User's Manual

EXA

Model DC402G Converter for Dual Cell Conductivity and Resistivity [Style: S2]

IM 12D08E02-01E

YOKOGAWA
Yokogawa Electric Corporation

IM 12D08E02-01E
7th Edition

Introduction

Thank you for purchasing the DC402G Converter for Dual Cell Conductivity and Resistivity.

Please read the following respective documents before installing and using the DC402G.

The related documents are as follows.

General Specifications:	GS 12D08E02-01E
User's Manual:	IM 12D08E02-01E (this manual)

* the "E" in the document number is the language code.

NOTE

Electric discharge
The DC402G contains devices that can be damaged by electrostatic discharge. When servicing this equipment, please observe proper procedures to prevent such damage. Replacement components should be shipped in conductive packaging. Repair work should be done at grounded workstations using grounded soldering irons and wrist straps to avoid electrostatic discharge.

Installation and wiring
The DC402G should only be used with equipment that meets the relevant IEC, American or Canadian standards. Yokogawa accepts no responsibility for the misuse of this unit.

The Instrument is packed carefully with shock absorbing materials, nevertheless, the instrument may be damaged or broken if subjected to strong shock, such as if the instrument is dropped. Handle with care.

Although the instrument has a weatherproof construction, the transmitter can be harmed if it becomes submerged in water or becomes excessively wet.

Do not use an abrasive or solvent in cleaning the instrument.

Yokogawa is not responsible for damage to the instrument, poor performance of the instrument or losses resulting from such, if the problems are caused by:

- Improper operation by the user.
- Use of the instrument in improper applications
- Use of the instrument in an improper environment or improper utility program
- Repair or modification of the related instrument by an engineer not authorized by Yokogawa.

Product Disposal

The instrument should be disposed of in accordance with local and national legislation/ regulations.

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◆ Safety Precautions

■ Safety, Protection, and Modification of the Product

- In order to protect the system controlled by the product and the product itself and ensure safe operation, observe the safety precautions described in this user's manual. We assume no liability for safety if users fail to observe these instructions when operating the product.
- If this instrument is used in a manner not specified in this user's manual, the protection provided by this instrument may be impaired.
- If any protection or safety circuit is required for the system controlled by the product or for the product itself, prepare it separately.
- Be sure to use the spare parts approved by Yokogawa Electric Corporation (hereafter simply referred to as YOKOGAWA) when replacing parts or consumables.
- Modification of the product is strictly prohibited.
- The following safety symbols are used on the product as well as in this manual.

⚠ WARNING

This symbol indicates that an operator must follow the instructions laid out in this manual in order to avoid the risks, for the human body, of injury, electric shock, or fatalities. The manual describes what special care the operator must take to avoid such risks.

⚠ CAUTION

This symbol indicates that the operator must refer to the instructions in this manual in order to prevent the instrument (hardware) or software from being damaged, or a system failure from occurring.

CAUTION

This symbol gives information essential for understanding the operations and functions.

NOTE

This symbol indicates information that complements the present topic.

This symbol indicates Protective Ground Terminal.

This symbol indicates Function Ground Terminal. Do not use this terminal as the protective ground terminal.

■ Notes on Handling User's Manuals

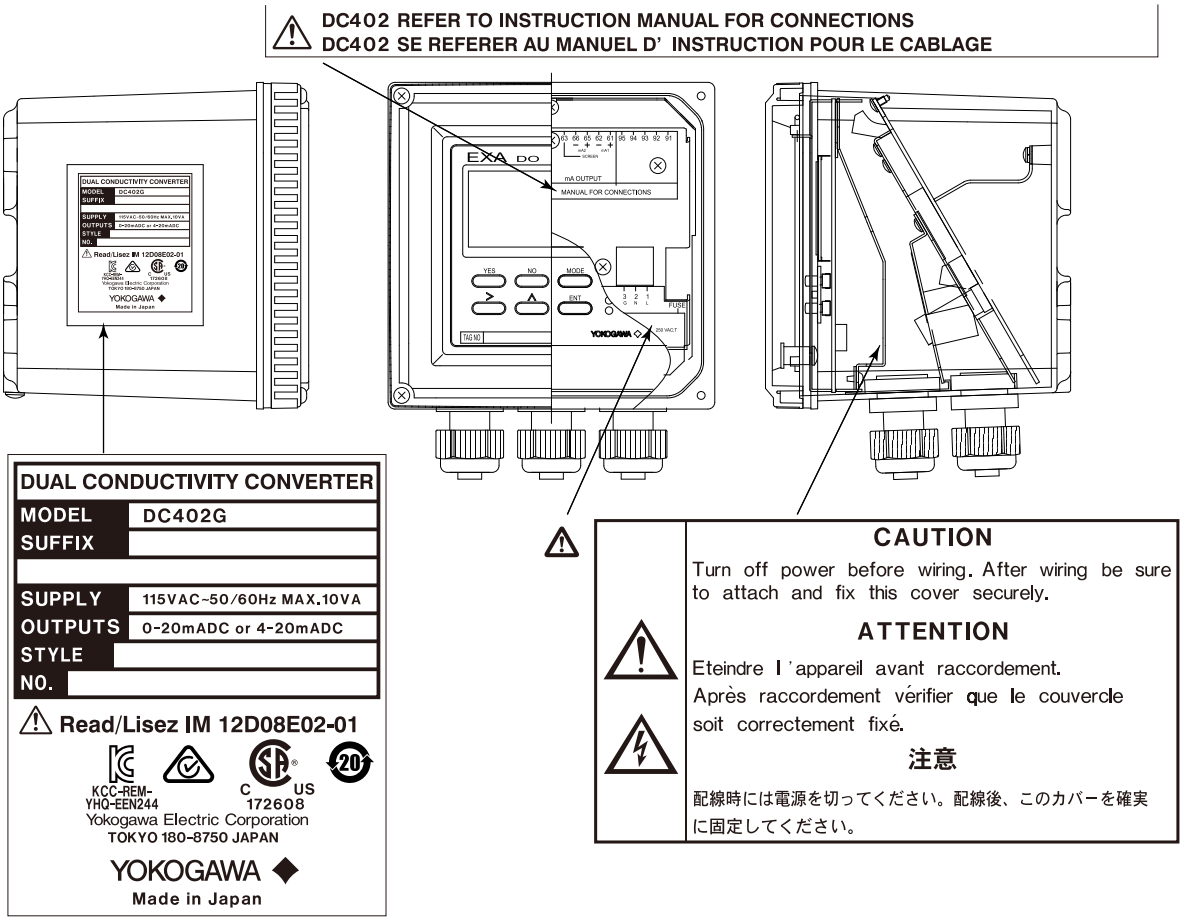
- Please hand over the user's manuals to your end users so that they can keep the user's manuals on hand for convenient reference.
- Please read the information thoroughly before using the product.
- The purpose of these user's manuals is not to warrant that the product is well suited to any particular purpose but rather to describe the functional details of the product.
- No part of the user's manuals may be transferred or reproduced without prior written consent from YOKOGAWA.
- YOKOGAWA reserves the right to make improvements in the user's manuals and product at any time, without notice or obligation.
- If you have any questions, or you find mistakes or omissions in the user's manuals, please contact our sales representative or your local distributor.

Warning and Disclaimer

The product is provided on an “as is” basis. YOKOGAWA shall have neither liability nor responsibility to any person or entity with respect to any direct or indirect loss or damage arising from using the product or any defect of the product that YOKOGAWA can not predict in advance.

Label

The next warning label is put on the product.



Drawing Conventions

Some drawings may be partially emphasized, simplified, or omitted, for the convenience of description.

Some screen images depicted in the user’s manual may have different display positions or character types (e.g., the upper / lower case). Also note that some of the images contained in this user’s manual are display examples.

Warranty and service

Yokogawa products and parts are guaranteed free from defects in workmanship and material under normal use and service for a period of (typically) 12 months from the date of shipment from the manufacturer.

Individual sales organisations can deviate from the typical warranty period, and the conditions of sale relating to the original purchase order should be consulted. Damage caused by wear and tear, inadequate maintenance, corrosion, or by the effects of chemical processes are excluded from this warranty coverage.

In the event of warranty claim, the defective goods should be sent (freight paid) to the service department of the relevant sales organisation for repair or replacement (at Yokogawa discretion). The following information must be included in the letter accompanying the returned goods:

- Part number, model code and serial number
- Original purchase order and date
- Length of time in service and a description of the process
- Description of the fault, and the circumstances of failure
- Process/environmental conditions that may be related to the failure of the device.
- A statement whether warranty or nonwarranty service is requested
- Complete shipping and billing instructions for return of material, plus the name and phone number of a contact person who can be reached for further information.

Returned goods that have been in contact with process fluids must be decontaminated/ disinfected before shipment. Goods should carry a certificate to this effect, for the health and safety of our employees.

Material safety data sheets should also be included for all components of the processes to which the equipment has been exposed.

Model DC402G
Converter for Dual Cell Conductivity and Resistivity [Style: S2]

IM 12D08E02-01E 7th Edition

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1. Introduction and General Description

The Yokogawa DC402G is a 4-wire converter designed for industrial process monitoring, measurement and control applications. This instruction manual contains the information needed to install, set up, operate and maintain the unit correctly. This manual also includes a basic troubleshooting guide to answer typical user questions.

Yokogawa can not be responsible for the performance of the DC402G if these instructions are not followed.

1.1 Instrument Check

Upon delivery, unpack the instrument carefully and inspect it to ensure that it was not damaged during shipment. If damage is found, retain the original packing materials (including the outer box) and then immediately notify the carrier and the relevant Yokogawa sales office.

Make sure the model number on the nameplate affixed to the left side of the instrument agrees with your order.

CAUTION

The nameplate will also contain the serial number and power supply selection.

Be sure to apply correct power to the unit.

Check that all the parts are present, including mounting bracket, as specified in the option codes at the end of the model number. For a description of the model codes, refer to Chapter 2 of this manual under General Specifications.

Basic Parts List:

Converter DC402G

Instruction Manual English

Optional mounting hardware when specified (See model code)

1.2 Application

The DC402G converter is intended to be used for continuous on-line measurement in industrial installations. The unit combines simple operation and microprocessor-based performance with advanced self-diagnostics and enhanced communications capability to meet the most advanced requirements. The measurement can be used as part of an automated process control system. It can also be used to indicate dangerous limits of a process, to monitor product quality, or to function as a simple controller for a dosing/neutralization system.

Yokogawa designed the DC402G to withstand harsh environments. The converter may be installed either indoors or outside because the IP65 (NEMA 4X) housing and cabling glands ensure the unit is adequately protected. The flexible polycarbonate window on the front door of the DC402G allows pushbutton access to the keypad, thus preserving the water and dust protection of the unit even during routine maintenance operations.

A variety of DC402G hardware is optionally available to allow wall, pipe, or panel mounting. Selecting a proper installation site will permit ease of operation. Sensors should normally be mounted closely to the converter in order to ensure easy calibration and peak performance. If the unit must be mounted remotely from the sensors, WF10 extension cable can be used up to a maximum of 50 metres (150 feet) with a BA10 junction box.

The DC402G is delivered with a general purpose default setting for programmable items. (Default settings are listed in Chapter 5 and again in Chapter 10). While this initial configuration allows easy start-up, the configuration should be adjusted to suit each particular application. An example of an adjustable item is the type of temperature sensor used. The DC402G can be adjusted for any one of five different types of temperature sensors.

To record such configuration adjustments, write changes in the space provided in Chapter 10 of this manual. Because the DC402G is suitable for use as a monitor, a controller or an alarm instrument, program configuration possibilities are numerous.

Details provided in this instruction manual are sufficient to operate the DC402G with all Yokogawa sensor systems and a wide range of third-party commercially available probes. For best results, read this manual in conjunction with the corresponding sensor instruction manual.

2. DC402G Specifications

2.1 General specifications

Input specifications

Two inputs , each 2-electrode measurement with square wave excitation, using cell constants(C) from 0.008 to 50.0 cm^{-1}, with up to 60 metres (200ft) connection cable.

Detection method

Frequency, read-pulse position and reference voltage are dynamically optimized.

Input ranges

Minimum : 1µS x C at process temperature (underrange 0.000 µS/cm).
Maximum : 25 mS x C at process temperature (overrange 30 mS x C).

- Resistivity : 0.00 kΩ - 999 MΩ/C at 25 °C (77 °F) reference temperature.

Minimum : 40 Ω/C at process temperature (underrange 0.001 kΩ x cm).
Maximum : 1 MΩ/C at process temperature (overrange 999 MΩ x cm).

- Temperature

Pt1000 : -20 to +250 °C (0 to 500 °F)
Pt100 and Ni100 : -20 to +200 °C (0 to 400 °F)
8K55 NTC : -10 to +120 °C (10 to 250 °F)
PB36 NTC : -20 to +120 °C (0 to 250 °F)

Span

Conductivity/Resistivity: Min. span : 0.010 µS/cm; 0.001 kΩ x cm
up to 90% maximum zero suppression.
Max. span : 1500 mS/cm; 999 MΩ x cm

Ratio (cell1/cell2): Min. span : 00.0
Max. span : 19.99

Difference (cell1- cell2): Min. span : 0.010 µS/cm
Max. span : 400 mS/cm

% Passage (100x[cell2/cell1]): Min. span : 00.0
Max. span : 199.9

% Rejection (100x[(cell1-cell2)/cell1]): Min. span : 0.1
Max. span : 400

% Deviation (100x[(cell2-cell1)/cell1]): Min. span : 0.1
Max. span: 400

VGB-directive 450 L: Min. span : 1.0 pH
Max. span : 14.0 pH

Temperature: Min. span : 25 °C (50 °F)
Max. span : 250°C (500 °F)

Difference Temperature: Min. span : 25 °C (50 °F)
Max. span : 250 °C (500 °F)

Transmission Signals

Two isolated outputs of 0/4-20 mA DC with common negative.

Max. load : 600 Ω.

Auxiliary output can be chosen from conductivity, linearized conductivity, resistivity, temperature, differential temperature calculated value or PI control of conductivity/resistivity.

Burn up (22 mA) or Burn down (0/3.5 mA) to signal failure.

Temperature compensation

Automatic, for temperature ranges mentioned under C (input ranges).

- Reference temperature : programmable from 0 to 100 °C or 30 to 210 °F (default 25 °C).

Compensation algorithm

According IEC 60746-3 NaCl tables (default). Two independent user programmable temperature coefficients, from 0% to 3.5% per °C (°F) by adjustment or calibration.

- Matrix compensation : with conductivity function of concen-tration and temperature. Choice of 5 preprogrammed matrixes and a 25-points userprogrammable matrix.

Display

Custom liquid crystal display, with a main display of 3 1/2 digits 12.5 mm high. Message display of 6 alphanumeric characters, 7 mm high. Warning flags and units (mS/cm, kΩ·cm, µS/cm and MΩ·cm) as appropriate.

Contact Outputs

- General : Four (4) SPDT relay contacts with LED indicators. For S1, S2, and S3, the LED is on when relay power is removed.

NOTE: For S4 (FAIL) LED lights when relay is deenergised (Fail safe).

Contact outputs configurable for hysteresis and delay time.

- Switch capacity : Maximum values 100 VA, 250 VAC, 5 Amps.
  Maximum values 50 Watts, 250 VDC, 5 Amps.
- Status : High/low process alarms, selected from conductivity, resistivity and temperature. Contact output is also available to signal “Hold active”
- Control function : On/Off

  PI pulsed : Proportional duty cycle control with integral term.

  PI frequency : Proportional frequency control with integral term. (PI control on Conductivity/Resistivity only) In addition FAIL alarm for system and diagnostic errors on S4.

Power Supply

Supply voltage rating: 115, 230 VAC

Applicable range: 97.8 to 132.2, 195.5 to 264.5 VAC

Supply frequency rating: 50 / 60 Hz

Applicable range: 50 Hz ± 5% / 60 Hz ± 5%

Power consumption: Maximum 10 VA for steady operation

Shipping Details

Package size : W x H x D 290 x 300 x 290 mm. 11.5 x 11.8 x 11.5 in.

Packed weight : Approx. 2.5 kg (5lb).

2.2 Operating specifications

- **Performance : Conductivity**

  Linearity: ± 0.5 % FS
  Repeatability: ± 0.5 % FS
  Accuracy: ± 0.5 % FS

- **Performance : Resistivity**

  Linearity: ± 0.5 % FS
  Repeatability: ± 0.5 % FS
  Accuracy: ± 0.5 % FS

- **Performance : Temperature with Pt1000Ω, Ni100Ω and PB36 NTC**

  Linearity: ± 0.3 ºC
  Repeatability: ± 0.3 ºC
  Accuracy: ± 0.3 ºC

- **Performance : Temperature with PT100Ω and 8k55Ω**

  Linearity: ± 0.4 ºC
  Repeatability: ± 0.4 ºC
  Accuracy: ± 0.4 ºC

  Note: The following tolerance are added to above performance.
  mA output tolerance : ± 0.02 mA of “0/4 - 20 mA”
  Digital display tolerance: +1 digit

- **Performance : Temperature compensation**

  NaCl table: ± 1%
  Matrix: ± 3%
  Step response: 90 % (< 2 decades) in ≤ 6 seconds

- **Ambient operating temperature**

  -10 to +55 °C (14 to 131 ºF)

- **Storage temperature**

  -30 to +70 °C (-22 to 158 ºF)

- **Humidity**

  10 to 90% RH non-condensing

- **Housing**

  Cast aluminium case with chemically resistant coating, cover with flexible polycarbonate window. Case color is off-white and cover is moss green. Cable entry is via six PG13.5 nylon glands. Cable terminals are provided for up to 2.5 mm finished wires. Weather resistant to IP65, NEMA 4X, CSA Type 3S. Pipe wall or panel mounting, using optional hardware.

- **Data protection**

  EEPROM for configuration and lithium battery for clock.

- **Watchdog timer**

  Checks microprocessor

Automatic safeguard

Return to measuring mode when no keystroke is made for 10 min.

Power interruption

Less than 50 milliseconds no effect.

Operation protection

3-digit programmable password.

Safety and EMC conforming standards

DC402G is not CE-marking applicable.

Safety: conforms to EN 61010-1
EN 61010-2-030
EN 61010-2-201
CAN/CSA No.61010-1
UL Std. No. 61010-1
CSA C22.2 No. 94.2
UL 50E

EMC: EN 61326-1* Class A, Table 2 (Note 1)
EN 61326-2-3
EN 61000-3-2 Class A
EN 61000-3-3

RCM: EN61326-1 Class A

Korea Electromagnetic Conformity Standard Class A
한국 전자파적합성 기준

*: Influence of immunity environment (Criteria A): Output shift is specified within ±25% of F.S.

Installation altitude: 2000 m or less

Category based on IEC 61010: II (Note 2)

Pollution degree based on IEC 61010:2 (Note 2)

Note 1: This instrument is a Class A product, and it is designed for use in the industrial environment. Please use this instrument in the industrial environment only.
A급 기기 (업무용 방송통신기자재)
이 기기는 업무용(A급) 전자파적합기기로서 판매자 또는
사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서
사용하는 것을 목적으로 합니다.

Note 2: Installation category, called overvoltage category, specifies impulse withstand voltage. Category II is for electrical equipment. Pollution degree indicates the degree of existence of solid, liquid, gas or other inclusions which may reduce dielectric strength. Degree 2 is the normal indoor environment.

2.3 Model and suffix codes

[Style: S2]

Model	Suffix code		Option code	Description
DC402G	••••••••••••••••••		••••••••••••••••••	Dual Conductivity Converter
Type	**-1**		••••••••••••••••••	General
Power Supply Voltage	**-1**		••••••••••••••••••	115 V +/-15% AC, 50/60 Hz (*2)
	-2		••••••••••••••••••	230 V +/-15% AC, 50/60 Hz
Language		**-E**	••••••••••••••••••	English
		-J	••••••••••••••••••	Japanese
Options			**/U**	Pipe, wall mounting bracket (Stainless steel)
			/PM	Panel mounting bracket (Stainless steel)
			/H3	Hood for sun protection (Carbon steel)
			/H4	Hood for sun protection (Stainless steel)
			/SCT	Stainless steel tag plate
			/AFTG	G 1/2
			/ANSI	1/2 NPT
			/X1	Epoxy baked finish (*1)

*1: The housing is coated with epoxy resin.
*2: When CSA safe standard conformity product is needed, select 115V “-1” of Power Supply Voltage.

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3. Installation and Wiring

3.1 Installation and dimensions

CAUTION

Installation must be performed by a qualified personnel. If this rules is not followed and a damage occurs, Yokogawa will not be held responsible.

3.1.1 Installation site

CAUTION

This instrument is a Class A product, and it is designed for use in the industrial environment. Please use this instrument in the industrial environment only.

The DC402G converter is weatherproof and can be installed inside or outside. It should, however, be installed as close as possible to the sensor to avoid long cable runs between sensor and converter. In any case, the total cable length should not exceed 60 meters (200 feet). Select an installation site where:

- Mechanical vibrations and shocks are negligible
- No relay/power switches are in the direct environment
- Access is possible to the cable glands (see figure 3.1)
- The converter is not mounted in direct sunlight or severe weather conditions
- Maintenance procedures are possible (avoiding corrosive environments)

The ambient temperature and humidity of the installation environment must be within the limits of the instrument specifications. (See chapter 2).

