



INSTALLATION AND INSTRUCTION MANUAL

PHASE DYNAMICS, INC.

Low-Range and Mid-Range Water in Hydrocarbon Analyzer

Enhanced/Expanded

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(ECO Number 425)

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This Phase Dynamics product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Phase Dynamics will, at its option, either repair or replace products which are defective.

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ATTENTION

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ATTENTION:

Denotes an important step or technical note. It calls attention to an important procedure or note.

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1 Overview

1.1 System description

The Phase Dynamics analyzer is a microwave device that measures the percentage of water in a flowing hydrocarbon liquid stream. The measurement technique is based on a principle known as load-pull. The system is designed with no moving parts and is calibrated for the highest accuracy over a broad range of water cuts, and temperatures.

The system consists of 4 components, as shown in Figure 1.1:

1. Electronics enclosure with 4-line LCD display or optional color touch-screen
2. Measurement section with an oscillator inside the explosion-proof football
3. A system cable connecting the two
4. Ground cable
5. Temperature sensor (RTD) used for temperature correction

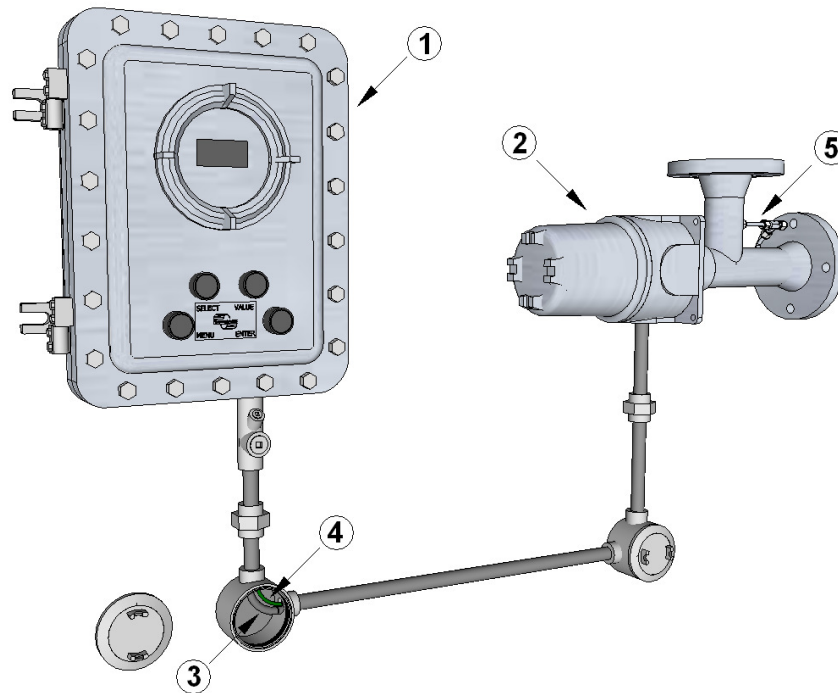


Figure 1.1

1.2 System Specifications

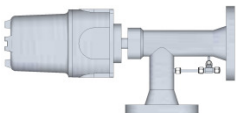

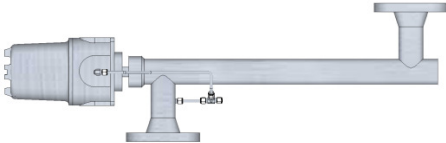
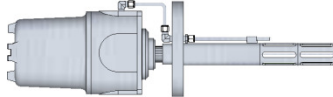
The following table resumes all the specification for Low and Mid-Range Analyzers.

| Range | Low Range | | | Mid-Range |
|--------------------------------|--|----------|---------|-------------|
| Measurement Range | 0-4% | 0-10% | 0-20% | 0-Inversion |
| Uncertainty | +/-0.04% | +/-0.1% | +/-0.2% | +/-0.5% |
| Repeatability | +/-0.02% | +/-0.02% | +/-0.1% | +/-0.1% |
| Resolution | 0.01% | 0.01% | 0.1% | 0.1% |
| Salinity | Not affected by Salinity | | | |
| Flowing Flow Temperature | 0 - 71°C (32 - 160°F); 0 - 104°C (32 - 220°F); 0 to 204°C (32 - 400 °F) or 0 - 315°C (32 - 600°F) | | | |
| Fluid Temperature Compensation | Automatic with Built-In RTD Temperature Probe | | | |
| Fluid Densities | 500 to 1150 Kg/m3 | | | |
| Minimum Flow Speed | 2 feet per second (0.6 m per second) | | | |
| Maximum Flow Speed | 14 feet per second (4.25 m per second) | | | |
| Oscillator Frequency | 220 to 590 MHz (Low Range) – 90 to 130 MHz (Mid-Range) | | | |
| Radio Frequency Power | 0.2W | | | |
| Power Requirements | 24VDC +/- 5% or 100-240 VAC 50/60Hz, 165 Watts Typical, 27 Watts Maximum for Enhanced Electronics with LCD display | | | |
| Ambient Temperature Ranges | 0 to 48°C (32 to 120°F), Sun Shade Recommended -40 to 48°C (-40 to 120°F), with Optional Enclosure Heater | | | |
| Analog Inputs | Enhanced Electronics: 1 x 4-20mA – Expanded Electronics: 5 x 4-20mA | | | |
| Analog Outputs | Enhanced Electronics: 1x 4-20mA – Expanded Electronics: 5 x 4-20mA | | | |
| Pulse Inputs | Enhanced Electronics: 1 x Pulse Input - Expanded Electronics 3x Pulse Inputs | | | |
| MODBUS Ports | 4 x MODBUS ports (see note below) | | | |
| HART Communication | 1 x port on Analog Output 1 (Optional) | | | |

Note: The Optional Touch Screen uses the Communication Port number 2 making this port unavailable for the user. All the ports are slaves unless they are used to read a Micro Motion® flow meter in applications Involving Density Correction or on our CCM (Compact Cyclone Meter).

1.3 Measurement Section Types and Specifications

Phase Dynamics has 4 basic types of measurement section configurations.

| "L" configuration | "U" Configuration |
|---|--|
|  |  |
| "Z" configuration | Insertion |
|  |  |

- Installation Weight and Size: See Installation Drawings in Section 11
- All factory and production sequences are ISO 9001:2015 Certified.
- Optional Certifications: ATEX, PED, CSA, FM
- Area Classifications:
 - Explosion Proof Enclosure
 - Available materials: Cast Aluminum and Stainless Steel 316L
 - Class 1, Div 1, Groups C & D.
 - SIRA99ATEX1049X:
 - II 2 GD
 - Ex tb IIB T5 Gb – Control Enclosure
 - Ex tb IIIB T89°C Db – Control Enclosure
 - Ex db IIB T5 ... T1 Gb – Probe Enclosure
 - Ex tb IIIB T78°C...T315°C Db – Probe Enclosure
 - Ta = -40°C to +60°C
 - IP66
 - IECEX
 - Ex db IIB T5 Gb
 - Ex tb IIIB T89° Db (Control Enclosure)
 - Ex tb IIIB T78°C Db (Analyzer Enclosure)

ATTENTION:

Ex db/Ex tb IP66 rated cable gland to be used by the end user accordingly

Ex db /Ex tb blanking plug to be used in the event any entry is not being used by the end user.

- IP66

- NEMA4X, NEMA 7
- Fiber Glass Enclosure
 - NEMA 4X
- Process Connections:

| Configuration | Range | Flange Diameter | Flange Rating |
|---------------|-------------------|-------------------|----------------------------------|
| “U” and “Z” | Low Range | 1”, 2”, 3” and 4” | ANSI 150, 300, 600, 900 or 1,500 |
| “U” and “Z” | Mid Range | 2”, 3” and 4” | ANSI 150, 300, 600, 900 or 1,500 |
| “L” | Low and Mid Range | 2”, 3” and 4” | ANSI 150, 300, 600, 900 or 1,500 |
| Insertion | Low and Mid Range | 3” | ANSI 150, 300, 600 or 900 |

- Materials of wet parts: Stainless Still 316L, Hastelloy. (For other materials consult factory)

1.4 Measurement Section Description

The Figure 1.2 shows a transversal cut view of a Low Range, “U” type, measurement section. It is a coaxial wave guide connected to an oscillator without any moving parts. The microwave energy travels in the space surrounded the center rod and the propagation of that energy is affected directly by the permittivity of the fluid. This is the physical property that allows this analyzer to measure water cut. It also includes a temperature sensor (RTD) for temperature compensation.

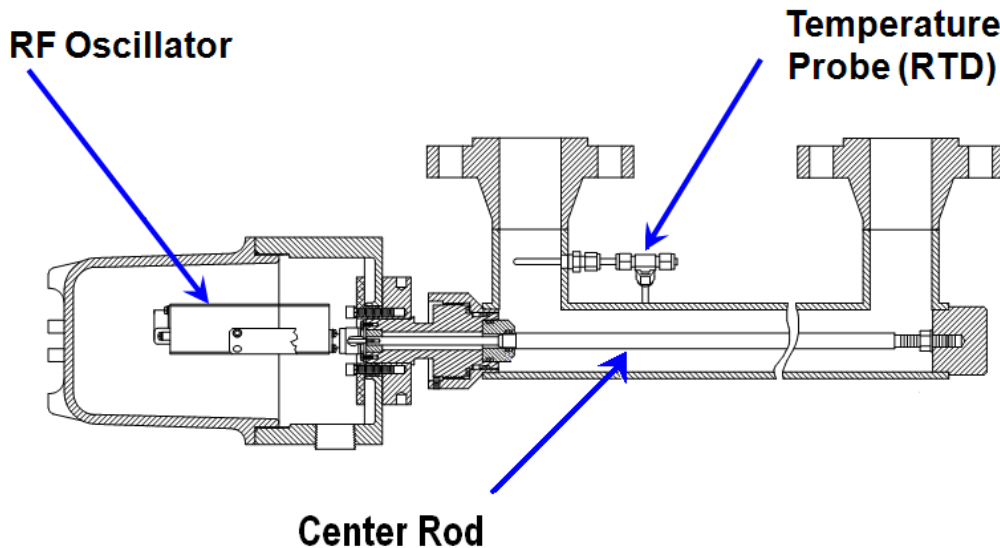


Figure 1.2

1.5 Electronics Enclosure Options

- Aluminum 3, 4, 5 or 6 Conduit Entries Explosion Proof Enclosures. 17.4 H x 14.0 W x 9.9 D Inches. 59 lbs. NEMA 4, 4X and 7. Class 1, Div 1, Groups C&D; EEx d IIB T5 89°C-IP66 (optional)

- Stainless Steel 3, 4, 5 or 6 Conduit Entries Explosion Proof Enclosures. 15.3 H x 13.5 W x 9.8 D Inches. 195.2 Lb, NEMA 4, 4X and 7. Class 1, Div 1, Groups C&D; EEx d IIB T5 89°C-IP66 (Optional)
- Aluminum 8 Conduit Entries, 17.4 H x 14.0 W x 11.9 D Inches, 71 lbs, NEMA 4, 4X and 7. Class 1, Div 1, Groups C&D; EEx d IIB T5 89°C-IP66 (Optional).
- Rain and Dust Tight Fiberglass Enclosure. 16.3 H x 10.5 W x 7.9 D Inches, 17 lbs, NEMA 4X.

1.6 Electronics

The electronics is based on a DSP programmed to read from the oscillator all the parameters needed to calculate the water cut of the fluid and to perform the control of the peripherals and the Flow Computer. The system is operated through 4 push buttons on the front panel with a 4-line LCD for visualization. A color touch screen with data logging capability is also available (optional). The touch screen can be operated from the push buttons or from the screen itself. All the electronics is mounted on an aluminum chassis. The Components of the chassis are shown in figure 1.3

With the release of the mother-board part number 2000-00072-000A and the Communication Board Part Number 2000-00067-000A along with the software version 6.15.07, the Enhanced and Expanded electronics now feature a Data Logging capacity over a flash drive (Optional). The flash can be connected via an USB port identified as J3 located on the mother-board.

1. Motherboard with 2 relays and spare fuses (part number 2000-00072-000A)
2. 24VDC input board (Part Number 2000-00035-0000 or 100/240VAC power supply (Part Number 2070-00004-000)
3. Power supply board (Part number 2000-00069-000)
4. Processor board (Part number 2000-00066-000A)
5. Communications board (Part number 2000-00067-000A)
6. Analyzer board (Part Number 2000-00068-000E)
7. Optional analog input/output board (Part Number 2000-00070-000A)
8. Optional enclosure heater. 24 VDC 100W (Part Number 2050-00069-000) or 120 VAC 100W (Part Number 2050-00016-000) or 230 VAC 100W (Part Number 2050-00019-000)

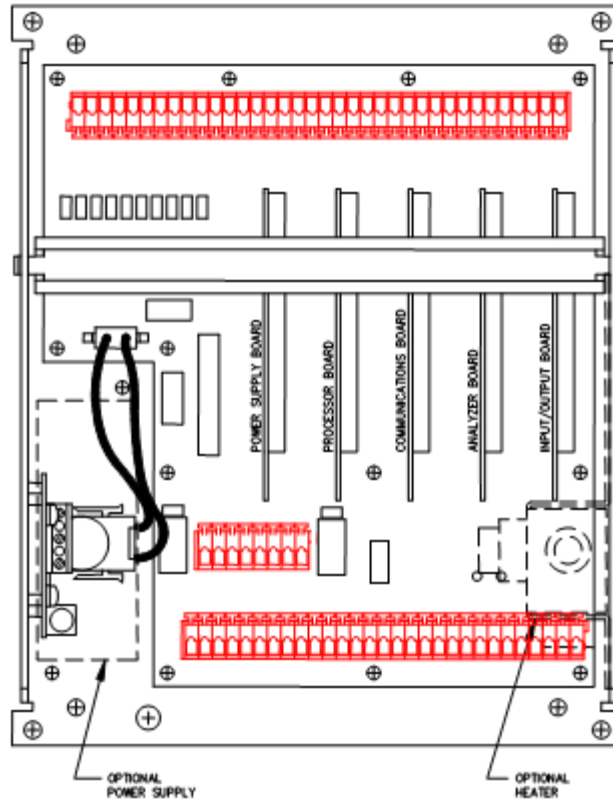


Figure 1.3

There are switches in some of the boards used for configuration purposes:

Processor Board: It has 8 switches in 2 groups of 4. They are for factory use only.

Analyzer Board: It has 8 switches in 2 groups of 4. They are used to configure the Pulse Input 1 and the Analog Output 1. Please see section 2.6.1

Input Output Board: There are 12 switches in 3 groups of 4. They are used to configure the Pulse Inputs 2 and 3. Please see section 2.6.2

Communication Board: There are 16 switches in 4 groups of 4. They are used to set some termination, pull up and pull-down resistors in each communication channel. Please see section 2.6.3

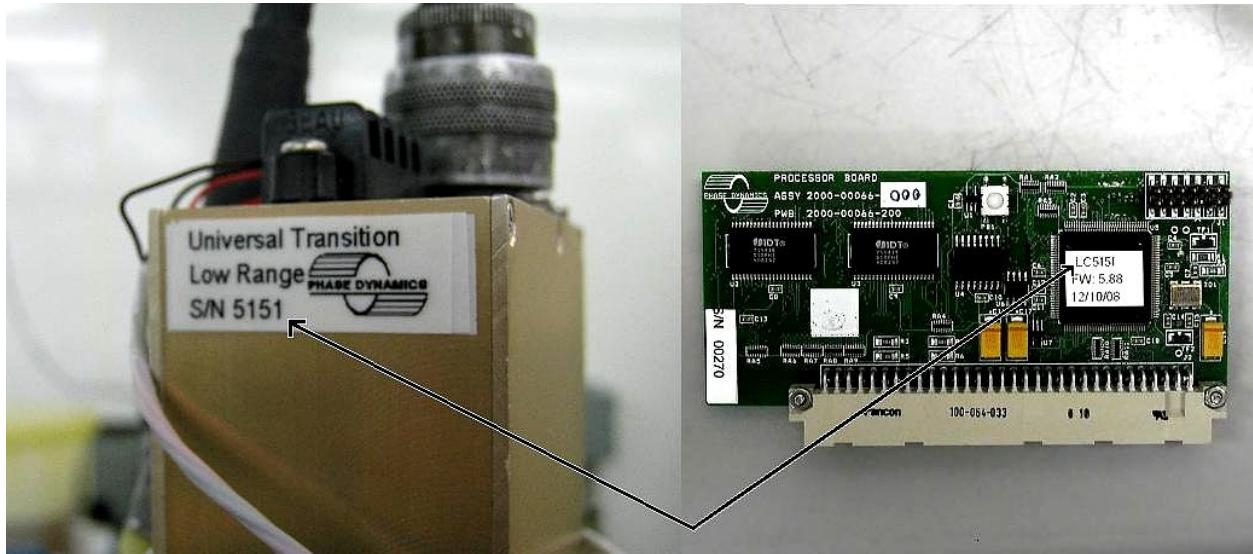
Power Supply board: There are no switches in the Power Supply Board.

Display Board: There are 8 switches in 2 groups of 4. They are used to configure the screen mode and to enable the write protection mode. Please see section 4.

2 Installation

2.1 Pre-Installation notes

The Phase Dynamics analyzer is composed of a matched pair, a measurement section and associated electronics. For this reason, it is VERY important that the serial number on the white sticker that is over the microprocessor in the processor board, matches the serial number in the white sticker that is located at the side of the oscillator (The golden box inside the measurement section) and the serial number stamped in the measurement section. Picture 2.1 shows both stickers:



Picture 2.1

This assures that the processor board was programmed with the calibration curves of that pair Oscillator/Measurement section.

ATTENTION:

Make sure the serial number of the Measurement Section and the Electronics match.

The place where the serial number is stamped in the measurement section depends on the model. On the “U” and “Z” models it is stamped at the bottom, on the “L” models is stamped on the collar and on the insertion models it is stamped on the flange as shown in picture 2.2.



"U" and "Z" units stamped at the bottom



Insertion units stamped at the flange



"L" Units stamped at the collar

Picture 2.2

2.2 Measurement Section Mounting Considerations

There are three ways in which the Measurement Section can be installed: a) in a flow-through mode, b) by-pass mode, and c) in an insertion mode. They can be mounted on horizontal or vertical lines.

ATTENTION:

Regardless of installation mode, the Analyzer **should** be neither the highest point nor the lowest point of the piping system. Being the highest point may contribute to the accumulation of gas, being the lowest point to the accumulation of water and/or sediments inside the Analyzer.

There are three ways in which the Measurement Section can be installed - in a flow-through mode, in a fiscal by-pass mode where existing fast loops exist, and in an insertion mode:

- **In the flow-through mode, the Measurement Section is the same diameter as the pipeline. Flow Through Analyzers are available in 1" (Low Range Only), 2", 3" and 4" pipe sizes plus the insertion model.**
- **In the by-pass type of installation, the Measurement Section is installed in parallel with the pipeline in an existing fast loop normally used for fiscal sample extraction and density measurement.**
- **Low Range Insertion Analyzers have a fixed probe length of 11.9", and can be installed in pipelines of 6" and up. Mid Range Insertion Analyzers have a fixed probe length of 16.6" and can be installed in pipelines of 12" and up. Mid Range Insertion units can also be mounted on pipelines 10" and larger at 45°. Low and Mid Range Insertion analyzers can also be installed in 6" pipeline or larger on a Long Radius Elbow only. These insertion units are not retractable under pressure as probes designed in this fashion are a safety and health hazard. The connecting flange size is always 3".**

Wherever possible, a flow-through installation is preferred over a by-pass installation and in turn a by-pass installation over an insertion installation. Although the Analyzer performance is the same for each type of installation, there is a difference in the degree of confidence that can be obtained. In a flow-through Analyzer, the entire cross section of the flow to be measured is subject to the microwave field and therefore the measurement has the highest degree of confidence. The Insertion Analyzer has the microwave fields exposed to the fraction of the flow that is located inside the "cage" (the slotted part of the probe).

The following section will define more clearly some of the considerations for installation:

1. Regardless of installation mode, the Analyzer should be neither the high point nor the low point of the piping system. This prevents gas, oil, water or sand from accumulating and affecting good measurement. Being the high point may contribute to the accumulation of gas. Mounting in the low point can allow the accumulation of water and/or sediment inside the Analyzer.
2. The general recommendation for all flow regions where the product is well mixed (greater than 2 ft/second or low water in very heavy viscous oil) is to mount the Analyzer horizontally, parallel to the ground, in the center plane of the pipeline. The goal is that everything which goes into the Analyzer can go back out. For low flow situations the analyzer is best located in the vertical plane of piping with the flow from the bottom-up so that separated water does not reside unmixed and the analyzer cannot accumulate gas as in a vertical flowing downward situation. In this situation the water will distribute itself as it is being pushed upward and will give better performance than in a horizontal plane at low flow. Vertical flowing downward is also acceptable if no gas can accumulate in that leg.
3. For a good measurement, every Analyzer needs to see a flow as homogeneously mixed as possible. A good mixture is usually guaranteed by a turbulent flow regime, and a minimum flow velocity of 2-3 feet/second is recommended. If the flow has a lower velocity, mixture needs to be obtained by some other means, such as installation near a pump, a valve or an elbow. Elbows can either help to mix or act as a separator depending upon viscosity and density of the oil. Static mixers are normally only used in pipelines with percentages of water below 5%. This is because the mixer requires a given range of flow rates in order to be effective. Low flow rates and mixers are not acceptable as there is no mixing in this case. In well testing and other higher water situations the mixer can flash gas due to the pressure drop across it.
4. To prevent possible vibration damage to the ceramic that covers the central conductor in some models, we recommend that the maximum flow velocity not exceed 14 feet/second. If there is slugging and this velocity can be exceeded, it is best to install the analyzer so that the fluid is flowing into the

pipe at the end of the ceramic (towards the electronics). In this fashion the cross section of the ceramic is small compared to flow from the side.

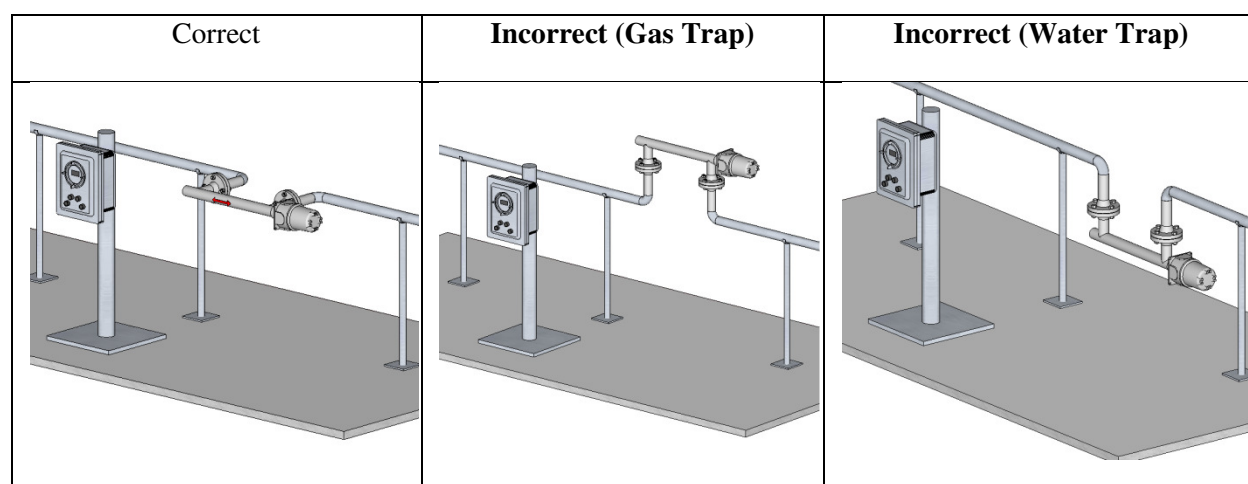
5. The normal connections are a “U” configuration (“in” and “out” flanges on the same side), in a “Z” configuration (“in” and “out” flanges on opposite sides) or in an “L” configuration (“in” and “out” flanges as an elbow). No one configuration is preferred over the other, and they can be chosen strictly to best fit the overall piping arrangement. The “L” pipe is generally more easily adapted to existing process arrangements. The “U” or “Z” configurations are preferred for a low range analyzer because it is the most rugged version.
6. There is no predetermined “in” and “out” to the Measurement section, and both flange connections can be used interchangeably. As mentioned previously in cases of slugging or high velocity flow rates, the flow should be towards the electronics.
7. Do not increase or decrease the line size to install a meter unless a pipeline size which is too large for the maximum flow rate is in place. In this case a smaller line size would provide good velocities to keep the mix and it would be acceptable to step down the line size from the mainline diameter. Again, the velocity should not exceed 14 ft/second.
8. In cases of the by-pass installation, there must be enough pressure drop in the main pipeline to provide a reasonable flow rate in the bypass. A by-pass installation makes it possible to include isolation valves in the inflow and outflow legs of the by-pass, and thus to remove the Measurement Section from the process for purposes of inspection and repair.
9. For recommended installations of Insertion Analyzers please see our drawing 0070-00227-000. A critical issue in insertion installations is that the cage area is in full contact with the active flow. Insertion Analyzers are not available with flange ratings of Class 1500 and higher.
10. In the Low Range Insertion Analyzer, the bottom of the probe (“cage”) is closed. Make sure that the flow is always directed against the bottom of the Analyzer. This is to remove the concern that the area inside of the weldolet is flushed well by the oncoming fluids.
11. If free gas is present in the liquid stream of a flow-through or by-pass Analyzer, the “out” flange of the Analyzer should be mounted higher than the “in” flange, in order to allow the gas to escape the pipe section.
12. The only way to validate any Analyzer is to compare its readings with the result of samples analyzed in the laboratory. The sample port must be installed near the Analyzer. This sample port can be located either upstream or downstream of the Analyzer. Analyzer and sample port need to be close enough that the operator reading the Analyzer screen can communicate with the operator taking the sample. Long sample lines will bias the results.
13. The Electronics Enclosure should be mounted on a panel near the pipeline, about 5 feet above the ground. Ease of viewing, convenience of wiring, and simplicity of operation are the only considerations in the installation of the Electronics Enclosure. The distance between Measurement Section and Electronics Enclosure is limited by the length of the System Cable; the standard length is 30 feet, the maximum length available is 150 feet.
14. When used with process temperatures higher than 100 °C, the Measurement Section should be mounted vertically, with the oscillator enclosure being located at the bottom. This will allow the hot air to rise away from the oscillator electronics.

15. When prevailing ambient temperatures are above 100 °F (38°C), it is recommended that the Electronics Enclosure be protected by sun shade. Higher temperatures will not affect the performance of the Analyzer, but will reduce the life span of the electronic components.
16. When prevailing ambient temperatures are below 32 °F (0°C), it is recommended that the Electronics Enclosure be equipped with an internal heater. Lower temperatures will not affect the performance of the Analyzer, but will make the screen display unreadable. Install the Electronics Enclosure in such a way that it is not exposed to prevailing cold winds. If the ambient can go below freezing all process lines are typically insulated and/or heat traced. This is good engineering practice and the same guidelines should be followed for the analyzer.

2.2.1 Horizontal Installations

2.2.1.1 Flow-Through

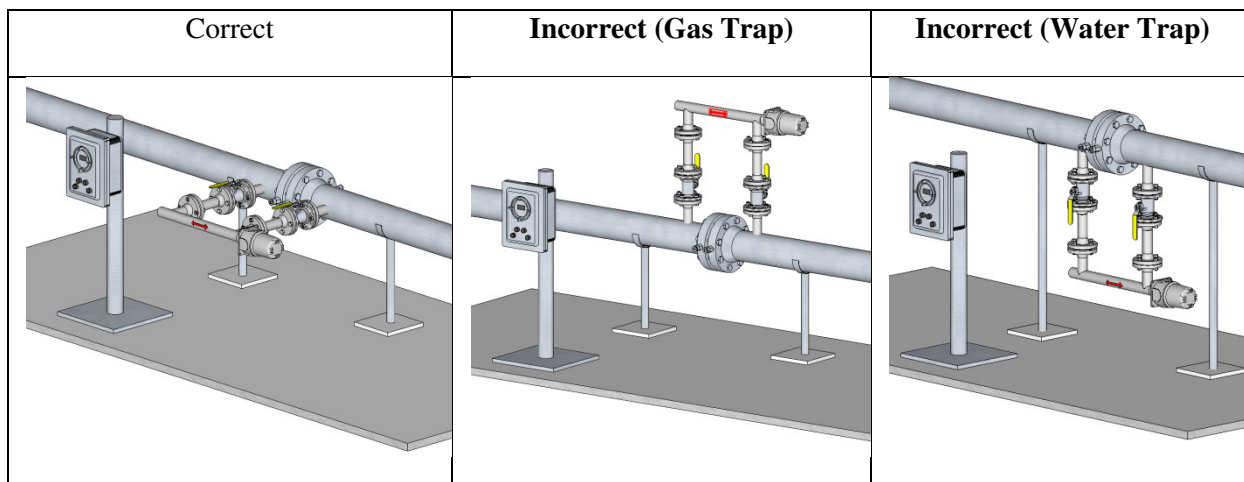
In the flow-through mode, the Measurement Section becomes an equal diameter part of the pipeline. Low Range Flow-through Analyzers are available in 1", 2", 3" and 4" pipe sizes. Mid Range Flow-through analyzers are available in 2", 3" and 4" pipe sizes. Make sure the measurement section is mounted horizontally in the same plane that the pipeline. Mounted in this way, everything that goes in will come out (gas, water, sand, etc.). Picture 2.3 shows some correct and incorrect ways to mount them.



Picture 2.3

2.2.1.2 By-Pass

A **critical** issue in by-pass installations is that there is enough pressure drop in the main pipeline, between the “in” and “out” flanges of the Measurement Section, so that active flow is assured in the by-pass line. We **recommend** an installation with Pitot tube (with Pitot tube reaching to center of pipe), since such an arrangement is recommended by API for sampling. The pressure drop can be also created by an orifice plate, a partially closed valve, an external pump, etc. The Measurement Section is installed in parallel with the pipeline. Picture 2.4 shows **the correct** and **two incorrect** ways to mount them.

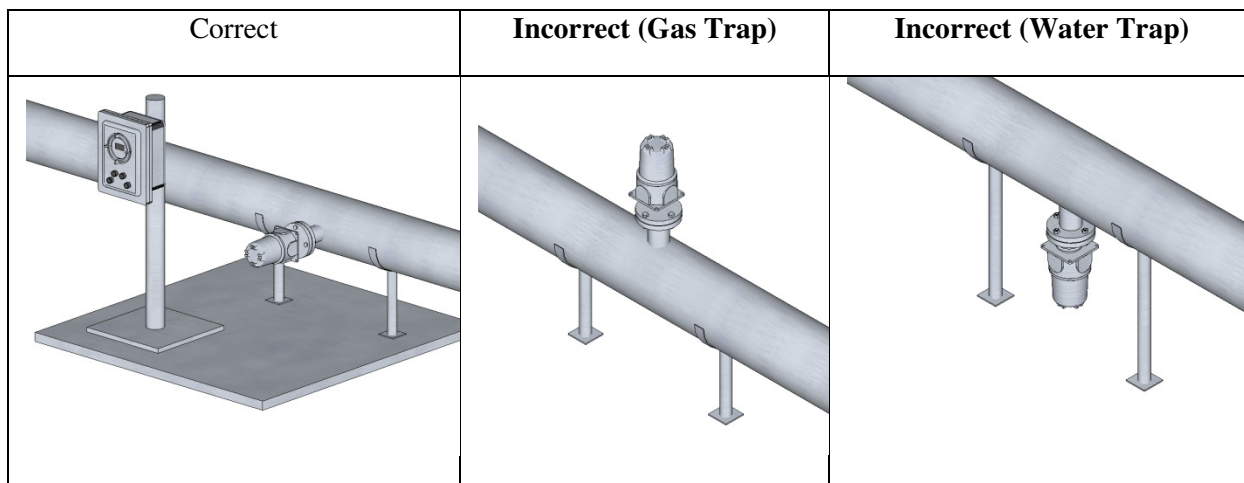


Picture 2.4

2.2.1.3 Insertion

A **critical** issue in insertion installations is that the active part of the Measurement Section be in full contact with the active flow.

The Low Range Insertion Measurement Sections are used in pipelines with diameters of 6 inches and larger. Depending of the thickness of the wall of the pipe the analyzer might not fit in a 6-inch line. Check the dimension in Section 11. The Mid Range insertion analyzer can be used in pipelines 12 inches and larger. This system is not retractable under pressure because probes designed in that fashion are a safety hazard. These analyzers are maintenance free therefore there is no need to remove them from the service. The connecting flange size is 3 inch. Picture 2.5 shows **the correct** and some **incorrect** ways to mount them.



Picture 2.5

ATTENTION:

A **critical** issue in insertion installations is that the active part of the Measurement has to be in full contact with the active flow. Distance from the mounting flange and the interior of the pipe has to be no larger than 6 inches. See section 11 for dimensions

The insertion analyzer can also be mounted horizontally at 45 degrees or in an elbow. These two installations some times are the only way to properly mount them due to the mechanical dimensions of both the measurement section and the pipeline. For lines with a diameter of 4 inch or less, use flow through analyzers. Picture 2.6 shows to proper ways to mount these analyzers.

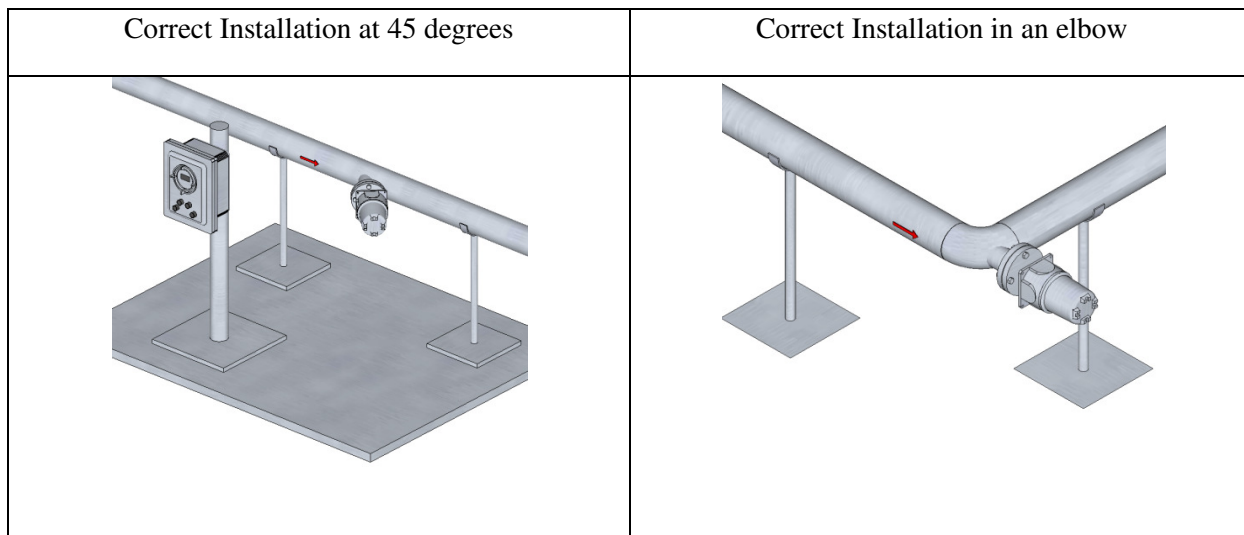


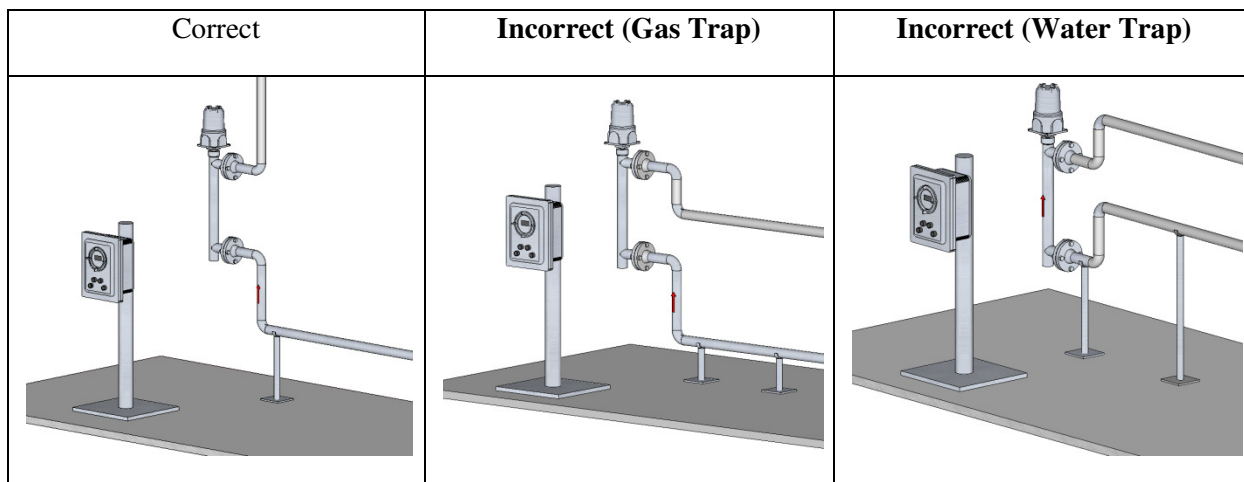
Figure 2.6

2.2.2 Vertical Installations

Vertical installations provide very good measurements. They are highly recommended when the flow speed is close or below 2 feet/second. The preferred flow direction is from bottom to top because it guaranties a liquid full pipe condition.

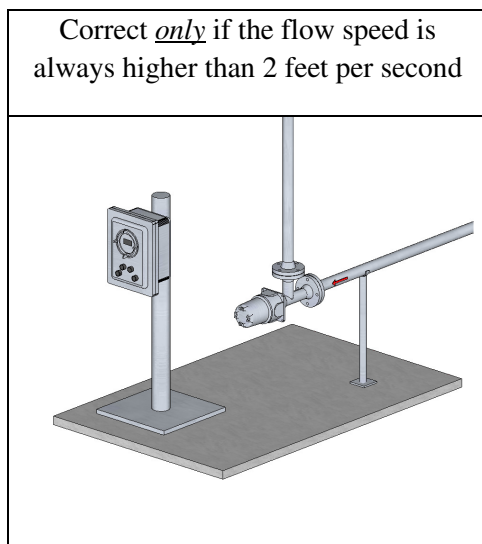
2.2.2.1 Flow Through analyzers

Picture 2.7 shows examples of a **correct** installation and two **incorrect** ones.



