

4

Tightening Reliability

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What is Tightening Reliability?

Bolt tightening reliability simply means tightening bolts properly. However, depending upon the circumstances there are the following assurance levels.

1. To pass tightening inspections (by retightening)
2. To tighten bolts to the required torque (within the tolerance) specified by the drawings
3. To tighten bolts up to the required initial tightening force (initial axial tension)
4. To tighten bolts up to the required working tightening force (axial tension)
5. To achieve the maximum performance of the bolt by using only parts or bolts that are in good condition which do not easily loosen or break and do not create leaks from bolted joints.

Even if the tightening torque is kept constant, the initial axial tension generated will greatly vary. Therefore, the target of "bolt tightening reliability" by the torque method is not to keep the axial tension fixed, but to maintain it within the given dispersion width. It is important not only to improve the reliability of the bolt tightening work, but also to link it with one of the assurance levels listed above to avoid generating any problems even if the axial tension used is varied. This is the feature of "bolt tightening reliability".

4-1

Characteristic Factors of Defects in Bolt Tightening

Characteristic factors(4M's) of defects in bolt tightening

1. **MAN** _____ Missed tightening
(Tightening operator human error) Improper tightening tool usage

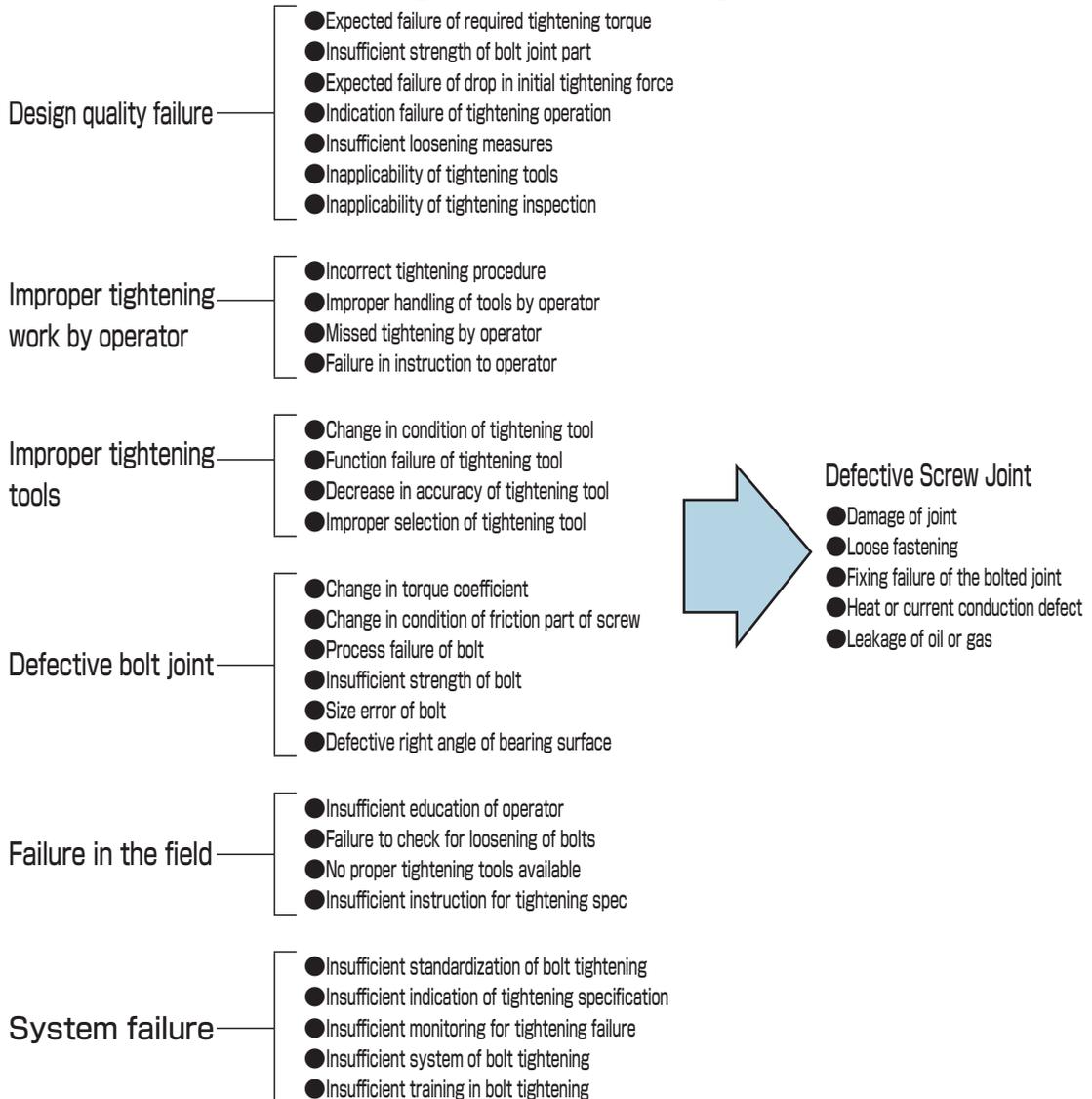
2. **METHOD** _____ Wrong tightening value specification
(Improper tightening specification) Wrong tightening procedure
Wrong tightening tool selection

3. **MACHINE** _____ Inaccuracy
(Improper tightening equipment) Mechanical failure

4. **MATERIAL** _____ Part out of tolerance
(Improper screw joint material) Defective part material
Insufficient screw part lubricant

Characteristic Cause Diagram of Defective Joints

Characteristic cause diagram of defective joints



4-3 Bolt Tightening Reliability

Bolt tightening reliability and tightening work

Bolts generate clamping force and can only show their performance after proper tightening work has been completed. However, we cannot correctly check whether a bolt has been correctly tightened or not after the bolt has been tightened. It is therefore important that the operator checks the tightening accuracy while performing the tightening work rather than by carrying out an inspection after the work has been completed. This is called "containing the quality while tightening". The factors that obstruct the reliability of the tightening work are classified into two categories: machine error due to the tightening tool and human error caused by the operator.

In general, tightening tools are classified by tightening accuracy into three categories shown in Table 4-1. The allowable tolerance of the tightening torque should be appropriately decided and standardized based upon the relation with the allowable dispersion width. Even if tightening is carried out at a higher accuracy than required, the variation in tightening force will not have much effect.