3.1.2 Mounting methods

Refer to figures 3.2 and 3.3. Note that the DC402G converter has universal mounting capabilities:

- Panel mounting using optional brackets
- Surface mounting on a plate (using bolts from the back)
- Wall mounting on a bracket (for example, on a solid wall)
- Pipe mounting using a bracket on a horizontal or vertical pipe (maximum pipe diameter 50 A)

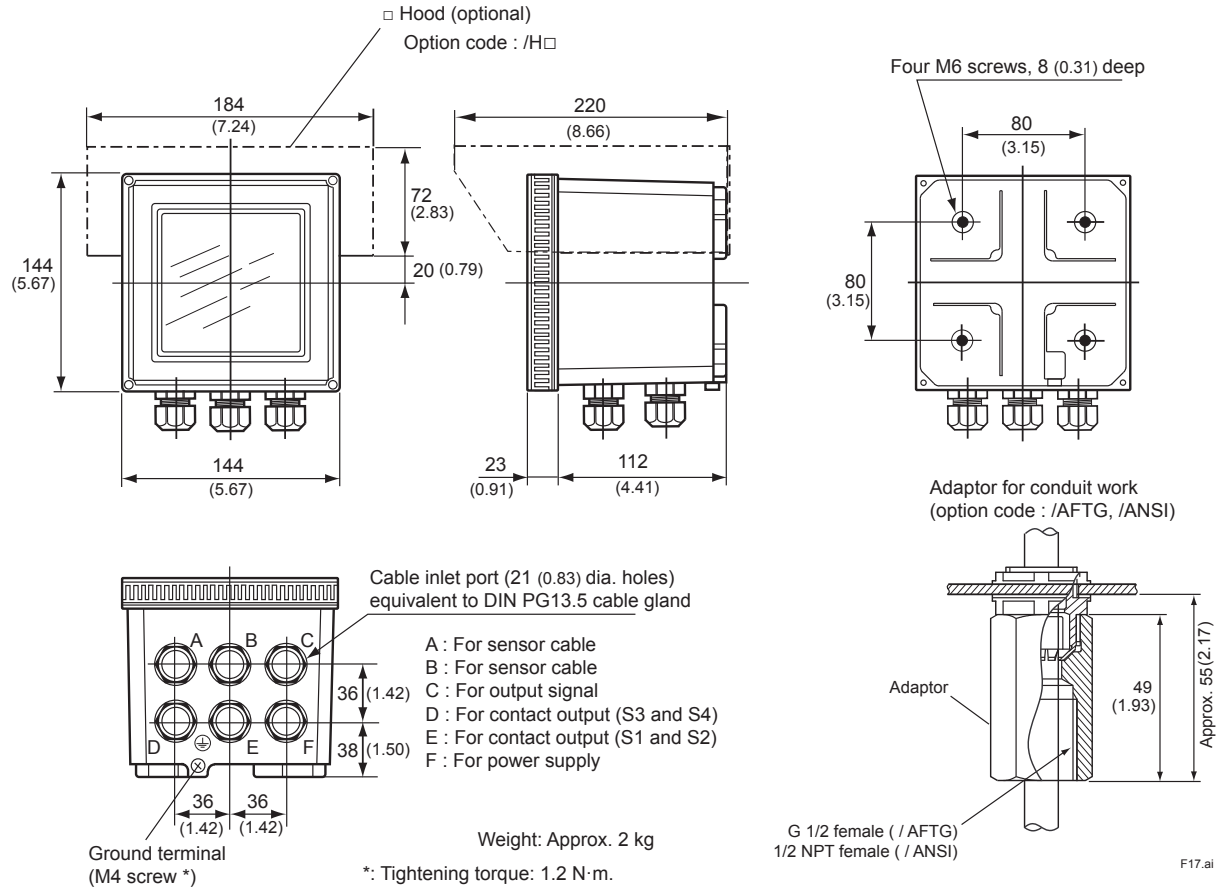


Figure 3.1 Housing dimensions and layout of glands

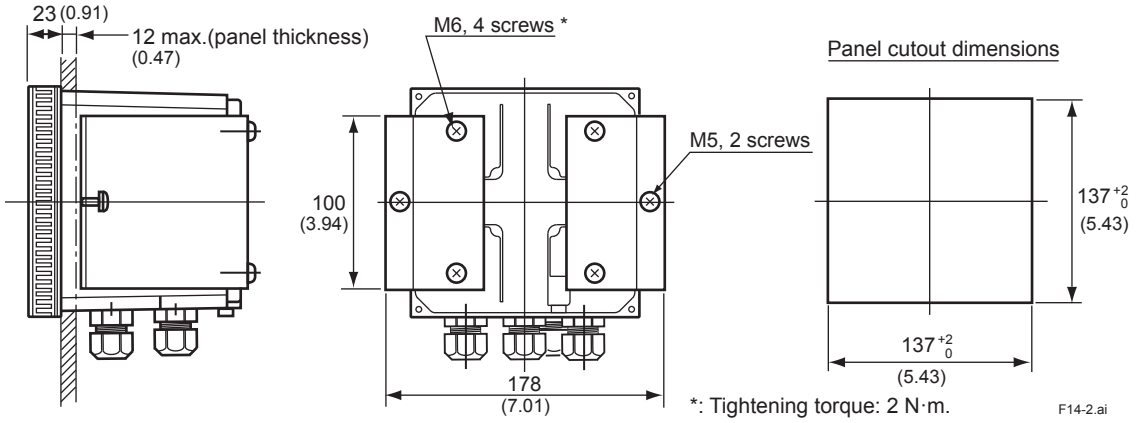
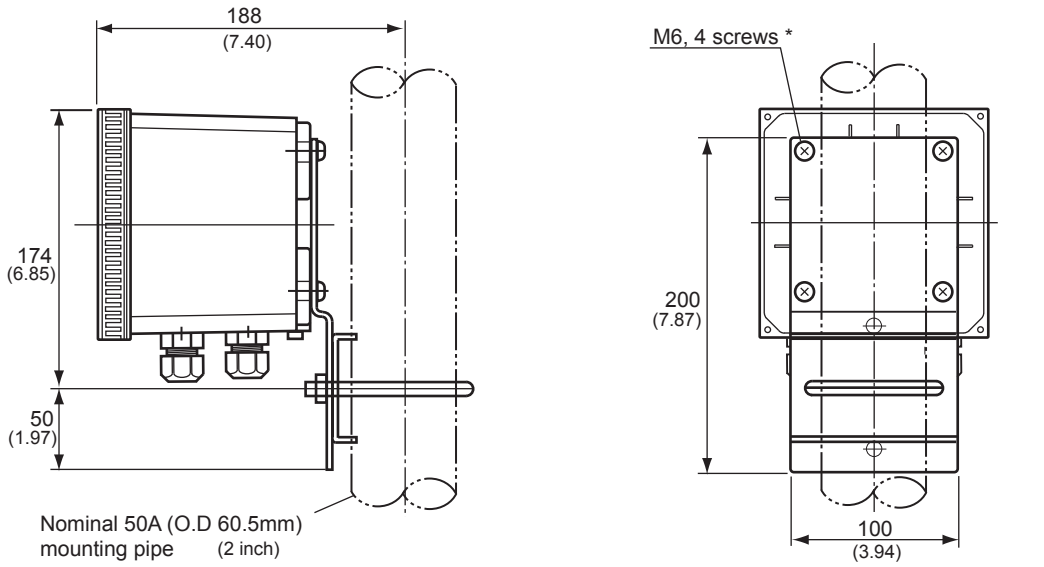
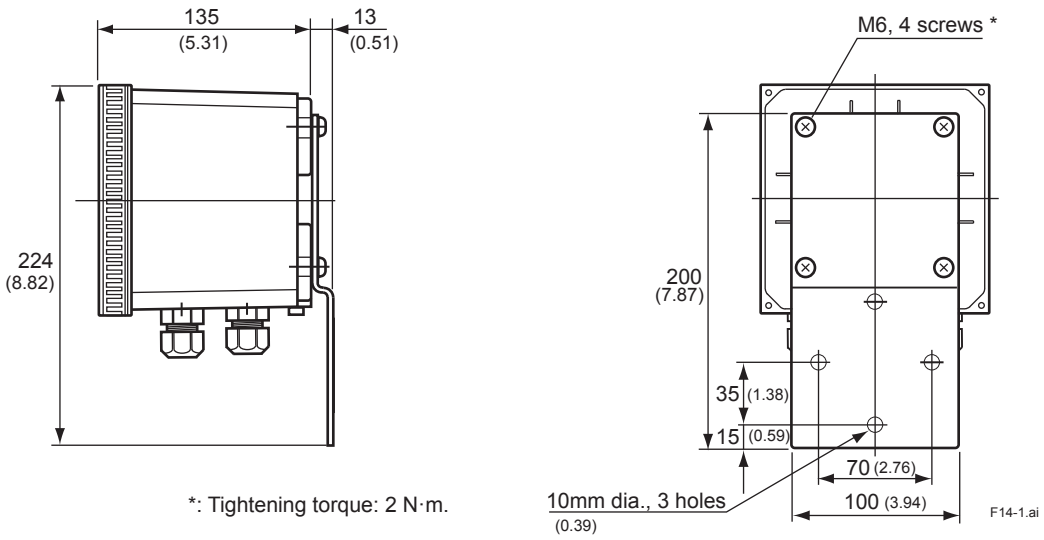


Figure 3.2 Panel mounting diagram (Option Code: /PM)

Example of bracket used for pipe mounting



Example of bracket used for wall mounting



*: Tightening torque: 2 N·m.

Figure 3.3 Wall and pipe mounting diagram (Option Code: /U)

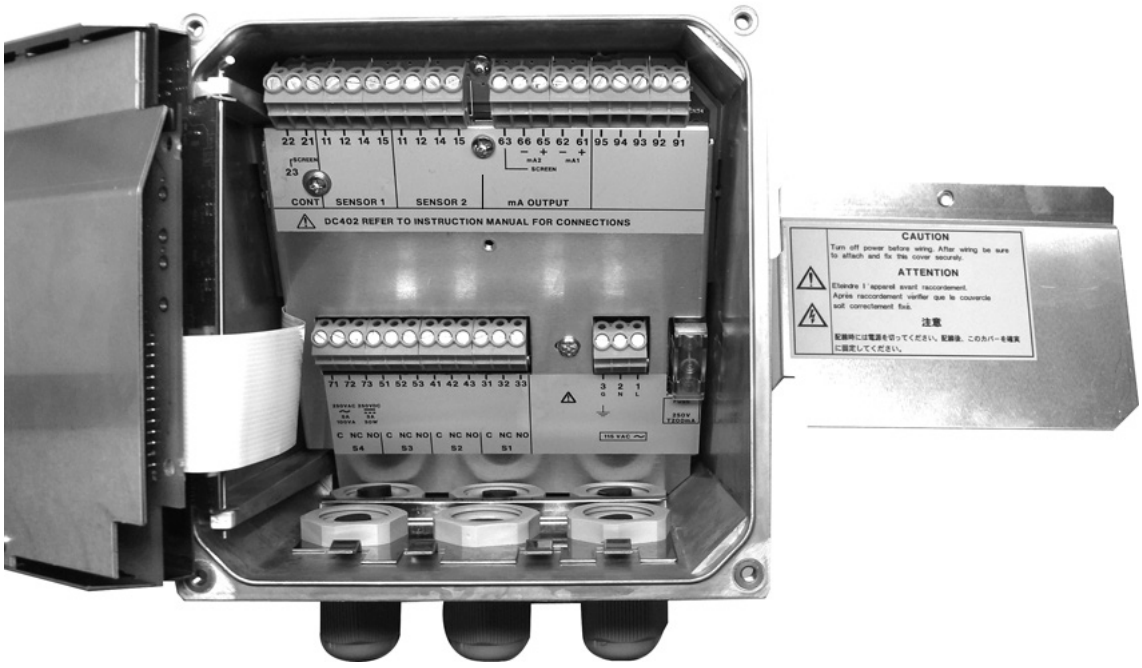


Figure 3.4 Internal view of DC402G wiring compartment

CAUTION

Wiring must be performed by a qualified personnel. If this rules is not followed and a damage occurs, Yokogawa will not be held responsible.

WARNING

Never apply power to the DC402G converter and other instruments connected to the DC402G converter until all wiring is completed.

WARNING

Where compliance with safety standard is necessary, the following wiring is required.

1. Install an external switch or circuit breaker to the power supply of the DC402G converter.
2. Use an external switch or circuit breaker rated 5A and conforming to IEC 60947-1 or IEC 60947-3.
3. It is recommended that the external switch or circuit breaker be installed in the same room as the DC402G converter.
4. The external switch or circuit breaker should be installed within reach of the operator and identified with marking as a power supply switch to the DC402G converter.
5. Power lines such as power cables and contact outputs should be fixed securely onto a wall or construction using cable racks, conduit tubing, nylon bands or other appropriate ways. Accidental removal from terminals by pulling may result in electric shock

3.2 Preparation

Refer to figure 3.4. The relay contact terminals and power supply connections are under the screening (shielding) plate. These should be connected first. Connect the sensor and outputs.

To open the DC402G for wiring:

1. Loosen the four frontplate screws and remove the cover.
2. Use the rubber knob in the lower right hand corner and swing open the display board to the left.
3. The upper terminal strip is now visible.
4. Remove the screen (shield) plate covering the lower terminal strip.
5. Connect the power supply and contact outputs. Use the three glands at the back for these cables.
6. Replace the screen (shield) plate over the lower terminals.

WARNING

Always replace the screen plate over the power and contact outputs for safety and to avoid interference.

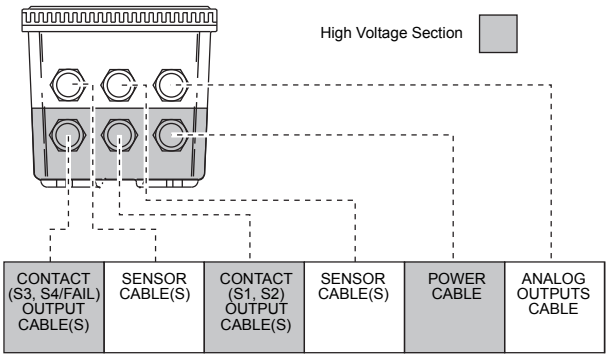
7. Connect the analog output(s) and the sensor input.
8. Use the front three glands for analog output, sensor input, contact input and communication cabling (see figure 3.5).
9. Close the display board and switch on the power. Commission the instrument as required or use the default settings.
10. Replace the cover and secure frontplate with the four screws.
    Tighten four frontplate screws to 1.5 N·m torque.

CAUTION

For wiring, use cables with a heat resistance of at least 70°C.

CAUTION

Tighten the cable glands to 1.5 N•m torque. Torque less than 1.5 N•m cannot maintain the IP65 protection level.



Suitable for cables with an outside diameter between 6 - 12 mm (0.24 - 0.47 in.)

Figure 3.5 Glands to be used for cabling

3.3 Wiring the power supply

3.3.1 General precautions

Make sure the power supply is switched off. Also, make sure that the power supply is correct for the specifications of the DC402G and that the voltage specified on the nameplate on the left side of the DC402G is satisfied.

Local health and safety regulations may require an external circuit breaker to be installed. The instrument is protected internally by a fuse. The fuse rating is dependent on the supply to the instrument. The 250 VAC fuses should be of the “time-lag” type, conforming to IEC60127.

The internal fuse is located next to the power terminals (in the lower right hand corner).

WARNING

Use only a fuse of the specified current, voltage and type ratings to prevent fire. For fuse replacement, refer to Section 7.3, “Fuse Replacement.”

3.3.2 Access to terminal and cable entry

Terminals 1 and 2 on the bottom terminal strip are used for the power supply. Guide the power cables through the gland closest to the power supply terminals. Use 2.5 mm^2 (14 AWG) wires to connect to the terminals.

We recommend that the cables be terminated with pin terminals (see figure 3.6).

Connect the wires as indicated in the wiring diagram (refer to figure 3.7).

CAUTION

Use cables whose outer diameter is 6 to 12 mm.

For power cables, use cables that comply with UL2556VW-1 or equivalent. Tighten the cables to 0.5 N•m torque.

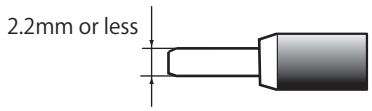


Figure 3.6 Pin terminal

Table 3.1 Connection method

	Power supply, contact output	Others
Power supply connection method	Pin form crimp terminal with the insulation sleeve	
Conformity shape	2.5 mm2 (14 AWG)	0.13 to 2.5 mm2 (26 to 14 AWG)
Clamping torque	0.5 N•m	
Crimp terminal example (Type)	Product made in wide Muller: H2.5/7, H2.5/10, H2.5/12, H2.5/18, H2.5/14D, H2.5/18D, H2.5/24D	Product made in wide Muller: (include the left model) H0.25/5, H0.5/6, H0.5/10, H0.75/6, H0.75/10, H1/6, H1/10, H1.5/7, H1.5/10, H1.5/12, H1.5/18, H0.14/10, H0.14/12, H0.25/10, H0.25/12, H0.34/10, H0.34/12, H0.5/10, H0.5/12, H0.5/14, H0.5/16, H0.75/12, H0.75/14, H0.75/16, H0.75/18H1/12, H1/14, H1/16, H1/18, H1.5/14, H1.5/16, H1.5/24

WARNING

When connecting an external device, install and wire it so that requirements of the standard to which the device complies are met.

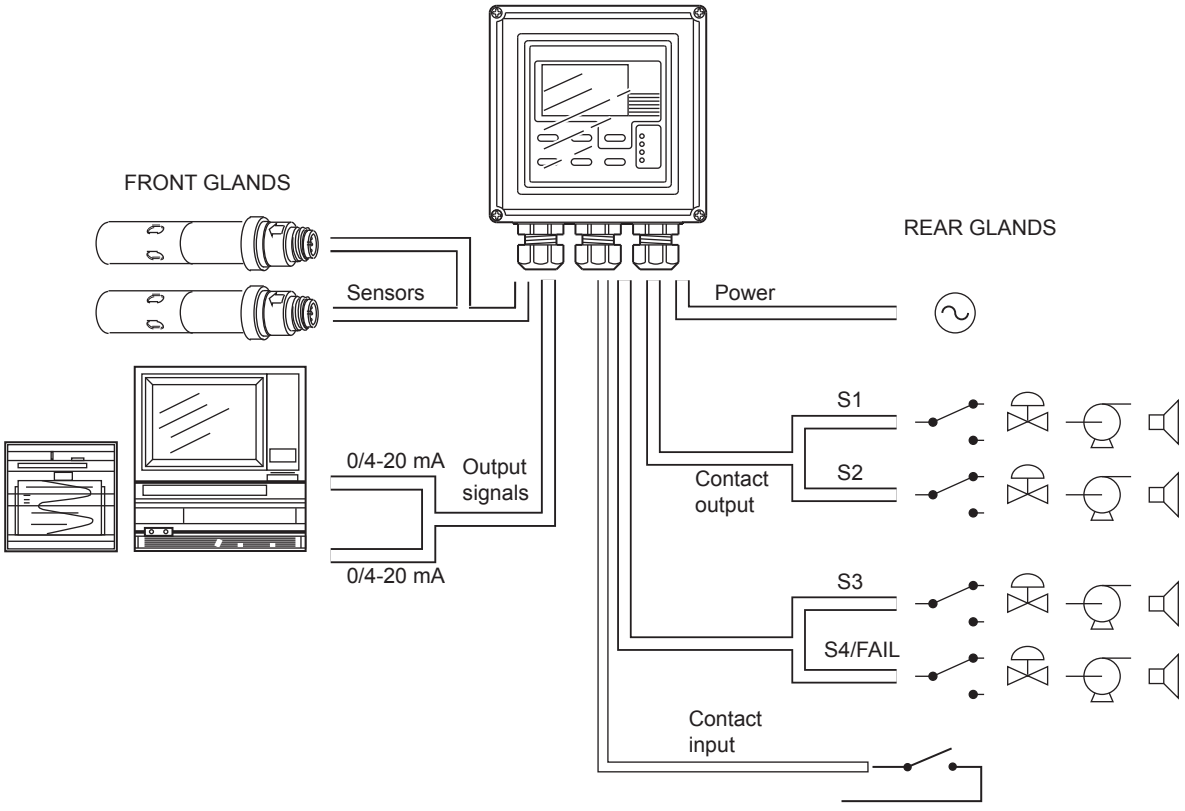


Figure 3.7 System configuration

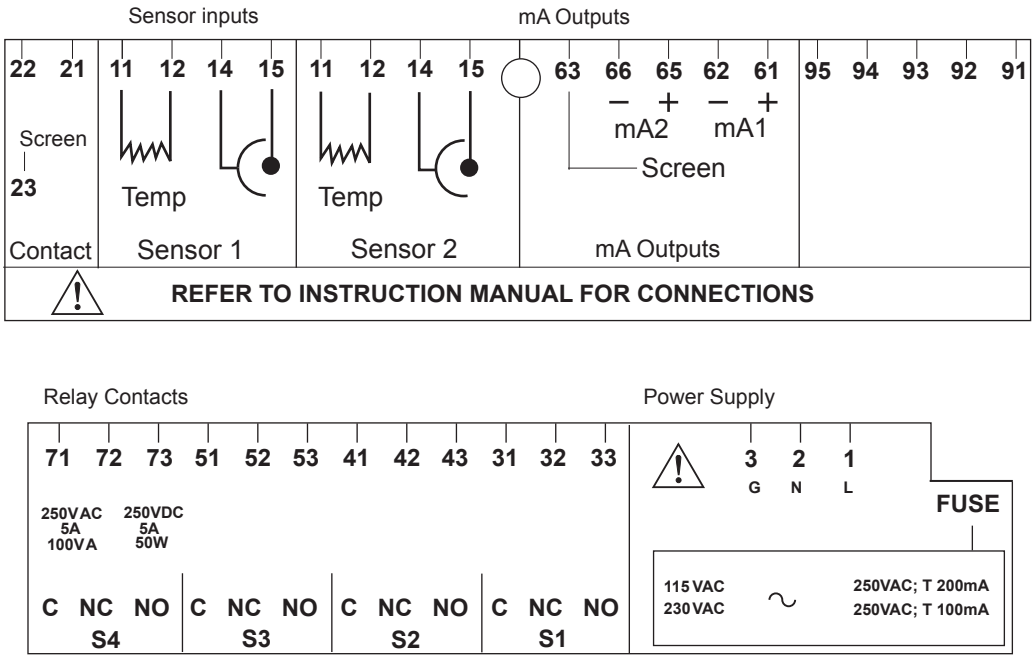


Figure 3.8 Input and output connections

3.3.3 AC power

Connect terminal 1 to the phase line of the AC power and terminal 2 to the zero line. The size of conductors should be at least 1.25 mm^2. The overall cable diameter should be between 6 & 12 mm (0.24 & 0.47 in).

CAUTION

Should be used the cable beyond 300 V AC.

3.3.4 Grounding the housing

WARNING

Protective grounding must be made to prevent electric shock.

To protect the instrument against interference, the housing should be connected to ground by a large area conductor. This cable can be fixed to the rear of the housing using a braided wire cable. See figure 3.9. This is separated from input ground by a galvanic isolation.

The internal grounding terminal is not the protective grounding terminal.

CAUTION

Please be sure to connect protective grounding of DC402G with cable of 1.25 mm^2 or larger cross section in order to avoid the electrical shock to the operators and maintenance engineers and prevent the influence of external noise. In addition, use cables whose colors are green and yellow stripes.

And further connect the grounding wire to the ⏚ mark (100 Ω or less).

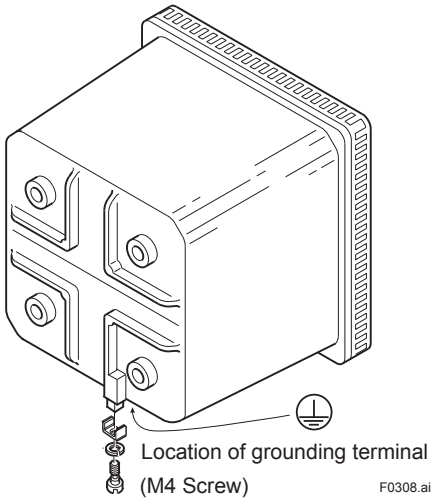


Figure 3.9 Grounding the housing

3.3.5 Switching on the instrument

After all connections are made and checked, the power can be switched on from the power supply.

Make sure the LCD display comes on. All segments will illuminate, then the instrument will momentarily display its unique serial number. After a brief interval, the display will change to the measured value. If errors are displayed or a valid measured value is not shown, consult the troubleshooting section (Chapter 8) before calling Yokogawa.

3.4 Wiring the contact signals

WARNING

There are high-voltage sections on the DC402G. Be sure to turn off the power before wiring.

3.4.1 General precautions

The contact output signals consist of voltage-free relay contacts for switching electrical appliances (SPDT). They can also be used as digital outputs to signal processing equipment (such as a controller or PLC). It is possible to use multi-core cables for the contact in and output signals and shielded multi-core cable for the analog signals.

We recommend that the cables be terminated with pin terminals (see figure 3.6).

3.4.2 Contact outputs

The DC402G unit's four contact outputs can be wired to suit your own custom requirements (Figure 3.7).

In the Non-Alarm or Power Off states, contacts S1, S2 and S3 are OFF, Common (C) and Normally Closed (NC) are in contact.

In the "Fail" or Power Off states, contact S4 is ON, Common (C) and Normally Closed (NC) are in contact.

You can either use them to switch AC power, or switch a DC Voltage for digital interfacing.

Default settings

- The contact S1 is pre-programmed for high alarm function.
- The contact S2 is pre-programmed for a low alarm function.
- The contact S3 is pre-programmed for wash function.
- The contact S4 is pre-programmed for FAIL.

