DELTA-*C*
TECHNOLOGIES INC.

WATER-IN-OIL ANALYZER
MODEL DC-1000

Instruction Manual

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1.0 INTRODUCTION

The Type DC-1000 analyzer consists of a microprocessor-based electronics unit mounted on a caged probe. A 100 ohm RTD assembly is mounted in the probe and provides a temperature input to the analyzer.

The analyzer uses the capacitance principle. A cylindrical sensor and outer barrel are fixed in size and distance from each other and form the electrodes of a coaxial capacitor. The oil sample flows between the "plates" as a dielectric fluid, changing the capacitance of the assembly proportionally with the change in dielectric constant of the fluid. The measured capacitance is converted to a water content output signal by the microprocessor and associated components.

Although the capacitance approach to the measurement of water in oil is sound in principle, previous methods have had limited success. This is caused by the difficulty of measuring the small capacitance change of a large standing value and implementing accurate compensation for the effect of temperature changes on the dielectric constant. Indeed, some instruments do not even make the effort. In any measurement system, accuracy depends on the number and stability of the components involved in the signal chain. Analog circuits used in other instruments (even those that incorporate digital displays) have, of necessity, many components that add errors at each stage of the signal processing with the consequent inferior performance.

In contrast, the DC-1000 analyzer's design reduces the primary dependency to a single component whose characteristics are known and well controlled. This, and the application of sophisticated algorithms, using a microprocessor, allows the DC-1000 to deliver stability and accuracy unmatched by others. A further benefit of this instrument is that it can be used to accurately determine variables necessary for its own calibration.

Temperature compensation is provided by an RTD input to the microprocessor. The RTD input shifts the calibration curve in the microprocessor, proportionally with a change in temperature. This shift is assumed to be linear with small temperature changes and small water percentages.

Density changes that can be identified as step changes are handled by switching the analyzer to an alternate calibration curve. A maximum of four calibration curves, each with its own temperature compensation, are available. Density changes that randomly drift up and down will affect the capacitance measurement. In this case, external density compensation must be used.

2.0 ASSEMBLY AND INSTALLATION

2.1 Sensor Assembly

Tools Required:

3/4" x 6" Pipe Nipple TBE
3/4" x 8" Pipe Nipple TBE
Bench Vise
Hydraulic hand pump suitable for 6000 PSIG

Assembly Instructions:

If the analyzer needs internal cleaning and this can not be done by back flushing with a solvent, **do not** try to disassemble the unit at the installation site. Disconnect all piping and electrical connections and take the unit to the shop to allow for proper reassembly.

When reassembling make sure that all the O-rings are clean and covered with a heavy grease before tightening the threaded connections.

Some threaded connections should not be undone after initial factory installation. These connections are on both ends of the 1.25” conduit nipple (Part#18) and on both ends of the sensor barrel (Part#05) to the 2” collars (Part#06). All mentioned threads are secured with "Threadlock" compound.

When disassembling the sensor, remove the electronic module first to prevent damage to the RTD temperature probe.

When ready to reassemble, after cleaning the parts, start at the bottom end by clamping in the lower end cap in a bench vise. Do not forget to install the compression spring before the insulator is inserted in the end cap.

Take the sensor barrel with the two collars and screw one end onto the end cap; it does not matter which end. Use one of the 3/4” conduit nipples and screw it into one of the collar connections to use as a lever. Do not use pipe wrenches on any of the components of the analyzer. Gently tighten the 2” threaded connection while **making sure that the shoulder of the collar seats on the end cap**.

Now, install the sensor plug by inserting it from the top end of the barrel, **making sure that the end of the plug fits into the hole of the lower insulator**.

Test the spring action by pushing down on the guide tube and **be sure that the 1/4" O-ring is in place on the guide tube**.

The upper end cap is still attached to the 1.25” conduit nipple and the electrical housing.

Inspect the 1.5” O-ring between the upper insulator and inside the upper end cap and apply ample amounts of grease to the O-ring. There should be good lubrication at this point.

After inserting the insulator, line up one of the four small holes with the electrical enclosure, as shown in figure 1, and **make sure it stays this way when tightening the threaded joint**.

Now lift the electrical enclosure and upper end cap with insulator, and slip the subassembly over the guide tube .

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Top view of explosion proof housing

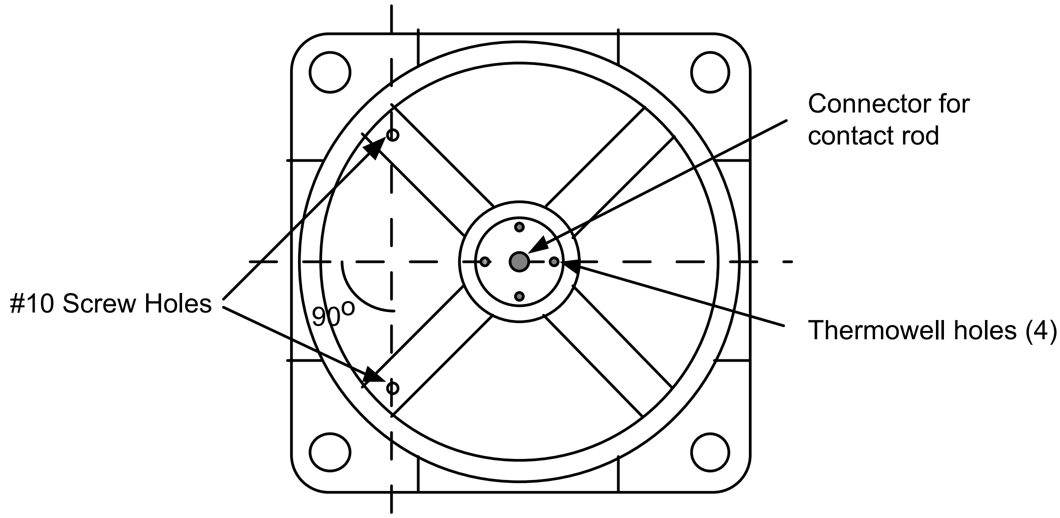


Figure 1 Thermowell hole alignment to case

Note: Thermowell hole in the insulator must be on a line that is at 90^{o} to the line through the #10 mounting screw holes.

Before installing the electronics module, loosen the setscrew of the RTD anchor and pull the RTD element down as far as possible. While inserting **the RTD element first** in the small hole of the insulator, line up the connection rod with the guide tube.

Now lower the module to the bottom of the enclosure while making sure that the RTD element stays inserted in the insulator. Only after the module is screwed down in the enclosure, tighten the RTD setscrew very gently to prevent damage to the RTD by crushing the tubing.

Do a hydraulic pressure test up to 3240 psig and check for leaks. Hold for 5 minutes.

2.2 Analyzer Installation

2.2.1 Mechanical Installation

The analyzer is normally installed in a vertical position with flow from bottom to top. This helps prevent the accumulation of gas bubbles in the probe assembly.

An adequate circulation rate is required to prevent water separation in the probe assembly. For oil service, a minimum rate of 4 USGPM is recommended. For condensate service, a minimum rate of 9 USGPM is required. The maximum rate is limited by the amount of driving force available. However, care must be taken to prevent any gas breakout of the liquid in the probe assembly caused by very high flowrates.

A sample stream of liquid is normally passed through the probe assembly. The driving force can be supplied by a small pump, by a restriction in the main line, or by a pump discharge to suction by-pass loop (see figure 7.) The user must be sure that this sample represents a true composition of the main line flow.

The unused top connection of the sensor is a convenient location to install a sample draw-off/vent valve.

•Warning•

If block valves are used in the supply and return sample lines, make sure that the vent valve is open when both block valves are closed. Failure to do this may result in rupture of the body or adjacent piping in case of thermal expansion of the liquid.