Picture 2.7

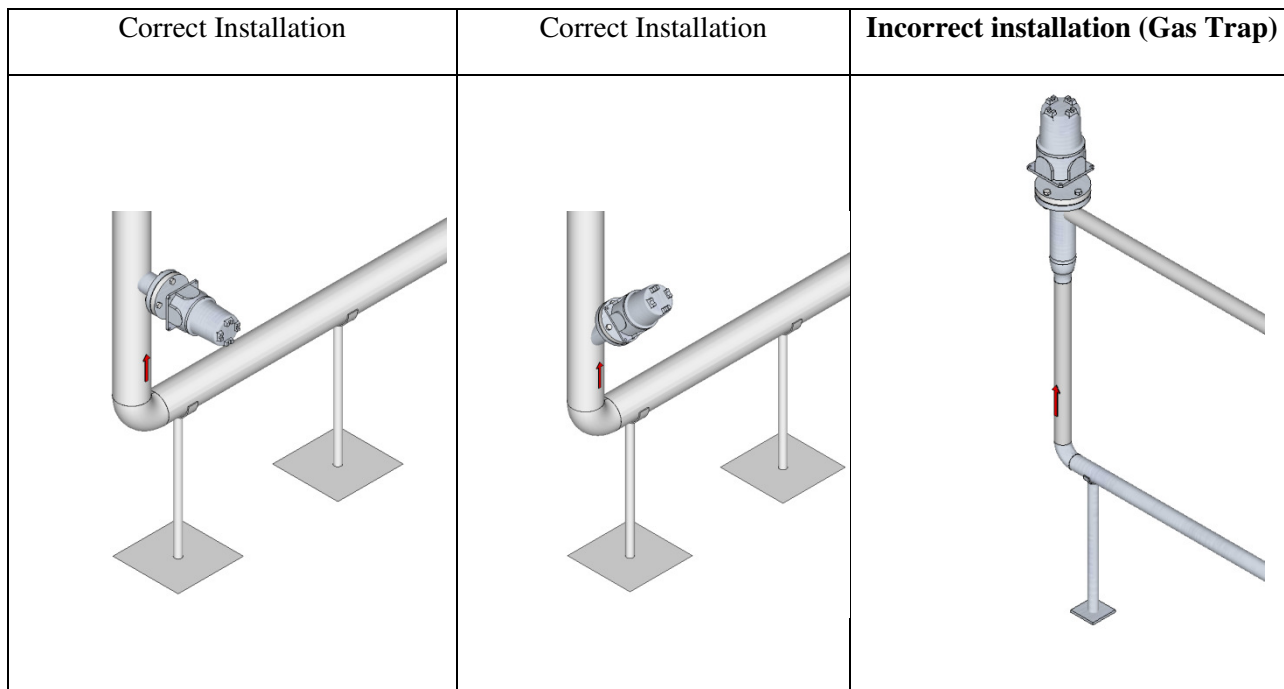
Picture 2.8 shows one typical “L” installations.



Picture 2.8

2.2.2.2 Insertion analyzers

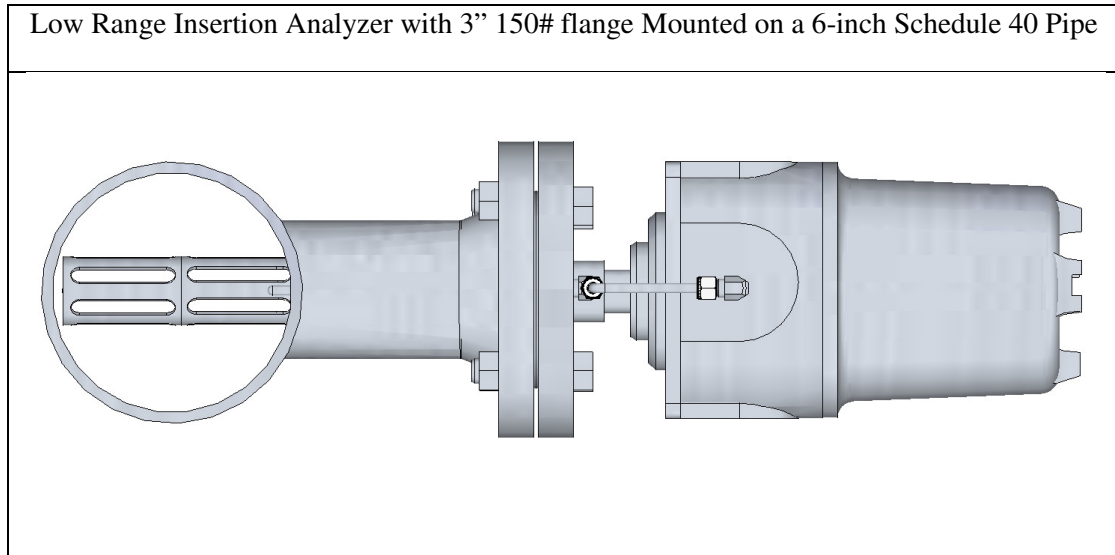
A **critical** issue in insertion installations is that the active parts of the Measurement Section have to be in full contact with the active flow. Picture 2.9 shows two correct installation and one incorrect installation.



Picture 2.9

Picture 2.10 shows a Low Range analyzer with a 3-inch ANSI 150 flange mounted on a 6-inch Schedule 40 pipe. Other flange ratings and pipe wall thicknesses **require** individual analysis, in order to

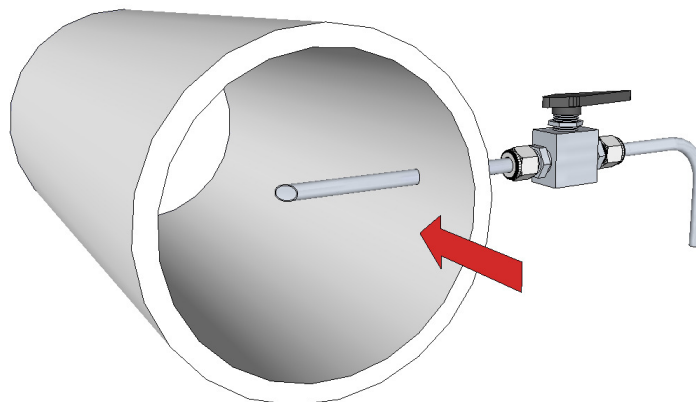
confirm acceptable clearances and sufficient insertion depths. Insertion Analyzers cannot be used – and are not available – with flange ratings of Class 1500 and higher.



Picture 2.10

2.3 Sampling Port

Since the only way to validate Analyzers is to compare its readings with the result of samples analyzed in the laboratory. A sample port must be installed near the Analyzer (Picture 2.11). This sample port can be located either upstream or downstream of the Analyzer. Analyzer and sample port need to be close enough so that the operator reading the Analyzer screen can communicate with the operator taking the sample, and the flow regime is the same at the sample port and at the Analyzer. A recommended sample port is a bore through fitting welded to the pipeline with a $\frac{1}{4}$ inch tubing cut as a quilt inserted to the center of the flow. The sample valve should be a quarter turn ball valve so a good extraction flow rate can be obtained.



Picture 2.11

2.4 Electronics Enclosure

The Electronics Enclosure should be mounted on a panel near the pipeline, about 5 feet above the ground. Ease of viewing, convenience of wiring, and simplicity of operation are the only considerations in the installation of the Electronics Enclosure. The distance between Measurement Section and Electronics Enclosure is limited by the length of the System Cable; our standard length is 30 feet, the maximum length available is 150 feet.

When prevailing ambient temperatures are above 100 °F (38°C), it is **recommended** that the Electronics Enclosure be protected by sun shade. Higher temperatures will not affect the performance of the Analyzer, but will reduce the life span of the electronic components.

When prevailing ambient temperatures are below 32 °F (0°C), it is **recommended** that the Electronics Enclosure be equipped with an optional enclosure heater. Lower temperatures will not affect the performance of the Analyzer, but will make the screen display unreadable. Install the Electronics Enclosure in such a way that it is not exposed to prevailing cold winds.

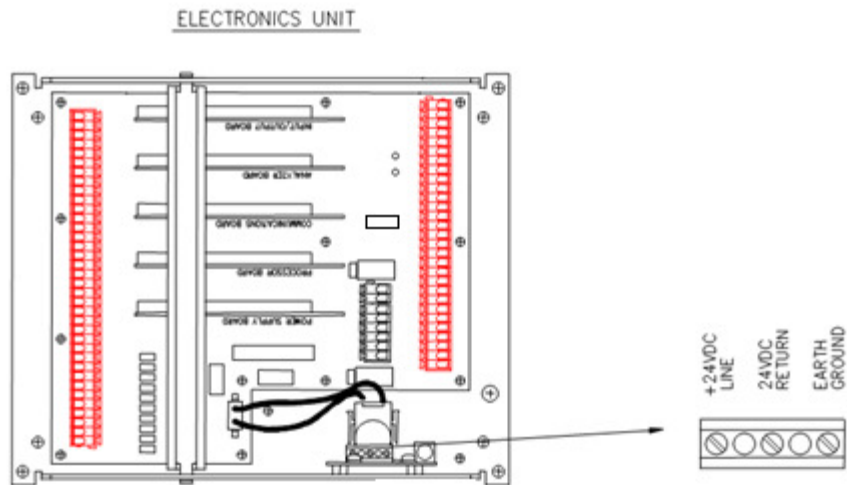
2.5 Electrical Wiring

Power Supply Connections

There are two power supply options for the Phase Dynamics analyzer. DC (24 Volts) and AC (100 to 240VAC). The connections are different for each one of them. The power consumption of the unit is 15 Watts typical, 27 Watts Maximum for Enhanced Electronics with LCD display and 19 Watts typical and 34 Maximum for units with Touch-screen and Expanded electronics. The gage of the wires has to be calculated to keep the voltage drop across the line to less than 5%.

2.5.1 24VDC:

In this case there is a power input board with 3 terminals marked as +24 VDC, 24 VDC RETURN and EARTH GROUND, as shown in picture 2.12. The wire gages accepted by the terminal strip are 14 to 22 AWG. Next to the terminal strip, there is a fuse holder. This fuse protects the system and it can be removed to power off the analyzer. **The connection of a non-interrupted earth ground on the EARTH GROUND connection is mandatory.** The power surge protections on the input board will not work if this grounding connection is not provided. This ground connection also protects the user from electroshock hazard. The power requirements are: 24 VDC +/- 5%, 0.625A Typical and 1.125A Maximum for Enhanced Electronics with LCD display and 0.8A typical and 1.45A Maximum for touch-screen with Expanded electronics.



Picture 2.12

Warning:

An uninterruptible safety Earth Ground **MUST BE** provided from the main power source to the Power input board terminal marked Earth Ground.

2.5.2 100 to 240 VAC:

In this case there is a power supply mounted on the bottom left corner of the electronics enclosure. The voltage supplied to this power supply has to be between 100 and 240 VAC. There are three terminals on the power supply marked as L (Line), N (Neutral) and GND (Ground), as shown in figure 2.13. The wire gages accepted by the terminals are 14-18 AWG. A circuit breaker or fuse has to be provided by the customer on the other end of the feed line. Failure to provide EARTH GROUND may cause a shock hazard that could result in personal injury. Also, the instrument may be damaged and will not operate properly and the warranty will be voided.

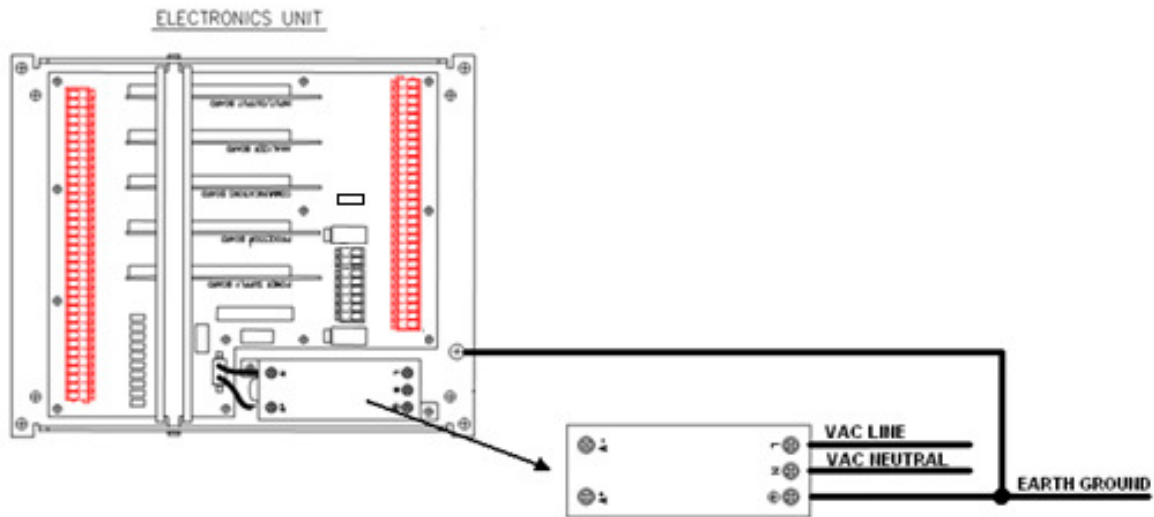


Figure 2.13

WARNING:

An uninterruptible safety Earth ground MUST BE provided from the main power source to the Power input board terminal marked Earth Ground

2.5.3 Earth Ground Connection

There is a ground kit provided with the analyzer. This kit contains a 16 AWG ground wire that is to be installed between the electronics enclosure and measurement section enclosure of the Phase Dynamics analyzer system. The wire provides a secondary ground connection between the two enclosures, and must be installed as described below. This assures a good ground which must be supplied for the analyzer even in the case of metal conduit which may become corroded and therefore not acceptable with time as a good ground.

Parts Contained

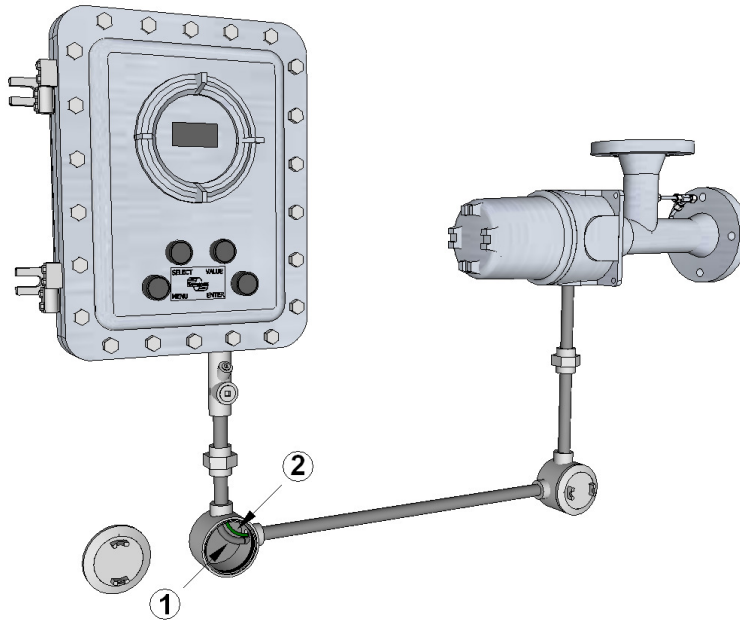
- 16 AWG green ground wire, with lug for #10 screw installed on one end
- #10-24 screw
- #10 lock washer
- crimp lug for 1/4" screw
- 1/4" lock washer

Installation Instructions

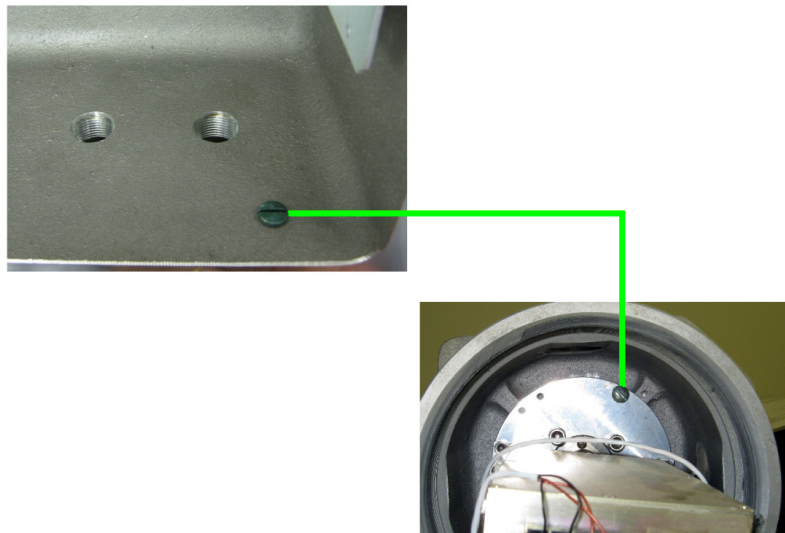
- a) Attach the ground wire to the collar inside the measurement section enclosure, as shown in the drawing below, using the #10-24 screw and lock washer.
- b) Pull the other end of the ground wire through the conduit (user supplied) connecting the two enclosures. It may be most convenient to perform this operation when the main system cable is installed, pulling the ground wire and system cable through the conduit at the same time.
- c) Cut the ground wire to length, and strip the insulation from the end.

- d) Crimp the lug for 1/4" screw onto the ground wire and install this lug under the 1/4" ground screw which is located inside the electronics enclosure, using the 1/4" lock washer.

Picture 2.14 shows the System Cable and the ground cable in an electrical conduit. Picture 2.15 shows the ground connections in both ends.



Picture 2.14 - 1: System Cable – 2: Ground Cable



Picture 2.15 - Detailed picture of the ground cable terminals

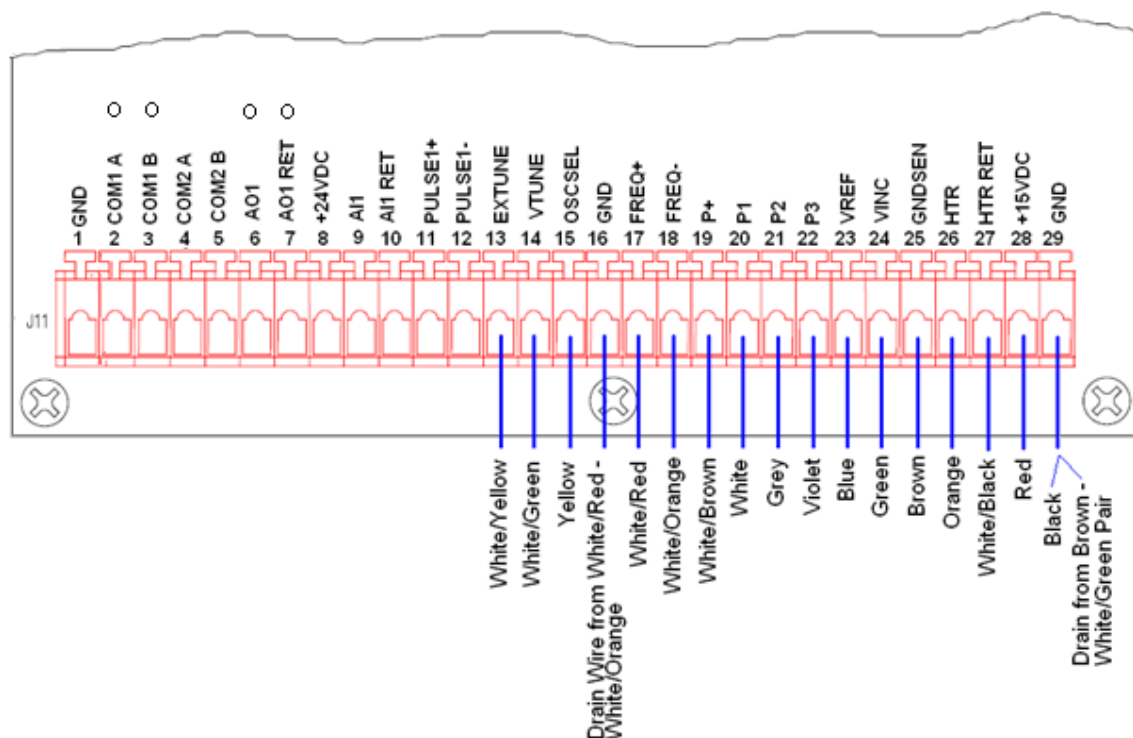
2.5.4 System Cable Connection

The system cable is used to connect the Electronics Enclosure and Measurement Section. For the explosion-proof installation requirement, a conduit installation is needed. A factory-installed circular military type of connector is attached to one end of the cable while the other end requires stripping the individual wires. This circular connector fits through the threaded hole of the enclosure protecting the oscillator module and then is connected to the mating circular connector at the rear of the oscillator module. Typically, a 30 feet of system cable is supplied to connect the analyzer to the measurement section. If required longer system cables (up to 150 feet) are available from Phase Dynamics. Phase Dynamics recommends the use of one single cable; DO NOT splice cables together. The wires on the other end have to be connected to the terminal strip J11 in the Electronics Enclosure, according to the following table:

System Cable Wiring Table

| Wire Color | Terminal Number | Terminal Strip | Terminal Label | Function |
|--|------------------------|-----------------------|-----------------------|-------------------------|
| White/Yellow | 13 | J11 | EXTUNE | External Tune Selection |
| White/Green | 14 | J11 | VTUNE | Tuning Voltage |
| Yellow | 15 | J11 | OSCSEL | Oscillator select |
| Drain wire from White/Red-White/Orange pair | 16 | J11 | GND | Ground |
| White/Red | 17 | J11 | FREQ+ | Oscillator frequency + |
| White/Orange | 18 | J11 | FREQ- | Oscillator frequency - |
| White/Brown | 19 | J11 | P+ | RTD drive high |
| White | 20 | J11 | P1 | RTD sense high |
| Grey | 21 | J11 | P2 | RTD sense low |
| Violet | 22 | J11 | P3 | RTD drive low |
| Blue | 23 | J11 | VREF | Reflected power |
| Green | 24 | J11 | VINC | Incident power |
| Brown | 25 | J11 | GNDSEN | Ground Sense |
| Orange | 26 | J11 | HTR | Heater voltage |
| White/Black | 27 | J11 | HTR RTN | Heater Return (Ground) |
| Red | 28 | J11 | +15VDC | +15 VDC supply |
| Black and Drain wire from Brown-White/Green pair | 29 | J11 | GND | Ground |
| White/Blue | N/A | N/A | N/A | Not Used (Cut Short) |
| White/Violet | N/A | N/A | N/A | Not Used (Cut Short) |
| White/Gray | N/A | N/A | N/A | Not Used (Cut Short) |
| Drain from White/Violet & White Grey | N/A | N/A | N/A | Not Used (Cut Short) |

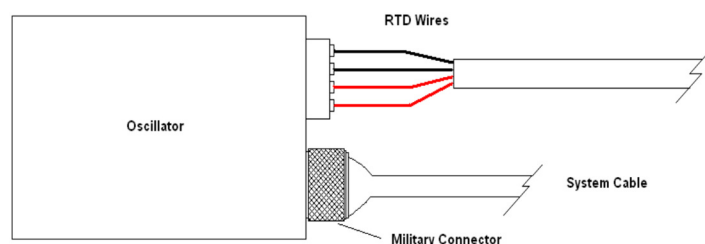
Picture 2.16 shows the wiring of the System Cable on Terminal Strip J11



Picture 2.16

2.5.5 RTD Connections

Each Phase Dynamics analyzer is equipped with a 4-wire RTD to measure the process temperature. These wires are connected at the factory. In case of a malfunction (wrong temperature indication), verify that the wires of the temperature probe are connected properly, as shown in figure 2.17 below, to the terminal strip at the top of the oscillator module according to the following table:



| Terminal Name | Wire Color |
|---------------|------------|
| P+ | Red |
| P1 | Red |
| P2 | Black |
| P3 | Black |

Figure 2.17

See section 9 to troubleshoot the RTD.

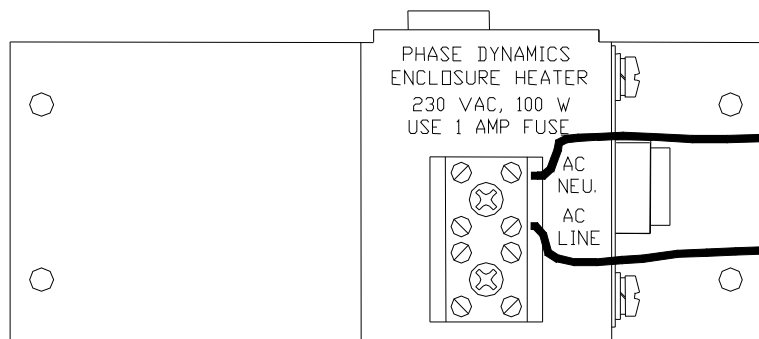
2.5.6 Electronic Enclosure Heater Connections

This optional heater assembly is used in cold environments to maintain a minimum temperature of 32°F inside the Phase Dynamics electronics enclosure. The heater features an on-off automatic thermostat that turns on the heater when the internal temperature is below 40°F.

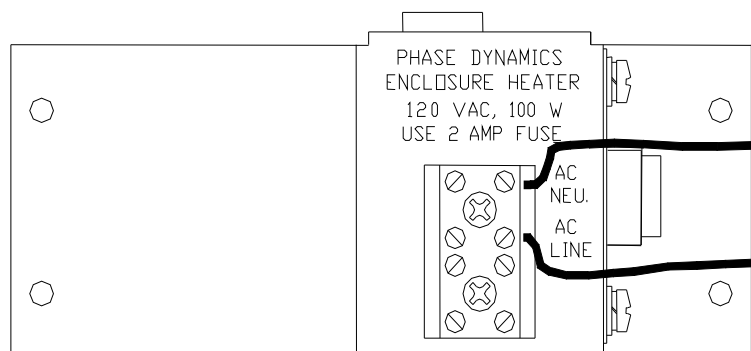
There are three types of power supply to choose which are 230VAC (Picture 2.18), 120VAC (Picture 2.19) and 24VDC (Picture 2.20). All of them are rated 100W. The unit is already assembled in the Electronic Enclosure; the only requirement for the connection is to attach the wires to the heater assembly terminal block as shown in the drawings below. The size of the wires should be calculated properly to not produce a voltage drop higher than 5% across the line. The wire gages accepted by the connector are 22 to 12 AWG. Phase Dynamics don't wire these enclosure heaters because it is up to the customer the way they will be connected. For example, if a separate breaker is needed for the enclosure heater so the power can be shut off independently, then a separate line has to be brought for the enclosure heater. If no independent breaker is necessary and the voltage of the Analyzer matches the voltage of the enclosure heater, then the power wires can be split inside the enclosure to power both with the same line.

The heater assembly is internally fused at 1 ampere, 2 amperes or 8 amperes for 230VAC, 120VAC or 24VDC respectively. Other values should not be substituted.

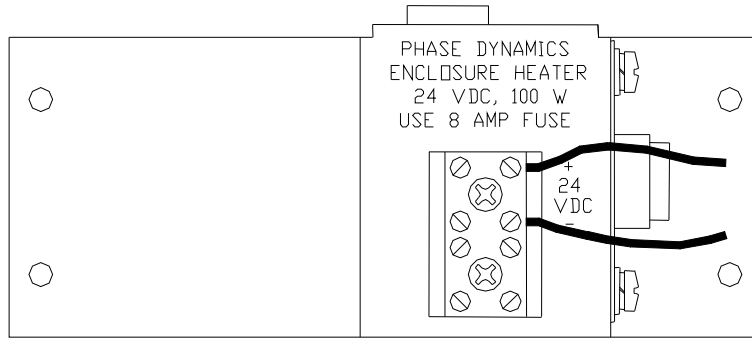
The heater assembly is mechanically attached to the chassis which is already grounded so no ground connection is necessary.



Picture 2.18 - 230 VAC Enclosure Heater Terminal Block



Picture 2.19 - 120 VAC Enclosure Heater Terminal Block



Picture 2.20 - 24 VDC Enclosure Heater Terminal Block

2.6 Signals Wiring

The wire gages accepted by the terminal Strip J1, J13 and J11 are 12 to 28 AWG.

2.6.1 Analog Inputs and Outputs

ATTENTION:

The analog Inputs and Outputs are NOT ISOLATED. The analog Outputs are INTERNALLY POWERED.

The analyzer has 1 Analog Input and 1 Analog Output (Enhanced Model) or 5 Analog Inputs and 5 Analog Outputs (Expanded Model). Each analog input has a +24VDC terminal associated that can be used to power field devices. These power supplies are individually fused. The Inputs and Outputs are also fused. The corresponding fuses are located in the Analyzer Board (for Analog Input/Output 1) and in the Input/Output board (for Analog Inputs/Outputs 2 to 5). All the analog outputs are active (internally powered) so no external power supply is required to use them.

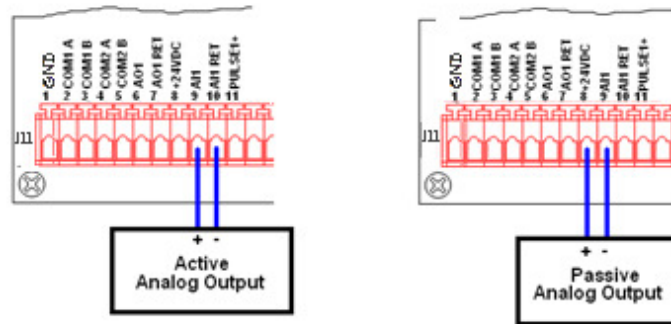
The terminals of all the analog inputs/outputs are described in the following table: (Note: I/O Board means Input/Output Board and A. Board means Analyzer Board).

| Description | Terminal Strip | Terminal Number | Terminal Label | Fuse Location | Fuse number/ Amperage |
|---------------------------------|----------------|-----------------|----------------|---------------|-----------------------|
| Analog Output 1 (+) | J11 | 6 | AO1 | A. Board | F7/0.125A |
| Analog Output 1 (-) | J11 | 7 | AO1 RET | Not Fused | |
| Analog Input 1 (+ 24VDC Supply) | J11 | 8 | +24VDC | A. Board | F1/0.125A |
| Analog Input 1 (+) | J11 | 9 | AI1 | A. Board | F9/0.125A |
| Analog Input 1 (-) | J11 | 10 | AI1 RET | Not Fused | |
| Analog Input 2 (+ 24VDC Supply) | J1 | 9 | +24VDC | A. Board | F16/0.125A |
| Analog Input 2 (+) | J1 | 10 | AI2 | I/O Board | F12/0.125A |
| Analog Input 2 (-) | J1 | 11 | AI2 RET | Not Fused | |
| Analog Input 3 (+ 24VDC Supply) | J1 | 12 | +24VDC | I/O Board | F15/0.125A |
| Analog Input 3 (+) | J1 | 13 | AI3 | I/O Board | F10/0.125A |
| Analog Input 3 (-) | J1 | 14 | AI3 RET | Not Fused | |

| Description | Terminal Strip | Terminal Number | Terminal Label | Fuse Location | Fuse number/ Amperage |
|------------------------------------|-----------------------|------------------------|-----------------------|----------------------|------------------------------|
| Analog Input 4 (+) 24VDC Supply | J1 | 15 | +24VDC | I/O Board | F14/0.125A |
| Analog Input 4 (+) | J1 | 16 | AI4 | I/O Board | F8/0.125A |
| Analog Input 4 (-) | J1 | 17 | AI4 RET | Not Fused | |
| Analog Input 5 (+) 24VDC Supply | J1 | 18 | +24VDC | I/O Board | F13/0.125A |
| Analog Input 5 (+) | J1 | 19 | AI5 | I/O Board | F8/0.125A |
| Analog Input 5(-) | J1 | 20 | AI5 RET | Not Fused | |
| Analog Output 2 (+) | J1 | 21 | AO2 | I/O Board | F24//0.125A |
| Analog Output 2(-) | J1 | 22 | AO2 RET | Not Fused | |
| Analog Output 3(+) | J1 | 23 | AO3 | I/O Board | F22/0.125A |
| Analog Output 3(-) | J1 | 24 | AO3 RET | Not Fused | |
| Analog Output 4(+) | J1 | 25 | AO4 | I/O Board | F20/0.125A |
| Analog Output 4(-) | J1 | 26 | AO4 RET | Not Fused | |
| Analog Output 5(+) | J1 | 27 | AO5 | I/O Board | F18/0.125A |
| Analog Output 5(-) | J1 | 28 | AO5 RET | Not Fused | |

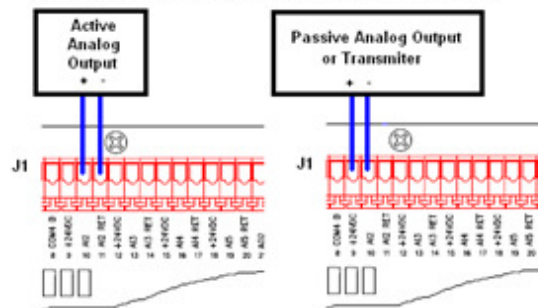
Picture 2.21 shows the Analog Input/s wiring.

Analog Input Wiring

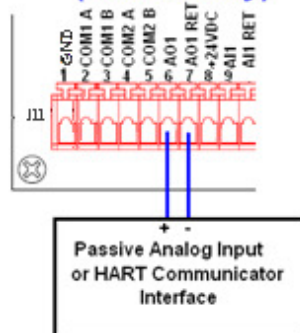


Expanded Analog Inputs (2 to 5)

Analog Inputs 3, 4 and 5 should be connected in the same way

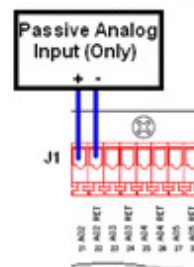


Analog Output And HART Communication Wiring (Active Only)



Expanded Analog Outputs (2 to 5)

Analog Output 3, 4 and 5 should be connected in the same way



Picture 2.21

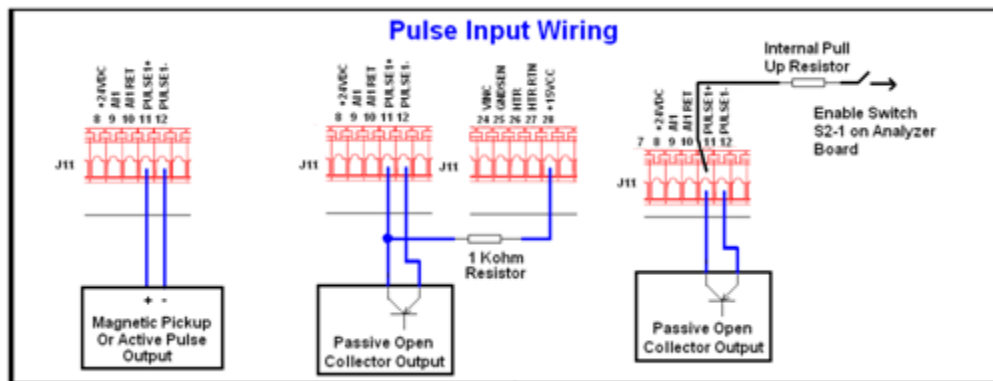
2.6.2 Pulse Inputs

The analyzer has 1 Pulse Input (Enhanced Model) or 3 Pulse Inputs (Expanded Model). The pulse inputs are fused. The fuse for the Pulse Input 1 is in the Analyzer Board. The fuses for the Pulse Inputs 2 and 3, are located in the Input/Output board.

The connections are located on terminal strips J1 and J11 according to the following table: (Note: I/O Board means Input/Output Board and A. Board means Analyzer Board).

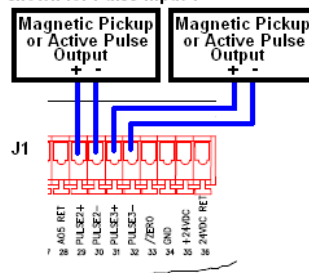
| Description | Terminal Strip | Terminal Number | Terminal Label | Fuse Location | Fuse number/Amperage |
|-------------------|----------------|-----------------|----------------|---------------|----------------------|
| Pulse Input 1 (+) | J11 | 11 | PULSE1+ | A. Board | F5/0.125A |
| Pulse Input 1 (-) | J11 | 12 | PULSE1- | A. Board | Not Fused |
| Pulse Input 2 (+) | J1 | 29 | PULSE2+ | I/O Board | F4/0.125A |
| Pulse Input 2 (-) | J1 | 30 | PULSE2- | I/O Board | Not Fused |
| Pulse Input 3 (+) | J1 | 31 | PULSE3+ | I/O Board | F4/0.125A |
| Pulse Input 3 (-) | J1 | 32 | PULSE3- | I/O Board | Not Fused |

Picture 2.22 shows the wiring diagram for the Pulse Inputs.



Expanded Pulse Inputs 2 and 3

There is no Internal Pull Up resistors for these inputs. In case of a Passive Open Collector output, please use an external 1KOhm resistor as shown for Pulse Input 1



Picture 2.22

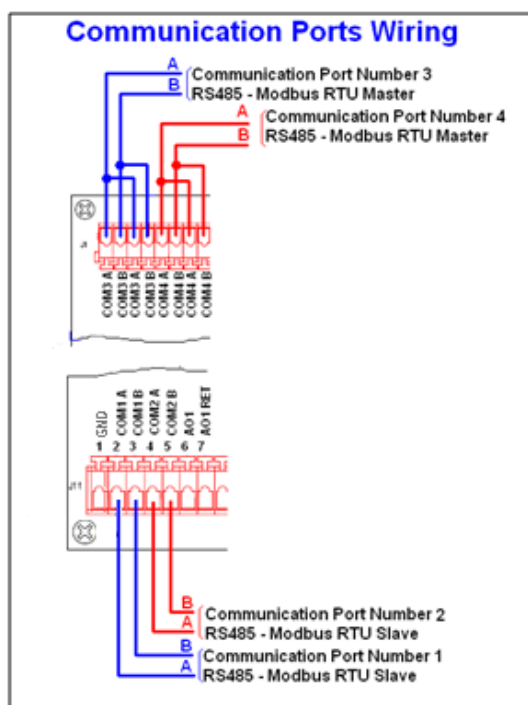
2.6.3 Communication Ports

The analyzer has four RS485 ports with MODBUS® RTU protocol. Port 1 and 2 are always slaves and they are normally used for communication with SCADA systems. When the analyzer has an optional Touch-Screen, Port 2 becomes unavailable to the user.