The three control contacts (S1 to S3) can be used for simple process control by programming their function (Chapter 5). The FAIL contact is programmed to signal a fault in the measuring loop. Always connect the FAIL contact to an alarm device such as a warning light, sound annunciator, or alarm panel to make full use of the fault detection possibilities (self diagnostics) of the DC402G converter.

CAUTION

Should be used the cable beyond 300 V AC.

When using ON/OFF signals whose voltage is 33 VAC or 70 VDC or higher, use 2.5 mm^2 (AWG14) wires. If using voltages lower these voltages, select wires in the range of 0.13 to 2.5 mm^2 (AWG26 to AWG14) according to the current capacity of the connected load.

Use cables that comply with UL2556VW-1 or equivalent and whose outer diameter is 6 to 12 mm. Tighten the cables to 0.5 N•m torque.

3.4.3 Contact input

Voltage-free contact (do not apply voltage)

Wash start or input remote range change (either choice)

It is necessary to use screening/shielding on the output signal cables. Screw (M3) 23 is used to connect the shielding.

Select wires in the range of 0.13 to 2.5 mm^2 (AWG26 to AWG14) according to the current capacity of the connected load.

Use cables that comply with UL2556VW-1 or equivalent and whose outer diameter is 6 to 12 mm. Tighten the cables to 0.5 N•m torque.

3.5 Wiring the analog output signals

3.5.1 General precautions

The analog output signals of the DC402G transmit low power standard industry signals to peripherals like control systems or strip-chart recorders (Figure 3.7).

Do not apply voltage.

CAUTION

Should be used the cable beyond 30 V AC.

Select wires in the range of 0.13 to 2.5 mm^2 (AWG26 to AWG14) according to the current capacity of the connected load.

Use cables that comply with UL2556VW-1 or equivalent and whose outer diameter is 6 to 12 mm. Tighten the cables to 0.5 N•m torque.

We recommend that the cables be terminated with pin terminals (see figure 3.6).

3.5.2 Analog output signals

The output signals consist of active current signals of either 0-20 mA or 4-20 mA. The maximum load can be 600 ohms on each.

It should be necessary to use screening/shielding on the output signal cables. Terminal 63 is used to connect the shielding.

3.6 Sensor wiring

Refer to figure 3.9, which includes drawings that outline sensor wiring.

The DC402G can be used with a wide range of commercially available sensor types if provided with shielded cables, both from Yokogawa and other manufacturers. The sensor systems from Yokogawa fall into two categories, the ones that use fixed cables and the ones with separate cables.

To connect sensors with fixed cables, simply match the terminal numbers in the instrument with the identification numbers on the cable ends.

Note that the DC402G uses the 2 electrode measuring principle. Yokogawa sensors and cables are prepared for compatibility with 4-electrode measuring systems. To avoid problems either cut off and insulate the wires tagged 13 &16 or connect the wires in tandem 13 &14 into terminal 14 or 15 &16 into terminal 15.

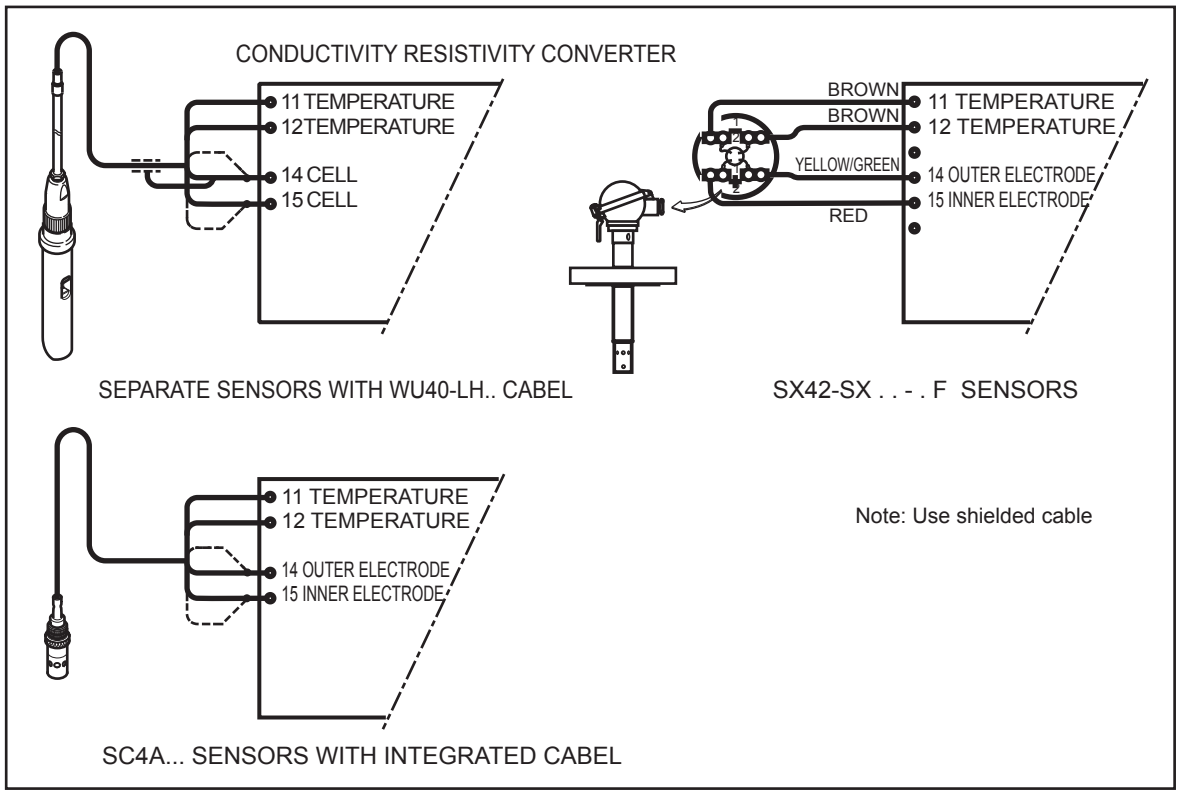


Figure 3.10 Sensor wiring diagrams

3.7 Sensor connection using junction box and extension cable

Where a convenient installation is not possible using the standard cables between sensors and converter, a junction box and extension cable may be used. The Yokogawa BA10 junction box and the WF10 extension cable should be used. These items are manufactured to a very high standard and are necessary to ensure that the specifications of the system can be met. The total cable length should not exceed 60 metres (e.g. 10 m fixed cable and 50 m extension cable).

NOTE

Numbers 17 of both WF10 and BA10 do not need to be used.

3.8 Other sensor systems

To connect other sensor systems, follow the general pattern of the terminal connections as listed below:

11 and 12	Always used for temperature compensation resistor input (Pt1000, Ni100, Pt100, PB36 and 8k55)
14	Normally used for the outer electrode
15	Used for inner electrode

In case a 4-electrode measuring system will be used, 14 and 16 should be used for the current electrodes. Please ensure that shielded cabling will be used.

In figure 3.10 this is shown in a schematic way.

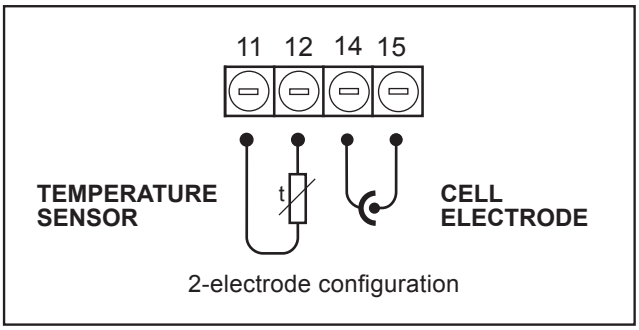


Figure 3.11 Connection diagram for other sensors

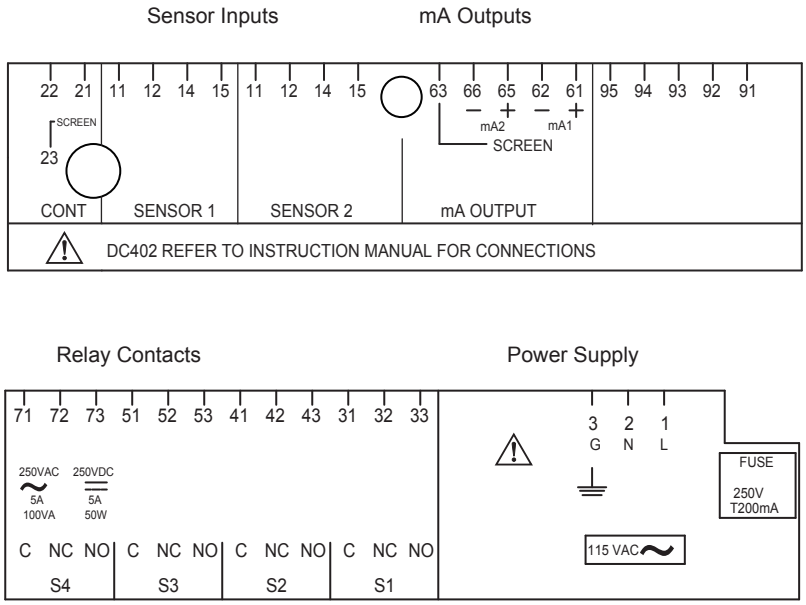


Figure 3.12 Terminal identification labels example

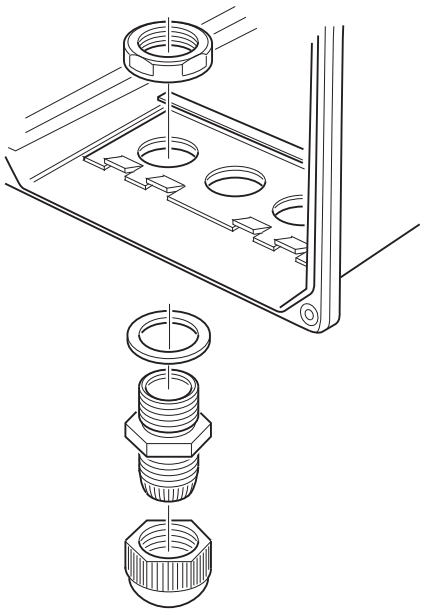


Figure 3.13 Sensor cable connections

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4. Operation; Display Functions And Setting

4.1 Operator interface

This section provides an overview of the operation of the DC402G operator interface. The basic procedures for obtaining access to the three levels of operation are described briefly. For a step-by-step guide to data entry, refer to the relevant section of this instruction manual. Figure 4.1 shows the DC402G operator interface.

- **LEVEL 1: Maintenance**

  These functions are accessible by pushbutton through a flexible front cover window. The functions make up the normal day-to-day operations that an operator may be required to complete. Adjustment of the display and routine calibration are among the features accessible in this way. (See table 4.1).

- **LEVEL 2: Commissioning**

  A second menu is exposed when the DC402G front cover is removed and the display board is revealed. Users gain access to this menu by pressing the button marked * in the lower right of the display board. This menu is used to set such values as the output ranges and hold and wash features. It also gives access to the service menu. (See table 4.1).

- **LEVEL 3: Service**

  For more advanced configuration selections, press the button marked * , then press “NO” repeatedly until you reach SERVICE. Now push the “YES” button. Selecting and entering “Service Code” numbers in the commissioning menu provide access to the more advanced functions. An explanation of the Service Codes is listed in chapter 5 and an overview table is shown in chapter 10.

Table 4.1 Operations overview

	Routine	Function	Chapter
Maintenance	SETPOINTS CALIB 1(2) DISPLAY 1(2) HOLD	Adjust alarm setpoints (when activated) Calibration with a standard solution or a sample Read auxiliary data or set message display Switch hold on/off (when activated)	5 6 4 5
Commissioning	SETPOINTS RANGE SET HOLD TEMP	Adjust alarm setpoints Adjust the output range Activate the hold function Select method of temperature compensation	5 5 5 5
Service (Access to coded entries from the commissioning level)	SERVICE	Fine tune the specialized functions of the converter	5

NOTE: All three levels may be separately protected by a password. See Service Code 52 in chapter 5 Service Code table for details on setting passwords.

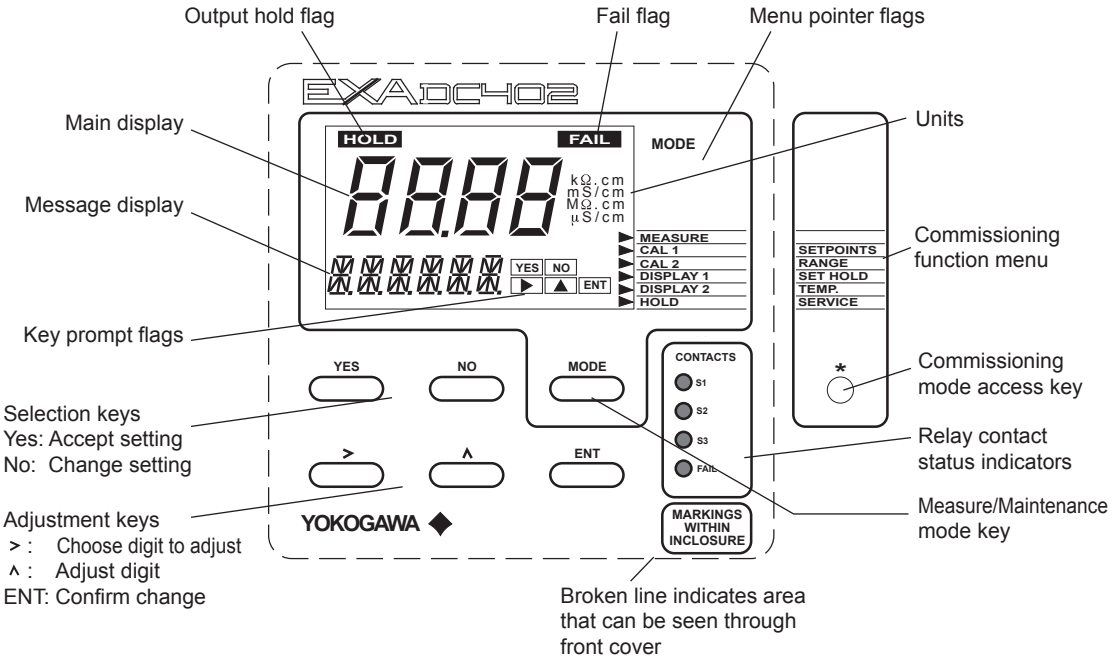


Figure 4.1 DC402G operator interface

4.2 Explanation of operating keys

MODE key — This key toggles between the Measuring and Maintenance modes. Press once to obtain access to the maintenance function menu.

SETPOINTS
CAL.1/CAL.2
DISP.1/DISP.2
HOLD

Press again to return to the Measuring mode (press twice when hold is activated).

YES/NO keys — These are used to select choices from the menu.

YES is used to accept a menu selection.
NO is used to reject a selection, or to move ahead to the next option.

DATA ENTRY keys (> ^ ENT)

> is used as a “cursor” key. Each press on this key moves the cursor or flashing digit one place to the right. This is used to select the digit to be changed when entering numerical data.

^ is used to change the value of a selected digit. Each press on this key increases the value by one unit. The value can not be decreased, so in order to obtain a lower value, increase past nine to zero, then increase to the required number.

ENT When the required value has been set using the > and ^ keys, press ENT to confirm the data entry. Please note that the DC402G does not register any change of data until the ENT key is pressed.

* key — This is the Commissioning mode key. It is used to obtain access to the Commissioning menu. This can only be done with the cover removed or opened. Once this button has been used to initiate the Commissioning menu, follow the prompts and use the other keys as described above.

4.3 Setting passcodes

In Service Code 52, DC402G users can set passcode protection for each one of the three operating levels, or for any one or two of the three levels. This procedure should be completed after the initial commissioning (setup) of the instrument. The passcodes should then be recorded safely for future reference.

When passcodes have been set, the following additional steps are introduced to the configuration and programming operations:

- **Maintenance**

  Press MODE key. The display shows 000 and *PASS*

  Enter a 3-digit passcode as set in Service Code 52 to obtain access to the Maintenance Mode

- **Commissioning**

  Press * key. The display shows 000 and *PASS*

  Enter a 3-digit passcode as set in Service Code 52 to obtain access to the Commissioning Mode.

- **Service**

  From the commissioning menu, select *Service by pressing YES key. The display shows 000 and *PASS*

  Enter a 3-digit passcode as set in Service Code 52 to obtain access to the Service Mode.

NOTE

See Service Code 52 for the setting of passcodes.

4.4 Display example

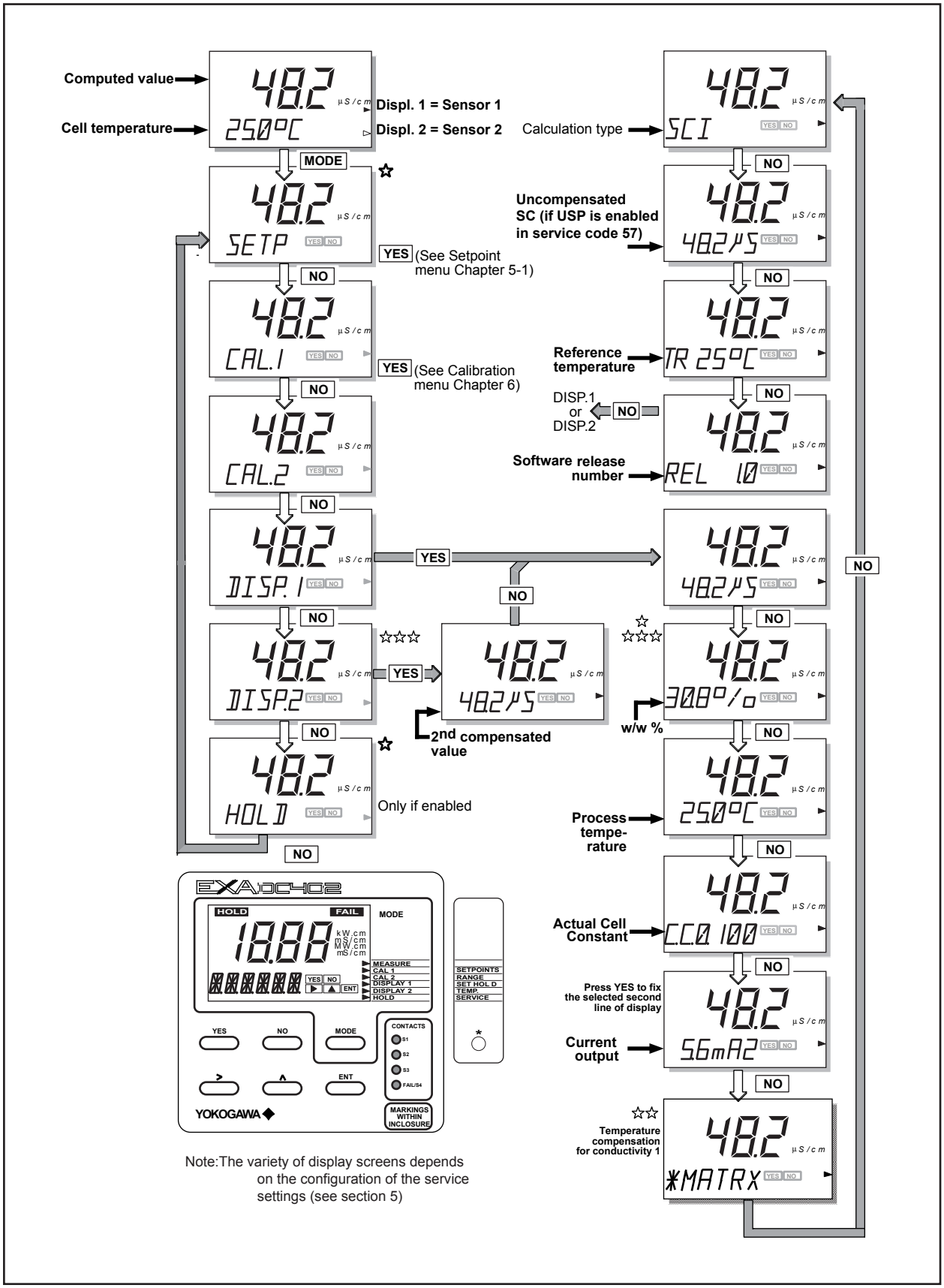
The next page shows the sequence of button presses and screens displayed when working in default configuration.

More or less options will be made available by the configuration of some service codes, or by choices made in the Commissioning menu.

The following deviations are possible:

- ☆ Items marked are omitted when switched off in commissioning mode and/or service code 51.
- ☆☆ Temperature compensation will be displayed dependent on chosen compensation method: NaCl, TC 2.1 or matrix.
- ☆☆☆ DISP.2 only appears if mA2 is configured for a 2nd (different) temperature compensation or if % by weight.2 is enabled in code 55.
- ☆ ☆☆☆ W/W % only appears if switched on in service code 55.

4.5 Display functions



Note:The variety of display screens depends on the configuration of the service settings (see section 5)

5. Parameter setting

5.1 Maintenance mode

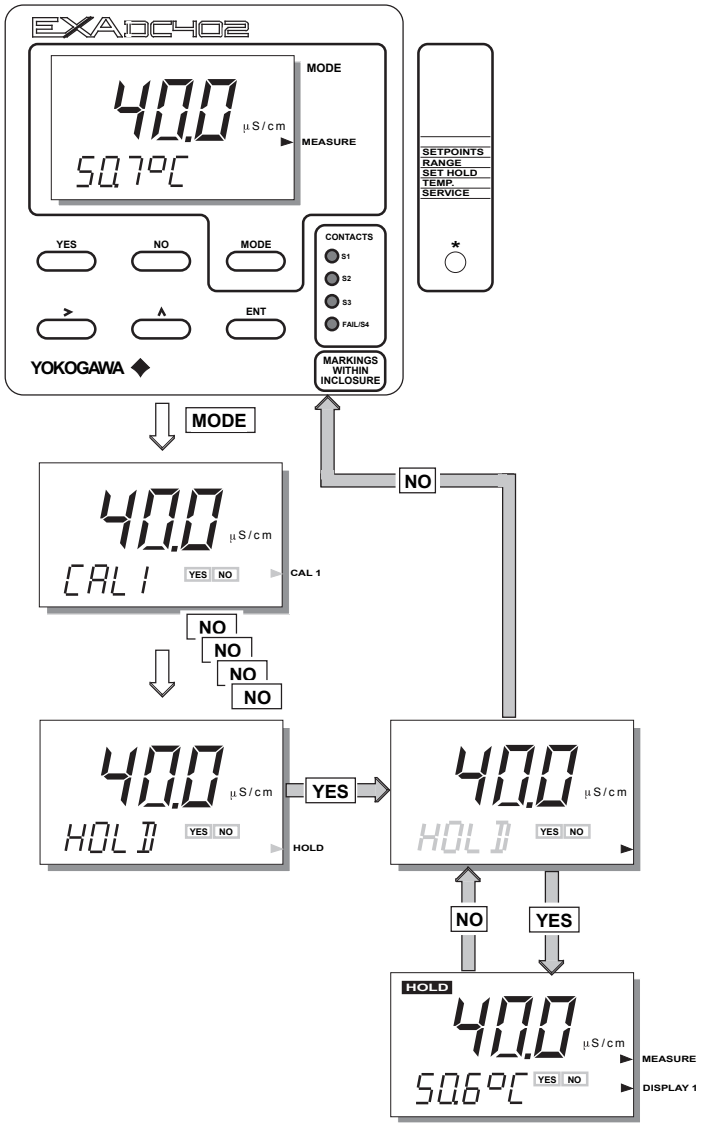
Standard operation of the DC402G instrument involves use of the Maintenance (or operating) mode to set up some of the parameters.

