User Guide OI/TB82TC–EN Rev. B

Type TB82TC Advantage Series™ Toroidal conductivity transmitter

Power and productivity
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WARNING notices as used in this manual apply to hazards or unsafe practices which could result in personal injury or death.

CAUTION notices apply to hazards or unsafe practices which could result in property damage.

NOTES highlight procedures and contain information which assist the operator in understanding the information contained in this manual.

WARNING

INSTRUCTION MANUALS
DO NOT INSTALL, MAINTAIN, OR OPERATE THIS EQUIPMENT WITHOUT READING, UNDERSTANDING, AND FOLLOWING THE PROPER ABB INSTRUCTIONS AND MANUALS, OTHERWISE INJURY OR DAMAGE MAY RESULT.

RADIO FREQUENCY INTERFERENCE
MOST ELECTRONIC EQUIPMENT IS INFLUENCED BY RADIO FREQUENCY INTERFERENCE (RFI). CAUTION SHOULD BE EXERCISED WITH REGARD TO THE USE OF PORTABLE COMMUNICATIONS EQUIPMENT IN THE AREA AROUND SUCH EQUIPMENT. PRUDENT PRACTICE DICTATES THAT SIGNS SHOULD BE POSTED IN THE VICINITY OF THE EQUIPMENT CAUTIONING AGAINST THE USE OF PORTABLE COMMUNICATIONS EQUIPMENT.

POSSIBLE PROCESS UPSETS
MAINTENANCE MUST BE PERFORMED ONLY BY QUALIFIED PERSONNEL AND ONLY AFTER SECURING EQUIPMENT CONTROLLED BY THIS PRODUCT. ADJUSTING OR REMOVING THIS PRODUCT WHILE IT IS IN THE SYSTEM MAY UPSET THE PROCESS BEING CONTROLLED. SOME PROCESS UPSETS MAY CAUSE INJURY OR DAMAGE.

Preface

This publication is for the use of technical personnel responsible for installation, operation, and maintenance of the ABB's Advantage Series TB82TC.

Where necessary, this publication is broken into sections detailing the differences between transmitters configured for conductivity or concentration. In addition, the configuration section will give a detailed overview of all transmitter functions and how these functions have been grouped into the two major configuration modes: Basic and Advanced.

The Series TB82TC transmitter is delivered with default hardware and software configurations as shown in the table below. These settings may need to be changed depending on the application requirements.

<table>
<tr><th colspan="3">Factory Default Settings</th></tr>
<tr><th colspan="2">Software</th><th>Hardware</th></tr>
<tr><td>Instrument
Mode:</td><td>Basic</td><td rowspan="8">Microprocessor/Display PCB
W1 (Configuration Lockout):[2] — 1-2, Disable Lockout[3]
2-3, Enable Lockout

[1] Feature available only in Advanced programming.
[2] See Figure 8-5 for jumper location.
[3] Bold text indicates default hardware settings.</td></tr>
<tr><td>Analyzer
Type:</td><td>Conductivity</td></tr>
<tr><td>Temperature Sensor
Type:</td><td>3k Balco</td></tr>
<tr><td>Temperature Compensation
Type:</td><td>Manual</td></tr>
<tr><td>Output
Range:</td><td>0.00 to 199.9 mS/cm</td></tr>
<tr><td>Damping
Value:</td><td>0.5 Seconds</td></tr>
<tr><td>Safety Mode
Failed Output State:</td><td>Low</td></tr>
<tr><td>Spike Output[1]
Level:</td><td>0%</td></tr>
</table>

List of Effective Pages

Total number of pages in this manual is 152, consisting of the following:

Page No.	Change Date

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Safety Summary

GENERAL WARNINGS	**Equipment Environment** All components, whether in transportation, operation, or storage, must be in a noncorrosive environment. **Electrical Shock Hazard During Maintenance** Disconnect power or take precautions to insure that contact with energized parts is avoided when servicing.

SPECIFIC WARNINGS	Use this equipment only in those classes of hazardous locations listed on the nameplate. Installations in hazardous locations other than those listed on the nameplate can lead to unsafe conditions that can injure personnel and damage equipment. Allow only qualified personnel (refer to INTENDED USER in SECTION 1, INTRODUCTION) to commission, operate, service, or repair this equipment. Failure to follow the procedures described in this instruction or the instructions provided with related equipment can result in an unsafe condition that can injure personnel and damage equipment. Consider the material compatibility between cleaning fluids and process liquids. Incompatible fluids can react with each other causing injury to personnel and equipment damage. Use solvents only in well ventilated areas. Avoid prolonged or repeated breathing of vapors or contact with skin. Solvents can cause nausea, dizziness, and skin irritation. In some cases, overexposure to solvents has caused nerve and brain damage. Solvents are flammable - do not use near extreme heat or open flame. Substitution of any components other than those assemblies listed in this section will compromise the certification listed on the transmitter nameplate. Invalidating the certifications can lead to unsafe conditions that can injure personnel and damage equipment. Do not disconnect equipment unless power has been switched off at the source or the area is known to be nonhazardous. Disconnecting equipment in a hazardous location with source power on can produce an ignition-capable arc that can injure personnel and damage equipment. All error conditions are considered catastrophic. When such an error has been reported, the transmitter should be replaced with a known-good transmitter. The non-functional transmitter should be returned to the factory for repair. Contact the factory for processing instructions.

SPECIFIC CAUTIONS	To prevent possible signal degradation, separate metal conduit runs are recommended for the sensor and signal/power wiring.

SECTION 1 - INTRODUCTION

OVERVIEW

The TB82TC Series is a 2-wire, 4 to 20 mA compatible conductivity/concentration transmitter with state-of-the-art electronics, internal and external diagnostic functionality, innovative user interface having SmartKey capability, two user-selectable modes of operation, and DIN size packaging.

Diagnostic interrogation of the internal circuitry and external sensing devices are continually conducted to ensure accuracy and provide immediate notification of problem situations when they occur. Diagnostic functions monitor slope, process variable over/under range, and temperature over/under range. When these diagnostic conditions occur, the transmitter can be programmed for local or remote diagnostic alarming.

The transmitter packaging conforms to DIN standards and has mounting options that include pipe, wall, hinge, and panel installations. Due to the modular design of the electronics, changing the transmitter sensing capability to other analytical properties such as pH/ORP/pION, Two-Electrode Conductivity, or Four-Electrode Conductivity can be quick and easy.

The user interface is an innovative, patent-pending technology which facilitates a smooth and problem-free link between the user and transmitter functionality. The programming structure and multi-function keys reduce programming difficulties by providing a toggle between *Basic* and *Advanced* functions.

INTENDED USER

Installation Personnel

Should be an electrician or a person familiar with the National Electrical Code (NEC) and local wiring regulations. Should have a strong background in installation of analytical equipment.

Application Technician

Should have a solid background in conductivity and/or concentration measurements, electronic instrumentation, and process control and be familiar with proper grounding and safety procedures for electronic instrumentation.

Operator

Should have knowledge of the process and should read and understand this instruction book before attempting any procedure pertaining to the operation of the TB82TC Series transmitter.

Maintenance Personnel

Should have a background in electricity and be able to recognize shock hazards. Personnel must also be familiar with electronic process control instrumentation and have a good understanding of troubleshooting procedures.

FEATURES

Diagnostic Sensor Capability

The TB82TC Series transmitter offers the necessary hardware and software for full compatibility with all TB404 Series Toroidal Conductivity Sensors and three different types of Resistive Temperature Devices. Diagnostic capability includes process and temperature variable over/under range and invalid calibration detection.

Multiple Applications

Accepts inputs from all ABB toroidal conductivity sensors. The isolated analog output allows use in grounded or floating circuits.

Automatic Temperature Compensation

Menu-selectable choices provide the user with a wide range of easily configurable selections for temperature compensation.

1. Manual (0.1N KCl based)
2. Automatic based on either:
   a) Standard (0.1N KCl based)
   b) Coefficient (0 to 9.99%/°C adjustable)
   c) 0 to 15% NaOH
   d) 0 to 20% NaCl
   e) 0 to 18% HCl
   f) 0 to 20% H_2SO_4
   g) User Defined

Wide Rangeability

Analog output span does not affect display range of 0 µS/cm to 1999 mS/cm for Conductivity and 0 to 1999 digits, specified in the configured Engineering Units, for Concentration. Minimum output span is 100 µS/cm.

Innovative User Interface

Using four Smart Keys and a custom Liquid Crystal Display (LCD), multiple functions have been assigned to each key and are displayed at the appropriate time depending on the programming mode being used. This patented technology reduces the number of keys and allows for the use of a larger, more visible LCD.

Simple Calibration

Zero and Span calibration routines for the process variable allows for greater flexibility in making adjustments to the sensor gain (i.e., slope) or offset. Smart temperature calibration routines automatically adjusts slope, offset, or both values to ensure precise measurement of the process temperature. Provisions for viewing and modifying the sensor calibration data are also included.

NEMA 4X/IP65 Housing

Suitable for corrosive environments, the electronics enclosure is a corrosion resistant, anodized aluminum alloy. A chemical resistant polyester powder coating provides external protection.

Suitable for Hazardous Locations

The TB82TC Series transmitter design complies with industry standards for intrinsically safe and non-incendive installations (certification pending).

Diagnostic Indication

The custom LCD has dedicated icons which act as visible indications of an output hold, fault, and diagnostic spike condition.

Secure Operation

A hardware lockout feature prevents unauthorized altering of instrument configuration parameters while allowing other transmitter functions to be fully accessible. Software security codes can also be assigned to the Configure, Calibrate, and Output/Hold Modes of Operation.

Compact Packaging

Industry standard ½-DIN size maintains standard panel cut-outs and increases installation flexibility by providing pipe, wall, hinge, and panel mounting options.

Nonvolatile Memory

In the event of a power failure, the nonvolatile memory stores and retains the configuration and calibration data.

Transmitter Diagnostics

Built-in electronic circuitry and firmware routines perform a series of self-diagnostics, monitoring such areas as memory and input circuit integrity. Irregularities are indicated for maintenance purposes.

EQUIPMENT APPLICATION

The TB82TC Series transmitter can be used anywhere conductivity or concentration measurements are desired.

INSTRUCTION CONTENT

Introduction

This section provides a product overview, the purpose of this publication, a description of the instruction manual sections, and how each section should be used. This section also has a glossary of terms and abbreviations, a list of reference documents on related equipment and/or subjects, the product identification (nomenclature), and a comprehensive list of hardware performance specifications including accessories and applicable certification information.

Transmitter Functionality And Operator Interface Controls

This section provides a short description on the functionality of the TB82TC series transmitter.

Installation

This section provides information on transmitter installation such as unpacking directions, location considerations, transmitter mounting options and procedures, wiring instructions for transmitter power/output, sensor connections, and grounding procedures.

Operating Procedures

This section addresses the operator interface controls and their functions. The Mode of Operation and transmitter condition icons are listed and their functions are described.

Measure Mode

This section describes the normal transmitter mode of operation which includes the primary and secondary display regions, Fault Information Smart Key, and Menu Smart Key functions.

Calibrate Mode

This section provides sensor and transmitter output calibration procedures and calibration data descriptions.

Output/Hold Mode

This section describes the Output/Hold States of Operation including hold, rerange, damping, and spike features.

Configure Mode

This section defines the required actions to establish and program the transmitter configuration.

Security Mode

This section provides the procedures necessary to set and clear transmitter security codes.

Secondary Display Mode This section provides the procedure necessary to set the information displayed in the secondary display region in the Measure Mode.

Utility Mode This section defines the reset options and Basic/Advanced programming toggle.

Diagnostics This section provides a description of the diagnostic tools available to aid with unit servicing. This section also provides a listing of displayed faults and the corrective action to be taken.

Troubleshooting This section provides an analyzer and sensor troubleshooting guide to help determine and isolate problems.

Sensor Maintenance This section provides cleaning procedures for conductivity sensors.

Repair/Replacement This section includes procedures for transmitter assembly and sensor replacement.

Support Services This section provides a list of replacement parts unique to the TB82TC Series transmitter.

Appendix A This section provides temperature compensation information.

Appendix B This section provides concentration configuration information.

Appendix C This section provides a glossary of text prompts used in the secondary display during transmitter programming.

Appendix D This section provides a configuration worksheet used to record the transmitter's configuration and show default values when a configuration reset is performed.

HOW TO USE THIS MANUAL

For safety and operating reasons, reading and understanding this product instruction manual is critical. Do not install or complete any tasks or procedures related to operation until doing so.

The sections of this product instruction are sequentially arranged as they relate to initial start-up (from UNPACKING to REPAIR/REPLACEMENT PROCEDURES). After initial start-up, refer to this instruction as needed by section.

GLOSSARY OF TERMS AND ABBREVIATIONS

Table 1-1. Glossary of Terms and Abbreviations

Term	Description
Analog	Continuously variable as opposed to discretely variable.
Boredom Switch	An automatic timer built into the TB82TC that returns the instrument to the Measure Mode of Operation if a user has entered another mode of operation and has not initiated another action for twenty minutes.
Conductivity	Term derived from Ohm's Law which is defined as **E=IR**. When voltage **E** is connected across an electric conductor, electric current **I** will flow which is dependent on the resistance **R** of the conductor. Conductivity is the reciprocal of resistance.
Control Output	The control system signal that influences the operation of a final control element.
Damping	Damping time described as a lag.
Digital	A discretely variable signal usually having only two states, on or off.
EEPROM	Electrically Erasable Programmable Read Only Memory. A type of non-volatile memory that is electrically programmed and erased.
EPROM	Erasable Programmable Read Only Memory. This memory holds the operation program for the microcomputer.

Term	Description
EU	Engineering Units. A set of units which define the numeric variable (e.g., ppm, %, TDS, etc.).
FS	Full Scale. The maximum allowable range specified for a given piece of equipment.
Ground Loop	A path between two separate ground connections thus allowing unwanted current flow through the measurement cabling or circuitry.
HotKey	A short-cut that moves the user from the View Configure State to the Modify Configure State of Operation.
Icon	A text or symbolic image representing a function, condition, or Engineering Unit.
LCD	Liquid Crystal Display. The custom three-and-one-half-digit display, six-character alphanumeric field, and support icons that allows for local readout of the process variable, programming of transmitter functions, and local indication of fault and hold conditions.
Loop	That portion of an analog process control loop which resides within the transmitter. It typically consists of an analog input measuring the process variable and an analog output driving a final control element or data recorder.
LSD	Least Significant Digit
µS/cm	Unit of conductivity, microsiemens per centimeter or 10^{-6} siemens/cm (equivalent to 1 micromho/cm).
mS/cm	Unit of conductivity, millisiemens per centimeter or 10^{-3} siemens/cm (equivalent to 1 millimho/cm).
Non-volatile Memory	Memory that retains programmed information such as configuration and calibration parameters, even when power is removed.
PCB	Printed Circuit Board. A flat board which contains pads for integrated circuit chips, components, and connections and electrically conductive pathways between those elements that function together to form an electronic circuit.

Term	Description
Process Variable	Temperature compensated conductivity or concentration, depending on the configured analyzer.
RH	Relative Humidity.
RTD	Resistive Temperature Detector. An element whose resistance has a relationship with the temperature of its surroundings.
SEEPROM	Serial Electrically Erasable Programmable Read Only Memory. A type of non-volatile memory that is electrically programmed and erased using serial communication techniques.
Slope	The linear relation between two sets of variables that describes the rate of change between these variables.
Solution Coefficient	A method of temperature compensation that assumes a constant change in solution conductivity to temperature. The units are in percentage of conductivity per ^{o}C.
SSD	Static sensitive device.
Temperature Compensation	Correction of the process variable for the effects of temperature.

REFERENCE DOCUMENTS

Table 1-2. Reference Documents

Number	Document
E67-23-2	Toroidal Conductivity Sensors
WTPEEUS110002A0	Sanitary Toroidal Conductivity Sensor
WTPEEUS520005A0	TB82TC Series Product Specification
P-E21-001	Installing a 4 to 20 mA Transmitter in a Hazardous Location

NOMENCLATURE

Type TB82 □ □ □ □ □ □ □ □ □ **Advantage Series Transmitter**

(Positions 5, 6, 7, 8, 9, 10, 11, 12, 13)

Position		
5–6		**Input**
	PH	pH/ORP/pION
	EC	Four-Electrode Conductivity
	TC	Toroidal Conductivity
	TE	Two-Electrode Conductivity
7		**Programming**
	1	Basic
	2	Advanced
8		**Digital Communications**
	0	None
	1	HART™
	2	FOUNDATION™ Fieldbus
	3	PROFIBUS™ PA
9		**Lightning Arrestor**
	1	Included
10		**Housing Type**
	0	Powder Coated, Anodized Aluminum
11		**Mounting Hardware**
	0	None
	1	Pipe
	2	Hinge
	3	Panel
	4	Wall
12		**Agency Approval (Consult Factory)**
	0	None
	1	FM
	2	CSA
	3	ATEX
13		**Label**
	0	None
	1	Stainless Steel
	2	Mylar

NOTE: A single digit or letter must be used in each nomenclature position.

SPECIFICATIONS

Table 1-3. Specifications

Property	Characteristic/Value
Process Display Range Conductivity Concentration	 0 μS/cm to 1999 mS/cm 0.000 to 1999 Digits (EU Configurable)
Temperature Display Range	-20° to 300°C (-4° to 572°F).
Sensor Full Scale Measurement Ranges	0 μS/cm to 1999 mS/cm
Resolution, Display Conductivity Concentration Temperature	 1 μS/cm 0.001 Digits (Configuration Dependent) 1°C, 1°F.
Accuracy, Display Conductivity Temperature Accuracy, Output	 ±0.1% FS 1°C ±0.02 mA For An Output Range Set To FS Values
Non-linearity, Display Conductivity Temperature Non-linearity, Output	 ±0.1% FS 1°C ±0.02 mA For An Output Range Set To FS Values
Repeatability, Display Conductivity Temperature Repeatability, Output	 ±0.5% FS 1°C ±0.02 mA For An Output Range Set To FS Values
Stability, Display Conductivity Temperature Stability, Output	 ±2 LSD Typical; 5 LSD Maximum 1°C ±0.01 mA For An Output Range Set To FS Values
Temperature Compensation	Manual (0.1N KCl based) Automatic - Configurable as: Standard (0.1N KCl based) Coefficient (0 to 9.99%/°C adjustable) 0 to 15% NaOH 0 to 20% NaCl 0 to 18% HCl 0 to 20% H_2SO_4 User Defined
Input Types Conductivity/ Concentration Temperature	 ABB Toroidal Conductivity Sensors ABB Toroidal Conductivity Sensors 3 kohm Balco, Pt 100, Pt 1000
Dynamic Response	3 sec. for 90% step change at 0.00 sec. damping.

Property	Characteristic/Value
Ambient Temperature Effect Conductivity Output	 ±0.05%/°C FS @ 95% RH ±0.01 mA/°C @ 95% RH
Output Minimum Span Conductivity Concentration	 100 μS/cm 5% Maximum Concentration Range
Output Maximum Span (full scale settings) Conductivity Concentration	 1999 mS/cm 1999 Digits
Damping	0.0 to 99.9 seconds
Supply Voltage	13 to 53 Vdc 13 to 42 Vdc (Required for Agency Approvals) Minimum supply voltage for HART transmitters is 13.5 Vdc. Add 0.5 Vdc to all minimum voltage values for Lightning Suppressor Power Supply version and add 1.0 Vdc when shorting jumper is removed from TEST terminals. Installation Category II.
Load Resistance Range	See Figure 1-1
Power Supply Effect	±0.02% of full scale span per volt
Turn-On Time	2 seconds typical, 4 seconds maximum
Maximum Sensor Cable Length	100 ft (30.5 m)
Sensor Diagnostic	PV and Temperature Over- or Under-Range and Slope and Offset Check
Diagnostic Notification Analog Mode	Local indication via a FAULT and SPIKE icon. Programmable output pulse, 0 to 16 mA for 1 second on 6 second cycles
Environmental Operating temperature LCD Range Storage temperature	 -20° to 60°C (-4° to 140°F) -20° to 60°C (-4° to 140°F) -40° to 70°C (-40° to 158°F)
Mounting Position Effect	None
Enclosure Classification	NEMA 4X IP65
Size Height Minimum panel depth Maximum panel cutout Recommended panel cutout	 144 mm high x 144 mm wide x 171 mm long (5.66 in. high x 5.66 in. wide x 6.70 in. long) 145 mm (5.70 in.) 139 mm x 139 mm (5.47 in. x 5.47 in.) 135.4 mm x 135.4 mm (5.33 in. x 5.33 in.)
Weight	4.2 lb (1.9 kg) without mounting hardware 7.5 lb (3.4 kg) with Pipe Mounting Hardware

Property	Characteristic/Value
EMC Requirements	CE certified: Electromagnetic Emission - EN50081-2: 1994 EN55011: 1991 (CISPR11: 1990) Class B Electromagnetic Immunity - EN50082-2: 1995 EN61000-4-2: 1995 4 kV Contact 4 kV Indirect EN61000-4-3: 1997 10 V/m 20 to 1000 MHZ EN61000-4-4: 1995 1 kV Signal Lines 5/50 T_r/T_h nS 5 kHz EN61000-4-8: 1994 50 Hz 30 A(rms)/m ENV50141: 1994 10 V (unmodulated, rms) 0.15 to 80 MHZ 80% AM (1 kHz) 150 ohms, source impedance ENV50204: 1996 10 V/m (unmodulated, rms) 900 ±5 MHZ 50% duty cycle 200 Hz
Agency Approvals[1] (pending) FM	Intrinsically safe (when used with appropriate barriers per application guide P-E21-001). Classes I, II, III; Division 1; applicable Groups A, B, C, D, E, F, and G; T3C. Nonincendive. Class I, Division 2, Groups A, B, C, and D. Class II, Division 2, Groups F and G. Class III, Division 2.
CSA	Intrinsically safe (when used with appropriate barriers per application guide P-E21-001). Classes I, II, III; Division 1; applicable Groups A, B, C, D, E, F, and G; T3C. Nonincendive. Class I, Division 2, Groups A, B, C, and D. Class II, Division 2, Groups E, F, and G. Class III, Division 2.
ATEX	Intrinsically safe (when used with appropriate barriers per application guide P-E21-001). EEX ia, Zone 1; Group IIC, T4.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

1. Hazardous location approvals for use in flammable atmospheres are for ambient conditions of -25° to 40°C (-13° to 104°F), 86 to 108kPa (12.5 to 15.7 psi) with a maximum oxygen concentration of 21%.

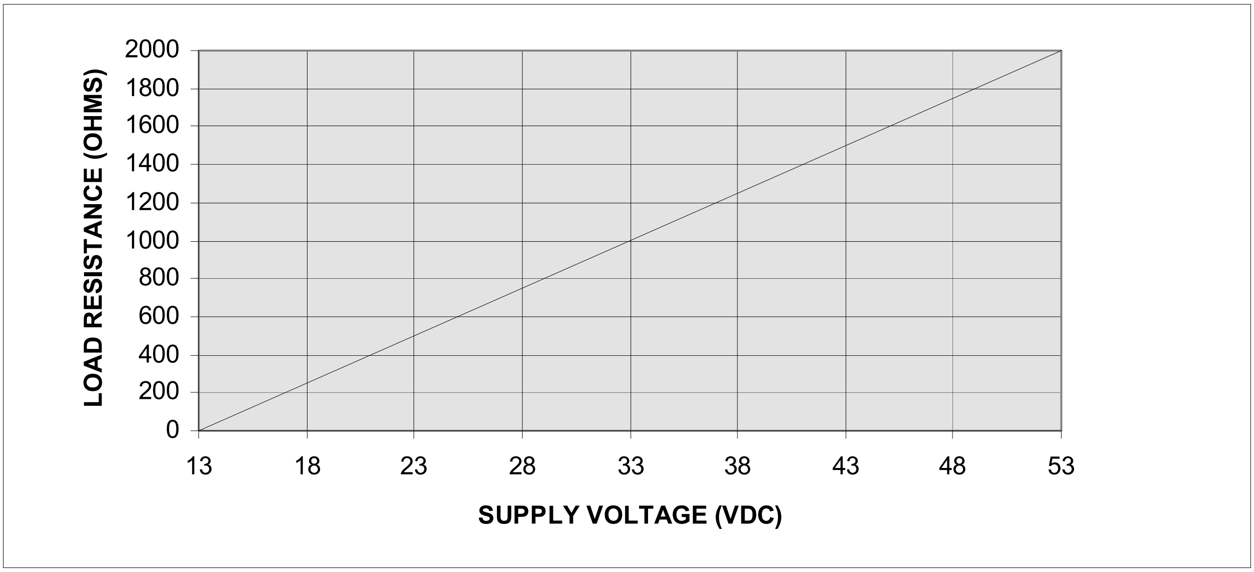


Figure 1-1. Load Limits

ACCESSORIES

Kits

Part Number	Mounting Kit
4TB9515-0124	Pipe
4TB9515-0125	Hinge
4TB9515-0156	Wall
4TB9515-0123	Panel

Sensors

Nomenclature	Fitting Type
TB4042	In-line, Submersible Low-pressure Ball Valve Insertion, High Pressure Ball Valve Insertion
TB4043	Sanitary Tri-Clamp

SECTION 2 - TRANSMITTER FUNCTIONALITY AND OPERATOR INTERFACE CONTROLS

INTRODUCTION

This section contains an overview of the TB82TC Toroidal Conductivity Series transmitter functionality, important information for configuration personnel and descriptions on the operator interface controls and transmitter modes of operation.

FUNCTIONAL OPERATION

The TB82TC Series transmitter provides a 4 to 20 mA output signal that is proportional to the solution conductivity as measured by the transmitter and sensor. The TB82TC Series transmitter is only compatible with ABB toroidal conductivity sensors.

The transmitter is equipped with diagnostic monitoring of the electronics and firmware for any potential problems. The diagnostic capability includes the detection of sensor integrity such as out of range process variables and invalid calibration values.

USER INTERFACE

The user interface consists of a tactile keypad having four non-dedicated keys and a custom LCD. The LCD has a three-and-one-half digit numeric region that displays the process variable, a six-character alphanumeric region that displays secondary information and programming prompts, and several status-indicating and programming icons.

Using a patented approach, each of the four keys is located under a given set of icons. In each of the transmitter modes and mode states, one icon over any given key will be illuminated and will represent the key's function. These Smart Key assignments will vary as the user moves into different programming modes and states. In addition to the Smart Key assignments, text located in the six-character alphanumeric field (i.e., secondary display) is used as programming prompts. The end result is an interface that provides a great deal of flexibility and functionality with a simple look and feel.

MODULAR ELECTRONIC ASSEMBLIES

The TB82TC Series transmitter consists of three separate PCB assemblies that concentrate specific circuit functionality onto each of the three boards. This modular design allows for the ability to change the transmitter from one of four types of instruments: pH/ORP/pION, four-electrode conductivity, two-electrode conductivity, and toroidal conductivity. In addition, instrument repair can be quickly accomplished by simply replacing the non-functioning board with an operational one.

TEMPERATURE COMPENSATION

The process temperature can be monitored using one of three types of RTD inputs: 3 kohm Balco, Pt100, and Pt1000. The secondary display area can also be set to display the temperature in degrees Celsius or Fahrenheit when the TB82TC Series transmitter is in the Measure Mode of operation.