2.2.2 Electrical Installation

The Type DC-1000 analyzer has been designed for installation in a Class I, Div. 1, Gr. C&D area. The electrical installation must conform to the requirements of applicable local electrical codes.

Refer to Figure 4 for details in the terminal connections.

2.2.2.1 Power Supply

Terminals #1 and #2 are provided for the power input with #1 as negative and #2 as positive. The power supply voltage required is between 18 and 28 V DC and can be grounded or ungrounded. The power supply input is fully isolated from ground to allow use of standard ground fault detectors in D.C. power systems. A 3/4 amp fuse is provided with the unit. It is a Littlefuse P/N 273.750 and is located in the top of the electronic enclosure.

2.2.2.2 Analog Output

Terminals #3 and #4 are used for 0/4 to 20 mA output. The DC-1000 powers the loop. The analog output is fully isolated from instrument ground to prevent ground loop problems. The maximum loop load is 500 ohms @ 24 V DC.

2.2.2.3 RS-232C I/O

Terminals #5, #7 and #8 are provided for RS-232C communications. Terminal #5 is common, terminal #7 is RD and terminal #8 is TD. The analyzer is the computer and the configuring device is a "Dumb Terminal". The "Dumb Terminal" should have a screen with a minimum of 8 lines and 65 characters per line. If the configuring device is a computer, a program such as "Kermit" or "Procomm" has to be installed so that it will emulate a terminal. When computers are used as terminals RD and TD must be reversed when wiring the RS-232C port. Terminal #6 is not used for RS-232C communication. It is provided for the optional RS-422/RS-485 communication format. It is recommended that shielded cable be used between the terminal and the analyzer with no less than 20 AWG conductors and not exceeding 150 feet in length.

2.2.2.4 Temperature Input

Terminals #9 and #10 are used for the temperature sensor input connections. To test the RTD, disconnect it and measure the resistance and temperature. Then consult the RTD tables.

2.2.2.5 Range Switch Selection

Terminals #1, #11 and #12 are provided for calibration curve selection. The 4 independent calibration curves of the analyzer are used to provide accurate water content measurement for oils of various densities. The desired curve is selected by connecting terminals #11 and/or #12 to terminal #1. The selection is made as follows:

1) curve 0 connect #1 to #11 **and** #12
2) curve 1 connect #1 to #12
3) curve 2 connect #1 to #11
4) curve 3 #11 and #12 not connected

2.2.2.6 Relay Contacts

Terminals #13, #14 and #15 provide normally closed and normally open contacts. These contacts are isolated and rated for 2 Amps @ 24V DC non-inductive load. Terminal #13 is common, terminal #14 is normally closed and terminal #15 is normally open. A plug-in form C relay is used to allow field service if the relay is defective.

An inductive load snubber is required to prolong the life of the relay contacts. An inductive load is a load like an external relay or a solenoid valve that has a coil. A suitable snubber for a DC coil would be a diode whose cathode is connected to the more positive terminal of the coil.

The Electrical Code allows only AC and DC voltages of less than 30 volts. **Do NOT attempt to use any higher voltage**. A suitable 2.5 amp fuse in the "hot" supply circuit will protect the relay and circuit board traces against accidental burn-out.

For fail-safe operation, use the normally open contact. When the unit is powered up and the water content is below the alarm point, the contacts will be closed. On power failure or measurement above the alarm setpoint, the contacts will open and trip the annunciator.

3.0 CALIBRATION THEORY

For low water content, in the range of 0 to 10%, the variation of dielectric constant with water concentration may be considered to be linear and is of the form:

$$R = ax+b$$

where

R = ratio value proportional to dielectric constant

x = concentration of water in oil

a = slope

b = intercept

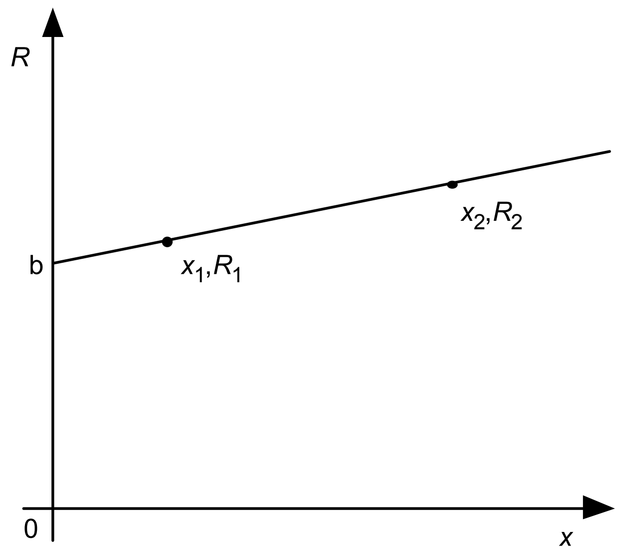


Figure 2 Ratio vs. water content

To completely characterize the curve, two known points are necessary. These are shown in Fig. 2 as x_1, R_1 and x_2, R_2. During the calibration process, the DC-1000 analyzer measures R_1 and R_2 and the corresponding x_1 and x_2 values are supplied by the operator.

This equation, by itself, is not adequate for measurement because the dielectric constant is also significantly affected by the oil temperature. This dependency, for most oils, is negative, such that the dielectric constant decreases with increasing temperature.

The combination of the two effects describes a plane as shown in Fig. 3 below:

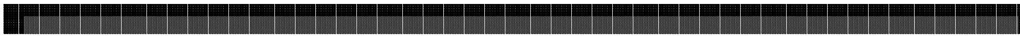


Figure 3 Ratio vs. water content and temperature

The correspondence to Figure 2 is that the temperature variation simply shifts the curve up and down in the *R-x* plane. The additional information required is the temperature compensation, which, along with the temperature measurements, characterizes the plane. The section on Temperature Compensation describes how to use the Analyzer to measure this factor accurately.

4.0 CALIBRATION

4.1 Operator Interface

The analyzer software is a menu driven system where all tasks related to calibration or viewing guide the operator through the process by lists of questions. Whenever a value is required the unit of measurement is shown. For example, when the alarm delay is to be set, the menu question will show that the number is in units of seconds (the operator does not have to type the units, in this case "sec").

Some special keys are used by the analyzer:

(esc) The key marked ESC
(cr) The key marked ENTER or RETURN
(bs) The key marked BS., BACKSPACE or the left arrow
(del) The key marked DEL or DELETE

The following general rules apply to the operation of the analyzer:

1. Typing (esc) aborts the current command and **leaves previous values intact**.

2. Whenever a number is required, the following keys are allowed:

   0 through 9

   (.) decimal point
   (bs) erases last entered character
   (del) erases last entered character
   (esc) abort numeric entry return to command level
   (cr) accept current number
   If no new numbers have been typed on the current line, then it will retain the old value. This is a way to examine previous calibration values without disturbing anything.

3. Whenever Y/N is required, the following keys are valid:

   (Y) accepts the current values
   (N) leaves the old information intact and moves to the next question
   (cr) leaves the old information intact and moves to the next question
   (esc) aborts the current command without changing previous values.

   When the monitor is waiting for a command, the following is displayed:

   [1] Command (? for help) >

   The number in brackets at the beginning of the prompt line indicates which calibration curve is in use. The other calibration curves are shown as [0], [2] and [3]. See wiring diagram for access to the other calibration curves.

4.2 Calibration

The analyzer is calibrated with a computer terminal, using an RS-232C interface. Calibration should be carried out in the following sequence:

1) Determine Temperature Compensation of the fluid.
2) Perform Water Content Calibration using either "Calibrate Full" or "Calibrate Simple".
3) Perform analog output calibration and alarm relay calibration if desired.