The function of the ports number 3 and 4 depends on the application. For example, they can be used to connect the analyzer to a Micro Motion® Coriolis Meter to obtain the online density readings needed to perform the density correction. When they are not used to read Micro Motion® Meters, they are also slaves.

| Description | Terminal Strip | Terminal Number | Terminal Label |
|--------------------------|----------------|-----------------|----------------|
| Communication Port 1 (A) | J11 | 2 | COM1 A |
| Communication Port 1 (B) | J11 | 3 | COM1 B |
| Communication Port 2 (A) | J11 | 4 | COM2 A |
| Communication Port 2 (B) | J11 | 5 | COM2 B |
| Communication Port 3(A) | J1 | 1 | COM3 A |
| Communication Port 3 (B) | J1 | 2 | COM3 B |
| Communication Port 3 (A) | J1 | 3 | COM3 A |
| Communication Port 3 (B) | J1 | 4 | COM3 B |
| Communication Port 4 (A) | J1 | 5 | COM4 A |
| Communication Port 4 (B) | J1 | 6 | COM4 B |
| Communication Port 4(A) | J1 | 7 | COM4 A |
| Communication Port 4 (B) | J1 | 8 | COM4 B |

The default configuration for the ports is described in the Section 4.22. Figure 2.23 shows the wiring diagram.



Picture 2.23

2.6.4 Relays

The analyzer has two configurable relays with one SPDT switch each. They have their own terminal strip (J3). The contacts are individually fused. The fuses are F1 and F2 (figure 2.24). The contacts are rated 1A 125VAC.

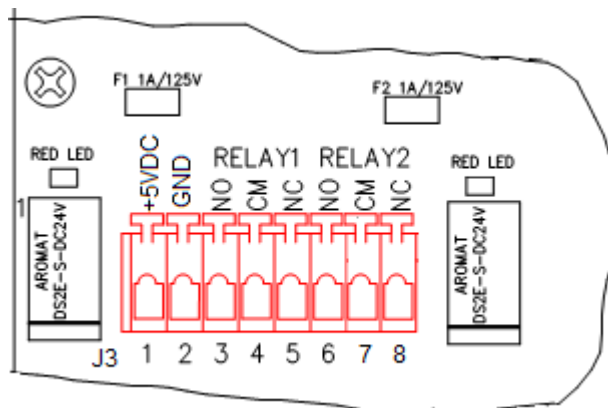


Figure 2.24

The connections are specified in the following table:

| Description | Terminal Strip | Terminal Number | Terminal Label |
|--------------------------------|----------------|-----------------|----------------|
| +5VDC | J3 | 1 | +5VDC |
| Ground | J3 | 2 | GND |
| Relay 1 Normal Open Terminal | J3 | 1 | NO |
| Relay 1 Common Terminal | J3 | 2 | CM |
| Relay 1 Normal Closed Terminal | J3 | 3 | NC |
| Relay 2 Normal Open Terminal | J3 | 4 | NO |
| Relay 2 Common Terminal | J3 | 5 | CM |
| Relay 2 Normal Closed Terminal | J3 | 6 | NC |

2.6.5 HART® Port

The network HART® BELL202 / ANALOG OUTPUT 1 (4-20mA) can be used for any HART® application. The Analog output is not galvanically isolated.

The HART® signal (Optional) is available over the Analog Output 1 (Terminals 6(+) and 7(-) on terminal strip J11) as shown in figure 2.25. There are a couple of test clips over the terminal for easy connection of portable HART® handheld communicator.

The maximum allowable loop resistance is 600Ω.

The port has fuse protection (Fuses on Analog Output 1), ESD protection, and transient voltage suppression. For wiring refer to the next picture or see section 2.6.1 and find the wiring diagram for Analog Output 1.

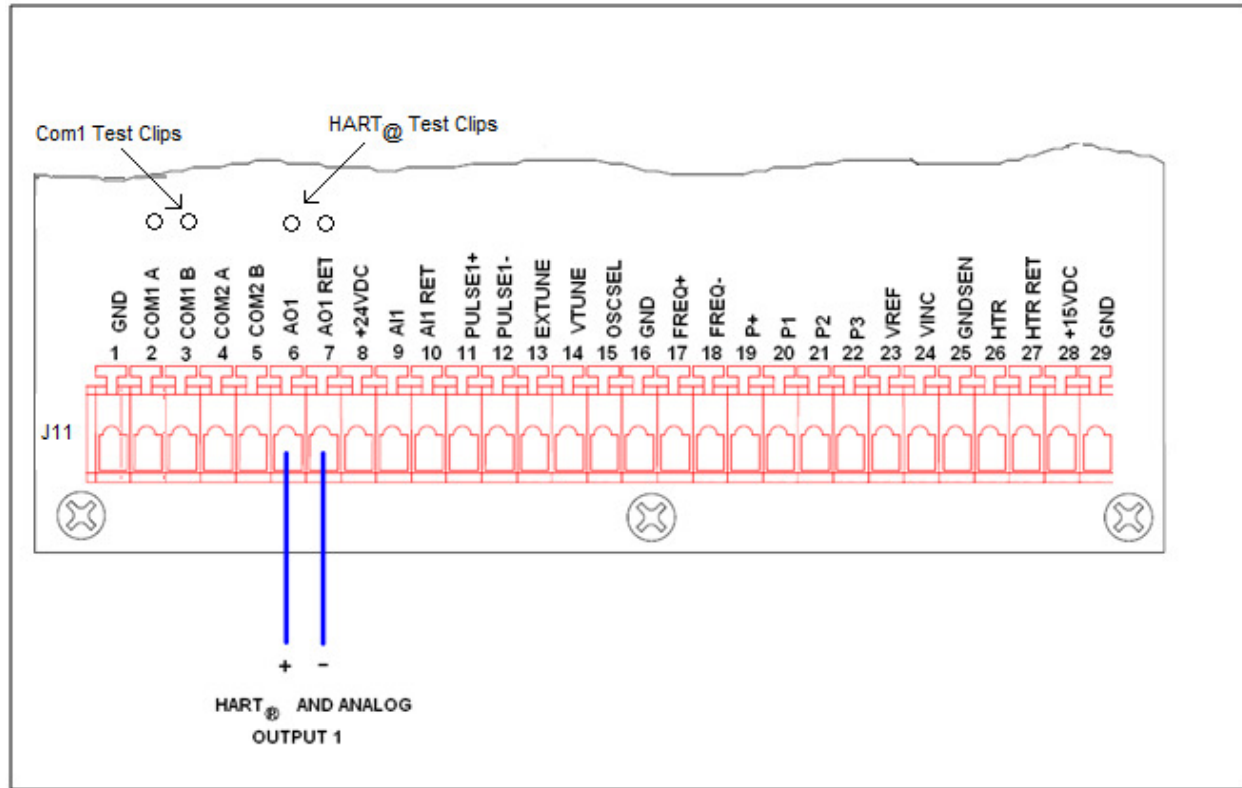


Figure 2.25

There are some switches in the Analyzer Board that are used in some special cases to configure HART. There are 2 groups of 4 switches called S1 and S2 (figure 2.26). For HART® the only ones used are S2-3 and S2-4.

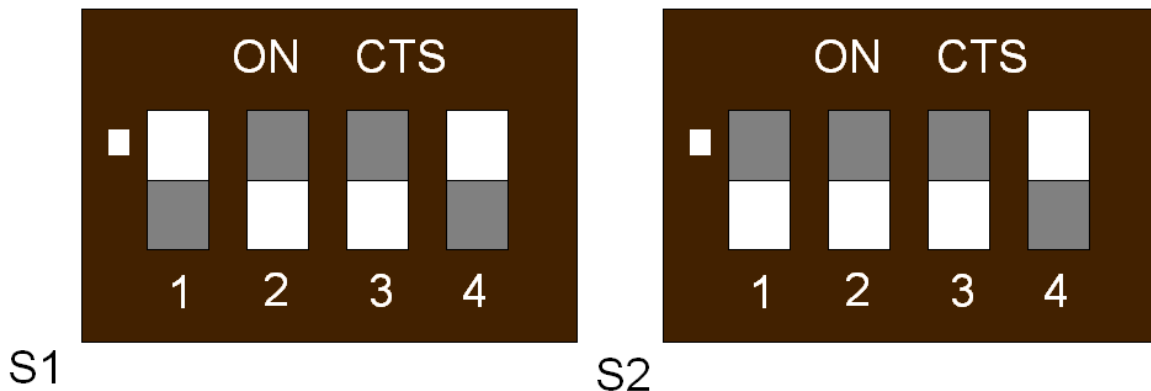


Figure 2.26

S2-3: AO1 TERMINATION: Then this switch it turned on (up position) a termination resistor is connected in parallel with the Analog Output line. This is used to avoid ringing in the line when there are more than one instrument communicating over the same line and/or when the line is too long. If this switch is turned on, then S2-4 should be turned off. The default position for this switch is OFF.

S2-4: AO1 ENABLE: This switch enables the Analog Output 1. When more than one analyzer is connected on the same line the AO1 can be disabled allowing only the HART[®] communication signal to be present. In this way the 4-20mA signal will NOT be present. The default position for this switch is ON.

3 Theory of Operation

The following sections describe, in detail, the specific operation of the Phase Dynamics load-pull system and how it is used to measure water content. The sections are separated into two main parts - one describing the fundamental behavior of the instrument to changing water content and one describing temperature effects.

3.1 Detailed Description of Frequency Response

The load-pull system relates the frequency of an oscillator connected to the probe to water content. During factory calibration, coefficients are derived to relate the measured frequency to water content for a given temperature. The water content is calculated as follows;

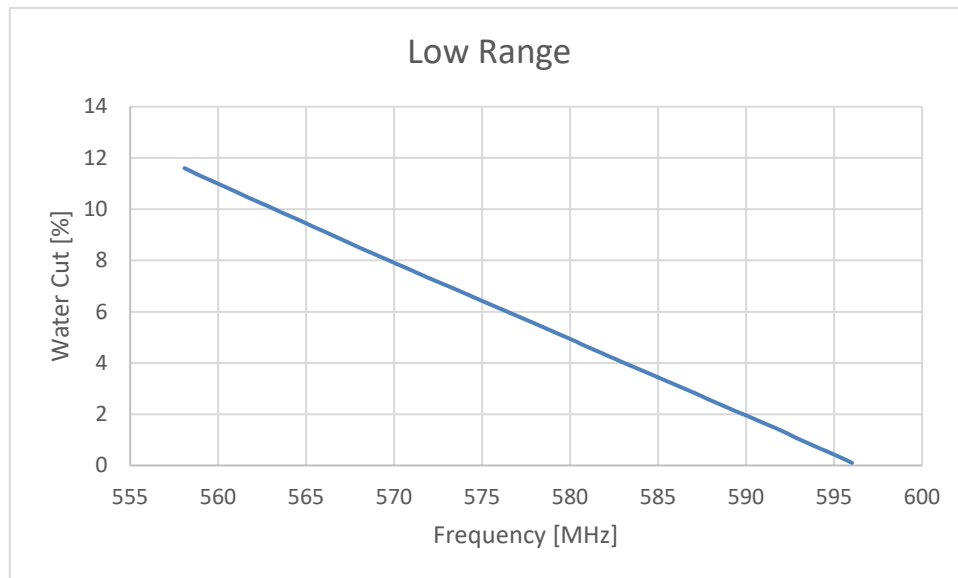
$$\begin{aligned}\text{Water content} &= \text{O3} \times (\text{Frequency} + \text{Oil Index})^3 \\ &+ \text{O2} \times (\text{Frequency} + \text{Oil Index})^2 \\ &+ \text{O1} \times (\text{Frequency} + \text{Oil Index}) \\ &+ \text{O0} \\ &+ \text{Oil Adjust}\end{aligned}$$

Where Frequency is the measured oscillator frequency,
O3, O2, O1 and O0 are the oil constants (O-constants),
Oil Index is a frequency index value, and
Oil Adjust is a linear offset value.

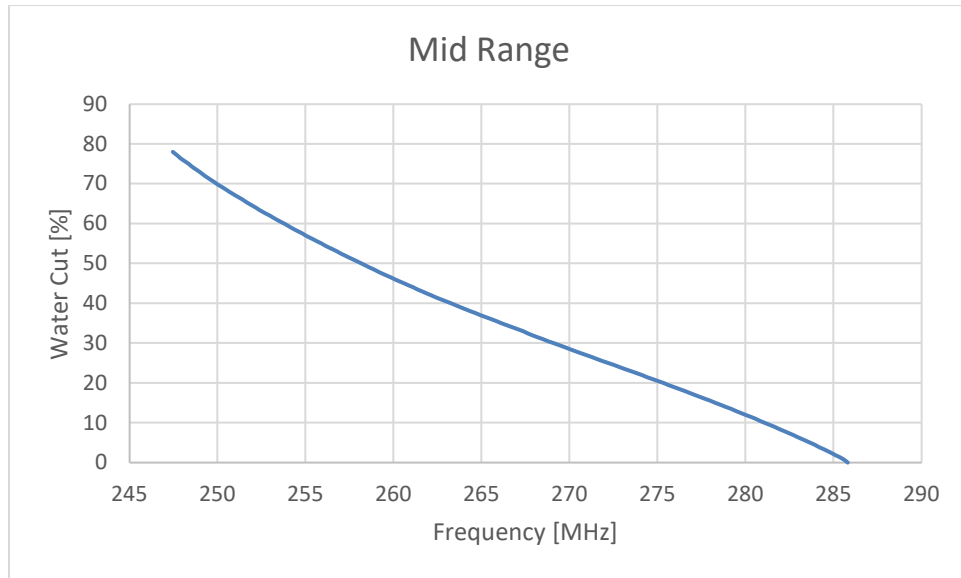
The factory default values for Oil Index and Oil Adjust are zero (0). In this case the above equation simplifies to;

$$\text{Water content} = \text{O3} \times \text{Freq}^3 + \text{O2} \times \text{Freq}^2 + \text{O1} \times \text{Freq} + \text{O0}.$$

Picture 3.1a shows a typical factory calibration curve for a Low-Range Analyzer at constant temperature and Picture 3.1b shows a typical calibration curve for a Mid-Range Analyzer at constant temperature



Picture 3.1a – Low-Range Factory Calibration, Frequency versus Water Content



Picture 3.1b – Mid-Range Factory Calibration, Frequency versus Water Content

To compensate for differences in density between the factory calibration oil and actual process conditions, a linear offset factor, Oil Adjust, may be added to or subtracted from the computed water content. The effect of Oil Adjust is as shown in Figure 3.2

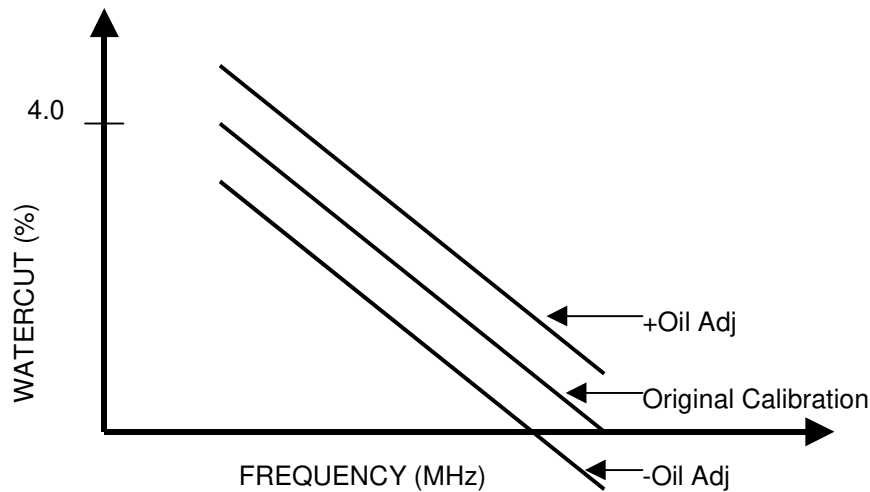


Figure 3.2 - Effect of Changing Oil Adjust

On rare occasions, it may be necessary to include a frequency index. The effect of Index is as shown in Figure 3.3. Note: The preferred method for field calibration includes the use of Oil Adjust, as opposed to Index. However, Index is included to provide greater flexibility to the user, if needed. Please don't use Oil Index unless instructed by a Phase Dynamics specialist.

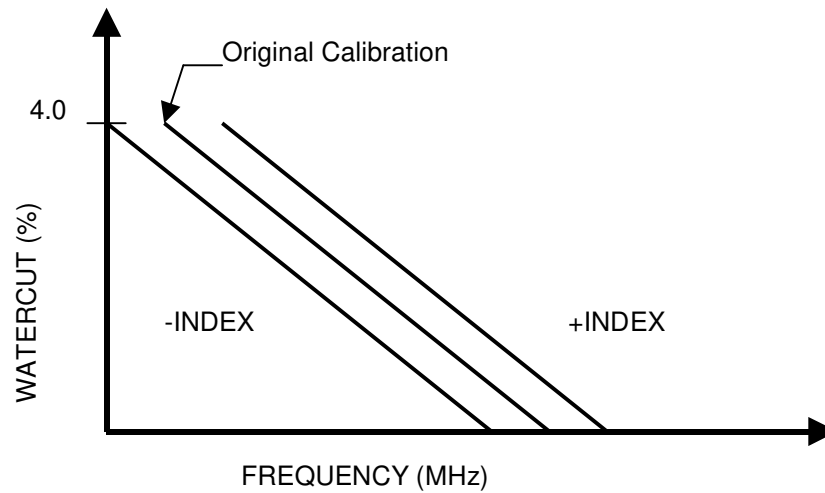


Figure 3.3 - Effect of Changing Index

The Phase Dynamics Water in Hydrocarbon Analyzer includes an operational feature which allows the instrument to determine an over range condition for the measured water content. The reflected power (Ref Pwr) signal from the oscillator module is measured and compared to a threshold value; it is a DC voltage indicative of the signal level reflected from the measurement section. Typically, the measured level will be above the threshold value when the measured water content is within range. For the over range condition, the reflected power level will be below the threshold value.

The reflected power threshold level (RP Threshold) may be frequency dependent and is given by;

$$\text{RP Threshold} = P1 \times (\text{Frequency} + \text{Index}) + P0$$

Where:

Frequency: Is the measured oscillator frequency,

Index: is the frequency index,

P1 is the slope of the threshold curve, and

P0 is the intercept of the threshold curve.

Figure 3.4 shows a typical reflected power threshold curve for the Phase Dynamics Analyzer.

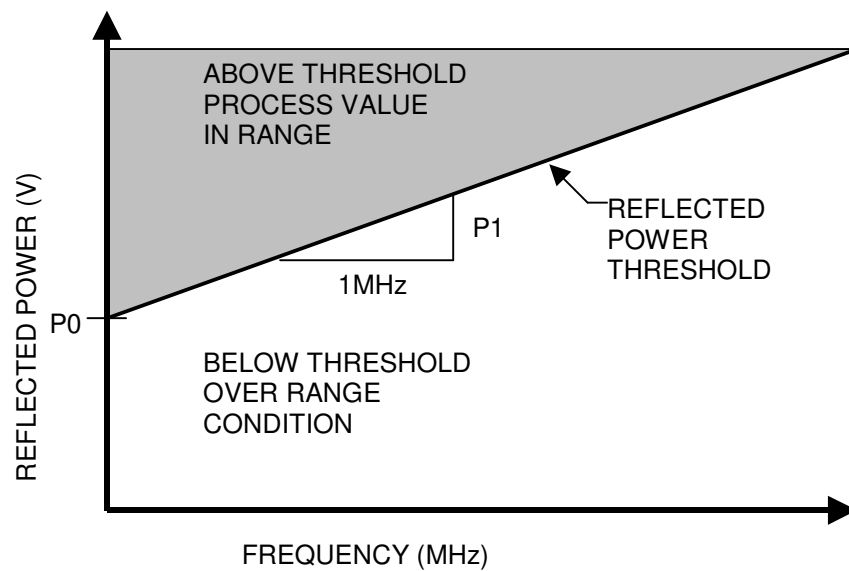


Figure 3.4 - Reflected Power Threshold Curve

Beginning at the main screen, the user can browse through the menu or through the Flow Computer screens. The Flow Computer screens (Shown by pressing the [SELECT] key while in the main screen) depend on the configuration. For example, if the density correction is enabled, there are extra screens showing the density related information.

The menu is organized as a flow chart. The whole list of sub-menus is browsed by pressing [MENU] repeatedly. As the analyzer has 2 different modes, Technician and Normal, the submenus that can be accessed depend on which mode the analyzer is set to. While in Normal mode, the user can access the Technician mode by using a password or by setting a switch marked as S1 (Figure 4.1) that is located behind the display board.

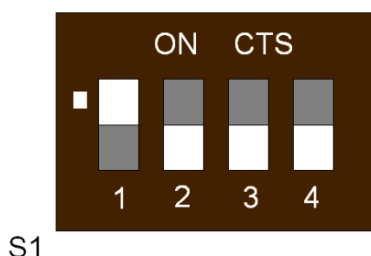


Figure 4.1

Modes:

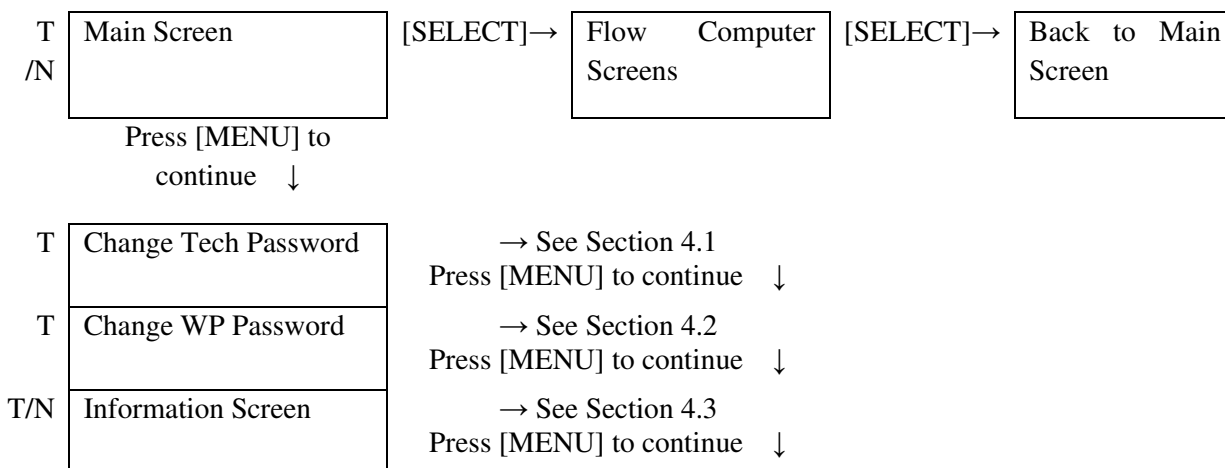
Normal mode (OFF-OFF-X-X) contains basic menus for normal operation.

Technician mode (ON-OFF-X-X) contains all menus including installation and configuration settings.

Write-protect mode (X-X-ON-X) prevents all data entry until a password is entered. The default password is 1357 (For software version 6.10 and older the password is 1234). When unlocked, the unit will remain unlocked until either a power-cycle or until MENU is pressed for about 5 seconds to logout and return to the main screen.

Lockdown mode (XX-XX-XX-ON) prevents all data entry and menu activity, except on the main screen.

The following table describes the menus flow chart. Please note the “T”, “N” or “T/N” at the left of each submenu. The “T” means that they are only available in Technician Mode. The “N” means that those submenus are only available in the Normal mode and the “T/N” means that they are available in both.



| | | |
|-----|---------------------|--|
| T/N | Diagnostics | → See Section 4.4 Press [MENU] to continue ↓ |
| T | Time and Date | → See Section 0 Press [MENU] to continue ↓ |
| T | Process Averaging | → See Section 4.6 Press [MENU] to continue ↓ |
| T/N | Stream Select | → See Section 4.7 Press [MENU] to continue ↓ |
| N | Access Tech Mode | → See Section 4.8 [Press [MENU] to continue ↓ |
| T | Temperature Units | → See Section 4.9 Press [MENU] to continue ↓ |
| T | Temperature Adj. | → See Section 4.10 Press [MENU] to continue ↓ |
| T | Average Temperature | → See Section 4.11 Press [MENU] to continue ↓ |
| T | Capture (Oil Phase) | → See Section 4.12 Press [MENU] to continue ↓ |
| T | Cal (Oil Phase) | → See Section 4.13 Press [MENU] to continue ↓ |
| T | Adjust (Oil Phase) | → Section 4.14 Press [MENU] to continue ↓ |
| T | Process Low (%) | → Section 4.15 Press [MENU] to continue ↓ |
| T | Process High (%) | → See Section 4.16 Press [MENU] to continue ↓ |
| T | Oil Index (MHz) | → See Section 4.17 Press [MENU] to continue ↓ |
| T | Oil Frequency Low | → See Section 4.18 Press [MENU] to continue ↓ |
| T | Oil Frequency High | → See Section 4.19 Press [MENU] to continue ↓ |
| T | Oil P1 (V/MHz) | → See Section 4.20 Press [MENU] to continue ↓ |
| T | Oil P0 (V) | → See Section 4.21 Press [MENU] to continue ↓ |
| T | Configure Comm | → See Section 4.22 Press [MENU] to continue ↓ |
| T | Configure Relay | → See Section 4.23 Press [MENU] to continue ↓ |

| | | |
|-----|----------------------------|--|
| T | Configure AI | → See Section 4.24 Press [MENU] to continue ↓ |
| T | Configure AO | → See Section 4.25 Press [MENU] to continue ↓ |
| T | Trim RTD Lo | → See Section 4.26 Press [MENU] to continue ↓ |
| T | Trim RTD Hi | → See Section 4.27 Press [MENU] to continue ↓ |
| T | Density Correction | → See Section 4.28 Press [MENU] to continue ↓ |
| T | Configure Flow Computer | → See Section 4.29 Press [MENU] to continue ↓ |
| T\N | USB Logging | → See Section 4.304.30 Press [MENU] to continue ↓ |
| T | Restart | → See Section 4.31 Press [MENU] to continue ↓ |
| T | Reset Factory Defaults | → See Section 4.32 Press [MENU] to continue ↓ |
| | Main Menu | |

Submenus Details:

4.1 Change TECH Password

This screen will display when unlocked. Enter here a new password for accessing technician mode from Normal Mode. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor, then [VALUE] to change the digits and [ENTER] to accept. The default password is 1357 (For software version 6.0 and before, the password is 1234). If the password is changed by the operator a reset to Factory Defaults will also reset the password to the factory value.

4.2 Change WP Password (Write protection)

This screen will show when unlocked. To lock the screen set the Write Protection Switch to the “ON” position on the switch S1-4 located behind the display board (See the beginning of Section 4). After the switch is on, the controller will not allow any changes unless the password is entered. The default password is 1357 (For software version 6.0 and before, the password is 1234). If the password is changed by the operator a reset to Factory Defaults will also reset the password to the factory value.

4.3 Information Screen:

Nothing can be changed on this screen. It only shows the analyzer information.

Serial Number: XXXXXX
 PDXXXXX
 LL1R2012FB012E

4.4 Diagnostics:

This screen shows the errors. There are two diagnostic words containing 16 bits each. That makes 32 error codes. Every single bit of these two words can be masked. To mask the errors the analyzer performs a logic AND function between the corresponding diagnostic word and its mask. By default, the masks are disabled so all the errors are displayed. This means that the bits of the masks are all ones.

The masks are shown as hexadecimal numbers which means that a mask with value “FFFF” will not filter any error. Press [MENU] to skip this menu, press [ENTER] to clear all errors, press [SELECT] to edit the masks to filter errors.

If some error is still present, it will reappear after you press the Enter key
 The flags are:

Diagnostic word 1

| Bit Number | Name | Hexadecimal Mask | Binary Mask |
|------------|------------------------|------------------|-----------------|
| 1 | External Memory | FFFE | 111111111111110 |
| 2 | Execution Fail | FFFD | 111111111111101 |
| 3 | Timer Fail | FFFB | 111111111111011 |
| 4 | Flash Memory | FFF7 | 111111111110111 |
| 5 | Flash Write Protection | FFEF | 111111111101111 |
| 6 | Variable Boundaries | FFDF | 111111111101111 |
| 7 | Variable Units | FFBF | 111111111011111 |
| 8 | Internal Memory | FE7F | 111111101111111 |
| 9 | Frequency Low | FEFF | 111111101111111 |
| 10 | Frequency High | FDFF | 111111011111111 |
| 11 | Temperature Low | FBFF | 111110111111111 |
| 12 | Temperature High | F7FF | 111101111111111 |
| 13 | Process Low | EFFF | 111011111111111 |
| 14 | Process High | DFFF | 110111111111111 |
| 15 | Reset | BFFF | 101111111111111 |
| 16 | Reset Basics. | 7FFF | 011111111111111 |

Diagnostic word 2

| Bit Number | Name | Hexadecimal Mask | Binary Mask |
|------------|-------------------------------|------------------|-----------------|
| 1 | Time Reset | FFFE | 111111111111110 |
| 2 | Flow Computer 1 Failed | FFFD | 111111111111101 |
| 3 | Reserved | FFFB | 111111111111011 |
| 4 | Reserved | FFF7 | 111111111110111 |
| 5 | Sample Error | FFEF | 111111111110111 |
| 6 | Flow Computer 1 Extrapolation | FFDF | 111111111101111 |
| 7 | Reserved | FFBF | 111111111011111 |
| 8 | Reserved | FE7F | 111111110111111 |
| 9 | Flash Memory Log | FEFF | 111111110111111 |
| 10 | Reserved | FDFF | 111111011111111 |
| 11 | Reserved | FBFF | 111110111111111 |

| | | | |
|----|----------|------|------------------|
| 12 | Reserved | F7FF | 1111011111111111 |
| 13 | Reserved | FFFF | 1110111111111111 |
| 14 | Reserved | DFFF | 1101111111111111 |
| 15 | Reserved | BFFF | 1011111111111111 |
| 16 | Reserved | 7FFF | 0111111111111111 |

To enable two or more masks just do a logic AND between the binary codes of the respective masks. For example, if the Variable Boundaries, Hi Process and Lo Process alarms need to be masked, do a logic AND between:

```

111111111011111
AND 111011111111111
    110111111111111
    110011111011111 = CFDF

```

Convert this number to Hexadecimal (in this case CFDF) and enter it in the mask screen. The selected alarms will never be seen again.

4.5 Time and Date:

This screen shows the current Time and Date. Time is 24 hours format and Date is MM/DD/YY.

Press [MENU] to skip this menu or press [SELECT] to edit. Use [SELECT] to move the cursor and [VALUE] to change the digits. When the changes are done, press [ENTER] to accept them.

4.6 Process Averaging:

Process Averaging, is the number of samples computed to calculate the water cut by averaging. This number could be anything from 1 to 300. If 1 is used, the reading will be unfiltered. Press [MENU] to skip this menu. To edit the current number, press [SELECT] to enter the edition mode. Use [SELECT] to move the cursor and [VALUE] to change the digits. When the changes are done, press [ENTER] to accept them.

4.7 Stream Select:

Shows the Stream configuration currently used (1 to 60). Press [MENU] to skip this menu. To edit the current stream, press [SELECT]. Use [SELECT] to move the cursor and [VALUE] to change the digits. When the changes are done, press [ENTER] to accept them

4.8 Access Tech Mode:

This screen is only available in Normal Mode. It allows the user to switch the analyzer to Technician Mode through a password. Up to the software release 6.10 the password was 1234. On software release 6.11 and over, the password was changed to 1357. Press [SELECT] to enter into the edition mode. Use [SELECT] and [VALUE] to change the digits and press [ENTER] to accept the changes. Press [MENU] to skip this item. To return to Normal mode press and hold [MENU] for 5 seconds.

4.9 Temperature Unit:

This submenu allows the user to change the main screen temperature unit. The available options are: °C, °F, °R, °K. Press [MENU] to skip this menu or use [VALUE] and/or [SELECT] to change the units and [ENTER] to accept it or [MENU] to exit without changes.

4.10 Temperature Adjust:

Enter here a value to offset the temperature value. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Use [SELECT] to move the cursor and [VALUE] to change the digits. When the changes are done, press [ENTER] to accept them or [MENU] to exit without changes.

4.11 Average Temperature:

This screen shows the temperature average. The average is kept for 24 hours starting at the time it was reset. For example, if the average is reset at 10:00 AM, then the average temperature shown will be the average from 10:00AM to the present time. The average will be reset at 10:00AM the next day and so on. Press [MENU] to skip this menu or press [ENTER] to reset the temperature average.

4.12 Capture (Oil Phase)

This is a very useful command to be used when the water cut offset needs to be adjusted. At the same time that a sample is taken, activate this command to capture current data. The offset will be automatically calculated after the actual water cut is entered on the “CALIBRATE OIL PHASE” menu after the result of the sample is obtained from the laboratory. Press [MENU] to skip this menu or press [SELECT] to clear the last capture. Press [ENTER] to start a new capture. While a capture is running a “Capturing” message is shown. When the capture is finished, the time and date of the capture are shown at the bottom of the screen. For software version 6.09 and over the user has to press ENTER to start the capture and then press ENTER again to stop the capture. If [ENTER] is not pressed within 30 seconds, the capture will be finished by the analyzer at the end of this period.

4.13 Cal (Oil Phase)

Enter the water cut corresponding to the captured sample described on the “Capture” command. If no capture data is stored, the current reading will be used. Press [MENU] to skip this menu or use [SELECT] to start the edition mode. Press [SELECT] to move the cursor and [VALUE] to change the digits. When the changes are done, press [ENTER] to accept them or [MENU] to exit without changes.

4.14 Adjust (Oil Phase)

This is an offset added to the water cut. It is necessary to compensate for constant density changes in the oil. This offset is automatically changed after doing a Capture and entering the sample result (4.13 and 4.14). The “Capture” is the prefer method to modify this offset but if needed, it can be manually changed. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor and [VALUE] to change the digits. When the changes are done, press [ENTER] to accept them or [MENU] to exit without changes.

4.15 Process Low (%):

This value sets the lower limit for water cut to activate the “Low Process” status condition on the diagnostics. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor and [VALUE] to change the digits. When the changes are done, press [ENTER] to accept them or [MENU] to exit without changes.

4.16 Process High (%):

This value sets the upper limit for water cut to activate the “High Process” status condition on the diagnostics. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT]

to move the cursor and [VALUE] to change the digits. After the changes are done, press [ENTER] to accept them or [MENU] to exit without changes.

4.17 Oil Index (MHz)

The Oil Index is an offset that is added to the measured frequency of the Oscillator. This parameter should be used by qualified technicians only. Otherwise, it should be equal to 0 Mhz. Accepted values for this parameter are between -1000 to 1000 Mhz. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor and [VALUE] to change the digits. After the changes are done, press [ENTER] to accept them or [MENU] to exit without changes.

4.18 Oil Frequency Low (MHz)

Frequencies below this limit will cause the analyzer to read full scale. Default value is 0.000 Mhz. Press [SELECT] to enter in edition mode. Press [SELECT] and [VALUE] to modify the digits. Press [ENTER] to accept the changes or [MENU] to skip this item without modifying the value.

4.19 Oil Frequency High (MHz)

Frequencies over this limit will cause the analyzer to read zero. Default value is 1000.000 MHz. Press [SELECT] to enter in edition mode. Press [SELECT] and [VALUE] to modify the digits. Press [ENTER] to accept the changes or [MENU] to skip this item without modifying the value.

4.20 Oil P1 (V/MHz):

A threshold line determined by the equation:

$$X = \text{Frequency}[\text{MHz}] * P1 + P0,$$

is used to detect a rollover condition of the oscillator. The value of P1 and P0 are determined during calibration and shouldn't be changed unless requested by a specialized technician from Phase Dynamics Inc. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor and [VALUE] to change the digits. After the changes have been done, press [ENTER] to accept or [MENU] to exit without changes.

4.21 Oil P0 (V):

See Oil P1. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor and [VALUE] to change the digits. After the changes have been done, press [ENTER] to accept or [MENU] to exit without changes.

4.22 Configure Com ports:

This menu allows the user to configure all the communication ports. Press [MENU] to skip this menu or press [SELECT] to choose your option from:

- Modbus Com1 / PDI
- Modbus Com2 / OIT
- Modbus Com3
- Modbus Com4
- HART
- IrDA

After reaching the desired port, press [ENTER] to go to the appropriate submenu

4.22.1 Submenu *MODBUS® Com x*

Note: “x” means the port number. Press the [MENU] key to navigate through the following submenus:

- Cx Slave ID

Enter here the slave address. Values from 1 to 255 are allowed. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor and [VALUE] to change the digits. After the changes have been done, press [ENTER] to accept or [MENU] to exit without changes.

- Cx Baud Rate

Press [MENU] to skip this menu or press [SELECT] to change to the desired baud rate. Available options are 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 125200. After the baud rate has been selected, press [ENTER] to accept it or [MENU] to exit without changes.

- Cx Prefix (ct)

The prefix is the time in CT (Character Time) that processor drives the network before starting a transmission. Values from 0.0 to 255.0 are allowed. The default value is 1.5. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor and then VALUE to change digits. After the changes are done, press ENTER to accept the changes.

- Cx Suffix (ct)

The Suffix is the time in CT (Character Time) that processor drives the network after finishing a transmission. The Default value is 0. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor and then VALUE to change digits. After the changes are done, press ENTER to accept the changes.