Since temperature affects the activity of the disassociated ions in solution and hence the conductivity of the solution, temperature compensation is an essential feature. Manual or automatic temperature compensation functions can be set to any desired reference temperature. Temperature compensation options for conductivity and concentration configurations include Manual (0.1N KCl based) and seven types of Automatic Compensation routines. See Section 1, Introduction, for compensation types.

DAMPING

Input damping can be adjusted from 0 to 99.9 seconds. This feature is useful in noisy process environments to help reduce bounce in the displayed process variable and output current.

Damping simulates a capacitive type lag where reaction to any signal change is slowed according to an entered time constant. For example, a step change will reach approximately 63 percent of its final value in five seconds for five seconds of damping.

DIAGNOSTICS

Diagnostics are provided for both the transmitter and sensor. Diagnostic detection of a serious condition (i.e., Error Code - EC) that prevents the instrument from properly functioning enables a preset Safe Mode state. This Safe Mode state is configured by the user and forces the instrument output to be either high or low.

For problems that occur that do not render the transmitter in a non-functioning state (i.e., Problem Code - PC), the user has the option of linking these conditions to a Diagnostic Spike Output feature. Detection of over forty problem conditions can be enabled by the user if so desired.

In both cases, diagnostic conditions cause the FAULT and FAULT INFO icons on the display to be energized. Interrogation of each fault condition is available with a single keystroke.

Transmitter

Five critical errors in operation are monitored and linked to the Safe Mode feature. These conditions include inoperable or incorrect input circuit, bad RAM, and damaged EE memory.

Sensor

The transmitter continually performs diagnostics on sensor integrity. Inconsistencies in sensor performance are notified by the FAULT and FAULT INFO icons and the Spike Output feature if configured.

Sensor faults include shorted/open temperature sensor, high and low PV, high and low temperature, and many more. See Section 12, Diagnostics, for more details.

Spike Output

Remote notification of problem conditions is supported by the TB82TC Series transmitter using the SPIKE State in the Configure and Output/Hold Modes of operation. The Spike Output option allows users to program a 1 to 100% (i.e., 0.16 to 16 mA) pulse that will be impressed on the 4 to 20 mA output for 1 second out of a 6 second repeating cycle should a problem condition be detected. Should the actual output of the transmitter be below 12 mA, the pulse will add current; if the output is at 12 mA or above, it will subtract current.

SECTION 3 - INSTALLATION

INTRODUCTION

This section of the manual will aide the user in all levels of the installation process. The intention is to provide simple procedures for placing the TB82TC Series transmitter into service.

SPECIAL HANDLING

Besides the normal precautions for storage and handling of electronic equipment, the transmitter has special static sensitive device (SSD) handling requirements. This equipment contains semiconductors subject to damage by discharge of static electricity; therefore, avoid direct contact with terminal block conductors and electronic components on the circuit board.

To minimize the chances of damage by static electricity, follow these techniques during wiring, service, troubleshooting, and repair.

1. Remove assemblies containing semiconductors from their protective containers only:

    a. When at a designated static-free work station.

    b. After firm contact with an anti-static mat and/or gripped by a grounded individual.

2. Personnel handling assemblies with semiconductors must be neutralized to a static-free work station by a grounding wrist strap connected to the station or to a good ground point at the field site.

3. Do not allow clothing to make contact with semiconductors. Most clothing generates static electricity.

4. Do not touch connectors, circuit traces, and components.

5. Avoid partial connection of semiconductors. Semiconductors can be damaged by floating leads. Always install electronic assemblies with power removed. Do not cut leads or lift circuit paths when troubleshooting.

6. Ground all test equipment.

7. Avoid static charges during maintenance. Make sure the circuit board is thoroughly clean around its leads but do not rub or clean with an insulating cloth.

UNPACKING AND INSPECTION

Examine the equipment upon receipt for possible damage in transit. File a damage claim with the transportation company responsible, if necessary. Notify the nearest ABB sales office.

Carefully inspect the packing material before discarding it to make certain that all mounting equipment and any special instructions or paperwork have been removed. Careful handling and installation will insure satisfactory performance of the unit.

Use the original packing material and container for storage. Select a storage environment free of corrosive vapors and extremes of temperature and humidity. Storage temperatures must not exceed the values listed in Table 1-3, Specifications.

Remove the protective film from the transmitter lens after the transmitter has been placed in its final installed location.

LOCATION CONSIDERATIONS

When mounting the unit, leave ample clearance for removal of the front bezel and rear cover. Signal wiring should not run in conduit or open trays where power wiring or heavy electrical equipment could contact or interfere with the signal wiring. Twisted, shielded pairs should be used for the best results.

HAZARDOUS LOCATIONS

WARNING **Use this equipment only in those classes of hazardous locations listed on the nameplate. Installations in hazardous locations other than those listed on the nameplate can lead to unsafe conditions that can injure personnel and damage equipment.**

Refer to Table 1-3, Specifications, in Section 1 for a list of certifications and approvals applicable to the TB82TC Series transmitter.

Refer to the ***Installing a 4 to 20 mA Transmitter in a Hazardous Location*** application guide for additional information when using equipment in a hazardous area.

RADIO FREQUENCY INTERFERENCE

Most electronic equipment is affected to some extent by radio frequency interference (RFI). Caution should be exercised with regard to the use of portable communications equipment in areas where this electronic equipment is being used. Post appropriate cautions in the plant as required.

MOUNTING

The TB82TC transmitter can be pipe, hinge, wall, or panel mounted. Figure 3-1 shows the overall dimensions of the TB82TC without mounting hardware. Mounting hardware attaches to the four sets of threaded holes located on the corners of the main housing. To ensure adequate serviceability, select an installation site that minimizes shock and vibration. Additionally, this location must conform to the temperature constraints listed in Table 1-3, Specifications.

Pipe Mounting

The TB82TC Pipe Mount Kit (p/n 4TB9515-0124) contains a pipe and instrument mounting bracket with associated hardware. The pipe mounting bracket can be fitted to pipe sizes up to two-inches in diameter.

Using Figure 3-2 as a reference, mount the TB82TC transmitter as follows:

1) Select the desired orientation of the TB82TC transmitter;

2) Attach the instrument mounting bracket to the pipe mounting bracket using the supplied 3/8" x 3/4" bolts, 3/8" flat washers, 3/8" lock washers, and 3/8" nuts;

3) Attach the pipe mounting bracket to the pipe using the supplied 5/16" U-bolts, 5/16" flat washers, 5/16" lock washers, and 5/16" nuts; and

4) Attach the instrument to the instrument mounting bracket using the supplied 3/8" x 5/8" bolts, 3/8" flat washers, and 3/8" lock washers.

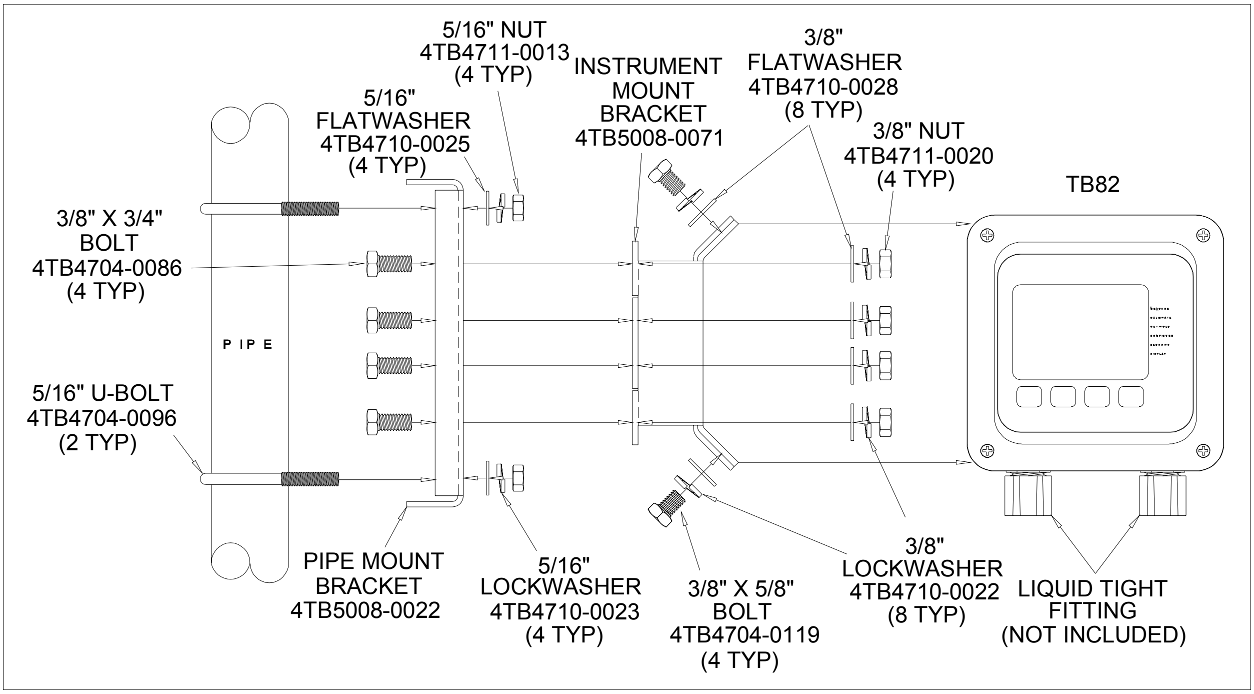


Figure 3-2. Pipe Mount Installation Diagram

Hinge Mounting

The TB82TC Hinge Mount Kit (p/n 4TB9515-0125) contains an L- and instrument mounting bracket, a stainless steel hinge, and associated hardware. The hinge mounting bracket provides easy access to the rear of the instrument.

Using Figure 3-3 as a reference, mount the TB82TC transmitter as follows:

1) Select the desired location and orientation of the TB82TC transmitter;

2) Attach the L-bracket to the selected location using the appropriate type of fastener as required by the type of mounting surface material;

3) Attach the stainless steel hinge to the L-bracket using the supplied 3/8" x 3/4" bolts, 3/8" flat washers, 3/8" lock washers, and 3/8" nuts;

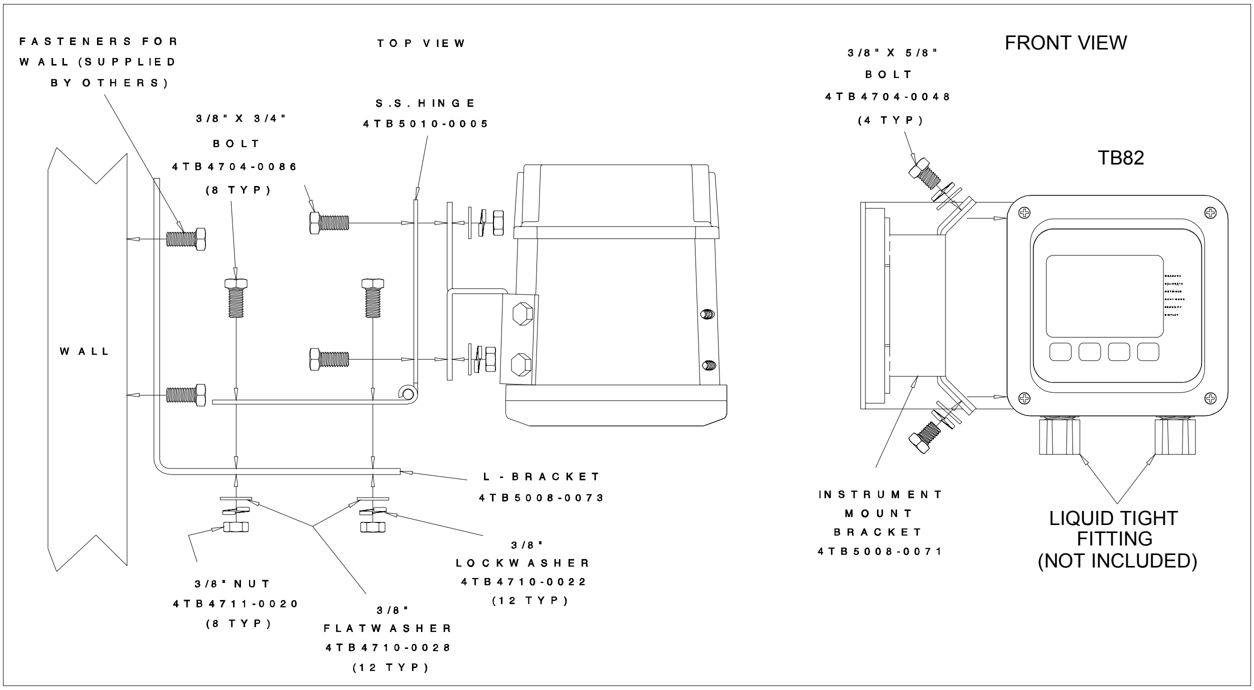


Figure 3-3. Hinge Mount Installation Diagram

4) Attach the instrument mounting bracket to the stainless steel hinge using the supplied 3/8" x 3/4" bolts, 3/8" flat washers, 3/8" lock washers, and 3/8" nuts; and

5) Attach the instrument to the instrument mounting bracket using the supplied 3/8" x 5/8" bolts, 3/8" flat washers, and 3/8" lock washers.

Wall Mounting

The TB82TC Wall Mount Kit (p/n 4TB9515-0156) contains an instrument mounting bracket with associated hardware. Wall mounting accommodates installations where the transmitter can be positioned for a clear line of sight and free access to the rear terminations. These types of installations include supporting beams, flange brackets, and wall ends.

Using Figure 3-4 as a reference, mount the TB82TC transmitter as follows:

1) Select the desired location and orientation of the TB82TC transmitter;

2) Attach the instrument mount bracket to the selected location using the appropriate type of fastener as required by the type of mounting surface material; and

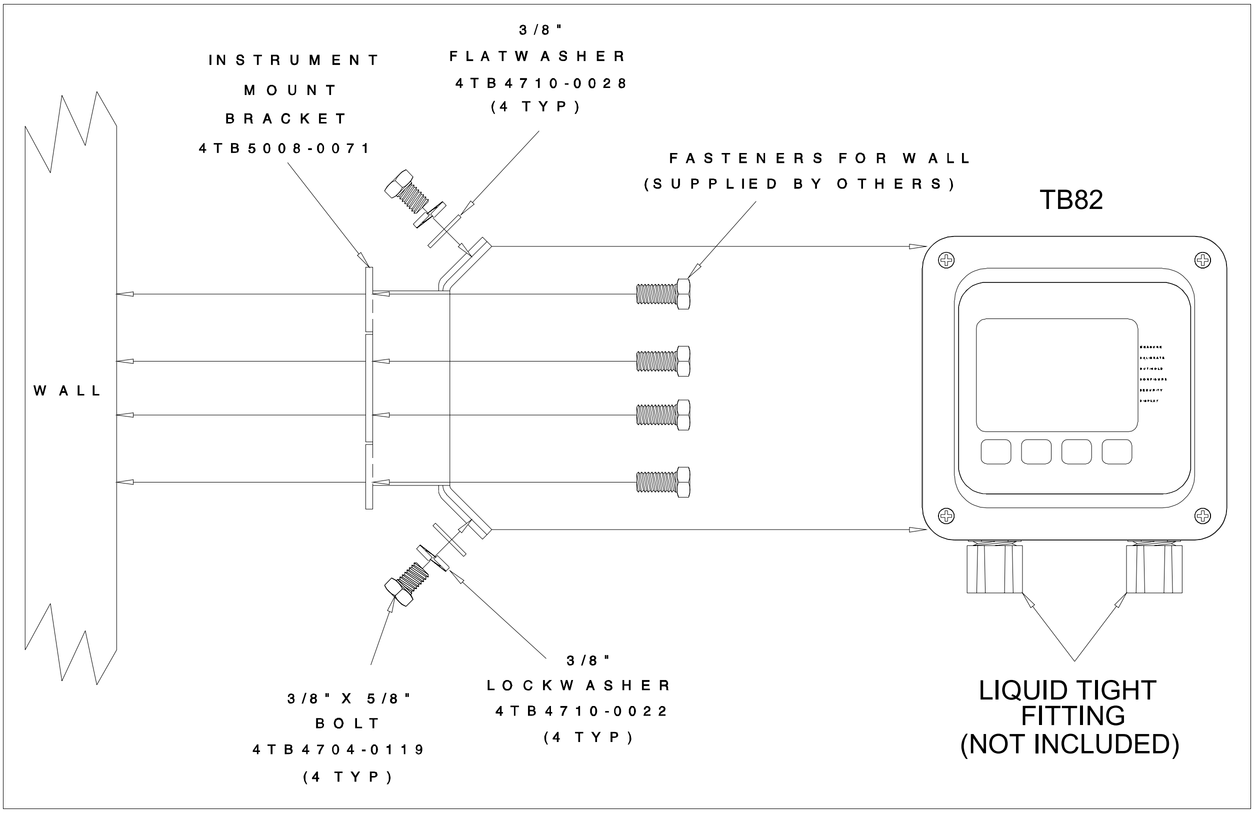


Figure 3-4. Wall Mount Installation Diagram

3) Attach the instrument to the instrument mounting bracket using the supplied 3/8" x 5/8" bolts, 3/8" flat washers, and 3/8" lock washers.

Panel Mounting

The TB82TC Panel Mount Kit (p/n 4TB9515-0123) contains four panel mounting bracket assemblies and a panel gasket. The TB82TC enclosure conforms with DIN sizing and requires a 135.4 mm x 135.4 mm cut-out for panel mounting. The panel brackets accommodate a maximum panel thickness of 3/8".

Using Figure 3-5 as a reference, mount the TB82TC transmitter as follows:

1) Select the desired location of the TB82TC transmitter;

2) Cut a 135.4 mm x 135.4 mm hole with diagonal corners through the panel as shown in Figure 3-5;

3) Install the panel gasket onto the instrument;

4) Insert the instrument through the panel cut-out;

5) Attach the panel mounting bracket assemblies to the four corners of the instrument; and

6) Tighten the adjustment screws on the panel mounting brackets until the instrument tightly seats against the panel.

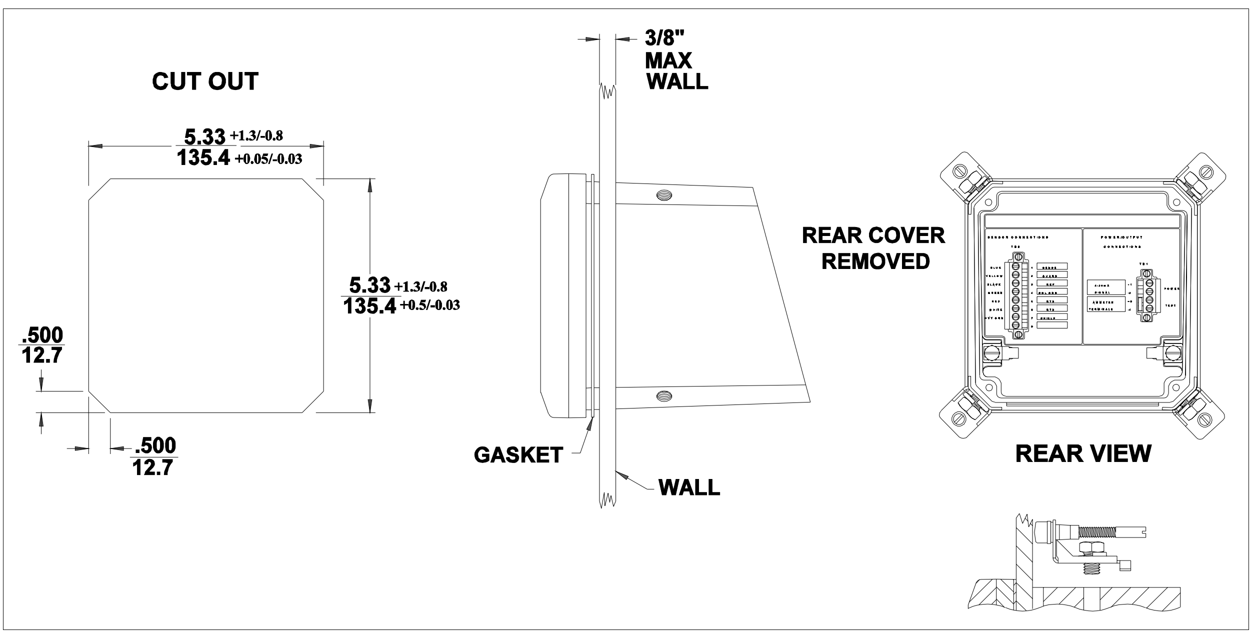


Figure 3-5. Panel Mount Installation Diagram

WIRING CONNECTIONS AND CABLING

CAUTION	**To prevent possible signal degradation, separate metal conduit runs are recommended for the sensor and signal/power wiring.**

Under ideal conditions, the use of conduit and shielded wire may not be required. However, to avoid noise problems, it is recommended that sensor and signal/power wiring be enclosed in separate conduit. Just prior to entering the housing, rigid conduit should be terminated and a short length of flexible conduit should be installed to reduce any stress to the housing.

Signal/power wiring must bear a suitable voltage rating, carry a maximum temperature rating of 75°C (167°F), and be in accordance with all NEC requirements or equivalent.

Signal/Power Wiring

The signal terminals, located in the back of the instrument housing (Figure 3-6), accept wire sizes 12 to 24 AWG. Pin-style terminals are recommended for all connections.

The terminal block label is marked **POWER** and shows the polarity for the signal connections. All wiring should not be run in conduit or open trays where power wiring or heavy electrical equipment could contact or physically and/or electrically interfere with the signal wiring. Twisted, shielded pairs should be used for cabling to ensure the best performance. Reverse polarity protection, built into the transm itter, protects it against accidental reversal of the field wiring connections.

All power passes over the signal leads. The maximum supply voltage is 53 Vdc. Minimum supply voltage (Figure 1-1) is determined by the loop resistance (R) as follows:

Minimum Supply = 13 Volts + 0.020 Amps x R (ohms)

Load resistance must include any meters external to the

TB82TC Series transmitter, the wiring, and the system input.

NOTE:
1) The equation for minimum supply voltage is based on a maximum output current of 20 mA. In some cases such as a fail high or process variable over-range condition, the output current limits to 21.5 mA. To support these cases, use 0.0215 instead of 0.020.

2) If the jumper is removed from the TEST terminals (i.e., TB1-3 and 4), the minimum lift-off voltage is 14.0 Vdc instead of 13.0 Vdc. Also, do not connect any permanent receiving devices (meters, recorders, etc.) to the TEST terminals. Only remove the jumper from the TEST terminals when attaching a temporary meter.

3) If using the optional lightning arrestor, add 0.5 Vdc to the minimum lift-off voltage.

Sensor Wiring

Instrument connections for the sensor wiring are located next to the signal connections. Sensor wiring should run in shielded conduit, or similar, to protect it from environmental influences. Do not allow the wires to become wet or to lay on the ground or over any other equipment. Ensure cables are not abraded, pinched, or bent at installation.

The sensor cable must be connected to the terminal block in the rear cavity of the TB82TC transmitter. The seven leads are color coded and have the following functions and connections:

Terminal Block Location	Sensor Color Code	Function
TB2-1	Black	Drive
TB2-2	Blue	Drive
TB2-3	White	Sense
TB2-4	Red	Sense
TB2-5	Green	RTD
TB2-6	Yellow	RTD
TB2-7	Hvy Grn	Shield
TB2-8	N/A	N/A

Use Figure 3-6 as a reference for making sensor wiring termination. Note, maximum wire gauge for the terminal connectors is 12 AWG; minimum is 24 AWG. Pin-style terminals are recommended for all connections.

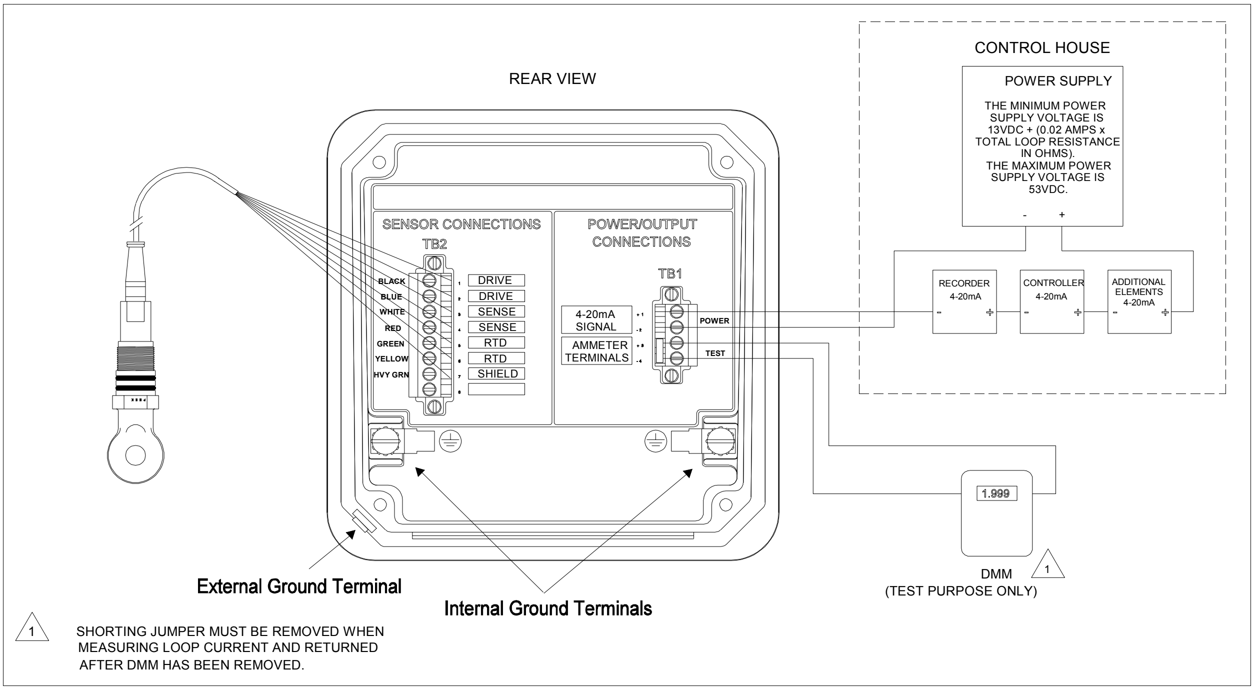


Figure 3-6. Instrument Wiring Diagram

GROUNDING

Signal wiring should be grounded at one point in the signal loop preferably before signal processing occurs or may be ungrounded (floating) if electrical noise is minimal. To improve transmitter shielding against electrical interface, the enclosure should be connected to earth ground using a large area conductor having less than 0.2 ohms of resistance. Internal and external earth ground terminals are provided for convenience and shown in Figure 3-6.

OTHER EQUIPMENT INTERFACE

The TB82TC Series is an isolated transmitter that controls the loop current between 4 and 20 mA depending on the range and process variable values. Since the TB82TC transmitter output is isolated, the instrument loop may have a maximum of one non-isolated device within its circuit. The maximum load on the current loop must not exceed the specification listed in Figure 1-1.

INSTRUMENT ROTATION

The TB82TC Series transmitter has four pairs of threaded mounting holes. Since these holes are located at the corners of the instrument, the TB82TC transmitter can be positioned in any of the four positions as demonstrated in Figure 3-7.