A menu is available on the computer terminal that displays the available commands. This menu is accessed by typing the key (?) and displays :

(CS)	Calibrate Simple
(CF)	Calibrate Full
(CO)	Calibrate Output
(SA)	Set Alarm
(DB)	Display BS & W
(DC)	Display/Modify Calibration
(ESC)	Exit/Abort

The calibration steps and these commands are explained in greater detail on the following pages.

4.2.1 Temperature Compensation

An emulsion of water in oil exhibits a temperature dependency such that an increase in temperature causes a decrease in the mixture's dielectric constant. This decrease is a zero shift and shows as an apparent decrease in water content of approximately 0.01% water per °C.

In order to compensate, the DC-1000 Analyzer is able to measure the oil temperature in the measurement cell. It measures the temperatures during calibration, calculates normalization factors and applies a supplied correction factor so that the correct water content is measured.

The instrument may be used to determine, very accurately, the correct temperature compensation factor.

Although the temperature factor above is shown in terms of % water per °C, for purposes of transferability, the DC-1000 uses the units of % per °C. This is in fact the percent change in dielectric constant (dimensionless) per degree Celsius.

To determine the temperature compensation factor proceed as follows:

Provide the means to circulate dry oil, the identical type that is used in the field measurement, through the measuring cell and a means to heat the oil.
Start circulating cool oil at normal ambient conditions.

Use the command **DB** to display water content, temperature and R (R is a raw measurement value directly proportional to the dielectric constant). These are displayed in the order as above from left to right.

Ignore the water content value (the instrument need not be calibrated for this procedure) and note the temperature and R value until they stabilize.

When stable, record the temperature as T_1 and R as R_1.

Apply heat to raise the oil temperature by 10 or more degrees Celsius and wait until the temperature has stabilized. Usually a fast and steady oil circulation will increase the temperature, provided that the sensor is well insulated.

Record the new temperature as T_2 and R as R_2.

Solve the equation $R = aT + R_o$ as follows:

$$a = \frac{(R_2 - R_1)}{(T_2 - T_1)}$$

$$R_o = R_2 - aT_2$$

Then, the temperature compensation factor (T_c) is determined:

$T_c = 100a/R_0$ in percent

Record the temperature compensation factor. It will be entered into the Analyzer during the water content calibration step.

Typical values for T_c are:

gravity	0.95	to	1.00 gm/cc	0.01
gravity	0.80	to	0.95 gm/cc	0.03
gravity	0.50	to	0.80 gm/cc	0.07

Because of the wide variation in T_c, it is desirable to test the oil rather than rely on the above estimates.

The dimensionless units of T_c are in terms of %R/°C.

Please note that the T_c combines the temperature coefficient of the sensor and the oil. The sensor T_c has a positive slope and the oil has a larger and negative slope. For some of the heavier crude oils it will appear as if the T_c is zero, but actually the two T_cs cancel each other.

4.2.2 CF - Calibrate Full

This is the normal, full-accuracy calibration method for the DC-1000 Analyzer. It allows partial calibration to be done as circumstances permit, then, when all required values are known, the working coefficient memory may be updated.

With this advanced method, laboratory standard calibration can be achieved for the actual oil in use, by drawing samples during this process, analyzing them in the lab and entering the results into the monitor at a later date. All data is stored in non-volatile memory so that partial calibration data is not affected by power failures.

Before calibration, make sure that samples can be drawn for analysis and that the oil contains some water for at least one of the two calibration points.

For full calibration, proceed by typing CF; the response is:

Calibrate Full - Curve # [3]
Measure Point #1 now (Y/N)?

Now, draw a sample of oil for analysis, and while drawing, type **Y**. Record the displayed R value as R_1 and temperature as T_1.

The next prompt is:

Water content #1 (%)

If the value is known exactly (as may be the case for lab test stands) type it in, followed by **(cr)** to store it in memory. Otherwise type **N** for entry at some later date.
Similarly, follow the above procedure for point #2.

The last prompt for data is:

Temperature Compensation (%/C)?

NOTE! The temperature compensation value entry requires the negative sign if the coefficient is negative. This is true for software versions W/O 014 and higher. Earlier versions assume that the coefficient is negative only, no sign is required or accepted.

To check the version, turn the power off then on. The startup message will indicate the version number of the operating software.

Type in the correct value, then **(cr)** to advance to:

Done (Y/N/esc) ?

If all values have been entered, type **Y**. This places the data in working memory. If calibration is incomplete, type (**esc**). The missing data will be entered later.

If any item needs to be modified, type **N**. This will begin the **CF** procedure again.

It is also advisable to keep a permanent written record of the calibration values in case of accidental modification or instrument repair (but not replacement). Using the **DC** (Display/Modify Calibration) command, all calibration data may be restored by typing in previously recorded values. See section 4.2.4

If a mistake has been made, but records were kept, use **(esc)** to abort and restore the data using the **DC** command. This avoids the need to repeat the full calibration procedure.

4.2.3 CS - Calibrate Simple

There are instances when the instrument is installed and it is not possible to perform a proper two point calibration but one still wishes to operate the monitor.

The **CS** calibration function provides for just such cases, however, performance is less accurate for this mode than the specifications. Even so, the intelligence built into the DC-1000 allows the addition of accurate data to bring calibration to full accuracy at a later date.

This mode is a single point calibration using one measurement and an intelligently estimated slope value supplied by the operator.
To calibrate the instrument using the single point method and proceed as follows:

At the top command level type **CS.**

Machine responds with:

Calibrate Simple - curve # [3]
Measure point now (Y/N)?

At this point, a sample of the oil should be drawn and Type **Y**.

The response is to display the raw value R and the temperature followed by the next prompt.

Water Content (%)?

Type in the known water content (the % character does not have to be typed) and (cr) which advances the menu to:

Slope (dR/d%)? **(Water slope Figure 3)**

An intelligent estimate of the slope must now be supplied. If it is not known, then use an estimate of 0.030.

The next menu item is:

Temperature Compensation (%/C)? **(Temp slope Figure 3)**

Type in the compensation value, if not known use 0.030 for light crudes.

Next prompt is:

Done (Y/N/esc)

Type **Y** if satisfied with calibration, **N** if any changes necessary or (esc) to abandon updating the operating memory values.

If the user simply wishes to review the calibration values, enter **CS** and type a **(cr)** for every prompt to display the values. At the last prompt, type **(esc)** to return to the top command level.

If multiple calibration curves are in use, select the appropriate curve using the selector switch. The switch is customer supplied and is not part of the DC-1000 Oil/Water Analyzer.

Press **(cr)** to verify that the correct curve is being accessed; this is shown on the prompt line of the display.

4.2.4 DC - Display/Modify Calibration

This command allows a review of the complete set of calibration data in the working area. In addition, the data can be modified to allow recovery in case of accidental changes. (The numbers shown are only examples, actual numbers depend on each unit's calibration).

Typing DC will show:

Display/Modify Calibration - Curve #[3]
Ratio #1 = 1.069492
Water Content #1 = 0.11%
Temperature #1 = 25.4°C
Ratio #2 = 1.164575
Water Content #2 = 10.11
Temperature #2 = 26.0° C
Temperature Compensation = 0.025
Ratio #1 ?

For each item presented on the last line, the operator may type in a new value or just press **(cr)** to keep the current value that is then displayed and the next item prompted. At the end of the list, the question **Done (Y/N/esc)?** is presented.

As for the calibration routines, typing Y will replace the working data with the data just modified. The temporary memory area used by the calibration routines is also updated by the Y response. Typing N erases the current value before typing in an updated value.

