 8:00
Monitor stop time [SStop]	PM 6:00
Monitor interval [SIntvl]	60 min.
Monitoring is enabled by remote signal being turned on	[SRte Sgl ON]
Remote signal delay time [SRte Sgl dl]	10 sec



d. If it becomes “Monitor stop time” [SStop] during the monitoring process, the system will enter “Monitor standby” mode upon the completion of that monitoring.

⚠ CAUTION

If the remote signal setting is for “Monitoring is enabled by remote signal being turned on" [SRte Sgl On], periodically check to verify that automatic monitoring is performed.
If no remote signal is available due to a signal problem, the monitoring process will never be initiated.

4-4-2 Manual monitoring

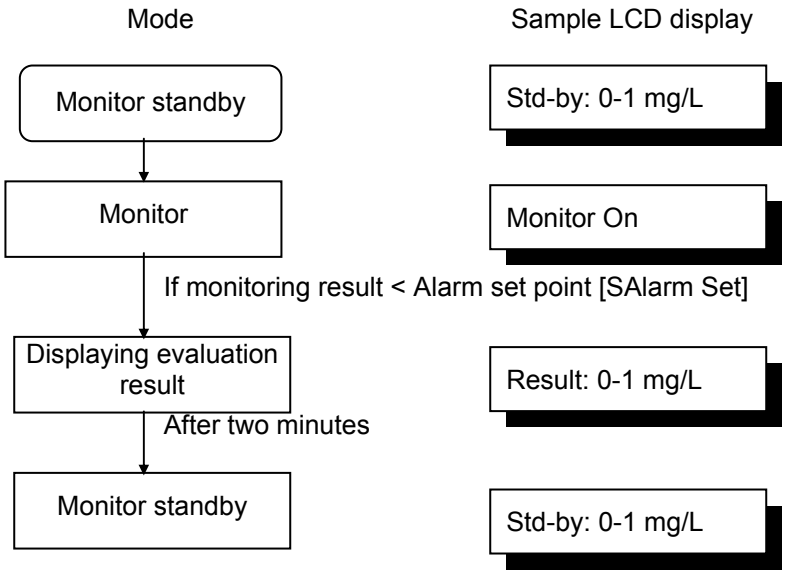
Press the “Manual Monitor” switch to monitor regardless of the Monitor interval, Remote signal, Monitor start or stop time settings.
(The monitoring process will not be initiated, if the reagent cartridge is expanded. The system may initiate the status-verification test for a system error.)

4-5 Evaluation method

The system evaluates ionic concentrations to three levels: 0 – 1 mg/L, 1 – 2 mg/L, and over 2 mg/L.
Alarm set point may be set to trigger either at 1 mg/L and up, or 2 mg/L and up.
The evaluation method is the same for the automatic and manual monitor settings.

4-5-1 How a normal evaluation is processed

If a monitoring result is below the Alarm set point [SAlarm Set], as set in Setting mode [Set Mode], it will be evaluated as normal. The result of such evaluation will be displayed and monitoring is complete. The system enters Monitor standby mode in two minutes after completion of monitoring.



Name of mode	Display indication (example)	Alarm*	Bz*	Remarks
Displaying evaluation result	Result: 0-1 mg/L	OFF	OFF	To be displayed for two minutes following monitoring (Note 1)
Monitor standby	Std-by: 0-1 mg/L	OFF	OFF	To be displayed two minutes after monitoring (Note 1)