Figure 4-1. Accuracy of tightening torque and dispersion of tightening tension

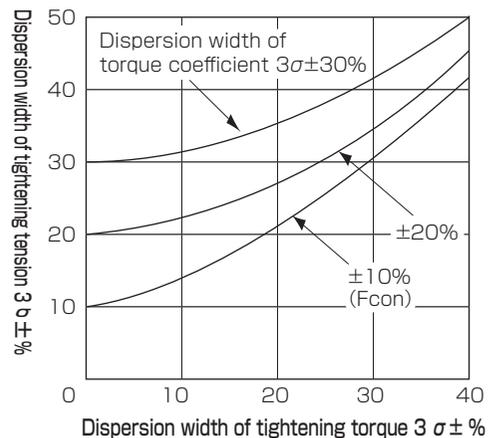


Table 4-1. Tightening method classifications

Method	Mechanism	Accuracy range (3σ)	Tightening Tool
① By guesswork	The operator judges the tightening condition according to the force or sound, and stops the tightening work.	Over ±30%	<ul style="list-style-type: none"> • Manual wrench • Manual screwdriver • Impact wrench (no torque control)
② By maximum capacity	The bolt is tightened by adjusting the pressure or current until the motor stalls or the clutch slips.	±10~30%	<ul style="list-style-type: none"> • Stall type • Slip clutch type • Impact wrench (control type)
③ By torque detection	The tightening torque is measured, and when the required torque is reached the tightening is stopped.	Within ±10%	<ul style="list-style-type: none"> • Torque wrench • Mechanical type torque control • Electric type torque control

4-4 Machine Error

(1) Machine error

2 methods to find a change of tightening torque

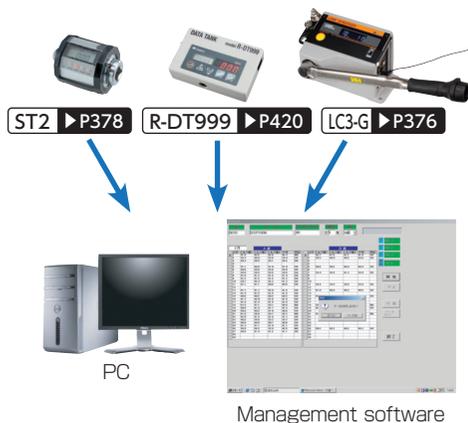
For any tightening tool, sooner or later the tightening torque will change and the accuracy will go out of tolerance due to wear of the tightening tool. In most cases, however, the operator will be unaware of the change, resulting in defects of a large quantity of products. There are two methods required to be carried out to recognize changes in the tightening torque.

The first method uses daily inspections and periodic calibrations to regularly confirm the operating torque of the tightening tool.

■ Daily inspections

Daily inspections of torque tools before and after carrying out the work keep the occurrence of problems to a minimum. Tools for daily inspections are arranged to be easy to operate and take the minimum of time.

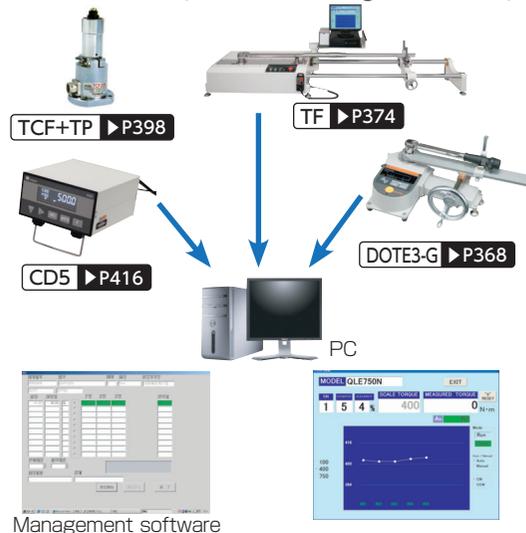
Daily inspections (Checker + PC + Management software)



■ Periodic calibrations

Periodic calibrations are different from the daily checks, in that it is necessary to precisely measure the accuracy of the torque tools to assure the torque tools used for the work. One common problem of power tightening tools is that the calibration results often differ from the actual tightening torque. (P.51 Figure 4-2) This difference is due primarily to the fact that the calibration procedure does not accurately replicate the joint hardness or softness (joint coefficient) and it will be important to simulate the actual bolt tightening conditions.

Periodic calibrations (Tester + PC + Management software)



Note that the checkers and testers used for checking and calibration must themselves be calibrated regularly, and it will be necessary to establish traceability.

4-4 Machine Error

The second method is to sample the tightened bolts and check them by using the retightening torque inspection method to assume the tool tightening torque.

■ Inspection data management system

Through the development of electronic instruments, tightening torque value and retightening torque values can be monitored and furthermore, recorded. The recorded data can be submitted to a third party for proof in protection against product liability. However, the monitoring should use a measuring system that is independent from the control system of the tightening torque. Otherwise, trouble within the control system cannot be observed.

Using this method, the degree of wear and the tendency of the tightening tools can be predicted and as a result, preventive maintenance becomes possible. Accidental accuracy defects do not usually occur in tightening tools, but if they do, they result in defects in a large quantity of products. Therefore, it is preferable to keep the tool within a repairable range even if this would result in some possible defects relating to the frequency of the periodic calibration retightening inspection.



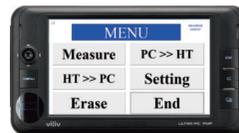
Digital Torque Wrench

CEM3-G-BT ▶P282

CTB2-G-BT ▶P294



Wireless Link

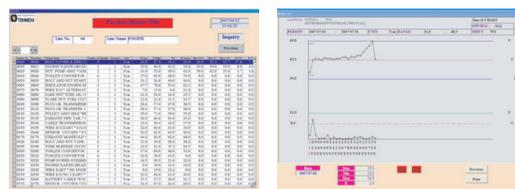


Inspection Data Management System ▶P314

Wireless Link



PC



4-4 Machine Error

(2) Joint coefficient

When the static characteristics of torque tools are discussed, only the tightening torque is considered and the rotation of the screw is neglected. But when dynamic characteristics (over-torque measures in nut runners) are discussed, the way the tightening torque increases with the rotation of the screws will become a problem. While this is generally known qualitatively as a "soft joint" or "hard joint", it will be necessary to express this quantitatively. The joint coefficient (e) is identified and written as follows.