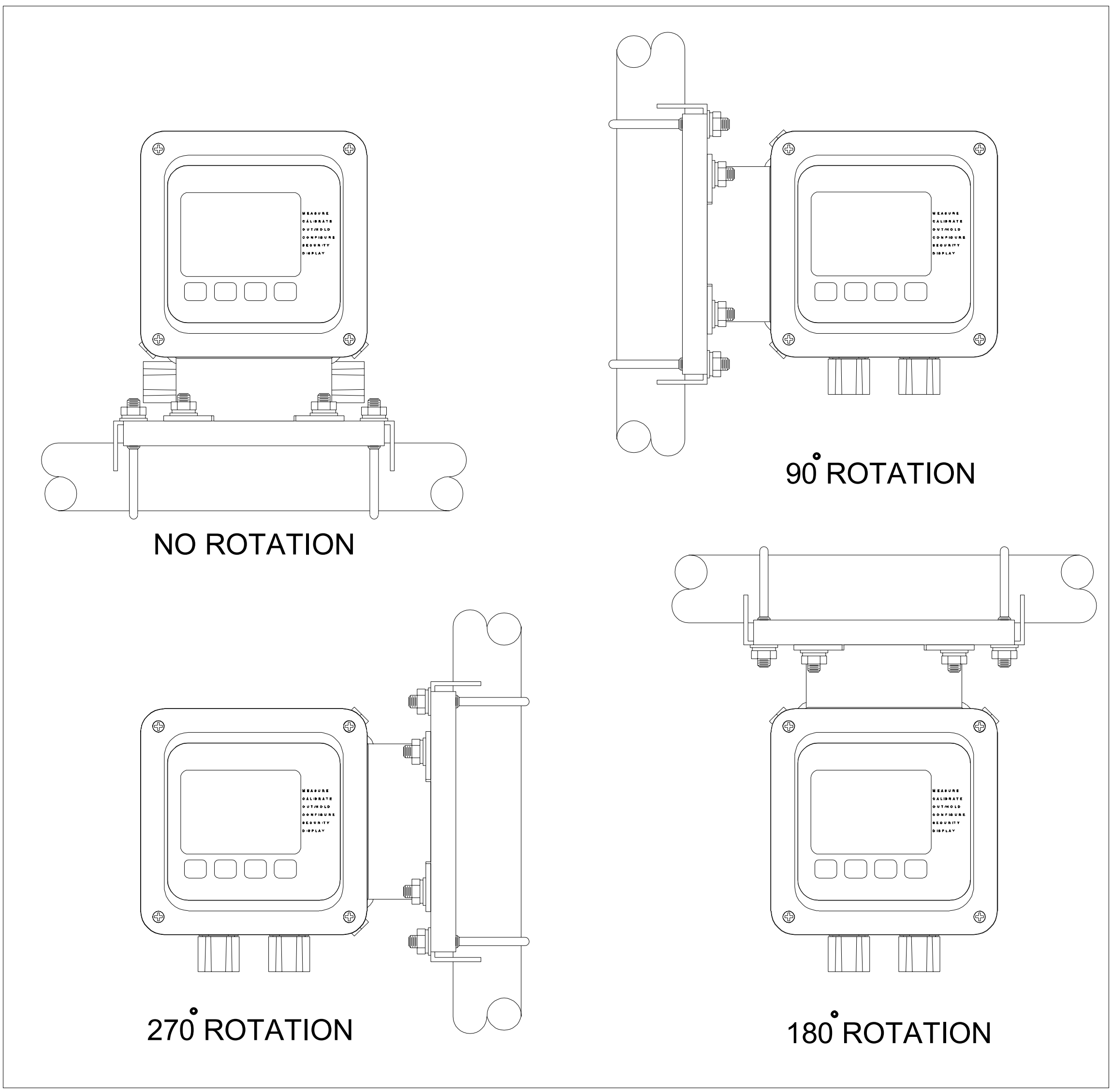


Figure 3-7. Mounting Rotation (Pipe Mount Shown)

SECTION 4 - OPERATING PROCEDURES

INTRODUCTION

The TB82TC Series transmitter has six main operating modes: Measure, Calibrate, Output/Hold, Configure, Security, and secondary Display. Within each mode, several programming states containing functions specific to the related mode are available.

The TB82TC Series transmitter is equipped with a built-in user interface through which all transmitter functions are programmed or monitored. In order to maximize the viewing area and minimize the space needed for the keypad, the interface is based on a custom LCD that contains groups of two or more icons for each button on the four-button keypad. The icon represents the function of the key.

Two display regions in the custom LCD handle the majority of instrument functions. These regions include a primary display area for the process variable (e.g., Conductivity) and a secondary display area for programming prompts or auxiliary information.

In addition to the user-friendly interface, the TB82TC Series transmitter is equipped with a group of icons that alerts the user of an existing FAULT condition, diagnostic SPIKE output, or output HOLD condition. These icons are located at the top of the LCD and are only energized when the specified condition is active. FAULT conditions are shown in the secondary display when the instrument is in the Measure Mode of Operation and the FAULT INFO key has been pressed.

OPERATOR INTERFACE CONTROLS REVIEW

Liquid Crystal Display (LCD)

The LCD contains nine regions that supply information on the primary and secondary process variables, engineering unit, mode of operation, key functions, and hold, spike, and fault conditions. Figure 4-1 shows a fully energized LCD and keypad representation.

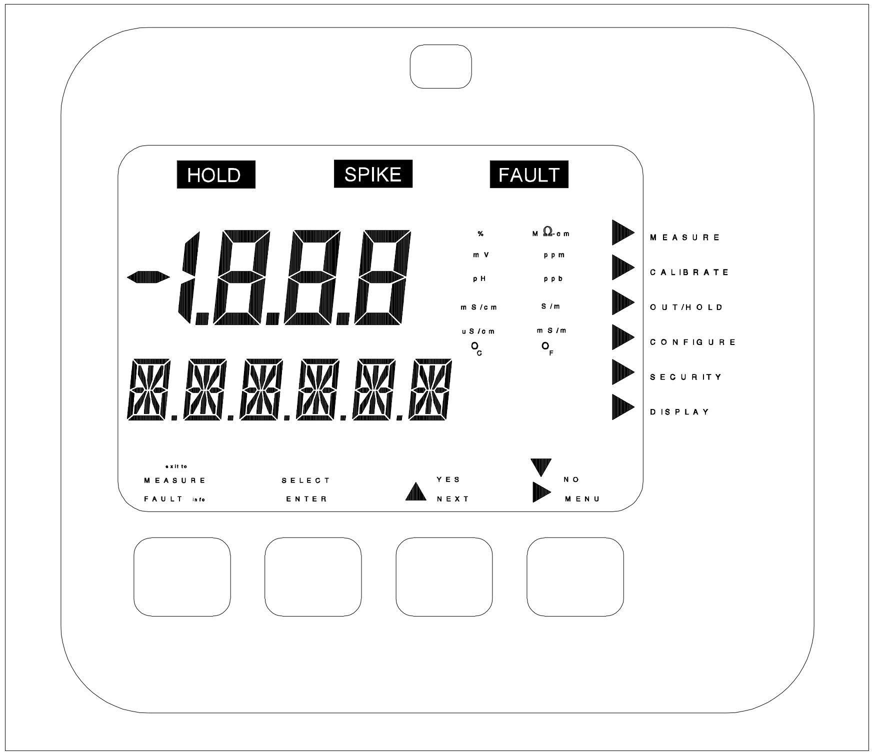


Figure 4-1. Fully Energized Display And Supporting Information

The top set of icons informs the user of an abnormal operating condition such as active HOLD, FAULT, or SPIKE states. These icons are only energized when such a condition is detected and are active in all modes of operation.

For the mode of operation indicators (shown as right arrows grouped next to the mode text), only one indicator will be lit and will indicate the current mode of operation of the transmitter. As a user moves from one mode to the next, the appropriate indicator will be energized. The mode of operation indicator is active in all modes of operation.

The process variable is displayed in the three-and-one-half digit, seven-segment region. This display region is supported by the engineering unit region. These regions are normally active in all modes of operation; however, some programming states use this region for data entry.

The secondary variable is displayed in the six-character, fourteen-segment region. This display region is used for displaying secondary information and fault information in the Measure Mode of Operation and textual programming prompts in all other modes of operation. Due to the limited number of characters for this display region, many of the prompts take the form of abbreviations (See Appendix B for abbreviation list). The secondary display region is active in all modes of operation.

The Smart Key assignments are grouped into four sets of icons, each group directly positioned above one of the four keys. These icons are textual representations of the function for the associated key. Only one assignment may be energized per Smart Key at any given time.

Multi-Function Smart Keys

A five-button, tactile keypad is located on the front panel of the instrument. The four main buttons are embossed to enhance their location. A fifth, hidden button located top, center of the keypad has been included to provide access to functions that are infrequently used.

The four embossed keys are called Smart Keys since their functions are dependent on the mode and/or state of the instrument. Since these four keys do not have a preassigned function, icons are energized over the key to indicate their function. If a Smart Key does not have an icon energized above its location, this key does not have a function and will not initiate an action when pressed. Using this Smart Key method, a reduced number of keys can be used without complicating instrument functionality.

Table 4-1. Smart Key Definition of Operation

Icon	Smart Key Function
exit to MEASURE	Escapes back to the Measure Mode from all other modes of operation and/or programming states. This function is not available in the Measure Mode.
FAULT info	Accesses information on diagnostic problem and/or error conditions. Displays this information as a short text string and code. Errors are always shown first in the order of detection. Problems are shown second also in the order of detection. This function is only available in the Measure Mode.
SELECT	Moves the user into the mode or programming state of operation shown in the secondary display region.
ENTER	Stores configured items and alpha numeric data into permanent memory.
YES	Initiates the action that is about to take place.
▲	Increments numeric values or moves through a series of parameters.
NEXT	Increments through a series of programming states.
▼	Decrements numeric values or moves through a series of parameters.
NO	Stops the action that is about to take place.
►	Steps to the right thus moving from one digit to the next.
MENU	Increments through the modes of operation.

For each operating mode and/or state, pressing the Smart Key initiates the displayed function of that Smart Key. For example, the function NEXT allows a user to cycle through a series of programming states. The function SELECT enables the user to enter into a given mode or programming state of operation. Using this method, the TB82TC Series transmitter guides the user through the necessary steps to program or monitor any desired function. A general description of each Smart Key function is given in Table 4-1.

MODES OF OPERATION

The Measure Mode is the normal operating mode of the TB82TC Series transmitter and is the default mode upon power-up. The Measure Mode is the starting point for entry into other modes of operation. Each mode contains a unique set of transmitter functions (i.e., programming states). These modes and their functions are shown in Table 4-2.

Table 4-2. Mode of Operation Definitions

MODE	FUNCTION
Measure	Used to display the process and secondary variable and is the normal operating mode of the transmitter.
Calibrate	Used to calibrate input and output functions.
Out/Hold	Used for on-line tuning of output parameters or to manually set the transmitter output, for example, during instrument maintenance.
Configure	Used to set transmitter functions such as the type of conductivity analyzer, temperature compensation, temperature sensor, temperature units, etc.
Security	Used to set password protection for Calibrate, Out/Hold, and Configure Modes of Operation.
Display	Used to select the variable shown in the secondary display region when the instrument is in the Measure Mode of Operation.

OUTPUT HELD ICON

The Output Hold icon energizes when a hold condition is active. An output hold condition can only be manually enabled. Manual activation is accessible in the Output/Hold Mode of Operation. In this mode, the Hold Programming State permits the output to be held at the current level or at a level manually set by the user.

FAULT ICON

The Fault icon energizes when a fault condition has been detected by the TB82TC Series transmitter. Fault conditions include all problem and error detection as outlined in Section 12, Diagnostics.

SPIKE ICON

When enabled, the Spike Output function induces a step change in the level of the output current. The magnitude of the step change is configured as a percentage of the output current. Once the TB82TC Series transmitter detects a fault condition and the Spike Output function is enabled, the transmitter output will begin to modulate and the Spike icon will energize. This function provides local and remote indication of a measurement loop fault condition. For more information on Spike Output and Fault conditions, see Section 12, Diagnostics.

SECTION 5 - MEASURE MODE

INTRODUCTION

The Measure Mode is the mode of operation upon transmitter power-up and is the normal operating state of the transmitter. In this mode, the process variable, output state, fault condition state, spike state, and secondary display information will be displayed. From the Measure Mode, all other modes of operation and fault information can be accessed.

BOREDOM SWITCH

When a user enters any operating mode or state and does not return to the Measure Mode as the final step, the TB82TC Series automatically returns to the Measure Mode of Operation after 20 minutes of unattended use. This feature ensures the transmitter will always be returned to its normal mode of operation.

PRIMARY DISPLAY

The primary display shows the process variable. The value of this variable is dependent on the configured analyzer, temperature compensation type, temperature value, sensor output, and damping value. The engineering units for the process variable are dependent only on the configured analyzer. Table 5-1 lists the analyzer types and corresponding engineering units.

Table 5-1. Engineering Unit And Analyzer Relationship

ANALYZER TYPE	ENGINEERING UNIT
Conductivity	• mS/cm • µS/cm
Concentration	• ppm (parts per million) • ppb (parts per billion) • % (percent) • User Defined

SECONDARY DISPLAY

The secondary display has the ability to show a large array of information. Since this display area has six characters, only one item can be shown at any given time. Typically, this region will be used for displaying the process temperature in degrees Celsius; however, it can be changed to display the process temperature in degrees Fahrenheit, output current in milliamperes (i.e., mA), sensor type, conductivity value and solute name for a concentration analyzer, and firmware revision. See Section 10, Secondary Display Mode, for more information.

FAULT INFORMATION Smart Key

Fault information can only be accessed from the Measure Mode of Operation and is interrogated through the FAULT Info Smart Key. A fault condition causes the FAULT icon to blink and the FAULT Info Smart Key to appear. These indicators will continue to be present as long as the fault condition continues.

When pressing the FAULT Info Smart Key, the first fault condition will be shown in the secondary display. A short text string followed by the fault code will be sequentially shown. Depressing the FAULT Info Smart Key progressively moves from one fault to the next until all faults have been shown. Once all faults have been cycled through, the FAULT icon will stop blinking and will remain on until all fault conditions have been removed. If a new fault condition is detected, the FAULT icon will begin to blink to inform the user of the newly detected condition. For more information on fault conditions and codes, see Section 12, Diagnostics.

MENU Smart Key

The MENU Smart Key provides access to all other modes of operation. By pressing the MENU Smart Key, the transmitter moves from one mode of operation to the next. Visual feedback is provided in two manners: the mode indication arrow moves to the next mode of operation (e.g., Calibrate) and the secondary display shows the text string representative of that mode (e.g., CALIBR). Access into the displayed mode of operation is allowed by pressing the SELECT Smart Key. An escape function that returns the user to the Measure Mode of Operation is provided through the Exit to MEASURE Smart Key.

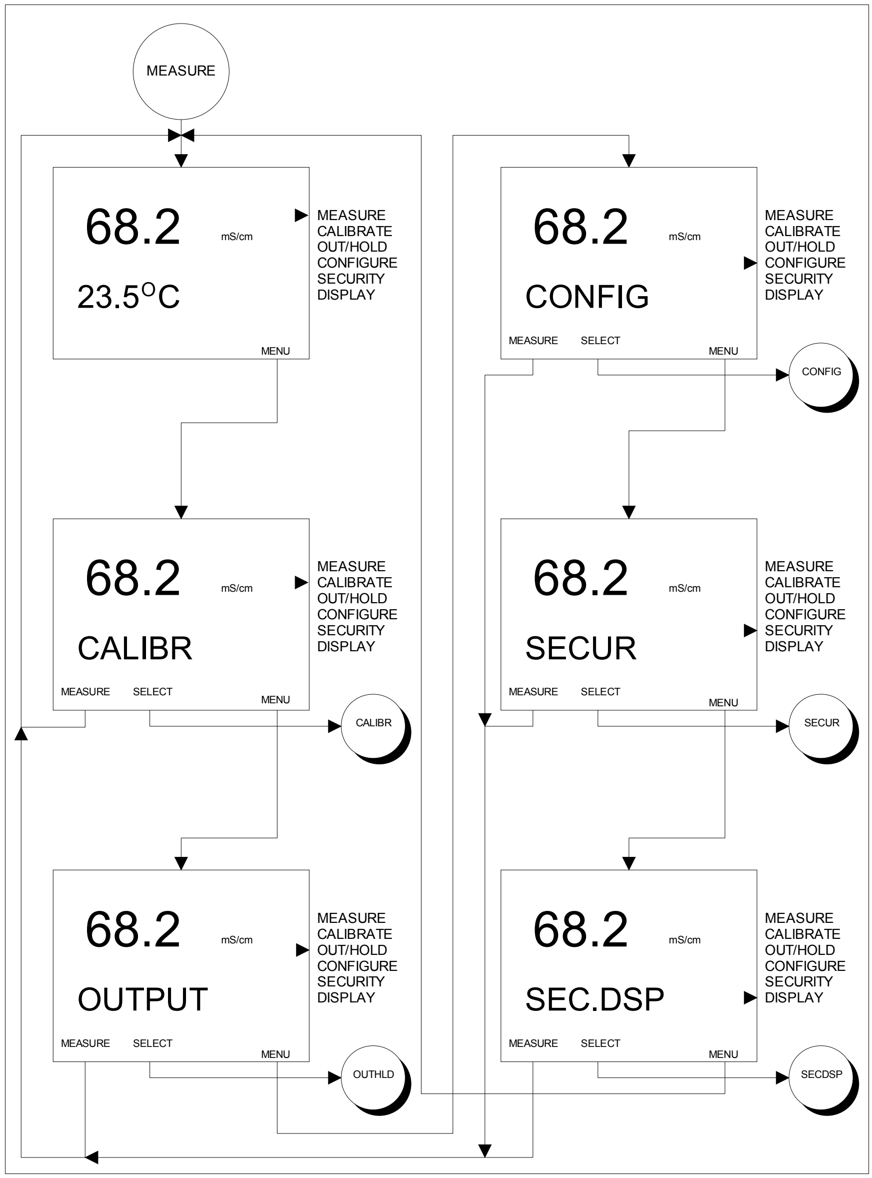


Figure 5-1. Screen Flow Diagrams For Mode of Operation

As seen by the detailed screen flow diagram shown in Figure 5-1, pressing the MENU Smart Key when in the Measure Mode moves the user to the Calibrate Mode. Once in the Calibrate Mode, pressing the Exit to MEASURE Smart Key returns the transmitter back to the Measure Mode, pressing the SELECT Smart Key moves the transmitter into the Calibrate States of Operation, and pressing the MENU Smart Key moves the transmitter to the Output/Hold Mode. Use Figure 5-1 to identify the Smart Key assignments and the resulting action.

The following sections contain detailed descriptions of each mode of operation. Screen flow diagrams showing the programming text prompts, Smart Key assignments, and the resulting action for each Smart Key are also included. Refer to Appendix C for a programming text string glossary and a programming function tree showing the relationship of all modes and states of operation.

SECTION 6 - CALIBRATE MODE

INTRODUCTION

The Calibrate Mode of Operation provides the ability to calibrate the sensor input, temperature input, and transmitter output. These functions (i.e., Calibrate States of Operation) include process variable, temperature, edit, reset, and output calibrations.

CALIBRATE STATES OF OPERATION

The Calibrate Mode consists of five states of operation. Table 6-1 describes the function of each state of operation.

Table 6-1. Calibrate States

State	Function
CON.CAL	Used to calibrate the sensor input via a zero-point offset or span-point slope calibration.
TMP.CAL	Used to calibrate the temperature sensor input via a one-point smart calibration that adjusts the offset, slope, or both based on the sensor calibration history.
EDT.CAL	Used to manually adjust the process and/or temperature offset and slope values.
RST.CAL	Used to restore calibration values for the process and temperature to factory settings.
OUT.CAL	Used to calibrate the transmitter output values to measured values using an external validation device.

When in the Calibrate Mode, the NEXT Smart Key provides access to all Calibrate States. Pressing the NEXT Smart Key sequentially moves the user through each Calibrate State. This cycle repeats until a Calibrate State is selected using the SELECT Smart Key or, the escape function is chosen using the Exit To MEASURE Smart Key. Use Figure 6-1 to identify the Smart Key assignments and the resulting action.

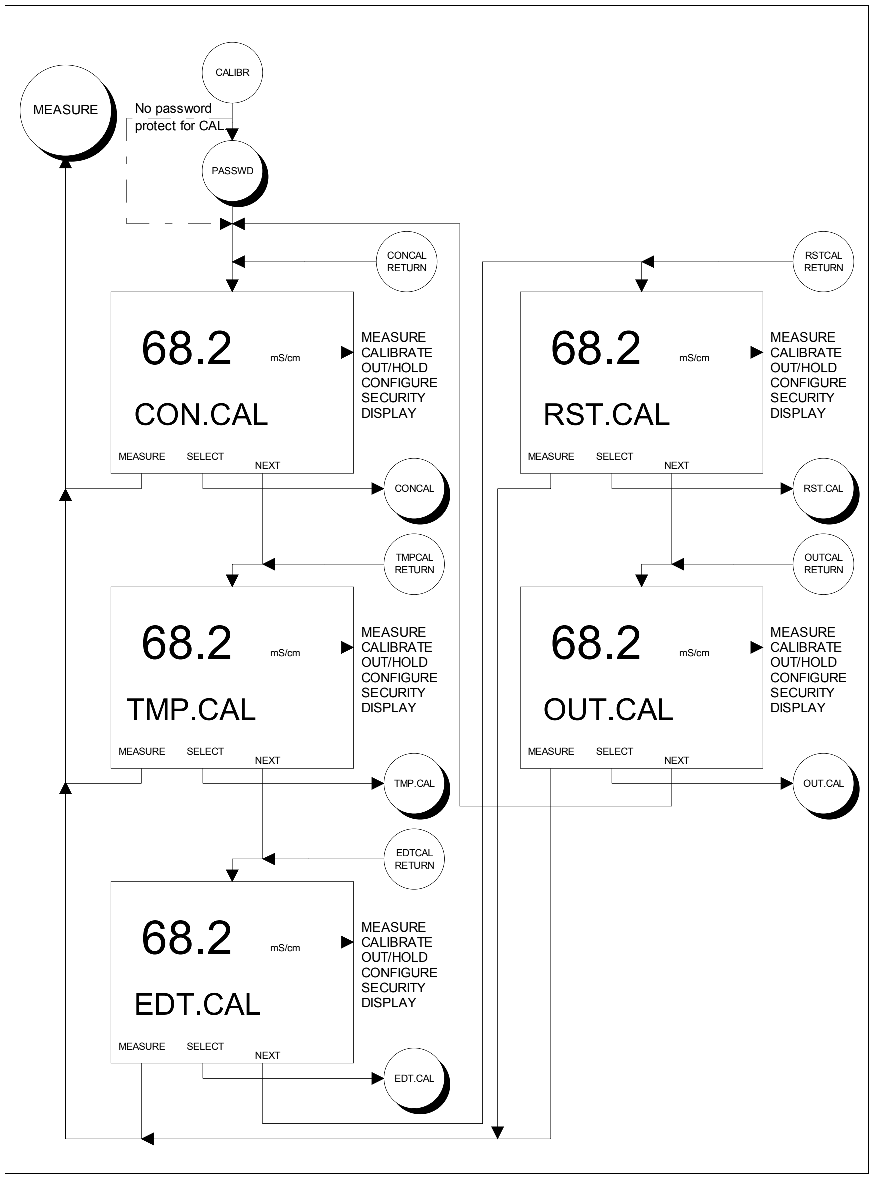


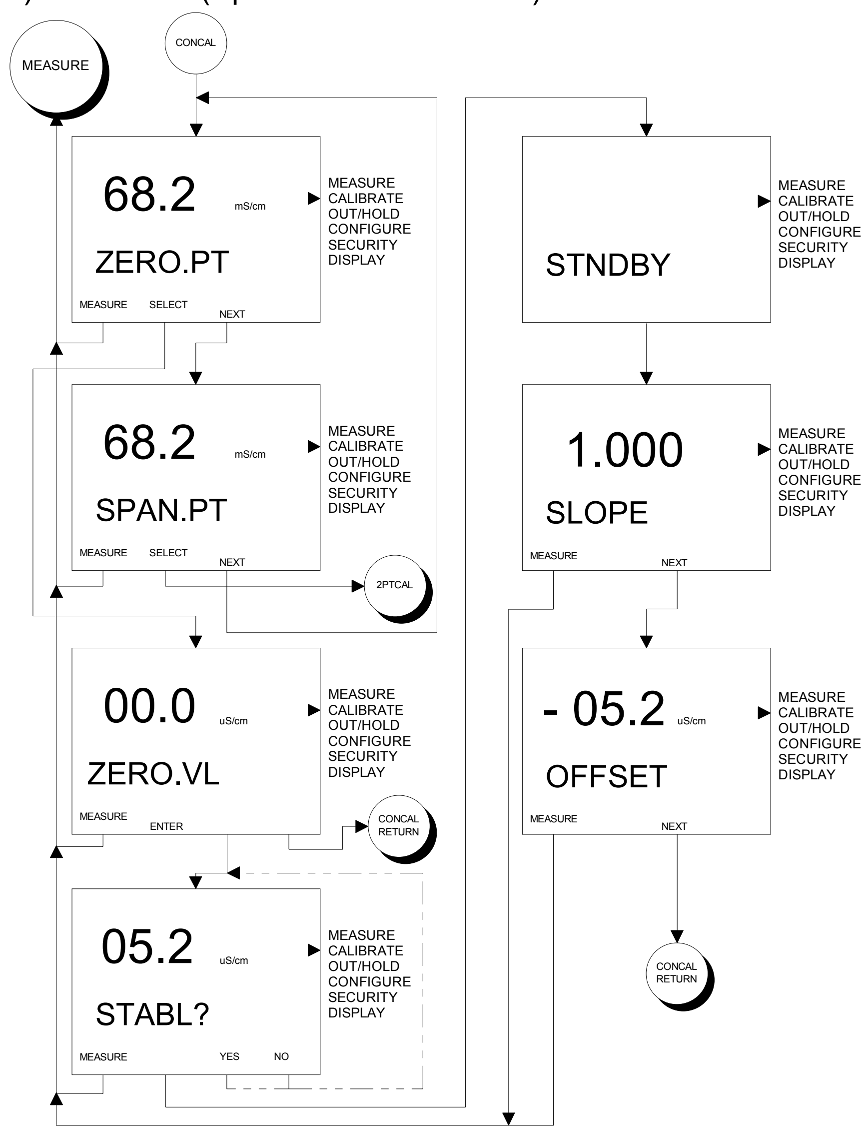
Figure 6-1. Screen Flow Diagrams For Calibrate States of Operation

The following subsections contain detailed descriptions of each Calibrate State of Operation.

Process Sensor Calibrate State

The Conductivity/Concentration Calibrate State contains two calibration procedures:

1) ZERO.PT (Zero-Point Calibration) and,
2) SPAN.PT (Span-Point Calibration).



As with the other modes and states of operation, the two calibration procedures can be toggled using the NEXT Smart Key, selected using the SELECT Smart Key, and escaped through the Exit To MEASURE Smart Key.