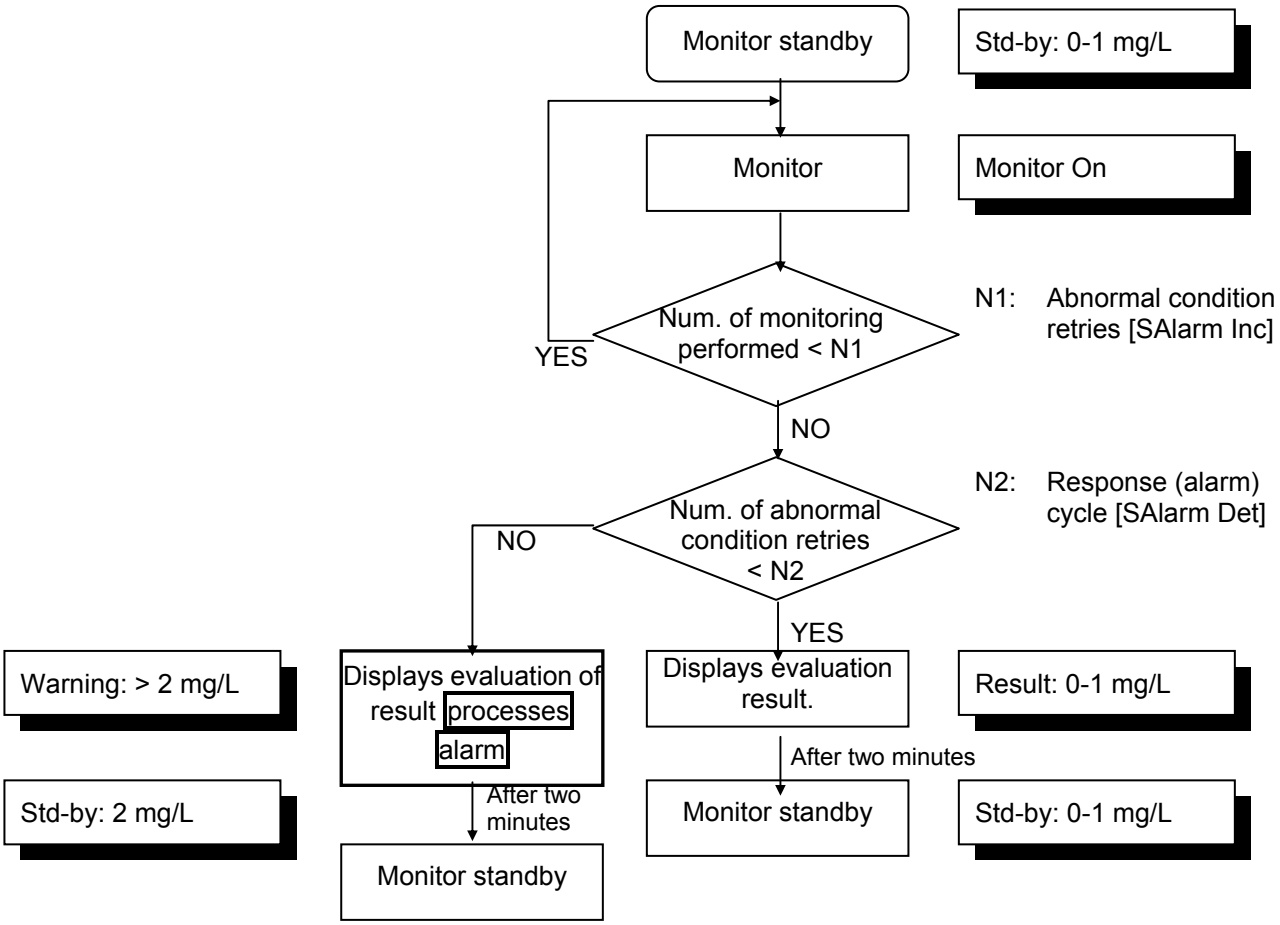
* Alarm: External-alarm master-contact output Bz: Buzzer output

Note 1: The sample display, shown in the table, represents an evaluation within the 0 – 1 mg/L range. If the alarm set point is set at 2 mg/L and it is evaluated to be in the 1 – 2 mg/L range, the LCD display will read [******** 1-2mg/L].