- Cx Reply Delay

Enter here the desired reply delay in milliseconds. Values from 0 to 255 are allowed. The default value is 10. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor and then VALUE to change digits. After the changes are done, press ENTER to accept the changes or [MENU] to exit without changes.

- Cx Watchdog

The Watchdog is the time in CT (Character Time) the processor will wait before dropping an incomplete received transmission packet. Values from 1.5 to 255.0 are allowed. The default value is 50. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor and then VALUE to change digits. After the changes are done, press ENTER to accept the changes or [MENU] to exit without changes.

- Cx Parity

Press [MENU] to skip this menu or press [SELECT] to find the desired option. Available values are:

- NONE
- ODD
- EVEN
- MARK/1

- SPACE/0

After reaching the desired one, press [ENTER] to accept it or [MENU] to exit without changes.

- Cx Retry Time (s)

Enter here the desired retry time in seconds. Values from 0.1 to 10 are allowed. The default value is 0.4. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor and then VALUE to change digits. After the changes are done, press ENTER to accept the changes or [MENU] to exit without changes.

- Cx Statistics

This screen shows information about the communication port. There are two screens. The first one shows the following information:

| | |
|----------|--|
| ERRORS: | (Number of errors) |
| WDOG: | (Number of times the Watchdog resets occurred) |
| INV. PKT | (Number of invalid packets) |

After pressing [MENU] one more time, the second Statistics screen will show:

| | |
|----------|---------------------------------------|
| INV CMD: | (Number of invalid commands) |
| SUCCESS: | (Number of packets sent successfully) |
| # Retry: | (Number of retries) |

Press MENU one last time to exit this submenu.

4.22.2 Submenu for HART communication port:

Press the [MENU] key to navigate through the following submenus:

- C5 Slave ID

Enter here the slave address for the HART communication. Values from 1 to 15 are allowed. Press [MENU] to skip this menu or press [SELECT] to start the edition mode. Press [SELECT] to move the cursor and then VALUE to change digits. After the changes are done, press ENTER to accept the changes.

- HART # Preambles

Press [MENU] to skip this menu or press "SELECT to change the values. Values available are from 5 to 20. Press ENTER to accept the value selected.

- HART Version

Press [MENU] to skip this menu or press [SELECT] to choose V5 or V6. After selecting, press ENTER to accept.

- HART Port Statistics

This screen shows information about the HART port. There are two screens. The first one shows the following information:

| | |
|---------|--|
| ERRORS: | (Number of errors) |
| WDOG: | (Number of times the Watchdog resets occurred) |

INV. PKT (Number of invalid packets)

After pressing [MENU] one more time, the second Statistics screen will show:

ERRORS: (Number of errors)
INV CMD: (Number of invalid commands)
SUCCESS: (Number of packets sent successfully)

Press MENU one last time to exit this submenu.

4.23 Configure Relay:

This Menu allows the user to configure both relays. The bottom line of this screen shows the relay number and his current status (Relay #1 (ON) for example). Press [MENU] to skip this menu or press [SELECT] to choose the relay to be configured (1 or 2). Then press [ENTER] to start the configuration of the chosen relay. On the following screen, the operation mode of the relay can be selected from the following options (Press [SELECT] to go through them):

- Manual
- Variable Status
- Variable = Set point
- Variable >= Set point
- Variable > Set point
- Variable < Set point
- Variable <=Set point
- Variable != Set point
- Toggle
- Diagnostics 1
- Diagnostics 2
- Other

4.23.1 Manual Option:

Press [SELECT] to turn the selected relay ON or OFF. It is not necessary to press [ENTER] to accept it. This option is useful to test the connection with the control room.

4.23.2 Variable Status:

The relay will activate any of the bits of the Variable status word is true. After selecting this option, the next screen will give a list of 128 variables that can be selected (see variable list at the end of this chapter). Press [MENU] to skip this menu or browse the list using the [SELECT] key. Press [ENTER] to accept the desired variable. The next screen will show a mask that allows the user to ignore some of the status bits. The default value is FFFF. The variable status word is 16 bits long. Only 4 of them are available to the user. The rest are reserved for future upgrades. The following is the detail description of the variable status word.

| Bit Number | Meaning | Bit Number | Meaning |
|------------|--|------------|----------|
| 1 | Reserved | 9 | Reserved |
| 2 | Reserved | 10 | Reserved |
| 3 | Reserved | 11 | Reserved |
| 4 | Reserved | 12 | Reserved |
| 5 | Hi Boundaries (Value greater than the limit) | 13 | Reserved |
| 6 | Lo Boundaries (Value below the limit) | 14 | Reserved |

| | | | |
|---|---|----|----------|
| 7 | Hi Alarm (Value greater than alarm setting) | 15 | Reserved |
| 8 | Lo Alarm (Value lower than alarm setting) | 16 | Reserved |

For Example, if the only condition that wants to be considered to activate the relay is “Hi Boundaries” of the selected variable, then the mask for this relay should be the binary number 0000100000000000 that is the hexadecimal 0800. If no mask is used, any of these conditions will trigger an alarm.

4.23.3 Variable Compared with Set Point

- Variable = Set point
- Variable >= Set point
- Variable > Set point
- Variable < Set point
- Variable <=Set point
- Variable != Set point

For all these options, the relay will activate if the condition is satisfied. After browsing and accepting the desired condition by pressing [ENTER], another screen that can be navigated using the [SELECT] key, will give the option of choosing one out of 128 variables (see variable list at the end of this chapter). After the desired variable is selected and accepted by pressing [ENTER], another screen will allow the user to set the units of the variable. This screen will show only units that are valid for the selected variable. Browse them by pressing [SELECT] and accept the desired one by pressing [ENTER]. The next screen will allow the user to set the value of the set point. Press [SELECT] to move the cursor and [VALUE] to change the digits. Then press [ENTER] to accept the changes.

4.23.4 Toggle:

Selecting this option will switch the relay ON and OFF every half a second. Once selected, just press [ENTER] to start this command.

4.23.5 Diagnostics1 and Diagnostics2:

These two menus will allow the user to set the correspondent relay to activate if any bit on the Diagnostic word assigned is set to 1. Any of the bits can be masked so they don't produce an error indication. The correspondent relay will deactivate if the error condition disappears.

The meaning of every bit on both diagnostics words are:

Diagnostic word 1

| Bit Number | Name |
|------------|------------------------|
| 1 | External Memory |
| 2 | Execution Fail |
| 3 | Timer Fail |
| 4 | Flash Memory |
| 5 | Flash Write Protection |
| 6 | Variable Boundaries |
| 7 | Variable Units |
| 8 | Internal Memory |
| 9 | Frequency Low |
| 10 | Frequency High |
| 11 | Temperature Low |

| | |
|----|------------------|
| 12 | Temperature High |
| 13 | Process Low |
| 14 | Process High |
| 15 | Reset |
| 16 | Reset Basics. |

Diagnostic word 2

| Bit Number | Name |
|------------|-------------------------------|
| 1 | Time Reset |
| 2 | Flow Computer 1 Failed |
| 3 | Reserved |
| 4 | Reserved |
| 5 | Sample Error |
| 6 | Flow Computer 1 Extrapolation |
| 7 | Reserved |
| 8 | Reserved |
| 9 | Flash Memory Log |
| 10 | Reserved |
| 11 | Reserved |
| 12 | Reserved |
| 13 | Reserved |
| 14 | Reserved |
| 15 | Reserved |
| 16 | Reserved |

After selecting the option Diagnostic1 or Diagnostic2 and pressing [ENTER], the display will show the corresponding mask. The masks are 16 bits words express in hexadecimal format. If the mask is equal to hexadecimal number FFFF, any bit on the diagnostic word will activate the relay. If some of the conditions in the diagnostic word need to be excluded as a condition to activate the relay, the correspondent bit on the mask must be set to zero. For example, if the conditions “External Memory”, “Execution Fail” and “Timer Fail” have to be excluded, then the mask should be equal to the binary number 0001111111111111 which is equal to the hexadecimal 1FFF.

4.23.6 Other:

This option is reserved to be used when the relay has to be activated by other special conditions in the software (Like external coil writing via MODBUS®)

4.24 Configure AI (Analog Inputs):

This menu allows the user to configure the analog input/s. If the system is an “Enhance” model, only one analog input is available. If the system is an “Expanded” model, then five analog inputs are available. Press [MENU] to skip this menu or press [SELECT] to choose the analog input to be configured (Expanded models), then press [ENTER] to start configuring the selected Analog Input.

Note: “x” means the Analog Input number.

4.24.1 AI #x Variable:

Press [MENU] to skip this submenu or press [SELECT] to browse the variables list to choose the variable to be assigned to this Analog Input. Then press [ENTER] to accept it. See the variable list at the end of this chapter.

4.24.2 AI #x Unit:

Press [MENU] to skip this submenu or press [SELECT] to browse the units list. Press [ENTER] to accept it. The units list shown, depends on the variable selected.

4.24.3 AI #x LRV:

This screen will show the current Analog Input “Lower Range Value” LRV. This value is the value that will be assigned to a current input of 4mA. Press [MENU] skip this submenu or [SELECT] to enter the edition mode. If the value needs to be changed, press [SELECT] to move the cursor and [VALUE] to change the digits. When finished, press [ENTER] to accept it.

4.24.4 AI #x URV:

This screen will show the current Analog Input “Upper Range Value” URV. This is the value that will be assigned to a current input of 20 mA. Press [MENU] to skip this submenu or [SELECT] to enter the edition mode. If the value needs to be changed, press [SELECT] to move the cursor and [VALUE] to change the digits. When finished, press [ENTER] to accept it.

4.24.5 AI #x Trim 4 mA:

This screen allows the user to trim the lower end of the Analog Input. Press [MENU] to skip the submenu. If the Analog Input needs to be trimmed, connect a current source at the Analog Input being trimmed and set the current source to 4mA. Then press [ENTER] to accept the new trimming value.

To reset factory defaults settings for the 4 mA trimming, press [SELECT]

4.24.6 AI #x Trim 20 mA:

This screen allows the user to trim the upper end of the Analog Input. Press [MENU] to skip this submenu. If the Analog Input needs to be trimmed, connect a current source at the Analog Input being trimmed and set the current source to 20mA. Then press [ENTER] to accept the new trimming value.

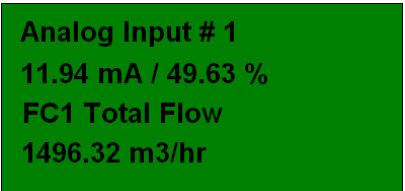
To reset factory defaults settings for the 20 mA trimming, press [SELECT]

4.24.7 AI #x Dampening (s):

This screen allows the user to set the dampening time in seconds. Press [MENU] to skip this submenu. Press [SELECT] to enter the edition mode. Use [SELECT] to move the cursor and [VALUE] to change the digits. Then press [ENTER] to accept the new value.

4.24.8 Analog Input #x:

This last screen shows the actual value of the Analog Input selected. Nothing can be changed on this screen.



Analog Input # 1
11.94 mA / 49.63 %
FC1 Total Flow
1496.32 m3/hr

4.25 Configure AO (Analog Outputs):

This menu allows the user to configure the analog output/s. If the system is an “Enhance” model, only one analog output is available. If the system is an “Expanded” model, then five analog outputs are available. Press [MENU] to skip this menu or press [SELECT] to choose the analog output to be configured

(Only one is available for Expanded models). Then press [ENTER] to start configuring the selected Analog Input.

Note: “x” means the Analog Output number.

4.25.1 AO #x Variable:

At this point the menu will show the variable list. (See variable list at the end of the chapter). Press [MENU] to skip this menu or press [SELECT] to browse the list of variables (See variable list at the end of the chapter). Then press [ENTER] to accept.

4.25.2 AO #x Unit:

This screen will show the Units list. Browse the list using the [SELECT] key or press [MENU] to leave the current one. If a new unit is selected, press [ENTER] to accept it. The list of units, depends on the variable.

4.25.3 AO #x LRV:

This screen will show the current Analog Output “Lower Range Value” LRV. Press [MENU] to accept the current value or [SELECT] to change it. If the value has to be changed, press [SELECT] to move the cursor and [VALUE] to change the digits. When finished, press [ENTER] to accept the changes.

4.25.4 AO #x URV:

This screen will show the current Analog Output “Upper Range Value” URV. Press [MENU] to accept the current value or [SELECT] to enter the edition mode. If the value needs to be changed, press [SELECT] to move the cursor and [VALUE] to change the digits. When finished, press [ENTER] to accept the changes.

4.25.5 AO #x Trim 4 mA:

This screen allows the user to trim the lower end of the Analog Output.

Press [MENU] to skip this submenu. Press [SELECT] to reset factory defaults for 4 mA trimming.

If the Analog Output needs to be trimmed, connect a current meter at the Analog Output being trimmed. Then press [ENTER] to trim. The next screen will allow the user to enter the real current value indicated by the current meter. Use the [SELECT] key to move the cursor. Press [VALUE] to change the digits and press [ENTER] when finished to accept the new value. The trimming of the 4mA is finished.

4.25.6 AO #x Trim 20 mA:

This screen allows the user to trim the upper end of the Analog Output.

Press [MENU] to skip this menu. Press [SELECT] to reset the factory default for the 20mA trimming.

If the Analog Output needs to be trimmed, connect a current meter at the Analog Output being trimmed. Then press [ENTER] to trim. The next screen will allow the user to enter the real current value indicated by the current meter. Use the [SELECT] key to move the cursor. Press [VALUE] to change the digits and press [ENTER] when finished to accept the new value. The trimming of the 20mA is finished.

4.25.7 AO #x Alarm Select:

This submenu allows the selection of the value of the Analog Output on an alarm condition. Two options are available.

High (20mA)

Low (4mA)

Use the [MENU] key to skip this submenu or use [SELECT] to choose the desired option. Then press [ENTER] to accept it.

4.25.8 AO #x Mode:

Three options are available:

Automatic: The analog output is controlled by the assigned variable.

Manual: The analog output is controlled manually from the menu. This option is useful to simulated the Analog Output/s during start up

Automatic/Reverse: The analog output is controlled by the assigned variable but reversed. The lower value of the variable will produce 20mA and the upper value of the variable will produce 4mA.

Use the [MENU] key to skip this submenu or use [SELECT] to choose the desired option. Then press [ENTER] to accept it.

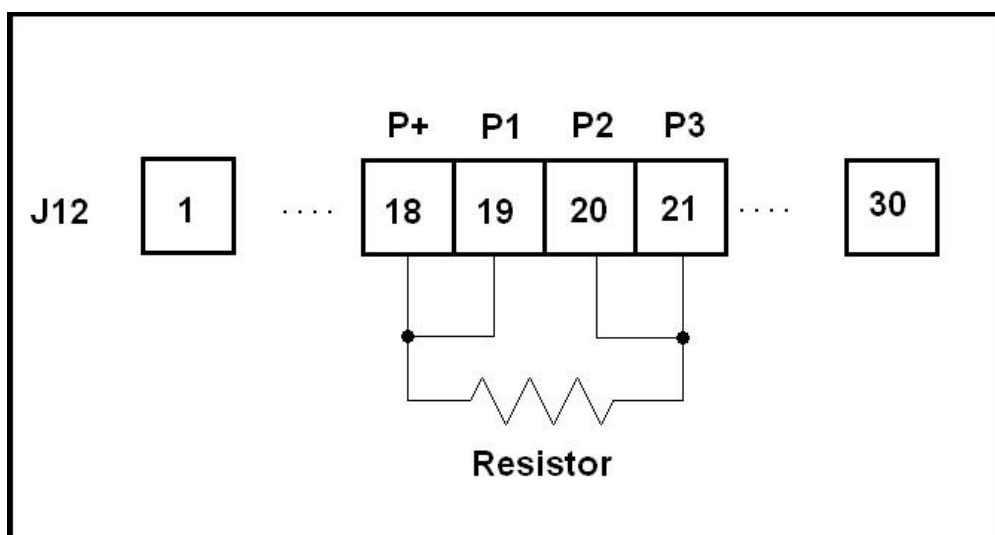
If the Manual option is selected, another extra screen will allow the user to manually change the value of the Analog Output being configured. Use [SELECT] to move the cursor, [VALUE] to change the digits and [ENTER] to accept it.

4.25.9 AO #x Dampening (s):

This screen allows the user to set the dampening time in seconds. Press [MENU] to skip this submenu or press [SELECT] to enter the edition mode. Use [SELECT] to move the cursor and [VALUE] to change the digits. Then press [ENTER] to accept the new value.

4.26 Trim RTD Lo (Software Version 6.09 and over)

The screen will instruct the operator to connect a 100 Ohms resistor. The resistor has to be connected between the terminals P1 and P2. Also, a short circuit has to be done between P+ and P1 and another between P2 and P3 (See Picture 4.2). Press [MENU] to skip or [ENTER] to trim (after the resistor has been connected). If [ENTER] is pressed, the system will ask the operator to press [SELECT] if he wants to proceed or [MENU] to abort and skip this menu.



Picture 4.2

4.27 Trim RTD Hi (Software Version 6.09 and Over)

The screen will instruct the operator to connect a 125 Ohms resistor. The resistor has to be connected between the terminals P1 and P2. Also, a short circuit has to be done between P+ and P1 and another between P2 and P3 (See Picture 1). Press [MENU] to skip or [ENTER] to trim (after the resistor has been connected). If [ENTER] is pressed, the system will ask the operator to press [SELECT] if he wants to proceed or [MENU] to abort and skip this menu

4.28 Density Correction:

This screen allows the user to configure the density correction options. See chapter 8 for more information on the Density Correction Routine. Press [MENU] to skip this menu or press [SELECT] to browse the options. There are 7 different options. They are:

| OPTIONS | MEANING |
|----------|-------------------------------|
| Disabled | Density correction not enable |

| | |
|---------------------------|---|
| Coriolis, PDI Temp | Micro Motion® Coriolis Flow Meter via RS485, Phase Dynamics temperature |
| Coriolis, ALT Temp | Micro Motion® Coriolis Flow Meter via RS485, Temperature via Analog Input 1 |
| Coriolis_API60F, COR Temp | Micro Motion® Coriolis Flow Meter via RS485 for density and temperature. |
| Coriolis_API60F, PDI Temp | Micro Motion® Coriolis Flow Meter via RS485, Phase Dynamics temperature |
| Coriolis_API60F, ALT Temp | Micro Motion® Coriolis Flow Meter via RS485, Temperature via Analog Input. |
| Other | Density via analog input. Phase Dynamics temperature |

After selecting the desired one, press [ENTER] to accept.

4.28.1 Coriolis Options:

If any of the Coriolis options is selected, the analyzer will use the selected communication port as a MODBUS® master to poll ONLY Micro Motion® Coriolis Meters. For all the Coriolis options the following screens will be shown:

4.28.1.1 Coriolis Port:

The default option is Com3 (Communication port number 3). This is the recommended port to be used for density compensation. The settings of the port for density correction are: 9600 8 N 1. Configure your Micro Motion® Coriolis Mass Flow Meter accordingly.

4.28.1.2 Cor1 Dampen Density (s):

This screen allows the user to set the dampening constant for density in seconds. The default value is zero. Press [MENU] to skip this submenu or press [SELECT] to enter the edition mode. Press [SELECT] to move the cursor, [VALUE] to change the digits and [ENTER] to accept the changes.

4.28.1.3 Cor1 Dampen Flow (s):

This screen allows the user to set the dampening constant for flow in seconds. The default value is zero. Press [MENU] to skip this submenu or press [SELECT] to enter the edition mode. Press [SELECT] to move the cursor, [VALUE] to change the digits and [ENTER] to accept the changes.

4.28.1.4 Cor1 VFR Cutoff:

This screen allows the user to set the volumetric flow rate cut off. The default value is zero. Press [MENU] to skip this submenu or press [SELECT] to enter the edition mode. Press [SELECT] to move the cursor, [VALUE] to change the digits and [ENTER] to accept the changes.

4.28.1.5 Coriolis Zero:

This menu allows the user to zero the Mass Flow Meter. Press [MENU] to skip this menu. Press Enter to zero the meter. The time needed to zero the meter depends on the Mass Flow Meter settings. Normally is about 40 seconds.

4.28.2 Other:

This option will use the FC1 (Flow Computer 1) density as the input for the density correction.

The following screens are available for either the “Coriolis” options or the “Other” option. The equation used for the density correction is:

$$\text{Corrected Water cut} = WC + \text{Adjust (Oil Phase)} + \text{Density correction}$$

$$\text{Density Correction} = (\text{Density} - \text{Calibration Density} + \text{FC1 Density adjust}) * DI$$

Where:

- WC is the uncorrected water cut
- Adjust (Oil Phase) is the calibration offset for the oil phase (See Adjust (Oil Phase) menu)
- Density is the density corrected to 60°F or to 15°C depending on the unit. If the density provided is not corrected (process conditions) the analyzer corrects it internally.
- Calibration density is a value dependent of the unit selected (see below)
- FC1 Density adjust is an offset that can be used to match the density reading with the densitometer if they have a small difference.
- D1 is the Slope (See below)
- D0 is the offset (See below)

Density correction for API at 60°F = $(\text{Density} - 32) * 0.16 + 0$

Density correction for Kg/m³ at 15°C = $(\text{Density} - 0) * (-0.0286) + 24.6$ (This equation is only valid for a density range of 750 kg/m³ to 998 kg/m³)

4.28.3 Density Correction Unit:

This menu allows the user to select one of the two options for the density correction units. API at 60°F or Kg/m³ at 15°C. Use [SELECT] to choose one of them and then [ENTER] to accept it or use [MENU] to skip this menu.

4.28.4 Calibration Density:

The default value depends on the units selected on the previous menu. For API at 60°F, the default value is 32. For Kg/m³ at 15°C, the default value is 0.00. Press [MENU] to skip this menu. Press [SELECT] to enter the edition mode. Then press [SELECT] to move the cursor and [VALUE] to change the digits. When done, press [ENTER] to accept the changes.

4.28.5 Density Coeff. D3:

The default value is zero for both API @ 60°F or KG/m³ at 15°C. Press [MENU] to skip this menu. Press [SELECT] to enter the edition mode. Then press [SELECT] to move the cursor and [VALUE] to change the digits. When done, press [ENTER] to accept the changes.

4.28.6 Density Coeff. D2:

The default value is zero for both API @ 60°F or KG/m³ at 15°C. Press [MENU] to skip this menu. Press [SELECT] to enter the edition mode. Then press [SELECT] to move the cursor and [VALUE] to change the digits. When done, press [ENTER] to accept the changes.

4.28.7 Density Slope D1:

The default value depends on the units selected on the previous menu. For API at 60°F, the default value is 0.16. For Kg/m³ at 15°C, the default value is -0.00286. Press [MENU] to skip this menu. Press [SELECT] to enter the edition mode. Then press [SELECT] to move the cursor and [VALUE] to change the digits. When done, press [ENTER] to accept the changes.

4.28.8 Density Adj Offset D0:

The default value depends on the units selected on the previous menu. For API at 60°F, the default value is 0.00. For Kg/m³ at 15°C, the default value is 24.6. Press [MENU] to skip this menu. Press [SELECT] to enter the edition mode. Then press [SELECT] to move the cursor and [VALUE] to change the digits. When done, press [ENTER] to accept the changes

4.28.9 FC1 Density Adjust:

The default value is 0.00 for both units. Press [MENU] to skip this menu. Press [SELECT] to enter the edition mode. Then press [SELECT] to move the cursor and [VALUE] to change the digits. When done, press [ENTER] to accept the changes.

4.29 Configure Flow Computer:

The Flow Computer can calculate Net Flow Rates, Net Totals, Gross Flow Rates and Gross Totals.

The Gross totals and flow rates are at process conditions. The Flow Rate input (if supplied) is affected by the actual water cut to calculate the Oil flow rate, Water flow rate, Oil total and water total.

The Net values are corrected to standard conditions. The total flow rate is affected by the actual water cut. Then the oil volume is corrected using the API tables to standard conditions. The Shrink factor and Meter Factors are also used in this correction. The Shrink Factor takes care of the flashed light hydrocarbons that will not be present on “Tank storage conditions”. This factor can be ignored by keeping it equal to 1.0000. The Meter Factor is a correction that takes in account all the pressure and temperature correction of the flow meter. This Meter Factor can be ignored by keeping it equal to 1.0000

The calculation of the Net Oil Production is:

$$\text{Oil Production} = \text{Indicated Volume} \times \text{MF} \times \text{Shrink} \times \text{WC} \times \text{TCF}$$

Where:

- Indicated Volume: Volume integrated by the Flow Computer
- MF: Meter Factor
- SHRINK: Is the factor that correct the volume reduction produced by evaporation of the light hydrocarbons when the production is stored in tanks.
- TCF: Temperature Correction Factor calculated using the API tables

While on the “Configure Flow Computer” screen, press [MENU] to skip this menu or press [ENTER] to start the configuration of the Flow Computer.

Note: “x” means the selected Flow Computer Number.

4.29.1 FC1 Enable:

There are two options: ON and OFF. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it.

4.29.2 FC1 Flow Enable:

There are two options: ON and OFF. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it.

4.29.3 FC1 Gross Enable:

This submenu enables the calculation of Gross Flow Rate and Gross Totals (readings at process conditions). There are two options: ON and OFF. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it.

4.29.4 FC1 Pulse Enable:

This enables the “Pulse Input”. There are two options: ON and OFF. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it. If this option is enabled, there will be another screen to configure the pulse input.

4.29.5 FC1 Density Enable:

There are two options: ON and OFF. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it.

4.29.6 FC1 Net Enable:

This submenu enables the “Net Calculations” (Values corrected to standard conditions). There are two options: ON and OFF. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it.

4.29.7 FC1 Flow Class:

There are two options here: “Volumetric Flow” or “Mass Flow”. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it.

4.29.8 FC1 Flow Unit:

This submenu allows the user to select the Flow Rate units. The units depend on the class selected on the previous submenu. Press [MENU] to skip this submenu. Press [SELECT] to browse the units. When selected, press [ENTER] to accept it.

4.29.9 FC1 Accumulator Unit:

This Submenu allows the user to select the units for the totalizers. The unit list depends on the Flow Class selected above. Press [MENU] to skip this submenu. Press [SELECT] to browse the units. When selected, press [ENTER] to accept it.

4.29.10 FC1 # Pulses/volumetric or mass total unit:

This submenu only appears if the submenu FC1 Pulse Enable was set to ON. This submenu allows the user to enter the number of pulses per volumetric or mass total units.

4.29.11 FC1 Temperature Unit:

This submenu allows the user to select the temperature units. Press [MENU] to skip this submenu. Press [SELECT] to browse the units. When selected, press [ENTER] to accept it. Possible units are °C, °F, °K and °R

4.29.12 FC1 Density Units:

This submenu allows the user to select the density units. Press [MENU] to skip this submenu. Press [SELECT] to browse the units. When selected, press [ENTER] to accept it.

4.29.13 FC1 Pressure Units:

This submenu allows the user to select the pressure units. Press [MENU] to skip this submenu. Press [SELECT] to browse the units. When selected, press [ENTER] to accept it.

4.29.14 FC1 Manual Density:

If a density signal is not available, the density can be entered manually. There are two options: NO and YES. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it.

4.29.15 FC1 Manual Pressure:

If a pressure signal is not available, it can be entered manually. There are two options: NO and YES. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it.

4.29.16 FC1 Manual Flow:

If a flow signal is not available the flow can be entered manually. There are two options: NO and YES. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it.

4.29.17 FC1 Use PDI WC:

A manual Water Cut value could be used instead of the Phase Dynamics reading. There are two options: YES and NO. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it.

4.29.18 FC1 Use PDI Temperature:

A different temperature reading could be used instead of the Phase Dynamics reading. For example, a temperature signal could be supplied through an analog input. There are two options: YES and NO. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it.

4.29.19 FC1 Use PDI Salinity:

A different salinity reading could be used instead of the Phase Dynamics value. For example, a salinity signal could be supplied through an analog input. There are two options: YES and NO. Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it.

4.29.20 FC1 API Table:

This submenu allows the user to select the API table used to perform the corrections. There are four options:

- A: General Crude
- B: General Products
- C: Special
- D: General Lubricants

Press [MENU] to skip this submenu. Press [SELECT] to change. After changing, press [ENTER] to accept it. (For more information about the API correction tables, consult the “Manual of Petroleum Measurement Standards” Chapter 20 – Allocation Measurement. API)

4.29.21 M.F.:

This Submenu allows the user to change the Meter Factor (M.F.). The default value is 1.0000. Press [MENU] to skip this menu. Press [SELECT] to start the edition mode. Press [SELECT] to move the cursor. Press [VALUE] to change the value of the digits. Press [ENTER] to accept the new values when finished. (For more information about the Meter Factor, consult the “Manual of Petroleum Measurement Standards” Chapter 11.1 – Volume Correction Factors. API)

4.29.22 SHRINK:

This Submenu allows the user to change the SHRINK factor. The default value is 1.0000. Press [MENU] to skip this menu. Press [SELECT] to start the edition mode. Press [SELECT] to move the cursor. Press [VALUE] to change the value of the digits. Press [ENTER] to accept the new values when finished. (For more information about the SHRINK factor, consult the “Manual of Petroleum Measurement Standards” Chapter 20 – Allocation Measurement. API)

4.29.23 FC1 Oil Dens@ST (API):

This submenu allows the user to enter the oil density at standard conditions in API. Press [MENU] to skip this menu. Press [SELECT] to start the edition mode. Press [SELECT] to move the cursor. Press [VALUE] to change the value of the digits. Press [ENTER] to accept the new value when finished.

4.29.24 FC1 Water Dens@ST (Kg/m3):

This submenu allows the user to enter the water density at standard conditions in Kg/m3. Press [MENU] to skip this menu. Press [SELECT] to start the edition mode. Press [SELECT] to move the cursor. Press [VALUE] to change the value of the digits. Press [ENTER] to accept the new value when finished.

4.29.25 FC1 Oil Dens@PT (API):

This submenu allows the user to enter the Oil density at process conditions in API. Press [MENU] to skip this menu. Press [SELECT] to start the edition mode. Press [SELECT] to move the cursor. Press [VALUE] to change the value of the digits. Press [ENTER] to accept the new value when finished.

4.29.26 FC1 Water Dens@PT (Kg/m3):

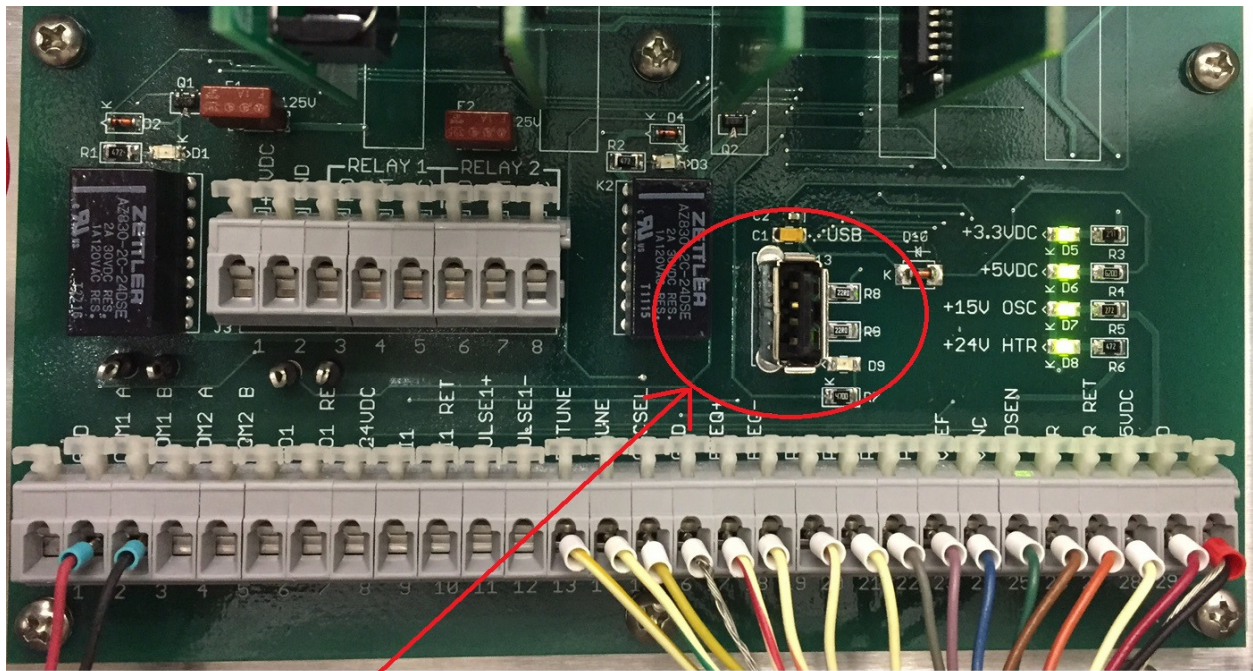
This submenu allows the user to enter the Water density at process conditions in Kg/m3. Press [MENU] to skip this menu. Press [SELECT] to start the edition mode. Press [SELECT] to move the cursor. Press [VALUE] to change the value of the digits. Press [ENTER] to accept the new value when finished.

4.29.27 FC1 Density Adjust:

This submenu allows the user to enter an offset for the density in case the display value doesn't match the densitometer to compensate for analog inputs/outputs errors. Press [MENU] to skip this menu. Press [SELECT] to start the edition mode. Press [SELECT] to move the cursor. Press [VALUE] to change the value of the digits. Press [ENTER] to accept the new value when finished.

4.30 USB Logging (Optional)

This Menu allows the user to enable the data logging feature. This electronic has a USB port that can be used for data logging. The connector is on the Mother Board and it is identified as J13.



USB CONNECTOR

Before inserting a flash memory, make sure this screen shows the message “USB Logging: OFF”. Insert the memory on J13 and then Press [SELECT] to change the status to “ON”. After that the screen will show two messages: “MEDIA DETECTED: NO/YES”, and “MEDIA MOUNTED: NO/YES”. After the media is ready to start logging both messages will show “YES”.

To stop the data logging, press [SELECT] or [VALUE] to select “NO” and press [ENTER]. Then you will need to press [ENTER] again to confirm. DO NOT remove the media without stopping the data logger first or the file can be damaged.

ATTENTION:

DO NOT remove the media without stopping the data logger first or the file can be damaged

After turning data logging on and pressing [MENU] the next screen will allow the user to change the data logging period. Press [SELECT] to start the edition mode. Press [SELECT] to move the cursor. Press [VALUE] to change the value of the digits. Press [ENTER] to accept the new value when finished.

When the data logger is enabled, a new comma separated values file is created every day at midnight. The name of the file is:
LOG_Month-Day-Year.CSV
For example: LOG_05-16-2017.CSV

The first row on the file is the list of variables. The data is not scaled.

4.31 Restart:

This menu restarts the CPU. Press [MENU] to skip this menu. Press [ENTER] to restart.

4.32 Restore Factory Defaults:

This menu allows the user to restore to factory default configuration. Press [SELECT] to select YES and the Enter to proceed.

5 Touch Screen Menu Description

The touch screen can be used in 2 ways. Touching the screen itself when the screen is exposed or through the four push buttons [MENU], [SELECT], [VALUE] and [ENTER]. The screens that are available are the same when navigating by touch or by the push buttons.

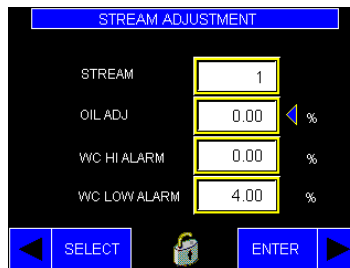
5.1 General operation of the screens

The screens are very easy to navigate just by touching the screen (When the screen is mounted on a non-dangerous area or a hot permit has been obtained to remove the glass cover of the explosion proof enclosure). Also, the operator can navigate and operate the analyzer by using the four push buttons [MENU], [SELECT], [VALUE] and [ENTER].

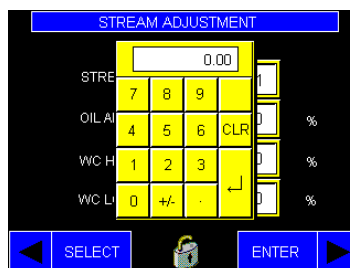
There are 3 general operations:

5.1.1 Editing Values on a text box

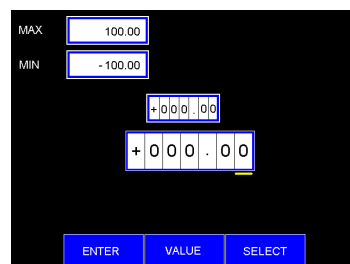
In the next screen the value of Oil Adj has to be changed. Touch the Text Box or press [SELECT] twice until the pointer points the Oil Adj text box and then press [ENTER]



If touched, a key pad will show over the base screen. Just key the number in and press the Enter key on the key pad.



If instead the [ENTER] button is used, the following screen will show up:

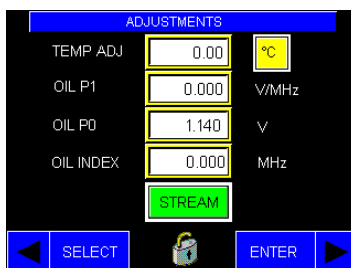


Once on this screen, press [SELECT] to move the cursor, press [VALUE] to increase the value of the selected digit. Press [ENTER] when done to accept the change or press [MENU] to exit without changes.

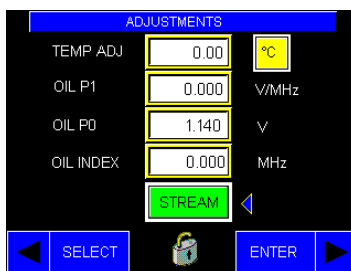
5.1.2 Activating Buttons

If the touch-screen is accessible, just touch the button to activate it. If not, press [SELECT] until the blue index point to the button that needs to be activated and then press [ENTER]

For example, to enter in the Stream Configuration Screen, the Green “STREAM” button has to be pressed.