Access to the Maintenance mode is available via the six keys that can be pressed through the flexible window in the instrument front cover. Press the “MODE” key once to enter this dialog mode.

(Note that at this stage the user will be prompted for a pass code where this has been previously set up in service code 52, section 5.)

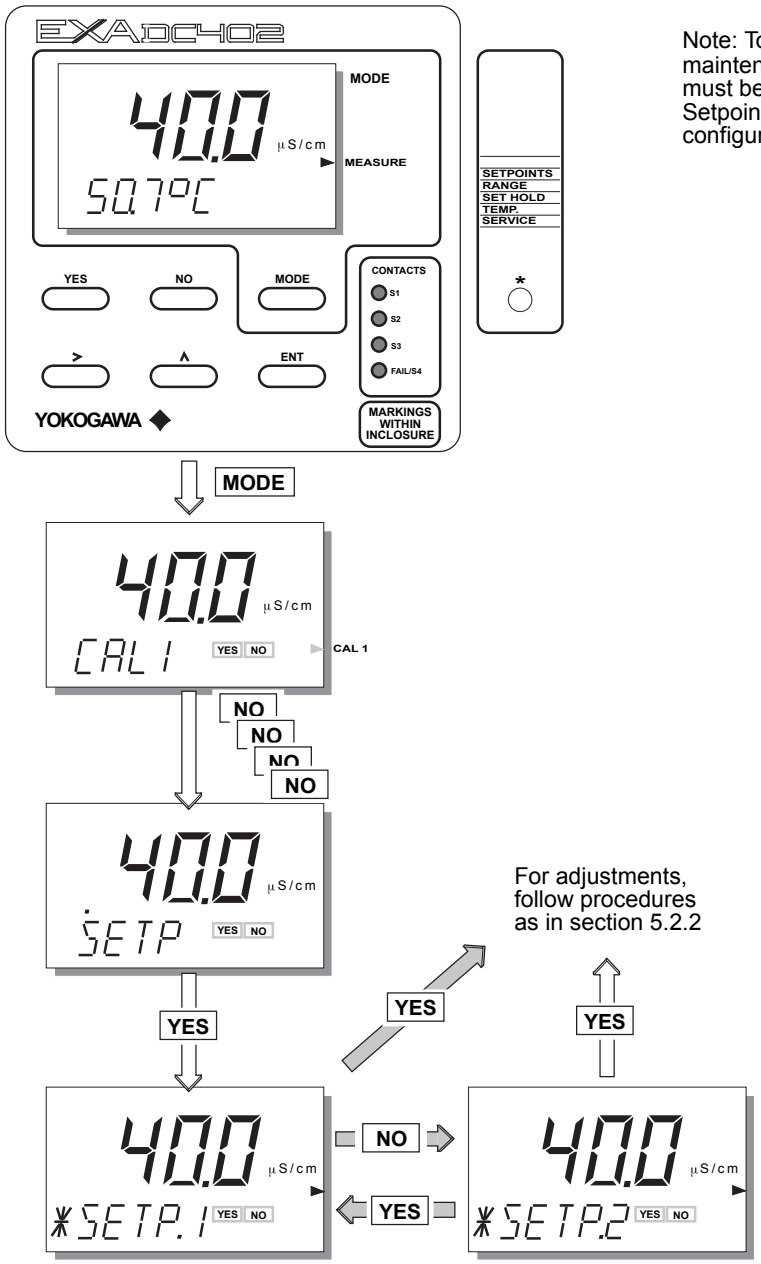
Setpoint	Select and adjust setpoint (when enabled in service menu section 5.3, service code 51). See adjustment procedure 5.2.2.
Calibrate	See “calibration” section 6.
Display setting	See “operation” section 4.
Hold	Manually switch on/off “hold” (when enabled in commissioning menu). See adjustment procedure 5.2.4.

5.1.1 Manual activation of Hold



Note: The HOLD feature must first be activated in the commissioning mode section 5.2.4

5.1.2 Setpoint adjustment



Note: To enable adjustments of setpoints in maintenance mode, Service Code 51 must be set to "ON".
Setpoints available will depend on their configuration in the Service Code.

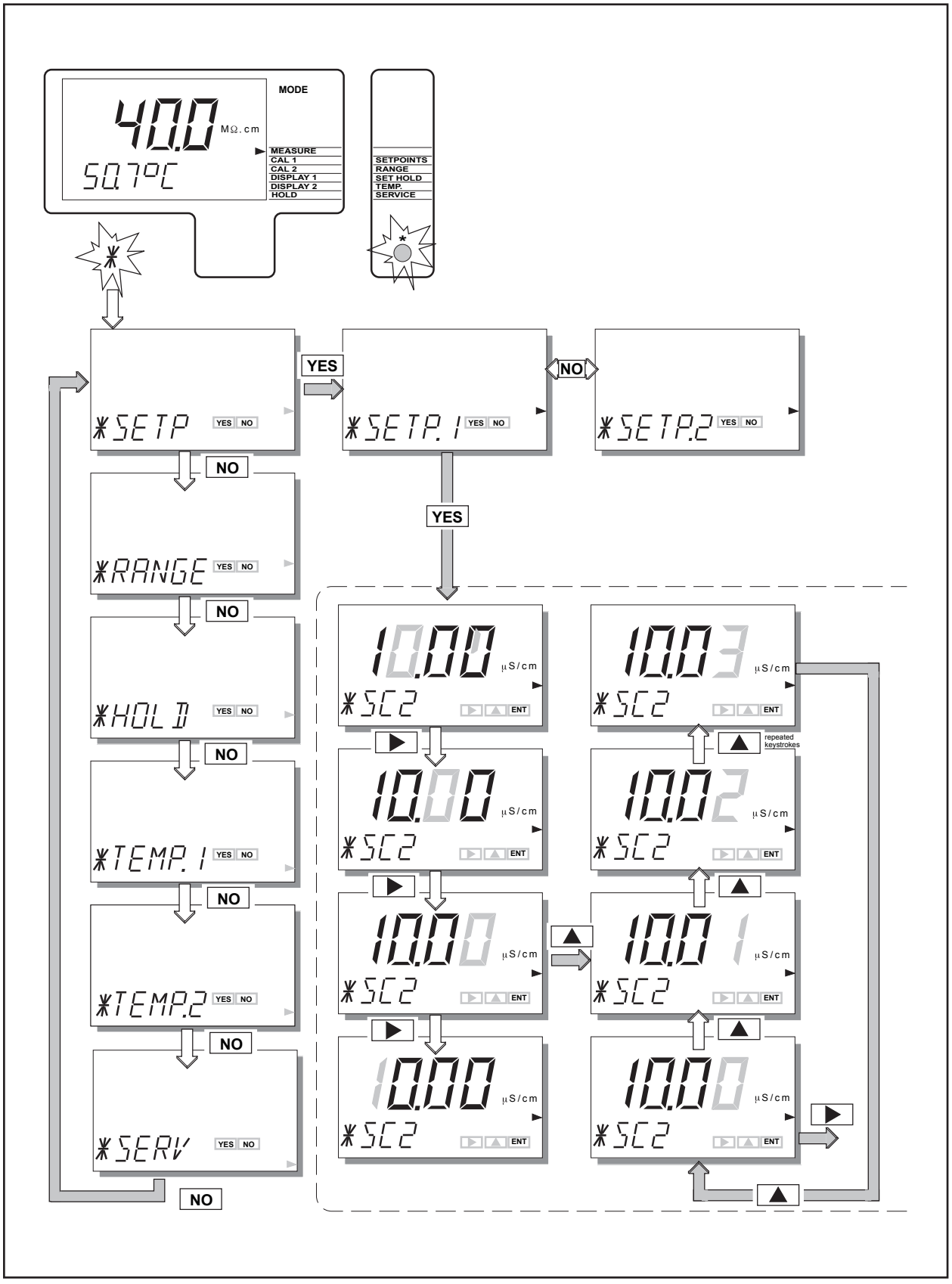
5.2 Commissioning mode

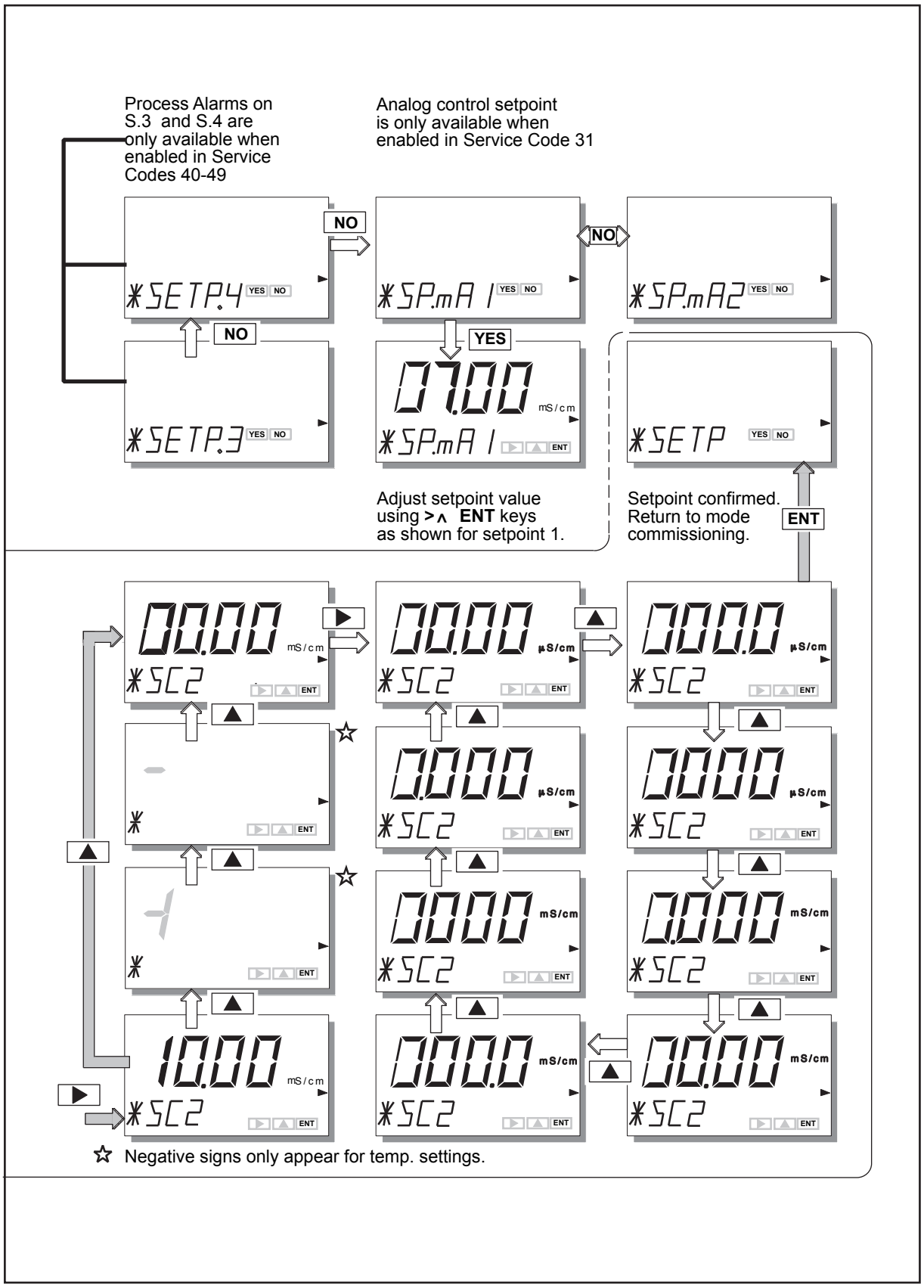
In order to obtain peak performance from the DC402G, you must set it up for each custom application.

Setpoints	Alarms are set by default	S1 - high process alarm S2 - low process alarm S3 - not activated S4 - Fail
	The setpoints are at arbitrary default value. Therefore, you must set these to meaningful values, or set them to off. (See service codes 40 to 49 and user interface codes 50 to 59.)	
Output ranges	mA output 1 is set as default to 0-100 µS/cm or 0-19.99 MΩ•cm.	
	For enhanced resolution in more stable measuring processes, it may be desirable to select 5-10 µS/cm range, for example, and maybe 0-25 °C temperature range.	
	Service codes 30 to 39 can be used to choose other output parameters on mA output 2.	
	Choose from Table, temperature or PI control.	
Hold	The DC402G converter has the ability to “HOLD” the output during maintenance periods. This parameter should be set up to hold the last measured value, or a fixed value to suit the process.	
Service	This selection provides access to the service menu.	

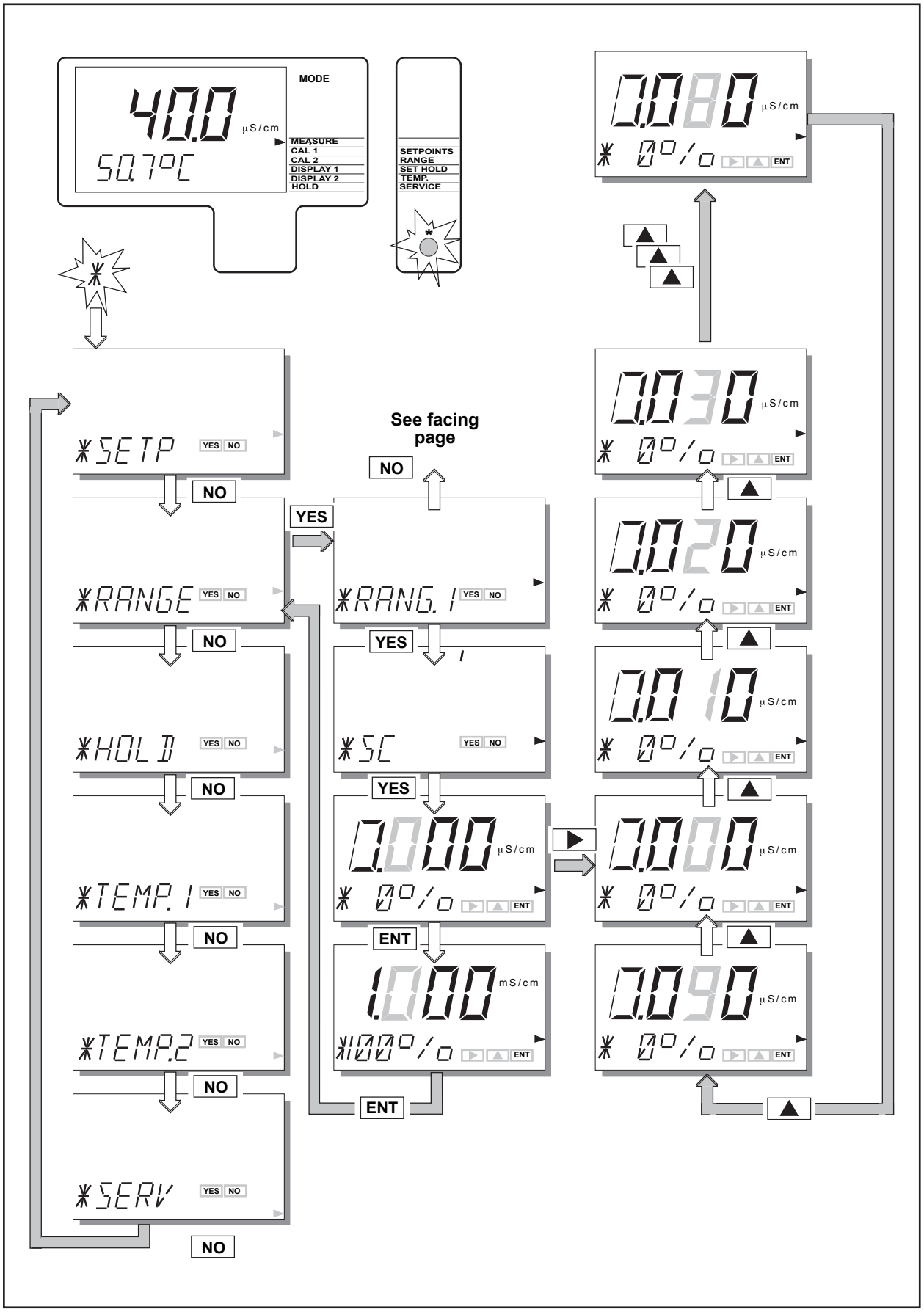
What follows are pictorial descriptions of typical frontplate pushbutton sequences for each parameter setting function. By following the simple YES/NO prompts and arrow keys, users can navigate through the process of setting range, setpoints, hold and service functions.

5.2.1 Setpoints




Process Alarms on S.3 and S.4 are only available when enabled in Service Codes 40-49
Analog control setpoint is only available when enabled in Service Code 31
SETP.4
SETP.3
SP.mA 1
SP.mA2
SETP
NO
YES
ENT
07.00 mS/cm
Adjust setpoint value using > ∧ ENT keys as shown for setpoint 1.
Setpoint confirmed. Return to mode commissioning.
SC2
00.00 mS/cm
0.000 µS/cm
0000 µS/cm
0.000 mS/cm
0000 mS/cm
000.0 mS/cm
00.00 mS/cm
10.00 mS/cm
☆ Negative signs only appear for temp. settings.

5.2.2 Range

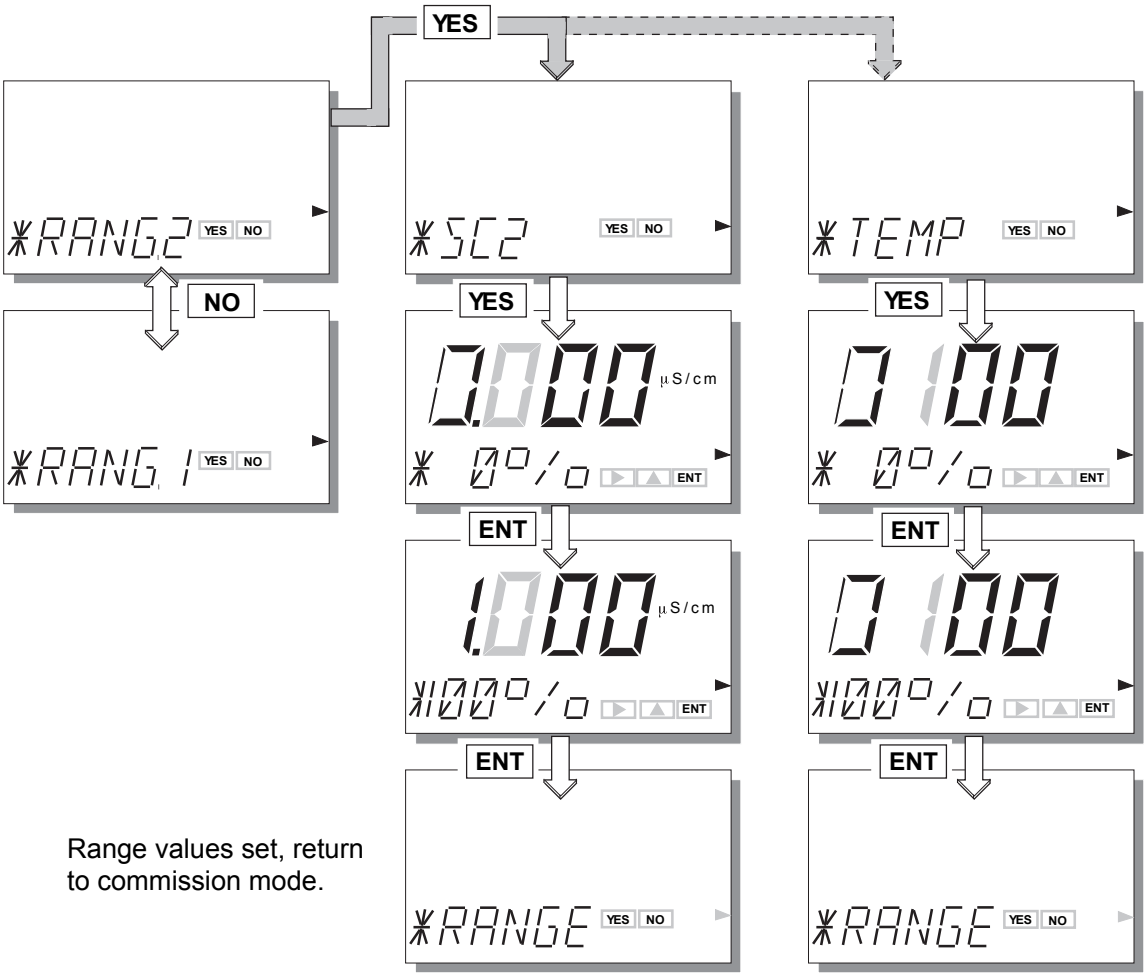

MODE
40.0 µS/cm
50.7°C
MEASURE
CAL 1
CAL 2
DISPLAY 1
DISPLAY 2
HOLD
SETPOINTS
RANGE
SET HOLD
TEMP.
SERVICE
SETP
RANGE
HOLD
TEMP.1
TEMP.2
SERV
RANG.1
SC
YES
NO
ENT
See facing page
0.080 µS/cm
0.030 µS/cm
0.020 µS/cm
0.010 µS/cm
0.000 µS/cm
0.090 µS/cm
0.000 µS/cm
1.000 mS/cm
100%

Choose Range to adjust, then set begin scale (0%) and end scale (100%) of the mA output signal, using the **>, ^** and **ENT** keys. Selection of mA output(0-20 / 4-20 mA) is in Service Code 30.

The decimal point and unit setting can be changedas described before in Setpoint Settings.