4-5-2 How the system operates in evaluating an abnormal condition

[1] If an evaluation result exceeds alarm set point [SAlarm Set] (the "1 mg/L and up," or "2 mg/L and up" setting), monitoring is repeated the number of times as set (between one and three times) in Abnormal-condition retries [SAlarm Inc] setting. If all retry results have exceeded alarm set point [SAlarm Set], only then will the monitor result will be determined as abnormal.
If, on the other hand, all retry results are lower than alarm set point [SAlarm Set] setting, the condition will be determined to be normal and monitoring will be terminated.

[2] However, an abnormal evaluation made in step (1) alone would not trigger an abnormal-condition alarm (that is, to sound buzzer and close the slave-remote output contact).
An abnormal-condition alarm is given only on the occurrence of an abnormal condition repeated for Response (alarm) cycle [SAlarm Det] (selectable between one and three times) in automatic monitoring at Monitor interval [SIntvl] (selectable between 30 and 180 minutes in 30-minute intervals) or in manually initiated monitoring.

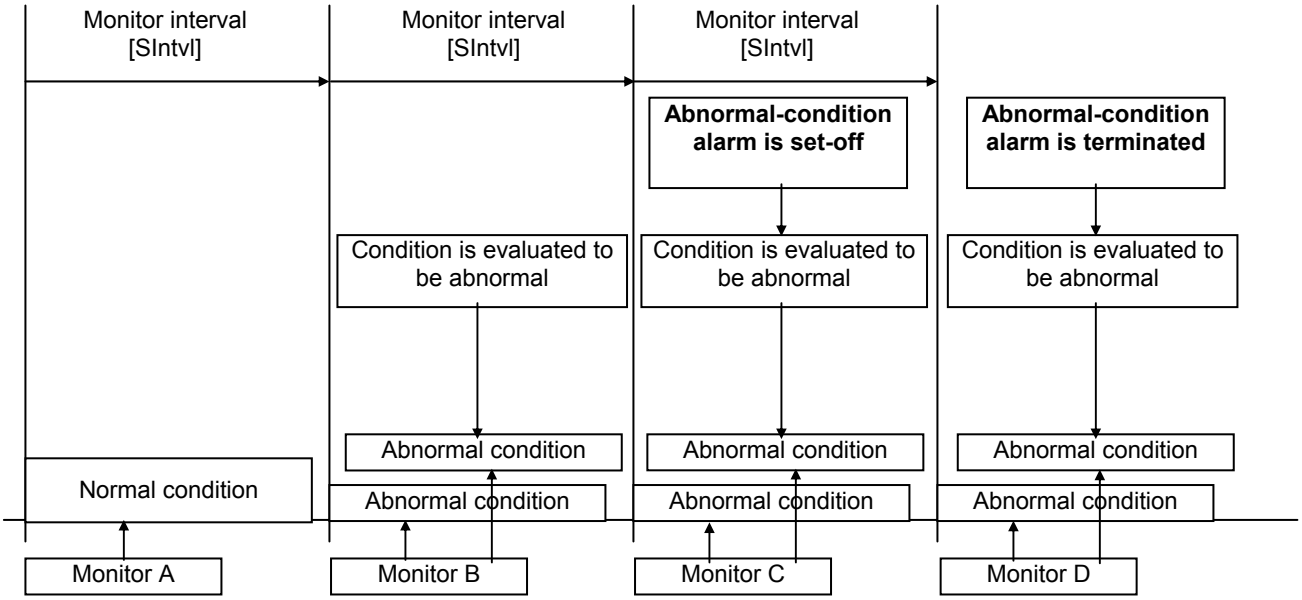


[3] If an abnormal condition occurs repeatedly in a series of automatic monitoring at Monitor interval [SIntvl], or in manually initiated monitoring, the abnormal-condition alarm will stay on continuously.