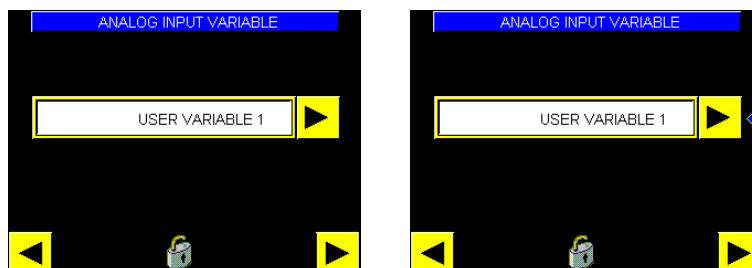
If the touch-screen is accessible, just touch it. If not, press [SELECT] repeatedly until the blue index points to the “STREAM” Button.



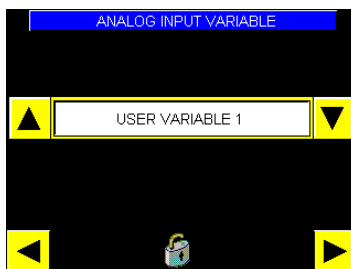
Press [ENTER] to access the Stream Configuration Screen

5.2 Operating List Boxes

List Boxes show different preselected values for some variables. The operation of all the list boxes is identical. For example, to select the variable for the Analog Input 1 the analyzer will display a screen like this one:



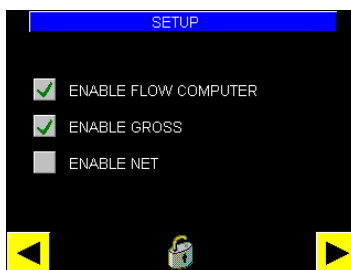
To change this variable for another available in the list, Touch the list box (if the touch-screen is accessible) or press [SELECT] repeatedly until the blue index points to the list box and then press [ENTER] to display the options. For this example, the list will be like this:



Pressing [VALUE] or touching the arrow pointing up will browse the list in ascending order. Pressing [SELECT] or touching the arrow pointing down will browse the list in reverse order. The list shown depends on the List Box being operated.

5.2.1 Toggling check mark statuses

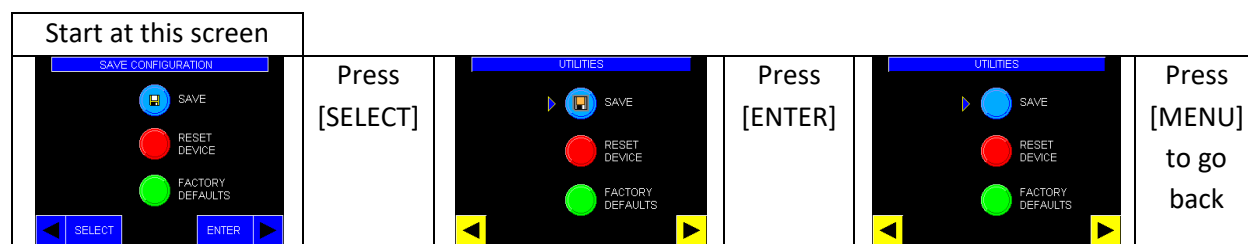
All the check marks operate in the same way. Touch them to toggle the status of the check mark if the touch-screen is accessible or press [SELECT] repeatedly until the blue index point at it and then press [ENTER] to toggle the status. Examples of Check Marks are the Enable Flow Computer, Enable Gross and the Enable Net check marks.



5.2.2 Saving Configurations

Every time a parameter is changed by the operator or by MODBUS®, a little floppy disk icon will show up in some of the screens. That is a reminder that there are configurations that need to be saved. If the analyzer loses power, all this non saved configurations will be lost. After the configurations is saved, the little floppy icon will disappear (this normally takes a couple of seconds)

To save the configurations just follow the next list of operations:

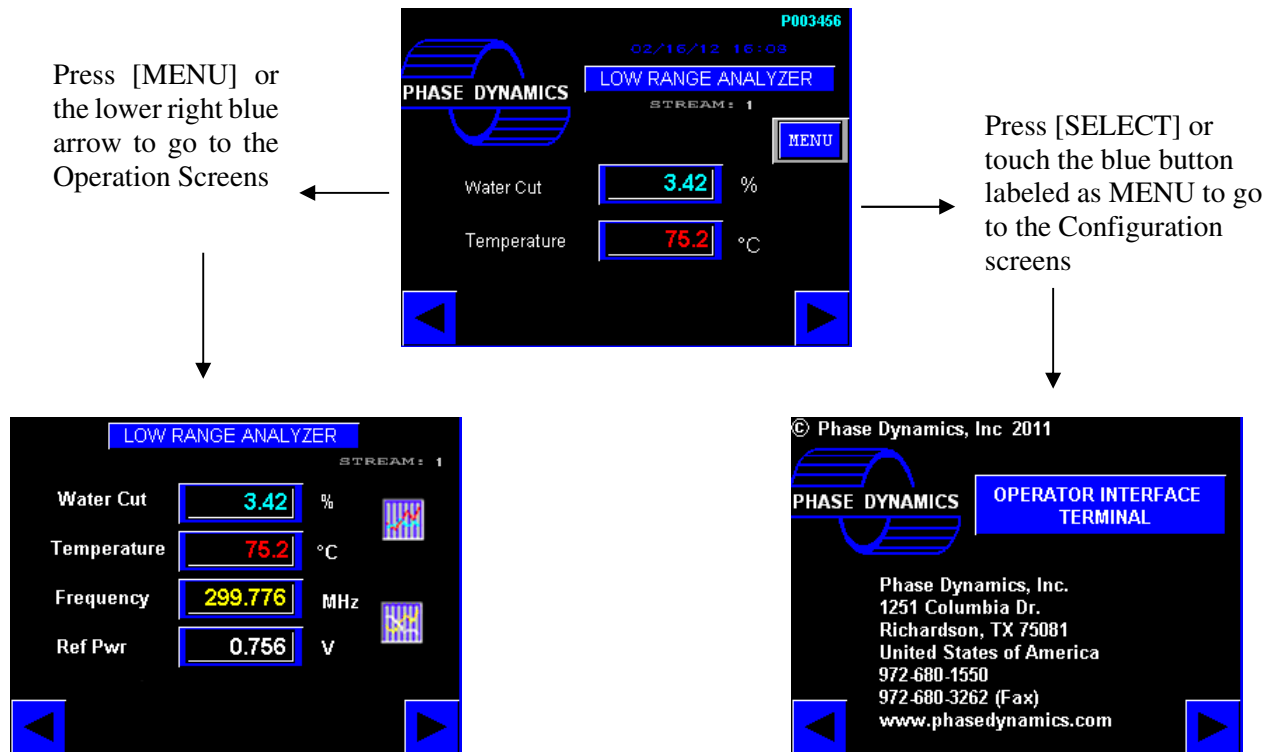


5.3 Screen types

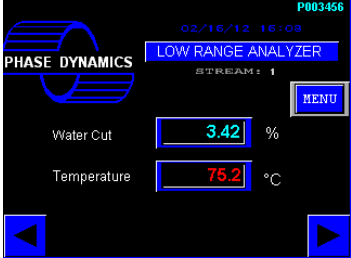
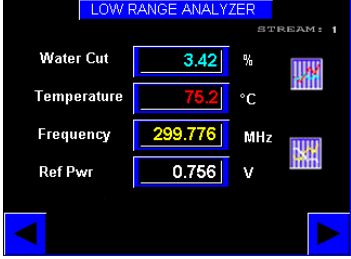
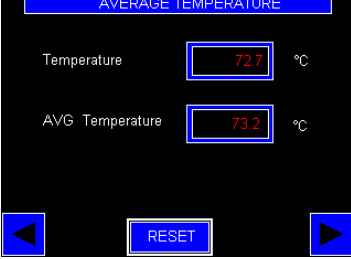
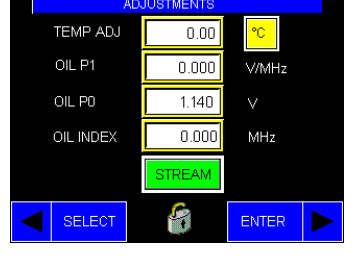
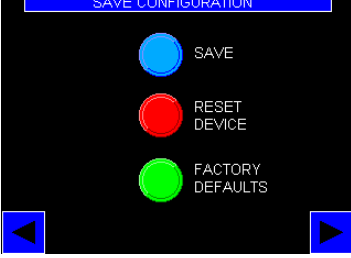
There are two sets of screens. One set is to configure and operate the analyzer itself and it is accessed by pressing [MENU]. The second set of screens is used to configure peripherals and other

important features such as Density Correction, Data logging, Flow computer, etc. and it is accessed by pressing [SELECT]

The following diagram shows how to access one set or the other:



5.4 Operation Screens

| | |
|--|---|
| <p>Start on this Screen</p> | |
|  <p>The screen displays 'PHASE DYNAMICS' and 'LOW RANGE ANALYZER'. It shows 'Water Cut' at 3.42% and 'Temperature' at 75.2°C. A 'MENU' button is in the top right. Navigation arrows are at the bottom.</p> | <p>See section 7.1.3.1</p> <p>Press MENU or Touch the Blue Arrow at the bottom Right corner to continue</p> <p>↓</p> |
|  <p>The screen displays 'LOW RANGE ANALYZER'. It shows 'Water Cut' at 3.42%, 'Temperature' at 75.2°C, 'Frequency' at 299.776 MHz, and 'Ref Pwr' at 0.756 V. Small waveform graphs are next to Frequency and Ref Pwr. Navigation arrows are at the bottom.</p> | <p>See section 7.1.3.2</p> <p>Press MENU or Touch the Blue Arrow at the bottom Right corner to continue.</p> <p>↓</p> |
|  <p>The screen displays 'AVERAGE TEMPERATURE'. It shows 'Temperature' at 72.7°C and 'AVG Temperature' at 73.2°C. A 'RESET' button is at the bottom center. Navigation arrows are at the bottom.</p> | <p>See section 7.1.3.3</p> <p>Press MENU or Touch the Blue Arrow at the bottom Right corner to continue</p> <p>↓</p> |
|  <p>The screen displays 'ADJUSTMENTS'. It shows 'TEMP ADJ' at 0.00°C, 'OIL P1' at 0.000 V/MHz, 'OIL P0' at 1.140 V, and 'OIL INDEX' at 0.000 MHz. A 'STREAM' button is in the center. Navigation arrows are at the bottom.</p> | <p>See section 7.1.3.4</p> <p>Press MENU or Touch the Blue Arrow at the bottom Right corner to continue</p> <p>↓</p> |
|  <p>The screen displays 'SAVE CONFIGURATION'. It has three large colored buttons: a blue 'SAVE' button, a red 'RESET DEVICE' button, and a green 'FACTORY DEFAULTS' button. Navigation arrows are at the bottom.</p> | <p>See section 7.1.3.5</p> <p>Press [MENU] or Touch the Blue Arrow at the bottom Right corner to go back to the Main Screen</p> |

5.4.1 Main Screen

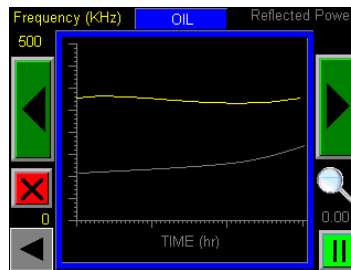
It shows the current Water Cut and Temperature

5.4.2 Detailed Screen

It shows the current Water Cut, Frequency, Reflected power and Temperature. The Upper graph icon shows the trend for Water Cut and Temperature. The one in the bottom will show if pressed the trend for frequency and Reflected Power.

- Trend Graphs

There are two Trend Graphs in Low Range Analyzers. Touch the graph Icon located to the right of the Water Cut indication to see the Water Cut and Temperature Trend. Touch the graph icon at the right of the frequency box to see the trend of Frequency and Reflected Power. If the touch-screen is not accessible, press [SELECT] once to see the Water Cut and Temp trend in hours, press [SELECT] again to see the Water Cut and Temperature Trends in Minutes. Press [SELECT] again to see the Frequency and Reflected Power trend in Hours and press [SELECT] one more time to see the Frequency and Reflected Power trends in minutes.



The following functions are only available by touching the screens and can't be done by using the push buttons. The “X” button erases the logged data and resets the screen. The magnifier button changes the time scale from hours to seconds. The button with two bars pauses the trend. The two big buttons with arrows pointing to the left and right move the trend forward or backwards (when there is more than one screen of data collected). The small arrow on the lower left corner exits the trend screen and goes back to the previous screen.

5.4.3 Average Temperature Screen

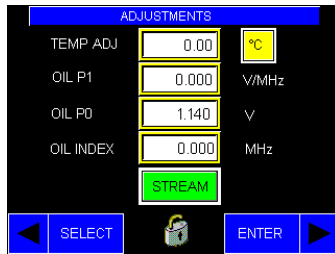
This screen shows the current temperature and the average temperature since the last time the RESET button was pressed.

5.4.4 Adjustments Screen

This screen allows the user to change configuration parameter like: Temperature Adjust, Oil P1, Oil P0 and Oil Index. All the values in the text boxes can be edited.

C/°F Button: Allows the user to change the temperature units.

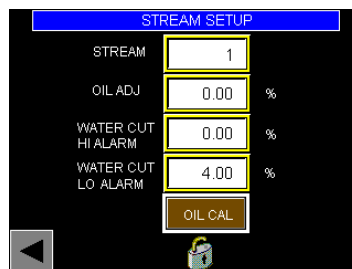
Stream Button: It accesses the Stream Configuration Screen.



5.4.5 Stream Configuration Screen

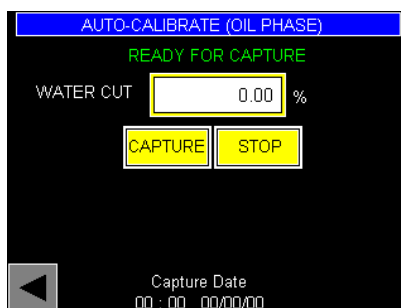
The analyzer has 60 memories called “Streams”. All the parameters in this screen are stream dependent. This means that different parameters can be stored for different streams (Wells, production pipelines, production areas, etc.).

The “OIL CAL” Button access a very important screen that performs an automatic calculation of the Adj. Oil parameter. (See section [4.4](#) for more information about the Oil Cal procedure).

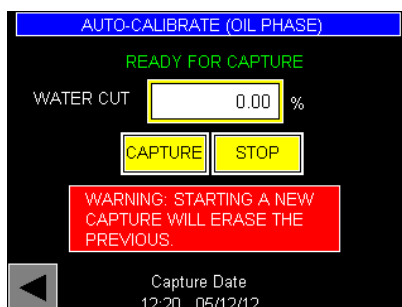


- Oil Cal

Select the Stream number (memory) where you want to perform and store the Automatic Calibration in the “Stream Adjustments” screen. Then activate the OIL CAL button to show the Auto Adjust (Oil Phase) screen. Ask a helper to take a sample and at the same time activate the button “CAPTURE”. The button will become red and the message “Ready for Capture” will change to “Capturing”. When the helper finished extracting a sample, activate the “STOP” button. The button will become red for a couple of seconds and then will go back to yellow. The Capture Date and time at the bottom will now be replaced for the time and date the capture was taken.



After the capture has been finished, the screen will look like this:

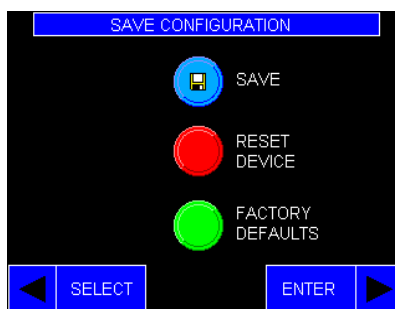


Now the capture date is showing the date and time the sample was taken. At this point the analyzer can be brought back to the main screen for regular operation. Remember to save configurations so this captured data is not lost (Section 7.1.3.5). After the sample has been taken to the laboratory for analysis, and the result has been obtained, go back to the Stream Adjustments screen (section 7.2.1.3.1). **MAKE SURE** you select the stream where the sample corresponding to the laboratory result was stored. Activate the OIL CAL button. Now you can enter the result from the lab in the WATER CUT text box. The analyzer will automatically calculate the “Adjust Oil” that was necessary to match the analyzer reading with the sample result the day it was taken. This new value of OIL ADJUST will be stored in the current Stream (memory).

5.4.6 Save Configurations

This screen has three buttons. One is used to save configurations. The second one is to reset the device and the third one is to reset all the configurations to Factory Defaults. Every time a parameter is changed by the operator or by MODBUS®, a little floppy disk icon will show up in some of the screens. That is a reminder that there are configurations that need to be saved. If the analyzer loses power, all this non saved configurations will be lost. After the configurations is saved, the little floppy icon will disappear (this normally takes a couple of seconds). This configuration is stored as “User Configuration”.

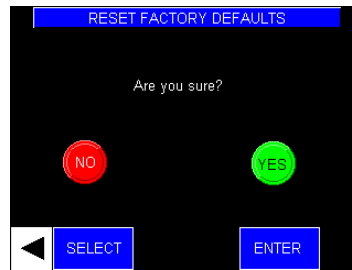
To save the configuration activate the Blue Button that has a floppy icon in it. After a few seconds the floppy will disappear.



To reset the microprocessor, activate the RESET DEVICE red button. If some changes have been done in the configuration that have not been save, the microprocessor will reboot with the current User Configuration parameters that were last saved.

If the Factory Configuration needs to be recovered, just activate the FACTORY DEFAULTS green button. Warning: The User Configuration will be lost. After activating the button, another screen will

display asking for confirmation. Activate the Green YES button if you want to proceed or the Red NO button if you want to keep the current configuration.



5.5 Configuration screens

| | |
|-----------------------------|---|
| <p>Start on this Screen</p> | |
| | <p>Touch the blue [MENU] button or press [SELECT]</p> <p style="text-align: center;">↓</p> |
| | <p>Factory contact information</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p style="text-align: center;">↓</p> |
| | <p>To change the language just Activate the corresponding button.</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p style="text-align: center;">↓</p> |

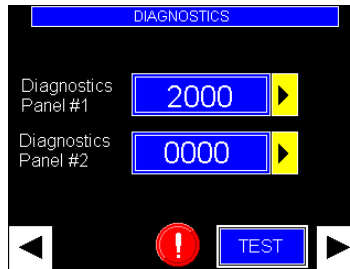
| | |
|--|---|
| | <p>Analyzer and factory Information. None of these fields are editable.</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p style="text-align: center;">↓</p> |
| | <p>See section 7.1.4.1</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p style="text-align: center;">↓</p> |
| | <p>See section 7.1.4.2</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p style="text-align: center;">↓</p> |
| | <p>See section 7.1.4.3</p> <p>Press the lower Right Corner Arrow or press [MENU] to go back to the Main Screen</p> |

5.5.1 Utilities

This screen allows the access to the Diagnostics Screen, Data logging Screen, Security Screen, Alarm Log and the Time and Date screen. Just activate the icon of the screen that needs to be accessed.

5.5.1.1 Diagnostics

Activating the Diagnostic Icon on will display the following screen:

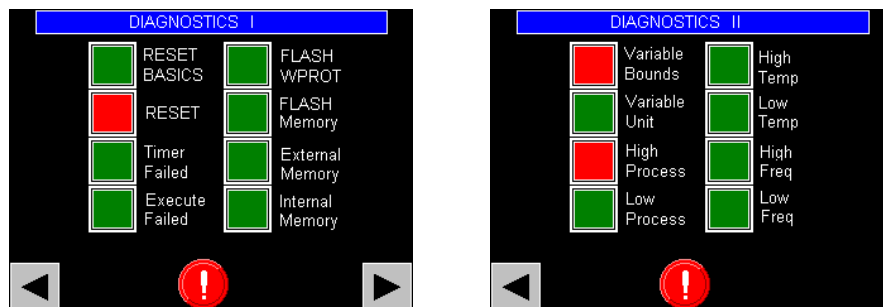


This screen shows two error codes. These codes correspond to two 16 bits diagnostic words. Each bit represents a different error. The codes on this screen are in Hexadecimal format.

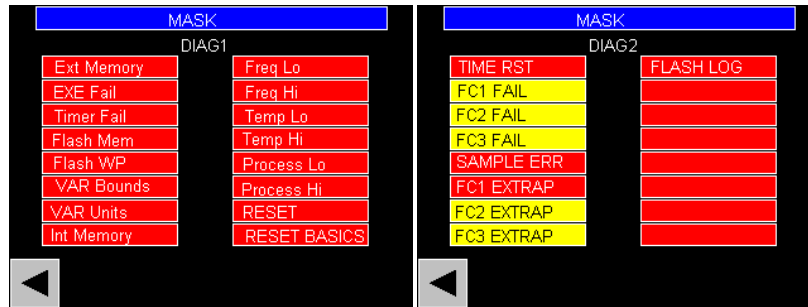
Touching the “TEST” button will trigger a Self-Test of the electronics.

The circle in the bottom center of the screen is an acknowledge button. When there are no errors, its color is green. When there are or there were errors, it is red and it has an exclamation mark on it. Pressing it will acknowledge all the errors and it will become green again. At the same time the error codes will be reset to zero. If the error/s is still present, then the button will become red again and the error code will change showing only the present errors.

Activating the grey arrow on the bottom right corner will display the two detailed diagnostic screens. Pressing the grey arrow will navigate from one to the other. The errors that are still not acknowledged have a red button. All the others are green. Touch the individual red buttons to acknowledge that particular error. If the error is no longer present, the button will become green. Pressing the red circle in the bottom will acknowledge all the errors at the same time.



Touching the yellow arrow at the right of the two hexadecimal diagnostic words will show the 2 masking screens. In these screens each individual error can be masked. For example, each time the calculated water cut is below zero, the errors Variable Bounds and Low Process will be activated. They will stay even when the water cut goes back to normal until they are acknowledged by the user. These two errors can be masked so they don't are no longer displayed by the analyzer. To mask them, just access the mask screen and touch the corresponding error. The labels of the masked errors are yellow. The unmasked ones are red. The following are the 2 masking screens:



5.5.1.2 Alarm Log

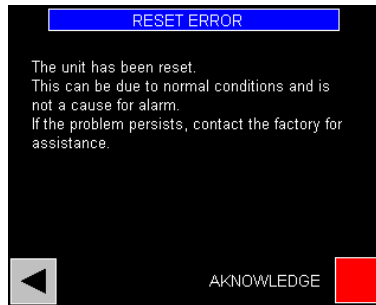
The alarms are logged so the user can review them. To access them just activate the “Alarm Log” icon on the Utilities Screen. A screen like this will be displayed:

| Date/Time | Message | Recovery |
|-------------|------------|-------------|
| 08/09 15:28 | Process Hi | |
| 08/09 15:28 | VAR Bounds | |
| 08/09 10:53 | Process Hi | 08/03 19:28 |
| 08/09 10:53 | VAR Bounds | 08/03 19:28 |
| 07/02 07:25 | RESET | 07/02 09:12 |

This screen shows a list of alarms, the time they happened and the time they recovered. To select a particular item in the list, touch “SEL”. The first item will be highlighted:

| Date/Time | Message | Recovery |
|-------------|------------|-------------|
| 08/09 15:28 | Process Hi | |
| 08/09 15:28 | VAR Bounds | |
| 08/09 10:53 | Process Hi | 08/03 19:28 |
| 08/09 10:53 | VAR Bounds | 08/03 19:28 |
| 07/02 07:25 | RESET | 07/02 09:12 |

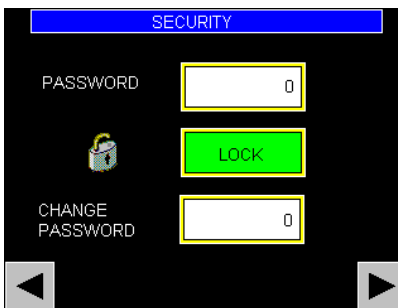
Touch the vertical arrows to move up or down in order to select the item that needs to be deleted, acknowledge or see in more detail. After the item has been selected, touch the DEL button to remove it from the list. Press ALL to delete all the alarms at the same time. Touch the magnifier to see the details for the highlighted alarm. For example, selecting the RESET alarm and touching the magnifier will show the following screen:



The alarm can be acknowledged in this screen by touching the ACKNOWLEDGE button.

5.5.1.3 Security

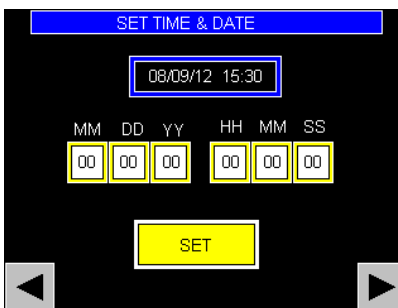
Touch the “SECURITY” icon to access this screen:



Touch the “LOCK” button to lock the screen. The button will become red. To unlock the screen, press the code 1234 (for release 6.09 or older) or 1357 (for release 6.10 and newer). The default factory password can be changed when the screen is unlocked by typing a new password on the “CHANGE PASSWORD” text box.

5.5.1.4 Time and date

Touch the “TIME & DATE” icon to see or change the current time and date.



Touch the text boxes in sequence to enter the new time and date. A little keypad will allow the user to enter the new values. After all the numbers have been entered, press “SET”.

5.5.1.5 Touch-Screen Data Logging

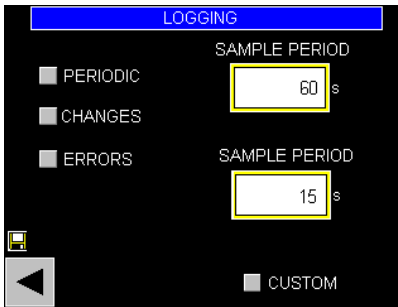
The touch screen can log data. There are 4 different log files that can be created.

Periodic: is a fix list of 30 variables. They are fixed integer values.

Changes: Every time a configuration is changed, it will be saved in this log

Errors: It is a Log of all the errors and alarms

Custom: This is a log of 30 variables that can be selected for special conditions. Contact factory if something else than the Periodic list of variables is needed.



The logged values are scaled. For example, if PERIODICS is checked, a file called “Log20.csv” will be created on the compact flash memory card inserted in the touch screen. The file is a comma separated values. Each column has a label and each row a time stamp. The values are scaled using the maximum and minimum ranges to get a maximum integer value of 30000 (The touch screen only log integers). The parameters that are logged are:

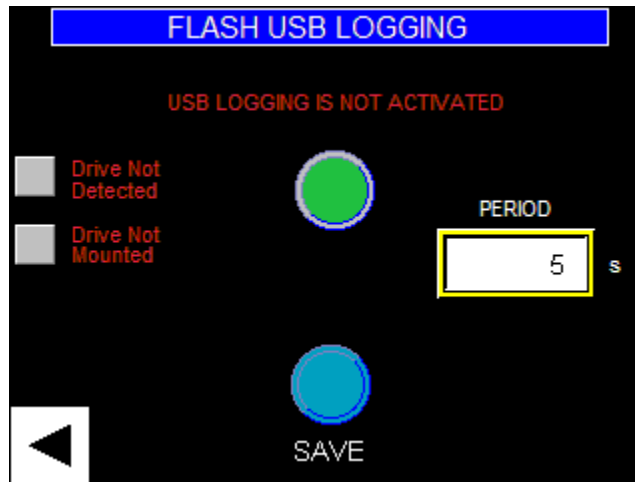
| | |
|-----------------------------|---|
| FreqO (Oil Frequency) | Re-scaled frequency (MHz) = value * 1000/30000 = Value /30 As an example, if the value in the FreqO is 6601, the real Oil frequency is 6600 / 30 = 220.000 MHz |
| IPO (Incident Power Oil) | Re-scaled Incident Power Oil (V) = value * 5/30000 = Value /6000 |
| RPO (Reflected Power Oil) | Re-scaled Reflected Power Oil (V) = value * 5/30000 = Value /6000 |
| FreqW (Water Frequency) | Non applicable to this model |
| IPW (Incident Power Water) | Non applicable to this model |
| RPW (Reflected Power Water) | Non applicable to this model |
| Process (Water Cut) | Re-scaled Process = value *100/30000 |
| Temperature | Re-scaled temperature (in the selected units) (Maximum Temp – Min temp)/30000 – Min Temp The defaults values for Max and Min temperature are 1000°C and -273.15 °C. In this case to re-scale use Temperature = 1273.15/30000 – 273.15 |
| Level Set point | Non applicable to this model |
| Level | Non applicable to this model |
| Pressure Set point | Non applicable to this model |
| Pressure | Non applicable to this model |
| Gas Valve | Non applicable to this model |
| Liquid Valve | Non applicable to this model |
| Flow | Non applicable to this model |
| Oil Flow | Non applicable to this model |
| Gas Flow | Non applicable to this model |

5.5.1.6 USB Data Logging (Optional)

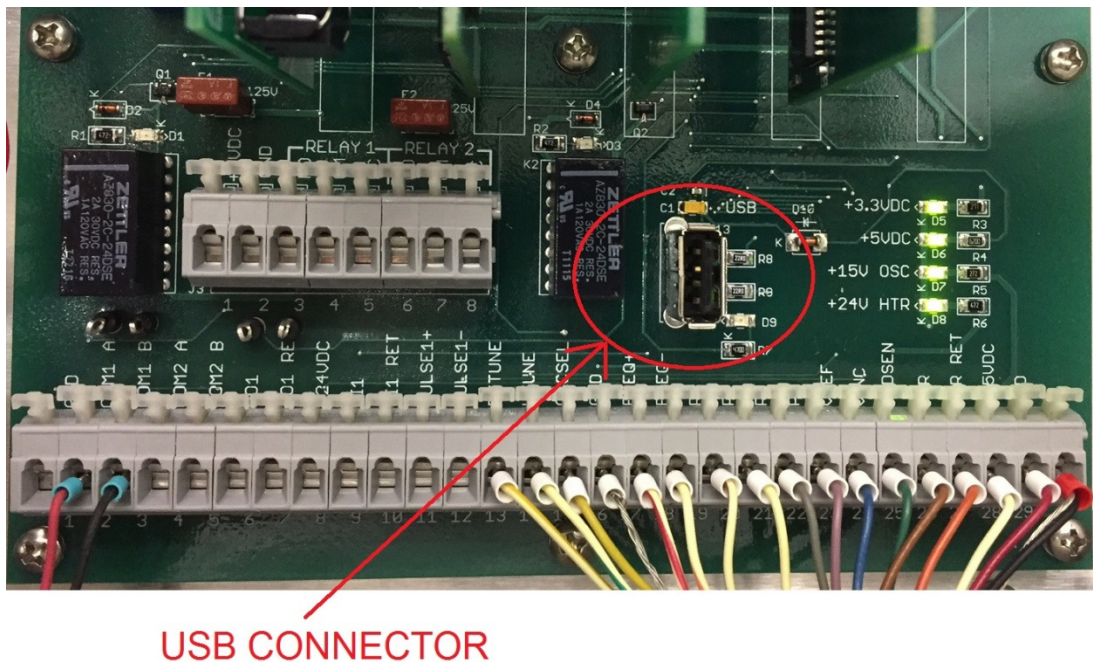
The latest model of motherboard (PN 2000-00072-000A) in combination with the latest Communication Board (PN 2000-00067-000A) and the firmware version starting at 6.15.07 allows

the data logging of 50 different variables in floating point format in a USB flash drive. The USB connector is located on the motherboard and it is identified as J13 (See picture below).

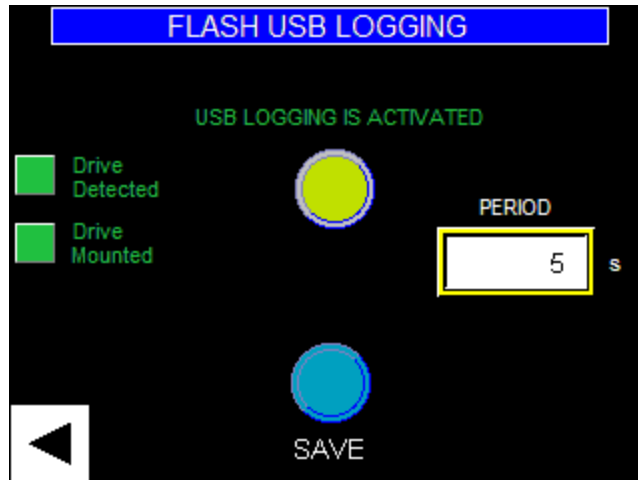
Touching the Data logging icon on the “Utilities” screen will access the Flash Drive Logging screen:



Initially with no drive connected there are 2 red messages. One indicates that “No Drive is Detected” and the other indicates that “No Drive is Mounted”. Insert a USB flash drive on the connector identified as J13 (See picture below)



Then select the period for the logging (2 to 120 seconds). Then press the green button to activate the data logging. After a few seconds the flash drive will be detected and mounted. The red text and the 2 grey buttons will turn green.



After finishing all the changes, press the SAVE button or the data logger will get deactivated if the device loses power.

ATTENTION:

When the Flash Drive needs to be removed, first the data logger has to be stopped by pressing the green button. If the flash drive is extracted without stopping the data logging, the file may get damaged and become unreadable.

The data logger will automatically create one new file per day starting at midnight. The name of the file is:

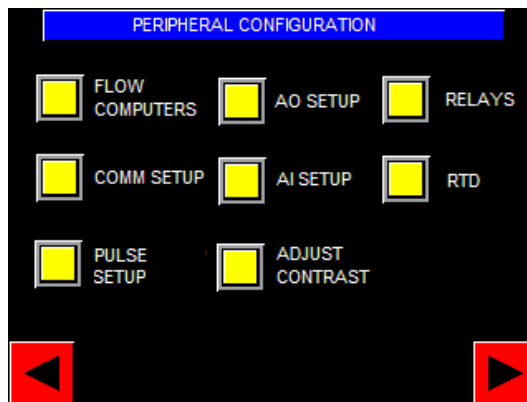
LOG_Month-day-year.csv

For example, LOG_05-23-2017.csv

The file starts with a header that indicates all the variables recorded.

5.5.2 Peripherals Configuration

This screen conducts to all the configuration screens for all the peripherals and the Flow Computer.

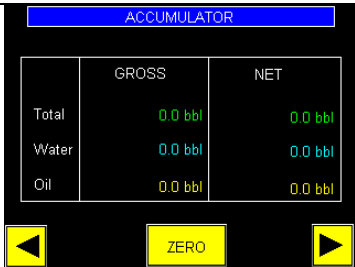
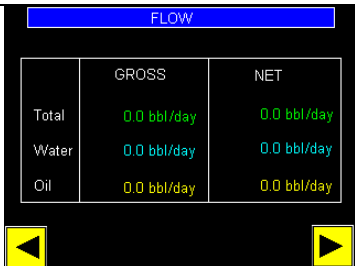
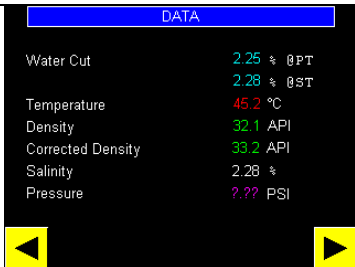


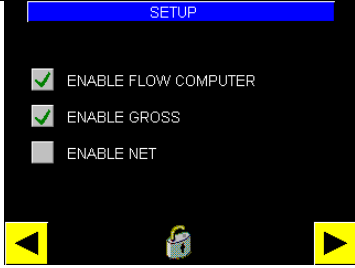
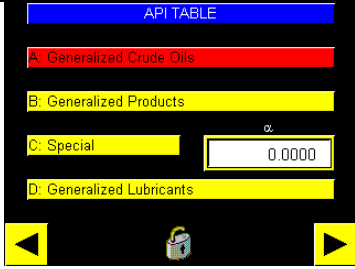
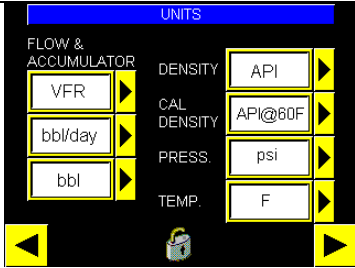
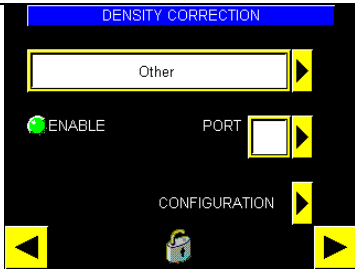
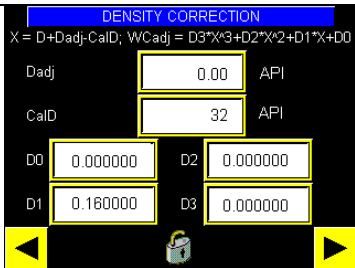
Activate the following buttons to go to:

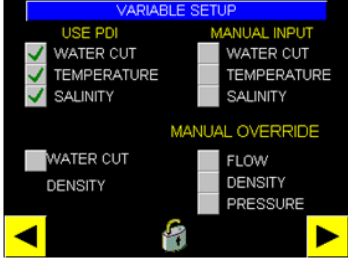
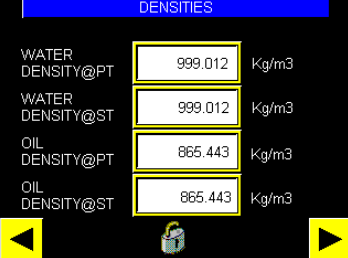
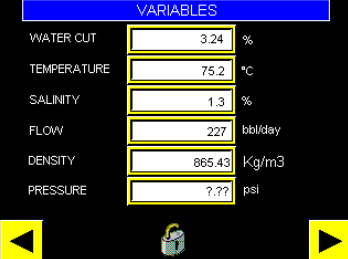
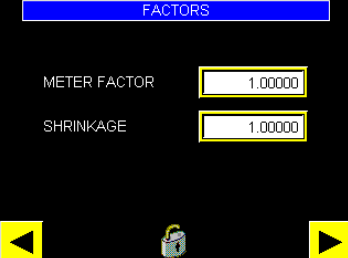
| | |
|--|---------------------|
| FLOW COMPUTERS: Configuration of the Flow Computer | see section 5.5.2.1 |
| COMM SETUP: Communication Setup | see section 5.5.2.2 |
| PULSE SETUP: Configuration of the Pulse/s input | see section 5.5.2.3 |
| ADJUST CONTRAST: Adjust the contrast of the screen | see section 5.5.2.4 |
| AO SETUP: Configuration of the Analog output/s | see section 5.5.2.5 |
| AI SETUP: Configuration of the Analog Input/s | see section 5.5.2.6 |
| RTD: Temperature Sensor Trimming | see section 5.5.2.7 |
| RELAYS: Configuration of both relays | see section 5.5.2.8 |

5.5.2.1 Flow Computer

Activate this button to see all the Flow Computer information and configurations.

| | |
|---|---|
| <p>Activate the FLOW COMPUTER button to access this subset of screens</p> <p>↓</p> | |
|  | <p>Shows the Gross and Net accumulated volume in the selected units. Press ZERO or press [ENTER] to reset the Totals. See section 5.5.2.1.1</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |
|  | <p>Shows the Gross and Net flow rates in the selected units. See section 5.5.2.1.2</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |
|  | <p>See section 5.5.2.1.3</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |

| | |
|---|--|
|  | <p>See section 5.5.2.1.4</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |
|  | <p>See section 5.5.2.1.5</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |
|  | <p>See section 5.5.2.1.6</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |
|  | <p>See section 5.5.2.1.7</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |
|  | <p>See section 5.5.2.1.8</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |

| | |
|---|---|
|  | <p>See section 5.5.2.1.9</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p style="text-align: center;">↓</p> |
|  | <p>See section 5.5.2.1.10</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p style="text-align: center;">↓</p> |
|  | <p>See section 5.5.2.1.11</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p style="text-align: center;">↓</p> |
|  | <p>See section 5.5.2.1.12</p> <p>Press the lower Right corner Arrow or press [MENU] to go back to the Peripheral Configuration screen</p> |

5.5.2.1.1 Accumulator

Shows the Gross and Net accumulated volume in the selected units. Press ZERO or press [ENTER] to reset the Totals. See section 7.1.4.2.1.10 if Net calculations are used.