If no changes are required, then **(esc)** may be pressed at any point to return to the top command level.

4.2.5 DB - Display Water Content

This command will continuously display the current water content, the temperature and the Ratio.in that order

Display W/O - Curve #[3}
(type <esc> to exit)
0.11 % 25.4 C 1.069492

To exit, press **(esc).**

4.2.6 SA - Set Alarm

Alarm conditions are continually monitored and signaled according to operator defined values. The pick-up and drop-out values may be defined, as well as a time delay to avoid tripping on transient conditions. The different pick-up and drop-out levels provide hysteresis to avoid "rattling" the alarm relay.

It should be noted that alarm pick-up means that the alarm relay will in fact be de-energized if the water content exceeds the pick-up value. This is a normal fail-safe type of arrangement for cases of power failure or program failure (The Model DC-1000 also has a watch-dog timer, resetting the processor and dropping the alarm relay if the program runs amok).

Typing **SA** gives:

Alarm Pick-up (%)?

If only the dropout value is to be changed or just examined, then a **(cr)** will show the value and advance to the next step. Otherwise, type in the desired value and a **(cr)** to advance:

Alarm Drop-out (%)?

Again, the value may be changed or observed and then move to the next step:

Alarm Delay (sec)

Type in a new delay followed by a **(cr)** or **(cr)** only to keep the old value. Next on the display:

Done (Y/N/esc)?

If done, type **Y**, otherwise type **N** or a **(cr)** and it will go back to the beginning of the alarm set menu.

Note that pressing **(esc)** anytime during the **SA** sequence will abort back to the command level and the values before the menu was called are retained, but the just typed values are all discarded.

Although the delay may be set in increments of one second, **(NOTE: Maximum delay is 255 seconds)** the actual delay has about a three second uncertainty. The alarm relay is only changed during the few milliseconds between measurement cycles. This is done to prevent any errors in measurement due to noise from load switching.

4.2.7 CO - Calibrate Analog Output

The analog output of the DC-1000 Analyzer requires a stable current meter to measure the current during calibration. The meter's accuracy should be in the 4 1/2 digit class because the monitor output is very stable and has a resolution of 1 part in 10,000 or 0.01% of full SPAN.

Typing **CO** will show:

Calibrate Output
Zero Scale Output (%)?

The question being asked is what water content should represent zero scale value.

This could be 0.00% or some elevated span zero such as 2.00%.

The desired value should now be typed followed by a **(cr)**. If the existing value is only to be examined, press the **(cr)** only. Next prompt is:

Full Scale Output (%)?

Similarly, type in the water content for full scale output or just a **(cr)** to examine current value.

Next prompt is:

Calibrate Zero (Y/N)?

At this point the monitor is asking if you wish to proceed with trimming the output at 4 mA. or any other value to match the display scale. If **N** is typed, it will proceed to the full scale trim, **(esc)** aborts, leaving previous calibration intact.

Typing **Y** shows the following HELP instructions:

Use one of the following:

U	**increase output (coarse)**
u	**increase output (fine)**
D	**decrease output (coarse)**
d	**decrease output (fine)**
<cr>	**to accept calibration**
<esc	**to abort calibration**

Each press of the upper case **U** increases the current output; for fast change use the auto key repeat (available on most terminals) by holding the shift and the U key down. Once the output is close to the desired 4 mA. value, use the lower case u to reach it exactly at a slower rate.

When satisfied with the zero value, press the (**cr**) to bring up the next prompt:

Calibrate Full (Y/N)?

As for the zero trim, use the **u** and **d** keys to reach the desired value followed by a **(cr)**.

Now the prompt is:

Done (Y/N/esc)?

Typing **Y** completes the calibration and places the values into permanent memory.

It may be noted that 4 mA. is not the lower limit of the current output, but is in fact 0 mA. If so desired, the low end could be set to any value. Similarly, the full scale output may be set at any value with an upper limit of about 22 mA., but it must be higher than the "elevated zero".

Because there is no interaction between the zero scale and top scale value, the scaling procedure need only be done once.

5.0 APPENDICES

5.1 Specifications

5.1.1 General

Water in Oil Range	0.00 to 10.00%
Minimum Sample Flow Rate	4 USGPM for oil 9 USGPM for condensate
Resolution	0.01% water
Number of Calibration Ranges	Four independent calibration curves
Temperature Compensation	Separate for each range
Temperature Stability	0.0015%water/°C
Temperature Sensor	100 Ohm Platinum RTD
Temperature Compensation Range	32°F-300°F (0°C-150°C), linear
Shipping Weight	38 lbs (17.4 kg)

5.1.2 Mechanical

Max. Working Pressure	2160 psig@ 100°F (15 MPa @ 38°C)
Max. Fluid Temperature	300°F (150°C)
Max. Ambient Temperature	158°F (70°C)
Operating Temp for Electronics	32°F-158°F (0°C-70°C)
Storage Temp. for Electronics	-40°F-185°F(-40°C-85°C)
Sample Line Connection Size	3/4" NPT
Specific Volume	0.070 U.S. gal. (235 ml)
Sensor Cross Section Flow Area	Approx. 0.75 $inch^2$ ($4.84cm^2$)

5.1.3 Electrical

Power Required	18 - 28 VDC @ 150 mA.(Grounded
or ungrounded)	
Enclosure	Hazardous area Class I, Div. 1, Gr. C&D

5.1.4 Output

Analog Current	0/4 - 20 mA. DC, isolated, self-powered
Maximum Load	500 Ohms
Isolation Voltage	500 Volts peak
Relay Contacts	SPDT-2 Amp @ 24V DC, Non-inductive
Adjustable Delay	0-255 seconds
Adjustable Hysteresis	0-10.00% water

5.1.5 Terminal/Computer Interface.

Asynchronous	RS-232C Full duplex or RS-422/RS-485 Half Duplex (optional)
Speed	1200 Baud
Word Size	8 Bits
Parity	None
Stop Bits	One

5.2 Parts List

5.2.1 Probe (See Figure 6).

Part No.	Item	Type
03	Upper Guide Tube	Stainless Steel
04	Sensor Plug	Steel
05	Sensor Barrel	Stainless Steel
06	Upper & Lower Collar	Stainless Steel
08	Upper End Cap	Stainless Steel
09	Upper Insulator	Ceramic or PPS
10	Lower End Cap	Stainless Steel
11	Lower Insulator	Ceramic or PPS
12	0.375" x 0.250" x 0.0625" O-Ring	Viton
13	1.500" x 1.250" x 0.125" O-Ring	Viton
14, 21	2.000" x 1 750" x 0.125" O-Ring (2)	Viton
15	Spring	Inconel
16	RTD Temperature Sensor (100 Ohm Pt)	Stainless Steel
17	Contact Rod	Bronze
18	Conduit Nipple, 1 1/4" x 3"	Galv. Steel
19	1/2" E.P. Vent Assembly	Stainless Steel
20	Explosion Proof Enclosure	Aluminum

5.2.2 Electronics

Type DC-1000 Electronic Assembly

5.2.3 Recommended Spare Parts for Model DC-1000

Mechanical

2 only	O-Rings	2.0" x 1.750" x 0.125"	Viton
1 only	O-Rings	1.5" x 1.250" x 0.125"	Viton
1 only	O-Ring	0.375"x0.250"x0.0626"	Viton

Electrical

1 only	Alarm Relay SPDT	P/N 17000
1 box	Fuse 3/4 Amp. (5)	Littlefuse # 273.750
1 only	RTD Temp. Sensor 100 Ohm	P/N S-7798P100Y8
1 only	Electronic Module	DC-1000