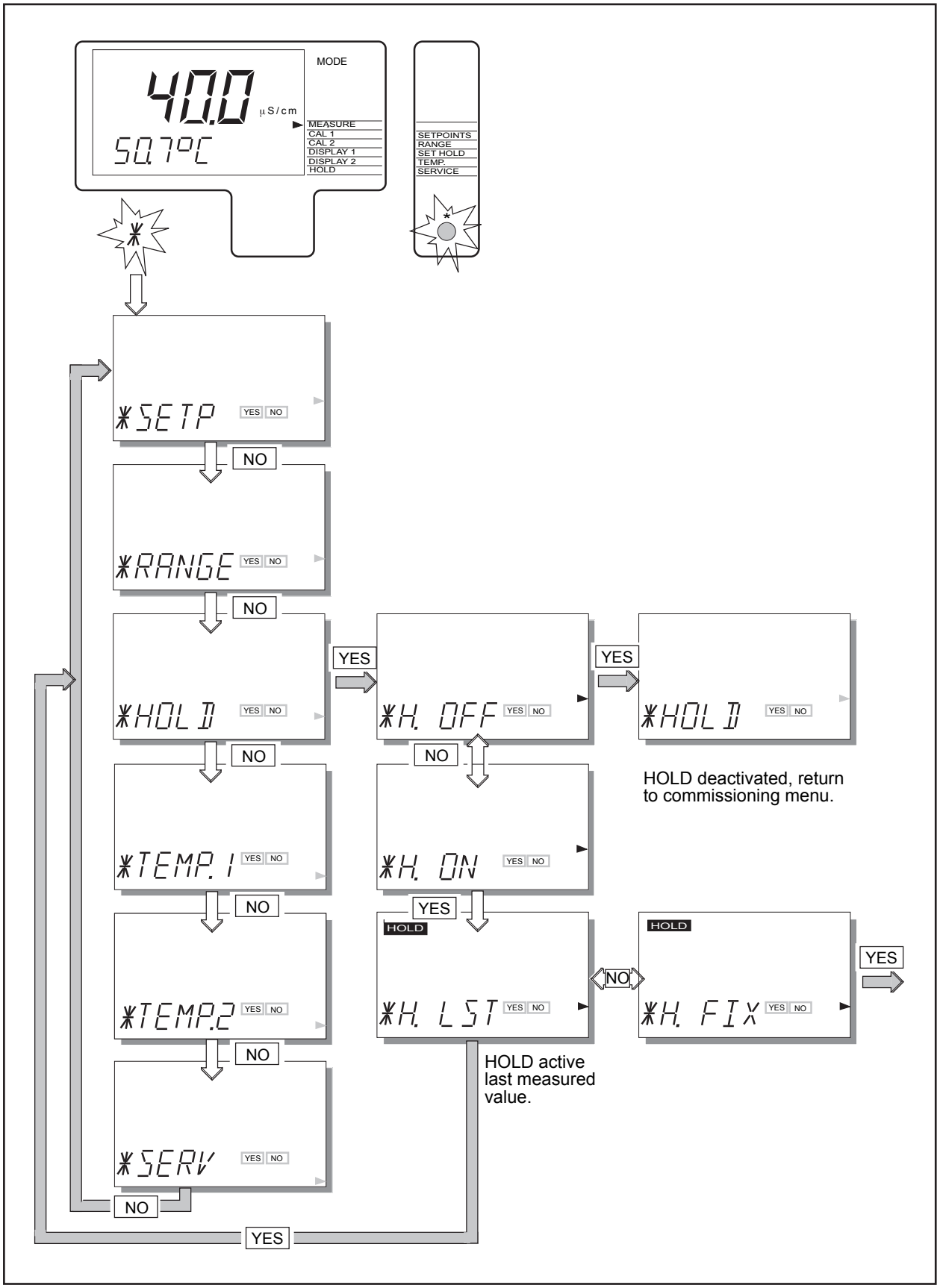
Note: Range 2 does not appear when PI control set on mA2

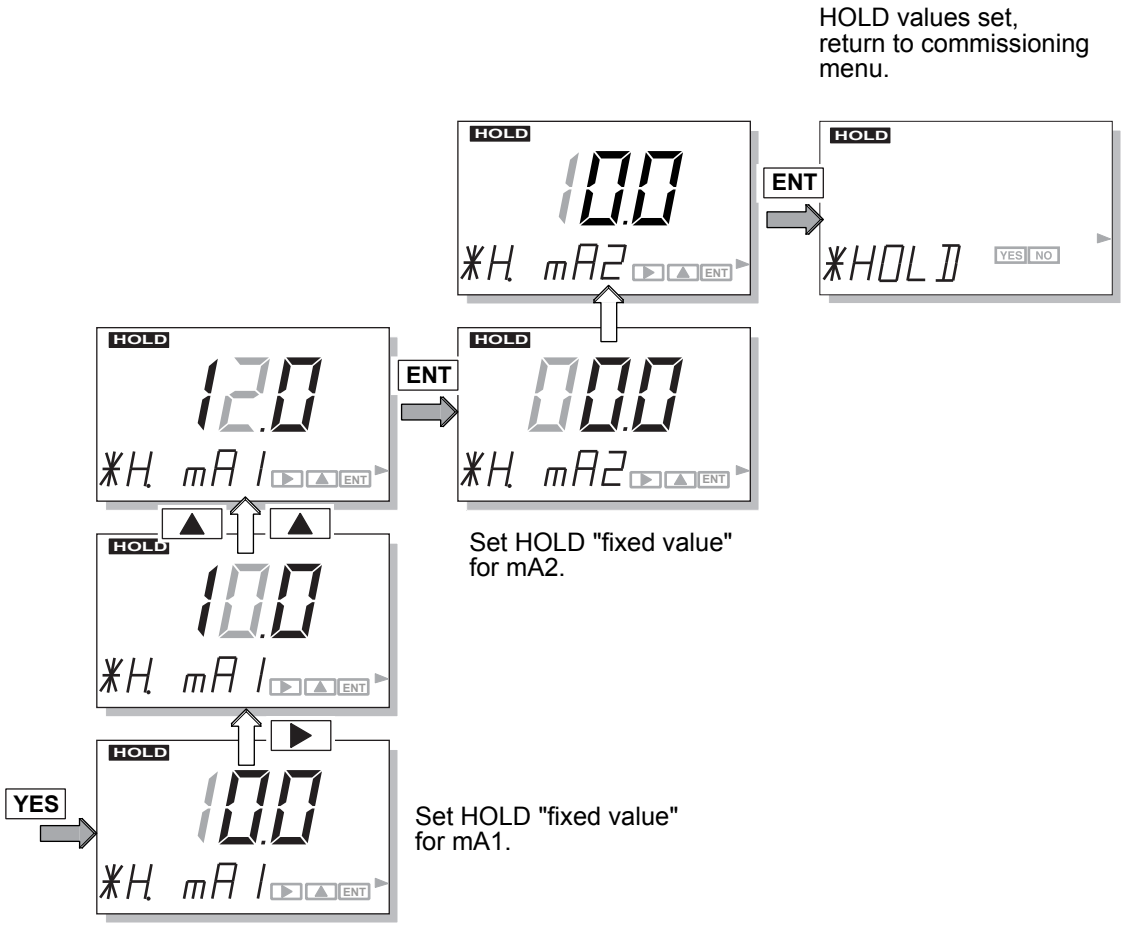
Range Selection
Options are determined by
Service Code 31



Range values set, return to commission mode.

5.2.3 Hold


MODE
40.0 µS/cm
50.7°C
MEASURE
CAL 1
CAL 2
DISPLAY 1
DISPLAY 2
HOLD
SETPOINTS
RANGE
SET HOLD
TEMP.
SERVICE
SETP
RANGE
HOLD
TEMP.1
TEMP.2
SERV
H. OFF
H. ON
H. LST
H. FIX
YES
NO
HOLD
HOLD deactivated, return to commissioning menu.
HOLD active last measured value.


HOLD values set,
return to commissioning
menu.
HOLD
100
*H. mA2
ENT
HOLD
*HOLD
YES NO
ENT
HOLD
120
*H. mA1
HOLD
000
*H. mA2
Set HOLD "fixed value"
for mA2.
HOLD
100
*H. mA1
HOLD
100
*H. mA1
YES
Set HOLD "fixed value"
for mA1.

5.2.4 Temperature compensation

1. Why temperature compensation?

The conductivity of a solution is very dependent on temperature. Typically for every 1 °C change in temperature the solution conductivity will change by approximately 2 %.

The effect of temperature varies from one solution to another and is determined by several factors like solution composition, concentration and temperature range.

A coefficient (a) is introduced to express the amount of temperature influence in % change in conductivity/°C.

In almost all applications this temperature influence must be compensated before the conductivity reading can be interpreted as an accurate measure of concentration or purity.

Table 5.1 NaCl-compensation according to IEC 60746-3 with Tref = 25 °C

T	Kt	a	T	Kt	a	T	Kt	a
0	0.54	1.8	60	1.76	2.2	130	3.34	2.2
10	0.72	1.9	70	1.99	2.2	140	3.56	2.2
20	0.90	2.0	80	2.22	2.2	150	3.79	2.2
25	1.0	---	90	2.45	2.2	160	4.03	2.2
30	1.10	2.0	100	2.68	2.2	170	4.23	2.2
40	1.31	2.0	110	2.90	2.2	180	4.42	2.2
50	1.53	2.1	120	3.12	2.2	190	4.61	2.2
						200	4.78	2.2

2. Standard temperature compensation

From the factory the DC402G is calibrated with a general temperature compensation function based on a sodium chloride salt solution. This is suitable for many applications and is compatible with the compensation functions of typical laboratory or portable instruments.

A temperature compensation factor is derived from the following equation:

$$a = \frac{K_t - K_{ref}}{T - T_{ref}} \times \frac{100}{K_{ref}}$$

In which:

a = Temperature compensation factor (in %/ °C)

T = Measured temperature (°C)

K_t = Conductivity at T

T_{ref} = Reference temperature (°C)

K_{ref} = Conductivity at T_{ref}

3. Manual temperature compensation

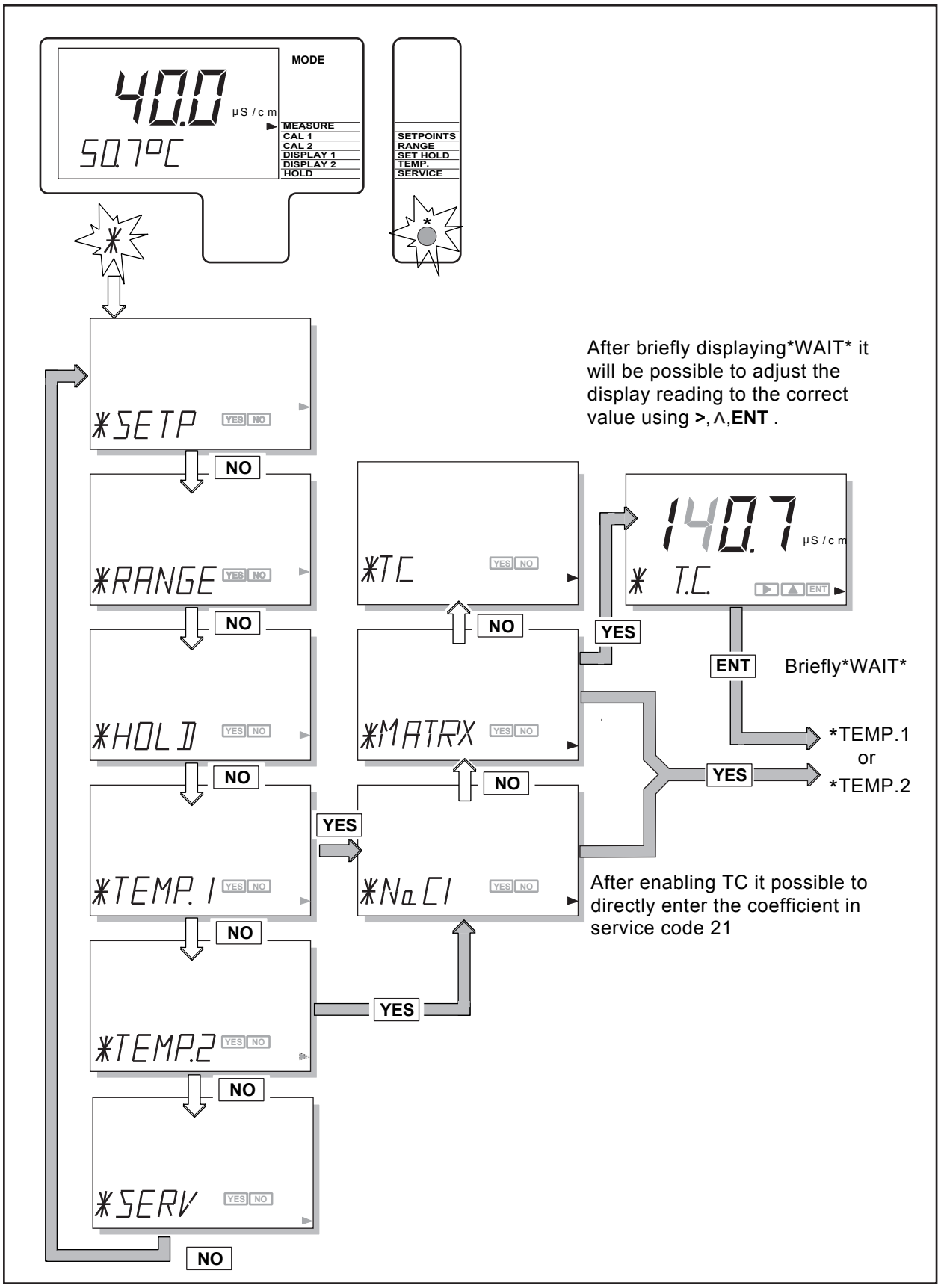
If the standard compensation function is found to be inaccurate for the sample to be measured, the converter can be set manually for a linear factor on site to match the application.

The procedure is as follows:

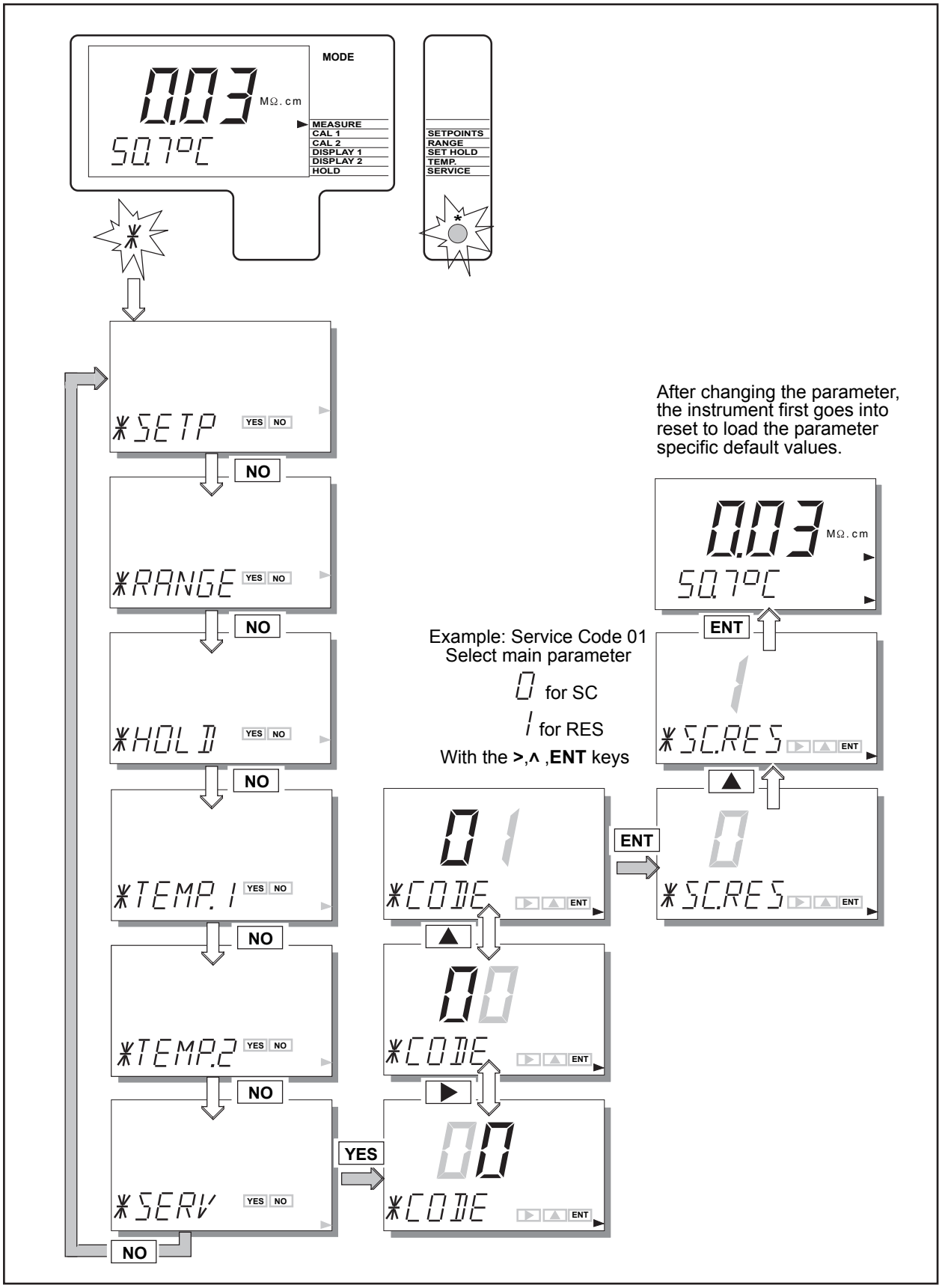
1. Take a representative sample of the process liquid to be measured.
2. Heat or cool this sample to the reference temperature of the converter (usually 25 °C).
3. Measure the conductivity of the sample with the DC402G and note the value.
4. Bring the sample to the typical process temperature (to be measured with the DC402G).
5. Adjust the display indication to the noted value at the reference temperature
6. Check that the temperature compensation factor has been changed
7. Insert the conductivity cell into the process again.

4. Other possibilities (section 5.3.3)

1. Enter calculated coefficient.
2. Enter matrix temperature compensation.


40.0
µS/cm
50.7°C
MODE
MEASURE
CAL 1
CAL 2
DISPLAY 1
DISPLAY 2
HOLD
SETPOINTS
RANGE
SET HOLD
TEMP.
SERVICE
*SETP
*RANGE
*HOLD
*TEMP.1
*TEMP.2
*SERV
*TC
*MATRX
*NaCl
140.7
µS/cm
* T.C.
ENT
Briefly*WAIT*
*TEMP.1
or
*TEMP.2
YES
NO
After briefly displaying*WAIT* it will be possible to adjust the display reading to the correct value using >, ∧,ENT .
After enabling TC it possible to directly enter the coefficient in service code 21

5.2.5 Service


MODE
0.03 MΩ.cm
50.7°C
MEASURE
CAL 1
CAL 2
DISPLAY 1
DISPLAY 2
HOLD
SETPOINTS
RANGE
SET HOLD
TEMP.
SERVICE
SETP
RANGE
HOLD
TEMP.1
TEMP.2
SERV
YES NO
NO
YES
ENT
CODE
SC.RES
After changing the parameter, the instrument first goes into reset to load the parameter specific default values.
Example: Service Code 01
Select main parameter
0 for SC
1 for RES
With the >,^ ,ENT keys

5.3 Notes for guidance in the use of service coded settings

Don't set or input service code numbers other than the code numbers defined in this manual. Setting an undefined service code may make the converter malfunction.

When an undefined service code is input by some accident, push the MODE key and escape from the service level.

5.3.1 Parameter specific functions

Code 1	*SC.RES	Choose the required parameter, either conductivity or resistivity. If the parameter is changed the instrument will go into reset to load parameter specific default values, followed by starting measurement. For all other service codes the instrument will return to commissioning mode after the service code setting is finished. Note: For resistivity a fixed display format is used.
Code 3	*CC1 *CC2	Enter the factory calibrated cell constant mentioned on the nameplate or on the fixed cable. This avoids the need for calibration. Any value between 0.005 and 50.0 /cm may be entered. First choose to set the constant for Cell 1or Cell 2 (*CC1 or *CC2). The cell constant is set as a combination of a number in the main display, and a factor in the second line. This gives the necessary resolution and decimal point placement. Example: To set 0.00987 cm^{-1} first set factor 0.01xC1 in second line then set number 0.987 in main display. *NOTE: If the actual cell constant is changed after a calibration or if the entered cell constant differs from previous value, then the message "RESET?" will appear on the second line display. After pressing "YES" the entered value becomes the new nominal and calibrated cell constant. After pressing "NO" the update procedure of the cell constant entry is cancelled.
Code 4	*AIR 1 *AIR 2	*AIR 1 and *AIR 2 select by the "NO" key To eliminate cable influences on the measurement, a "zero" calibration with a dry sensor may be done. If a connection box (BA10) and extension cable (WF10) will be used, "zero" calibration should be done including the connection equipment.
Code 5	*POL.CK	The DC402G has a polarisation check capable of monitoring the signal from the cell for distortion of capacitive or polarisation errors. If there is a problem with the installation or the cell becomes fouled, this will trigger E1. For some application this error detecting can cause unwanted signals during operation. Therefore this code offers the possibility to disable/ enable this check.

Code	Display	Function	Function detail	X	Y	Z	Default values	
Parameter Specific functions								
01	*SC.RES	Select main parameter	Conductivity	0			0	Cond.
			Resistivity	1				
02			Not used					
03	*CC1/ *CC2	Set cell constant	Press NO to step through choice of multiplying factors on the second display. 0.10xC 1.00xC 10.0xC 100.xC 0.01xC Press YES to select a factor Use >, ^, ENT keys to adjust MAIN digits				0.100 0.10xC 1.000	cm^{-1}
04	*AIR 1/ *AIR 2 *START *"WAIT" *END	Zero calibration	Zero calibration with dry cell connected Press YES to confirm selection Press YES to start, after briefly displaying "WAIT", *END will be displayed Press YES to complete					
05	*POL.CK	Polarization check	Polarization check off Polarization check on	0 1			 1	 On
06-09			Not used					

5.3.2 Temperature functions

Code 10 *T.SENS Selection of the temperature compensation sensor. The default selection is the Pt1000 Ohm sensor, which gives excellent precision with the two wire connections used. The other options give the flexibility to use a very wide range of other conductivity/resistivity sensors.
Note: The temperature sensor for both conductivity cells must be the same.

Code 11 *T.UNIT Celsius or Fahrenheit temperature scales can be selected to suit user preference.

Code 12 *T.ADJ 1 First select sensor 1 or sensor 2 for temperature adjustment (*T.ADJ 1 or *T. ADJ 2).
With the process temperature sensor at a stable known temperature, the temperature reading is adjusted in the main display to correspond.
The calibration is a zero adjustment to allow for the cable resistance, which will obviously vary with length.

*T.ADJ 2 The normal method is to immerse the sensor in a vessel with water in it, measure the temperature with an accurate thermometer, and adjust the reading for agreement.

Code	Display	Function	Function detail	X	Y	Z	Default values	
Temperature Measuring Functions								
10	*T.SENS	Temperature sensor	Pt1000 Ni100 PB36 Pt100 8k55	0 1 2 3 4			0	Pt1000
11	*T.UNIT	Display in °C or °F	°C °F	0 1			0	°C
12	*T.ADJ 1 *T.ADJ 2	Calibrate temperature	Adjust reading to allow for cable resistance. Use >, ^ , ENT keys to adjust value					None
13-19			Not used					

5.3.3 Temperature compensation functions

Code 20 *T.R.°C
Choose a temperature to which the measured conductivity (or resistivity) value must be compensated to. Normally 25°C is used, therefore this temperature is chosen as default value. Limitations for this setting are: 0 to 100 °C.
If *T.UNIT in code 11 is set to °F, default value is 77°F and the limitations are 32 - 212°F.

Code 21 *T.C.1/T.C.2
In addition to the procedure described in section 5.2.5 it is possible to adjust the compensation factor directly. If the compensation factor of the sample liquid is known from laboratory experiments or has been previously determined, it can be introduced here, for sensor 1 and/or sensor 2.
Adjust the value between 0.00 to 3.50 % per °C. In combination with reference temperature setting in code 20 a linear compensation function is obtained, suitable when enabled as in section 5.2.6 the matrix may be selected for each sensor input for all kinds of chemical solutions.

Code 22 *MATRX
The DC402G is equipped with a matrix type algorithm for both inputs, accurate temperature compensation in various applications. Select the range as close as possible to the actual temperature/concentration range. The DC402G will compensate by interpolation and extrapolation. Consequently, there is no need for a 100% coverage.
If 9 is selected the temperature compensation range for the adjustable matrix must be configured in code 23. Next the specific conductivity values at the different temperatures must be entered in codes 24 to 28. See section 5.2.6 for how to enable MATRIX compensation.

Code 23 *T1, *T2, *T3, *T4 & *T5 °C
Set the matrix compensation range. It is not necessary to enter equal temperature steps, but the values should increase from T1 to T5, otherwise the entry will be rejected. Example: 0, 10, 30, 60 and 100 °C are valid values for the T1....T5. The minimum span for the range (T5 - T1) is 25 °C.

Code 24-28 *L1xT1 - *L5xT5
In these access codes the specific conductivity values can be entered for 5 different concentrations of the process liquid; each one in one specific access code (24 to 28). The table below shows a matrix entering example for 1 - 15% NaOH solution for a temperature range from 0 - 100 °C.

Notes:

1. In chapter 10 a table is included to record your programmed values. It will make programming easy for duplicate systems or in case of data loss.
2. Each matrix column has to increase in conductivity value.
3. Error code E4 occurs when two standard solutions have identical conductivity values at the same temperature within the temperature range.