[1] Definition of joint coefficient (e)

The relation between the tightening torque and rotation for a screw is shown in Figure 4-2. The joint coefficient (e) at $T = T_0$ for this joint is defined as shown in Formula (1). Use the rotation angle (θ) in Formula (2)

$$e = \frac{1}{T_0} \left(\frac{dT}{dn} \right)_{T=T_0} \dots \text{Formula(1)}$$

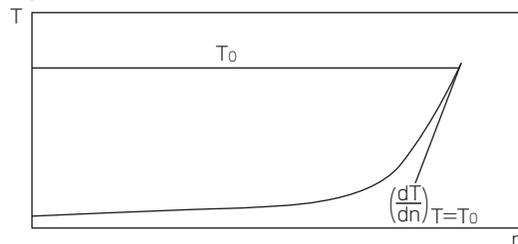
n : Number of screw turns
 T_0 : Tightening torque

$$\theta = 360n \quad d\theta = 360dn$$

$$e = \frac{360}{T_0} \left(\frac{dT}{d\theta} \right)_{T=T_0} \dots \text{Formula(2)}$$

θ : Rotation angle of the screw ($^\circ$)

Figure 4-2



Technical Data

[2] Meaning of the joint coefficient

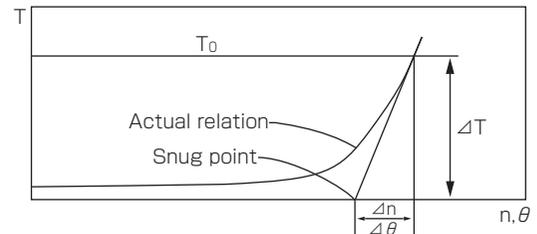
- ① To make the explanation easier, when the relation of the torque and amount of rotation (rotation angle) is shown by a straight line, the right formula results. $e = 10$ means that the tightening torque is reached from snug torque at $\Delta n = \frac{1}{10}$ rotation or $\Delta \theta = 36^\circ$
- ② As the joint coefficient (e) is a non-dimensional figure, it is not changed by the size of the screw.

$$e = \frac{1}{T} \cdot \frac{\Delta T}{\Delta n} \quad \Delta T = T_0$$

$$e = \frac{1}{\Delta n} \quad \text{or} \quad e = \frac{360}{\Delta \theta}$$

$$\Delta n = \frac{1}{e} \quad \Delta \theta = \frac{360}{e}$$

Figure 4-3



4-4 Machine Error

[3] Methods of obtaining the joint coefficient

① Method by drawing

Measure the tightening torque and amount of rotation (angle) from the actual screw. (In this case, the origin of the rotation amount, the angle, can be neglected.) Plot on the drawing as shown Figure 4-4, and determine Δn or $\Delta \theta$ from the tangent of the prescribed tightening torque (T_0). (e) can be calculated from formulas (3) and (4).

$$e = \frac{1}{\Delta n} \quad \dots \text{Formula(3)}$$

$$e = \frac{360}{\Delta \theta} \quad \dots \text{Formula(4)}$$

② Simple method

Tighten up to 80% of the tightening torque (T_0). Then, use the formula (5) to calculate (e) from the rotation angle ($\Delta \theta$) at the time of retightening up to T_0 .

$$\theta = \frac{72}{\Delta \theta'} \quad \dots \text{Formula(5)}$$

$$e = \frac{360}{T_0} \cdot \frac{T_0 - 0.8T_0}{\Delta \theta'}$$

Example of actual joint coefficient measurement.

*Using the (2) simple method above

Bolt: M8

Tightening torque (T_0): For 13.4 [N · m], 0.8 T_0 will be 10.7 [N · m]

① Preparation

Place a protractor on the outside of the measuring bolt. (The protractor should have a hole so that the bolt will be in the center.)

Set the line so that the index is on the outside of the socket.

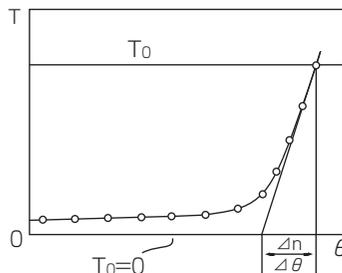
② Measurement

Tighten up to 0.8 T_0 (10.7 [N · m]).

Next, align the index of the protractor to "0".

Then tighten to T_0 (13.4 [N · m]) and read the angle (7.2°).

Figure 4-4

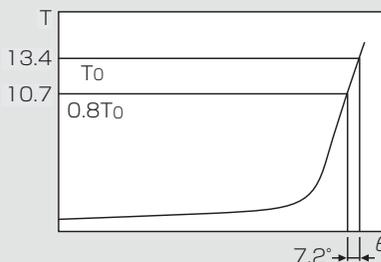


③ Calculation

From the simple method formula $e = \frac{72}{\Delta \theta} = \frac{72}{7.2} = 10$

Medium joints can be calculated from this formula

Figure 4-5



4-5 Human Error

(1) Human error

For the reliability of the tightening work, human error is the most difficult problem. We know that people make mistakes due to human nature. It is also difficult to observe any human errors by machine. We always have to take into consideration the fact that human error can be reduced through education. Tightening by a human operator means that at the same time the operator can execute a visual inspection in which they can observe bolt tightening defects, such as machine errors and galling. This visual inspection is a very effective method to improve the reliability of the bolt tightening.

Among human errors, "missed tightening" is the number one problem. In order to tighten bolts effectively and uniformly, bolts are tightened to the required torque after first carrying out provisional tightening. But in this case the provisionally tightened bolts, which are visually indistinguishable from fully tightened bolts, may be felt not fully tightened. Since this kind of human error happens accidentally, it is very difficult to find the error by doing a sampling test.

In order to eliminate "missed tightening" it is important to confirm that the bolts have been fully tightened at the same time of full tightening. Among the confirmation methods, there is the counting method, in which a tightening completion signal is output upon reaching the set torque and counted by a counter. There is also the monitoring method where OK/NG judging is carried out based on the tightening torque value, and the marking method in which the torque wrench operation applies a mark to the head of the bolt. By selecting the method that best matches each of the work environments it will be possible to prevent missed tightening.

Among relatively frequent human errors are "erroneous operations" such as stopping pulling the torque wrench before completion of tightening and releasing the trigger of a power tool.



4-5 Human Error

As tightening confirmation methods, there is the counter method in which a counter is used to count up the number of tightening completion signals that are output each time the set torque is attained. There is the monitoring method, where OK/NG judgment is carried out using the tightening torque values, and there is also the marking method, in which a mark is applied to the bolt head simultaneously with the operation of the torque wrench. By selecting the method according to each of the operating environments, it will be possible to prevent missed bolt tightening.

Counter method

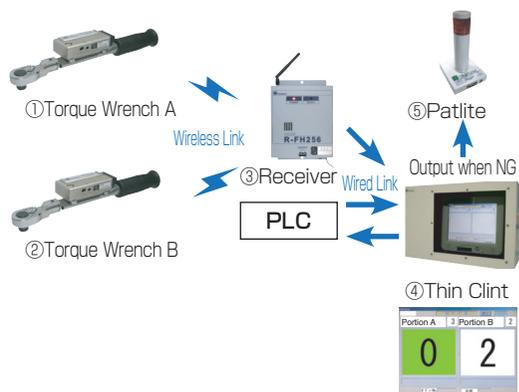
When the set torque is attained, the tightening completion signal is output and the signal is counted up by the counter (CNA-4mk3) for confirmation of the number of items tightened. In addition to the wired counting method (QSPLS, etc.) using the signal from the limit switch, there is the wireless counting method (QSPFH, etc.)