[4] An abnormal-condition alarm is automatically terminated (the buzzer stops and the slave alarm's output-contact opens) when the condition is determined to be normal in automatic monitoring at Monitor interval [SIntvl], or in manually initiated monitoring.

Example of Monitor no. 1:

Abnormal-condition retry [SAlarm Inc] setting: 2
Response cycle [SAlarm Det] setting: 2



Monitor A: The result is below the alarm set point (setting), and therefore the condition is deemed to be normal.

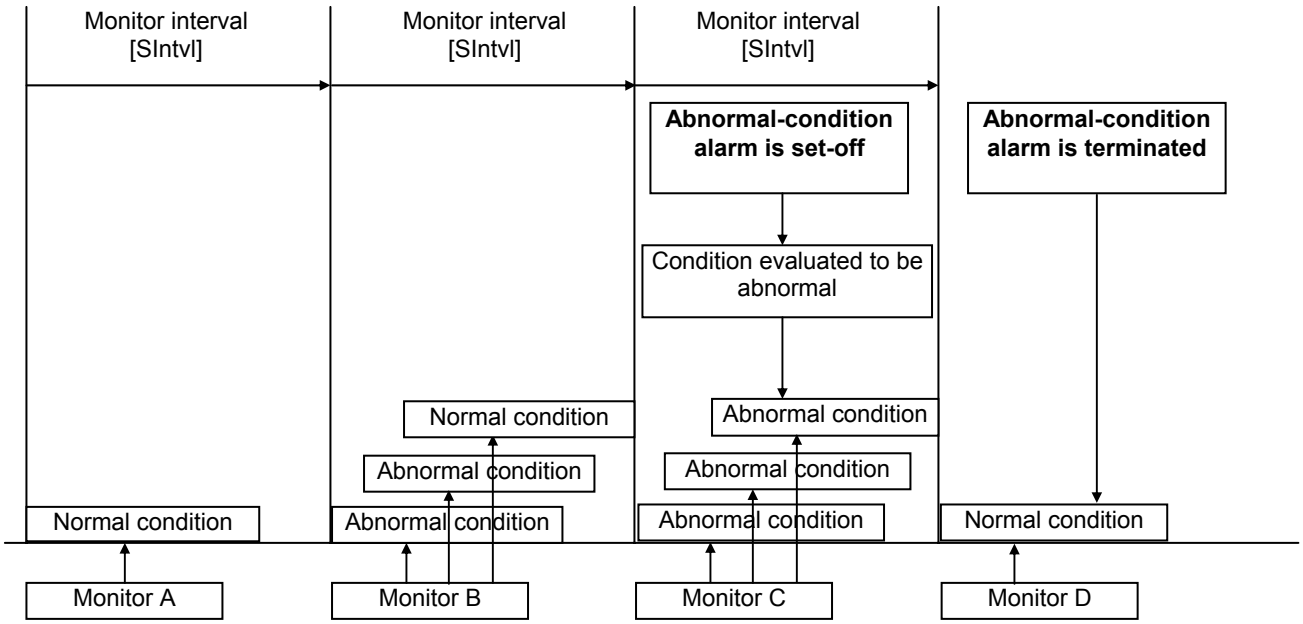
Monitor B: The result has exceeded the alarm set point. Since the abnormal condition retry setting is for two times, another monitoring is performed, which again exceeded the alarm set point. The condition in monitor B is therefore evaluated to be abnormal.

Monitor C: As was the case with monitor B, the first two results have exceeded the alarm set point. The result of monitor C, therefore, is also evaluated to be abnormal.
An abnormal condition has been verified twice -- in monitor B and C -- so that an abnormal-condition alarm is now issued.

Monitor D: The result has exceeded the alarm set point on two consecutive occasions.
The subsequent result has again been evaluated as an abnormal condition, following an already issued abnormal-condition alarm. Therefore, the alarm will continue.