5.3 Diagrams

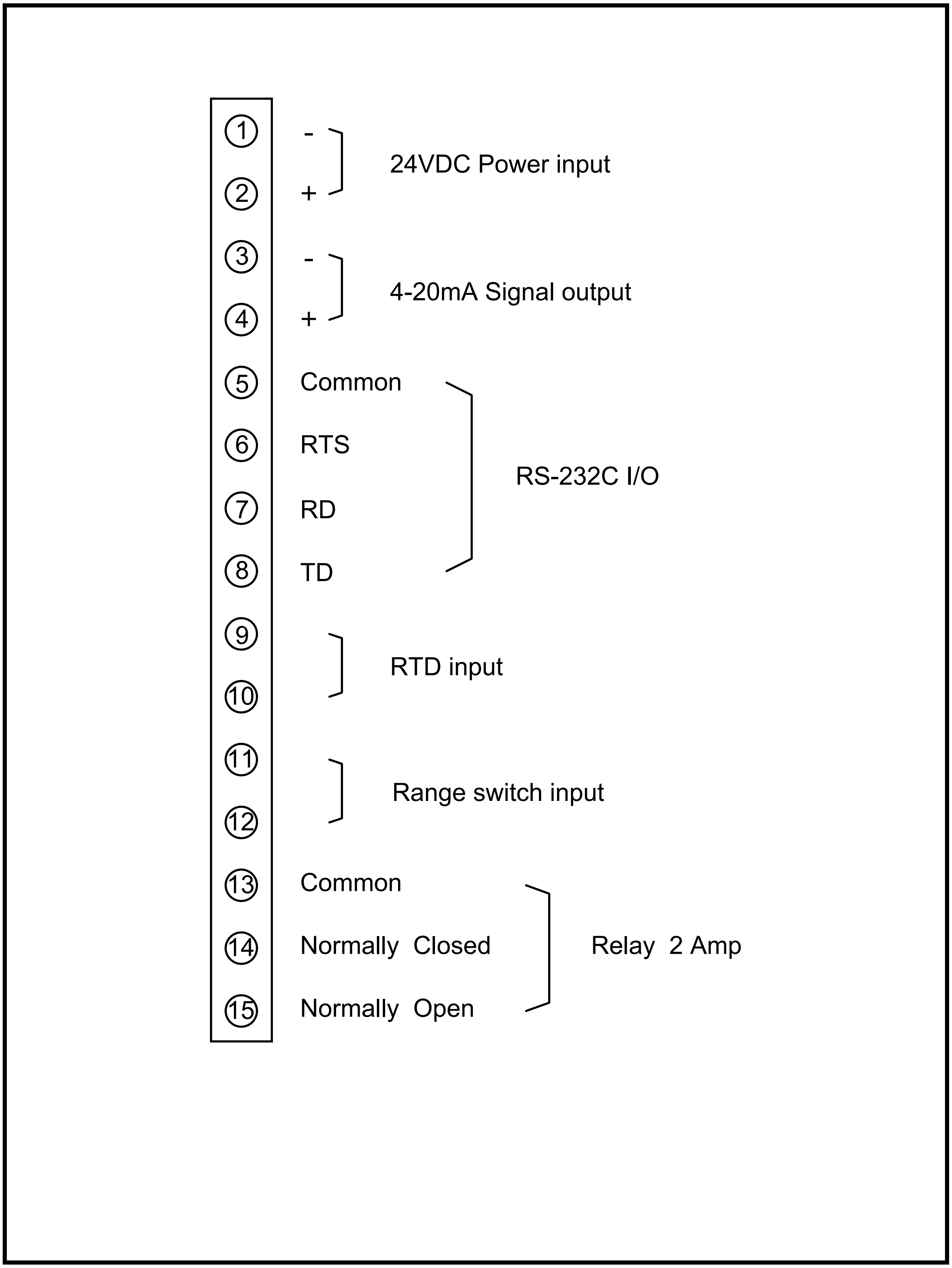


Figure 4 Terminal Wiring

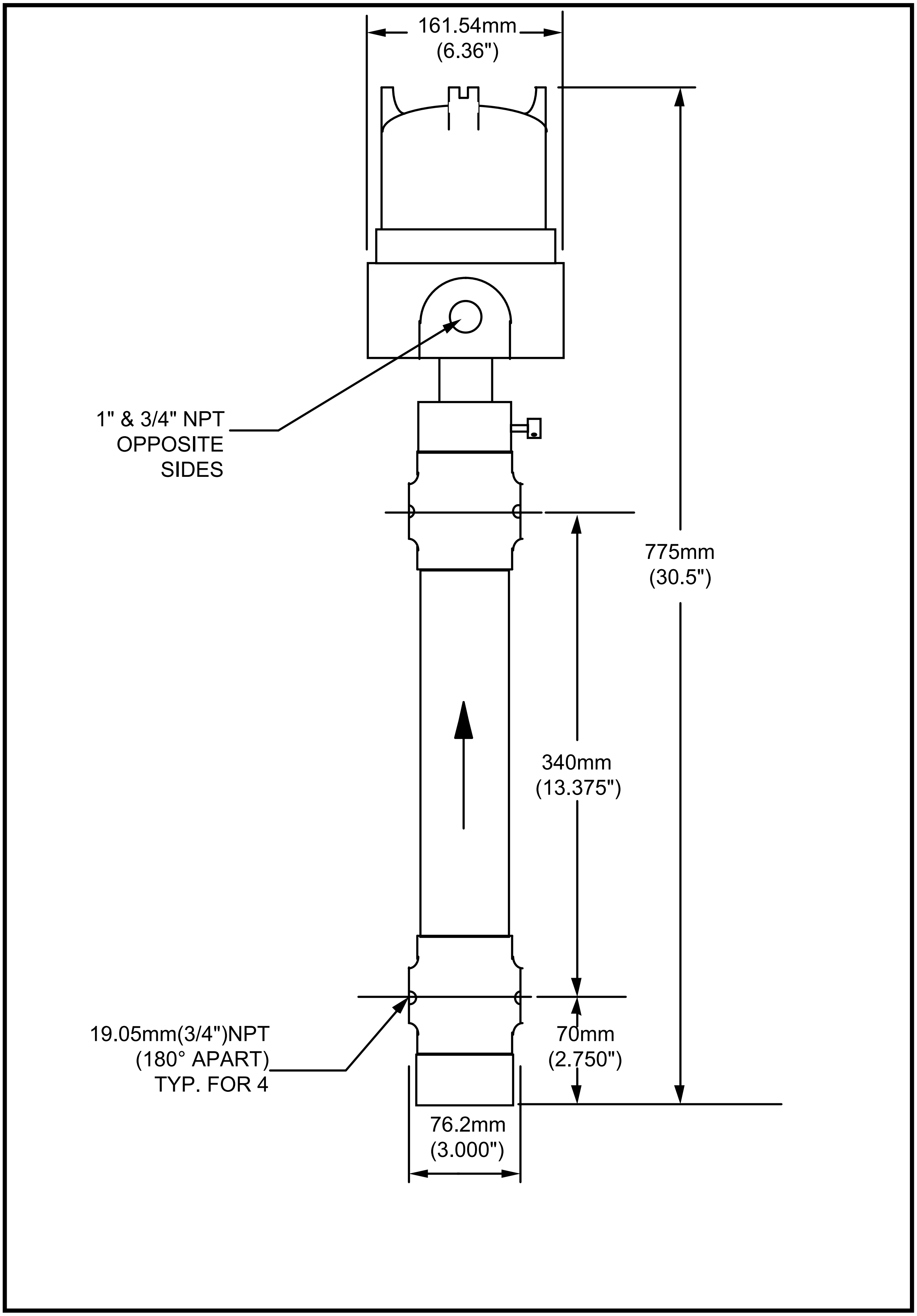