Use Figure 6-2 to identify the Smart Key assignments and the resulting action.

Zero-Point Calibrate State

The Zero-Point Calibrate State conducts an offset adjustment on the sensor input. This calibration procedure is typically termed an Air Calibration since the calibration is conducted with the sensor out of the process liquid or calibration standard. Variations in toroidal sensors require a Zero-Point Calibration on all new sensors. Also, periodically conduct this calibration as the sensor ages to ensure accurate performance characteristics.

Conduct a Zero-Point Calibration using the following procedure:

1) Remove the sensor from the process piping and thoroughly dry sensor if necessary.

2) Select the ZERO.PT in the Process Sensor Calibrate State of Operation using the SELECT Key.

3) Accept the ZERO.VL by pressing the ENTER Key.

4) Confirm the displayed reading is stable (i.e., STABL?) using either the YES or NO Key. Pressing the YES Key confirms a stable reading exists. Pressing the NO Key returns the TB82TC Series to the Process Sensor Calibration State (i.e., CON.CAL). For an unstable condition, conduct one or more of the following steps:

a) Check to see if the TB82TC Series detected a Fault condition by looking for the Fault icon on the LCD. Interrogate the fault by escaping to the Measure Mode using the Exit to MEASURE Key and the FAULT Info Key in that order.
b) See Section 13, Troubleshooting.

4) After a successful calibration, the Slope value is displayed. Press the NEXT Key to sequentially display the Slope and Offset values of the calibration, or press the Exit to MEASURE Key to escape to the Measure Mode.

Poor calibration values can generate one of three types of warnings: BAD.CAL (i.e., Bad Calibration value), UNSTBL (i.e., Unstable Calibration value), or DRIFT (i.e., Drifting Calibration value). If a BAD.CAL condition is encountered, the calibration value will not be accepted and the transmitter will return to the CON.CAL State. If a UNSTBL or DRIFT condition is encountered, the Slope and Offset values will be shown followed by a query to ACCEPT the calibration. Though a poor calibration value was encountered by the transmitter, it can be overridden by pressing the YES Key to accept the calibration value. The NO Key rejects the calibration value. In both cases, the user is returned to the CON.CAL State. For more information on calibration problems, see Section 12, Diagnostics. For information on sensor and/or transmitter troubleshooting, refer to Section 13, Troubleshooting.

Note: If an output Hold condition is present, the TB82TC transmitter inquires if this condition should be released.

Span-Point Calibrate State

The Span-Point Calibrate State sets the slope to characterize the sensor response at conductivity values typical of the final installed location. This calibration procedure can be completed using two different methods: Grab Sample or Standard Solution.

Since toroidal conductivity sensors measure conductivity using inductive coupling, these sensors are sensitive to the materials and proximity of the process piping. Thus, the most accurate calibration method uses a grab sample solution while the sensor is installed in its final location. The conductivity of the grab sample is measured using an external validation device with the same type of temperature compensation. By subtracting the transmitter conductivity value, taken when the grab sample was drawn, from the conductivity of the grab sample and adding this difference to the displayed value on the transmitter when conducting the calibration provides an easy, accurate method of characterizing the sensor under actual process conditions.

When the grab sample method is not practical, a Span-Point Calibration can be completed using a known conductivity standard and a sample container having the same approximate shape, size, and material of the sensor receptacle/piping configuration. For the known standard method, position the sensor in the container filled with the conductivity standard in the same manner as it would be in the final installed location. The calibration value would be equal to the temperature compensated conductivity value of the standard or the actual conductivity of the standard when the TB82TC is in Manual Temperature Compensation set to 25ºC.

Conduct a Span-Point Calibration using the following procedure.

1) Select the SPAN.PT in the Process Sensor Calibrate State of Operation using the SELECT Key.

2) Remove the sensor from the process piping if required.

3) Determine the conductivity of the process liquid or known solution based on calibration methodology.

5) Enter the SPAN.VL (i.e., Span Value) using ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the new value.

6) Confirm the displayed reading is STABL? (i.e., stable) using either the YES or NO Key. Pressing the YES Key confirms a stable reading exists. Pressing the NO Key returns the TB82TC Series to the Process Sensor Calibration State (i.e., CON.CAL). For an unstable condition, conduct one or more of the following steps:

   a) Check to see if the TB82TC Series detected a Fault condition by looking for the Fault icon on the LCD. Interrogate the fault by escaping to the Measure Mode using the Exit to MEASURE Key and the FAULT Info Key in that order.
   b) See Section 13, Troubleshooting.

Poor calibration values can generate one of three types of warnings: BAD.CAL (i.e., Bad Calibration value), UNSTBL (i.e., Unstable Calibration value), or DRIFT (i.e., Drifting Calibration value). If a BAD.CAL condition is encountered, the calibration value will not be accepted and the transmitter will return to the CON.CAL State. If an UNSTBL or DRIFT condition is encountered, the Slope and Offset values will be shown followed by a query to ACCEPT the calibration. Though a poor calibration value was encountered by the transmitter, it can be overridden by pressing the YES Key to accept the calibration value. The NO Key rejects the calibration value. In both cases, the user is returned to the CON.CAL State. For more information on calibration problems, see Section 12, Diagnostics. For information on sensor and/or transmitter troubleshooting, refer to Section 13, Troubleshooting.

Note: If using a known standard method, the measurement principle used by a toroidal conductivity sensor is inherently sensitive to surfaces surrounding the sensing area of the sensor. To combat this effect, clearance around the sensing area should mimic the process sensor fitting to obtain repeatable results.

Note: If an Output Held condition is present, the TB82TC Series inquires if this condition should be released.

Temperature Calibrate State

The Temperature Calibrate State is a smart calibration routine that allows for single-point and dual-point calibration. By calibrating the temperature at two points which are at least 20°C apart, the TB82TC Series transmitter automatically adjusts the temperature sensor's offset, slope, or both. Since this routine only uses the most recent calibration data, calibration can be conducted throughout the sensor's life thus ensuring consistent performance. If an incorrect calibration has been entered, the Reset Calibrate State provides the ability to return the transmitter to factory settings. See Reset Calibrate State in this section.

Note: The Reset Calibration State will reset all calibration values including the sensor calibration; therefore, a process variable and temperature calibration is required after performing the Reset Calibration procedure.

Conduct a Temperature Calibration using the following procedure.

1) Before installing the sensor into its final installed location, allow the sensor to reach ambient temperature.

2) Select the Temperature Calibrate State in the Calibration Mode of Operation using the SELECT Key.

3) Confirm the displayed reading is STABL? (i.e., stable) using either the YES or NO Key. Pressing the YES Key confirms a stable reading exists. Pressing the NO Key returns the TB82TC Series to the Process Sensor Calibration State (i.e., CON.CAL). For an unstable condition, conduct one or more of the following steps:

   a) Wait until the temperature stabilizes,
   b) Check to see if the TB82TC Series transmitter has detected a Fault condition by looking for the Fault icon on the LCD. Interrogate the fault by escaping to the Measure Mode using the Exit to MEASURE Key and the FAULT Info Key in that order.
   c) See Section 13, Troubleshooting.

4) Enter the ambient temperature as the NEW VAL (i.e., new temperature value) using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the new value.

5) Repeat steps 2 through 4 once the sensor has been mounted in its final installed location; however, use the process fluid temperature as the NEW VAL and allow the temperature indication to stabilize.

Edit Calibrate State

The Edit Calibrate State allows a user to manually adjust the sensor and temperature slope and offset values. This Calibrate State facilitates quick and easy access to these calibration values for troubleshooting and calibration of multiple identical measurement loops.

Conduct an Edit Calibration using the following procedure:

1) Select the Edit Calibrate State in the Calibrate Mode of Operation using the SELECT Key.

2) Edit the sensor SLOPE value using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the new value and to proceed to the sensor offset value. Press the Exit To MEASURE Key to escape to the Measure Mode. Valid slope values range from 0.20 to 5.00.

3) Edit the sensor OFFSET value using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the new value and to proceed to the temperature slope value. Press the Exit To MEASURE Key to escape to the Measure Mode. Valid offset values are ±100 mS/cm.

4) Edit the temperature SLOPE value using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the new value and to proceed to the temperature offset value. Press the Exit To MEASURE Key to escape to the Measure Mode. Valid slope values range from 0.2 to 1.5.

5) Edit the temperature OFFSET value using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the new value and to proceed to the Edit Calibrate State. Press the Exit To MEASURE Key to escape to the Measure Mode. Valid offset values range from -40 to +40°C.

Reset Calibrate State

The Reset Calibrate State sets all calibration data (i.e., sensor and temperature) to factory values. This state enables the user to purge the calibration history and to start a new history.

When interrogating the calibration values after a reset has been performed, the slope and offset values for both the sensor and temperature will be 1.000 and 0.000, respectively.

Conduct a Reset Calibration using the following procedure.

1) Select the Reset Calibrate State in the Calibrate Mode of Operation using the SELECT Key.

2) Confirm or refuse the RESET? operation using either the YES or NO Key, respectively.

Note: The Reset Calibration State will reset all calibration values; therefore, a process variable and temperature calibration is required after performing the Reset Calibration procedure.

Output Calibrate State

The Output Calibrate State trims the output signal to maintain precise transmission of the process variable to the final monitoring system. Though the TB82TC Series transmitter output current is factory calibrated, the output can be trimmed to compensate for other Input/Output devices in the measurement loop.

Conduct an Output Calibration using the following procedure.

1) Select the Output Calibrate State in the Calibrate Mode of Operation using the SELECT Key.

2) Use the ▲ or ▼ Keys to increase or decrease the 4 milliampere output signal, respectively. Press the ENTER Key to enter the new value or to proceed to the 20 milliampere output level.

3) Use the ▲ or ▼ Keys to increase or decrease the 20 milliampere output signal, respectively. Press the ENTER Key to enter the new value or to proceed to the Output Calibrate State.

Note: If the output level has been adjusted and the adjusted level has been entered using the Enter Key, this adjusted value will be permanently stored. To rectify a bad calibration, the output calibration procedure must be repeated.

Note: During an output calibration procedure, the primary displayed process variable will not be affected by the calibration.

SECTION 7 - OUTPUT/HOLD MODE

INTRODUCTION

The Output/Hold Mode of Operation provides the ability to set the output to a fixed level, change the output range, damp the output signal, or enable/disable the diagnostic spike.

OUTPUT/HOLD STATES OF OPERATION

The Output/Hold Mode consists of five states of operation. Table 7-1 describes the function of each state of operation.

Table 7-1. Output/Hold States

State	Function
HOLD	Used to fix the output level at the value captured when the hold was initiated or at a manually entered value.
REL.HLD	Used to release an existing output HOLD state.
RERANG	Used to change the output range.
DAMPNG	Used to reduce fluctuation in the output signal.
SPIKE	Used to enable or disable the spike output function if configured.

When in the Output/Hold Mode, pressing the NEXT Smart Key sequentially moves the user through each Output/Hold State. This cycle repeats until an Output/Hold State is selected using the SELECT Smart Key or the escape function is chosen using the Exit To MEASURE Smart Key. Use Figure 7-1 to identify the Smart Key assignments and the resulting action.

The following subsections contain detailed descriptions of each Output/Hold State of Operation.

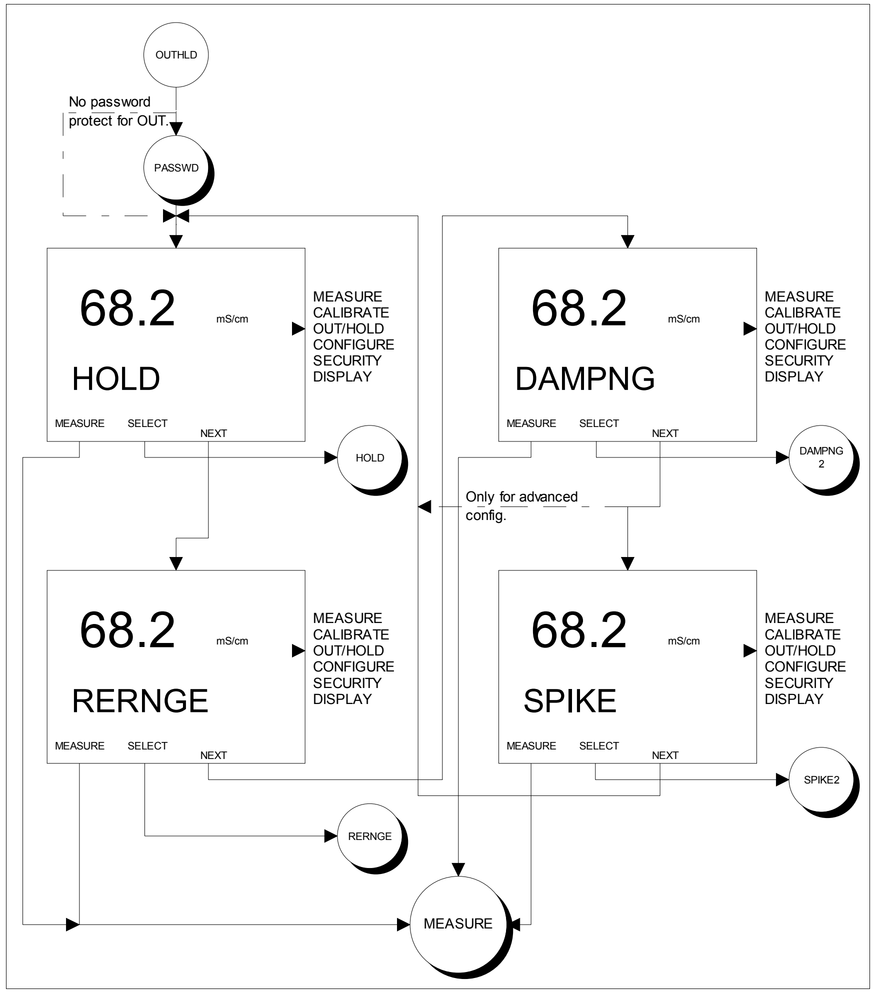


Figure 7-1. Screen Flow Diagrams For Output/Hold States of Operation

Hold/Release Hold Output State

The Hold Output State allows a user to fix the transmitter output at a level captured when the hold was initiated or to manually adjust this capture level to any value between 0 and 100% of the output range (i.e., 4 to 20 milliampere).

Conduct a Hold Output using the following procedure.

1) Select the Hold State in the Output/Hold Mode of Operation using the SELECT Key.

2) Accept the current Hold value by pressing the ENTER Key, or edit the hold value using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit and press the ENTER Key to enter the new value. Press the Exit To MEASURE Key to escape to the Measure Mode.

If a hold condition already exists and the user selects the Hold State of Operation, the TB82TC Series transmitter will request whether the hold condition should be released (i.e., REL.HLD). Press the YES Smart Key if the hold condition should be released or the NO Smart Key if the hold condition should remain.

Rerange State

The Rerange Output/Hold State provides the ability to change the output range. One or both end point values can be changed to any value or range of values that are within the specifications listed in Table 1-3.

Conduct a Rerange output values using the following procedure.

1) Select the Rerange State in the Output/Hold Mode of Operation using the SELECT Key.

2) Edit the process variable value for the four milliampere point using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit, decimal point, and/or unit of conductivity and press the ENTER Key to enter the new value, or press the ENTER Key to continue to the 20 milliampere value. Press the Exit To MEASURE Key to escape to the Measure Mode.

3) Press the ENTER or Exit To MEASURE Key to escape to the Measure Mode, or edit the process variable value for the 20 milliampere point using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit, decimal point, and/or unit of conductivity and press the ENTER Key to enter the new value.

Note: If 1)the four milliampere value is changed, 2)the new value is valid per the specification in Table 1-3, 3)this change is accepted using the Enter Key, and 4)the user escapes to the Measure Mode using the Exit To Measure Key without adjusting the 20 milliampere value, the output range will now reflect the newly entered four milliampere point.

Damping State

The Damping State applies a lag function on the output signal and will reduce the fluctuations caused by erratic process conditions. The damping value can be set from 0.0 to 99.9 seconds where this value represents the time required to reach 63.2% of a step change in the process variable.

Apply Damping on the output using the following procedure.

1) Select the Damping State in the Output/Hold Mode of Operation using the SELECT Key.

2) Edit the new damping value using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit, and press the ENTER Key to enter the new value. Press the Exit To MEASURE Key to escape to the Measure Mode.

Spike State

The Spike State toggles the operational state of the spike output function. The spike function modulates the current output by an amount set in the transmitter configuration. See Section 8, Configure Mode, for more information.

Toggle the Spike output using the following procedure.

1) Select the Spike State in the Output/Hold Mode of Operation using the SELECT Key.

2) Toggle the spike output function to the desired state (i.e., OFF or ON) using the ▲ Key, and press the ENTER Key to accept. Press the Exit To MEASURE Key to escape to the Measure Mode.

Note: Once the Spike State is OFF, changing the configured spike level in the Configure Mode will not reenable the Spike State. The Spike State can only be turned ON or OFF in the Output/Hold Mode of Operation.

SECTION 8 - CONFIGURE MODE

INTRODUCTION

The Configure Mode of Operation establishes the operating parameters of the TB82TC Series transmitter. These parameters include programming type, analyzer type, temperature sensor type, temperature compensation type, output range, damping value, safe mode level, and spike magnitude (i.e., level).

A description of each configuration item and related parameters will be included. Review each of the following sections before configuring the TB82TC Series transmitter.

PRECONFIGURATION DATA REQUIRED

Before attempting to configure the TB82TC Series transmitter, the following requirements must be defined.

1. Analyzer parameters.
2. Output Range values.
3. Security requirements.

Use the worksheets found in Appendix D to help identify and record the proper settings for any given application. Use these sheets during the configuration entry procedure and retain them as a historical record for future reference.

CONFIGURE VIEW/MODIFY STATE

Upon selecting the Configure Mode, a decision point is reached to determine whether to Modify or View the TB82TC Series transmitter configuration. The Modify Configure State sets the transmitter functionality and saves it into permanent memory. In order to provide security to the Modify Configure State yet allow the ability to view the configuration data, a View Configure State is available.

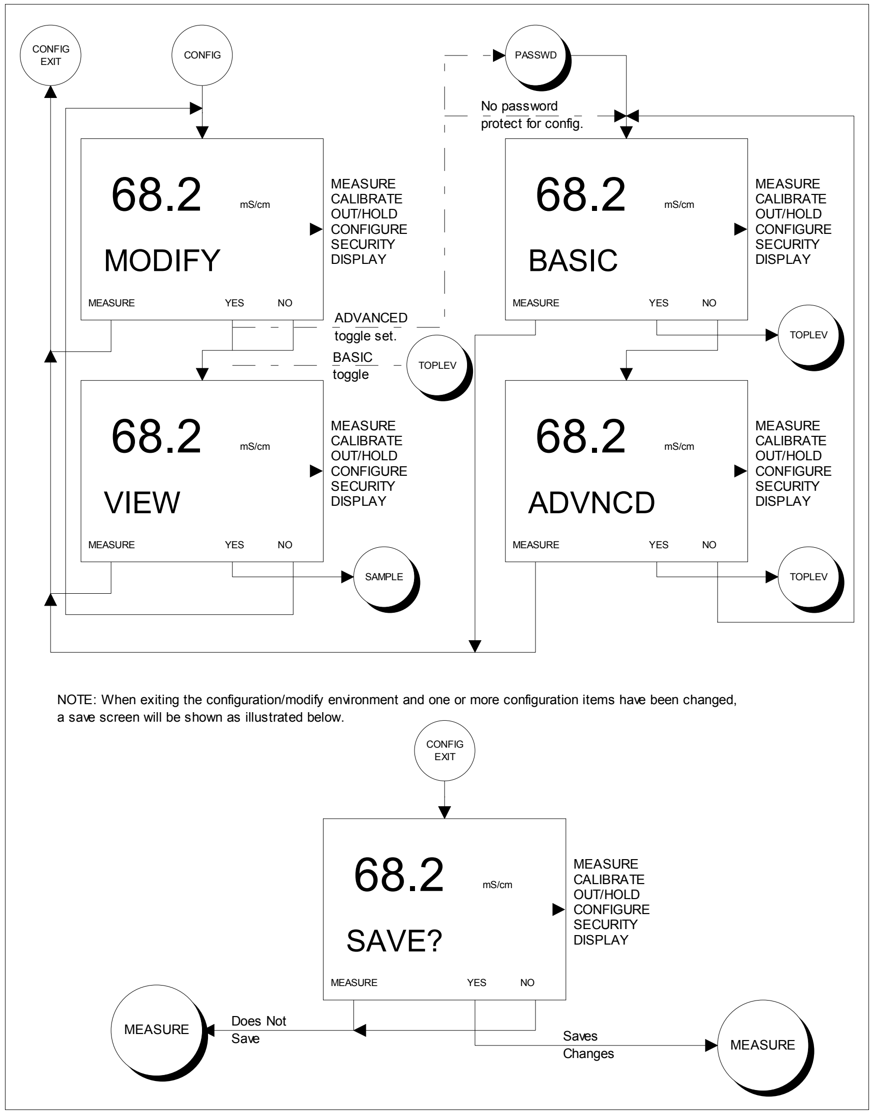


Figure 8-1. Screen Flow Diagram For Modify/View and Basic/Advanced Configure States of Operation.

As seen in Figure 8-1, the TB82TC Series transmitter queries if the user would like to Modify the configuration. Pressing the YES Smart Key moves the user into the Modify Configure State, pressing the NO Smart Key moves the user to the View configuration inquiry, and pressing the Exit To MEASURE Smart Key escapes to the Measure Mode. To view a configuration, the user presses the YES Smart Key when queried to View the configuration.

If a configuration requires modification and the user is in the

View Configure State, access to the Modify Configure State is provided through a HotKey function. The HotKey links the View Configure State to the Modify Configure State using the ENTER Smart Key. For example, the TMP.SNS (i.e., temperature sensor) in the View Configure State can be modified from Pt100 to None by pressing the ENTER Smart Key when viewing the PT100 option. An intermediate confirmation screen will query the user on their desire to modify this option. The YES and NO Smart Keys are then used to respond to this query. If the Modify Configure State has been secured, the security code will be requested. Upon entering the correct code or if the Modify Configure State has not been secured, the TB82TC Series transmitter will go directly to TMP.SNS Modify Configure State and allow the user to change the temperature sensor type. After completing the change, pressing the Exit To MEASURE Smart Key moves the user to the configuration SAVE? State. Pressing the YES Smart Key saves the new temperature sensor option and returns the transmitter to the Measure Mode.

BASIC/ADVANCED PROGRAMMING MODE

The Configure Mode is split into two groups of programming: Basic and Advanced. These two options are specified by nomenclature and control the number of configuration options available in the Modify Configure Mode.

The Basic Programming Mode contains a subset of configuration options found in the Advanced mode. Fewer options reduces confusion and the possibility of configuration errors. When Advanced programming is ordered, the programming toggle (i.e., Basic/Advanced) is set in two locations: the User State in the Utility Mode and the Modify Configure State in the Configure Mode. To select either the Basic or Advanced Programming in the Modify Configure State, the Programming Mode must be set to Advanced in the User State. See Section 11, Utility Mode, for more information on setting the Programming Mode to Advanced.

When in the Configure Mode and Advanced programming has been set in the User State, the TB82TC Series transmitter can be set to either Basic or Advanced programming. Pressing the ENTER Smart Key on the BASIC Programming State moves the user into the Modify Configure States, pressing the NEXT Smart Key moves the user to the ADVNCD (i.e., Advanced) Programming State, and pressing the Exit To MEASURE Smart Key escapes to the Measure Mode. To set the transmitter to Advanced programming, the user presses the ENTER Smart Key when the ADVNCD Programming State is displayed. See Figure 8-1 for the corresponding screen flows.

MODIFY CONFIGURE STATES OF OPERATION

The Modify Configure State contains all the available settings that establish the functionality of the TB82TC Series transmitter. Upon receipt of the transmitter, the default configuration (unless otherwise specified by the customer when ordering the TB82TC Series transmitter) will be used once the transmitter has been powered. See the Preface for the default settings.

Before installing the transmitter, the configuration should be modified to reflect the final installed requirements. Modify Configure States of Operation define the analyzer type, temperature sensor options, output parameters, and diagnostic functionality. Table 8-1 describes each of these programming modes and their function.

As with the other modes and states of operation, pressing the NEXT Smart Key sequentially moves the user through each Modify Configure State. This cycle repeats until a Modify Configure State is selected using the SELECT Smart Key or the escape function is chosen using the Exit To MEASURE Smart Key. Use Figure 8-2 to identify the Smart Key assignments and the resulting action.

Table 8-1. Modify Configure States

State	Function	Programming Mode
ANALZR	Used to define the type of analyzer. Choices include Conductivity (COND) and Concentration (CONCEN).	Basic: Conductivity Advanced: All Options
TMP.SNS	Used to define the type of temperature sensor. Choices include None, Pt100, Pt1000, and 3 kohm Balco.	Basic/Advanced
TC.TYPE	Used to define the type of temperature compensation. Choices include Manual (0.1N KCl based), and Automatic which can be set to one of the following: Standard KCl (0.1N KCl based), Temperature Coefficient (%/°C based), 0 to 15% NaOH, 0 to 20% NaCl, 0 to 18% HCl, 0 to 20% H_2SO_4, and User-Defined.	Basic: Manual Standard KCl Coefficient Advanced: All Options
OUTPUT	Used to set the output range.	Basic/Advanced
DAMPNG	Used to reduce fluctuation in the output signal.	Basic/Advanced
SAFE.MD	Used to define the output signal state in case of a detected error that renders the transmitter inoperable. Choices include fail Low or fail High.	Basic/Advanced
SPIKE	Used to set the spike magnitude.	Advanced

When selecting a Modify Configure State, the configured item within that state will be the first item shown. This item will remain the configured item until a new item is entered and the configuration is saved.

The following subsections contain detailed descriptions of each Modify Configure State of Operation.