A maximum of four torque wrenches can be connected to the count checker. In case of wireless, I/O-FH256 is required.

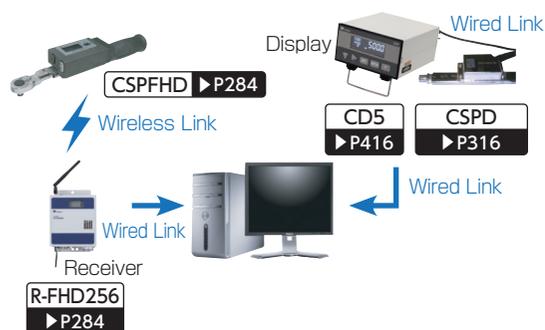
Example of ID recognition from Thin Client (PC) using the FH receiver RS-232C output.

This is a wireless error-proofing (Pokayoke) system for use when carrying out tightening of two positions on one work piece. When the body No. indication is received from the PLC (Programmable Controller), the tool will become able to conduct tightening. At part A, torque wrench A is used to tighten three bolts. When tightening has been completed, the tightening bolts at part B will be displayed, and it will be possible to conduct tightening. Using torque wrench B, the two bolts are tightened, and when the work has been completed an OK signal is output to the PLC. If torque wrench B is used for tightening at part A, an error occurs and the display will appear in red to indicate a warning as an error check to ensure that the correct torque wrench is used to tighten the bolts. An NG signal will also be output to the lamp. In addition, because the tightening at part B can not be carried out until the tightening at part A has been completed, the tightening work procedure will also be maintained. Using the thin client, it is possible to store and process data for each body No.



Monitoring method

In addition to checking the number of units tightened, the actual tightening torque is shown, judgment is made whether or not the torque is within the standards, and data is stored. It is increasing the tightening reliability. There is the wired system (CSPD+CD5) and wireless system (CSPFHD). This is also used as a backup for power tools.



Example of ID recognition from Thin Client (PC) using the CSPFHD receiver RS-232C output.



Marking method

A tightening confirmation mark is applied when the tightening torque is achieved. Previous systems had problems, such as the method where a sponge filled with ink was input in the socket, since simply setting the wrench was enough to apply a mark and so it did not result in tightening confirmation. In addition, for the method of making a mark using a marker pen, the making of the mark itself became work and it was possible to make a mark even if tightening was not carried out, so this too did not fulfill the requirements as a marking system.

To solve this problem, there are marking torque wrenches available, where a marker is activated to simultaneously prevent missed tightening and erroneous operations only when the torque wrench is activated and unfaillingly applies the tightening torque; they are MPQL model for hexagonal bolts and CMQSP model for bolts with hexagonal holes.



(2) How to use torque tools

1. Precautions when selecting accessories

- There is a danger that hexagonal sockets, (ballpoint type), universal joints, and flexible joints may adversely affect the tightening accuracy.
- There is a danger that extension bars and torsion bars may adversely affect the durability of the torque tools.
- Use sockets, bits and adaptors that come within the range of assured strength.
- Use sockets and bits that match the screw size.

Depending on the accessories such as sockets and extension bars, there is a danger that the tightening accuracy and the tool durability may be lost. Take care when selecting the accessories.

2. Inspections when starting work

- Confirm the usage torque.
For adjustable type tools, confirm that the scale values are correctly set to the usage torque.
For preset type tools, confirm that the torque values described in the main unit are correctly set.
- Check whether or not there are scratches or rust on the main unit.
- Confirm that there is no distortion of the main unit.
- Confirm that there are no parts missing. (Take particular care about damage to the ratchet part.)
- Check whether there is wear on the socket and bit.

Quickly detect degradation and damage to parts, and carry out the tightening work using equipment that can be guaranteed.

3. Method of applying force in manual torque tools

-  apply force in the direction marked "ONLY". (See How to Use on P.320)
- Apply force at the effective length line. (See How to Use on P.320)
- Pull (or push) the force horizontally. (See How to Use on P.320)
- Apply the force at right angles. (See How to Use on P.320)
- Do not apply the force with momentum.
- Do not add your body weight when applying the force.
- As soon as you hear the "click" sound or feel that the operation has finished, quickly remove the force.
- Do not repeat the same operation two or three times on the same screw.

By carrying out operations using an unreasonable posture, it will not be possible to use the torque tools correctly. Be sure to confirm the work environment where the force is applied naturally.

4. Cautions when using manual torque tools

- Take care that dirt or water does not enter into the tool.
- Do not drop or allow the equipment to contact other objects.
- Do not apply over-torque.
- Do not use for screw returning work.
- Use the tool with the extension handle. (QLE2, CLE2)
- Do not use the tool by extending the handle part.
- Use the wrench with in the scale range.

5. Cautions for storage

- When storing torque tools, reduce the graduation. (Adjustable types)
- Store in a location with low humidity where there is little change in temperature.
- If the tool is not used for a long period of time, inspect it occasionally.

6. Cautions when using power torque tools

- Adjust the usage pressure with a regulator (pressure at hand).
- Ensure that the usage pressure does not vary.
- Use the stipulated air hose diameter item.
- Do not use a longer air hose than the required length.
- Take care that dirt or water does not enter into the equipment.
- When first making the connection, connect after blowing into the air hose.
- Apply oil (ISO VG32 (Turbine oil #90)).
- Use the three-point set (Regulator, filter, oiler).
- When the equipment will not be used for one week or longer, insert oil directly into the cap (approximately 10 drops), lightly rotate it one time, and then store it.
- Continue to pull the starting lever until the tightening has been completed. (Automatic stop or automatic reversing)
- Do not repeat the same operation two or three times on the same screw.

4-6

Bolt Tightening Reliability and Bolts

Bolt tightening reliability and bolts

To ensure the "bolt tightening reliability", first the reliability of the bolts themselves must be maintained. The initial axial tension has to be controlled so that the force comes into the specified range determined by the standardization or the design when the bolt is tightened to the required torque. Since the torque coefficient changes due to the friction of the bearing surface and the threaded parts, factors such as oil on the threads, surface hardness, and surface treatment should remain constant. As with high-tension bolts for construction, the torque coefficient can be measured by a tension meter to verify that the torque coefficient is within the specified variation to further improve the bolt tightening reliability. In this case, a certain number of samples will be required to find the variation of the torque coefficient.