Table 5.2 Example of user adjustable matrix

Matrix			Example	Example	Example	Example	Example
Code 23	Temperature	T1...T5	0 °C	25 °C	50 °C	75 °C	100 °C
Code 24	Solution 1 (1%)	L1	31 mS/cm	53 mS/cm	76 mS/cm	98 mS/cm	119 mS/cm
Code 25	Solution 2 (3%)	L2	86 mS/cm	145 mS/cm	207 mS/cm	264 mS/cm	318 mS/cm
Code 26	Solution 3 (6%)	L3	146 mS/cm	256 mS/cm	368 mS/cm	473 mS/cm	575 mS/cm
Code 27	Solution 4 (10%)	L4	195 mS/cm	359 mS/cm	528 mS/cm	692 mS/cm	847 mS/cm
Code 28	Solution 5 (15%)	L5	215 mS/cm	412 mS/cm	647 mS/cm	897 mS/cm	1134 mS/cm

Code	Display	Function	Function detail	X	Y	Z	Default values
Temperature compensation functions							
20	*T.R.°C	Set reference temp.	Use >, ^, ENT keys to set value				25 °C
21	*T.C.1 *T.C.2	Set temp. coef. 1 Set temp. coef. 2	Adjust compensation factor for mA1 output, if set to TC in section 5.2.5. Set value with >, ^, ENT keys Adjust compensation factor for mA2 output, if set to TC in section 5.2.5. Set value with >, ^, ENT keys				2.1 % per °C 2.1 % per °C
22	*MATRX	Select matrix X= Sensor 1 Y= Sensor 2	Choose matrix if set to matrix comp. in section 5.2.5, using >, ^, ENT keys Matrix selected in section 5.2.6 HCl (cation) pure water (0-80 °C) Ammonia pure water (0-80 °C) Morpholine pure water (0-80 °C) HCl (0-5 %, 0-60 °C) NaOH (0-5 %, 0-100 °C) User programmable matrix	 1 2 3 4 5 9	 1 2 3 4 5 9		
23	*T1 °C (°F) *T2.. *T3.. *T4.. *T5..	Set temp. range	Enter 1st (lowest) matrix temp. value Enter 2nd matrix temp. value Enter 3rd matrix temp. value Enter 4th matrix temp. value Enter 5th (highest) matrix temp. value				
24	*L1xT1 *L1xT2 .... *L1xT5	Enter conductivity values for lowest concentration	Value for T1 Value for T2 Value for T5				
25	*L2xT1	Concentration 2	Similar to code 24				
26	*L3xT1	Concentration 3	Similar to code 24				
27	*L4xT1	Concentration 4	Similar to code 24				
28	*L5xT1	Concentration 5	Similar to code 24				
29			Not used				

5.3.4 mA output functions

Code 30 *mA Select 4-20mA or 0-20mA according to associated equipment (recorders, controllers etc.)

Code 31 *OUTP.F Note: For resistivity measurement, read resistivity in stead of conductivity.
Output mA1 Conductivity linear
(terminals 61&62) Conductivity with 21 point output table. (The table can be configured to give an output linear to concentration, see example at the end of this page).
Output mA2 Conductivity linear
(terminals 65&66) Conductivity with 21 point output table.
Temperature linear
PI control on conductivity (analog output control signal with proportional and integral functions).
Direct or reverse action of the mA control output. Direct gives rising output with rising measurement. Reverse gives falling output with rising measurement.

Code 32 *BURN Diagnostic error messages can signal a problem by sending the output signals upscale or downscale (22mA or 0/3.5mA). This is called upscale or downscale burnout, from the analogy with thermocouple failure signalling of a burned-out or open circuit sensor. In the case of the DC402G the diagnostics are extensive and cover the whole range of possible sensor faults.

Code 33 *RG.mA1(2) This function sets the proportional range for the mA output control signal. The range setting is expressed in % of setpoint.

Code 34 *tI.mA1(2) This function sets the integral time for the mA output control signal

Code 35-36*TABL1(2) The table function allows the configuration of an output curve by 21 steps (intervals of 5%)
The following example shows how the table may be configured to linearize the output with a W/W% curve. On the next page some other possibilities are shown.

Code 37 *DAMP Transmission signal damping (not mA control output).

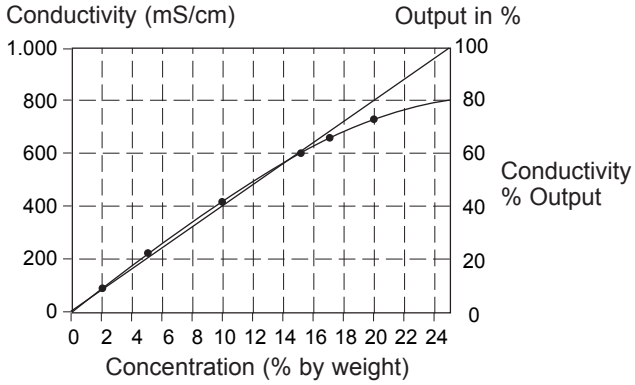


Fig. 5.1 Linearization of output Example: 0-25% Sulfuric acid

Table 5.3

Code Output	mA 0-20	mA 4-20	% H_2SO_4	mS/cm
0	0	4	0	0
5	1	4.8	1.25	60
10	2	5.6	2.5	113
15	3	6.4	3.75	180
20	4	7.2	5	218
25	5	8	6.25	290
30	6	8.8	7.5	335
35	7	9.6	8.75	383
40	8	10.4	10	424
45	9	11.2	11.25	466
50	10	12	12.5	515
55	11	12.8	13.75	555
60	12	13.6	15	590
65	13	14.4	16.25	625
70	14	15.2	17.5	655
75	15	16	18.75	685
80	16	16.8	20	718
85	17	17.6	21.25	735
90	18	18.4	22.5	755
95	19	19.2	23.75	775
100	20	20.0	25	791

Code	Display	Function	Function detail	X	Y	Z	Default values	
mA output functions								
30	*mA	mA output range	mA1 = 0-20 mA mA1 = 4-20 mA mA2 = 0-20 mA mA2 = 4-20 mA	0 1	 0 1		1.1	 4-20 4-20
31	*OUTP.F	mA output functions Direct/reverse action (For PI control only)	Calculated value (Service Code 58) Meas. conductivity linear Meas. conductivity table Meas. temperature T1-T2 For rising signal, set for increasing mA out. For rising signal, set for decreasing mA out.	0 1 2 3 4 5 6	0 1 2 3 4 5 6		1.1	 Cond.1/2 (direct) (reverse)
32	*BURN	Burn function	mA 1 No burnout mA 1 Burnout downscale mA 1 Burnout upscale mA 2 No burnout mA 2 Burnout downscale mA 2 Burnout upscale	0 1 2	 0 1 2		0.0	No Burn. No Burn.
33	*RG. mA1(2)	PI range	Proportional range for mA control signal (use >, ^, ENT keys to adjust value)					
34	*tI.mA1(2)	Integral time (for PI control)						
35	*TABL1 *0% *5% *10% *90% *100%	Output table for mA1	Linearization table for mA1 in 5% steps. The measured value is set in the main display using the >, ^, ENT keys, for each of the 5% interval steps. Where a value is not known, that value may be skipped, and a linear interpolation will take place.					
36	*TABL2	Output table for mA2	Similar to code 35					
37	*DAMP	Damping time	Damping on mA output 0-120 sec.					0. sec.
38- 39			Not used					

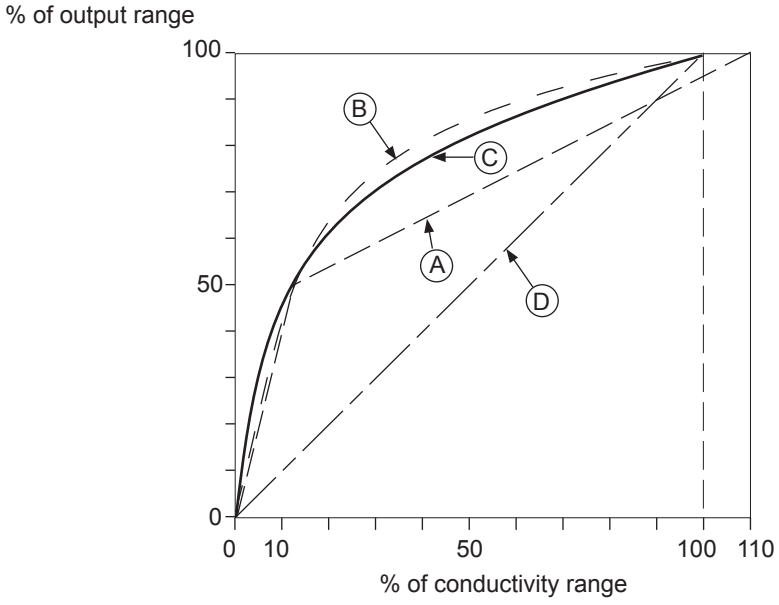


Fig. 5.2 Percentage of mA-output range versus percentage of conductivity range

EXAMPLES:
A = bi-lineair
B = hyperbolic (2 decades)
C = logarithmic (2 decades)
D = linear

Table 5.4 Example of output tables

Output	bi-lin	log 2	log 3	hyp 2	hyp 3
0%	0.0	1.0	0.10	1.00	0.10
5%	1.0	1.3	0.14	1.20	0.27
10%	2.0	1.6	0.20	1.82	0.43
15%	3.0	2.0	0.28	1.90	0.61
20%	4.0	2.5	0.40	2.00	0.83
25%	5.0	3.2	0.56	3.75	1.10
30%	6.0	4.0	0.79	4.80	1.36
35%	7.0	5.0	1.12	5.92	1.68
40%	8.0	6.3	1.58	7.00	2.05
45%	9.0	7.9	2.24	8.31	2.49
50%	10.0	10.0	3.16	10.00	3.00
55%	20.0	12.6	4.47	11.85	3.66
60%	30.0	15.8	6.31	14.00	4.33
65%	40.0	20.0	8.91	16.65	5.22
70%	50.0	25.1	12.6	19.50	6.80
75%	60.0	31.6	17.8	23.80	8.25
80%	70.0	39.8	25.1	29.55	11.0
85%	80.0	50.1	35.5	36.70	14.8
90%	90.0	63.1	50.1	48.50	21.8
95%	100.0	79.4	70.8	68.60	36.5
100%	110.0	100.0	100.0	100.0	100.0

bi-lin = bi-lineair over 2 decades
log 2 = logarithmic over 2 decades
log 3 = logarithmic over 3 decades
hyp 2 = hyperbolic over 2 decades
hyp 3 = hyperbolic over 3 decades
NOTE: Multiply the values from the table with appropriate factors to get the end-scale value you want.

5.3.5 Contact outputs

Code 40, 41, 42 and 43 *S1, *S2 *S3, *S4

Process relays can be set for a variety of alarm and control function.

Digit “X” sets the type of trigger:
Off means that the relay is not active
Low setpoint means that the relay is triggered by a decreasing measurement.
High setpoint means that the relay is triggered by an increasing measurement “HOLD” active means that there is maintenance activity in progress so the measurement is not live.
For *S4 There is the extra possibility to set up for “FAIL” indication.

Digit “Y” sets the control action:
Process alarm is a simple On/Off trip controlled by the high/low setpoint.
Proportional duty cycle control has a pulse width modulation for proportional dosing with solenoid valves.
Proportional frequency control is used for controlling electrically positioned valves.
Temperature alarm is an On/Off trip on the measured temperature.

Digit “Z” sets the control parameter:
Alarm on main process
Control on main process
(Main process means conductivity/resistivity depending on the setting of service code 01).

Code	Display	Function	Function detail	X	Y	Z	Default values	
Contact Settings								
40	*S1	Relay 1 settings Note: Main process means cond. or resist. whichever is set in code #1	Off Low setpoint High setpoint “HOLD” active Process alarm Proportional duty cycle control ** Proportional frequency control ** PI duty cycle ** PI pulse freq. ** USP contact Calculated value Meas cond/res. value cell 1 Meas cond/res. value cell 2 Meas temp. value cell 1 Meas temp. value cell 2 Meas temp. T1-T2	0 1 2 3	 0 1 2 3 4 5	 0 1 2 3 4 5	2.0.1	 High Alarm Cell 1
41	*S2	Relay 2 settings Note: “HOLD” active relay contact is used to indicate when the measuring mode is interrupted	Off Low setpoint High setpoint “HOLD” active Process alarm Proportional duty cycle control Proportional frequency control PI duty cycle ** PI pulse freq. ** USP contact Calculated value Meas cond/res. value cell 1 Meas cond/res. value cell 2 Meas temp. value cell 1 Meas temp. value cell 2 Meas temp. T1-T2	0 1 2 3	 0 1 2 3 4 5	 0 1 2 3 4 5	1.0.1	 Low Alarm Cell 1
42	*S3	Relay 3 settings	Off Low setpoint High setpoint “HOLD” active Process alarm Proportional duty cycle control Proportional frequency control PI duty cycle ** PI pulse freq. ** USP contact Calculated value Meas cond/res. value cell 1 Meas cond/res. value cell 2 Meas temp. value cell 1 Meas temp. value cell 2 Meas temp. T1-T2	0 1 2 3	 0 1 2 3 4 5	 0 1 2 3 4 5	0.0.0	Off
43	*S4	Relay 4 settings Note: “FAIL” relay contact is used to indicate when the diagnostics detect a problem	Off Low setpoint High setpoint “HOLD” active Fail alarm Process alarm Proportional duty cycle control Proportional frequency control PI duty cycle ** PI pulse freq. ** USP contact Calculated value Meas cond/res. value cell 1 Meas cond/res. value cell 2 Meas temp. value cell 1 Meas temp. value cell 2 Meas temp. T1-T2	0 1 2 3 4	 0 1 2 3 4 5	 0 1 2 3 4 5	4.0.0	 FAIL Alarm

Code 44 *D.TIME The delay time sets the minimum relay switching time. This function can be adjusted to give a good alarm function in a noisy process, preventing the relay from “chattering” or repeatedly switching when the signal is close to the setpoint.

*SC.HYS The hysteresis is the value beyond the setpoint that the measured value must exceed before the control function will start working. For conductivity this setting is expressed in % of programmed setpoint value.

*T.HYST
*C.HYST

Code 45 *RANGE Proportional range is the value above (or below) the setpoint that generates full output in proportional control. This is expressed in % of the programmed output span.

*PER. The time period of the overall pulse control cycle (one ON and one OFF period). See fig 5.4.

*FREQ. The maximum frequency for the pulse frequency control. See fig 5.5.

Code 46 *tI.CNT The integral time for the PI control settings.

Code 47 *EXPIR When a system is set up to control on the relay outputs, the expiry time can be enabled to warn of an ineffective control. In other words, when the setpoint is exceeded for more than 15 minutes an error message is generated. This can mean, for example, that the reagent tank is empty.

*tE.min

Code 48 *SC1 For proportional or PI control on the conductivity level, a working range *SC1 must be set. When *SC1 is set as an output on mA1 and *SC2 is set as an output on mA2, code 48 has no relevance. When using mA1 as mA2 for calculated values or temperature etc. the range for control setting of the relays should be done in code 48. After activating code 48 *SC1 is displayed. Press YES to set range *SC1 or NO to go to *SC2.

Code	Display	Function	Function detail	X	Y	Z	Default values	
Contacts Settings								
44	*D.TIME	Delay time	Minimum relay switching time					0.2 sec.
	*SC.HYS	Process hysteresis	Minimum change of process value for relay reset after switching					2.0 %
	*T.HYST	Hysteresis temp.	Minimum temperature change for relay reset after switching (fig. 5.3)					1 °C
	*C.HYST	Calculation hysteresis						0
45	*RANGE	Proportional range	When proportional control selected in code 40, 41, 42 or 43					10.0 %
	*PER.	Duty cycle period	Pulse control On time + Off time (fig. 5.4)					10 sec.
	*FREQ.	Maximum frequency	100% value for frequency control (fig. 5.5)					70 p/m
46	*tI.CNT	Integral time	Integral time for relay controls when PI is set					100 sec.
47	*EXPIR	Expiry time	Warning of ineffective control action On Warning of ineffective control action Off	1 0			0	Off
	*tE.mn	Set expiry time	Set expiring time using >, ^, ENT keys					15 min
48	*SC1	Set control range	Set range for *SC1 (*SC2) for proportional contact control when *SC1 (*SC2) are not used on mA1 (mA2)					
	0%	Set begin scale	Use >,^, ENT keys to set value					
	*100%	Set end scale	Use >,^, ENT keys to set value					
49			Not used					

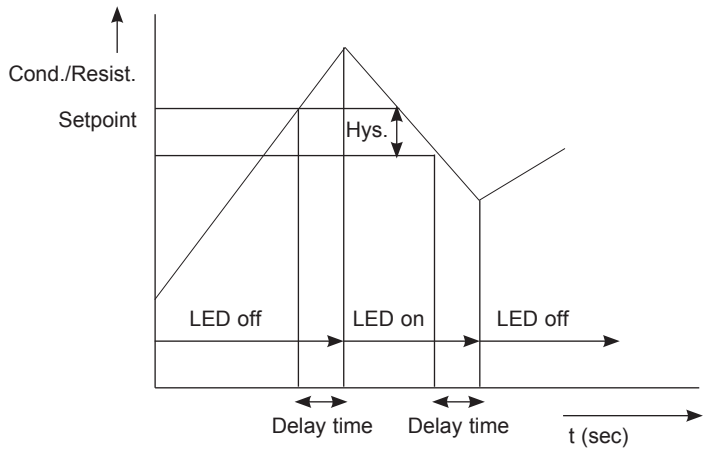


Fig. 5.3

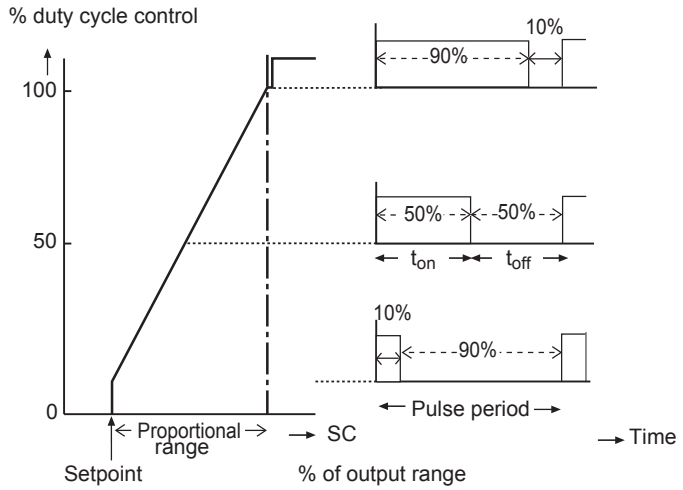


Fig. 5.4 Duty cycle control

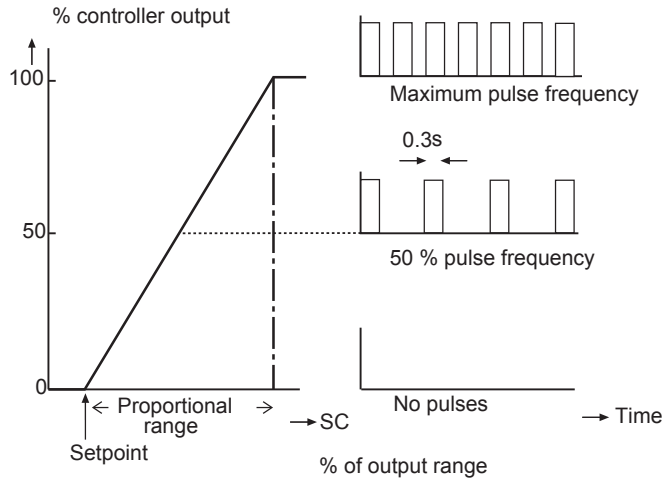


Fig. 5.5 Pulse frequency control

5.3.6 User interface

Code 50	*RET.	When Auto return is enabled, the converter reverts to the measuring mode from anywhere in the configuration menus, when no button is pressed during the set time interval of 10 minutes.
Code 51	*MODE	The adjustment of the contact setpoints can be setup for operation in the maintenance mode. (Through the closed front cover).
Code 52	*PASS	Passcodes can be set on any or all of the access levels, to restrict access to the instrument configuration.
Code 53	*Err.01	Error message configuration. Two different types of failure mode can be set. Hard fail gives a steady FAIL flag in the display, and a continuous contact closure. All the other contacts (controls) are inhibited (except HOLD contacts), and a Fail signal is transmitted on the outputs when enabled in code 32. Soft fail gives a flashing FAIL flag in the display, and the relay contacts are pulsed. The other contacts (controls) are still functional, and the controller continues to work normally. The call for maintenance is a good example of where a SOFT fail is useful.
	*SOFT	If set to 1, soft fail gives a flashing FAIL flag in the display and no pulsing contact.
Code 54	*E5.LIM *E6.LIM	Limits can be set for shorted and open measurement. Dependent on the main parameter chosen in code 01, the DC402G will ask for the absolute conductivity/resistivity (without influence of absolute cell constant or Temp. comp).
Code 55	*%	For some applications the measured parameter values may be (more or less) linear to concentration. For such applications it is not needed to enter an output table, but 0 and 100% concentration values directly can be set.
Code 56	*DISP	The display resolution is default set to autoranging for conductivity reading. If a fixed display reading is needed, a choice can be made out of 7 possibilities. For resistivity the default reading is fixed to xx.xx MΩ·cm.
Code 57	*USP	Input 1 and/or Input 2 can be set to give automatic checking for compliance with the water purity standard set in USP <645> (United States Pharmacopea directive 23). For more detailed description see Appendix 10.8.
Code 58	*CALC	A calculation type can be chosen to suit a variety of applications. See appendix 10.9 for more details. For conductivity a choice can be made from 7 options. For Resistivity only “differential” or “no calculation” is possible.