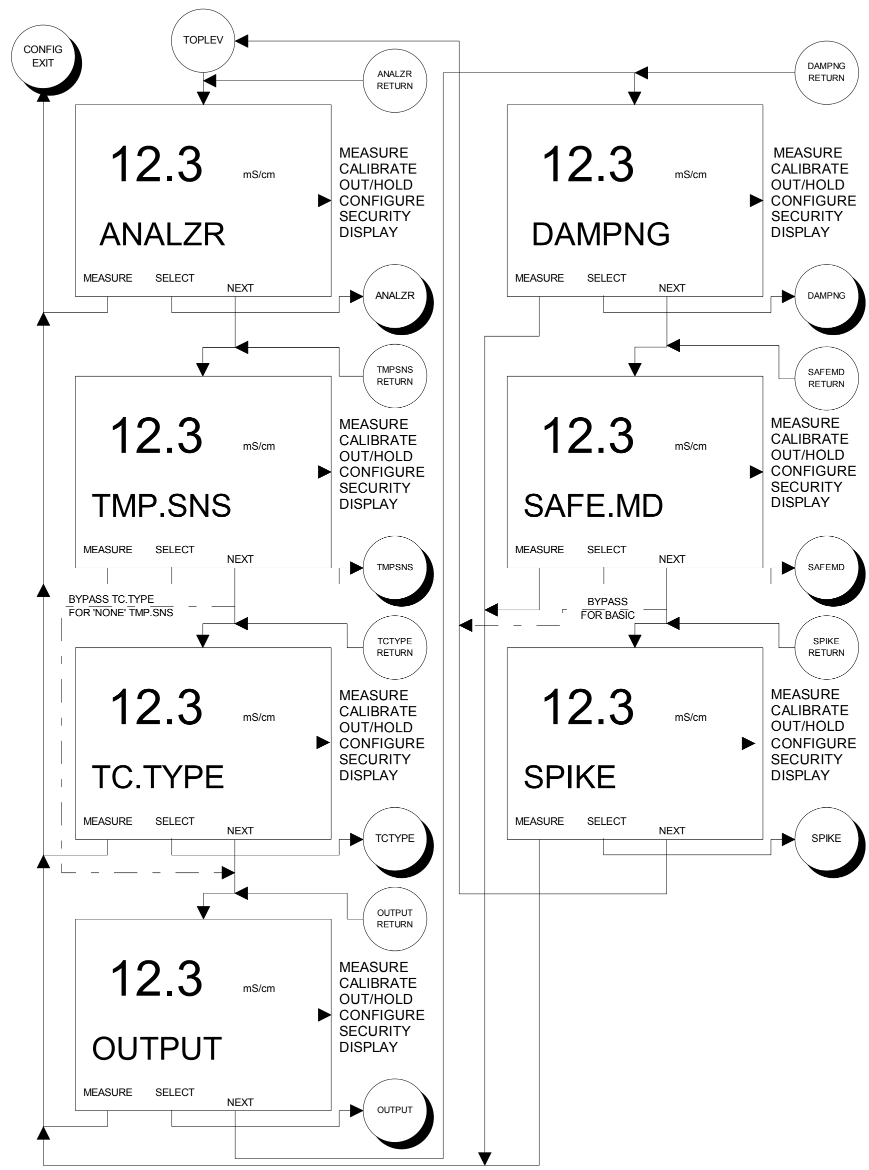


Figure 8-2. Screen Flow Diagram For Modify Configure States of Operation.

Analyzer State (Basic/Advanced)

The Analyzer State determines the transmitter type. Table 8-2 describes the function and programming mode of each state.

Table 8-2. Analyzer States

State	Function	Programming Mode
Conductivity	Used to measure the conductivity of a solution. Process variable engineering units are mS/cm and µS/cm.	Basic/Advanced
Concentration	Used to measure the conductivity of a solution and convert this non-specific measurement to a specific solute concentration. Process variable engineering units are %, ppm, ppb, and user-defined.	Advanced

Conductivity Analyzer State (Basic/Advanced)

The Conductivity Analyzer State does not contain any other states of operation. Since ABB Toroidal Conductivity Sensors only have one cell constant, sensor information is not needed for analyzer setup. Only ABB Toroidal Sensors are compatible with the TB82TC Series transmitter.

Configure a Conductivity Analyzer State using the following procedure:

1) Select the ANALZR (i.e., Analyzer) State in the Configure Mode of Operation using the SELECT Key.

2a) If the Programming Mode is set to Basic, the TB82TC Series transmitter will skip the Analyzer State and go directly to the Temperature Sensor State.

2b) If the Programming Mode is set to Advanced, choose the COND State by using the NEXT Key to toggle between COND and CONCEN (i.e., Conductivity and Concentration, respectively). Once the correct option is displayed, press the ENTER Key to accept the choice.

Note: The CONCEN State is only available when the Advanced Programming State has been purchased and selected. See Section 11, Utility Mode, for more information on Programming Mode selection.

Concentration State (Advanced)

The Concentration State converts conductivity values to concentration units. This state applies temperature-compensated conductivity measurements to a pre-defined or user-defined function that converts the conductivity measurements to concentration values having a fixed decimal point location (i.e., decimal point ranging will not occur).

The Concentration State provides the following pre-defined configurations:

- 0 to 15% Sodium Hydroxide (NaOH)
- 0 to 20% Sodium Chloride (NaCl)
- 0 to 18% Hydrochloric Acid (HCl)
- 0 to 20% Sulfuric Acid (H_2SO_4)

These pre-defined configurations are based on data contained in the **International Critical Tables**. For more information on pre-defined concentration configurations, see Appendix B, Concentration Programming.

The user-defined configuration provides capability for selecting an Engineering Unit icon, decimal point position, custom text description, and six-point linear curve fit. The Engineering Unit icon options include percent (i.e., %), parts-per-million (i.e., ppm), parts-per-billion (i.e., ppb), and no Engineering Unit icon.

The six-point linear curve approximation sets the end-point and break-point values of the desired conductivity-to-concentration conversion. The end-point values define the full-scale output range, and the break-points identify the transition points between the five line segments defining the conductivity-to-concentration curve.

To define the end and break-points, a plot of temperature-compensated conductivity against solute concentration must be divided into five line segments that best approximate the shape of the conductivity-to-concentration curve. The beginning of the first and end of the fifth line segment identify the end-points of the linear approximation and output range.

Table 8-3 and Figure 8-3 show example data and the linear approximation for 0 to 45% NH_4NO_3. As can be seen by this example, the conductivity-to-concentration curve is a non-linear function which has been divided into five line segments. The end-points represent Point Numbers 1 and 6, while the break-points represent Point Numbers 2 through 5. Though the solute conductivity to concentration relationship is non-linear, the transmitter output will be linear relative to the solute concentration (i.e., Ammonium Nitrate concentration). Since the end-points (i.e., Point Numbers 1 and 6) define the full-scale output range, rerange of the output values is restrained to the range between Point Numbers 1 and 6 (i.e., 0 and 45% Ammonium Nitrate in the example).

Table 8-3. Non-linear Output Example Values

Point Number	Ammonium Nitrate Conductivity (mS/cm)	Ammonium Nitrate Concentration (%)	Output (mA)
1	0	0	4.0
2	55	5	5.8
3	105	9	7.2
4	195	16	9.7
5	310	28	14.0
6	400	45	20.0

Configure a Concentration Analyzer State using the following procedure.

1) Select the ANALZR (i.e., Analyzer) State in the Configure Mode of Operation using the SELECT Key.

2) Choose the CONCEN State by using the NEXT Key to toggle between COND and CONCEN (i.e., Conductivity and Concentration, respectively). Once the correct option is displayed, press the ENTER Key to accept the choice.

Note: The CONCEN State is only available when the Advanced Programming State has been purchased and selected. See Section 11, Utility Mode, for information on Programming Mode selection.

3) Set one of the four pre-defined concentration options (i.e., NAOH, NACL, HCL, or H2SO4) or the User-Defined option by using the NEXT Key to scroll through the available options. Once the correct option is displayed, press the ENTER Key to accept the choice.

4a) For canned concentration configurations, the TB82TC will return to the Analyzer State thus providing access to the remaining configuration options.

4b) For User-Defined configurations, view the icon options (i.e., %, ppm, ppb, and NO.ICON) using the NEXT Key. Once the correct option is displayed, press the ENTER Key to accept the choice.

5) Choose the decimal point location by using the ▲ Key to move the blinking decimal point to the next location. Press the ENTER Key to set the decimal point location.

6) Set the text string by using the ▲ Key to increment the character and the ▶ Key to move to the next character and press the ENTER Key to enter the text string.

7) Set the end-point conductivity value (i.e., X1.COND) by using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit, decimal point, and/or Engineering Unit. Press the ENTER Key to enter the value.

8) Set the end-point concentration value (e.g., Y1.CONC) that represents the end-point conductivity value entered in step 9 by using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the value.

9) Set the next four break-point values (i.e., X2.COND/Y2.CONC, X3.COND/Y3.CONC, ...) using the same technique described in steps 8 and 9.

10) Set the final end-point values (i.e., X6.COND/Y6.CONC) using the same technique described in steps 8 and 9.

The Temperature Sensor State configures the temperature input for a Pt100, Pt1000, 3 kohm Balco, or none. When the NONE option is entered, the temperature and temperature compensation will be fixed to 25°C and MANUAL, respectively. To set a different fixed temperature, calibrate the temperature to the desired value.

Set the Temperature Sensor State using the following procedure.

1) Select the TMP.SNS (i.e., Temperature Sensor) State in the Configure Mode of Operation using the SELECT Key.

2) Choose the desired temperature sensor by using the NEXT Key to toggle between NONE, 3K.BLCO (i.e., 3 kohm Balco), PT100, and Pt1000. Enter the parameter using the ENTER Key when the choice is displayed.

Temperature Compensation State (Basic/Advanced)

Temperature has a marked effect on the conductance of many solutions. The effect is generally nonlinear and dependent on the particular ionic species and their concentration.

The TB82TC Series transmitter contains a number of preprogrammed correction algorithms that compensate the effect of temperature on conductivity to a reference temperature of 25°C. For the Advanced Programming Mode, the reference temperature can be set to values other than 25°C. Valid reference temperature values are limited to the displayed temperature range as listed in Table 1-3, Specifications.

The options for temperature compensation are grouped into two sets: MANUAL and AUTO (i.e., Automatic). The MANUAL state does not contain any additions options and is fixed to a specific process temperature independent of the selected temperature sensor. To change the fixed process temperature value, the value can be adjusted by initiating a temperature calibration.

The AUTO compensation options use temperature values measured by the transmitter's temperature input. Within the AUTO State, compensation algorithms include Standard KCl (0.1N KCl based), Solution Coefficient, 0 to 15% NaOH, 0 to 20% Sodium Chloride, 0 to 18% Hydrochloric Acid, 0 to 20% Sulfuric Acid, and User-Defined.

The User-Defined temperature compensation option requires uncompensated conductivity data from the minimum to the maximum process temperature on a representative sample of process solution. With this data, the ratio of uncompensated conductivity to the conductivity at the reference temperature is calculated. These ratios are plotted against the temperature. If a different reference temperature is desired, the new reference temperature can be entered after entering the ratio data referenced at 25°C or the reference temperature can remain at 25°C if the entered ratio data uses conductivity values referenced to the desired temperature.

Table 8-4. User-Defined Temperature Compensation Example

Temperature (°C)	**Uncompensated Conductivity (mS/cm)**	**Conductivity Ratio (K/K_{STD})**
0	7.21	0.70
25	10.30	1.00
50	12.25	1.19
75	12.97	1.26
100	12.82	1.24
200	9.06	0.88

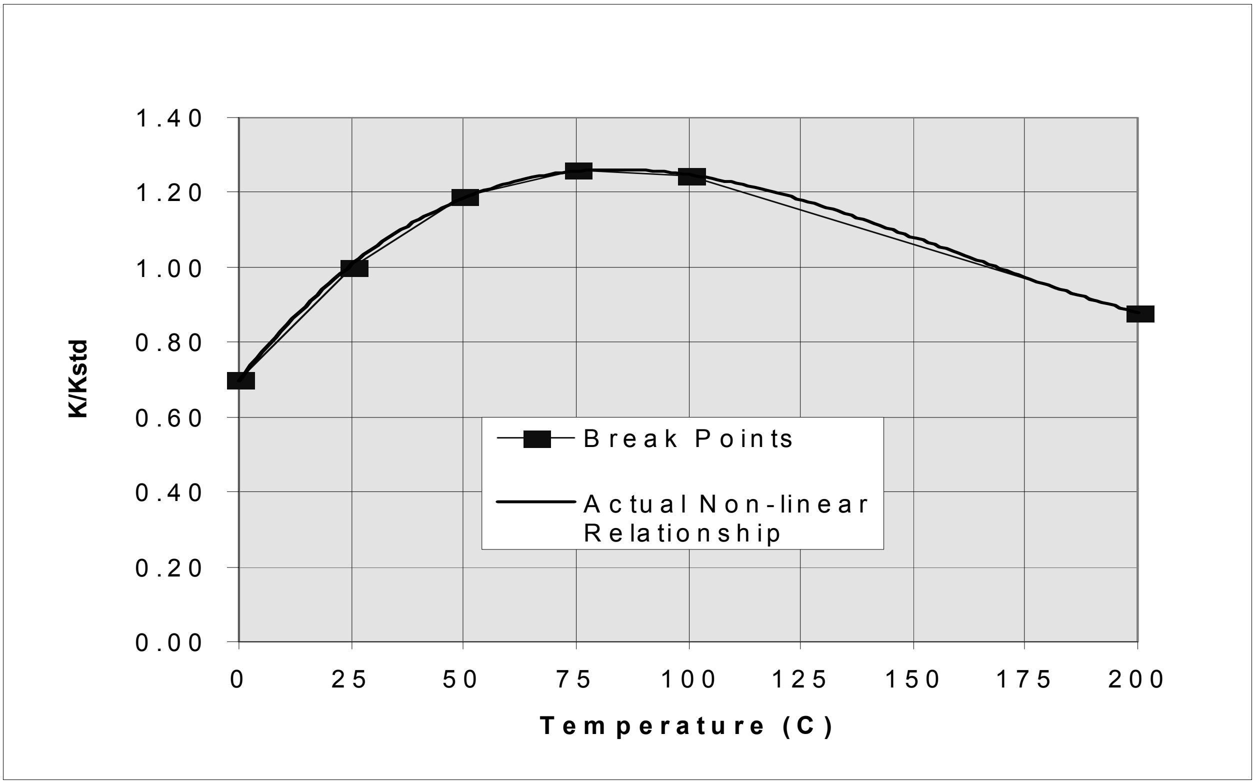


Figure 8-4. User-Defined Temperature Compensation Break Point Determination.

Table 8-4 and Figure 8-4 shows an example of a typical user-defined temperature compensation plot. As seen in this example, the non-linear plot is segmented into five linear segments. The end-points (i.e., columns 1 and 3 of Table 8-4) of each segment are used to define the break-points for user-defined temperature compensation option. Each set of points are entered in sequence from the lowest to the highest (i.e., 0°C/0.70 for TMP1°C/K1/K25, 25°C/1.00 for TMP2°C/K2/K25, ..., 200°C/0.88 for TMP6°C/K6/K25).

Table 8-5. Temperature Compensation States

State	Function	Programming Mode
MANUAL	Used when a fixed temperature value can be used instead of a measured value. The initial value is set at 25°C. Use the Temperature Calibrate State to change the fixed temperature value. Compensation is 0.1N KCl based.	Basic/Advanced
STD.KCL (AUTO)	Used when a measured temperature value is being provided by a temperature sensor. Compensation is 0.1N KCl based.	Basic/Advanced
TC.COEF (AUTO)	Used when a measured temperature value is being provided by a temperature sensor. Compensation is based on a percent change per degree Celsius of the conductivity relative to the conductivity at the reference temperature (e.g., 25°C).	Basic/Advanced
NAOH (AUTO)	Used when a measured temperature value is being provided by a temperature sensor. Compensation is 0 to 15% Sodium Hydroxide (i.e., NaOH) based.	Advanced
NACL (AUTO)	Used when a measured temperature value is being provided by a temperature sensor. Compensation is 0 to 20% Sodium Chloride (i.e., NaCl) based.	Advanced
HCL (AUTO)	Used when a measured temperature value is being provided by a temperature sensor. Compensation is 0 to 18% Hydrochloric Acid (i.e., HCl) based.	Advanced
H2SO4 (AUTO)	Used when a measured temperature value is being provided by a temperature sensor. Compensation is 0 to 20% Sulfuric Acid (i.e., H_2SO_4) based.	Advanced
USR.DEF (AUTO)	Used when a measured temperature value is being provided by a temperature sensor. Compensation is defined as a ratio of uncompensated conductivity over the referenced conductivity value for a specific set of temperatures.	Advanced

Table 8-5, Temperature Compensation States, lists the temperature compensation options, their functions, and the Programming Modes in which they are available.

Set the Temperature Compensation State using the following procedure.

1) Select the TC.TYPE (i.e., Temperature Compensation Type) State in the Configure Mode of Operation using the SELECT Key.

2) Enter the desired temperature compensation group by using the NEXT Key to toggle between MANUAL and AUTO. Press the ENTER Key to accept the choice.

3a) For MANUAL compensation, the TB82TC will return to the TC.TYPE State for Basic Programming Modes or RF.TMP.C (i.e., Reference Temperature in °C) for Advanced Programming Modes. Set the Reference temperature using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit and pressing the ENTER Key once the new value has been entered, or press the ENTER Key to accept the displayed value. Note, the default value is equal to 25°C.

3b) For AUTO compensation, choose one of the compensation options using the NEXT Key. Once the correct option is displayed, press the ENTER Key to accept the choice.

4) For the TC.COEF (i.e., Temperature Compensation Coefficient) option, set the coefficient value by using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit. Press the ENTER Key to enter the value.

5a) For the USR.DEF (i.e., User-Defined) option, enter the TMP1°C (i.e., Temperature point 1 in degrees Celsius) by using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit. Press the ENTER Key to enter the value and continue onto the ratio entry state.

5b) Enter the K1/K25 (i.e., Conductivity point 1 to Conductivity at the reference temperature of 25°C) by using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit. Press the ENTER Key to enter the value.

5c) Repeat steps 5a and 5b for the remaining five points.

6) For Advanced Programming Modes, enter a new reference temperature value using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit and pressing the ENTER Key once the new value has been entered, or press the ENTER Key to accept the displayed value. Note, the default value is equal to 25°C.

Output State (Basic/Advanced)

The Output State sets the output type and range. The default output range values are ten percent of the full scale process variable. If a reverse-acting output is required, reverse the 4 and 20 milliampere process variable values.

Set the Output State using the following procedure.

1) Select the OUTPUT State in the Configure Mode of Operation using the SELECT Key.

2) Set the process variable value for the 4 milliampere point using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit, decimal point, and Engineering Unit. Press the ENTER Key to enter the new value.

3) Set the process variable value for the 20 milliampere point using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit, decimal point, and Engineering Unit. Press the ENTER Key to enter the new value.

Damping State (Basic/Advanced)

The Damping State applies a lag function on the output signal and reduces fluctuations caused by erratic process conditions. The damping value can be set from 0.0 to 99.9 seconds where this value represents the time required to reach 63.2% of a step change in the process variable.

Set the Damping State using the following procedure.

1) Select the DAMPNG State in the Configure Mode of Operation using the SELECT Key.

2) Set the damping value using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit. Press the ENTER Key to enter the new value.

Safe Mode State (Basic/Advanced)

The Safe Mode State determines the output level of the TB82TC Series transmitter if an error condition occurs that renders the transmitter inoperable. The available states are FAIL.LO (i.e., fail low) and FAIL.HI (i.e., fail high). For more information on error conditions, see Section 12, Diagnostics.

Set the SAFE.MD (i.e., Safe Mode) State using the following procedure.

1) Select the SAFE.MD State in the Configure Mode of Operation using the SELECT Key.

2) Choose the desired safe mode by using the NEXT Key to toggle between FAIL.LO and FAIL.HI. Enter the desired safe mode by using the ENTER Key when the correct mode is displayed in the secondary display.

Spike State (Advanced)

The Spike State sets the diagnostic spike level as a percent of output. This level determines the magnitude of the spike.

When the Spike has been set for any level greater than 0% and is enabled in the Spike State located in the Output/Hold Mode, the TB82TC Series transmitter will modulate the output signal by the configured level for one second out of every six seconds. Using this modulation, the transmitter informs the operator of a detected diagnostic condition.

For more information on error conditions, see Section 12, Diagnostics. For a description of the diagnostic spike feature, see Section 2, Transmitter Functionality And Operator Interface Controls.

Set the Spike State using the following procedure:

1) Select the SPIKE State in the Configure Mode of Operation using the SELECT Key.

2) Set the SPK.MAG (i.e., spike magnitude) using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit. Press the ENTER Key to enter the new value. The Spike Magnitude is entered as a percentage of the 16 milliampere output range (e.g., 10% will generate a 1.6 milliampere spike).

   Note: Once the Spike State is OFF, changing the configured spike level in the Configure Mode will not reenable the Spike State. The Spike State can only be turned ON or OFF in the Output/Hold Mode of Operation.

CONFIGURATION LOCKOUT

The TB82TC Series transmitter has a lockout feature that, once engaged, prohibits access to the Configure Mode. This feature does not affect parameters that can be changed in the other modes of operation which include Calibrate, Output/Hold, Security, and secondary Display.

To enable the lockout feature, change jumper W1 on the Microprocessor/Display PCB from pins 1 and 2 (i.e., position A - the factory default position) to pins 2 and 3 (i.e., position B). See Figure 8-5 and Section 15, Replacement Procedures, for jumper position and circuit board handling.

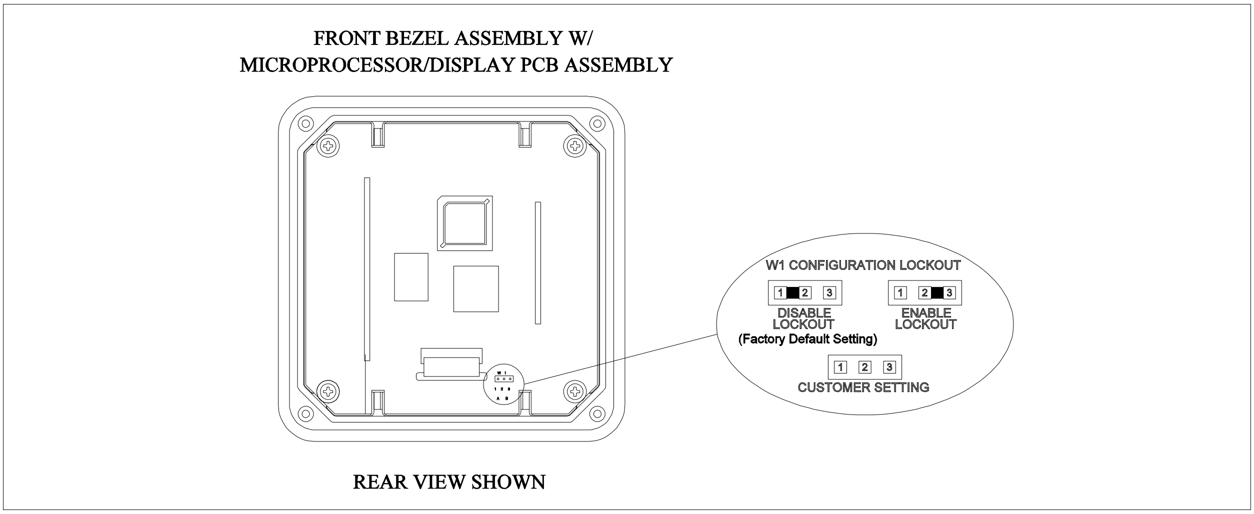


Figure 8-5. Configuration Lockout Jumper Location On Microprocessor/Display PCB Assembly.

SECTION 9 - SECURITY MODE

INTRODUCTION

The Security Mode of Operation establishes password protection against unauthorized changes to transmitter functions by unqualified personnel. Password protection can be assigned to the Calibrate and Out/Hold Modes and Modify Configure State of Operation.

SECURITY STATE OF OPERATION

The Security Mode of Operation contains one state of operation that provides password protection of critical operating environments. Each mode or state of operation that can be password protected can be set by toggling the primary display between security OFF and security ON using the ▲ Smart Key. As seen in Figure 9-1, all security assignments must be made before a password can be defined.

When one or more mode/state has the security ON, the Security Mode will also be secured. One password assignment applies to all secured modes/states.

Set the Security State using the following procedure.

1) Select the SECUR Mode of Operation using the SELECT Key.

2) Set the security ON for the CALIBR (i.e., Calibrate) Mode by pressing the ▲ Key and then the ENTER Key, or leave the security OFF for CALIBR by using the ENTER Key.

3) Set the security ON for the OUTPUT (i.e., Output/Hold) Mode by pressing the ▲ Key and then the ENTER Key, or leave the security OFF for OUTPUT by using the ENTER Key.

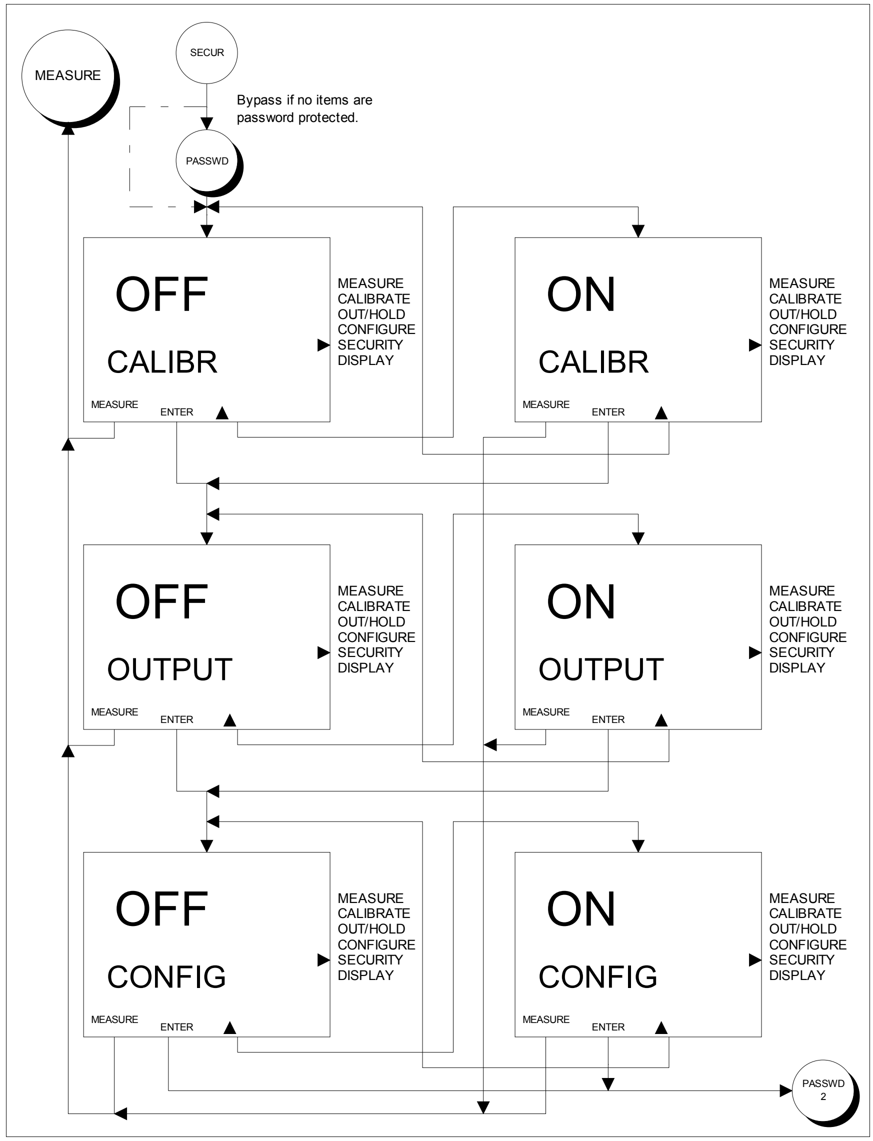


Figure 9-1. Screen Flow Diagram For Security State of Operation

4) Set the security ON for the CONFIG (i.e., Modify Configure) State by pressing the ▲ Key and then the ENTER Key, or leave the security OFF for CONFIG by using the ENTER Key.

5) Define the password for all secured modes and states using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit. Press the ENTER Key to enter the password.