Figure 5 DC-1000 Dimensions

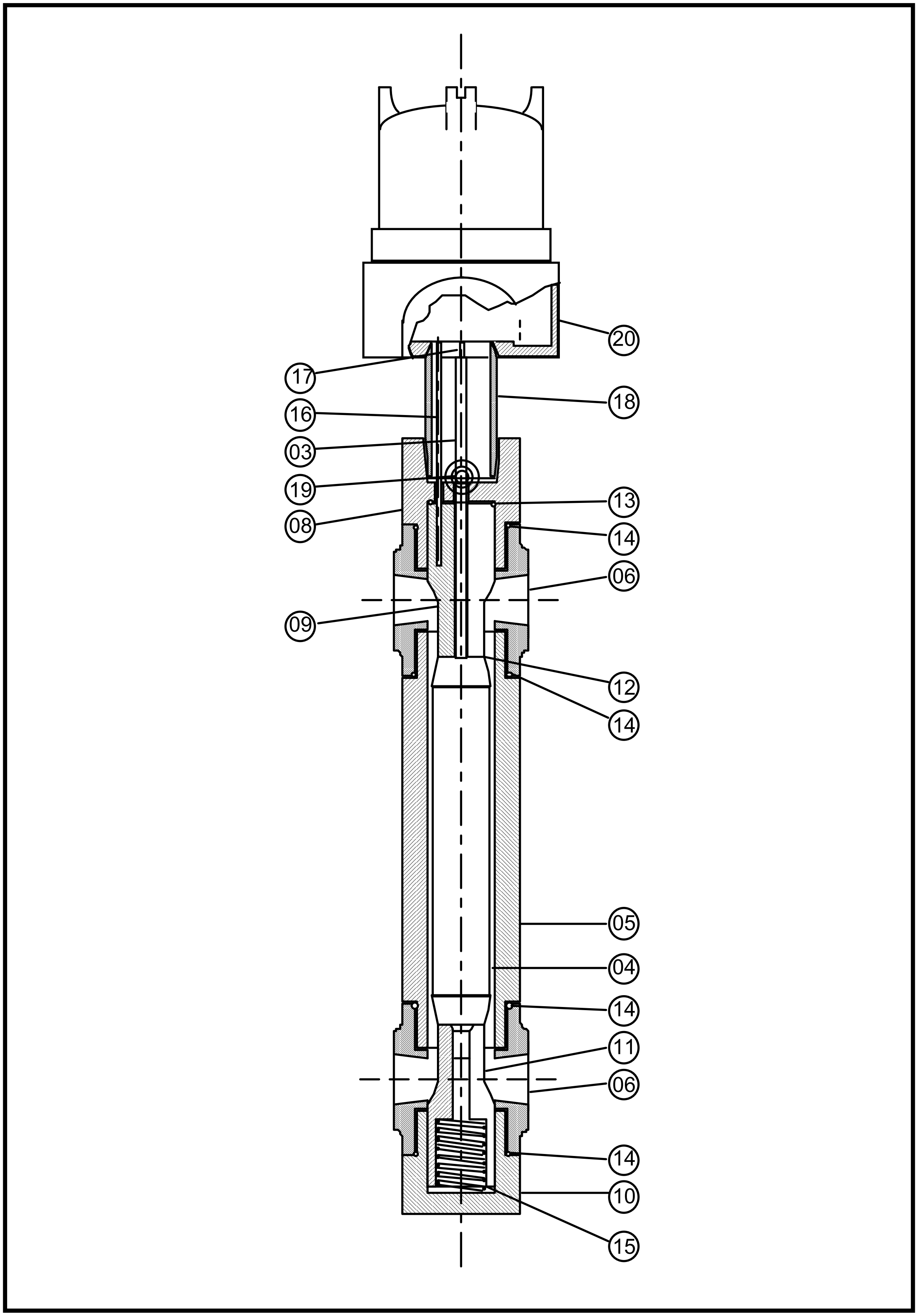
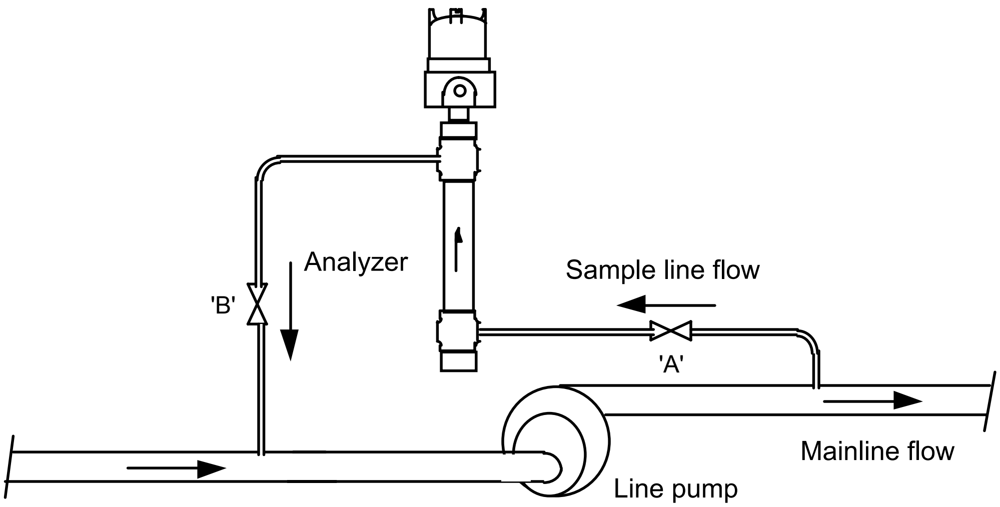