5.5.2.1.2 Flow Rates

Shows the Gross and Net flow rates in the selected units. Press ZERO or press [ENTER] to reset the Totals. See section 7.1.4.2.1.10 if Net calculations are used.

5.5.2.1.3 Data

It shows current data values.

5.5.2.1.4 Setup

Allows the user to enable the Flow Computer, The Gross Calculation and the Net Calculation. See section 7.1.4.2.1.10 if Net calculations are used.

5.5.2.1.5 API Table

Allows the user to select the API Table that will be used to convert densities from process condition to standard conditions and vice versa. The default selection is Table A: Generalized Crude Oils. To change the selection, touch the label or press [SELECT] repeatedly until the blue index points the desired table and then press [ENTER].

5.5.2.1.6 Units

Allow the user to select the units for every variable.

5.5.2.1.7 Density Correction

This screen allows the user to enable the Density Correction Function and select the source for an external density signal. See Section 5 “Density Correction” for more information.

5.5.2.1.8 Density Correction Coefficients

This screen is used to modify the coefficients used by the Density Correction Function. See chapter 5 for more information on Density Correction.

5.5.2.1.9 Variable Setup

This screen allows the selection of the variables used for the Flow Computer. These variables are for the exclusive use of the flow computer. For example, if the check box Water Cut Manual Input is checked, the manually entered Water Cut will be used for the Flow Computer calculations only. The Water Cut shows on the main screen will be the water cut measured by the Phase Dynamics analyzer. When a variable is entered via MODBUS®, then the corresponding check box has to be checked too. A MODBUS® writing is considered a manual input. For example, when a density will be written via MODBUS® to be used for density correction, then the check box “Override Density” has to be checked.

5.5.2.1.10 Densities

The densities in this screen are used to perform the Net calculations. If Net calculations are required, make sure to enter the proper densities for the process. The following equations are used for the calculation of Oil and Water flow rate and totals

$$Gross\ Oil\ Flow\ Rate = Total\ Flow\ Rate \times (1 - Water\ Cut)$$

$$Gross\ Oil\ Total = \int_0^t Gross\ Oil\ Flow\ Rate \times dt$$

$$Gross\ Water\ Total = \int_0^t Gross\ Water\ Flow\ Rate \times dt$$

$$\text{Net Oil Flow Rate} = \frac{\text{Gross Oil Flow rate} \times \text{Density of Oil at Process Temperature}}{\text{Density of Oil at Standard Temperature}}$$

$$\text{Net Water Flow Rate} = \frac{\text{Gross Water Flow rate} \times \text{Density of Water at Process Temperature}}{\text{Density of Water at Standard Temperature}}$$

$$\text{Net Oil Total} = \frac{\text{Gross Oil Total} \times \text{Density of Oil at Process Temperature}}{\text{Density of Oil at Standard Temperature}}$$

$$\text{Net Water Total} = \frac{\text{Gross Water Total} \times \text{Density of Water at Process Temperature}}{\text{Density of Water at Standard Temperature}}$$

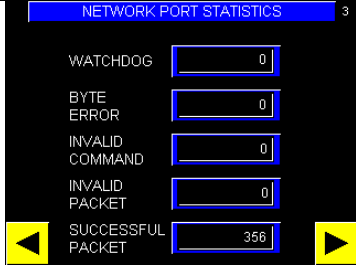
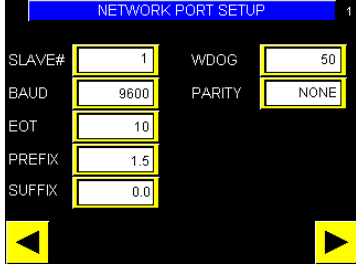
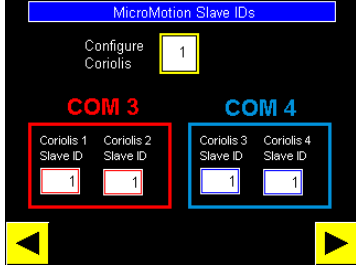
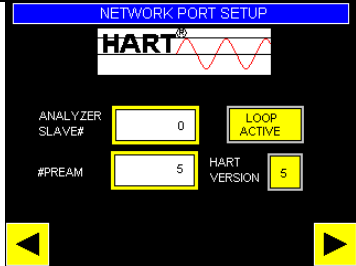
5.5.2.1.11 Variables

This screen is used to enter values for some variables manually. To do this, the variable has to be selected as a manual input on the Variable Setup Screen (Section 5.5.2.1.9).

5.5.2.1.12 Factors

These two factors are part of the API calculations. The meter factor is a correction factor for the flow meter. The Shrinkage factor is the volume reduction when the oil is taken from the process conditions to standard conditions due to the flashing of the light hydrocarbons.

5.5.2.2 Communications Setup

| | |
|---|--|
| <p>Activate the COMM SETUP button to access this subset of screens</p> | |
|  | <p>See section □</p> <p>Press the lower Right Corner Arrow 4 times or press [MENU] 4 times to continue.</p> <p style="text-align: center;">↓</p> |
|  | <p>See section □</p> <p>Press the lower Right Corner Arrow 4 times or press [MENU] 4 times to continue.</p> <p style="text-align: center;">↓</p> |
|  | <p>See section □</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p style="text-align: center;">↓</p> |
|  | <p>See section □</p> <p>Press the lower Right corner Arrow or press [MENU] to go back to the Peripheral Configurations Screen</p> |

- **Network Port Statistics**
There are 4 screens like this. One for each port. They show the current status of the communications.
- **Network Port Setup**
There are 4 screens like this. One for each port. They allowed the user to configure the parameters of the communications.

- Slave ID

Enter here the slave address desired for this device on the network. Values from 1 to 255 are allowed.

- Baud Rate

Available options are 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 125200.

- Prefix (ct)

The prefix is the time in CT (Character Time) that processor drives the network before starting a transmission. Values from 0.0 to 255.0 are allowed.

- Suffix (ct)

The Suffix is the time in CT (Character Time) that processor drives the network after finishing a transmission. The Default value is 0.

- Reply Delay

Enter here the desired reply delay in milliseconds. Values from 0 to 255 are allowed. The default value is 10.

- Watchdog

The Watchdog is the time in CT (Character Time) the processor will wait before dropping an incomplete received transmission packet. Values from 1.5 to 255.0 are allowed. The default value is 50.

- Parity

Available values are:

- NONE
- ODD
- EVEN
- MARK/1
- SPACE/0

- Retry Time (s)

Enter here the desired retry time in seconds. Values from 0.1 to 10 are allowed. The default value is 0.4.

ATTENTION:

After changing ANY parameter in ANY communication port, the configuration has to be saved and then the unit has to be power cycle to re-open the ports with the new configuration.

- Micro Motions Slave IDs

This screen automatically configures Micro Motion® Coriolis Meters connected to the ports 3 and/or 4. To use this feature, connect the meters to the port one at a time. For this Low range analyzer, the only application that uses a Micro Motion® on Com 3 or 4 is the density correction and never uses more

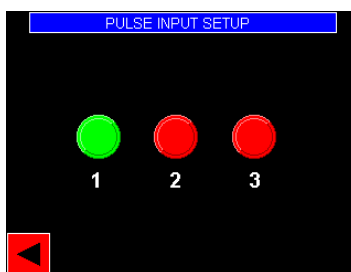
than one. Basically, this screen will change the slave address to the one the user enters in the text box and will also configure the units to the ones the analyzer uses internally for calculations.

- **HART®**

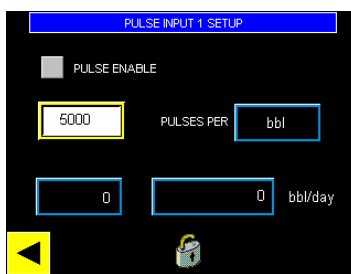
This screen allows the user to configure all the parameters for the HART® communication. HART® is not a standard feature in our analyzers. If HART is needed, it has to be specifically ordered.

5.5.2.3 Pulse Input

This submenu has only 2 screens. The first one selects the Input to be configured. On Enhanced Electronics there is only 1 Pulse Input. In the Expanded Electronics there are 3. The analyzer automatically detects the presence of 1 or 3 Pulse Inputs. Activate the button corresponding to the Pulse Input to be configured to go to the configuration Screen.



Check the PULSE ENABLE check mark and set the proper amount of pulses per volume units. The units can be changed on the FLOW COMPUTER configuration Screen (See Section 7.1.4.2.1.6)

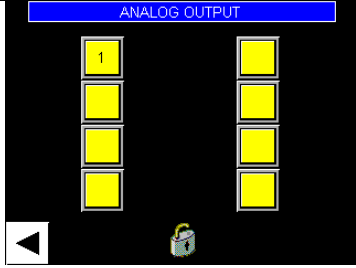
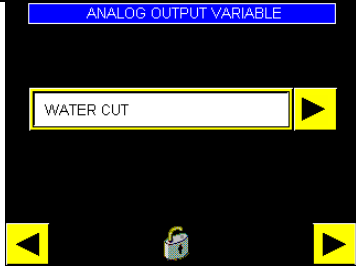
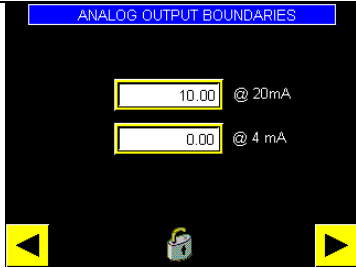
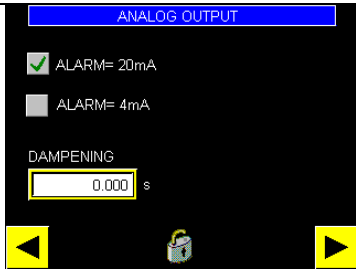
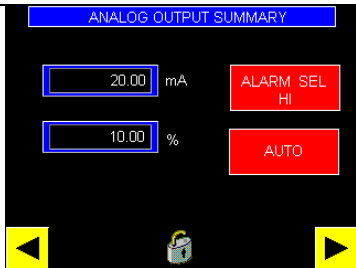


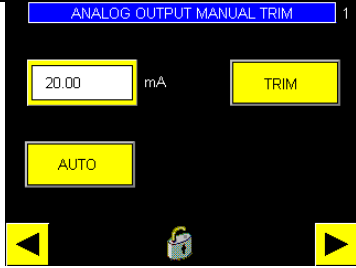
5.5.2.4 Adjust Contrast

This screen can only be operated by touch. It allows the user to change the Contrast of the Touch-Screen. Just touch the button to open the pop-up screen that will show on the upper left corner. Then touch the Arrows at the left to decrease the brightness or touch the Arrows on the right to increase the brightness. When finished press the “X” to close the pop-up screen.

5.5.2.5 Analog Output Set Up

There is 1 analog output in the Enhanced Electronics and 5 in the Expanded Electronics. Activate the AO SETUP button to enter this submenu. Then action the button of the Analog Output that needs to be configured.

| | |
|---|--|
|  | <p>See section 5.5.2.5.1</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |
|  | <p>See section 5.5.2.5.2</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |
|  | <p>See section 5.5.2.5.3</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |
|  | <p>See section 5.5.2.5.4</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |
|  | <p>See section 5.5.2.5.5</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p>↓</p> |

| | |
|---|---|
|  | <p>See section 5.5.2.5.6</p> <p>Press the lower Right corner Arrow or press [MENU] to go back to the Analog Output Configuration Screen</p> |
|---|---|

5.5.2.5.1 Analog Output selection

This screen allows the selection of the Analog Output that needs to be configured. In Enhanced electronics there is only one and in the Expanded Electronics there are 5. The analyzer automatically detects the presence of the analog outputs and enables the corresponding number of buttons. On the screen shown, only one Analog Output is present (Enhanced Electronics). Action the button corresponding to the Analog Output that needs to be configured. Don't forget to save configurations if any change is made. A little floppy disk shows in some of the screens as a reminder than a configuration has not been saved.

5.5.2.5.2 Analog Output Variable

The Analog Outputs can be assigned to a long list of variables such us Water Cut, Flow Computer Flow Rate, Flow Computer Gross Oil Flow Rate, etc. Browse the list and select the desired one. When done, action the bottom left arrow to go to the next screen.

5.5.2.5.3 Analog Output Boundaries

This screen is dependent of the previous one and it is used to select the upper and lower boundaries of the analog output. More specifically, it allows the user to select the value of the variable that corresponds to a current output of 4mA and the value that corresponds with 20mA. This is independent of the range of the analyzer. For example, if the analyzer is 0 to 10% water cut, the boundaries can be selected as 0 to 5%.

5.5.2.5.4 Analog Output Alarms and Dampening

This screen allows the selection of the analog output value when the water cut can't be calculated due to an error. In these cases, the Water Cut is shown has a question mark on the screen and the analog output goes to the value selected by the checkmark in this screen. This screen also allows the edition of the current value for the dampening. The dampening is the number of seconds the variable is averaged before the value is seen in the analog output. The default value is zero (no dampening)

5.5.2.5.5 Analog Output Summary

This screen shows the selected values for the analog output boundaries, the selected alarm level and the status (Automatic or Manual).

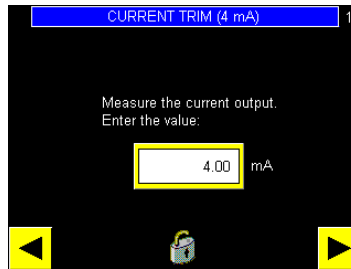
5.5.2.5.6 Analog Output Manual Trim

This screen has two main functions. One is to trim the selected Analog Output. The other is to force the value of the selected Analog Output to test the loop and the connection with the control room.

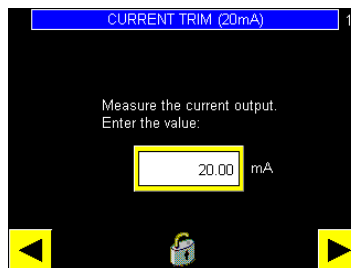
To force a current value, activate the AUTO button. It will change to "MANUAL". At this time the desired value to be forced can be entered in the text box. The forced value can be measured with a milliamp

meter connected in series with the current loop. (See section 2.6.1 for connections). When done forcing currents activate the MANUAL button. It will change back to AUTO.

To TRIM the selected Analog Output action the TRIM button. The following screen will show:



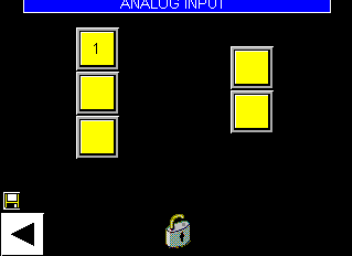
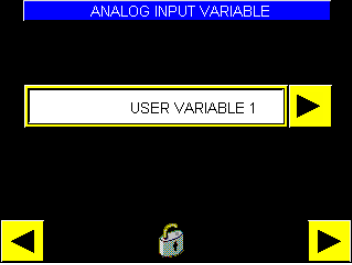
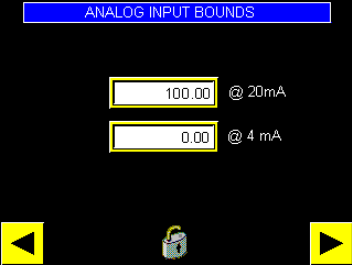
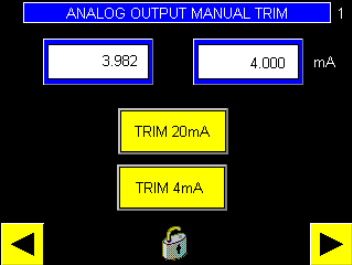
Disconnect any wiring on the selected Analog Output. Connect a milliamps meter on the corresponding terminals. See Section 2.6.1 for connection diagrams. Measure the current and enter the value in this screen. After that activate the lower right arrow. The screen that allows trimming the 20mA will show:



Measure the current and enter the measured value in the text box. Then activate the lower right arrow to finish the process.

5.5.2.6 Analog Input Set Up

There is 1 analog input in the Enhanced Electronics and 5 in the Expanded Electronics. Activate the AI SETUP button to enter this submenu. Then action the button of the Analog Input that needs to be configured.

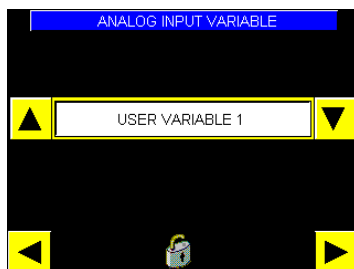
| | |
|---|--|
|  | <p>See Section 5.5.2.6.1</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p style="text-align: center;">↓</p> |
|  | <p>See section 5.5.2.6.2</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p style="text-align: center;">↓</p> |
|  | <p>See section 5.5.2.6.3</p> <p>Press the lower Right Corner Arrow or press [MENU] to continue.</p> <p style="text-align: center;">↓</p> |
|  | <p>See section 5.5.2.6.4</p> <p>Press the lower Right corner Arrow or press [MENU] to go back to the Analog Input Configuration Screen</p> |

5.5.2.6.1 Analog Input Selection

This screen allows the selection of the Analog Output that needs to be configured. In Enhanced electronics there is only one and in the Expanded Electronics there are 5. The analyzer automatically detects the presence of the Analog Inputs and enables the corresponding number of buttons. On the screen showed, only one Analog Input is present (Enhanced Electronics). Action the button corresponding to the Analog Input that needs to be configured to advance.

5.5.2.6.2 Analog Output Variable

The Analog Inputs can be assigned to a long list of variables such as Flow Computer Density, Flow Computer Flow Rate, etc. Browse the list and select the desired one. The default selection is USER VARIABLE 1. This variable is just a place holder and is not actually used for anything. The Analog Input 1 very commonly used for Automatic Density Correction (See Section 8). When done, action the bottom left arrow to go to the next screen.



5.5.2.6.3 Analog Input Boundaries

This screen is dependent of the previous one and it is used to select the upper and lower boundaries of the selected Analog Input. More specifically, it allows the user to select the value of the variable that corresponds to a current output of 4mA and the value that corresponds with 20mA.

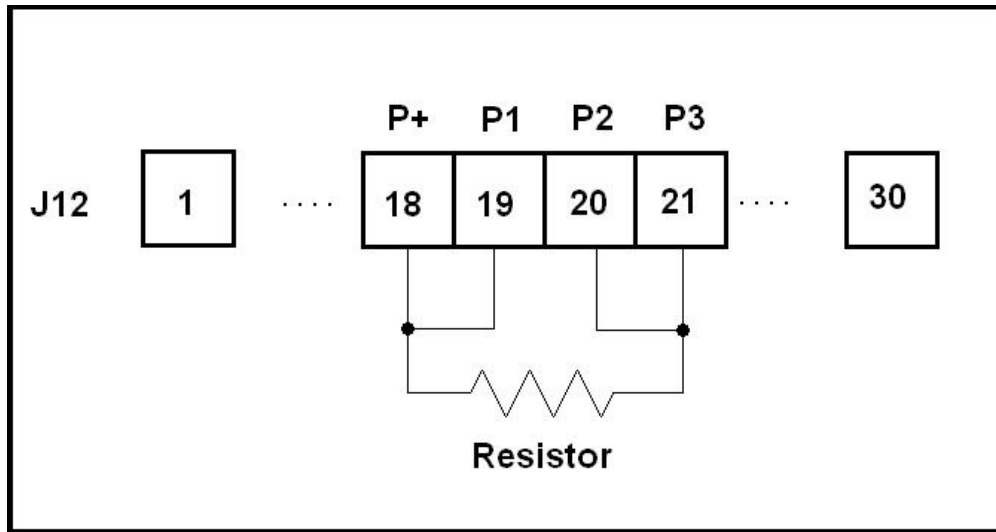
5.5.2.6.4 Analog Output Manual Trim

To TRIM the selected Analog Input, disconnect any wires attached to this input and connect a 4-20mA simulator in its place (See section 2.6.1 for the wiring diagrams). Set the generator to output 4mA. The text box on the left will show the raw value measured by the analyzer. The text box on the right will show the value of the analog input with the current trimming applied. If this text box is reading 4.000 mA (+/- 0.005) then no trimming is necessary. Otherwise activate the TRIM 4mA button to trim. The text box at the left will show the same value but the one at the right will show 4.000mA (+/- 0.005)

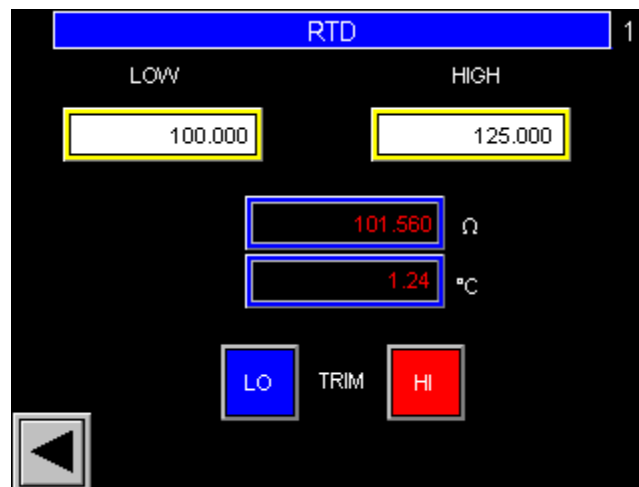
After that, set the simulator to generate 20.000mA. Again, the text box at the left will show the raw value and the one at the right will show the trimmed value. If the reading at the right is 20.000 (+/- 0.005) then no trimming is necessary. Otherwise, action the TRIM 20mA button to trim it. After that the text box at the right will show 20.000mA (+/-0.005)

5.5.2.7 RTD Trimming

To trim the RTD input a 100 Ohms resistor and a 125 Ohms resistor (0.1% precision if possible), should be connected to the RTD terminals on J12. The connection has to be done in a 4 wires fashion as shown in the following picture:



After that press the LO button on the RTD trimming screen. The resistance reading will indicate 100.00 Ohms and the temperature indication will show 0°C.



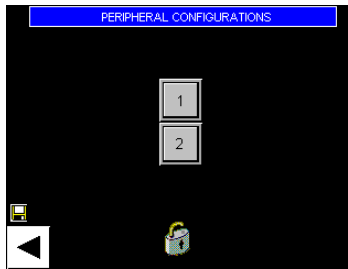
Then disconnect the 100 ohms resistor and connect a 125 resistor in the same way. Next, press the HI button. The reading will show 125.00 Ohms.

After the trimming is finished, don't forget to save the configuration.

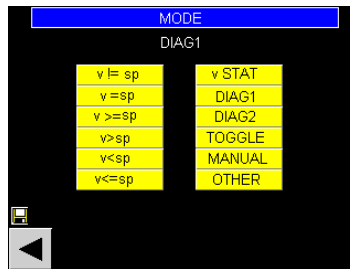
5.5.2.8 Relays Configuration

The analyzer has 2 relays. Both of them are configurable.

The first screen allows the selection of the relay to be configured.



Activate the button of the relay that needs to be configured to enter this configuration submenu.



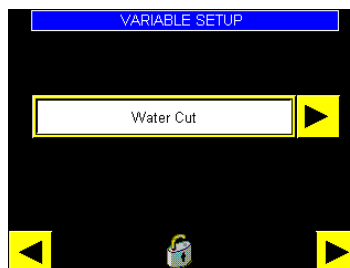
There are several ways or “modes” to operate the relays:

- a) Comparison between a variable and a Set Point.

The options are:

$V \neq sp$: Variable not equal to Set Point
 $V = sp$: Variable equal to Set Point
 $v \geq sp$: Variable greater or equal than Set Point
 $v > sp$: Variable greater than Set Point
 $v < sp$: Variable lesser than Set Point
 $v \leq sp$: Variable lesser or equal to Set Point

After selecting one of these modes, the next screen will allow to select the variable. There is a long list of variables than can be selected such us Water Cut (the most used), Emulsion Phase, User Temperature, etc.



After selecting the variable, the next screen will allow the user to enter the Set Point.

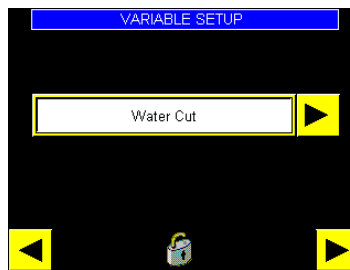


b) Status of a variable

Every variable has a 16 bits Status Word. Only 4 of these bits are used.

| | | | |
|-------|---------------|--------|----------|
| Bit 0 | Not used | Bit 9 | Not used |
| Bit 1 | Not used | Bit 10 | Not used |
| Bit 2 | Not used | Bit 11 | Not used |
| Bit 3 | Not used | Bit 12 | Not used |
| Bit 4 | Not used | Bit 13 | Not used |
| Bit 5 | High Boundary | Bit 14 | Not used |
| Bit 6 | Low Boundary | Bit 15 | Not used |
| Bit 7 | Hi Alarm | Bit 16 | Not used |
| Bit 8 | Lo Alarm | Bit 17 | Not used |

If this case has been selected, the next screen will allow the selection of the variable.

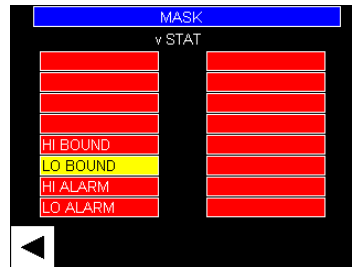


Browse through the list of variables by auctioning the yellow button at the right of the text box.

The next screen after selecting the variable will allow the user to set the Mask to be used over the status word. The Mask is a 16-bits register that is used to performed a logic AND with the Status Word. If one or more of the status bits is not desired it can be ignored by making the corresponding bit in mask equal to zero. The default value for the mask is FFFF which will not hide any of the bits of the status word. Activating the arrow at the right of the text box will show the detail masks screen.



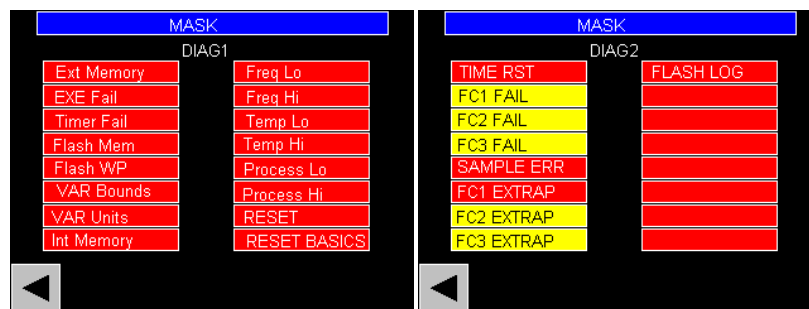
The Masks Screen is a very easy way to select the bits that needs to be masked. Just touch the Status or press [SELECT] as needed until the index points to the desired bit and press [ENTER] to activate that particular mask. The color red means that the mask is not active so that particular bit is not filtered. A yellow color means that that particular bit will activate the Status of this variable.



In the example screen only Low Boundaries status is going to be filtered. The other 3 will activate the status alarm and therefore the relay.

c) Diagnostics 1 and Diagnostics 2

There are two 16 bits diagnostics words. They are explained in the section 7.1.4.1.1. If any of these modes are selected then the next screen will show the Masks Screen.



As an example, if DIAG1 is the mode used and the Variable Boundaries (Water cut) is exceeded, then the relay will activate (unless that particular bit is masked).

d) Toggle:

If this option is selected, the corresponding relay will start switching three times per second.

e) Manual:

If this mode is used, the next screen will show a big button. Touching the button or pressing [ENTER] will toggle the relay status. This is useful when testing the connection with a control room.

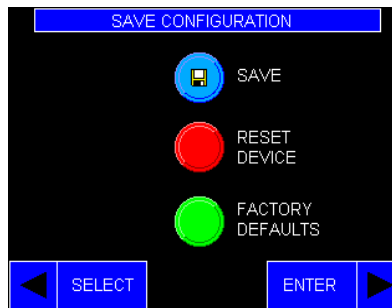
f) Other:

This option is used when the relays are going to be activated via MODBUS®. See the MODBUS® in section 0 to learn how to read or write the coils that control the relays.

5.5.3 Save Configurations

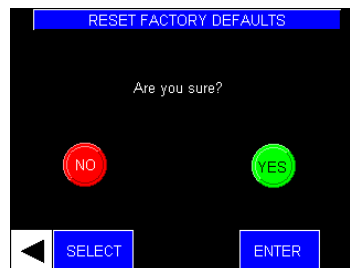
This screen has three buttons. One is used to save configurations. The second one is to reset the device and the third one is to reset all the configurations to Factory Defaults. Every time a parameter is changed by the operator or by MODBUS®, a little floppy disk icon will show up in some of the screens. That is a reminder that there are configurations that need to be saved. If the analyzer loses power, all this non saved configurations will be lost. After the configurations is saved, the little floppy icon will disappear (this normally takes a couple of seconds). This configuration is stored as “User Configuration”.

To save the configurations just activate the Blue Button that has a floppy icon in it. After a few seconds the floppy will disappear.



To reset the microprocessor, activate the RESET DEVICE red button. If some changes have been done in the configuration that have not been save, the microprocessor will reboot with the current User Configuration parameters that were last saved.

If the Factory Configuration needs to be recovered, just activate the FACTORY DEFAULTS green button. Warning: The User Configuration will be lost. After activating the button, another screen will show asking for confirmation. Activate the Green YES button if you want to proceed or the Red NO button if you want to keep the current configuration.



6 Operation

The Phase Dynamics Analyzers are calibrated at the factory over a broad range of water cuts and temperatures. These calibrations are converted to equations that are later programmed into the microprocessor memory. The processor reads frequencies and temperature from the measurement section and calculates water cut. The analyzer is then ready to operate and needs no further calibrations in the field (like providing dry crude oil or clean water for calibration purposes). Since the reading of the analyzer is affected by the density of the oil (see Density Correction section), an offset has to be introduced to match the analyzer reading with the actual fluids water content.

The offset used to correct the readings is called “Adjust Oil”. According to the application, it might be necessary to use more than one value. For example, if multiple streams are going to be measured individually, each one of them might need a different offset. To make these applications easier to handle, the analyzer has 60 memories called “Streams”. Each one of them can store a different offset so the operator will only need to change “Streams” instead of changing offset values. These offsets are introduced only once and then validated every now and then by taking samples. If the memories (Streams) are used, each one of them is assigned to a different well, oil type, oil area (for truck or ship unloading applications), etc. The Stream number can be changed manually by the operator through the push buttons on the front panel using the menu called “Stream Select” or remotely via MODBUS® or via any of the available Analog inputs.

6.1 Offset (Adjust Oil) Calculation

There are 2 ways to calculate the necessary offset: Manually or Automatically.

6.1.1 Manual Calculation

The calculation of this offset is very easy. For this calculation it is necessary to know the current value of “Adjust Oil”. Make yourself familiar with the operation of the analyzer screen type that you have (4 lines LCD or Touch-Screen in Section 44).

- a) Make sure the “Stream” (memory) that you normally use for the current well is selected
- b) Prepare to take a sample
- c) Wait for a steady reading on the analyzer
- d) Take a sample and at the same time ask a helper to write down the analyzer reading. As an example, say that the reading was 0.74%
- e) Take the sample to the laboratory. For this example, the laboratory result was equal to 0.27%
- f) Browse through the menu and find the current value of “Adjust Oil”. For this example, it is equal to 0.42%

The raw water cut read by the analyzer was:

$$\text{Raw Water Cut} = \text{Analyzer Reading} - \text{Adjust Oil}$$

For this example

$$\text{Raw water Cut} = 0.74 - 0.42 = 0.32$$

The actual difference between the raw reading and the actual water cut is:

$$\text{Difference} = \text{Lab Result} - \text{Raw Water Cut}$$

For this example

$$\text{Difference} = 0.27 - 0.32 = -0.05$$

This difference is the value we need the analyzer offset to be. Changing the offset to -0.05 will correct the measurement for this particular case.

The equation to calculate the new Adjust Oil value is:

$$\text{New Adjust Oil} = \text{Laboratory Result} - \text{Analyzer reading} + \text{Old Adjust Oil value}$$

$$\text{New Adjust Oil} = \text{Laboratory Result} - \text{Analyzer reading} + \text{Old Adjust Oil value}$$

For this example:

$$\text{New Adjust Oil} = 0.27 - 0.74 + 0.42 = -0.05$$

Remember the Adjust Oil value is stored in the current “Stream”. Changing the Stream number will change the Adjust Oil Value to the one preset for that particular Stream number.

6.1.2 Automatic Offset (Adjust Oil) Calculation

The analyzer has a routine that calculates the value of Adjust Oil automatically liberating the operator from doing any calculations. Make yourself familiar with the operation of the analyzer screen type that you have (See section 4 for 4 lines LCD or Section 5 for Touch-Screen).

Please follow this procedure to perform an automatic calculation:

- a) Make sure the “Stream” (memory) that you normally use for the current well is selected
- b) Prepare to take a sample
- c) Ask a helper to find the “Capture Oil” screen by browsing through the menu.
- d) Wait for a steady reading on the analyzer
- e) Ask your helper to press ENTER to initiate a data capture in the analyzer and at the same time take a sample.
- f) After the sample is taken ask your helper to press ENTER again to stop the data capture. Make sure the data capture was at least 4 seconds long. The analyzer can be brought back to the main screen. The data capture is stored in the selected “Stream” number.
- g) Take the sample to the laboratory.
- h) When the result is obtained, make sure the Stream selected in the analyzer is the one that was used when the sample was taken. Remember that the data that was captured was saved on that particular Stream memory.
- i) Browse through the menu and find the “Cal Oil Phase” menu. Enter here the laboratory result and press ENTER.
- j) The analyzer will calculate the necessary Adjust Oil and save it in the currently selected Stream.

6.2 *Regular Operation*

The operation of the analyzer depends on the particular application.

- a) Single Stream: The analyzer can be operated on Stream number 1 all the time. If the density of that single stream never changes then a calculation of a single Adjust Oil will be enough to operate this analyzer. If the density of this stream is not stable, then a density correction method should be selected. The density effects can be corrected by using the integrated Density Correction routine (recommended) or it can be remotely corrected on the control room. (See the Density Correction section)
- b) Multiple Streams: After the individual offset (Adjust Oil) for each stream have been calculated and entered, all that it is needed is to change the Stream Number by using the Stream Select function every time the stream is changed.

7 Flow Computer

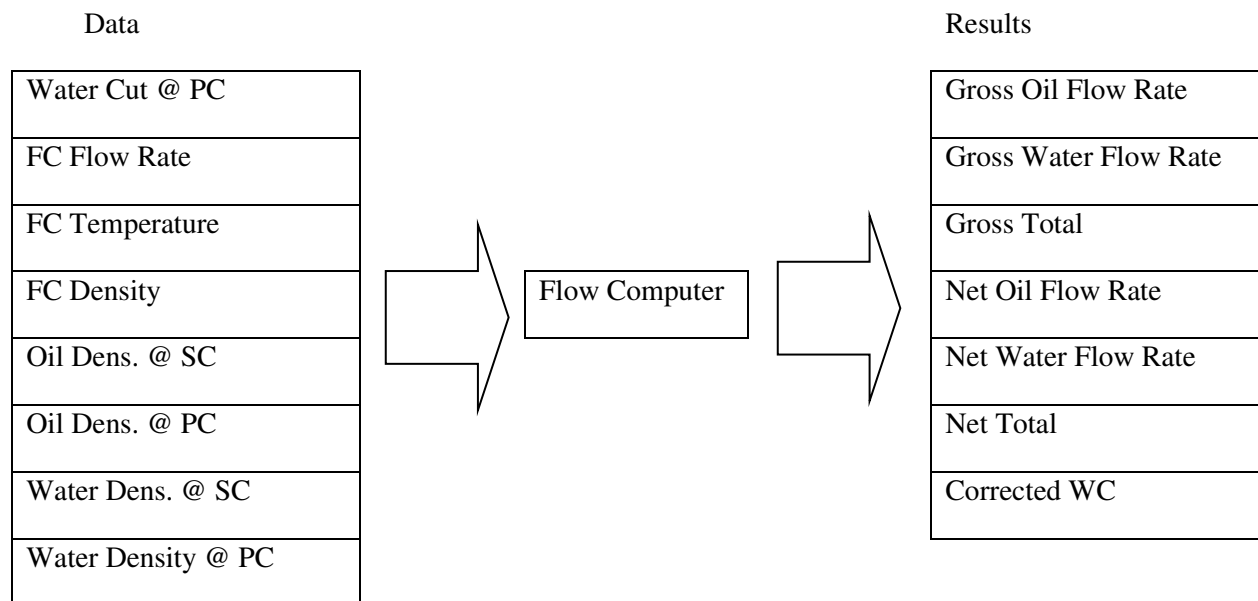
The Phase Dynamics analyzer is a full Flow Computer. If a flow meter is connected to the analyzer, the processor will calculate and display Water and Oil Gross Flow Rates and Totals. If the densities of the production water and the dry oil are entered, the analyzer will also calculate and display the Net water and oil flow rates and totals. The flow computer is also responsible for the Density Correction (See Section 8). The water cut is calculated by the processor by reading the frequency from the oscillator and converting this information to water cut by applying the calibration equations. The other variables needed, have to be supplied by the user. They can be entered in different ways.