Note: The password must be defined as three digits and verified to enable security on the modes/states entered in steps 2 through 4. If security is OFF for all modes/states, the password state will be bypassed.

6) Verify the password using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the password.

Remove all security using the following procedure.

1) Select the SECUR Mode of Operation using the SELECT Key.

2) Enter the password using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the password.

3) Set the security OFF for the CALIBR (i.e., Calibrate) Mode by pressing the ▲ Key and then the ENTER Key, or leave the security OFF for CALIBR by using the ENTER Key.

4) Set the security OFF for the OUTPUT (i.e., Output/Hold) Mode by pressing the ▲ Key and then the ENTER Key, or leave the security OFF for OUTPUT by using the ENTER Key.

5) Set the security OFF for the CONFIG (i.e., Modify Configure) State by pressing the ▲ Key and then the ENTER Key, or leave the security OFF for CONFIG by using the ENTER Key.

Change the password or security state using the following procedure.

1) Select the SECUR Mode of Operation using the SELECT Key.

2) Enter the password using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the password.
3) Leave the security state unchanged for CALIBR (i.e., Calibrate) Mode by pressing the ENTER Key, or change the security state for CALIBR (i.e., Calibrate) by pressing

the ▲ Key and then the ENTER Key to enter the new state.

4) Leave the security state unchanged for OUTPUT (i.e., Output/Hold) Mode by pressing the ENTER Key, or change the security state for OUTPUT by pressing the ▲ Key and then the ENTER Key to enter the new state.

5) Leave the security state unchanged for CONFIG (i.e., Modify Configure) Mode by pressing the ENTER Key, or change the security state for CONFIG (i.e., Modify Configure) by pressing the ▲ Key and then the ENTER Key to enter the new state.

6) Change the password for all secured modes and states using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit. Press the ENTER Key to enter the password, or enter the same password to accept the new secured modes/states using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit and pressing the ENTER Key to enter the password.

7) Verify the new password using the ▲ Key to increment the blinking digit and the ► Key to move to the next digit. Press the ENTER Key to enter the password.

   Note: If the password was not changed, the verification of the old password will not be required.

In the unlikely case that the password can not be retrieved and secured modes/states must be accessed, a Reset Password state has been included in the TB82TC Series transmitter. For the Reset Password procedure, see Section 11, Utility Mode.

SECTION 10 - SECONDARY DISPLAY MODE

INTRODUCTION

The TB82TC Series transmitter has two display regions. In the Measure Mode of Operation, the primary display region shows the measured variable, and the secondary display region can show a multitude of process, sensor, or transmitter information. The process temperature, current output value, sensor type, compensated conductivity (useful for concentration configurations), user-defined text description (concentration configuration only), spike mode status, and software revision can be viewed or set as the displayed value when in the Measure Mode of Operation.

SECONDARY DISPLAY STATE OF OPERATION

The Secondary Display Mode of Operation contains eight states of operation that provide information on the process variables, transmitter settings, and transmitter status. As seen in Figure 10-1, each Secondary State can be sequentially viewed by using the NEXT Smart Key. To have any given Secondary Display State be continually shown in the Measure Mode, press the ENTER Smart Key when the desired state is shown. The TB82TC Series transmitter will proceed to the Measure Mode and will display the entered Secondary Display State in the secondary display region.

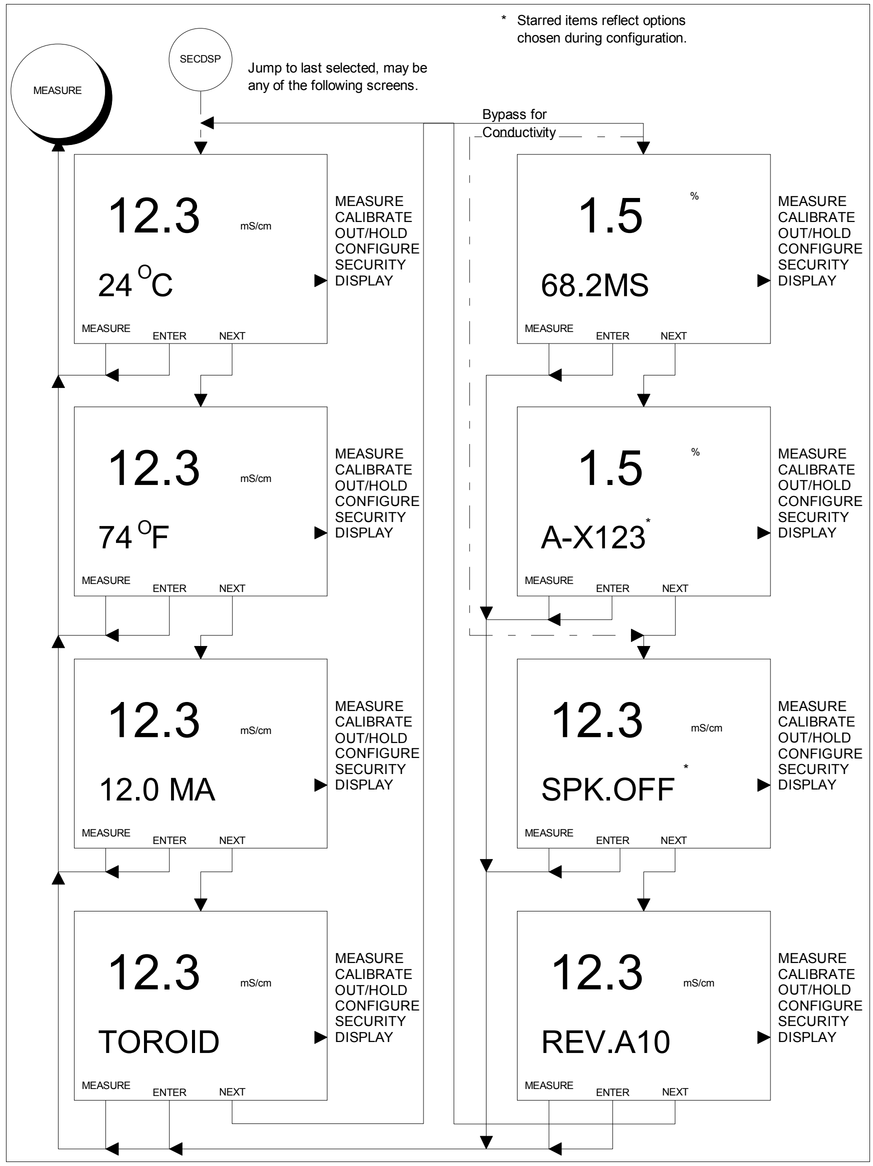


Figure 10-1. Screen Flow Diagrams For Secondary Display States of Operation.

SECTION 11 - UTILITY MODE

INTRODUCTION

The TB82TC Series transmitter contains a Utility Mode of Operation that provides access to powerful functions not typically needed during normal operating conditions. These functions have been separated into two categories: Factory and User. Factory functions are strictly reserved for ABB personnel.

User functions include Programming Mode selection, configuration reset to default settings, security removal, all parameter reset to default settings, and software reboot.

FACTORY/USER STATE

The Factory and User States of Operation can be accessed using the hidden fifth key located top, center on the keypad. Once the hidden key has been pressed, the textual prompt USER will be displayed in the secondary display region. Pressing the SELECT Smart Key moves the user into the User State, pressing the NEXT Smart Key moves the user to the Factory selection, and pressing the Exit to MEASURE Smart Key escapes back to the Measure Mode.

User State

The User State contains three reset functions and the primary toggle for setting the Programming Mode. Table 11-1 describes the function of each User State.

Table 11-1. User States

State	Function
MODE	Sets the Programming Mode (i.e., Basic or Advanced) that can be selected in the Modify Configure Mode of Operation.
RST.CON	Resets the configuration to factory default settings.
RST.SEC	Resets the security to the OFF state for all modes/states.
RST.ALL	Resets all programming parameters such as configuration, calibration, output/hold, security, and secondary display functions to factory default settings.
RST.SFT	Resets the transmitter and repeats the boot-up and self-test procedures.

The NEXT Smart Key sequentially moves through each of the five User States. This cycle repeats until a state is selected or the escape function is chosen using the Exit to MEASURE Smart Key. To select a state, press the SELECT Smart Key when the desired User State is shown in the secondary display region. Figure 11-1 identifies the Smart Key assignments and resulting action.

The following section describes each of the User States and their applicability.

Advanced/Basic Programming Mode User State

In order to simplify the configuration process for a user who only needs a limited amount of functionality, the TB82TC Series transmitter contains two types of Programming Modes: Basic and Advanced. The Programming Mode is a nomenclature option.

The Basic Programming Mode contains a reduced set of features found in the Advanced Programming Mode. Reducing the available features streamlines the configuration process. If the TB82TC Series transmitter is ordered with Advanced Programming, the Basic or Advanced Programming Mode can be used.

Contact ABB for information on Advanced Programming conversion.

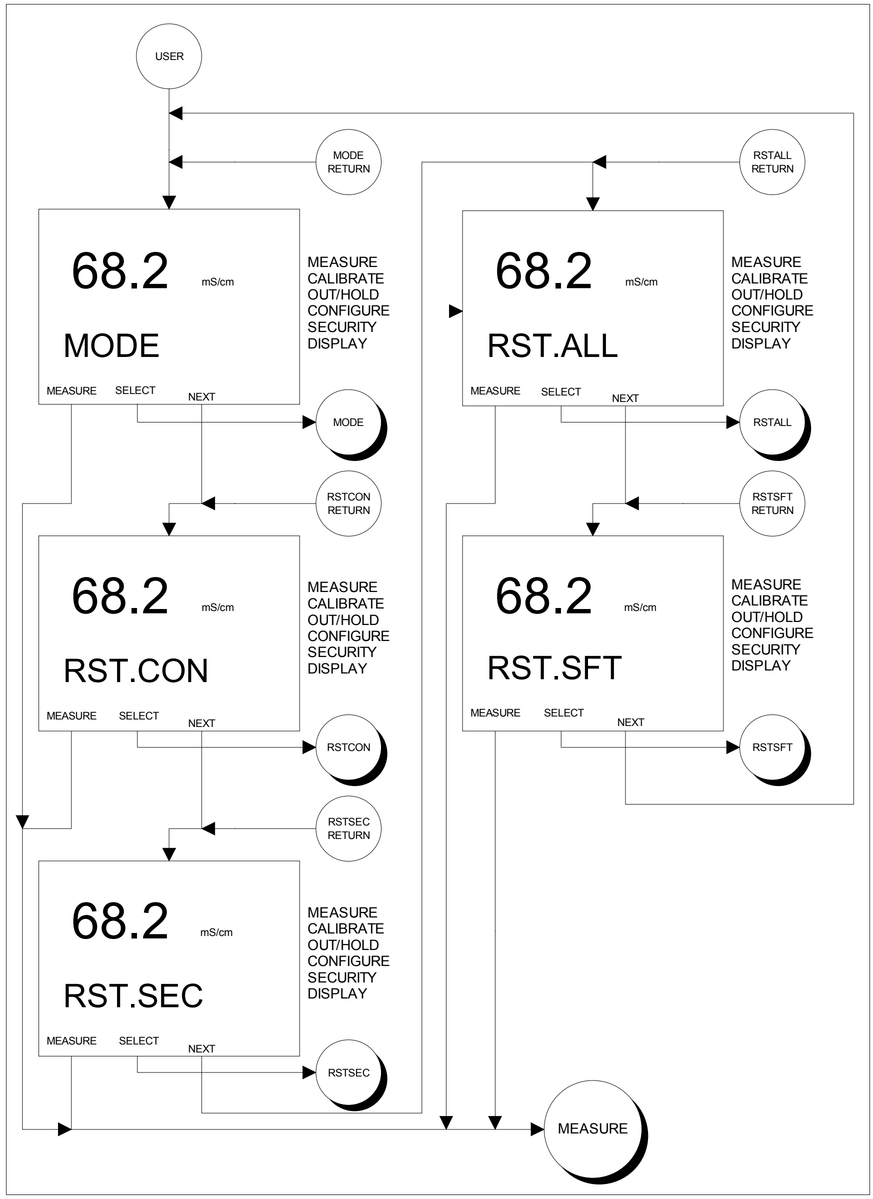


Figure 11-1. Screen Flow Diagram For User States of Operation.

Reset Configuration User State

The Reset Configuration User State returns the configuration of the TB82TC Series transmitter to factory default settings. See the Preface or Appendix D, Configuration Worksheets, for software default settings.

To reset the transmitter configuration to factory defaults, use the following procedure:

1) Access the User Mode by pressing the hidden button located top, center on the keypad. The text USER will appear in the secondary display once the hidden button has been pressed.

2) Press the SELECT Key to access the User Mode. The text MODE will appear in the secondary display.

3) Press the NEXT Key to display RST.CON (i.e., Reset Configuration) prompt in the secondary display.

4) Press the SELECT Key to reset the configuration.

5) Enter the security password (if the Configure Mode has been secured) using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the password.

6) Confirm the reset operation when the text RESET? is displayed by pressing the YES Key or abort the reset operation by pressing the NO Key.

Reset Security User State

The Reset Security User State returns the security of the TB82TC Series transmitter to factory default settings. The factory default is security OFF for all applicable modes and states (i.e., Calibrate, Output/Hold, and Modify Configure).

To remove transmitter security, use the following procedure:

1) Access the User Mode by pressing the hidden button located top, center on the keypad. The text USER will appear in the secondary display once the hidden button has been pressed.

2) Press the SELECT Key to access the User Mode. The text MODE will appear in the secondary display.

3) Press the NEXT Key until the secondary display region shows the text RST.SEC (i.e., Reset Security).

4) Press the SELECT Key to reset the security.

5) Enter the security password **732** using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the password.

6) Confirm the reset operation when the text RESET? is displayed by pressing the YES Key or abort the reset operation by pressing the NO Key.

Reset All User State

The Reset All User State returns all transmitter parameters of the TB82TC Series transmitter to factory defaults. This includes calibration, output/hold, configuration, security, and secondary display values.

To reset all the transmitter parameters, use the following procedure:

1) Access the User Mode by pressing the hidden button located top, center on the keypad. The text USER will appear in the secondary display once the hidden button has been pressed.

2) Press the SELECT Key to access the User Mode. The text MODE will appear in the secondary display.

3) Press the NEXT Key until the secondary display region shows the text RST.ALL (i.e., Reset ALL).

4) Press the SELECT Key to reset all transmitter parameters.

5) Enter the security password **255** using the ▲ Key to increment the blinking digit and the ▶ Key to move to the next digit. Press the ENTER Key to enter the password.

6) Confirm the reset operation when the text RESET? is displayed by pressing the YES Key or abort the reset operation by pressing the NO Key.

Soft Boot User State

The Soft Boot User State initiates a software reset. All programmable instrument parameters will be unaffected by the reset.

To reboot the transmitter without affecting any instrument parameters, use the following procedure:

1) Access the User Mode by pressing the hidden button located top, center on the keypad. The text USER will appear in the secondary display once the hidden button has been pressed.

2) Press the SELECT Key to access the User Mode. The text MODE will appear in the secondary display.

3) Press the NEXT Key until the secondary display region shows the text RST.SFT (i.e., Reset Software).

4) Press the SELECT Key to initiate the reboot operation.

5) Confirm the reboot operation when the text RESET? is displayed by pressing the YES Key or abort the reset operation by pressing the NO Key.

SECTION 12 - DIAGNOSTICS

INTRODUCTION

The TB82TC Series transmitter performs a number of diagnostic checks on hardware, software, and sensor functions. If a nonconforming condition is detected, the user is alerted to faults locally by a FAULT indicating icon and, if configured, remotely by modulating the output current (i.e., Spike Output).

Diagnostic faults are interrogated using the FAULT Info Smart Key. A short text string and fault code will be alternately shown in the secondary display region. If multiple faults exist, the FAULT Info Smart Key moves the user to the next fault. Once all faults have been interrogated, the TB82TC Series transmitter returns to the Measure Mode and the MENU Smart Key icon energizes.

The following section describes the type of fault conditions and their applicability to the TB82TC Series transmitter functionality.

FAULT CODES

Fault conditions are grouped into two categories based on their severity. Conditions that result in degradation of transmitter performance are reported as Problem Codes (i.e., PC), while conditions that render the transmitter inoperable are reported as Error Codes (i.e., EC).

Fault codes are reported in the secondary display region in a first in, first out order (i.e., the first detected fault condition is the first condition that is displayed upon interrogation). All active fault conditions can be viewed at any time while in the Measure Mode of Operation using the FAULT Info Smart Key. A flashing Fault icon indicates a newly detected fault condition. When all fault conditions have been resolved, the Fault icon and FAULT Info Smart Key will be disabled.

Problem Codes

Problem Codes result from fault conditions that impact the performance of the TB82TC Series transmitter. In most cases, these conditions can be resolved by the user using standard practices.

The occurrence of a Problem Code fault condition triggers the Fault icon to energize and the Spike output to modulate (if configured). These diagnostic indicators provide local and remote reporting capability.

Table 12-1 and Table 12-2 contain all the Problem Codes supported by the TB82TC Series transmitter. Each entry lists the Problem Code number, displayed text string, and a short description of the fault condition. See Section 13, Troubleshooting, for resolving a fault condition.

Table 12-1. Common Problem Code Definitions

Problem Codes	Text String	Description
PC6	HI.LOOP	Current loop above upper range value (+0.4 mA Hysteresis).
PC7	LO.LOOP	Current loop below lower range value (-0.2 mA Hysteresis).
PC8	HI.PV	Process Variable above transmitter range.
PC9	LO.PV	Process Variable below transmitter range.
PC10	HI.TEMP	Temperature above transmitter range.
PC11	LO.TEMP	Temperature below transmitter range.
PC12	HI.T.AD	Open or missing temperature sensor.
PC13	LO.T.AD	Shorted temperature sensor.

Table 12-2. Uncommon Problem Code Definitions

Problem Codes	Text String	Description
PC20	BAD.SEE	Bad Serial EEPROM or Conductivity Input PCB Assembly.
PC21	NO.F.CAL	Missing factory calibration and functional Serial EEPROM.
PC22	BLNK.uP	Blank microprocessor EEPROM.
PC25	ROM.SUM	Incorrect EPROM Checksum.

Table 12-2. Uncommon Problem Code Definitions

Problem Codes	Text String	Description
PC30	R0.F.CAL	Out of range or missing factory calibration for conductivity circuit range zero.
PC31	R1.F.CAL	Out of range or missing factory calibration for conductivity circuit range one.
PC32	R2.F.CAL	Out of range or missing factory calibration for conductivity circuit range two.
PC33	R3.F.CAL	Out of range or missing factory calibration for conductivity circuit range three.
PC34	R4.F.CAL	Out of range or missing factory calibration for conductivity circuit range four.
PC35	G0.F.CAL	Out of range or missing factory calibration for ground loop circuit range zero.
PC36	G1.F.CAL	Out of range or missing factory calibration for ground loop circuit range one.
PC37	G2.F.CAL	Out of range or missing factory calibration for ground loop circuit range two.
PC38	G3.F.CAL	Out of range or missing factory calibration for ground loop circuit range three.
PC39	G4.F.CAL	Out of range or missing factory calibration for ground loop circuit range four.
PC40	W0.F.CAL	Corrupt Serial EEPROM or microprocessor EE.
PC41	W1.F.CAL	Corrupt Serial EEPROM or microprocessor EE.
PC42	W2.F.CAL	Corrupt Serial EEPROM or microprocessor EE.
PC43	W3.F.CAL	Corrupt Serial EEPROM or microprocessor EE.
PC44	W4.F.CAL	Corrupt Serial EEPROM or microprocessor EE.
PC45	BA.F.CAL	Out of range or missing factory calibration for 3k Balco temperature sensor.
PC46	PT.F.CAL	Out of range or missing factory calibration for Pt100 temperature sensor.
PC48	PK.F.CAL	Out of range or missing factory calibration for Pt1000 temperature sensor.
PC50	R0.CHKS	Incorrect or missing conductivity circuit range zero checksum.
PC51	R1.CHKS	Incorrect or missing conductivity circuit range one checksum.
PC52	R2.CHKS	Incorrect or missing conductivity circuit range two checksum.
PC53	R3.CHKS	Incorrect or missing conductivity circuit range three checksum.
PC54	R4.CHKS	Incorrect or missing conductivity circuit range four checksum.

Table 12-2. Uncommon Problem Code Definitions

Problem Codes	Text String	Description
PC55	G0.CHKS	Incorrect or missing ground loop circuit range zero checksum.
PC56	G1.CHKS	Incorrect or missing ground loop circuit range one checksum.
PC57	G2.CHKS	Incorrect or missing ground loop circuit range two checksum.
PC58	G3.CHKS	Incorrect or missing ground loop circuit range three checksum.
PC59	G4.CHKS	Incorrect or missing ground loop circuit range four checksum.
PC60	W0.CHKS	Bad or missing auxiliary zero checksum.
PC61	W1.CHKS	Bad or missing auxiliary one checksum.
PC62	W2.CHKS	Bad or missing auxiliary two checksum.
PC63	W3.CHKS	Bad or missing auxiliary three checksum.
PC64	W4.CHKS	Bad or missing auxiliary four checksum.
PC65	BA.CHKS	Incorrect or missing 3k Balco temperature sensor checksum.
PC66	PT.CHKS	Incorrect or missing Pt100 temperature sensor checksum.
PC68	PK.CHKS	Incorrect or missing Pt1000 temperature sensor checksum.

Error Codes

Error Codes result from fault conditions that render the TB82TC Series transmitter inoperable. In most cases, these conditions can not be resolved by the user using standard practices.

The occurrence of an Error Code fault condition triggers the Fault icon to energize and the Safe Mode output to enable (i.e., fix the transmitter current output high or low based on the configured Safe Mode level). These diagnostic indicators provide local and remote reporting capability.

Table 12-3 contains all the Error Codes supported by the TB82TC Series transmitter. Each entry lists the Error Code number, displayed text string, and a short description of the fault condition. See Section 13, Troubleshooting, for resolving a fault condition.

Table 12-3. Error Code Definitions

Error Codes	Text String	Description
EC1	HI.PV.AD	Over range Process Variable A/D.
EC2	LO.PV.AD	Under range Process Variable A/D.
EC3	PH.PCB	pH/ORP/pION board with conductivity firmware.

Calibration Diagnostic Messages

During a Conductivity or Concentration calibration, the TB82TC Series transmitter monitors the quality and value of the process variable signal. Poor signals will generate one of three type of warnings: BAD.CAL (i.e., Bad Calibration value), UNSTBL (i.e., Unstable Calibration value), or DRIFT (i.e., Drifting Calibration value). A BAD.CAL condition occurs when the transmitter can not lock onto a signal. This conditions typically only occurs when a PV Overrange/Underrange Error (i.e., EC1 or EC2 Error Code, respectively) exists. A BAD.CAL condition rejects the calibration value and returns the transmitter to the CON.CAL State after displaying the BAD.CAL text string. Unstable (i.e., UNSTBL) or DRIFT conditions are also undesirable occurrences and considered problematic; however, for these occurrences, the user has the option to accept the calibration after viewing the calibration slope and offset data.

In addition to the above real time calibration diagnostics, the TB82TC Series transmitter performs automatic efficiency and offset calculations relative to a theoretically perfect conductivity and/or temperature sensor during each calibration cycle. Calibration history is retained for future interrogation using the Edit Calibrate State. The calibration constants that are displayed are Slope and Offset for the Process Variable and Temperature.

A Slope of less than 0.2 or greater than 5 indicates a potentially bad process calibration point or poorly performing sensor. In these cases, a text string communicates the encountered variance. These test strings include LO SLP (i.e., Low Slope) and HI SLP (i.e., High Slope). When calibration problems are encountered, the calibration value is rejected and the calibration data (i.e., Slope and Offset values) is returned to the previous values stored in memory prior.

An Offset value of less than -100 mS/cm or greater than 100 mS/cm also indicates a potentially bad process calibration or poorly performing sensor. Again, the problem is displayed using the text string LO OFF (i.e., Low Offset) or HI OFF (High Offset). As with the slope variances, the calibration data is returned to prior values.

For temperature, a bad calibration will be reported and calibration values will not be accepted for Slope values that are less than 0.2 or greater than 1.5 and Offset values that are less than -40ºC or greater than +40ºC. Temperature calibrations use smart software routines that automatically adjust the Slope, Offset, or Both values based on the calibration value being entered and calibration history if it exists.

Additional Diagnostic Messages

Other diagnostic messages may appear during transmitter programming. These messages include BAD.VAL (i.e., bad value) and DENIED.

BAD.VAL indicates the attempted numeric entry of a value which is out of the allowed transmitter range. See Section 1 for transmitter range limits.

DENIED indicates incorrect entry of a security password. See Section 9 for information on Security Mode of Operation.

RAM.ERR indicates a Random Access Memory read/write error. The transmitter will automatically reset when this error has been encountered. If the transmitter continues to reset, contact ABB for problem resolution.

SECTION 13 - TROUBLESHOOTING

INTRODUCTION

This section provides troubleshooting information for the TB82TC Series transmitter and associated sensor. Using Table 13-1, problem conditions can be identified and the corrective action for these conditions can be implemented. Refer to Section 12, Diagnostics, for descriptions of problem code conditions.

TRANSMITTER TROUBLESHOOTING

Table 13-1. Transmitter Troubleshooting Guide

Problem Code	Problem Text String	Corrective Action
PC6	HI.LOOP	1) Verify process conditions are within configured output range. If process variable is outside configured range, increase output range. 2) Verify TB82TC is configured for the correct temperature compensation type. 3) Verify sensor wiring is properly connected. 4) Remove any liquids, oils, scales, or corrosion from TB82TC terminal block or extension cable junction box terminals. 5) Clean sensor and perform a process calibration. 6) Conduct a temperature calibration. If a temperature sensor is not being used, verify the transmitter is configured as NONE for TMP.SNS and the proper process temperature has been set. 7) Electronically test the sensor and temperature compensator. Replace sensor if sensor does not meet requirements.
PC7	LO.LOOP	1) See PC6 corrective actions.
PC8	HI.PV	1) Verify process conditions are within transmitter range. Process variable must be within transmitter range. 2) Also See PC4 corrective actions.
PC9	LO.PV	1) See PC8 corrective actions.
PC10	HI.TEMP	1) Verify process conditions are within transmitter range. Process variable must be within transmitter range. 2) Also see PC6 corrective actions.
PC11	LO.TEMP	1) See PC10 corrective actions.
PC12	HI.T.AD	1) See PC10 corrective actions. If all items check out, implement item 2. 2) Replace Toroidal Conductivity Input PCB Assembly.
PC13	LO.T.AD	1) See PC12 corrective actions.