Code	Display	Function	Function detail	X	Y	Z	Default values	
User Interface								
50	*RET	Auto return	Auto return to measuring mode Off	0				
			Auto return to measuring mode On	1			1	On
51	*MODE	Mode setup	Setpoints in maintenance mode Off	0			0	Off
			Setpoints in maintenance mode On	1				
52	*PASS	Passcode	Maintenance passcode Off	0			0.0.0	Off
		Note # = 0 - 9, where 0	Maintenance passcode On	#				
		= no passcode, 1=111,	Commissioning passcode Off		0			Off
		2=333, 3=777, 4=888,	Commissioning passcode On		#			
		5=123, 6=957, 7=331,	Service passcode Off			0		Off
		8=546, 9=847	Service passcode On			#		
53	*Err. 1. 1(2)	Error setting	Polarisation too high Soft fail	0				
			Polarisation too high Hard fail	1			1	Hard
	*Err. 5. 1(2)		Shorted measurement Soft fail	0				
			Shorted measurement Hard fail	1			1	Hard
	*Err. 6. 1(2)		Open measurement Soft fail	0				
			Open measurement Hard fail	1			1	Hard
	*Err. 7. 1(2)		Temperature sensor open Soft fail	0				
			Temperature sensor open Hard fail	1			1	Hard
	*Err. 8. 1(2)		Temp. sensor shorted Soft fail	0				
			Temp. sensor shorted Hard fail	1			1	Hard
	*Err. 13. 1(2)		USP <645> limit exceeded Soft fail	0			0	Soft
			USP <645> limit exceeded Hard fail	1				
	*Err. 22. 1		Control time-out Soft fail	0			0	Soft
			Control time-out Hard fail	1				
	*SOFT	SOFT FAIL CONTACT	Pulsing contact	0			0	Pulsing
			No Pulsing contact	1				
54	*E5.LIM 1(2)	E5 limit setting	Maximum conductivity value				25	mS
			(Minimum resistivity value)				0.04	kΩ
	*E6.LIM 1(2)	E6 limit setting	Maximum conductivity value				1	μS
			(Minimum resistivity value)				1	MΩ
55	*%	Display mA in w/w%	mA1-range displayed in w/w% off	0			0.0	Off
			mA1-range displayed in w/w% on	1				
			mA2-range displayed in w/w% off		0			Off
			mA2-range displayed in w/w% on		1			
	*%1	Set w/w% for range 1	Press YES to access 0% value adjustm.					
	*0%		Set 0% output value in w/w%					
	*100%		Set 100% output value in w/w%					
	*%2	Set w/w% for range 2	Press YES to access 0% value adjustm.					
	*0%		Set 0% output value in w/w%					
	*100%		Set 100% output value in w/w%					
56	*DISP	Display resolution	Auto ranging display	0			0	Auto
			Display fixed to X.XXX μS/cm or MΩ•cm	1				
			Display fixed to XX.XX μS/cm or MΩ•cm	2				
			Display fixed to XXX.X μS/cm or MΩ•cm	3				
			Display fixed to X.XXX mS/cm or kΩ•cm	4				
			Display fixed to XX.XX mS/cm or kΩ•cm	5				
			Display fixed to XXX.X mS/cm or kΩ•cm	6				
			Display fixed to XXXX mS/cm or kΩ•cm	7				
57	*USP	USP setting	Disable the E13 (USP limit passed)	0	0		0.0	Off/Off
		X=Cell 1 Y= Cell 2	Enable the E13 (USP limit passed)	1	1			
58	*CALC	Calculation setting	Choose the main parameter for display					
			Ratio (a/b)	0			5	No calc.
			Differential (a-b)	1				
			% passage b/a	2				
			% rejection (100 (a-b)/a)	3				
			Deviation (100 X (b-a)/a)	4				
			No calculation SC1 in display	5				
			VGB directive 450L, pH calculation	6				
			When set for resistivity measuring, only selection 1 and 5 are available					

5.3.7 Communication setup

Please do not use the Code 61 due to the factory use.

Code 61 *HOUR
*MINUT
*SECND
*YEAR
*MONTH
*DAY

5.3.8 General

Code 70 *LOAD The load defaults code allows the instrument to be returned to the default set up with a single operation. This can be useful when wanting to change from one application to another.

5.3.9 Test and setup mode

Code 80 *TEST Not used

Note: Attempting to change data in this service code, or others in the series 80 and above without the proper instructions and equipment, can result in corruption of the instrument setup, and will impair the performance of the unit.

Code	Display	Function	Function detail	X	Y	Z	Default values	
Communication								
61	*HOUR *MINUT *SECND *YEAR *MONTH *DAY	Clock setup	Adjust to current date and time using >, ^ and ENT keys					
62-69			Not used					

Code	Display	Function	Function detail	X	Y	Z	Default values	
General								
70	*LOAD	Load defaults	Reset configuration to default values					
71-79			Not used					

Code	Display	Function	Function detail	X	Y	Z	Default values	
Test and setup mode								
80	*TEST	Test and setup	Not used					

6. Calibration

6.1 When is calibration necessary?

Calibration of conductivity/resistivity instruments is normally not required, since Yokogawa delivers a wide range of sensors, which are factory calibrated traceable to NIST standards. The cell constant values are normally indicated on the top of the sensor or on the integral cable. These values can be entered directly in service code 03 (section 5.3.1).

If the cell has been subjected to abrasion (erosion or coating) calibration may be necessary. In the next section two examples are given. Alternatively calibration may be carried out with a simulator to check the electronics only.

NOTE

During calibration the temperature compensation is still active. This means that the readings are referred to the reference temperature as chosen in service code 20 (section 5.3.3, default 25 °C).

Calibration is normally carried out by measuring a solution with a known conductivity value at a known temperature. The measured value is adjusted in the calibration mode. On the next pages the handling sequence for this action is visualized.

Calibration solutions can be made up in a laboratory. An amount of salt is dissolved in water to give a precise concentration with the temperature stabilized to the adjusted reference temperature of the instrument (default 25 °C). The conductivity of the solution is taken from literature tables or the table on this page.

Alternatively the instrument may be calibrated in an unspecified solution against a standard instrument.

Care should be taken to make a measurement at the reference temperature since differences in the type of temperature compensation of the instrument may cause an error.

NOTE

The standard instrument used as a reference must be accurate and based on an identical temperature compensation algorithm. Therefore the Model SC72 Personal Conductivity Meter of Yokogawa is recommended.

Typical calibration solutions.

The table shows some typical conductivity values for sodium-chloride (NaCl) solutions which can be made up in a laboratory.

Table 6.1 NaCl values at 25 °C

Weight %	mg/kg	Conductivity
0.001	10	21.4 µS/cm
0.003	30	64.0 µS/cm
0.005	50	106 µS/cm
0.01	100	210 µS/cm
0.03	300	617 µS/cm
0.05	500	1.03 mS/cm
0.1	1000	1.99 mS/cm
0.3	3000	5.69 mS/cm
0.5	5000	9.48 mS/cm
1	10000	17.6 mS/cm
3	30000	48.6 mS/cm
5	50000	81.0 mS/cm
10	100000	140 mS/cm

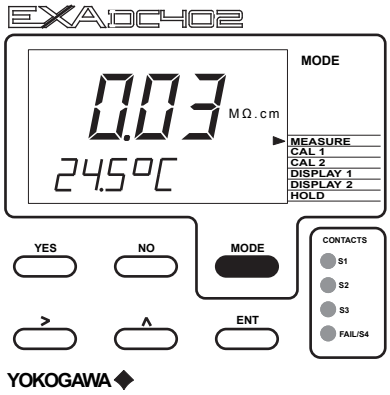
NOTE

For resistivity measurement the standard resistivity units of the calibration solution can be calculated as follows:

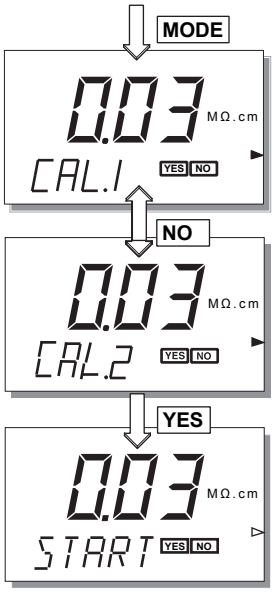
R = 1000/G (kΩ•cm if G = µS/cm)

Example:
0.001% weight
R = 1000/21.4 = 46.7 kΩ•cm

6.2 Calibration procedure



Press the **MODE** key. The legend CAL.1/CAL.2 appears, and the **YES/NO** key prompt flags flash. If the SETP legend appears, press **NO** first.



Note: See section 4-5 for full display access details

Put the sensor in standard solution. Press **YES**.

Set the value using the **>**, **^**, **ENT** key.

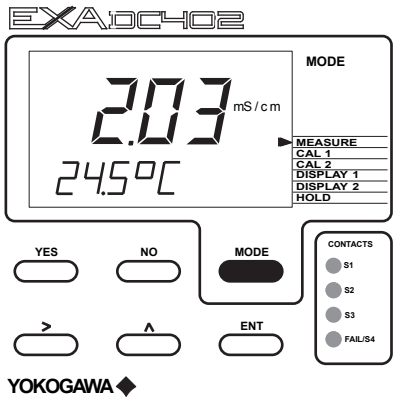
Select the flashing digit with the **>** key. Increase its value by pressing the**^** key

When the correct value is displayed, press **ENT** to enter the change.

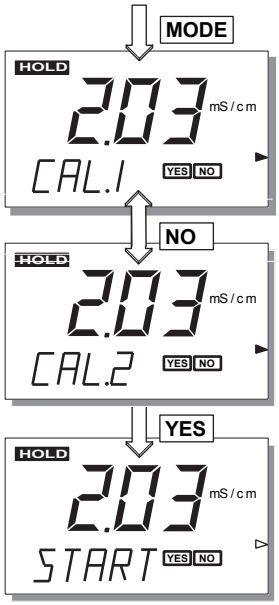
After briefing displaying WAIT, the CAL.END message appears.

The calibration is now complete. Put the sensor back in the process and press **YES** to return to the measuring mode.

6.3 Calibration with HOLD active



Press the **MODE** key. The legend CAL.1/CAL.2 appears, and the **YES/NO** key prompt flags flash. If the SETP legend appears, press **NO** first.



Note: See section 4-5 for full display access function

Put the sensor in standard solution. Press **YES**.

Set the value using the **>**,**^**, **ENT** key.

Select the flashing digit with the **>** key. Increase its value by pressing the**^** key

When the correct value is displayed, press **ENT** to enter the change.

After briefing displaying WAIT, the CAL.END message appears.

The calibration is now complete. Put the sensor back in the process and press **YES.**

HOLD will be displayed. Press **NO** to turn off HOLD and return to the measuring mode.

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7. Maintenance

7.1 Periodic maintenance for the DC402G converter

The DC402G converter requires very little periodic maintenance. The housing is sealed to IP65 (NEMA 4X) standards, and remains closed in normal operation. Users are required only to make sure the front window is kept clean in order to permit a clear view of the display and allow proper operation of the pushbuttons. If the window becomes soiled, clean it using a soft damp cloth or soft tissue. To deal with more stubborn stains, a neutral detergent may be used.

NOTE

Never used harsh chemicals or solvents. In the event that the window becomes heavily stained or scratched, refer to the parts list (Chapter 9) for replacement part numbers.

When you must open the front cover and/or glands, make sure that the seals are clean and correctly fitted when the unit is reassembled in order to maintain the housing's weatherproof integrity against water and water vapor. The measurement otherwise may be prone to problems caused by exposure of the circuitry to condensation.

The DC402G instrument contains a lithium cell to support the clock function when the power is switched off. This cell needs to be replaced at 5 yearly intervals (or when discharged). Contact your nearest Yokogawa service centre for spare parts and instructions.

7.2 Periodic maintenance of the sensor

NOTE

Maintenance advice listed here is intentionally general in nature. Sensor maintenance is highly application specific.

In general conductivity/resistivity measurements do not need much periodic maintenance. If the DC402G indicates an error in the measurement or in the calibration, some action may be needed (ref. chapter 8 trouble shooting). In case the sensor has become fouled an insulating layer may be formed on the surface of the electrodes and consequently, an apparent increase in cell constant may occur, giving a measuring error. This error is:

$$2 \times \frac{R_v}{R_{cel}} \times 100\ \%$$

where:

R_v = the resistance of the fouling layer

R_{cel} = the cell resistance

NOTE

Resistance due to fouling or to polarization does not effect the accuracy and operation of a 4-electrode conductivity measuring system.

If an apparent increase in cell constant occurs cleaning the cell will restore accurate measurement.

Cleaning methods

1. For normal applications hot water with domestic washing-up liquid added will be effective.
2. For lime, hydroxides, etc., a 5 ...10% solution of hydrochloric acid is recommended.
3. Organic foulings (oils, fats, etc.) can be easily removed with acetone.
4. For algae, bacteria or moulds, use a chlorous solution (bleaching liquid*).

* Never use hydrochloric acid and bleaching liquid simultaneously. The very poisonous gas chlorine will result.

7.3 Fuse Replacement

This section describes how to replace the power supply fuse.

WARNING

- Use only a fuse of the specified current, voltage and type ratings to prevent fire.
- Power to the instrument must be turned off at the external breaker before replacing the fuse. After replacing the fuse, install a high-voltage shield plate before turning the power on.
- Do not short circuit the fuse holder.

Specified Ratings of the Power Supply Fuse

The power supply fuse (recommended fuse) used in the DC402G is as follows.

115 V AC version

Rated breaking current: 35 A or 10 times the rated current, whichever is greater (low breaking)

Maximum rated voltage: 250 V

Maximum rated current: 200 mA

Compliance: UL, CSA, VDE, Japan's Electrical Appliance and material Safety Law

Part number: A1105EF

230 V AC version

Rated breaking current: 35 A or 10 times the rated current, whichever is greater (low breaking)

Maximum rated voltage: 250 V

Maximum rated current: 100 mA

Compliance: UL, CSA, VDE, Japan's Electrical Appliance and material Safety Law

Part number: A1103EF

How to replace the fuse

1. Before replacing the fuse, turn off power to the instrument at the external breaker.
2. Remove the instrument cover and the high-voltage shield plate.
3. Remove the cover from the fuse holder by pulling out by hand.
4. Remove the fuse and install a new, recommended or equivalent fuse on the holder.
5. Put the fuse cover back on the holder securely.
6. Install the high-voltage shield plate.

It is recommended that the fuse be replaced every two years even if it has not blown.

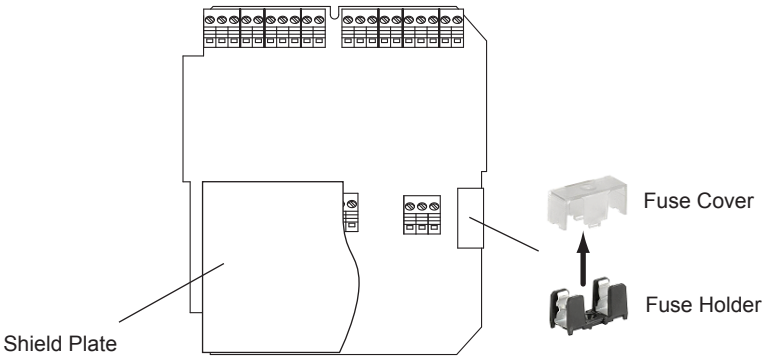

Figure 7.1 How to replace the fuse

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8. Troubleshooting

The DC402G is a microprocessor-based analyzer that performs continuous self-diagnostics to verify that it is working correctly. Error messages resulting from faults in the microprocessor systems itself are few. Incorrect programming by the user can be corrected according to the limits set in the following text.

In addition, the DC402G also checks the sensor to establish whether it is still functioning within specified limits.

The DC402G makes a distinction among diagnostic findings. All errors are signaled by the FAIL area in the display. Only faults in the measuring circuits activate the FAIL contact switching.

What follows is a brief outline of some of the DC402G troubleshooting procedures, followed by a detailed table of error codes with possible causes and remedies.

Diagnostics

Off-line checks

The DC402G converter incorporates a diagnostic check of the adjusted cell constant value at calibration. If the adjusted value stays within 80 - 120 % of the nominal value set in service code 03, it is accepted. Otherwise, the unit generates an error (E3).

The DC402G also checks the temperature compensation factor while performing manual temperature compensation as described in section 5.2.5. If the the TC factor stays within 0.00% to 3.50% per °C, it is accepted. Otherwise, E2 will be displayed.

On-line checks

The DC402G performs several on-line checks to optimize the measurement and to indicate a fault due to the fouling or polarization of the connected sensor. The fault will be indicated by the activation of the FAIL-contact, the lighting of the LED and the flag in the display.

During measurement the DC402G adjusts the measuring frequency to give the best conditions for the actual value being measured. At low conductivity there is a risk of error due to the capacitive effects of the cable and the cell. These are reduced by using a low measuring frequency. At high conductivity the capacitive effects become negligible and errors are more likely to be caused by polarisation or fouling of the cell. These errors are decreased by increasing the measuring frequency.

At all values the DC402G checks the signal from the cell to search for distortion which is typical of capacitive or polarisation errors. If the difference between pulse front and pulse rear is > 20% an error E1 will be displayed and the FAIL alarm will be activated. In service code 05 it is possible to turn this check on and off.

The following error message table gives a list of possible problems that can be indicated by the DC402G.

Table 8.1 Error Codes

Code	Error description	Possible cause	Suggested remedy
E1	Polarization detected on cell	Sensor surface fouled Conductivity too high	Clean sensor and calibrate Replace sensor
E2	Temperature coefficient out of limits (exceeds 0-3.5%/°C range)	Incorrect field calibration of TC	Re-adjust Set calculated TC
E3	Calibration out of limits	Calibrated value differs more than +/- 20 % of nominal value programmed in code 03.	Check for correct sensor Check for correct unit (µS/cm, mS/cm, kΩ•cm or MΩ•cm) Repeat calibration
E4	Matrix compensation error	Wrong data entered in 5x5 matrix	Re-program
E5	Conductivity too high or resistivity too low (Limits set in service code 54)	Incorrect wiring Internal leakage of sensor Defective cable	Check wiring (Sec. 3.6) Replace sensor Replace cable
E6	Conductivity too low or resistivity too high (Limits set in service code 54)	Dry sensor Incorrect wiring Defective cable	Immerse sensor Check wiring (Sec. 3.6) Replace cable
E7	Temperature sensor open (Pt1000 : T > 250°C or 500°F) (Pt100/Ni100 : T > 200°C or 400°F) (8k55 : T < -10°C or 10°F) (PB36 : T < -20°C or 0°F)	Process temperature too high or too low Wrong sensor programmed Incorrect wiring	Check process Check model code sensor Check connections and cable
E8	Temperature sensor shorted (Pt1000/Pt100/Ni100 : T < -20°C or 0°F) (8k55/PB36 : T > 120°C or 250°F)	Process temperature too high or too low Wrong sensor programmed Incorrect wiring	Check process Check model code sensor Check connections and cable
E9	Air set impossible	Too high zero due to cable capacitance	Replace cable
E10	EEPROM write failure	Fault in electronics	Try again, if unsuccessful contact Yokogawa
E13	USP Limit exceeded	Poor water quality	Check-ion exchangers
E15	Cable resistance influence to temperature exceeds +/- 15°C	Cable resistance too high Corroded contacts Wrong sensor programmed	Check cable Clean and reterminate Reprogram
E17	Output span too small	Incorrect configuration by user	Reprogram
E18	Table values make no sense	Wrong data programmed	Reprogram
E19	Programmed values outside acceptable limits	Incorrect configuration by user	Reprogram
E20	All programmed data lost	Fault in electronics	Contact Yokogawa
		Very severe interference	
E21	Checksum error	Software problem	Contact Yokogawa
E22	Alarm activation time exceeded	Process control not effective within set time	Check control equipment Adjust value in code 47
E24	Calculation out of limits	Incorrect configuration Extreme process condition	Check settings Check process

9. Spare Parts

See Customer Maintenance Parts List.

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10. Appendix

10.1 User setting for non-linear output table (code 31, 35 and 36)

Output signal value								
% Output	mA 0-20	mA 4-20						
000	0	00.4						
005	1	04.8						
010	2	05.6						
015	3	06.4						
020	4	07.2						
025	5	00.8						
030	6	08.8						
035	7	09.6						
040	8	10.4						
045	9	11.2						
050	10	0.12						
055	11	12.8						
060	12	13.6						
065	13	14.4						
070	14	15.2						
075	15	0.16						
080	16	16.8						
085	17	17.6						
090	18	18.4						
095	19	19.2						
100	20	20.0						

10.2 User entered matrix data (code 23 to 28)

Medium:			T1 data	T2 data	T3 data	T4 data	T5 data
Code 23	Temperature	T1...T5					
Code 24	Solution 1	L1					
Code 25	Solution 2	L2					
Code 26	Solution 3	L3					
Code 27	Solution 4	L4					
Code 28	Solution 5	L5					

Medium:			T1 data	T2 data	T3 data	T4 data	T5 data
Code 23	Temperature	T1...T5					
Code 24	Solution 1	L1					
Code 25	Solution 2	L2					
Code 26	Solution 3	L3					
Code 27	Solution 4	L4					
Code 28	Solution 5	L5					

10.3 Matrix data table (user selectable in code 22)

Matrix, Solution	Temp (°C)	Data 1	Data 2	Data 3	Data 4	Data 5
HCL-p (cation)		0 ppb	4 ppb	10 ppb	20 ppb	100 ppb
selection 1	0	0.0116 µS	0.0228 µS	0.0472 µS	0.0911 µS	0.450 µS
	10	0.0230 µS	0.0352 µS	0.0631 µS	0.116 µS	0.565 µS
	20	0.0419 µS	0.0550 µS	0.0844 µS	0.145 µS	0.677 µS
	30	0.0710 µS	0.085 µS	0.115 µS	0.179 µS	0.787 µS
	40	0.1135 µS	0.129 µS	0.159 µS	0.225 µS	0.897 µS
	50	0.173 µS	0.190 µS	0.220 µS	0.286 µS	1.008 µS
	60	0.251 µS	0.271 µS	0.302 µS	0.366 µS	1.123 µS
	70	0.350 µS	0.375 µS	0.406 µS	0.469 µS	1.244 µS
	80	0.471 µS	0.502 µS	0.533 µS	0.595 µS	1.373 µS
Ammonia-p		0 ppb	2 ppb	5 ppb	10 ppb	50 ppb
selection 2	0	0.0116 µS	0.0229 µS	0.0502 µS	0.0966 µS	0.423 µS
	10	0.0230 µS	0.0337 µS	0.0651 µS	0.122 µS	0.535 µS
	20	0.0419 µS	0.0512 µS	0.0842 µS	0.150 µS	0.648 µS
	30	0.0710 µS	0.0788 µS	0.111 µS	0.181 µS	0.758 µS
	40	0.113 µS	0.120 µS	0.149 µS	0.221 µS	0.866 µS
	50	0.173 µS	0.178 µS	0.203 µS	0.273 µS	0.974 µS
	60	0.251 µS	0.256 µS	0.278 µS	0.344 µS	1.090 µS
	70	0.350 µS	0.356 µS	0.377 µS	0.439 µS	1.225 µS
	80	0.471 µS	0.479 µS	0.501 µS	0.563 µS	1.393 µS
Morpholine-p		0 ppb	20 ppb	50 ppb	100 ppb	500 ppb
selection 3	0	0.0116 µS	0.0272 µS	0.0565 µS	0.0963 µS	0.288 µS
	10	0.0230 µS	0.0402 µS	0.0807 µS	0.139 µS	0.431 µS
	20	0.0419 µS	0.0584 µS	0.108 µS	0.185 µS	0.592 µS
	30	0.0710 µS	0.0851 µS	0.140 µS	0.235 µS	0.763 µS
	40	0.113 µS	0.124 µS	0.181 µS	0.289 µS	0.938 µS
	50	0.173 µS	0.181 µS	0.234 µS	0.351 µS	1.12 µS
	60	0.251 µS	0.257 µS	0.306 µS	0.427 µS	1.31 µS
	70	0.350 µS	0.357 µS	0.403 µS	0.526 µS	1.52 µS
	80	0.471 µS	0.481 µS	0.528 µS	0.654 µS	1.77 µS
Hydrochloric Acid		1%	2%	3%	4%	5%
selection 4	0	65 mS	125 mS	179 mS	229 mS	273 mS
	15	91 mS	173 mS	248 mS	317 mS	379 mS
	30	114 mS	217 mS	313 mS	401 mS	477 mS
	45	135 mS	260 mS	370 mS	474 mS	565 mS
	60	159 mS	301 mS	430 mS	549 mS	666 mS
Sodium Hydroxide		1%	2%	3%	4%	5%
selection 5	0	31 mS	61 mS	86 mS	105 mS	127 mS
	25	53 mS	101 mS	145 mS	185 mS	223 mS
	50	76 mS	141 mS	207 mS	268 mS	319 mS
	75	97.5 mS	182 mS	264 mS	339 mS	408 mS
	100	119 mS	223 mS	318 mS	410 mS	495 mS

10.4 Sensor Selection

10.4.1 General

The inputs of the DC402G transmitter are freely programmable for ease of installation. Standard 2-electrode type sensors with a cell constant of 0.100/cm and a Pt1000 temperature sensor, need no special programming. The DC402G indicates a fault with a signal in the display field if there is a mismatch of sensors in the connection.