FC Flow Rate: Analog Input, Pulse input and MODBUS[®],

FC Density: Analog input, MODBUS[®] or manually

Oil Density @ SC (Standard Conditions), Water Density @ SC, Oil Density @PC (Process conditions) and Water Density @ PC: Analog Input, MODBUS[®] or Manually

FC Temperature: By default, the analyzer temperature read from the RTD is used. If needed, an external signal can be entered via Analog Input or MODBUS[®].



See the Section 4.29 for configuration of the Flow Computer on a 4 lines LCD display.

See the section 5.5.2.1 for the configuration of the Flow Computer on a Touch Screen Display

8 Density Correction

The dielectric constant of the oil increases when density of the oil increases. This change causes an error on the water content measurement because this increase in dielectric constant is seen by the analyzer as water. The shift is 0.16 water per each API degree or 0.0286 per each Kg/m³. Phase Dynamics' analyzers are calibrated with oil with a density of 32 API. If a dry crude oil with a density of 31API (1API heavier) flows through our analyzer, the electronics will calculate a water cut of 0.16% which is incorrect because of the increased density. The Enhanced/Expanded electronics includes a Density Correction Software that automatically corrects the water cut deviations due to density if an online density signal is fed to the analyzer.

The density used internally for the correction is the corrected density at standard temperature and pressure. The user can feed either the density corrected at standard conditions or the density at process conditions. The analyzer has the capability to convert from one to the other. The software will do the corrections based on the units selected by the user. For this reason, extreme caution should be observed when inputs for the unit and limits from the densitometer are set in the analyzer. If the unit is for example Kg/m³, the Phase Dynamics analyzer will convert this density to Kg/m³ @ 15°C to do the density correction internally.

The density used for the correction is the density of the dry oil. Since an online densitometer is used, the assumption that the density is the one of the dry oil can only be kept when the water cut is below 5%. After that the density of the water introduces an error that is too big to keep using it. For this reason, the analyzer will use the online density only while the water cut is below 5%. Over that value, the last valid read density will be used until the water cut falls below 5% again.

The density can be fed in different ways:

Option A: Feeding a 4-20mA signal to one of the analog inputs,

Option B: Connecting a Micro Motion® Coriolis meter to one of the available RS485 communication port and letting the software poll the information from the meter itself. (On units with optional color touch-screen, the communication port number 2 is NOT available),

Option C: Writing the proper registers through the one of the available communication ports using the MODBUS® protocol. (On units with optional color touch-screen, the communication port number 2 is NOT available)

The equations used for the density correction are:

$$\text{Corrected Water cut} = \text{WC} + \text{Adjust (Oil Phase)} + \text{Density correction}$$

$$X = (\text{Density} - \text{Calibration Density} + \text{FC1 Density})$$

$$\text{Density Correction} = D3 * X^3 + D2 * X^2 + D1 * X + D0$$

Where:

- WC is the uncorrected water cut
- Adjust (Oil Phase) is the calibration offset for the oil phase
- Density is the density corrected to 60°F or to 15°C depending on the selected units. If the density provided is not corrected (process conditions) the analyzer corrects it internally.
- Calibration density is a value dependent of the unit selected (see below)
- FC1 Density adjust is an offset that can be used to correct the densitometer reading.
- D3 is the third order coefficient for the density correction equation.
- D2 is the second order coefficient for the density correction equation.
- D1 is the Slope (See below) for the density correction equation.
- D0 is the offset (See below) for the density correction equation.

The analyzer uses two different reference units for density. The equation used depends on the reference units selected by the user. These can be selected on the Flow Computer 1 Submenu. They are:

API 60F or Kg/m3 15C

If the unit selected is API @ 60F, then the coefficients used will be:

Calibration Density = 32

D3= 0

D2= 0

D1 = 0.16

D0 = 0

And the equation will be reduced to:

$$\text{Density correction for API at 60°F} = (\text{Density} - 32) * 0.16$$

If the selected unit is Kg/m3 @ 15C then the coefficients used will be:

Calibration Density = 0

D3= 0

D2= 0

D1 = -0.0286

D0 = 24.6

And the equation will be reduced to:

$$\text{Density correction for Kg/m3 at 15°C} = \text{Density} * (-0.0286) + 24.6$$

The settings of the density correction function are different for the 3 options (A, B or C) and for the two different types of screens available. There are some settings that are general (Sections 4.1 and 4.2) and some that are specific (Sections 4.3, 4.4 and 4.5).

Identify your option and read only the related sections:

Option A (4-20mA) with 4 lines LCD: Read sections 8.1 and 8.3

Option A (4-20mA) with Touch-Screen: Read sections 8.2, 8.3 and 8.8

Option B (Reading a Micro Motion® flow meter) with 4 lines LCD display: Read sections 8.1, 8.4 and 8.6

Option B (reading a Micro Motion® flow meter) with Touch-Screen: Read sections 8.2, 8.4, 8.7 and 8.8

Option C (Writing Registers) with 4 lines LCD: Read sections 8.1, 8.5 and 8.6.

Option C (Writing Registers) with a Touch-Screen: Read sections 8.2, 8.5, 8.7 and 8.8.

8.1 General Configuration on a 4 lines LCD Display

The user has to specify the way the density will be fed/obtained to perform the correction. Press [MENU] repeatedly to browse through the menu until the display shows the “Density Correction” screen. Press [SELECT] to navigate the options. The options are:

- Disable
- Coriolis, PDI Temp
- Cor-API60F, Alt Temp
- Cor-API60F, Cor Temp
- Cor-API60F, PDI Temp
- Cor-API60F, Alt Temp
- Other

For Analog Input (Option A) or to write the registers via MODBUS® (Option C), select the option: **OTHER** and then press [ENTER] to accept.

To read a Micro Motion® Coriolis meter connected to the communication port 1, 3 or 4 (Option B), select the proper option depending on the units configured in the meter and the temperature to be used. The most common selection for Option C is “Coriolis, PDI Temp.” In this case the Coriolis Meter units can be set as Kg/m3 or as API at process conditions and the temperature used will be the one read from the temperature sensor included in the Phase Dynamics analyzer. The analyzer will read the unit from the Micro Motion® mass flow meter and correct it to the one selected for display.

After the selection has been done, the next screen will show the “Density Correction Unit”. These are the units that will be used as reference and the unit that will be used to display the density at standard conditions. Also, by selecting the reference unit, the proper equation and coefficients will be loaded automatically.

There are two options:

- API 60F
- Kg/m3 15C

After selecting the reference unit, the next screens will show all the default coefficients. The default coefficients work well for mostly all applications. Please don't change them unless instructed by a Phase Dynamics specialist.

[SELECT] will enter the edition mode and shift the blinking digit. [VALUE] will increase the value of the blinking digit. [ENTER] will accept the edited value. [MENU] will exit without saving the changes.

- Third Order Density coefficient D3:
- Second Order Density coefficient D2:
- Density Slope D1:
- Density Adj. Offset D0:
- FC1 Density Adjust:

The next step is to configure the Flow Computer. Press [MENU] several times until you reach the screen “Configure FC1”. Press [ENTER].

The first screen is “FC1 Enable”. Make sure that it is ON.

Then press [MENU] until you reach the screen “FC1 Density Enable”. Make sure it is ON.

Then press [MENU] several times again until you reach the screen “FC1 Density Units”. Use [SELECT], [VALUE] and [ENTER] to select the desired density unit for visualization. For option A (4-20mA) and B (Micro Motion®) this unit can be different from the unit used in the densitometer. This is the

unit in which the densities will be shown in the screen. For option A (4-20mA) make sure the unit selected during the configuration of the Analog Input *match the one in the densitometer (See section 8.3.2)*. For option C (Writing MODBUS® registers), this unit is the unit of the value that will be written in the registers.

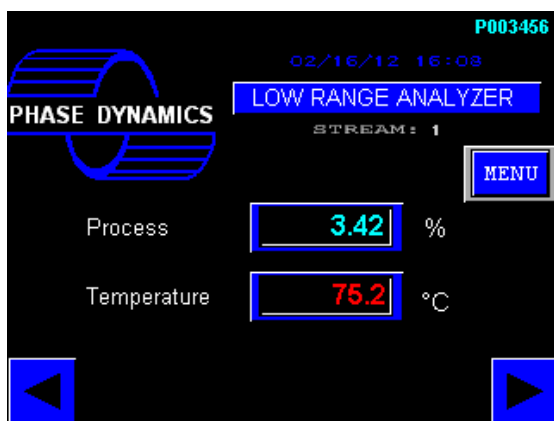
Then press [MENU] several times again until you find the screen “FC1 Manual Density”.

For option A (4-20mA) and B (Reading Micro Motion®) select “NO”.

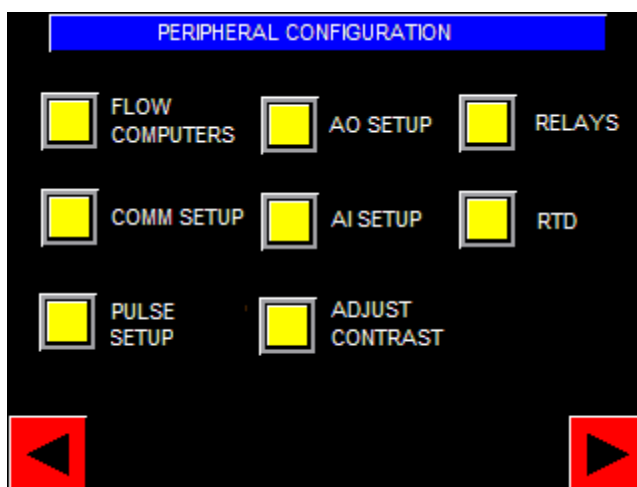
For option C (Writing MODBUS® registers) select “YES”

8.2 General Configuration on a Touch-screen

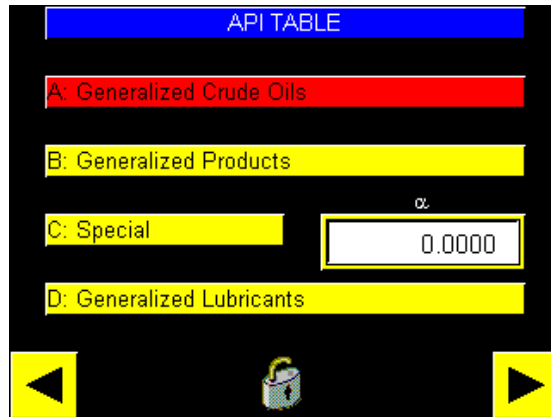
To access the configuration menus, press the blue MENU button (if the touch-screen is accessible) or press [SELECT] otherwise.



After that keep pressing the arrow (if touch-screen is accessible) or press [MENU] several times until you reach the PERIPHERAL CONFIGURATION screen:



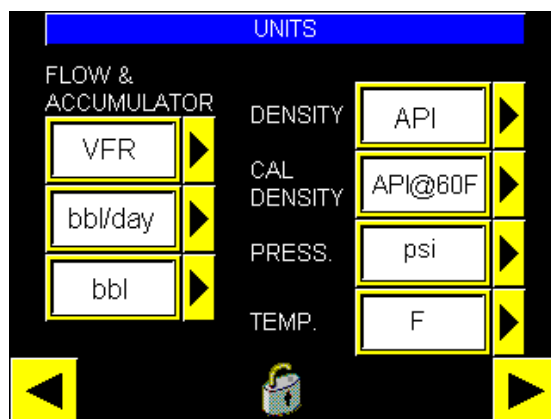
Press the FLOW COMPUTERS yellow button or press [SELECT] and then [ENTER] to access the Flow Computer configuration. Not all the screens are necessary for the density correction configuration. Press [MENU] to skip them until you reach the API TABLE screen:



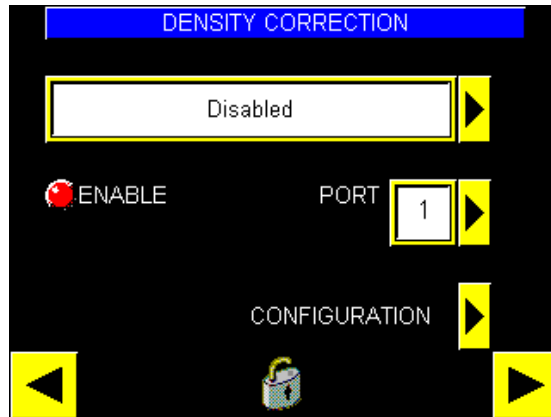
Make sure “A: GENERALIZED CRUDE OILS” is selected. This is the API table that will be used to convert densities from process to standard conditions or vice versa. Then press [MENU] or the arrow on the lower right corner.

Next screen will allow the user to configure the units for the values used or calculated by the Flow Computer. For this application two of them are very important. One is CAL DENSITY which selects the desired reference unit and the unit to show the corrected density. This is explained at the beginning of this chapter. Select your preferred reference unit from Kg/m3 @ 15C or API @ 60F.

The unit at the right of the label “DENSITY” is the unit that will be used to display the density fed to the analyzer. ***This one has to match the density supplied by the densitometer only for Option C (Writing MODBUS® registers).*** For the Option A (Analog input) and B (Micro Motion®) this unit can be different from the one supplied. In Option A the value is converted to the units selected on this screen. For the Micro Motion® the unit is read from the meter itself and then the value is converted to the units selected in this screen. As the analyzer uses the corrected density for the density correction, if the supplied density is NOT corrected (indicated by selecting the proper units) the analyzer will internally correct that density to standard conditions. For this reason, the list of units has some units repeated for different standard conditions. For example, “Kg/m3” means process conditions. Kg/m3 15C means that the density corrected at 15 C and atmospheric pressure.



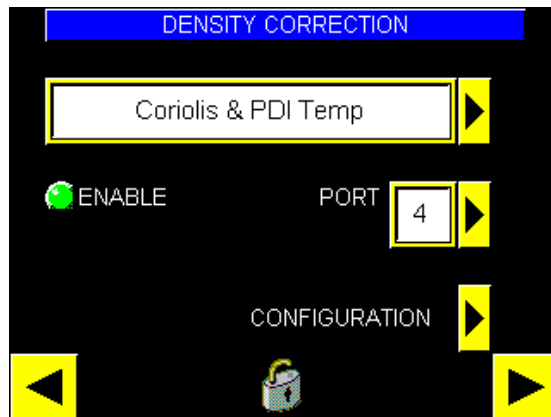
When done press [MENU] or the lower right arrow to go to the DENSITY CORRECTION screen:



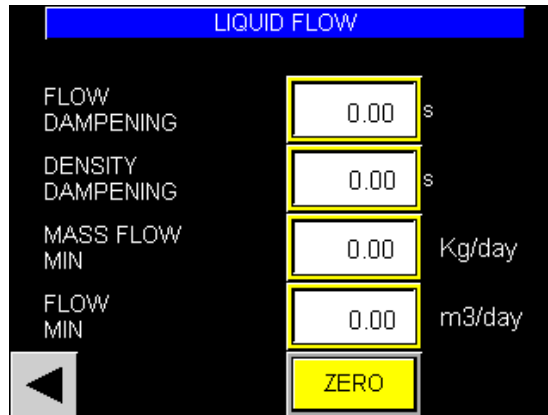
Make sure you select the appropriate option. They are:

- Disable
- Coriolis, PDI Temp
- Cor-API60F, Alt Temp
- Cor-API60F, Cor Temp
- Cor-API60F, PDI Temp
- Cor-API60F, Alt Temp
- Other

Select “Other” for the options A (Analog input) and C (writing MODBUS® registers). Select one of the others for the Option B (Reading Micro Motion®). For option B the most common is “Coriolis, PDI Temp” where the Micro Motion® unit has to be configured as Kg/m3 or API (Both in process Conditions). The temperature measured by the Phase Dynamics analyzer will be used for the corrections. Also, for option B (reading Micro Motion®) the proper communication port has to be selected. Touch the item you need to change or navigate the screen by using [SELECT], [VALUE] and [Enter]. In the next picture the option “Coriolis & PDI Temp” has been selected. Also, the communication port chosen was Com Port 4. For specific instruction to configure the selected port, see section 8.7.

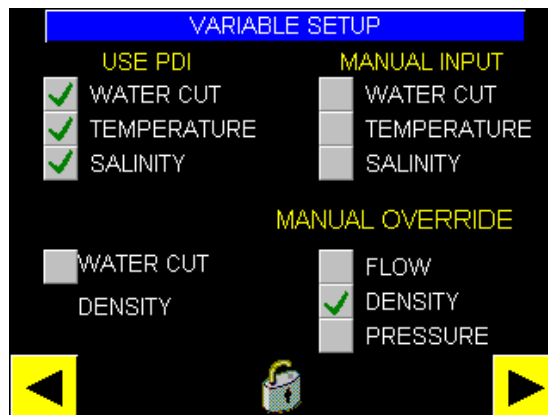


To configure the Micro Motion® Coriolis meter touch the “Configuration” arrow or access it by pressing [SELECT] until the blue arrow points to it and then [ENTER]. The LIQUID FLOW screen will show:



This screen can be used to configure some parameters of the Micro Motion® Coriolis Meter and also to zero it. The procedure to zero the meter is about 50 seconds long (depend on the internal configuration of the meter).

Go back by pressing the arrow on the lower left corner. Then press the arrow on the lower right corner or press [MENU]. The VARIABLE SETUP screen will show.



When supplying the density through one analog input (Option A) or reading it via MODBUS® from a Micro Motion® (Option B) leave the checkbox “DENSITY MANUAL OVERRIDE” **UNCHECKED**. For the option where the internal registers are written by MODBUS® (Option C) **CHECK** “DENSITY MANUAL OVERRIDE” the checkbox (as shown in the picture).

Leave all the other settings as they are for density correction.

Press [MENU] one more time to go to the following screen that shows the coefficients. The default coefficients work well for mostly all the application. Please don't modify them unless instructed by a Phase Dynamics specialist. The default coefficients are different for the two options in the Calibration Density. This is explained at the beginning of this chapter.

DENSITY CORRECTION

$X = D + D_{adj} - CalD; W/C_{adj} = D3 \cdot X^3 + D2 \cdot X^2 + D1 \cdot X + D0$

Dadj: 0.00 API

CalD: 32 API

D0: 0.000000 D2: 0.000000

D1: 0.160000 D3: 0.000000

This finishes the Flow Computer configuration. The three options require some extra information detailed in the separated sections that follow.

Remember to save the configurations after doing any change (See section 8.8)

8.3 *Specifics for Density Correction using a 4-20 mA Density Signal*

8.3.1 *Wiring*

The analog output of the densitometer has to be connected to the Analog Input 1 of the analyzer in Enhanced Electronics or in any of the 5 Analog Inputs of an Expanded Electronics. See section 2.6.1 for Analog inputs wiring.

8.3.2 *Setting the Analog Input on a 4 Lines LCD Display*

The first information needed is the Densitometer configuration. For example:

4mA = 800 Kg/m³ at standard conditions

20mA = 1000 Kg/m³ at standard conditions

Open the explosion proof box to access the back of the display board. Set the dip switches on S1 for “Technician Mode” (See section 4). S1-1 ON, S1-2 OFF.

Press [MENU] several times until you reach the screen “Configure AI”. If the unit is an Expanded model, more than one Analog Input will be available. Be sure the display shows the Analog Input number where you are going to connect the densitometer. If not, press [VALUE] to choose the desired Analog Input and then press [ENTER].

The next menu will be “AI # Variable”

Press [SELECT] to browse the variables list until you find “**FCI Density**”. Then press [ENTER] to accept it.

The next menu shown will be “AI # Unit”

Press [SELECT] to browse the units list. Press [ENTER] to accept it. As the variable is a density, the analyzer will show a list of density units. The options are:

| | | |
|--------|---------|-------------|
| API | g/cc | Lbs/m3 |
| API60F | g/ml | Ts/yd3 |
| API15C | g/l | Kg/m3 |
| Sg | Kg/l | Kg/m315C |
| Sg15C | Lbs/gal | Kg/m360F |
| Sg60F | Lbs/cf | API at 60°F |

Attention:

Select exactly the same unit used in the densitometer.

As the analyzer uses the corrected density for the density correction, if the supplied density is NOT corrected (indicated by selecting the proper units in the Analog Input) the analyzer will internally correct that density to standard conditions. For that reason, some units are repeated for different standard conditions. For example, “Kg/m3” means process conditions. Kg/m3 15C means that the density supplied by the densitometer is corrected at 15 C and atmospheric pressure.

After this, press [MENU] to access the next screen

AI #x LRV:

This screen will show the current Analog Input “Lower Range Value” LRV. This value is the value that will be assigned to a current input of 4mA. ***It has to match the setting of the densitometer.*** Press [MENU] skip this submenu or [SELECT] to enter the edition mode. If the value needs to be changed, press [SELECT] to move the cursor and [VALUE] to change the digits. When finished, press [ENTER] to accept it.

AI #x URV:

This screen will show the current Analog Input “Upper Range Value” URV. This is the value that will be assigned to a current input of 20 mA. ***It has to match the setting in the densitometer.*** Press [MENU] to skip this submenu or [SELECT] to enter the edition mode. If the value needs to be changed, press [SELECT] to move the cursor and [VALUE] to change the digits. When finished, press [ENTER] to accept it

AI #x Trim 4 mA:

This trimming is done at the factory so in this case this menu should be skipped.

AI #x Trim 20 mA:

This trimming is done at the factory so in this case this menu should be skipped.

AI #x Dampening (s):

This screen allows the user to set the dampening time in seconds. Press [MENU] to skip this submenu. Press [SELECT] to enter the edition mode. Use [SELECT] to move the cursor and "[VALUE] to change the digits. Then press [ENTER] to accept the new value.

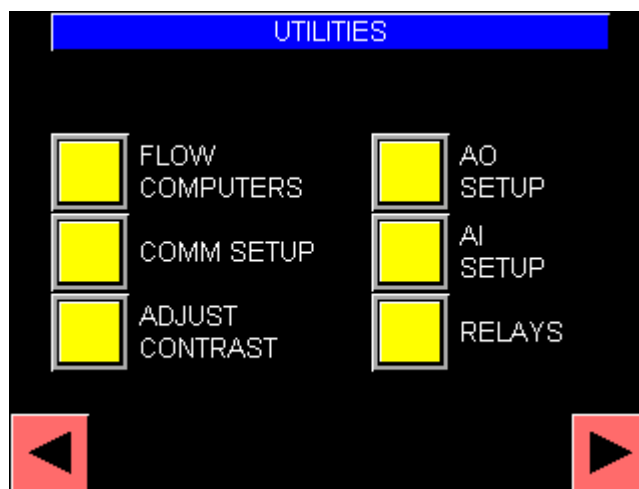
Analog Input #x:

This last screen shows the actual value of the Analog Input selected. Nothing can be changed on this one. This screen will allow the user to confirm that the signal from the densitometer is being received. The reading of the densitometer should match the reading on this screen.

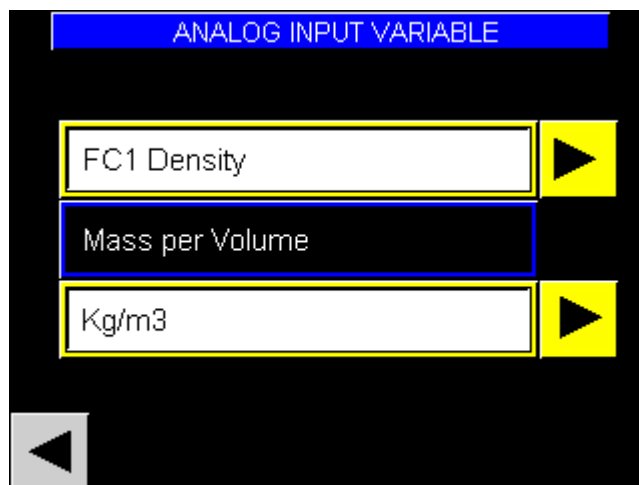
Analog Input # 1
11.94 mA / 49.63 %
FC1 Total Flow
1496.32 m3/hr

8.3.3 Setting the Analog Input on a Touch-Screen Display

Being on the main screen, press [SELECT] (or press the blue Menu button if the screen is accessible). Then press [MENU] several times (or touch the arrow on the lower right corner) until you reach the “Utilities” screen:

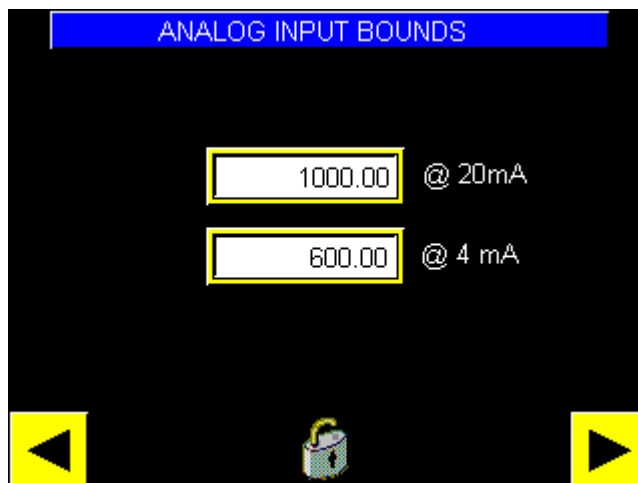


Then press [SELECT] many times until a small blue arrow points to AI SETUP and then press [ENTER] (or touch the AI SETUP button). If the analyzer electronics is Expanded, you will see a screen showing the 5 available analog inputs. Select the one it is going to be connected to the densitometer by pressing [SELECT] and then [ENTER] (Or by touching the button). If it is Enhanced, only one will be shown. Once inside the Analog Input setup the first screen will allow the user to select the variable and the unit. For density correction the variable *has to be* “FC1 Density”.



After selecting the variable, the proper units will be shown also. **You need to select exactly the same unit used in the densitometer.** The analyzer uses the corrected density for the density correction. If the supplied density is NOT corrected (indicated by selecting the proper units on the Analog Input) the analyzer will internally correct that density to standard conditions. That is the reason the list of units contains both standard and process. For example, “Kg/m3” means process conditions. Kg/m3 15C means that the density supplied by the densitometer is corrected at 15 C and atmospheric pressure.

Press [MENU] or touch the lower right arrow. The next screen lets the user set the Analog Input upper and lower limits. *These have to match the densitometer settings.*



The next screen (not shown here) is used to trim the analog input. As the trimming is done at the factory, skip this menu.

This finishes the setting of the analog input. Remember to save the configuration so the changes are not lost. See section 8.8 for instructions.

8.4 Specifics for Density Correction using a Micro Motion® Coriolis Meter (Option B)

The general configuration was explained in the sections:

8.1 – General Configuration on a 4 Lines LCD Display

And

8.2 – General Configuration on a Touch-Screen

The remaining task is to configure the communication port and to connect the Micro Motion® mass flow meter. For instructions on how to set the communication ports see Section 4.22 for a 4 lines LCD Display or Section 5.5.2.2 for a Touch-Screen

8.4.1 Wiring

After the communication port has been configured, use the following terminals according to the port set during the configuration to connect the Micro Motion® mass meter. If the Micro Motion® electronics is a core processor, a safety barrier has to be connected between the Micro Motion® and the Phase Dynamics electronics.

| Communication Port | Terminal Strip | Terminal Number | Terminal Name | Available with Touch-Screen |
|--------------------|----------------|-----------------|---------------|-----------------------------|
| 1 | J11 | 2 | COM1 A | YES |
| 1 | J11 | 3 | COM1 B | YES |
| 2 | J11 | 4 | COM2 A | NO |
| 2 | J11 | 5 | COM2 B | NO |
| 3 | J1 | 1 or 3 | COM3 A | YES |
| 3 | J1 | 2 or 4 | COM3 B | YES |
| 4 | J1 | 5 or 7 | COM4 A | YES |
| 4 | J1 | 6 or 8 | COM4 B | YES |

And the 24 VDC power for the mass flow meter can be connected at:

| Power | Terminal Strip | Terminal Number | Terminal Name | Available in Enhanced |
|---------|----------------|-----------------|---------------|-----------------------|
| + 24VDC | J1 | 35 | +24VDC | YES |
| GROUND | J1 | 36 | 24VDC RET | YES |

8.4.2 Micro Motion® Meter Configuration

The density units in the Micro Motion® have to be configured according to the option selected on the section 4.1 using Prolink®.

8.5 Specifics for Density Correction via MODBUS® (Option C)

The General Configuration was explained in the sections:

8.1– General Configuration on a 4 Lines LCD Display

And

8.2 – General Configuration on a Touch-Screen

Next is to connect the RS485 signal to the proper port and configure the port parameters. The signal can be connected to any port on analyzers with LCD screen. On analyzers with touch-screen the port 2 is not available.

8.5.1 Wiring

| Communication Port | Terminal Strip | Terminal Number | Terminal Name | Available with Touch-Screen |
|--------------------|----------------|-----------------|---------------|-----------------------------|
| 1 | J11 | 2 | COM1 A | YES |
| 1 | J11 | 3 | COM1 B | YES |
| 2 | J11 | 4 | COM2 A | NO |
| 2 | J11 | 5 | COM2 B | NO |
| 3 | J1 | 1 or 3 | COM3 A | YES |
| 3 | J1 | 2 or 4 | COM3 B | YES |
| 4 | J1 | 5 or 7 | COM4 A | YES |
| 4 | J1 | 6 or 8 | COM4 B | YES |

The communication parameters in the selected port have to match the one on the device writing to the analyzer. The default values for comm1 are 9600N1 and for comm2 are 115200N1. Both configurations can be changed from the UTILITIES screen. Please see the communication setup description on section 4.6 for 4 lines LCD and 4.7 for Touch-Screen.

8.5.2 Operation via MODBUS®

After the configuration is done, the density in the proper density unit (The one selected in sections 8.1 or 8.2), has to be written periodically on the floating-point register address: 20007. The byte order is ABCD.

8.6 Configuration of the Communication Ports on an LCD Screen

Check what port was selected during the general configuration (Section 8.1).

Being on the main screen, press [MENU] repeatedly until you find the screen “Configure Com1/PDI”. Press [SELECT] two or three times depending to the port to configure. The options are:

- Configure Com1/PDI
- Configure Com2/OIT
- Configure Com 3
- Configure Com 4

As mentioned before, for option B (reading Micro Motion mass meters) only Com3 and Com4 are available as master ports. Com1 and Com2 are Slaves. After reaching the desired port, press [ENTER] to access the configuration screens and then [MENU] to browse them, [SELECT] to enter in the edition mode and to move the cursor, [VALUE] to change the digits/options and [ENTER] every time a value has to be accepted.

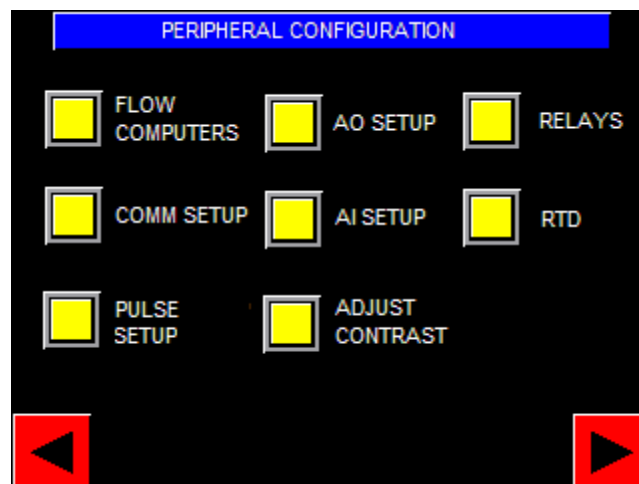
The submenus with their default values are:

- Cx Slave ID: 1
- Cx Baud Rate: 9600
- Cx Prefix (Ct): 1.5
- Cx Suffix (Ct): 0
- Cx Replay Delay (Ct): EOT 10
- Cx Watchdog (Ct): 50
- Cx Parity: NONE
- Cx Retry Time (s): 0.4
- Cx Statistics (Screen 1)
- Cx Statistics (Screen 2)

Make sure to configure them to match the Micro Motion® settings for Option B and to match the settings of the device writing the MODBUS® registers for Option C.

8.7 Configuration of the Communication Ports on a Touch-Screen

Check what port was selected during the general configuration (Section 8.2). Then being in the main screen, touch the blue Menu button or press [SELECT]. Then touch the lower right arrow or press [MENU] repeatedly until you find the following screen:



Touch the button “COMM SETUP” or press [SELECT] until a blue arrow points to it and then press [ENTER]. The first screens are statistics screens that show what is happening in the 4 communication ports. Press [MENU] several times to navigate through them or touch the lower right arrow. The following is the screen for port 3 shown as an example.

| NETWORK PORT STATISTICS | | 3 |
|-------------------------|-----|---|
| WATCHDOG | 0 | |
| BYTE ERROR | 0 | |
| INVALID COMMAND | 0 | |
| INVALID PACKET | 0 | |
| SUCCESSFUL PACKET | 356 | |

Keep browsing through the screens by pressing [MENU] or touching the lower right arrow. Find the screens to configure the ports 3 or 4 for Option B (Reading a Micro Motion®) or for port 1 for Option C (writing registers via MODBUS®). The port 2 is not available because is being used by the touch-screen. The following is the configuration screen for port 3.

| NETWORK PORT SETUP | | 3 | |
|--------------------|------|--------|------|
| SLAVE# | 1 | WDOG | 50 |
| BAUD | 9600 | PARITY | NONE |
| EOT | 10 | | |
| PREFIX | 1.5 | | |
| SUFFIX | 0.0 | | |

Look for the screen to configure the port that is going to be used and change the parameters so *they match the communication settings in the Micro Motion® for option B or the settings on the device writing the MODBUS® registers for option C.*

After the port is configured, keep touching the lower right arrow until you get out of the Communication Setup screens and go back to the Utilities screen. Once there, touch the lower right arrow several times to get to the screen that allows the user to save the configuration. Save the configuration by touching the floppy disk symbol and following instructions (See section 8.8) so it is not lost when the analyzer is power cycled. *After that power cycle the analyzer.* This needs to be done so the port is initialized with the new parameters.

8.8 Saving Configurations

This procedure is only used in the touch-screen version. The LCD display version saves the configuration every time the [ENTER] button is pressed. See section 5.5.3 to learn how to save configurations.

9 Instrument Repair and Service

9.1 Assistance and Factory address

Product maintenance agreements and other customer assistance agreements are available for this Phase Dynamics analyzer.

Phase Dynamics, Inc.
1251 Columbia Drive
Richardson, TX 75081
Voice: 972-680-1550
Fax: 972-680-3262
Email: techsupport@phasedynamics.com

9.2 Electrostatic Discharge (ESD)

All of the printed circuit board assemblies contain electronic components, which are sensitive to

CAUTION

Protect circuit boards and terminals from ESD at all times.

electrostatic discharge. Components damaged by ESD greatly increase the likelihood of a system error or failure.

Care should be taken to prevent damage from electrostatic discharge when working with the system. The technician should be wearing a ground strap. Boards removed from the system should be kept in anti-static bags.

9.3 Measurement Section and Analyzer

No field repair of the measurement section, oscillator, analyzer, or temperature probe should be necessary. If repair of these parts is needed, please consult Phase Dynamics.

9.4 Returning Items to the Factory

Please call or email Phase Dynamics prior to returning any equipment for service or repair. A return merchandise authorization (RMA) number may be required prior to shipment. Please include the following information with returned items:

1. Company name, address, telephone number
2. Key contact name, address, telephone number, fax number, email address
3. Serial number of item(s) being returned
4. A completed copy of the Troubleshooting Worksheet
5. Return merchandise authorization (RMA) number (if required)

9.5 Returning the Analyzer and the Measurement Section

Please drain and clean the measurement section of any and all dangerous or hazardous materials before returning to the factory.

Pack the analyzer and measurement section in the original shipping carton. If the original carton is missing, contact Phase Dynamics.

Place a packing slip on the outside of the carton containing both the return authorization and the serial number.

9.6 Troubleshooting Worksheet

The next few pages contain the Troubleshooting Worksheets. Please complete the form prior to contacting Technical Support.



PHASE DYNAMICS INC
 1251 COLUMBIA DR.
 RICHARDSON, TX 75081
 PHONE: 972 680 1550
 FAX: 972 680 3262
 EMAIL: thechsupport@phasedynamics.com

TROUBLESHOOTING WORKSHEET

| | |
|---------------------------|--|
| RMA NUMBER | |
| PDI CONTACT | |
| OSCILLATOR SERIAL NUMBER | |
| MEASUREMENT SERIAL NUMBER | |

| Company and Contact Information | | | |
|---------------------------------|--|-------|--|
| DATE | | PHONE | |
| COMPANY | | FAX | |
| CONTACT PERSON | | EMAIL | |
| ADDRESS | | | |
| ADDRESS | | | |

For 4 lines LCD display set the analyzer in technician mode (See section 4)

| Process and Analyzer Data | |
|---|---|
| Process Value (Current Actual Water Cut) | % |
| Process Temperature | <input type="checkbox"/> °C - <input type="checkbox"/> °F |
| Analyzer Reading (Indicated Water Cut) | % |
| Analyzer Frequency | MHZ |
| Analyzer RP | V |
| Density (Please indicate density units) | |
| Typical Flow Rate (Please indicate Flow rate units) | |
| Oil P1 | V/MHZ |
| Oil Po | V |
| Oil Frequency High | MHZ |
| Oil Frequency Low | MHZ |
| Adjust Oil | |
| Oil Index | MHZ |
| Diagnostics | |
| Error Code/Msg | |

POWER STATUS and RELAY INDICATORS

Connect power to the Analyzer.

Indicate the status of the Power Indicator and Relay LEDs. (Place a check-mark in the box if ON and well-lit.)