Problem Code	Problem Text String	Corrective Action
PC20	BAD.SEE	1) Input PCB Factory calibration constants can not be loaded. Calibrate sensor and order replacement Toroidal Conductivity Input PCB Assembly. Existing PCB should properly function until new assembly is received.
PC21	NO.F.CAL	1) Contact Factory for calibration procedure. Calibrate sensor for short-term usage until factory calibration can be performed or a new Toroidal Conductivity Input PCB can be installed.
PC22	BLNK.uP	1) Cycle transmitter power. 2) Contact Factory.
PC25	ROM.SUM	1) See PC22 corrective action.
PC30	R0.F.CAL	1) Contact Factory for calibration procedure. Calibrate sensor for short-term usage until a factory calibration can be performed.
PC31	R1.F.CAL	1) See PC30 corrective action.
PC32	R2.F.CAL	1) See PC30 corrective action.
PC33	R3.F.CAL	1) See PC30 corrective action.
PC34	R4.F.CAL	1) See PC30 corrective action.
PC35	G0.F.CAL	1) Input PCB Factory calibration constants have been corrupted. Order replacement Toroidal Conductivity Input PCB Assembly or return to factory for repair. Existing PCB should properly function until new assembly is received.
PC36	G1.F.CAL	1) See PC35 corrective action.
PC37	G2.F.CAL	1) See PC35 corrective action.
PC38	G3.F.CAL	1) See PC35 corrective action.
PC39	G4.F.CAL	1) See PC35 corrective action.
PC40	W0.F.CAL	1) See PC35 corrective action.
PC41	W1.F.CAL	1) See PC35 corrective action.
PC42	W2.F.CAL	1) See PC35 corrective action.
PC43	W3.F.CAL	1) See PC35 corrective action.
PC44	W4.F.CAL	1) See PC35 corrective action.
PC45	BA.F.CAL	1) Contact Factory for calibration procedure. Calibrate temperature sensor for short-term usage until factory calibration can be performed.
PC46	PT.F.CAL	1) See PC45 corrective action.
PC48	PK.F.CAL	1) See PC45 corrective action.

Problem Code	Problem Text String	Corrective Action
PC50	R0.CHKS	1) See PC30 corrective action.
PC51	R1.CHKS	1) See PC30 corrective action.
PC52	R2.CHKS	1) See PC30 corrective action.
PC53	R3.CHKS	1) See PC30 corrective action.
PC54	R4.CHKS	1) See PC30 corrective action.
PC55	G0.CHKS	1) See PC35 corrective action.
PC56	G1.CHKS	1) See PC35 corrective action.
PC57	G2.CHKS	1) See PC35 corrective action.
PC58	G3.CHKS	1) See PC35 corrective action.
PC59	G4.CHKS	1) See PC35 corrective action.
PC60	W0.CHKS	1) See PC35 corrective action.
PC61	W1.CHKS	1) See PC35 corrective action.
PC62	W2.CHKS	1) See PC35 corrective action.
PC63	W3.CHKS	1) See PC35 corrective action.
PC64	W4.CHKS	1) See PC35 corrective action.
PC65	BA.CHKS	1) See PC45 corrective action.
PC66	PT.CHKS	1) See PC45 corrective action.
PC68	PK.CHKS	1) See PC45 corrective action.

WARNING	**All error conditions are considered catastrophic. When such an error has been reported, the transmitter should be replaced with a known-good transmitter. The non-functional transmitter should be returned to the factory for repair. Contact the factory for processing instructions.**

INSTRUMENT TROUBLESHOOTING

When the transmitter is suspected as the problem source, it can be evaluated using a known good sensor and decade resistance box or set of resistors. A resistance simulates the load measured by the sensor and can be an easy way to check the operation of the analyzer.

Instrument Electronic Test

Disconnect the sensor connections from the analyzer and complete the following steps using Figure 13-1 as a reference:

1) Connect a known good sensor to the transmitter per the wire requirements identified in Section 3, Installation.

2) Using a six inch length of 22 AWG or larger wire, thread the wire through the center bore three times.

3) Connect the wire to a decade resistance box or the appropriate resistor to provide the sensor with a resistive load.

4) Connect the appropriate resistor, based on temperature sensor configuration, across the temperature sensor input (i.e., TB2-5 and TB2-6) or configure the analyzer for manual temperature compensation with the temperature set to 25ºC.

5) Conduct a Zero and Span-Point Calibration using the procedures in Section 6, Calibration and resistance values in Table 13-2.

6) Using the Table 13-2, compare the several applied resistance values against their displayed value. The measured values should be within the expected values by ± 5%.

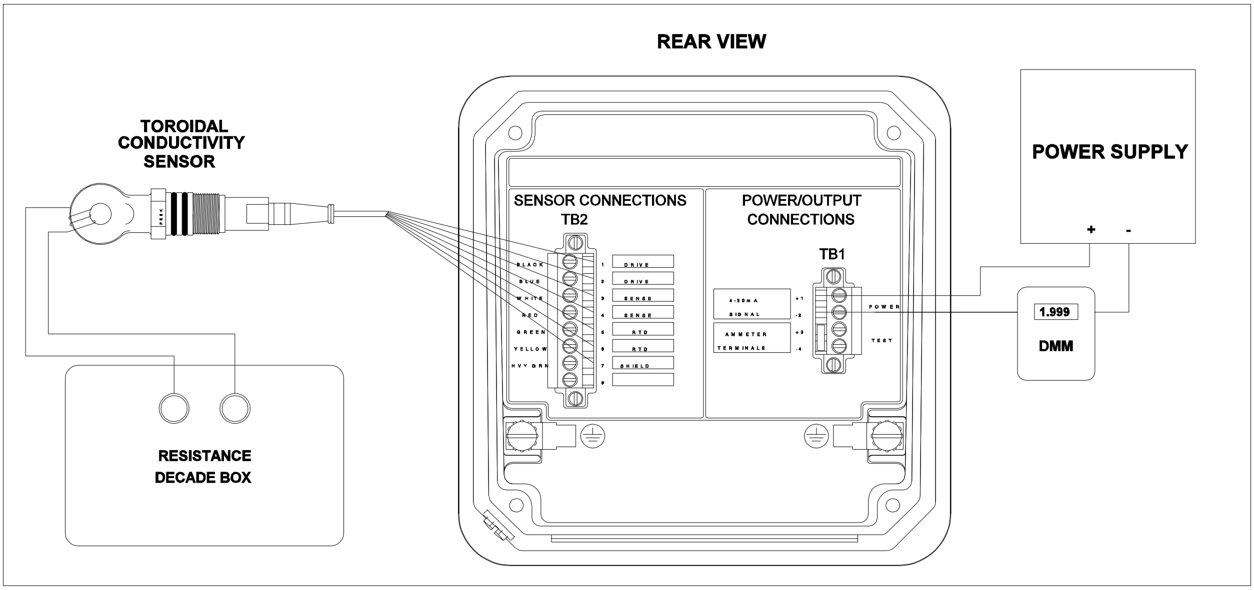


Figure 13-1. Electronic Test Setup.

Table 13-1. Sensor Simulation Values

Variable Resistance (Ohms)	Desired Display Value	Displayed Value
Open	0 µS/cm	
500,000	41 µS/cm	
200,000	103 µS/cm	
50,000	413 µS/cm	
20,000	1031 µS/cm	
5,000	4.13 mS/cm	
2,000	10.31 mS/cm	
500	41.3 mS/cm	
200	103.1 mS/cm	
50	413 mS/cm	
20	1031 mS/cm	
10.32	1999 mS/cm	

SENSOR TROUBLESHOOTING

If the sensor is suspected as problem source, a quick visual inspection in many cases can identify the problem. If nothing can be detected, a few electrical tests using a digital multimeter should be performed to determine if the sensor is faulty. Some of these tests can be performed with the sensor either in or out of the process stream.

Visual Sensor Inspection

Remove the sensor from the process and visually check the following:

Sensor body
Inspect the sensor body for cracks and distortions. If any are found, contact ABB for alternative sensor styles and materials.

Cable and connectors
Inspect the sensor cable for cracks, cuts, or shorts. If a junction box and/or extension cable are used, check for moisture, oil, corrosion, and/or particulates where connections are made. All connections must be dry, oil-free, corrosion-free, and particulate-free. Even slight amounts of moisture, corrosion, and particulates can short sensor signals and affect conductivity readings. Check to see that all wiring is dry and not shorting against any metal, conduit, or earth grounds. See Section 14, Maintenance, for sensor cleaning procedures.

O-ring seals
Inspect the sealing O-rings for attack by the process liquid. If the O-rings show evidence of corrosion, distortion, or deterioration, contact ABB for alternate material choices.

Sensor Electronic Test

Toroidal conductivity sensors can be electronically tested to verify the integrity of the sensor and cable. The sensor and RTD must be disconnected from the transmitter before any tests can be performed. Additionally, these tests require a Digital Multimeter (DMM) that has a conductance function capable of 0 to 200 nS and a resistance function capable of 0 to 20 kohms.

The RTD can be tested with the sensor in the process as follows:

1. Check the resistance of the RTD by measuring the resistance between the yellow and green leads.

For a 3 kohm Balco RTD, the expected resistance can be calculated using:

$$R_{TC} = [((T-25) * 0.0045) + 1] * 3000$$

where T is in degrees Celsius. The measured resistance should be within the expected value by ± 15%.

For a Pt100 RTD, the expected resistance can be calculated using:

$$R_{TC} = 100 + [(T - 0) * 0.385]$$

where T is in degrees Celsius. The measured resistance should be within the expected value by ± 5%.

For the Pt1000 RTD, the expected resistance can be calculated using:

$$R_{TC} = 1000 + [(T - 0) * 3.85]$$

where T is in degrees Celsius. The measured resistance should be within the expected value by ± 5%.

Moisture inside the sensor can also be detected without removing the sensor from the process using the following procedure:

1. Check the conductance between the yellow RTD lead and each of the other sensor leads (i.e., blue, red, white, black, and heavy green leads). The reading must be less than 0.05 nS.

2. Check the conductance between the blue Drive lead and one of the Sense leads (i.e., white or red.) The reading must be less than 0.05 nS.

3. Check the conductance between the blue Drive lead and the exposed metal surface on the back of the sensor. Repeat using the red Sense lead. Both readings must be less than 0.05 nS.

4. Check the conductance between the heavy green lead (i.e., Shield) and each of the other sensor leads (i.e., blue, yellow, black, green, red, and white leads). The reading must be less than 0.05 nS.

SECTION 14 - MAINTENANCE

INTRODUCTION

The reliability of any stand-alone product or control system is affected by maintenance of the equipment. ABB recommends that all equipment users practice a preventive maintenance program that will keep the equipment operating at an optimum level.

Personnel performing preventive maintenance should be familiar with the TB82TC Series transmitter.

WARNING	**Allow only qualified personnel (refer to INTENDED USER in SECTION 1, INTRODUCTION) to commission, operate, service, or repair this equipment. Failure to follow the procedures described in this instruction or the instructions provided with related equipment can result in an unsafe condition that can injure personnel and damage equipment.**

PREVENTIVE MAINTENANCE

Table 14-1 is the preventive maintenance schedule and check list for the TB82TC Series transmitter. The table lists the preventive maintenance tasks in groups according to their specified maintenance interval. The maintenance intervals are recommendations and may vary depending on the location, environment, and the process application. As a minimum, these recommended maintenance tasks should be performed during an extended process shutdown. Tasks in Table 14-1 are self-explanatory. For sensor cleaning procedures, refer to CLEANING THE SENSOR.

Table 14-1. Preventive Maintenance Schedule

Preventive Maintenance Tasks	Interval (months)
Check and clean all wiring and wiring connections.	12
Clean and inspect sensor.	As required.
Clean and lubricate all gaskets and O-rings, or replace and lubricate if damage is evident.	Each time seals are broken.
Calibrate transmitter output.	12
Calibrate transmitter sensor input.	As required.

Cleaning the Sensor

ABB toroidal conductivity sensors are cleaned using one or a combination of the following methods. These are recommendations and may not be suitable for all applications. Other cleaning methods may be developed that better suit particular applications. When cleaning, observe all safety precautions required for handling chemicals. When handling chemicals, always use gloves, eye protection, safety shield, and similar protective items and consult ***Material Safety Data Sheets***.

WARNING **Consider the material compatibility between cleaning fluids and process liquids. Incompatible fluids can react with each other causing injury to personnel and equipment damage.**

WARNING **Use solvents only in well ventilated areas. Avoid prolonged or repeated breathing of vapors or contact with skin. Solvents can cause nausea, dizziness, and skin irritation. In some cases, overexposure to solvents has caused nerve and brain damage. Solvents are flammable - do not use near extreme heat or open flame.**

Acid Dip Dip the wetted end of the sensor into a one to five percent hydrochloric acid (HCl) solution until this region is free of the unwanted coating. Minimize exposure of any metal on the sensor to this corrosive cleaning solution. This method removes scales from water hardness. After dipping, thoroughly rinse sensor with clean water.

Solvent Dip Dip the sensor into a solvent such as isopropyl alcohol. Remove solvent using a clean cloth. Do not use solvents which are known to be incompatible with the plastic of the sensor. This method removes organic coatings.

Physical Cleaning Use a rag, acid brush, or tooth brush to remove especially thick scales and accumulations.

SECTION 15 - REPLACEMENT PROCEDURES

INTRODUCTION

Due to the modular design of the TB82TC Series transmitter, the replacement of an assembly can be easily completed. Replacements are available for each major assembly. These include the conductivity input PCB, microprocessor PCB, power supply PCB, front bezel, shell, and rear cover assemblies. This section provides removal and installation procedures for these assemblies. Use Figure 15-1 as a reference during removal and installation procedures.

NOTE: Refer to Section 3 for special handling procedures when removal of electronic assemblies is required.

WARNING	**Substitution of any components other than those assemblies listed in this section will compromise the certification listed on the transmitter nameplate. Invalidating the certifications can lead to unsafe conditions that can injure personnel and damage equipment.**

WARNING	**Do not disconnect equipment unless power has been switched off at the source or the area is known to be nonhazardous. Disconnecting equipment in a hazardous location with source power on can produce an ignition-capable arc that can injure personnel and damage equipment.**

ELECTRONIC ASSEMBLY REMOVAL/REPLACEMENT

1. Turn off power to the transmitter. Allow at least 1 minute for the transmitter to discharge.

2. Remove the Front Bezel Assembly by unscrewing the four captive screws and lightly pulling the bezel from the shell.

3. Remove the four 6-32 machine screws that retain the Power Supply and Conductivity Input PCB assemblies if both assemblies or the Microprocessor PCB Assembly are being replaced.

4. Release the keypad ribbon cable connector latch by pressing the outside clips on the connector and lightly pulling outwards.

5. Remove the four 6-32 machine screws that retain the Microprocessor PCB Assembly.

6. Replace the appropriate PCB assembly and follow the reverse of this procedure for reassembly.

FRONT BEZEL ASSEMBLY REMOVAL/REPLACEMENT

1. Turn off power to the transmitter. Allow at least 1 minute for the transmitter to discharge.

2. Remove the Power Supply, Conductivity Input, and Microprocessor PCB Assemblies as described in Electronic Assembly Removal/Replacement procedure.

3. Attach the Power Supply, Conductivity Input, and Microprocessor PCB Assemblies to the new Front Bezel Assembly, install this new assembly into the Shell Assembly, and tighten the four exterior, captive 6-32 machine screws.

SHELL ASSEMBLY REMOVAL/REPLACEMENT

1. Turn off power to the transmitter. Allow at least 1 minute for the transmitter to discharge.

2. Remove the Front Bezel Assembly by unscrewing the four captive screws and lightly pulling the bezel from the shell.

3. Remove the Rear Cover Assembly by unscrewing the four captive screws.

4. Replace the old Shell Assembly with the new one.

5. Install the Rear Cover and Front Bezel Assemblies and

tighten the eight exterior, captive 6-32 machine screws.

REAR COVER ASSEMBLY REMOVAL/REPLACEMENT

1. Turn off power to the transmitter. Allow at least 1 minute for the transmitter to discharge.

2. Remove the Rear Cover Assembly by unscrewing the four exterior, captive 6-32 machine screws.

3. Replace with the new Rear Cover Assembly.

4. Tighten the four exterior, captive 6-32 machine screws.

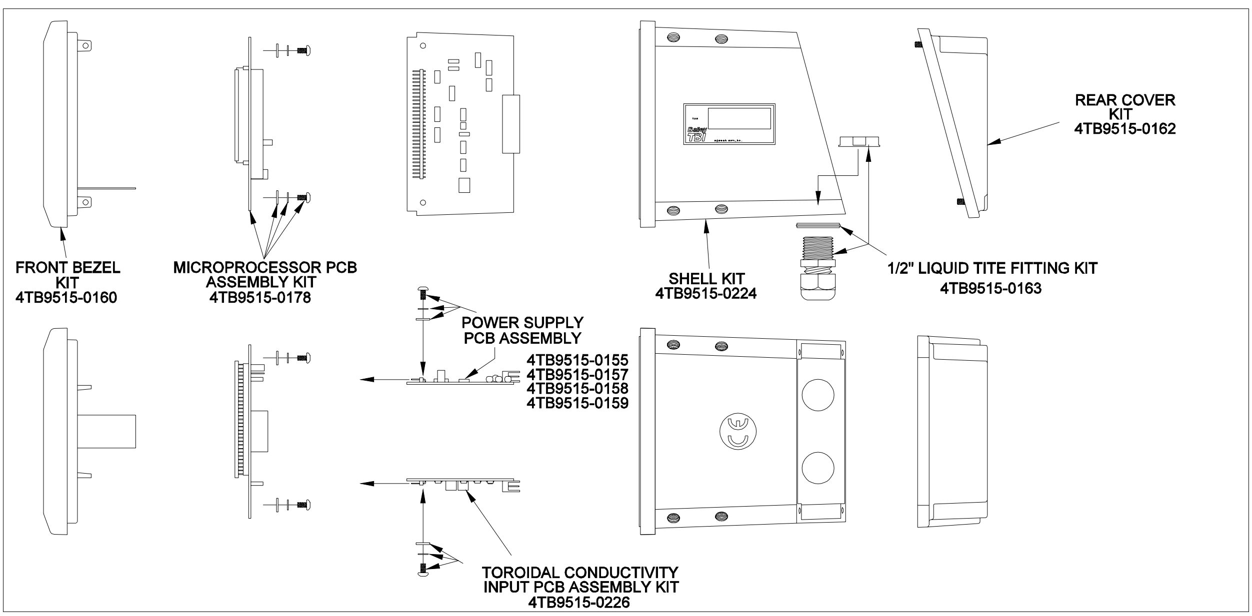


Figure 15-1. TB82 Advantage Series Exploded View Showing Kit Assignments.

SECTION 16 - SUPPORT SERVICES

INTRODUCTION

ABB is ready to help in the use and repair of its products. Requests for sales and/or application service should be made to the nearest sales or service office.

Factory support in the use and repair of the TB82TC Series transmitter can be obtained by contacting:

ABB Inc.
9716 S. Virginia St., Ste.E
Reno, Nevada 89511
USA
Phone: +1(775) 850-4800
FAX: +1(775) 850-4808
Website: www.abb.com

RETURN MATERIALS PROCEDURES

If any equipment should need to be returned for repair or evaluation, please contact ABB at (775)883-4366, or your local ABB representative for a Return Materials Authorization (RMA) number. At the time the RMA number is given, repair costs will be provided, and a customer purchase order will be requested. The RMA and purchase order numbers must be clearly marked on all paperwork and on the outside of the return package container (i.e., packing box).

Equipment returned to ABB with incorrect or incomplete information may result in significant delays or non-acceptance of the shipment.

REPLACEMENT PARTS

When making repairs at your facility, order spare parts kits from a ABB sales office. Provide the following information.

1. Spare parts kit description, part number, and quantity.

2. Model and serial number (if applicable).

3. ABB instruction manual number, page number, and reference figure that identifies the spare parts kit.

When you order standard parts from ABB, use the part numbers and descriptions from the **RECOMMENDED SPARE PARTS KITS** sections. Order parts without commercial descriptions from the nearest ABB sales office.

RECOMMENDED SPARE PARTS KITS

Table 16-1. Spare Parts Kits

Part Number	Description
4TB9515-0124	Pipe Mount Kit
4TB9515-0125	Hinge Mount Kit
4TB9515-0123	Panel Mount Kit
4TB9515-0156	Wall Mount Kit
4TB9515-0160	Front Bezel Kit (Enclosure)
4TB9515-0161	Shell Kit (TB82PH Enclosure)
4TB9515-0175	Shell Kit (used on TB82EC or TB82TE)
4TB9515-0224	Shell Kit (TB82TC Enclosure)
4TB9515-0162	Rear Cover Kit (Enclosure)
4TB9515-0163	1/2" Liquid-Tite Cable Grip Fitting Kit - Compatible with TB4 Four-Electrode Conductivity Sensors and TBX5 pH/ORP/pION Sensors
4TB9515-0155	Power Supply PCB Assembly Kit
4TB9515-0157	Power Supply w/ HART PCB Assembly Kit (Contact ABB for availability)
4TB9515-0158	Power Supply w/ Lightning Suppressor PCB Assembly Kit

Part Number	Description
4TB9515-0159	Power Supply W/ HART and Lightning Suppressor PCB Assembly Kit (Contact ABB for availability)
4TB9515-0178	Microprocessor PCB Assembly Kit (TB82EC/TE/TC Firmware Included)
4TB9515-0226	Toroidal Input PCB Assembly Kit
4TB9515-0164	BNC/TC to TB82PH Pin Adapter

APPENDIX A - TEMPERATURE COMPENSATION

GENERAL

The TB82TC Series transmitter has a variety of standard conductivity temperature compensation options. These include manual (0.1 N KCl), standard automatic (0.1 N KCl), temperature coefficient (0 to 9.99%/°C), zero to 15 percent sodium hydroxide (NaOH), zero to 20 percent sodium chloride (NaCl), zero to 18 percent hydrochloric acid (HCl), zero to 20 percent sulfuric acid (H_2SO_4), and user-defined.

The concentration analyzer configuration offers the same temperature compensation options as found in the standard conductivity analyzer configuration.

CONDUCTIVITY AND CONCENTRATION TRANSMITTER

For these two analyzer types, eight different types of temperature compensation are available. Manual temperature compensation is based on 0.1 N KCl. For Basic Programming, the reference temperature is fixed to 25 degrees Celsius. Advanced Programming provides the ability to set the reference temperature to any value within full scale temperature range of -20 to 200 degrees Celsius.

Automatic temperature compensation can be set to one of several temperature compensation options. When automatic compensation is configured, the transmitter will measure the process temperature via the resistive temperature device located either in the conductivity sensor or external to the sensor, and will automatically adjust the raw conductivity to a conductivity referenced to a values established by the user (25 degrees Celsius is the default setting.) As with Manual compensation, the reference temperature is limited to the range of -20 to 200 degrees Celsius.

The standard KCl temperature compensation option characterizes the temperature effect of 0.1 N KCl and has the following data break-points:

Temperature (°C)	**K_{REF}/K**
0	1.80
5	1.57
10	1.38
15	1.22
20	1.10
25	1.00
30	0.91
50	0.69
75	0.50
100	0.38
128	0.30
156	0.25
306	0.18

The temperature coefficient option allows for a fixed correction which is based on a percentage change of the reference conductivity (e.g., conductivity at 25°C) per degree Celsius. The temperature compensation factor is derived from the equation:

$$\alpha = TC.COEF = \frac{(\frac{K_T}{K_{REF}} - 1.0) * 100.0}{T - 25.0}$$

where:

α and TC.COEF = percentage change in the reference conductivity per degree Celsius.

K_T = conductivity at temperature T (°C).

K_{REF} = conductivity at the reference temperature (e.g., 25°C.)

T = temperature of the solution in degrees Celsius.

Typical ranges for temperature compensation coefficients are:

- Acids = 1.0 to 1.6%/°C.
- Bases = 1.8 to 2.0%/°C.
- Salts = 2.2 to 3.0%/°C.
- Neutral Water = 2.0%/°C.

The zero to 15 percent NaOH compensation option characterizes an average temperature correction required to cover a zero to 15 percent NaOH concentration range. Since NaOH has a relatively constant set of temperature coefficients over a large range of concentrations, this compensation can be used for weak as well as concentrated solutions of NaOH. Data for the break-points are:

Temperature (°C)	**K_{REF}/K**
0	1.79
25	1.00
50	0.69
75	0.53
100	0.43
156	0.30

The zero to 20 percent NaCl compensation option characterizes an average temperature correction required to cover a zero to 20 percent NaCl concentration range. Since NaCl has a relatively constant set of temperature coefficients over a large range of concentrations, this compensation can be used for weak as well as concentrated solutions of NaCl. Data for the break-points are:

Temperature (ºC)	**K_{REF}/K**
0	1.75
25	1.00
50	0.66
75	0.47
100	0.35
140	0.25
156	0.23

The zero to 18 percent HCl compensation option characterizes an average temperature correction required to cover a zero to 18 percent HCl concentration range. Since HCl has a relatively constant set of temperature coefficients over a large range of concentrations, this compensation can be used for weak as well as concentrated solutions of HCl. Data for the break-points are:

Temperature (ºC)	**K_{REF}/K**
0	1.55
25	1.00
50	0.75
75	0.61
100	0.52

156	0.43

The zero to 20 percent H_2SO_4 compensation characterizes an average temperature correction required to cover a zero to 20 percent H_2SO_4 concentration range. Data for the break-points are:

Temperature (°C)	**K_{REF}/K**
0	1.37
25	1.00
50	0.84
75	0.73
100	0.67
156	0.61

The user-defined temperature compensation option allows entry of six sets of break-point (i.e., K/K_{REF}) and temperature values. Each break-point value should be chosen to provide the closest fit of the line segment to the actual temperature in degrees °C versus K/K_{REF} relationship.

APPENDIX B - CONCENTRATION PROGRAMMING

GENERAL

The concentration analyzer configuration has four specific solute options and one user-defined option. The specific solute options include zero to 15 percent NaOH, zero to 20 percent NaCl, zero to 18 percent HCl, and zero to 20 percent H_2SO_4. Users needing a custom concentration configuration can select the user-defined option which provides a six-point, five-segment linear approximation of their own conductivity-to-concentration curve. For the user-defined option, custom units can be used by either selecting one of three engineering unit icons or entering a six-character, alphanumeric character string.

USER PROGRAMMED CONCENTRATION TO CONDUCTIVITY CURVES

The user-defined option allows the characterization of concentration-to-conductivity curves which have been determined separately in a laboratory or from published data such as the **International Critical Tables**. These curves must then be segmented into five straight lines and programmed into the function generator using the format as illustrated in Figures B-1 through B-5.

Unlike other concentration transmitters, users may enter any conductivity and concentration set in ascending or descending method. Some rules must be followed and are as follows:

1. Point 1 for both conductivity and concentration is always the 0% (i.e., 4 mA) output point.
2. Point 6 for both conductivity and concentration is always the 100% (i.e., 20 mA) output point.
3. All conductivity points must be ascending. Concentration points can be either ascending or descending.

4. For a reverse-acting output, set the end point values accordingly for the output range in either the Modify Configure State or Output/Hold Rerange State.
5. The output range (i.e., 4 and 20 mA output range) can not exceed the Point 1 and Point 6 concentration range; however, the output range can be compressed using the rerange (RERNGE) function in the Output/Hold mode of operation.

Users may also define their own engineering units by selecting either the PPM, PPB, or % icon that will be energized in the primary display or by entering a six-character, alphanumeric that can be viewed permanently or temporarily in the secondary display.

For processes with fixed solute types, the user can select one of the four pre-defined solute options. These options include zero to 15 percent NaOH, zero to 20 percent NaCl, zero to 18 percent HCl, and zero to 20% H_2SO_4.