Example of monitor no. 2:

Abnormal condition retry [SAlarm Inc] setting: 3
Response (alarm) cycle [SAlarm Det] setting: 1



Monitor A: The result is below the alarm set point (setting), and therefore the condition is considered normal.

Monitor B: The result has exceeded the alarm set point. Since the abnormal-condition retry setting is for three times, another monitoring is performed, which again exceeded the alarm set point. The third retry result, however, is below the alarm set point, and so passes as normal. Monitor B is therefore evaluated to represent a normal condition.

Monitor C: The first three results have exceeded the alarm set point.
With an abnormal condition verified once, an abnormal-condition alarm is now issued.

Monitor D: The result is below the alarm set point.
Since the result has been evaluated to be normal, the abnormal-condition alarm is now automatically terminated.

Remarks: If a result has exceeded the alarm set point but a subsequent result is invalidated so that the series of monitorings fails to satisfy the abnormal-condition retry [SAlarm Inc] requirement, the evaluation of the series will still be abnormal.

4-5-2-1 Display and output on abnormal condition (Note 1)

Name of mode	Display indication (a sample)	Alarm*	Bz*	Remarks
Displaying evaluation result	Result: > 2 mg/L	OFF	OFF	To be displayed for two minutes following monitoring (Note 2)
Monitor standby	Std-by: > 2 mg/L	OFF	OFF	To be displayed two minutes after monitoring (Note 2)

* Alarm: External-alarm master-contact output Bz: Buzzer output

Note 1: The sample indications shown in the table will remain displayed from the time of evaluating an abnormal condition until the abnormal condition alarm is issued.

Note 2: The sample display represents an evaluation exceeding 2 mg/L.
If the alarm set point is set at1 mg/L and the condition is evaluated to be in the 1 – 2 mg/L range, the LCD display will read [******** >1 mg/L].

4-5-2-2 Display and output on abnormal evaluation (refer to Section 4-5-2, "How the system operates in evaluating an abnormal condition," on page 32.)