Bolted joints consist of bolts, nuts, and joint members. Therefore, caution should be taken when adding oil to the joint or carrying out surface treatment of the joint, especially when wax-based oil or molybdenum-based lubrication is used. The torque coefficient will become small and the initial axial tension will sharply increase. The variations of joint face, parallelism, gaskets in between, or paint will all have an affect on the clamping force. "Galling" or "seating defects" will also prevent bolt reliability. Recently, an axial force stabilizer (Fcon) has been developed that stabilizes the torque coefficient to stabilize the axial force, which is effective in improving the above problems.



Fcon ▶ P438



Construction of a Tightening Reliability System

Construction of a tightening reliability system

There are many obstructive factors for "Bolt tightening reliability" as shown in P.47. To properly eliminate these factors, it is necessary to consider the total system.

The design, tightening operation, bolts, and the reliability in the field all have to be equally improved in a balanced manner at each step; otherwise, the errors in bolt tightening will not decrease. First of all, the suitability of the design and the preconditions has to be verified. In the torque method, mutual consent is required regarding the tightening torque, tolerance, torque coefficient and dispersion width, tightening force in use and inspection methods, and must include people from design engineering, tightening operations and inspection.

It is desirable that these are systemized by standardization. In order to construct a system of "bolt tightening reliability", the elimination of "machine error" and "human error" has to be

included. To maintain this reliability various methods have been designed, but their respective effects are different. (Table 4-2) More than one of these methods may be used in combination to reach the required reliability level, first seeking to eliminate all the obstructive factors with the minimum expense and time. Even if an expensive system is adopted, if it misses any of the requirements the reliability will not be maintained. Standardization of bolt tightening enables easy after-sales service. Even if the special tightening method can successfully be employed in the plant, the reliability will be lost if the same tightening cannot be achieved by the field service. The system of "bolt tightening reliability" in the broad sense must include maintenance.

Since bolts easily generate a large clamping force, many bolts are used in the assembly of products, but because there are many uncertain factors relating to bolt tightening, it influences the reliability of products and the entire system.

Table 4-2. Methods of confirming the reliability of tightening

Method	Machine error	Human error	Bolt Reliability	
			Visual check	Non-Visual check
1) 100% retightening inspection	◎	◎	×	◎
2) Two-stage tightening (Double check)	◎	◎	×	◎
3) Sampling retightening inspection	◎	×	×	○
4) Periodical inspection of tightening tools	◎	×	×	×
5) Visual inspection by tightening operator	×	○	◎	×
6) Marking (Socket)	×	○	×	○
7) Tightening completion by marking	×	◎	×	◎
8) Tightening completion by counting	×	◎		×
9) Tightening torque control data OK-NG judgment	○	◎		×
10) Tightening torque control data preservation	○	◎		×
11) Tightening torque monitoring (Independent)	◎	◎		○
12) Tightening torque angle monitoring	○	◎		◎
13) Clamping force measurement (Elongation, Ultrasonic)	◎	◎		◎
14) Sampling torque coefficient testing	×	×		○
15) Sampling product testing	◎	×		○

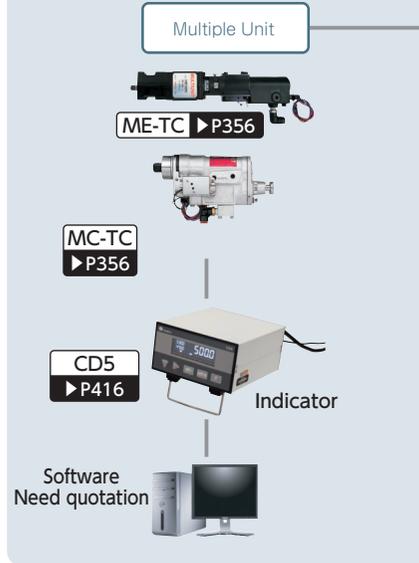
◎: Effective, ○: Slightly effective, ×: Ineffective, []: Visual inspection included
 Technical Data

4-8

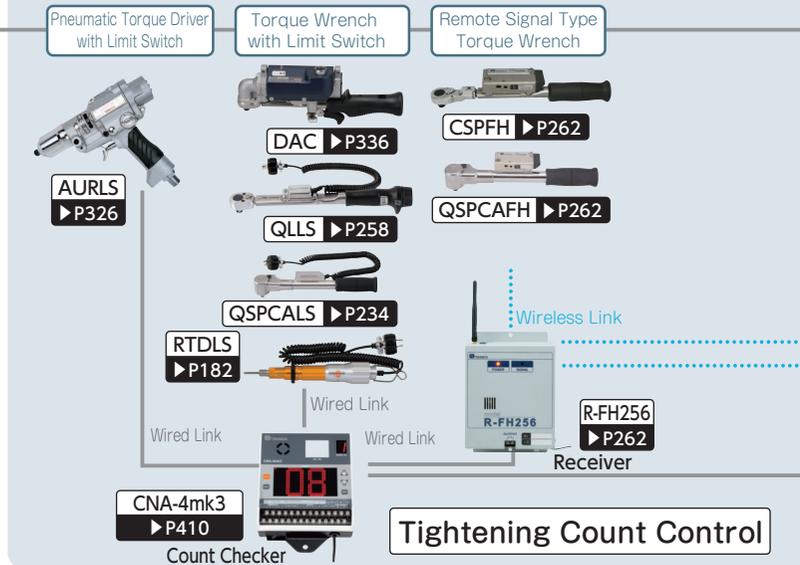
From Torque Control to Tightening Assurance System