Figure 6 DC-1000 Assembly Diagram

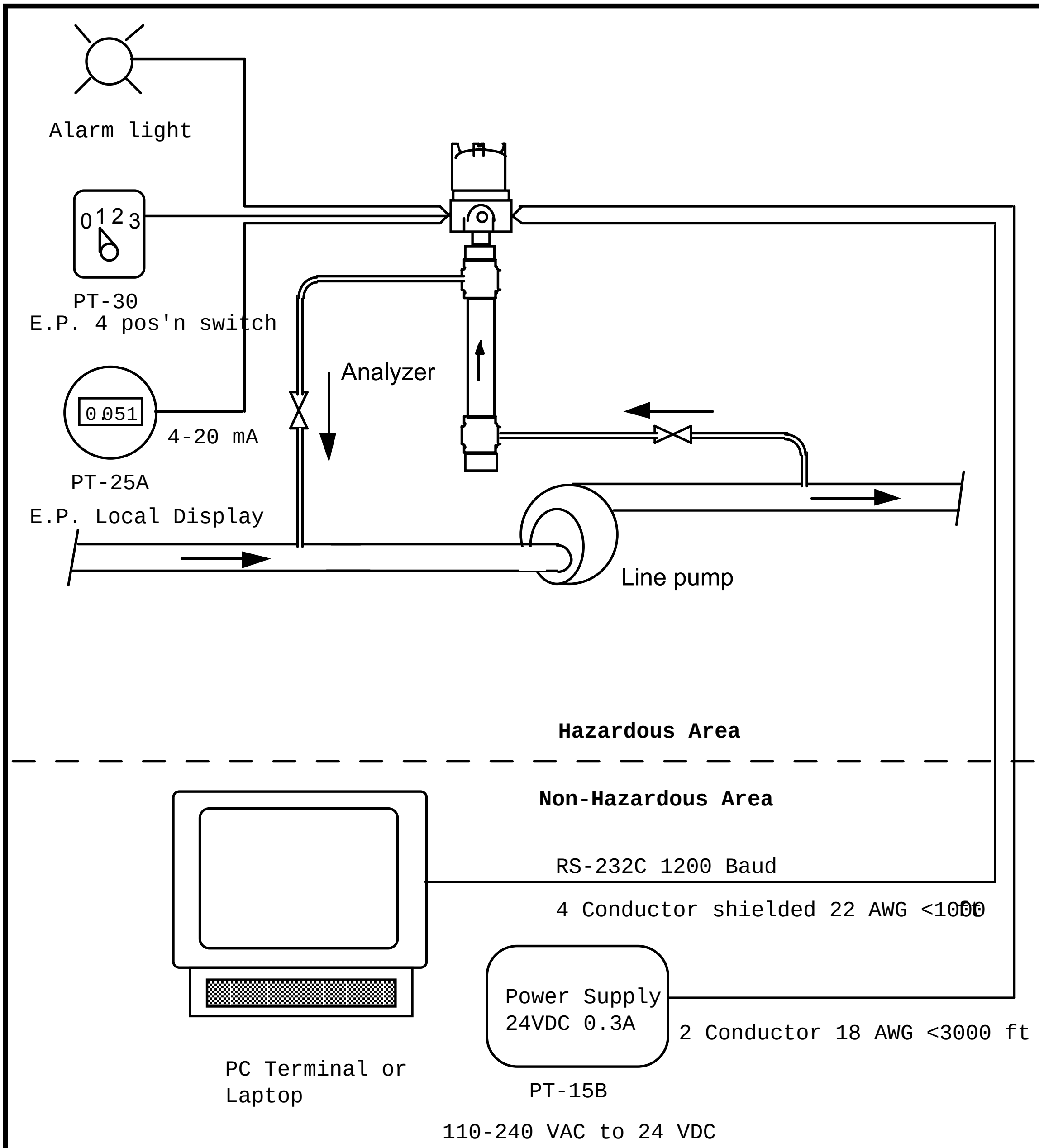
Installation in pump by-pass line



Upstream shut-off valve 'A' on sample line must be wide open.

Use 1" or 3/4" steel pipe or 1/2" steel tubing for sample line.
Sample line flow velocity must not be less than 4 feet per second.

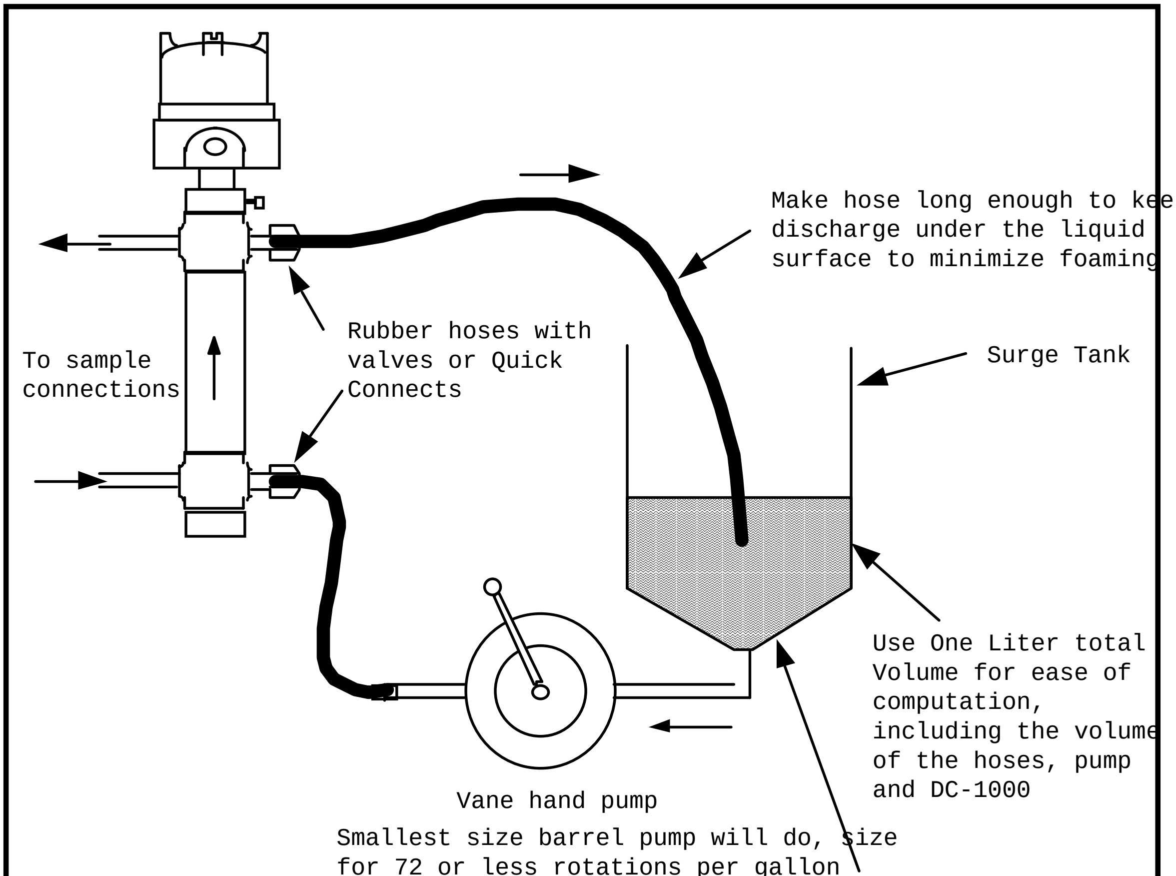
Figure 7 DC-1000 Installation Diagram



Note :
Sample take-off point should be as close to the pump discharge as possible (< 5
Maintain a high flow velocity in the sample line by not over sizing the line si
the sample lines short and prevent flashing in the sample lines.

Install 3/4" Quick Connect fittings on second set of inlet and outlet ports for
to flushing fluid pump (Diesel, Varsol or equal)

Figure 8 DC-1000 Application



Calibration Procedure :

1) Shut off both valves to the sample line
2) Drain the sensor probe through the bottom valve
3) Connect the hand pump hose to the bottom connection
4) Pour one litre* of currently used dry oil into the surge tank
5) Operate the pump and watch for the oil to circulate through the upper hose ba
surge tank
6) Circulate the oil slowly enough to prevent foaming.
7) To get the second calibration point as per the Instruction Manual, dump a 53*
centimeter volume of water into the surge tank and wait until the reading (code
terminal is stabilized while pumping the oil around.
8) The oil sample now has a 5 % water content of suitable accuracy for calibrati
9) Enter calibration data as per the Instruction Manual.

Note : To establish the temperature coefficient of the particular oil used, the
be heated about 15 to 25 °F. Use a dipstick heater or electric coil heater (c
warmer) and insert this in the surge tank while watching the temperature measur
the screen of the terminal

Circulating the oil over an extended time will heat up the oil about 5 to 10 deg

* Using one quart of dry oil with two ounces of water results in 5.88 % water
increase.