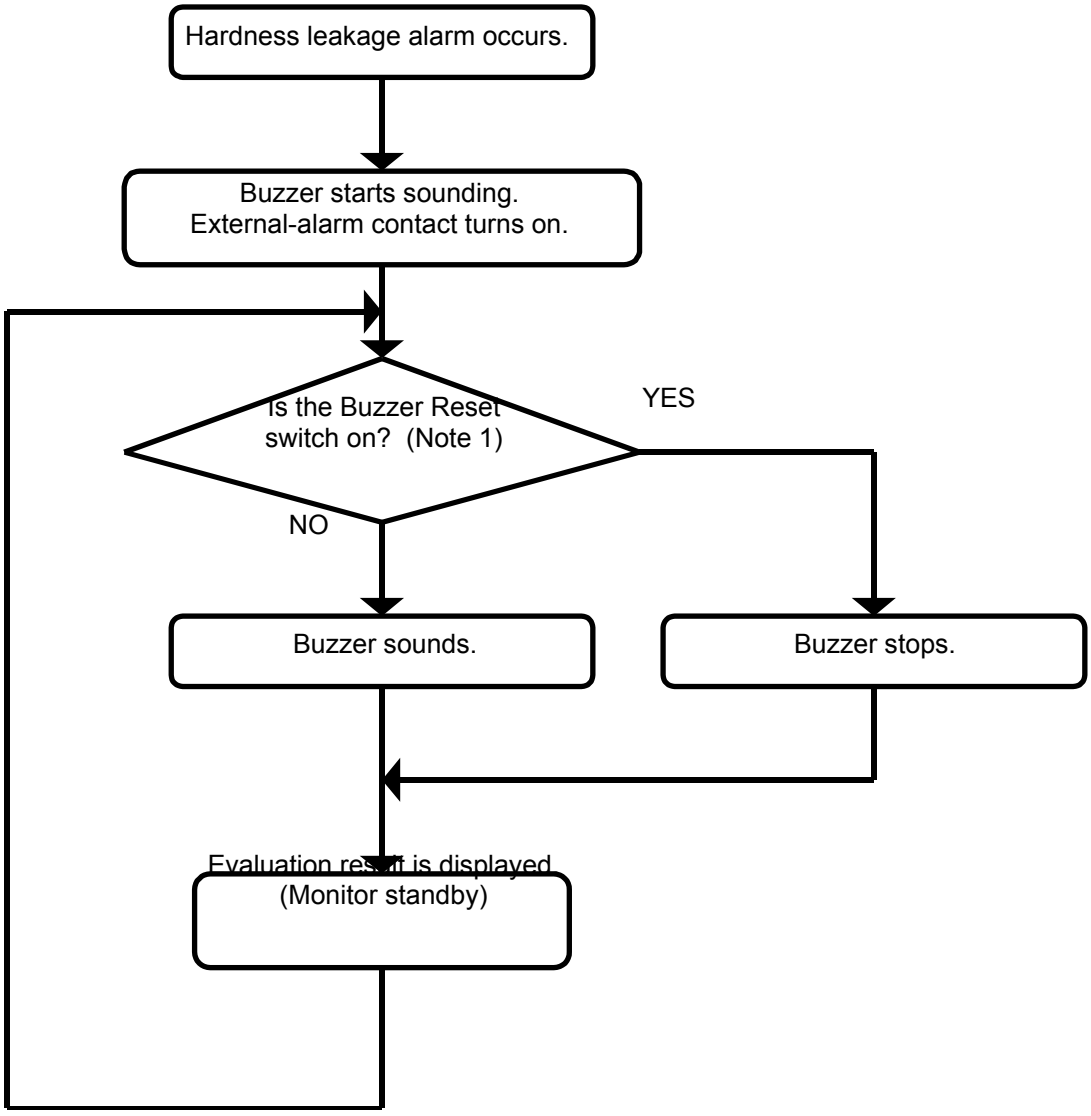
a. During an abnormal-condition alarm, the buzzer sounds and the external alarm's master contact closes.
b. When an abnormal-condition alarm is issued, pressing the Buzzer Reset switch on the front of the main unit will stop the buzzer.
The external-alarm's master contact, however, will remain closed until the condition is evaluated as normal in an automatic monitoring at Monitor interval [SIntvl], or monitoring initiated manually.
c. Once the buzzer is stopped by pressing the Buzzer Reset switch, it will remain disabled even if the immediately subsequent evaluation happens to be abnormal.
If, however, a condition is once evaluated as normal in automatic monitoring at Monitor interval [SIntvl] or manually initiated monitoring, then a subsequent occurrence of the abnormal-condition alarm will sound the buzzer.

Name of mode	Display indication (a sample)	Alarm*	Bz*	Remarks
Displaying evaluation result	Warning: > 2 mg/L	ON	ON	(Note 1)
Monitor standby	Warning: > 2 mg/L	ON	OFF	This is the result of pressing, the Buzzer reset switch once.

* Alarm: External-alarm master-contact output Bz: Buzzer output

Note 1: The sample display represents an evaluation exceeding 2 mg/L.
If the alarm set point is set at 1 mg/L and it is evaluated to be in the 1 – 2 mg/L range, the LCD display will read [******** >1 mg/L].
When the abnormal-condition alarm has been issued, the LCD display will remain the same even after two minutes have elapsed.

4-5-2-3 Workings of hardness leakage alarm and action to take



Note 1: The Buzzer Reset switch also functions as a manual monitor switch.
[1] The buzzer sounds on the occurrence of an abnormal condition.
[2] The buzzer stops on pressing the Buzzer Reset switch.
(The system will not automatically enter Manual monitor mode at this time. To start manual monitor, press the Buzzer Reset switch again.)
(The LCD display will remain the same.)

NOTE

External-alarm master contact will not be cancelled until the condition is evaluated as normal.