For reference processes, the following information is provided for these four preprogrammed options. This information has been compiled and extrapolated from the **International Critical Table**. All data and curves are referenced at 25^{o}C. This information has been curve-fitted to simple equations for use in the TB82TC Series transmitter and only approximates the actual concentration curves. If improved accuracy is required, especially in a narrow region of concentration, it is suggested that the user-defined option is selected and the data be manually entered.

The zero to 15 percent NaOH option is characterized by the following data:

Conductivity (mS/cm)	Weight Percent
0	0.0
140	3.0
252	6.0
331	9.0
396	12.0
410	15.0

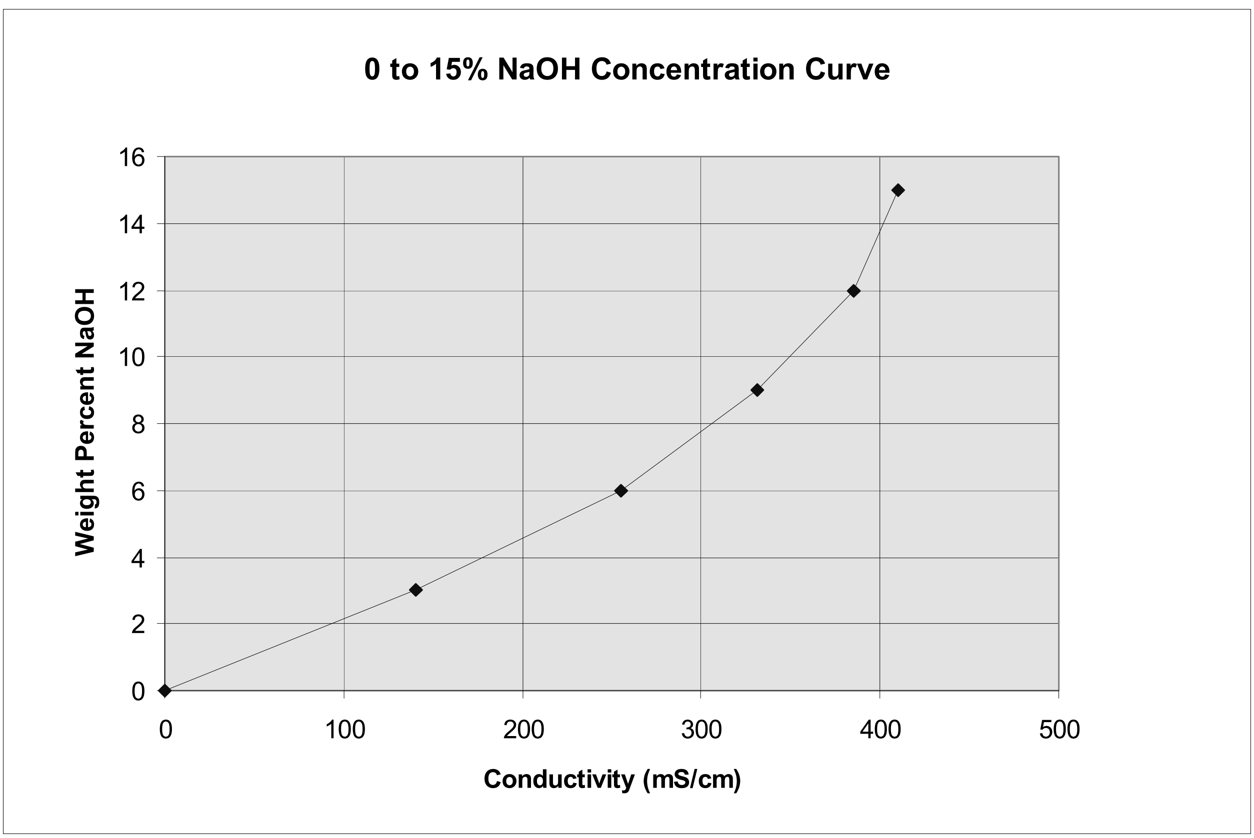


Figure B-1. 0 to 15% NaOH Concentration Curve

The zero to 20 percent NaCl option is characterized by the following data:

Conductivity (mS/cm)	Weight Percent
0	0.0
62	4.0
118	8.0
162	12.0
200	16.0
225	20.0

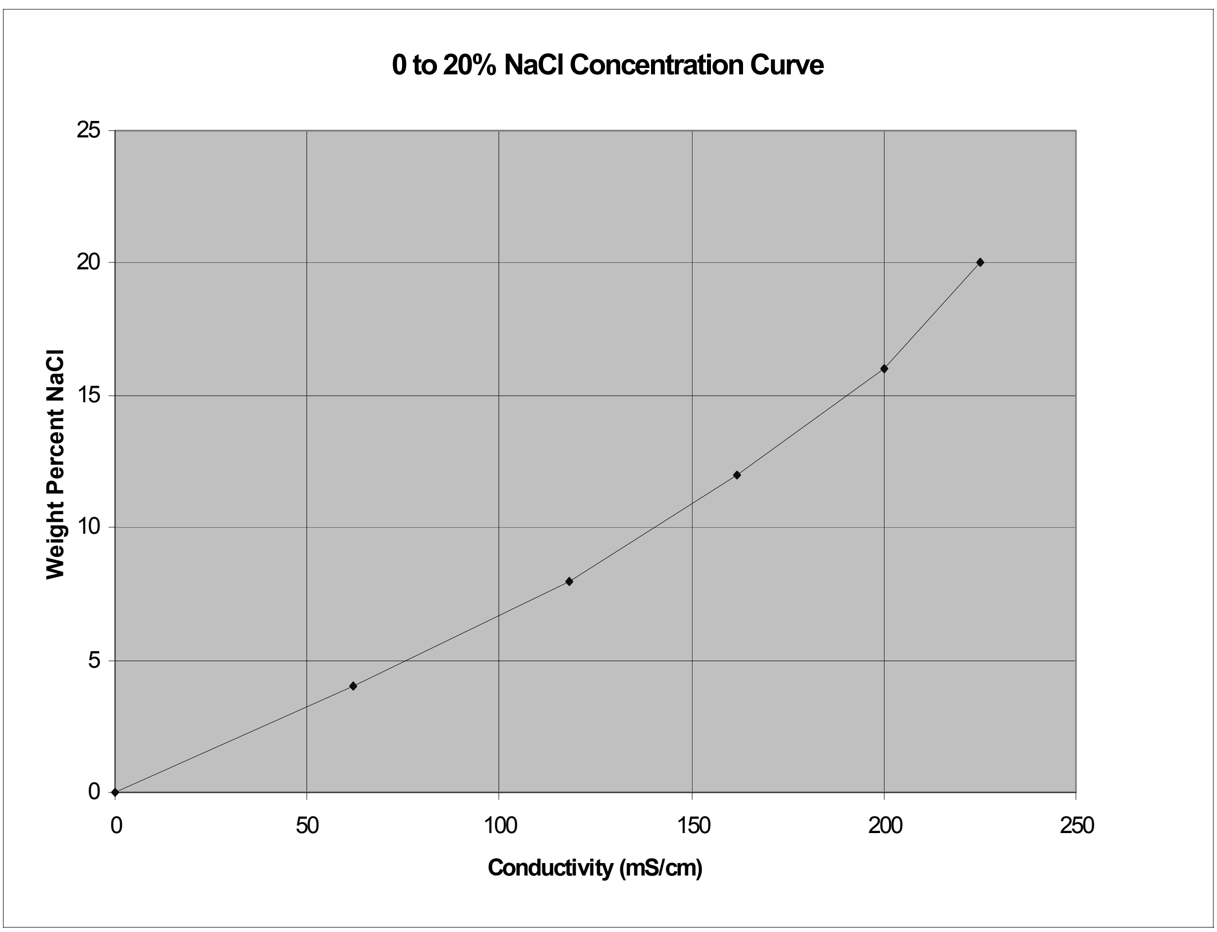


Figure B-2. 0 to 20% NaCl Concentration Curve

The zero to 18 percent HCl option is characterized by the following data:

Conductivity (mS/cm)	Weight Percent
0	0.0
365	4.0
625	8.0
755	12.0
820	15.0
850	18.0

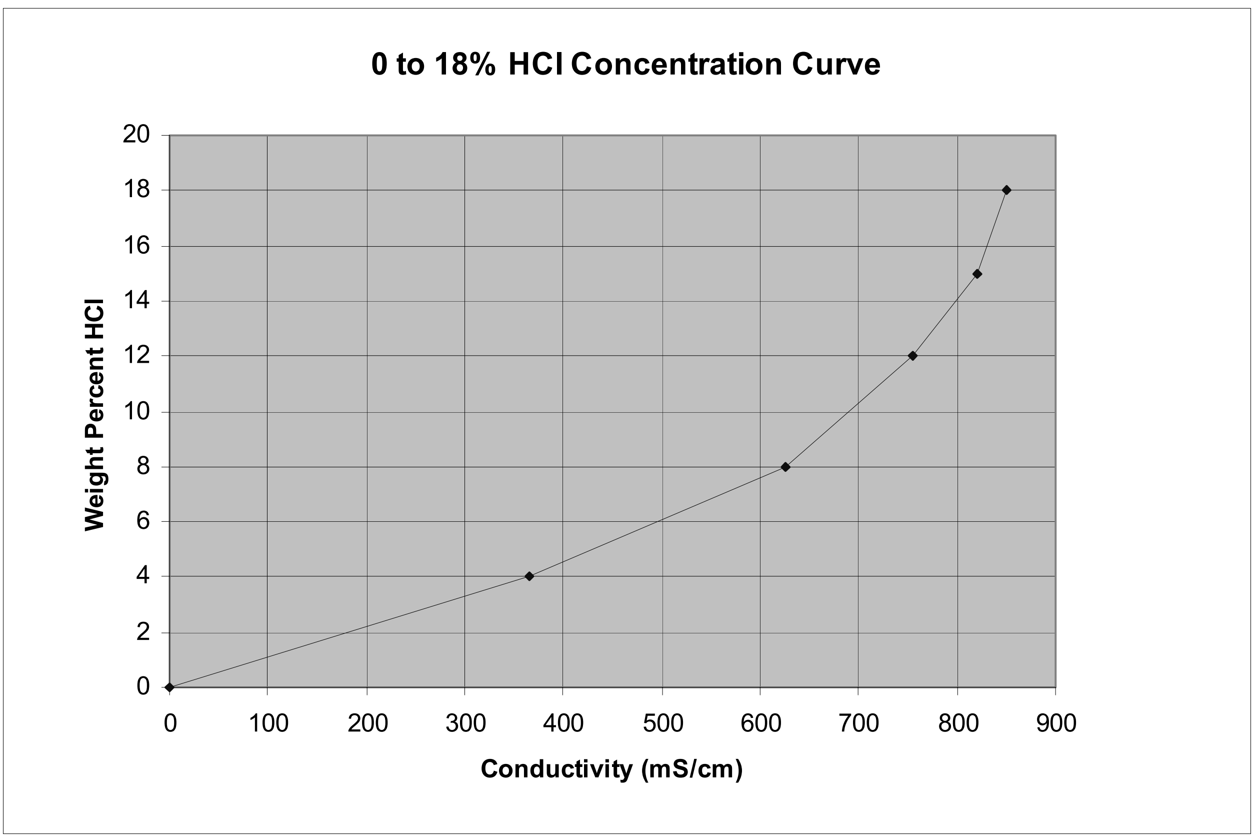


Figure B-3. 0 to 18% HCl Concentration Curve

The zero to 20 percent H_2SO_4 option is characterized by the following data:

Conductivity (mS/cm)	Weight Percent
0	0.0
190	4.0
355	8.0
499	12.0
618	16.0
710	20.0

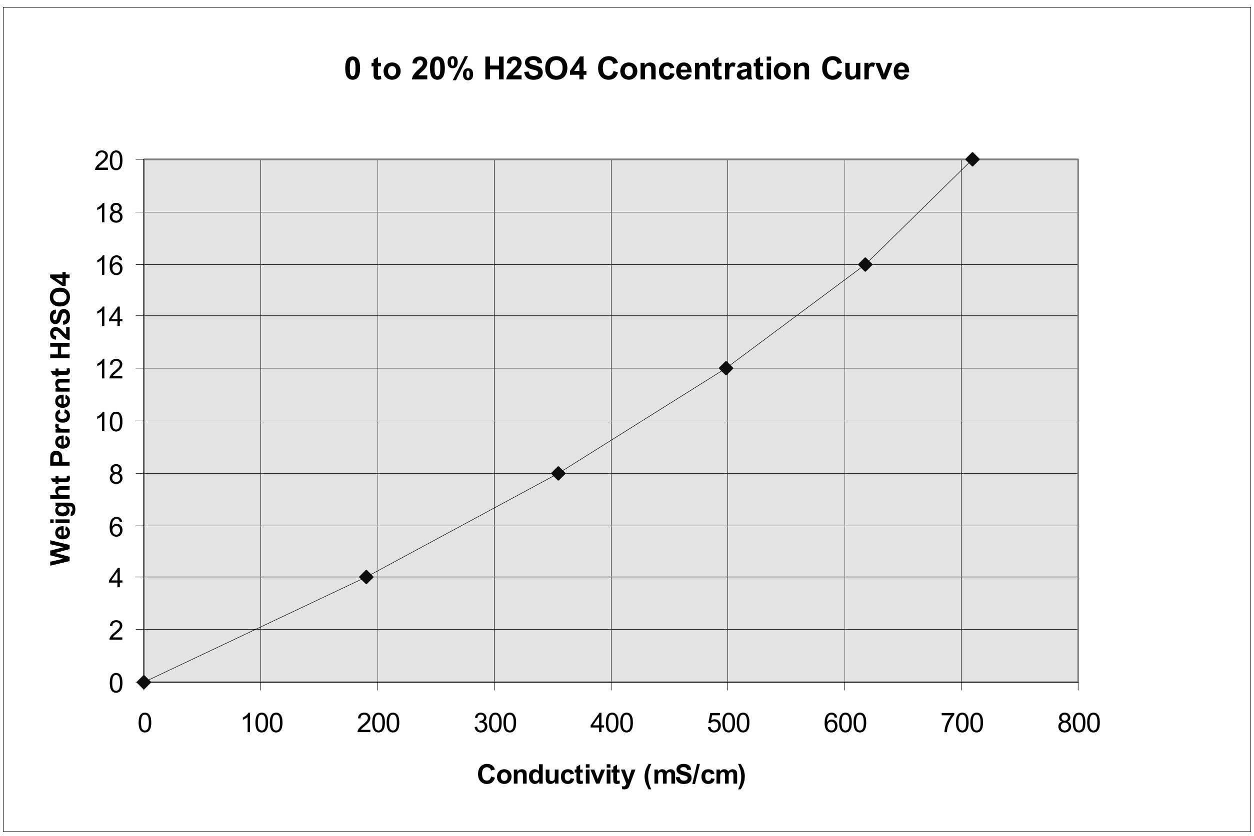


Figure B-4. 0 to 20% H_2SO_4 Concentration Curve

APPENDIX C - PROGRAMMING TEXT STRING GLOSSARY

GENERAL

When programming the TB82TC Series transmitter, the six-character, alphanumeric region will display a wide variety of text prompts. In many cases, these prompts are abbreviations or portions of words. This section contains a complete list of the text prompts and their full text equivalent.

GLOSSARY OF PROGRAMMING TEXT PROMPTS

Table C-1. Glossary of Text Prompts

TEXT STRING	DESCRIPTION
20MA.PT	20 Milliamp Point.
3K.BLCO	3 kohm Balco RTD.
4.75K.RTD	4.75 kohm RTD Network.
4MA.PT	4 Milliamp Point
AAAAAA	Alphanumeric Entry.
ACCEPT	Accept Calibration Variance.
ADVNCD	Advanced Programming State of Operation.
ANALZR	Analyzer State of Operation.
AUTO	Automatic Temperature Compensation.
BAD.CAL	Bad Calibration - Entered values caused the calculated values to exceed maximum values.
BAD.VAL	Bad Value - Entered value exceeds maximum or minimum allowable value for the entered parameter.
BASIC	Basic Programming State of Operation.
CALIBR	Calibrate Mode of Operation.
CON.CAL	Conductivity or Concentration Calibration State of Operation.
CONCEN	Concentration.

TEXT STRING	DESCRIPTION
COND	Conductivity.
CONFIG	Configure Mode of Operation.
D.P. POS	Decimal Point Position.
DAMPNG	Damping State of Operation.
DENIED	An incorrect security password has been entered.
DIAGS	Diagnostics State of Operation.
DISABL	Disable.
EDT.CAL	Edit Calibration State of Operation.
FAIL.HI	Fail High (i.e., 20 mA).
FAIL.LO	Fail Low (i.e., 4 mA).
H2SO4	Sulfuric Acid.
HCL	Hydrochloric Acid.
HI OFF	High Offset Value.
HI SLP	High Slope Value.
HLD.LEV	Hold Level.
HOLD	Hold State of Operation.
K1/K25	Conductivity at Temperature Point # 1 to Reference Conductivity at 25°C Ratio. Points 2 through 6 are represented in the same manner.
LO OFF	Low Offset Value.
LO SLP	Low Offset Value.
MANUAL	Manual.
MODIFY	Modify Configure State of Operation.
NACL	Sodium Chloride.
NAOH	Sodium Hydroxide.
NEW.VAL	New Calibration Value - The PV or Temperature value expected during a Process Variable or Temperature Calibration.

TEXT STRING	DESCRIPTION
NEW.VL.C	New Value in degrees Celsius.
NO D.P.	No Decimal Point is desired.
NO.ICON	No Icon is desired in the primary display.
NONE	None.
OUT.CAL	Output Calibration State of Operation.
OUTPUT	Output Mode of Operation.
PASSWD	Security Password.
PT 100	Pt100 Ohm RTD.
PV OFF	Process Variable Offset.
PV SLOPE	Process Variable Slope.
REL.HLD	Release Hold.
RERANG	Rerange State of Operation.
RESET?	Would you like to conduct a RESET operation?
REV.A10	Software Revision A10.
RST.ALL	Reset All Parameters to Factory Settings.
RST.CAL	Reset Calibration Constant and Data to Factory Settings.
RST.CON	Reset Configurations to Factory Defaults.
RST.SEC	Reset Security - Remove any existing security.
SAFE.MD	Safe Mode State of Operation.
SAVE?	Would you like to Save the Configuration?
SEC.DSP	Secondary Display Mode of Operation.
SECS	Seconds.
SECUR	Security Mode of Operation.
SLF.TST	Self Test.
SLOPE	Slope.

TEXT STRING	DESCRIPTION
SPAN.PT	Span-Point Calibration State of Operation.
SPIKE	Spike Output State of Operation.
SPK.MAG	Spike Output Magnitude.
SPK.OFF	Spike Output Function set to Off (i.e., Disabled).
STABL?	Is the displayed Process Variable Stable?
STNDBY	Standby.
T.OFF°C	Temperature Offset in degrees Celsius.
TC.COEF	Temperature Compensation Coefficient.
TC.TYPE	Temperature Compensation Type State of Operation.
TMP	Temperature.
TMP.CAL	Temperature Calibration State of Operation.
TMP.SLP	Temperature Slope.
TMP.SNS	Temperature Sensor Type State of Operation.
U.D.UNIT	User-Defined Engineering Units.
UNITS	Engineering Units.
USR.DEF	User-Defined.
VIEW	View Configure State of Operation.
X1.COND	Conductivity independent variable (i.e, X Point) value for break-point 1 in conductivity units. Points 2 through 6 are represented in the same manner.
Y1.CONC	Concentration dependent variable (i.e, Y Point) value for break-point 1 in concentration units. Points 2 through 6 are represented in the same manner.
ZERO.PT	Zero-Point Calibration State of Operation.

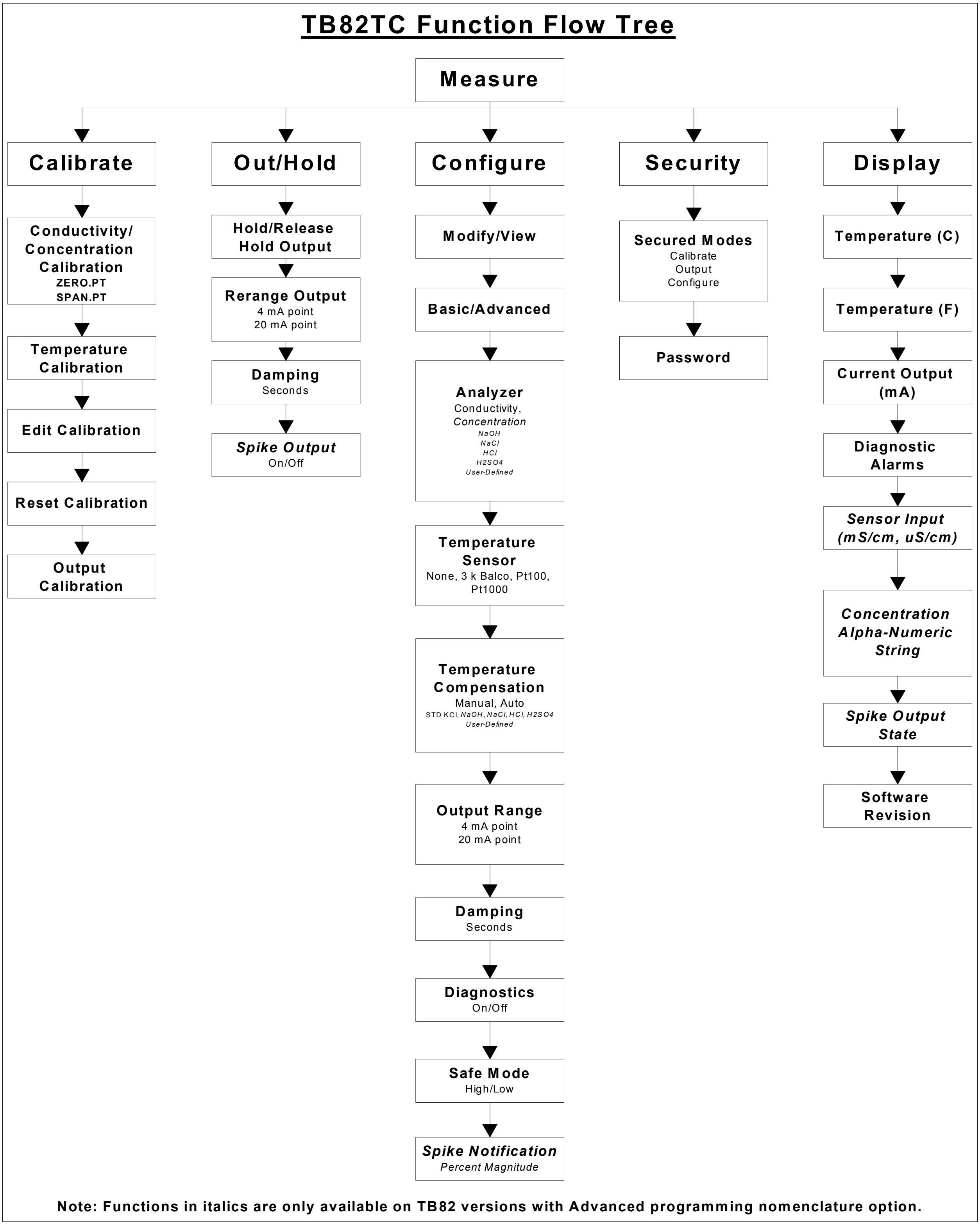


Figure C-1. TB82TC Programming Function Flow Chart.

APPENDIX D - CONFIGURATION WORKSHEETS

TB82TC WORKSHEET

Tag:	Date:
Programming Mode: ☐ Basic	☐ Advanced
Analyzer Type:	
☐ CONDUCTIVITY	☐ CONCENTRATION ☐ 0-15% NaOH ☐ 0-20% NaCl ☐ 0-18% HCl ☐ 0-20% H_2SO_4 ☐ User-Defined: Engineering Units: _____ COND1: ___ CONC1: ___ COND2: ___ CONC2: ___ COND3: ___ CONC3: ___ COND4: ___ CONC4: ___ COND5: ___ CONC5: ___ COND6: ___ CONC6: ___
Temperature Sensor: ☐ None ☐ 3k Balco	☐ Pt100 ☐ Pt1000
Temperature Compensation Type: ☐ Manual ☐ Auto: ☐ 0-15% NaOH ☐ 0-20% NaCl ☐ 0-18% HCl ☐ 0-20% H_2SO_4 ☐ User-Defined: T1: ___ K_{STD}/K_1: ___ T2: ___ K_{STD}/K_2: ___ T3: ___ K_{STD}/K_3: ___ T4: ___ K_{STD}/K_4: ___ T5: ___ K_{STD}/K_5: ___ T6: ___ K_{STD}/K_6: ___	
Output Range: 4 mA: ______ 20 mA: ______	
Damping Value: ______ Seconds	
Safe Mode Level: ☐ Fail Low ☐ Fail High	
Spike Magnitude: ______ %	
Security: ☐ Configure ☐ Calibrate ☐ Output/Hold Password: ______	

Products and customer support

Automation Systems

For the following industries:

- Chemical & Pharmaceutical
- Food & Beverage
- Manufacturing
- Metals and Minerals
- Oil, Gas & Petrochemical
- Pulp and Paper

Drives and Motors

- AC and DC Drives, AC and DC Machines, AC Motors to 1kV
- Drive Systems
- Force Measurement
- Servo Drives

Controllers & Recorders

- Single and Multi-loop Controllers
- Circular Chart and Strip Chart Recorders
- Paperless Recorders
- Process Indicators

Flexible Automation

- Industrial Robots and Robot Systems

Flow Measurement

- Electromagnetic Flowmeters
- Mass Flowmeters
- Turbine Flowmeters
- Wedge Flow Elements

Marine Systems & Turbochargers

- Electrical Systems
- Marine Equipment
- Offshore Retrofit and Refurbishment

Process Analytics

- Process Gas Analysis
- Systems Integration

Transmitters

- Pressure
- Temperature
- Level
- Interface Modules

Valves, Actuators and Positioners

- Control Valves
- Actuators
- Positioners

Water, Gas & Industrial Analytics Instrumentation

- pH, Conductivity and Dissolved Oxygen Transmitters and Sensors
- Ammonia, Nitrate, Phosphate, Silica, Sodium, Chloride, Fluoride, Dissolved Oxygen and Hydrazine Analyzers
- Zirconia Oxygen Analyzers, Katharometers, Hydrogen Purity and Purge-gas Monitors, Thermal Conductivity

Customer support

We provide a comprehensive after sales service via a Worldwide Service Organization. Contact one of the following offices for details on your nearest Service and Repair Centre.

USA

ABB Inc.
Tel: +1 800 HELP 365 (435 7365)
Fax: +1 860 298 7669

UK

ABB Limited
Tel: +44 (0)1453 826661
Fax: +44 (0)1453 829671

China

ABB Engineering (Shanghai) Limited
Tel: +86 (0) 21 6105 6666
Fax: +86 (0) 21 6105 6992

Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification. Periodic checks must be made on the equipment's condition. In the event of a failure under warranty, the following documentation must be provided as substantiation:

- A listing evidencing process operation and alarm logs at time of failure.
- Copies of all storage, installation, operating and maintenance records relating to the alleged faulty unit.

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Note
We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. ABB does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.

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Sales

Service

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