(1) Tohnichi Tightening Assurance System

Pneumatic Tightening Data Management System

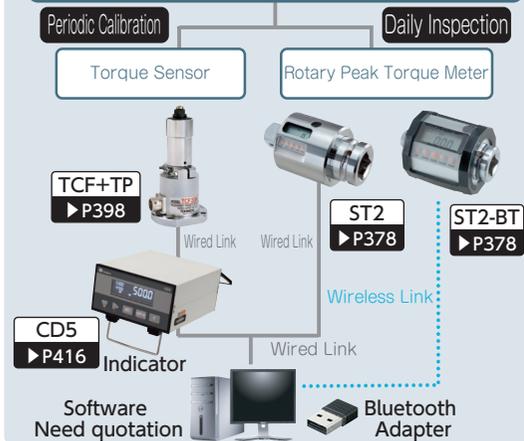


Pokayoke, Error Proofing System

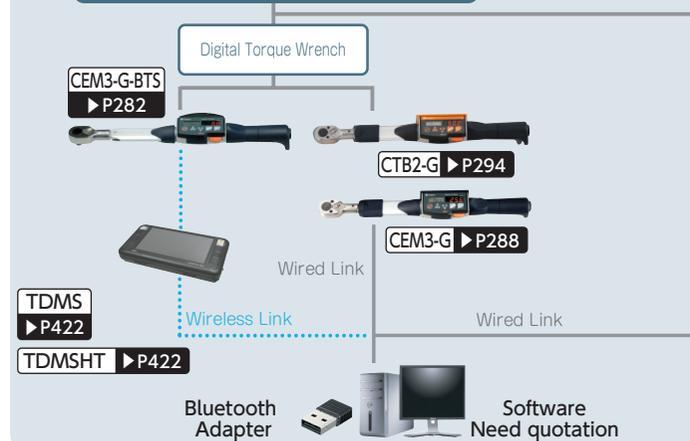


Tightening Count Control

Tool Management System for Pneumatic Tools



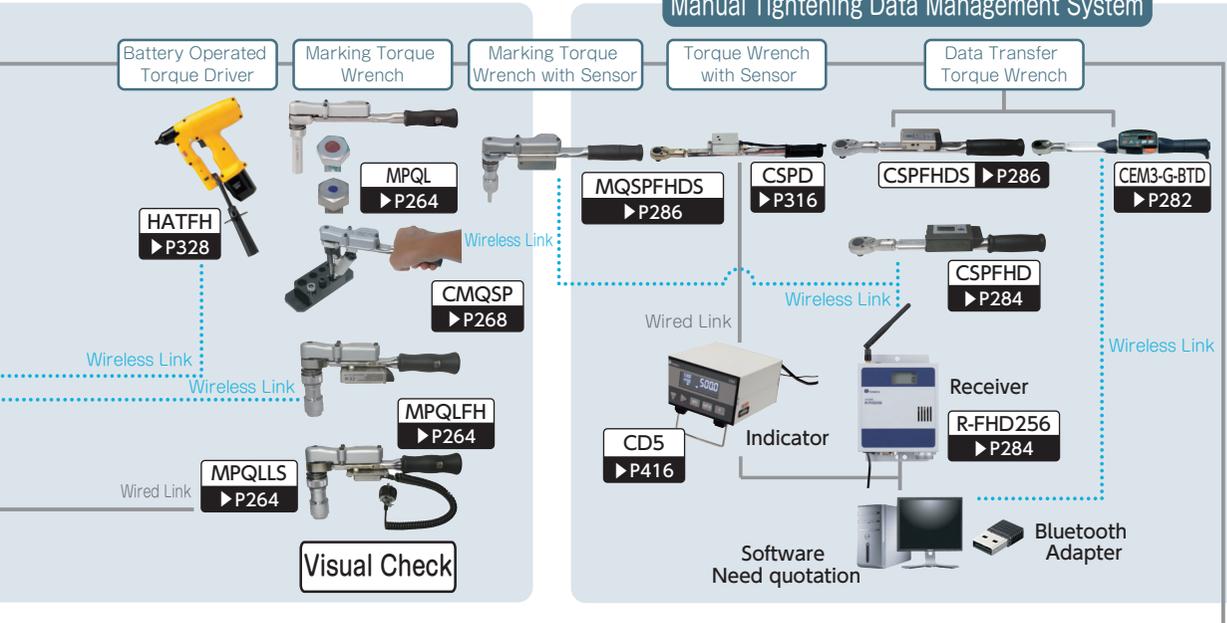
Inspection Data Management System



Tohnichi Tightening Assurance System advises the users how to tighten bolts properly and how to eliminate various mistakes which occur during bolt tightening operations.

Data Management System for Backup

Manual Tightening Data Management System



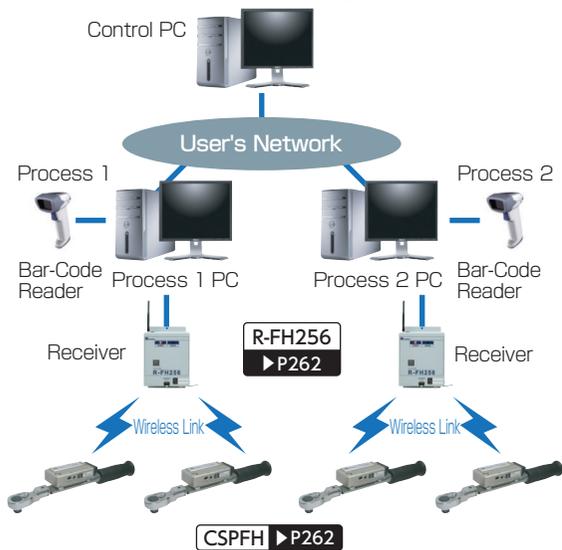
Tool Management System for Manual Tools



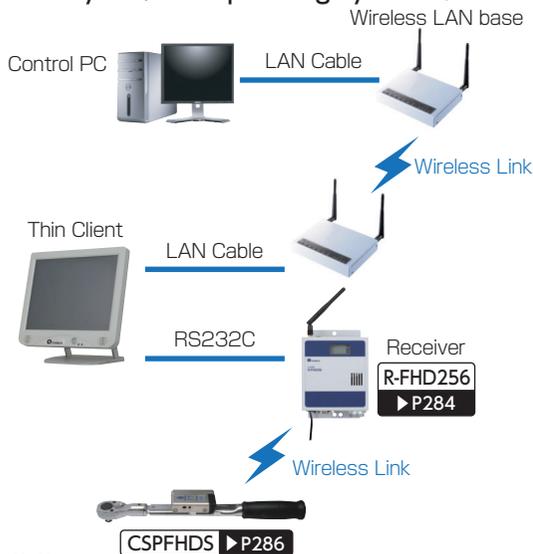
4-8 From Torque Control to Tightening Assurance System

(2) System configuration examples

■ Pokayoke, Error-proofing System ①



■ Pokayoke, Error-proofing System ②



Error-proofing System

Case of click type Torque Wrench with wireless ID recognition function, FH
Tightening spot of each process is displayed on PC and the system provides with operational instructions by sound.

First of all, operator checks a tightening work with bar-code reader and works on tightening according to the instructions from a PC. Besides, the tightening data is saved to a server via a network. Traceability of tightening work is available.