Drawing # 941215

Figure 8 DC-1000 calibrator for non-volatile liquids only

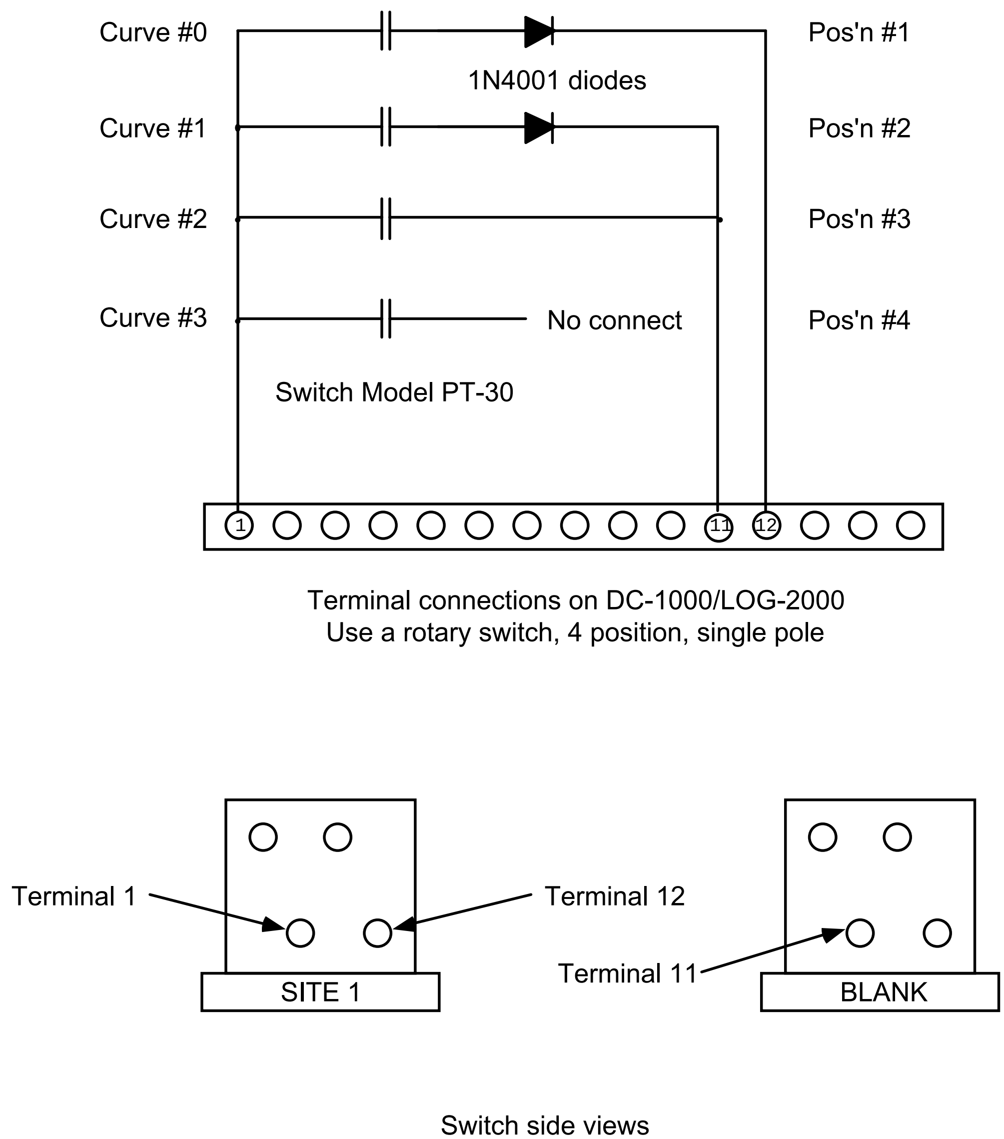
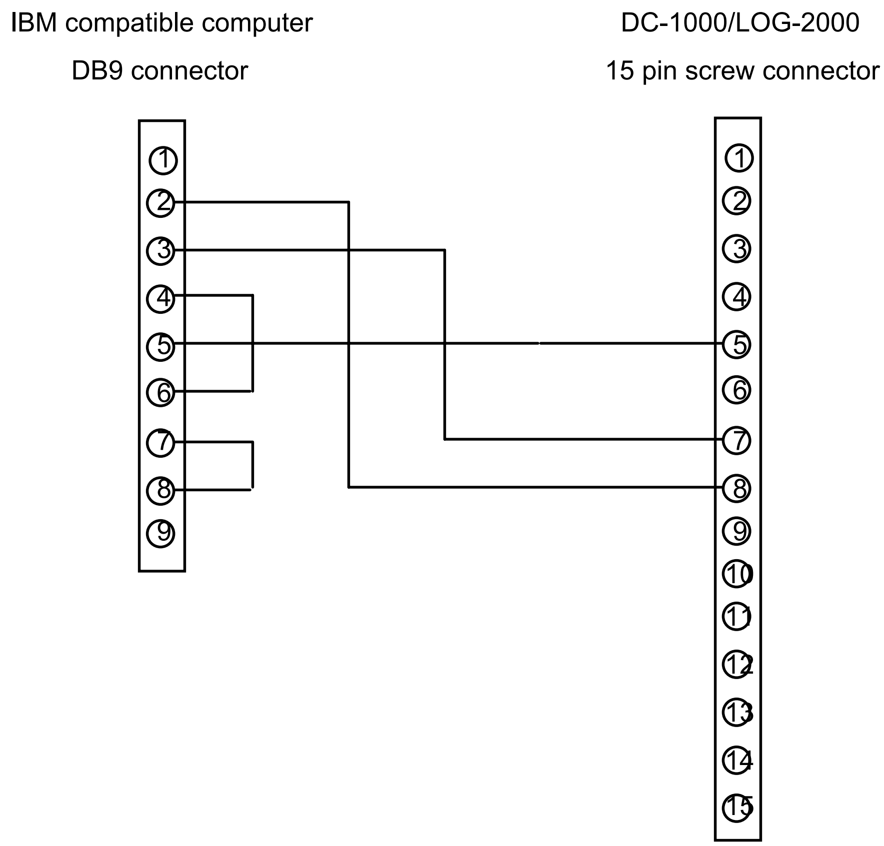
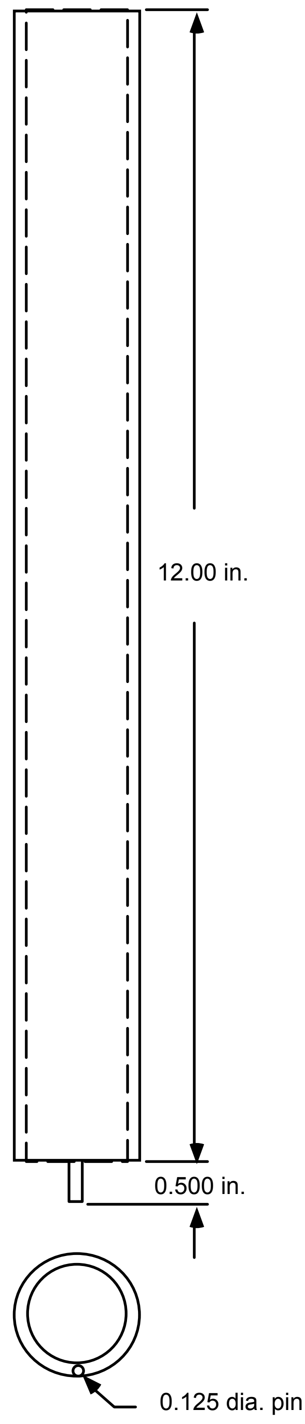


Figure 9 Switch diagram for curve selection



Use a terminal program to communicate with the DC-1000/LOG-2000. For MS-DOS, PROCOMM or Kermit are suitable, for Windows, use the Terminal program that is included with it.

Figure 10 Computer connection wiring diagram



Use a 1 inch , sched 40 steel pipe, 12.5 inches long and use a hacksaw to cut through part way of the pipe about 1/2" from the end of the pipe. Leave about 1/8" of the pipe wall to form a pin. Round pin to fit into the hole of the ceramic insulator

Figure 10 Alignment tool