10.4.2 Sensor selection

The DC402G is pre/programmed to accept standard 2-electrode sensors with a Pt1000 temperature sensor. The DC402G is universally compatible with all 2- and 4-electrode type of sensors with a cell constant within the range of 0.008/cm to 50.0/cm.

10.4.3 Selecting a temperature sensor

The DC402G reaches its highest accuracy when used with a PT1000 temperature sensor. This may influence the choice of the conductivity/resistivity sensor, as in most cases the temperature sensor is integrated in the conductivity/resistivity sensor.

10.5 Setup for other functions

- Contact Outputs

  Alarms, trips and proportional control are all possible with the relay outputs, and the configuration is by Service codes 40 - 49. In addition, FAIL alarm is available.

- Current Outputs

  Transmission signals for the measured parameters and control signals can be set up in service codes 30 - 39.

- Diagnostic checks

  Polarization check and checks on the calibrated cell constant and the adjusted Temperature Coefficient, are included in the DC402G.

Note: On the next page a reference list for the configuration of the DC402G is shown.

10.6 User setting table

FUNCTION		SETTING DEFAULTS		USER SETTINGS		
Parameter specific functions						
01	*SC.RES	0	SC			
03	*0.10xC	0.10xC	Factor			
	C.C.1	1.000	/cm			
	C.C.2	1.000	/cm			
04	*AIR	Perform zero calibration				
05	*POL.CK	1	On			
Temperature measuring functions						
10	*T.SENS	0	Pt1000			
11	*T.UNIT	0	°C			
12	*T.ADJ 1		None			
	*T.ADJ 2		None			
Temperature compensation functions						
20	*T.R.°C	25	°C			
21	*T.C.1	2.1	%/°C			
	*T.C.2	2.1	%/°C			
22	*MATRX		None, see 5.2.5			
23	*T1°C	T. range	See sep. table, §10.2			
24	*L1xT1	Cond. C1	See sep. table, §10.2			
25	*L2xT1	Cond. C2	See sep. table, §10.2			
26	*L3xT1	Cond. C3	See sep. table, §10.2			
27	*L4xT1	Cond. C4	See sep. table, §10.2			
28	*L5xT1	Cond. C5	See sep. table, §10.2			
mA outputs						
30	*mA	1.1	both 4-20mA			
31	*OUTP.F	1.1	SC1 & SC2.			
	*D/R	0	Reverse (control)			
32	*BURN	0.0	both off			
33	*RG.mA2	prop band	only for PI control			
34	*tI.mA2	integ. time	only for PI control			
35	*TABL1	21 pt table	see code 31, §10.1			
36	*TABL2	21 pt table	see code 31, §10.1			
37	*DAMP	0 sec	Output damping			
Contacts						
40	*S1	2.0.1	high SC1 Al.			
41	*S2	1.0.1	low SC2 Al.			
42	*S3	0.0.0				
43	*S4	4.0.0	FAIL			
44	*D.TIME	0.2	sec			
	*SC.HYS	2.0	% setpoint value			
	*T. HYST	1	°C			
	*C.HYST	0	% setpoint value			
45	*RANGE	1	% output span			
	*PER	10	sec			
	*FREQ	70	p/min			
46	*tI.CNT	100	sec			
47	*EXPIR	0	off			
	*tE.min	15	min			
48	*SC1	0	100µS/cm control range			
		0	20MΩ•cm			
	*SC2	0	100µS/cm control range			
		0	20MΩ•cm			
User Interface						
50	*RET	1	on			

FUNCTION		SETTING DEFAULTS		USER SETTINGS		
51	*MODE	0	off			
52	*PASS	0.0.0	all off			
53	*Err.1.1/1.2	1	hard fail			
	*Err.5.1/5.2	1	hard fail			
	*Err.6.1/6.2	1	hard fail			
	*Err.7.1/7.2	1	hard fail			
	*Err.8.1/8.2	1	hard fail			
	*Err.13.1/13.2	0	soft fail			
	*Err.22	0	soft fail			
54	*E5.LIM1	25 0.04	mS/cm kΩ•cm			
	*E6.LIM1	1 1	µS/cm MΩ•cm			
	*E5.LIM2	25 0.04	mS/cm kΩ•cm			
	*E6.LIM2	1 1	µS/cm MΩ•cm			
55	*%	0.0	Both off			
	*%1					
	*0%					
	*100%					
	*%2					
	*0%					
	*100%					
56	*DISP	0 (2)	Auto ranging (SC) (xx.xx MΩ•cm) (RES)			
57	*USP	0.0	Both disabled			
58	*CALC	5	SC1			
Communication						
61	*HOUR					
General						
70	*LOAD	reset	defaults			
Test and setup mode						
80	*TEST					

10.7 Configuration checklist for DC402G

Standard Configuration	Options	Reference for change	
Measured Variable(s)			
primary inputs	Conductivity (SC) and Temp	Resistivity i.s.o Conductivity	code 01
conductivity range	0.000 µS/cm - 100 µS/cm	any span within 0.000µS/cm - 1999mS/cm	“range”
conductivity units	Auto ranging µS/cm - mS/cm	Choice out of fixed µS/cm or mS/cm	code 56
resistivity range	0 - 19.99 MΩ•cm	any span within 0.000kΩ•cm - 999MΩ•cm	“range”
resistivity units	MΩ•cm	Auto ranging or other fixed values	code 56
temperature range	0 - 100 °C	any span in -20 ... +250	“range”
temperature unit	Celsius	Fahrenheit	code 11
Outputs			
analog output	4- 20 mA for SC	0- 20 mA or 4- 20 mA	code 30
second output	4- 20 mA for Temp	0- 20 mA or 4- 20 mA	code 30
output allocation	SC and Temp	SC, Resistivity, Temp, Table, PI control	code 31
contact outputs	S1= high at 100 µS/cm S2= low at 100 µS/cm S4= FAIL	(4) freely programmable	“setpoint” code 40. 41, 42, 43
contact allocation	mS/cm and FAIL	µS/cm, mS/cm, kΩ•cm, MΩ•cm, temp, PI control, HOLD, FAIL	code 40- 43
contact variables	dead time= 0.2 s; hyst= 0.1%	time: 0- 200 s; hyst 0.1- 100%	code 44
add. contact functions	none	time out alarm	code 47
control functions	none	PI on contacts or mA output	code 45, 46, 34, 33
digital outputs	none (Don’t use.)	–	code 60
Communication			
digital interface	disabled (Don’t use.)	–	code 60
variables on display	µS/cm (mS/cm) and temp	TC, %w/w, °C, mA1, mA2, CC, TR, REL	“display”
burn out	disabled	burn low (3.5)/ high (22) on mA1/ mA2	code 32
password protection	disabled	for maint/ comm./ serv level	code 52
autoreturn	return to measure in 10 min.	enable or disable	code 50
add. function in MAINT	disabled	setpoint adj	code 51
Diagnostics			
check on polarization	enabled	enable or disable	code 05
check on cell constant	active		“calibrate”
check on TC coefficient	active		“temp.”
Compatibility			
SC sensor	SC40, SX42	SC8SG, L&N compatible	code 10
temperature sensor	Pt1000	Ni100, PB36, Pt100, 8k55	code 10
cell constant	0.100/cm	from 0.008/cm up to 50.0/cm	code 03
Special Features			
temperature calibration	none	adjustment +/- 15 °C	code 12
zero calibration	none	adjustment -1 µS/cm	code 04
temp. comp.	acc to NaCl tables IEC 60746-3	NaCl, manual TC, matrix code 20 - 28	“temp.”,
HOLD during maintenance	disabled	hold last or hold fix	“Hold”
contact during HOLD	disabled	possible on S1,S2 or S3	code 40- 42
soft fail alarm	disabled	possible for E1, E5...E13, E22	code 53

10.8 USP <645> Water Purity Monitoring

What is USP?

USP stands for United States Pharmacopeia and it is responsible for issuing guidelines for the pharmaceutical industry. Implementing these guidelines is highly recommended for companies wishing to market drugs in the US. This means that USP is important for pharmaceutical companies worldwide. This new USP, aims at the replacement of 5 antiquated laboratory tests by simple conductivity analysis.

How have we accomplished this in DC402G?

1. In Software Rev. 1.1, (and later versions) we have defined an Error Code: E13. This is independent of what range the customer is measuring or what temperature compensation method he is using for water quality monitoring. When the display shows E13, then the water quality exceeds the USP limits, and the FAIL contact closes to signal that the system needs urgent attention.
2. We have introduced uncompensated conductivity in the DISPLAY menu. In the LCD display the user can read the temperature and the raw conductivity to compare his water quality with the USP table.
3. We have added a USP function to the contact allocation. All 4 contacts can be selected as USP alarms. The contact closes when the USP limit is approached. It is possible to adjust a safety margin for the water quality. For example, if the temperature is 64 °C. and the safety margin is adjusted for 20%, then the contact closes at 0.8 x 2.2 µS/cm. = 1.76 µS/cm. (2.2µS/cm is the USP limit at 64°C).
4. We have kept all the DC402G functionality: It is even possible to have the mA Output and Display readings in resistivity units. Most users will have very good water quality and in the resistivity mode they will have better resolution on the recorder or DCS. The readings are simply the reciprocal values of the conductivity values. In the example mentioned above the contact will close at an uncompensated resistivity of 1/1.76 µS/cm. = 0.568 MΩ•cm.

Setting up DC402G for USP

First enable USP in service code 57. Change the setting from 0 (default) to 1 (enabled).

This activates uncompensated conductivity in the display menu. The E13 alarm feature is also enabled. For E13 the FAIL alarm (S4) is triggered when the uncompensated conductivity exceeds the relevant value in the graph.

USP warning alarms can be selected for any of the 4 relay outputs.

Service codes 40 to 43 are for these alarms.

Set to 2.5.1 for input one, or 2.5.2 for input two.

The setpoint is the safety margin in %, and is set as described in sections 5.1.3 & 5.2.2.

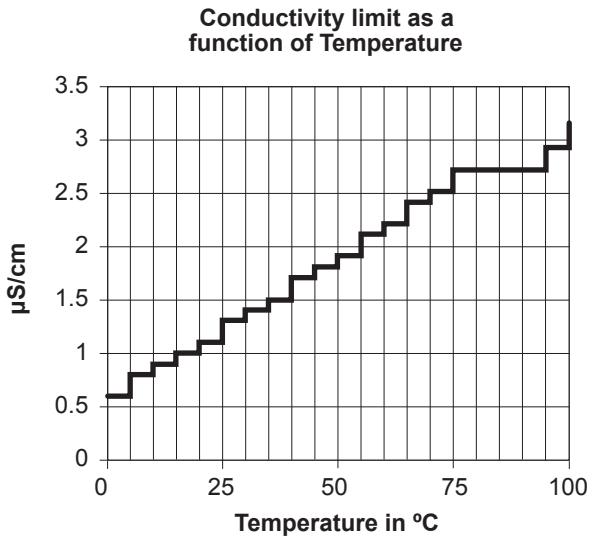


Fig. 10.1

10.9 WHAT IS DUAL CONDUCTIVITY?

Dual cell conductivity is a precise, comparative measurement.

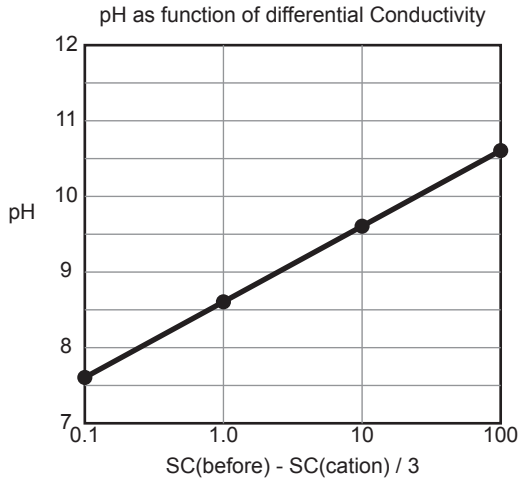
The DC402G receives inputs from two conductivity cells located at different points in the process and compares them according to one of six programmed user-selectable formula

- Ratio (a/b)
- Differential or linear difference (a-b)
- Percent passage (b/ax 100)
- Percent rejection {(a-b)/a x100}
- Deviation {(b/a) a x100}
- pH calculation acc. VGB directive 450L

The output signal corresponds directly to the formulas. The DC402G also displays the absolute value of each cell on a second display line, as desired by the user.

The unit displays all values in conductivity units (µS/cm or mS/cm), percentage (%), resistivity (MΩ•cm) or pH.

The pH value of the (boiler) water/condensate is calculated from the conductivity value before and after the cation filter according the VGB directive 450L.



This pH calculation requires two conductivity values which are compensated to 25ºC.

Normally matrix compensation for morpholine/ammonia and cation are used (service code 22 should be set to 2.1 or 3.1). Consequently the pH value displayed corresponds to 25ºC.

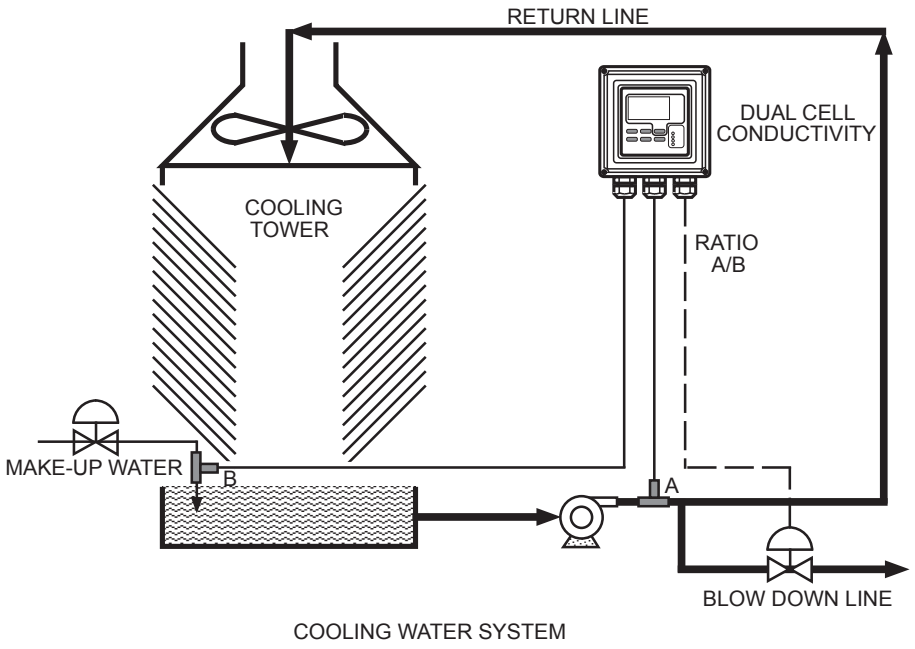


Fig. 10.2 Ratio output controls blow-down of cooling tower based on concentration factor.

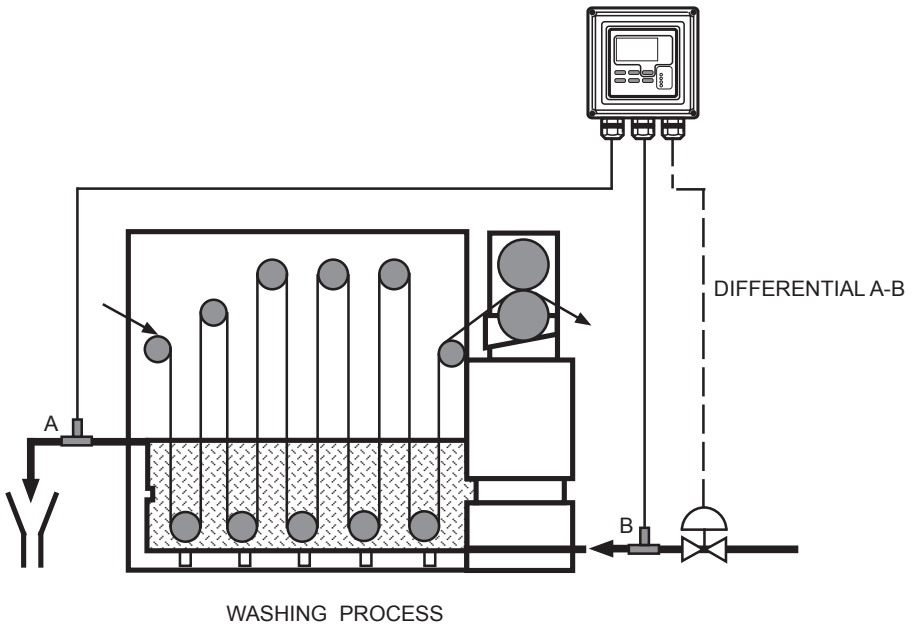


Fig. 10.3 Differential output water flow to optimize washing efficiency.

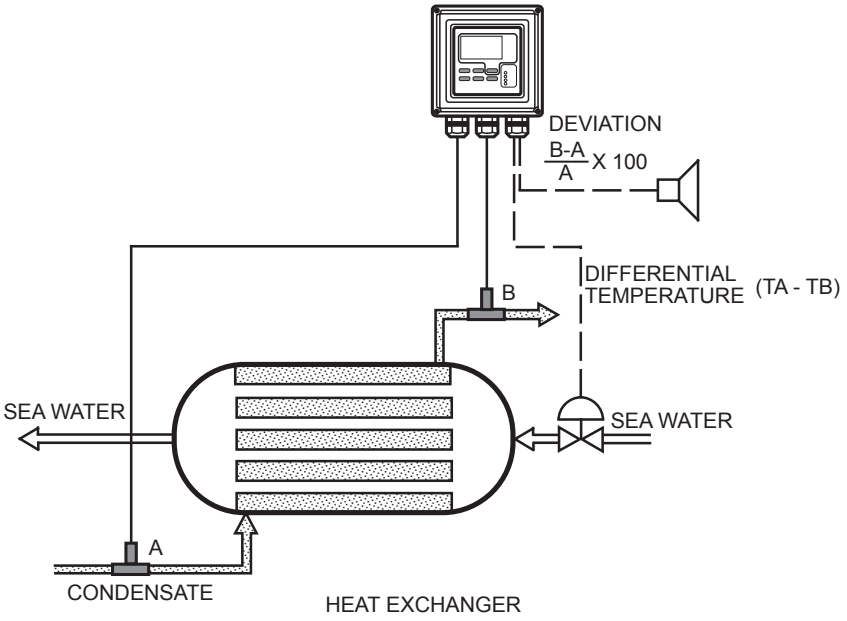


Fig. 10.4 Deviation output alarms directly after leakage in the heat exchanger.

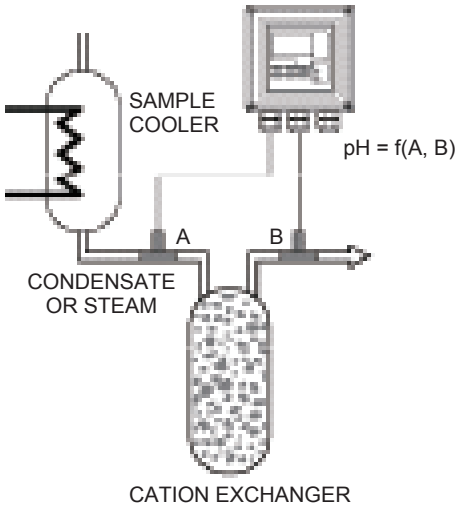


Fig. 10.5 pH output as a function of two conductivity values before and after the cation exchanger.

Error codes

Code	Error description	Possible cause	Suggested remedy
E1	Polarization detected on cell	Sensor surface fouled Conductivity too high	Clean sensor Replace sensor
E2	Temperature coefficient out of limits (exceeds 0 to 3.5%/ºC range)	Incorrect field calibration of TC	Re-adjust Set calculated TC
E3	Calibration out of limits	Calibrated value differs more than +/- 20 % of nominal value programmed in code 03.	Check for correct sensor Check for correct unit (µS/cm, mS/cm, kΩ•cm or MΩ•cm) Repeat calibration
E4	Matrix compensation error	Wrong data entered in 5x5 matrix	Re-program
E5	Conductivity too high or resistivity too low (Limits set in service code 54)	Incorrect wiring Internal leakage of sensor Defective cable	Check wiring (Sec. 3.6) Replace sensor Replace cable
E6	Conductivity too low or resistivity too high (Limits set in service code 54)	Dry sensor Incorrect wiring Defective cable	Immerse sensor Check wiring (Sec. 3.6) Replace cable
E7	Temperature sensor open (Pt1000 : T > 250°C or 500°F) (Pt100/Ni100 : T > 200°C or 400°F) (8k55 : T < -10°C or 10°F) (PB36 : T < -20°C or 0°F)	Process temperature too high or too low Wrong sensor programmed Incorrect wiring	Check process Check model code sensor Check connections and cable
E8	Temperature sensor shorted (Pt1000/Pt100/Ni100 : T < -20°C or 0°F) (8k55/PB36 : T > 120°C or 250°F)	Process temperature too high or too low Wrong sensor programmed Incorrect wiring	Check process Check model code sensor Check connections and cable
E9	Air set impossible	Too high zero due to cable capacitance	Replace cable
E10	EEPROM write failure	Fault in electronics	Try again, if unsuccessful contact Yokogawa
E13	USP Limit exceeded	Poor water quality	Check-ion exchangers
E15	Cable resistance influence to temperature exceeds +/- 15°C	Cable resistance too high Corroded contacts Wrong sensor programmed	Check cable Clean and reterminate Reprogram
E17	Output span too small	Incorrect configuration by user	Reprogram
E18	Table values make no sense	Wrong data programmed	Reprogram
E19	Programmed values outside acceptable limits	Incorrect configuration by user	Reprogram
E20	All programmed data lost	Fault in electronics Very severe interference	Contact Yokogawa
E21	Checksum error	Software problem	Contact Yokogawa
E22	Alarm activation time exceeded	Process control not effective within set time	Check control equipment Adjust value in code 47
E24	Calculation out of limits	Incorrect configuration Extreme process condition	Check settings Check process

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Revision Information

- Title : Model DC402G Converter for Dual Cell Conductivity and Resistivity [Style: S2]
- Manual No. : IM 12D08E02-01E

June 2017/7th Edition
Deleted CE-mark and its description. (pages i, iii, iv, 2-4, 3-4)

Feb. 2016/6th Edition
EN 61010-2-201 addition, etc.

Aug. 2015/5th Edition
Review all for a document software change.
Note addition for CSA safety standards, etc. (Pages iii, 1-1, 2-3, 2-4, 2-5, Chapter 3, 7-2)
Delete chapter 11.

Feb. 2014/4th Edition
Page 2-3, 3-3 Safety standard is revised.
Appendix 2 Quality Inspection added.
PREFACE, Addition of “How to dispose the batteries”.
Page Appendix 2 11-1 to 11-4 QIS 12D08E02-01E, QIC-12D08E02-01 revised (some change of withstanding voltage test).
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Appendix 2 Quality Inspection added.

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Page 2-3: Some of E. Housing and K. Safety and EMC conforming standards description revised (addition of CSA certified); Page 3-3: Terminal label of Figure 3-4 revised, CSA added to WARNING; Page 3-4: The torque to tighten frontplate screws added; Page 3-9: Terminal label of Figure 3-11 revised; Page 5-14: Some caution added to 5-3. Notes for guidance in the use of service code settings; Page 5-15: Code 12 description page moved; Page 5-17: Code 22 *MATRX description corrected; Page 5-25: Default value of code 58 added

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