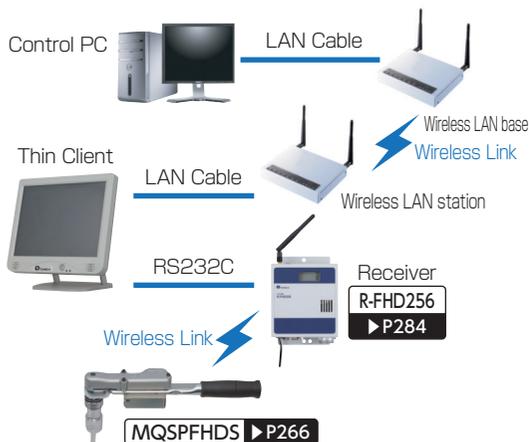
Error-proofing + Monitoring System

Case of click type Torque Wrench with wireless data transfer function, FHD
The system is capable of managing data of actual applied torque value and preventing missed tightening.

An operator conducts tightening work according to instructions from PC. OK/NG judging is carried out based on the tightening torque value of upper and lower limit. Results of the judgment are saved to a server and traceability of tightening work is available.



■ Pokayoke, Error-proofing System ③



Error-proofing + Monitoring + Marking System

Case of Marking Torque Wrench with wireless data transfer function, MQSPFHDS

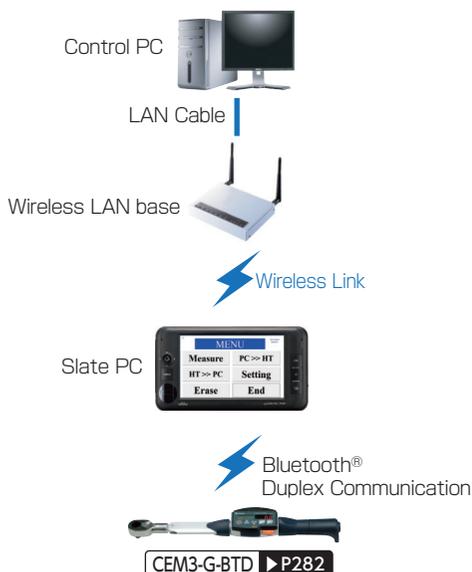
In addition to preventing missed tightening and managing actual applied torque value, marking bolt-head is also carried out.

It is very effective to prevent and confirm human error such as missed tightening by visual check.

It is an advanced system to control the both number of bolts to be tightened and actual applied torque value. All the data is saved to a server and traceability of tightening work is available.



■ Pokayoke, Error-proofing System ④

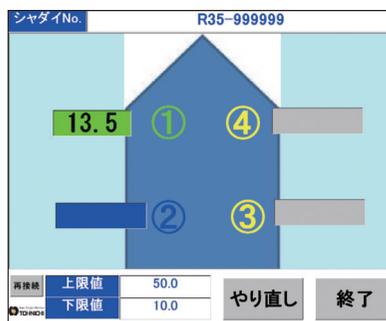


Error-proofing + Monitoring System

Case of Digital Torque Wrench with wireless data transfer function, CEM3-G-BTD

It is ideal for managing tightening data in cell-production. Upper/Lower limit can be set through PC via duplex communication.

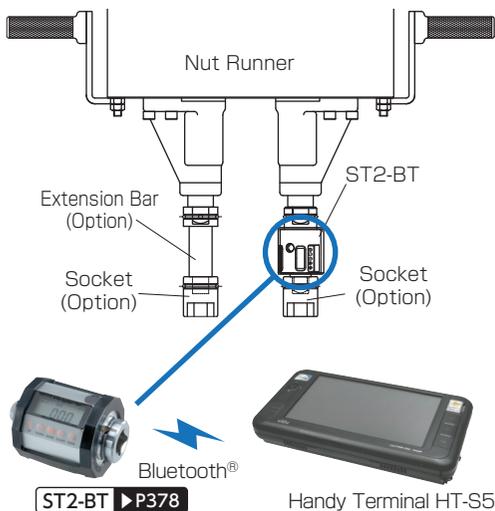
All the data is saved to a server and traceability of tightening work is available.



4-8 From Torque Control to Tightening Assurance System

Nut runner checking system

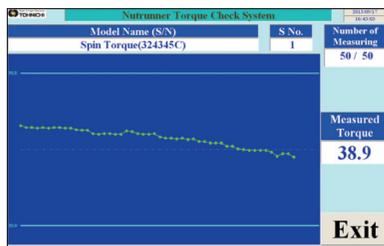
Case: Spintork / ST2-BT



Nut runner torque checking can be conducted in high accuracy and easy operation on a real-time basis by ST2-BT with handy terminal. Data transfer is executed by wireless communication.

Handy terminal, HT-S5, is excellent at compact mobility. Early detection is possible on the basis of information complied by handy terminal.

Most errors can be avoided in advance by statistical process of checked data. The tightening data is saved to a server via a network and traceability of tightening work is available.

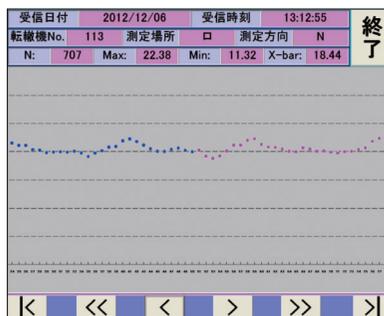


Torque·Angle measurement system

Case: Digital torque and Angle Wrench / CTA2-BT



In angle-controlled bolt tightening, torque and angle are stimulusly measured and displayed on handy terminal. Relations between torque and angle can be graphically-illustrated. Real-time analysis is possible.



Torque wrench daily inspection system Case: Torque Wrench Line Checker / LC3-G



Daily inspection of torque tools is conducted before and after carrying out the work and keeps the tool problems to a minimum. Data measured by LC3-G is saved to server and errors can be avoided in advance by statistical data. As a result, preventive maintenance can become possible.

年月	測定日	測定時刻	測定値	標準値	判定
2009/12	1	08:00	40.00	40.00	OK
2009/12	1	08:05	40.00	40.00	OK
2009/12	1	08:10	40.00	40.00	OK
2009/12	1	08:15	40.00	40.00	OK
2009/12	1	08:20	40.00	40.00	OK
2009/12	1	08:25	40.00	40.00	OK
2009/12	1	08:30	40.00	40.00	OK
2009/12	1	08:35	40.00	40.00	OK
2009/12	1	08:40	40.00	40.00	OK
2009/12	1	08:45	40.00	40.00	OK
2009/12	1	08:50	40.00	40.00	OK
2009/12	1	08:55	40.00	40.00	OK
2009/12	1	09:00	40.00	40.00	OK
2009/12	1	09:05	40.00	40.00	OK
2009/12	1	09:10	40.00	40.00	OK
2009/12	1	09:15	40.00	40.00	OK
2009/12	1	09:20	40.00	40.00	OK
2009/12	1	09:25	40.00	40.00	OK
2009/12	1	09:30	40.00	40.00	OK
2009/12	1	09:35	40.00	40.00	OK
2009/12	1	09:40	40.00	40.00	OK
2009/12	1	09:45	40.00	40.00	OK
2009/12	1	09:50	40.00	40.00	OK
2009/12	1	09:55	40.00	40.00	OK
2009/12	1	10:00	40.00	40.00	OK
2009/12	1	10:05	40.00	40.00	OK
2009/12	1	10:10	40.00	40.00	OK
2009/12	1	10:15	40.00	40.00	OK
2009/12	1	10:20	40.00	40.00	OK
2009/12	1	10:25	40.00	40.00	OK
2009/12	1	10:30	40.00	40.00	OK
2009/12	1	10:35	40.00	40.00	OK
2009/12	1	10:40	40.00	40.00	OK
2009/12	1	10:45	40.00	40.00	OK
2009/12	1	10:50	40.00	40.00	OK
2009/12	1	10:55	40.00	40.00	OK
2009/12	1	11:00	40.00	40.00	OK
2009/12	1	11:05	40.00	40.00	OK
2009/12	1	11:10	40.00	40.00	OK
2009/12	1	11:15	40.00	40.00	OK
2009/12	1	11:20	40.00	40.00	OK
2009/12	1	11:25	40.00	40.00	OK
2009/12	1	11:30	40.00	40.00	OK
2009/12	1	11:35	40.00	40.00	OK
2009/12	1	11:40	40.00	40.00	OK
2009/12	1	11:45	40.00	40.00	OK
2009/12	1	11:50	40.00	40.00	OK
2009/12	1	11:55	40.00	40.00	OK
2009/12	1	12:00	40.00	40.00	OK

測定開始

測定中止

1回目

2回目

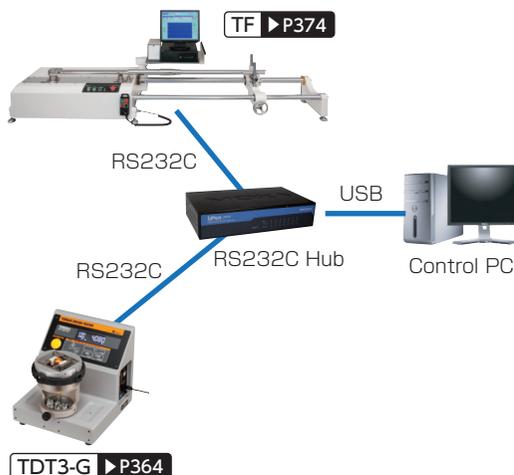
3回目

平均

合格

測定中止

Torque wrench periodic calibration system Case: Torque Wrench Tester / TF



This is the system to manage periodic calibration data of torque driver and wrench by control PC. The system generates following functions by saving all the data to a server.

- Tracking a full record from the beginning to the end
- Control of calibration cycle
- Alarm notification to announce calibration period
- Issuing calibration certificate
- Accuracy management by serial numbers and more...

測定開始時刻	測定時刻	測定値	標準値	判定
10:00	10:05	40.00	40.00	OK
10:10	10:15	40.00	40.00	OK
10:20	10:25	40.00	40.00	OK
10:30	10:35	40.00	40.00	OK
10:40	10:45	40.00	40.00	OK
10:50	10:55	40.00	40.00	OK
11:00	11:05	40.00	40.00	OK
11:10	11:15	40.00	40.00	OK
11:20	11:25	40.00	40.00	OK
11:30	11:35	40.00	40.00	OK
11:40	11:45	40.00	40.00	OK
11:50	11:55	40.00	40.00	OK
12:00	12:05	40.00	40.00	OK
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12:20	12:25	40.00	40.00	OK
12:30	12:35	40.00	40.00	OK
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13:00	13:05	40.00	40.00	OK
13:10	13:15	40.00	40.00	OK
13:20	13:25	40.00	40.00	OK
13:30	13:35	40.00	40.00	OK
13:40	13:45	40.00	40.00	OK
13:50	13:55	40.00	40.00	OK
14:00	14:05	40.00	40.00	OK
14:10	14:15	40.00	40.00	OK
14:20	14:25	40.00	40.00	OK
14:30	14:35	40.00	40.00	OK
14:40	14:45	40.00	40.00	OK
14:50	14:55	40.00	40.00	OK
15:00	15:05	40.00	40.00	OK
15:10	15:15	40.00	40.00	OK
15:20	15:25	40.00	40.00	OK
15:30	15:35	40.00	40.00	OK
15:40	15:45	40.00	40.00	OK
15:50	15:55	40.00	40.00	OK
16:00	16:05	40.00	40.00	OK
16:10	16:15	40.00	40.00	OK
16:20	16:25	40.00	40.00	OK
16:30	16:35	40.00	40.00	OK
16:40	16:45	40.00	40.00	OK
16:50	16:55	40.00	40.00	OK
17:00	17:05	40.00	40.00	OK
17:10	17:15	40.00	40.00	OK
17:20	17:25	40.00	40.00	OK
17:30	17:35	40.00	40.00	OK
17:40	17:45	40.00	40.00	OK
17:50	17:55	40.00	40.00	OK
18:00	18:05	40.00	40.00	OK
18:10	18:15	40.00	40.00	OK
18:20	18:25	40.00	40.00	OK
18:30	18:35	40.00	40.00	OK
18:40	18:45	40.00	40.00	OK
18:50	18:55	40.00	40.00	OK
19:00	19:05	40.00	40.00	OK
19:10	19:15	40.00	40.00	OK
19:20	19:25	40.00	40.00	OK
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19:40	19:45	40.00	40.00	OK
19:50	19:55	40.00	40.00	OK
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20:20	20:25	40.00	40.00	OK
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21:10	21:15	40.00	40.00	OK
21:20	21:25	40.00	40.00	OK
21:30	21:35	40.00	40.00	OK
21:40	21:45	40.00	40.00	OK
21:50	21:55	40.00	40.00	OK
22:00	22:05	40.00	40.00	OK
22:10	22:15	40.00	40.00	OK
22:20	22:25	40.00	40.00	OK
22:30	22:35	40.00	40.00	OK
22:40	22:45	40.00	40.00	OK
22:50	22:55	40.00	40.00	OK
23:00	23:05	40.00	40.00	OK
23:10	23:15	40.00	40.00	OK
23:20	23:25	40.00	40.00	OK
23:30	23:35	40.00	40.00	OK
23:40	23:45	40.00	40.00	OK
23:50	23:55	40.00	40.00	OK
24:00	24:05	40.00	40.00	OK

測定開始

測定中止