☐ 3.3V
 ☐ 5V
 ☐ 15V Osc
 ☐ 24V HTR
 ☐ Relay 1
 ☐ Relay 2


Motherboard Terminals – Measure with Voltmeter

| Signal Name | Terminal Strip | Probe | | Measured Voltage | Expected Voltage Range |
|-------------------|----------------|-------|----|------------------|------------------------|
| | | + | - | | |
| 5Volts Power | 3 | 1 | 2 | | +4.8 to +5.2VDC |
| 15 Volt Power | 11 | 28 | 29 | | +14.7 to 15.3VDC |
| Heater Power | 11 | 26 | 27 | | +22.0 to +28.0VDC |
| Ground Sense | 11 | 25 | 29 | | 0.00 to +0.40VDC |
| V Incident | 11 | 24 | 29 | | +0.20 to +4.95 VDC |
| V Reflected | 11 | 23 | 29 | | +0.20 to +4.95 VDC |
| Oscillator Select | 11 | 15 | 29 | | 0.00 to +12.5VDC |
| VTUNE | 11 | 14 | 29 | | 0.00 to +12.5VDC |
| EXTUNE | 11 | 13 | 29 | | 0.00 to 15VDC |

For 24 VDC Units Only

| Signal Name | Terminal Strip | Probe | | Measure Voltage | Expected Voltage Range |
|------------------------------|----------------|--------------|--------------|-----------------|------------------------|
| | | + | - | | |
| 24VDC Line to 24VDC Return | N/A | 24 VDC LINE | 24VDC RETURN | | -28 to + 28 VDC |
| 24VDC Return to Earth Ground | N/A | 24VDC RETURN | EARTH GROUND | | -28 to + 28 VDC |
| 24VDC Return to Chassis | N/A | 24VDC RETURN | Chassis | | -28 to + 28 VDC |

For 90 to 240 VAC Units Only

| Signal Name | Terminal Strip | Probe | | Measure Voltage | Expected Voltage Range |
|-------------------|----------------|-------|---|-----------------|------------------------|
| | | + | - | | |
| L to N | N/A | L | N | | 100 to 240VAC |
| N to Earth Ground | N/A | N |  | | 0 to 2VAC |
| N to Chassis | N/A | N | CHASSIS | | 0 to 2VAC |

RTD Test

Only in the case the temperature indication is wrong, please perform the following test:

Disconnect power and remove the Analyzer Board. Measure the RTD wires (P+, P1 ,P2 and P3) from the analyzer with an ohmmeter.

1. Measure P+(Term # 18) to P1 (Term 19). Is it 0Ω? ☐ YES ☐ NO _____ Ω
2. Measure P2 (Term # 20) to P3 (Term # 21). Is it 0Ω? ☐ YES ☐ NO _____ Ω
3. Measure P+ (Term # 18) to P3 (Term # 21). Is it 100-200Ω? ☐ YES ☐ NO _____ Ω

Connect a milliamp meter in series with the White/Brown wire (P+).

Install the Analyzer Board and reconnect power.

Measure the RTD current. Is it 0.200mA? ☐ YES ☐ NO _____ mA

If your meter cannot read less than 1mA, disconnect the 4 RTD wires and place a 1000Ω resistor across P+ and P3 and measure the voltage across the resistor.

Is it 0.20V? ☐ YES ☐ NO _____ V

Disconnect the power and reconnect the RTD.

DESCRIPTION OF THE PROBLEM:

[illegible]

NOTES:

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

9.7 Troubleshooting Guide

The following is a list of common problems, their probable cause and the solution

- Problem: Frequency and reflected power are zero:
- Possible cause: The oscillator is not receiving power.
- Solution: Measure the voltage between terminals 26 (HTR) and 27 (HTR RET) on the terminal strip J11. These terminals feed a heater that is inside the oscillator which function is to keep a constant temperature. This voltage should be 24VDC +/- 20%. If no voltage is measured, check the fuse F5 (2A) in the power supply board. If everything is correct with the heater power measure the voltage between terminals 28 (+15VDC) and 29 (GND) on the terminal strip J11. These terminals feed the oscillator itself. The voltage should be 15 VDC +/- 10%. If no voltage is measured, check the fuse F1 (0.5A) located on the power supply board and replace it if open. If both voltages are present and the frequencies and reflected powers reading are still zero replace the system cable. If readings are still zero, the oscillator has to be sent back to factory for repair.
- Problem: Analog Output doesn't work
- Possible cause: Bad fuse, Bad wiring or bad board.
- Solution: The analog output/s are ACTIVE and NON-ISOLATED. No external power is needed to generate the 4-20mA signal. Remove any wires on the analog output terminals. Connect a milliamp meter between the two output terminals. If there is no current at all, check the corresponding fuses on the Analyzer Board for Analog Output 1 and in the Input Output board for the Analog Output 2 to 5. See section 2.6.1 for terminals and fuses identification. If all the fuses are fine the corresponding board has to be replaced. If there is current present at the output, connect the wires going to the control room back to the terminals but also connect the milliamp meter in series with the positive wire. If there is no current, the loop is open somewhere. If the current is an unexpected value, the analog input might be active and it is supplying power to the analyzer. This might destroy the analog output. Disconnect the wires immediately and find a PASSIVE analog input to use with this output. The analog output/s value can be forced by setting the corresponding mode to "MANUAL". This is very useful while checking the communication with the control room. See section 5.5.2.5.6 to learn how to force the analog output/s
- Problem: Question Marks on the Water Content Reading
- Possible Cause: The analyzer is not able to calculate a valid water content
- Solution: If the analyzer has been power cycled and there are not frequency readings, it won't be able to calculate a valid water content and the screen will show question marks in the process text box. Please refer to the "Frequencies and reflected powers are zero" problem in the previous page.
- Problem: Analyzer reading is at full range all the time (4%, 10% or 20% water depending on the model).
- Possible Cause: The reflected power is too low.
- Solution: Set the analyzer into Technician Mode (for LCD screen only). Read the Frequency and the Reflected Power in the main screen. Browse through the menu and find the value of Oil P1 (See section 4.20) and Oil P0 (see section 4.21). Make sure that:

$$P0 + P1 \times \text{Frequency} < \text{Reflected Power}$$

If the condition is not true, decrease P0 until the term "P0+P1x Frequency" is at list 0.2 Volts less than the Reflected Power.

If the condition is true and the analyzer is still reading full scale then contact factory.

- Problem: Readings are erratic or don't match the samples
- Possible cause: Bad installation and/or low flow speed
- Solution: Check the prefer installations on section 2.2. Make sure your installation is not a water or a gas trap. Make sure the flow speed is higher than 2 feet per second.

The following are problems related only with the optional touch screen.

- Problem: Touch Screen not working
- Possible cause: Faulty power supply
- Solution: The touch screen has a power saving feature that put the screen to sleep after a certain time (programmable) of inactivity. To wake up the screen up just press [MENU]. If it is still not working measure the voltage between the terminals + and – on the back of the touch screen. This voltage should be 24VDC +/- 10%. If no voltage is present check the Fuse F2 (2A) and replace it if it is open. If there is voltage on the terminals + and – and the screen is still not working the screen is defective and have to be replaced.
- Problem: Touch Screen shows a “Host Communication Error”
- Possible Cause: The communication between the touch screen and the analyzer is lost.
- Solution: Power cycle the unit. If the problem persists check the wiring between the analyzer and the touch screen. If the problem persists, make sure all the fuses in the Power Supply board are fine. If the problem still persists, make sure the analog output and the MODBUS® communication on Com1 are working. If it is not working the problem could be a faulty processor board. If the 2 outputs are active then the problem could be a faulty communication board.

9.8 Error Descriptions

| <i>ERROR</i> | <i>DESCRIPTION</i> | <i>ACTION</i> |
|----------------------|--|--|
| Reset Basics | The analyzer has detected an error in the User Configuration and the Factory Configuration. Basic defaults have been loaded for operability. ALL data shall be considered invalid. | Contact Technical Support. |
| Reset | The unit has been reset, probably due to a power cycle. | If the condition persists, contact Technical Support. |
| Process out of range | The process value has exceeded its bounds. | <ol style="list-style-type: none"> 1. Complete the Troubleshooting Worksheet. 2. Check Oil Adjust, Water Adjust, and Salinity parameters. 3. Check reflected power (OIL) and compare to the power threshold line OIL P1, P0 to determine if the analyzer has detected the correct emulsion phase. 4. Check frequencies and compare to their boundaries. 5. Contact Technical Support. |
| Temperature error | The temperature has exceeded its bounds. | Check RTD and RTD assembly. |
| Frequency error | The frequency has exceeded its bounds. | <ol style="list-style-type: none"> 1. Complete the Troubleshooting Worksheet. 2. Check frequencies and compare to their boundaries. Contact Technical Support. |
| Variable Unit | An invalid unit code is detected. Data may be invalid. | Contact Technical Support. |
| Variable Bounds | A variable has exceeded its bounds. Data may be clipped or invalid. | Contact Technical Support. |
| Timer Failed | A timer has failed to initialize, or its queue is full. | Contact Technical Support. |
| Execute Failed | An execution event has failed, or its queue is full. | Contact Technical Support. |
| FLASH Memory | FLASH memory has failed. | Contact Technical Support. |
| Internal Memory | Internal memory has failed. | Contact Technical Support. |
| External Memory | External memory has failed. | Contact Technical Support. |
| Scaling error | Unable to scale primary variable for current output loop. | Check endpoint values. |
| Current Loop error | The loop current output does not correspond to the primary variable. | <ol style="list-style-type: none"> 1. Check HART address and if current loop is in fixed mode. 2. Check for error conditions that may signal with current loop. |

| <i>ERROR</i> | <i>DESCRIPTION</i> | <i>ACTION</i> |
|---|--|--|
| Salinity Calibration Over Range | The calculated salinity is greater than maximum. | Repeat Salinity Calibration. |
| Salinity Calibration Under Range | The calculated Salinity is less than minimum. | Repeat Salinity Calibration. |
| Salinity Calibration not Water Continuous | Fluid stream is oil continuous. | Repeat Salinity Calibration when water continuous. |
| Salinity Time | Not enough time for adequate salinity sample. | Allow more time for data capture. |

9.9 Diagnostic Error Codes

The most recent DIAGNOSTICS ERROR CODE remains until it is cleared.

| ERROR | DESCRIPTION |
|--------------|---|
| 0 | No error |
| 1 | Frequency error |
| 4 | User Temperature is out of range |
| 5 | Scaling error – cannot scale current output |
| 6 | Water Cut over range |
| 8 | FLASH failure |
| 9 | INTERNAL RAM failure |
| 10 | EXTERNAL RAM failure |
| 11 | Water Cut under range |
| 15 | Current Loop error |
| 16 | Reset Basics |
| 19 | Water Cut Overrange |
| 20 | RP Threshold |
| 21 | Salinity Time |
| 22 | Salinity Calibration over range |
| 23 | Salinity Calibration under range |
| 24 | Salinity Calibration not water continuous |
| 25 | Temperature under range |
| 26 | Temperature over range |
| 28 | Phase Logic Error (No longer used) |
| 34 | Oil Calibration not oil continuous |
| 35 | Time Reset Error |
| 50 | Invalid Watercut (No longer used) |

9.10 Faults and Alarms via Modbus

The faults and alarms are reflected in a pair of 16-bits registers (Diagnostics and Extended Diagnostics) and in individual coils in the MODBUS® Map.

The Diagnostics register is in the integer address 40002 and the floating-point register 3. The same 16 bits are individually decoded in the coils 1 to 16. The following table describe the Diagnostics register.

| Condition | Alarm/Fault | Diagnostic Bit [0-15] | Modbus Coil |
|-----------------------|-------------|-----------------------|-------------|
| Reset Basics | Fault | Bit 15 | 16 |
| Reset | Alarm | Bit 14 | 15 |
| Process High | Alarm | Bit 13 | 14 |
| Process Low | Alarm | Bit 12 | 13 |
| Temperature High | Alarm | Bit 11 | 12 |
| Temperature Low | Alarm | Bit 10 | 11 |
| Frequency High | Alarm | Bit 9 | 10 |
| Frequency Low | Alarm | Bit 8 | 9 |
| Internal Memory | Fault | Bit 7 | 8 |
| Variable Unit | Alarm | Bit 6 | 7 |
| Variable Bounds | Alarm | Bit 5 | 6 |
| FLASH Write-Protected | Alarm | Bit 4 | 5 |
| FLASH Memory | Fault | Bit 3 | 4 |
| Timer Failed | Fault | Bit 2 | 3 |
| Execute Failed | Fault | Bit 1 | 2 |
| External Memory | Fault | Bit 0 | 1 |

The following table describes the Extended Diagnostics Register and associated Coils. The Extended Diagnostics register is located in MODBUS address 40003 and floating point 5. The same bits are decoded individually into coil addresses 17 to 32

| Condition | Alarm/Fault | Diagnostic Bit [0-15] | Modbus Coil |
|-------------------------------|-------------|-----------------------|-------------|
| Time Reset | Fault | Bit 15 | 32 |
| Flow Computer 1 Failed | Alarm | Bit 14 | 31 |
| Reserved | | Bit 13 | 30 |
| Reserved | | Bit 12 | 29 |
| Sample Error | Fault | Bit 11 | 28 |
| Flow Computer 1 Extrapolation | Alarm | Bit 10 | 27 |
| Reserved | | Bit 9 | 26 |
| Reserved | | Bit 8 | 25 |
| Reserved | | Bit 7 | 24 |
| Reserved | | Bit 6 | 23 |
| Reserved | | Bit 5 | 22 |
| Reserved | | Bit 4 | 21 |
| Reserved | | Bit 3 | 20 |
| Reserved | | Bit 2 | 19 |
| Reserved | | Bit 1 | 18 |
| Time Reset | Fault | Bit 0 | 17 |

10 MODBUS® RTU

The Phase Dynamics Analyzer can communicate with MODBUS®-compatible hosts in a multi-drop RS-485 2-wire network. This appendix specifies the mapped addresses for the available data types, the implemented function codes, diagnostics, and other operational characteristics within the Phase Dynamics Analyzer.

| <i>Valid Function Codes</i> | <i>Address (Data) Type</i> | <i>Access</i> | <i>Description</i> |
|-----------------------------|-------------------------------|------------------------|---|
| 01,05,15 | Coil | Read/Write | Single ON/OFF, Bit (Boolean) |
| 02 | Discrete Input | Read-Only | Single ON/OFF, Bit (Boolean) |
| 03,04,16 | Floating-Point & Long Integer | Read-Only & Read/Write | Single Precision IEEE 754 Floating-Point Format or Long Integer Format using two consecutive 16-bit Registers |
| 04 | Input Register | Read-Only | Integer Format using a single 16-bit Register |
| 03,06,16 | Holding register | Read/Write | Integer Format using a single 16-bit Register |
| 03,04,06,16 | ASCII Characters | Read-Only & Read/Write | Two ASCII Characters packed in a single 16-bit register |

Coils, Discrete Inputs, and Registers may use the same address. The Function Code will determine which type of data is to be accessed.

10.1 Floating-Point / Long Integer Format

All floating-point register pairs are in the IEEE 754 Floating-Point Format. The standard byte transmission order is high to low per the following table:

| A | B | C | D |
|-----------|-----------|-----------|-----------|
| EEEE EEEE | EMMM MMMM | MMMM MMMM | MMMM MMMM |

A different byte transmission order can be requested by adding an offset to the floating-point and long integer register pairs that are to be accessed. The following table describes the offsets and the associated byte transmission orders:

| REGISTER OFFSET | BYTE TRANSMISSION ORDER | DESCRIPTION |
|------------------------|--------------------------------|---|
| 0 | A B C D | IEEE 754 Floating-Point Format Standard |
| 2000 | C D A B | IEEE 754 Floating-Point Format Word-swapped |
| 4000 | D C B A | IEEE 754 Floating-Point Format Reverse |
| 6000 | B A D C | IEEE 754 Floating-Point Format Byte-swapped |
| 8000 | A B C D | Scaled Long integer Standard |

10.2 Integer / ASCII-Pair Format

All word and ASCII byte-pair registers are transmitted high byte then low byte (AB). Integers are scaled, when appropriate. The scale factor is listed in the table.

10.3 Diagnostics Register Bit Definitions

The analyzer has a 16 bits diagnostics word. Every bit represents a different diagnostic.

Table 1 - DIAGNOSTICS BITS

| | | | | | | | |
|--------------|-----------|------------|------------|-----------|-----------|--------------|--------------|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
| Reset Basics | Reset | Process Hi | Process Lo | Temp Hi | Temp Lo | Frequency Hi | Frequency Lo |

| | | | | | | | |
|-----------------|----------|------------|-----------------------|--------------|--------------|----------------|-----------------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Internal Memory | VAR Unit | VAR Bounds | FLASH Write-Protected | FLASH Memory | Timer Failed | Execute Failed | External Memory |

| <i>DIAGNOSTICS FLAG</i> | <i>DESCRIPTION</i> |
|-------------------------|--|
| Reset Basics | The analyzer has detected an error in the User Configuration and the Factory Configuration. Basic defaults have been loaded for operability. ALL data shall be considered invalid. |
| Reset | The unit has been reset, probably due to a power cycle. |
| Process High | The process value has exceeded its upper bound. |
| Process Low | The process value has exceeded its lower bound. |
| Temperature High | The temperature has exceeded its upper bound. |
| Temperature Low | The temperature has exceeded its lower bound. |
| Frequency High | The frequency has exceeded its upper bound. |
| Frequency Low | The frequency has exceeded its lower bound. |
| Internal Memory | Internal memory has failed its check routine. |
| Variable Unit | An invalid unit code is detected. Data may be invalid. |
| Variable Bounds | A variable has exceeded its bounds. Data may be clipped or invalid. |
| FLASH Write-Protected | A write-protect error occurred while attempting to write to FLASH memory. |
| FLASH Memory | FLASH memory has failed its check routine. |
| Timer Failed | A timer has failed to initialize, or its queue is full. |
| Execute Failed | An execution event has failed, or its queue is full. |
| External Memory | External memory has failed its check routine. |

10.4 Diagnostics Error Code

The most recent DIAGNOSTICS ERROR CODE remains until it is cleared.

Table 2 - DIAGNOSTICS ERROR CODES

| <i>ERROR</i> | <i>DESCRIPTION</i> |
|--------------|---|
| 0 | No error |
| 1 | Frequency error |
| 4 | User Temperature is out of range |
| 5 | Scaling error – cannot scale current output |
| 6 | Water Cut over range |
| 8 | FLASH failure |
| 9 | INTERNAL RAM failure |
| 10 | EXTERNAL RAM failure |
| 11 | Water Cut under range |
| 15 | Current Loop error |

| | |
|----|---|
| 16 | Reset Basics |
| 21 | Salinity Time |
| 22 | Salinity Calibration over range |
| 23 | Salinity Calibration under range |
| 24 | Salinity Calibration not water continuous |
| 25 | Temperature under range |
| 26 | Temperature over range |
| 34 | Oil Calibration not oil continuous |

10.5 Saving the User Configuration

Notes:

1. Saving the configuration degrades the FLASH memory.
2. Saving ANY data will cause the ENTIRE configuration to be stored.
3. All auto-saves will save the ENTIRE configuration. There is, however, no Auto-save mode for the Coefficient Table. To save it, either write to an auto-save register, or write to the “*Save Configuration*” coil.
4. Locking and unlocking the device is considered to be an auto-save.

Upon completion of the setup, the user MUST save the configuration. There are three methods available to accomplish this:

1. Since all configuration data is updated in RAM, the unit will perform with the parameters as they are changed (except for the communications setup). However, upon reset, these parameters revert to their saved setting. To save the changes, write to the “*Save Configuration*” coil.
2. Sometimes a user will only need to update a few items. In most cases, the AUTOSAVE mode can be used. Simply add the appropriate offset to the address and your entire configuration will be automatically saved upon writing to that register. Care must be taken as to not use this too frequently because it will degrade the FLASH memory. Reading the offset registers will not cause an automatic save of the configuration.
3. An alternate AUTOSAVE mode is available for use with long integer or floating-point register pairs. The “*Automatic Save on Pair Boundary*” mode causes data to be saved upon write to the upper register boundary. For example, 00011..00012 is the register pair for Salinity. To automatically save this register, simply add 1 to the register address to read/write 00012..00013. This will only cause a boundary shift, and will not affect neighboring registers. If the “*Automatic Save on Pair Boundary*” mode is not set for the port, an address error will occur. Reading the offset registers will not cause an automatic save of the configuration.

Table 3 - AUTOSAVE OFFSETS

| TYPE | OFFSET |
|-------------------------------|-----------|
| Integer | 10000 |
| Floating-Point / Long Integer | 10000, 1* |
| Discrete IO / Coils | 10000 |

*This mode requires setting the “*Automatic Save on Pair Boundary*” coil for the corresponding port.

10.6 Write-Protection

Notes:

1. Upon lock or unlock, the configuration will be automatically saved!
The factory default code is 1234.
To unlock, simply enter the password into register 49990.

The Lock status bit 00050 reflects the current lock status.

To lock, simply write a 1 to the Lock status bit.

To change the password, the unit must be unlocked.

The password is stored in register 49980.

The password cannot be read.

There is a 10-second lockout if a wrong password is detected.

The FACTORY MODE unlock is limited to factory use and is not available to the user.

10.7 Calibration with MODBUS®

The Phase Dynamics Analyzer has two automatic-calibration modes. These modes allow the user to enter the measured water content to automatically adjust the parameters.

Prior to automatic-calibration, the user must take a sample and set the appropriate data-capture coil. This captured data will be used later when the current water content value is entered directly into the Calibrate Oil register. If this is not done first, the current measurements will be used instead. The oil calibration affects the value of the “Adjust Oil” factor. These values can also be adjusted manually, if desired. It is recommended that the configuration be saved upon completion of a capture.

10.8 MODBUS® Tables

Note: The addresses with a check mark in the “U” column can be saved in the User Configuration. The addresses with a checkmark in the “F” column can be saved in the Factory Configuration.

FACTORY MODE unlock is limited to factory use and is not available to the user

10.8.1 MODBUS® INTEGER TABLE

| ADDRESS (ABSOLUTE) | SCALE | U | F | DESCRIPTION |
|-----------------------|-------|---|---|--|
| 40001 | 1 | | | Serial Number – Measurement Section |
| 40002 | 1 | ✓ | ✓ | Diagnostics |
| 40003 | 1 | ✓ | ✓ | Extended Diagnostics |
| 40004 | 1 | ✓ | ✓ | Diagnostics Error Code |
| 40005 | 1 | ✓ | ✓ | Diagnostics Message Code |
| 40006 | 100 | | | Process Value (Water Content) |
| 40007 | 10 | | | Process Temperature |
| 40008 | 10 | | | User Temperature |
| 40009 | 1 | | | Emulsion Phase |
| 40010 | 1 | ✓ | ✓ | Stream Select |
| 40011 | 100 | ✓ | ✓ | Salinity |
| 40012 | 100 | ✓ | ✓ | Oil Adjust |
| 40014 | 1 | ✓ | ✓ | Unit Code – Temperature |
| 40015 | 1 | ✓ | ✓ | Mode - Oil Calculation |
| 40016 | 1 | ✓ | ✓ | Mode - Density Correction |
| 40017 | 1 | ✓ | ✓ | Density Correction Mode MODBUS® Master Port Select |
| 40018 | 1 | | | Timer Counter |

| ADDRESS (ABSOLUTE) | SCALE | U | F | DESCRIPTION |
|-----------------------|-------|---|---|--|
| 40019 | 1 | * | * | Mode – Demo Analyzer |
| 40020 | 1 | | ✓ | Mode – Analyzer |
| 40021 | 1 | | | Manufacturer ID |
| 40022 | 1 | | | HART Command Revision |
| 40023 | 1 | | | HART Transmitter Revision |
| 40024 | 1 | | | Firmware Version |
| 40025 | 1 | | | Hardware Version |
| 40026 | 1 | ✓ | ✓ | Number of Samples to Average |
| 40027 | 1 | | ✓ | Oil Phase Calculation Oscillator Select |
| 40029 | 1 | ✓ | ✓ | NaN Value for Integer |
| 40030 | 1 | | | Power Cycle Counter |
| 40031 | 1 | ✓ | ✓ | Mask - Diagnostics |
| 40032 | 1 | ✓ | ✓ | Mask - Extended Diagnostics |
| | | | | |
| 40091 | FS30K | | | Frequency – Oil Oscillator |
| 40092 | FS30K | | | Incident Power – Oil Oscillator |
| 40093 | FS30K | | | Reflected Power – Oil Oscillator |
| 40097 | FS30K | | | Water Content |
| 40098 | FS30K | | | Temperature |
| | | | | |
| 42101 | 1 | ✓ | ✓ | [1] Port – Slave Address |
| 42102 | 0.01 | ✓ | ✓ | [1] Port – Baud Rate |
| 42103 | 1 | ✓ | ✓ | [1] Port – Parity |
| 42104 | 100 | ✓ | ✓ | [1] Port – EOT Delay |
| 42105 | 100 | ✓ | ✓ | [1] Port – Prefix |
| 42106 | 100 | ✓ | ✓ | [1] Port – Suffix |
| 42107 | 100 | ✓ | ✓ | [1] Port – Watchdog |
| 42108 | 1 | ✓ | ✓ | [1] Port – Number of Bits |
| 42109 | 1 | ✓ | ✓ | [1] Port – Stop Bits |
| 42110 | 1 | ✓ | ✓ | [1] Port – Number of Retries |
| 42111 | 1 | ✓ | ✓ | [1] Port – Poll Time |
| 42112 | 1 | ✓ | ✓ | [1] Port – Timeout |
| 42113..42124 | | ✓ | ✓ | [2] Port |
| 42125..42136 | | ✓ | ✓ | [3] Port |
| 42137..42148 | | ✓ | ✓ | [4] Port |
| 42149 | | ✓ | ✓ | HART – Address (EEA) |
| 42150 | 1 | ✓ | ✓ | HART – Number of Preambles |
| | | | | |
| 44001 | 1 | ✓ | ✓ | Capture Oil – Number of Oil Oscillator Samples |
| 44002 | 1 | | | Capture Oil – Current Sample |
| 44003..44008 | 1 | | | Capture Oil – Time & Date Stamp |
| | | | | |
| 48001 | 1 | ✓ | ✓ | [1] Flow Computer – process unit code |
| 48002 | 1 | ✓ | ✓ | [1] Flow Computer – temperature unit code |

| ADDRESS (ABSOLUTE) | SCALE | U | F | DESCRIPTION |
|-----------------------|-------|---|---|--|
| 48003 | 1 | ✓ | ✓ | [1] Flow Computer – pressure unit code |
| 48004 | 1 | ✓ | ✓ | [1] Flow Computer – density unit code |
| 48005 | 1 | ✓ | ✓ | [1] Flow Computer – flow class code |
| 48006 | 1 | ✓ | ✓ | [1] Flow Computer – flow unit code |
| 48007 | 1 | ✓ | ✓ | [1] Flow Computer – accumulator unit code |
| 48008 | 1 | ✓ | ✓ | [1] Flow Computer – oil density unit code |
| 48009 | 1 | ✓ | ✓ | [1] Flow Computer – oil density @STP unit code |
| 48010 | 1 | ✓ | ✓ | [1] Flow Computer – water density unit code |
| 48011 | 1 | ✓ | ✓ | [1] Flow Computer – water density @STP unit code |
| 48012 | 1 | ✓ | ✓ | [1] Flow Computer – number of pulses per accumulation unit |
| 48013 | 1 | ✓ | ✓ | [1] Flow Computer – API Correction Table |
| | | | | |
| 48201..48202 | 1 | ✓ | ✓ | [1] Analog Input variable class, unit code |
| 48203..48204 | 1 | ✓ | ✓ | [2] Analog Input variable class, unit code |
| 48205..48206 | 1 | ✓ | ✓ | [3] Analog Input variable class, unit code |
| 48207..48208 | 1 | ✓ | ✓ | [4] Analog Input variable class, unit code |
| 48209..48210 | 1 | ✓ | ✓ | [5] Analog Input variable class, unit code |
| 48211..48212 | 1 | ✓ | ✓ | [1] Analog Output variable class, unit code |
| 48213..48214 | 1 | ✓ | ✓ | [2] Analog Output variable class, unit code |
| 48215..48216 | 1 | ✓ | ✓ | [3] Analog Output variable class, unit code |
| 48217..48218 | 1 | ✓ | ✓ | [4] Analog Output variable class, unit code |
| 48219..48220 | 1 | ✓ | ✓ | [5] Analog Output variable class, unit code |
| 48221..48222 | 1 | ✓ | ✓ | [6] Analog Output variable class, unit code |
| 48223..48224 | 1 | ✓ | ✓ | [7] Analog Output variable class, unit code |
| 48225..48226 | 1 | ✓ | ✓ | [8] Analog Output variable class, unit code |
| 48227..48228 | 1 | ✓ | ✓ | [9] Analog Output variable class, unit code |
| | | | | |
| 48229..48230 | 1 | ✓ | ✓ | [1] Relay variable class, unit code |
| 48231..48232 | 1 | ✓ | ✓ | [2] Relay variable class, unit code |
| | | | | |
| 45001..45002 | 1 | ✓ | ✓ | HART – Date |
| 45003..45019 | 1 | ✓ | ✓ | HART – Long Tag |
| 45020..45024 | 1 | ✓ | ✓ | HART – Short Tag |
| 45025..45033 | 1 | ✓ | ✓ | HART – Description |
| 45034..45050 | 1 | ✓ | ✓ | HART – Message |
| 45053..45054 | 1 | | ✓ | Calibration Version |
| 45055..45057 | 1 | | ✓ | Calibration Technician |
| 45058..42078 | 1 | | ✓ | Copyright |
| 45079..45089 | 1 | | ✓ | Analyzer Information |
| 45090..45095 | 1 | | ✓ | Assembly Date |
| | | | | |
| 49000 | 1 | ✓ | ✓ | Scratchpad Mirror of 49001 |
| 49001..49050 | 1 | ✓ | ✓ | Scratchpad |
| | | | | |

| <i>ADDRESS (ABSOLUTE)</i> | <i>SCALE</i> | <i>U</i> | <i>F</i> | <i>DESCRIPTION</i> |
|-------------------------------|--------------|----------|----------|------------------------------------|
| 49101..49120 | 1 | ✓ | ✓ | User-Select Register Configuration |
| | | | | |
| 49980 | 1 | ✓ | ✓ | Password Change |
| 49990 | 1 | * | * | Unlock (enter password here) |

10.8.2 MODBUS® FLOATING-POINT / LONG INTEGER TABLE

| ADDRESS (ABSOLUTE) | SCALE (LONG INT) | U | F | DESCRIPTION |
|-----------------------|------------------------|---|---|---|
| 00001 | 1 | | | Serial Number – Measurement Section |
| 00003 | 1 | ✓ | ✓ | Diagnostics |
| 00005 | 1 | ✓ | ✓ | Extended Diagnostics |
| 00007 | 1 | ✓ | ✓ | Diagnostics Error Code |
| 00009 | 1 | ✓ | ✓ | Diagnostics Message Code |
| 00011 | 1000 | | | Process Value (Water Content) |
| 00013 | 10 | | | Process Temperature |
| 00015 | 10 | | | User Temperature |
| 00017 | 1 | | | Emulsion Phase |
| 00019 | 1 | ✓ | ✓ | Stream Select |
| 00021 | 100 | ✓ | ✓ | Salinity |
| 00023 | 100 | ✓ | ✓ | Oil Adjust |
| 00027 | 1 | ✓ | ✓ | Unit Code – Temperature |
| 00029 | 1000 | | | Unadjusted, Unclipped Water Content Value |
| 00031 | 1000 | ✓ | ✓ | Oil Index |
| 00035 | 10000 | ✓ | ✓ | Oil P0 |
| 00037 | 10000 | ✓ | ✓ | Oil P1 |
| 00039 | 100 | ✓ | ✓ | Calibrate Oil Phase |
| | | | | |
| 00101 | 1000 | | | Frequency – Oil Oscillator |
| 00103 | 1000 | | | Incident Power – Oil Oscillator |
| 00105 | 1000 | | | Reflected Power – Oil Oscillator |
| 00107 | 1000 | | | IP/RP – Oil Oscillator |
| 00109 | 1000 | | | IP/RP (dB) – Oil Oscillator |
| | | | | |
| 00201 | 1000 | ✓ | ✓ | Oil Calculation Cutoff Value |
| 00203 | 1000 | ✓ | ✓ | Oil Calculation Curve 1 Maximum Value |
| 00205 | 1000 | ✓ | ✓ | Oil Calculation Curve 2 Maximum Value |
| | | | | |
| 00701 | 1000 | ✓ | ✓ | Dampening Value – Water Content |
| 00703 | 1000 | | ✓ | Minimum – Water Content |
| 00705 | 1000 | | ✓ | Maximum – Water Content |
| 00707 | 1000 | ✓ | ✓ | Alarm Low – Water Content |
| 00709 | 1000 | ✓ | ✓ | Alarm High – Water Content |
| | | | | |
| 00711 | 1000 | ✓ | ✓ | Dampening Value – Process Temperature |
| 00713 | 10 | | ✓ | Minimum – Process Temperature |
| 00715 | 10 | | ✓ | Maximum – Process Temperature |
| 00717 | 10 | ✓ | ✓ | Alarm Low – Process Temperature |
| 00719 | 10 | ✓ | ✓ | Alarm High – Process Temperature |
| 00721 | 10 | ✓ | ✓ | User Temperature Adjust |
| | | | | |
| 00723 | 100 | | ✓ | Minimum – Salinity |

| <i>ADDRESS (ABSOLUTE)</i> | <i>SCALE (LONG INT)</i> | <i>U</i> | <i>F</i> | <i>DESCRIPTION</i> |
|-------------------------------|---------------------------------|----------|----------|---|
| 00725 | 100 | | ✓ | Maximum – Salinity |
| | | | | |
| 00727 | 1000 | ✓ | ✓ | Minimum – Oil Frequency |
| 00729 | 1000 | ✓ | ✓ | Maximum – Oil Frequency |
| 00731 | 1000 | ✓ | ✓ | Low Oil Frequency |
| 00733 | 1000 | ✓ | ✓ | High Oil Frequency |
| | | | | |
| 00801 | 10000 | | | Oscillator Select Voltage |
| 00803 | 10000 | | | VTUNE Output Voltage |
| 00805 | 10000 | | | TUNE Select Voltage |
| 00807 | 10000 | | | Reflected Power |
| 00809 | 10000 | | | Incident Power |
| 00811 | 10000 | | | Process Temperature |
| 00813 | 10000 | | | Electronics Temperature |
| 00815 | 10000 | | | Ground Sense Voltage |
| 00817 | 10000 | | | VTUNE Input Voltage |
| | | | | |
| 00819 | 10000 | ✓ | ✓ | [1] DAC output voltage for Analog Output |
| 00821 | 10000 | ✓ | ✓ | [2] DAC output voltage for Analog Output |
| 00823 | 10000 | ✓ | ✓ | [3] DAC output voltage for Analog Output |
| 00825 | 10000 | ✓ | ✓ | [4] DAC output voltage for Analog Output |
| 00827 | 10000 | ✓ | ✓ | [5] DAC output voltage for Analog Output |
| 00829 | 10000 | ✓ | ✓ | [6] DAC output voltage for Analog Output |
| 00831 | 10000 | ✓ | ✓ | [7] DAC output voltage for Analog Output |
| 00833 | 10000 | ✓ | ✓ | [8] DAC output voltage for Analog Output |
| 00835 | 10000 | ✓ | ✓ | [9] DAC output voltage for Analog Output |
| | | | | |
| 00841 | 10000 | ✓ | ✓ | [1] ADC input voltage for Analog Input |
| 00843 | 10000 | ✓ | ✓ | [2] ADC input voltage for Analog Input |
| 00845 | 10000 | ✓ | ✓ | [3] ADC input voltage for Analog Input |
| 00847 | 10000 | ✓ | ✓ | [4] ADC input voltage for Analog Input |
| 00849 | 10000 | ✓ | ✓ | [5] ADC input voltage for Analog Input |
| | | | | |
| 00871 | 1 | ✓ | ✓ | [1] Relay – Mode |
| 00873 | 1 | ✓ | ✓ | [1] Relay – Status Mask |
| 00875 | 1 | ✓ | ✓ | [1] Relay – Variable Select |
| 00877 | 1 | ✓ | ✓ | [1] Relay – Setpoint Value |
| | | | | |
| 00881 | 1 | ✓ | ✓ | [2] Relay – Mode |
| 00883 | 1 | ✓ | ✓ | [2] Relay – Status Mask |
| 00885 | 1 | ✓ | ✓ | [2] Relay – Variable Select |
| 00887 | 1 | ✓ | ✓ | [2] Relay – Setpoint Value |
| | | | | |
| 00889 | 1000 | ✓ | ✓ | Density – Correction Factor for Temperature |
| 00891 | 10000 | ✓ | ✓ | Density – Correction Factor for Density |

| <i>ADDRESS (ABSOLUTE)</i> | <i>SCALE (LONG INT)</i> | <i>U</i> | <i>F</i> | <i>DESCRIPTION</i> |
|-------------------------------|---------------------------------|----------|----------|---|
| 00893 | 10000 | ✓ | ✓ | Density – Correction Factor Offset |
| 00895 | 100 | ✓ | ✓ | Density – Water Content Correction Factor |
| 00897 | 100 | ✓ | ✓ | Density – Water Content Correction Offset |
| 00899 | 100 | ✓ | ✓ | Density – Factory Calibration Density in API60F |
| | | | | |
| 01001 | 100 | ✓ | ✓ | [1] Analog Input – Current |
| 01003 | 100 | | | [1] Analog Input – Current Percent of Range |
| 01005 | 1 | ✓ | ✓ | [1] Analog Input – Value |
| 01007 | 1 | ✓ | ✓ | [1] Analog Input – Variable Select |
| 01009 | 1000 | ✓ | ✓ | [1] Analog Input – Current Dampening Value |
| 01011 | 1 | ✓ | ✓ | [1] Analog Input – Minimum Trim Value |
| 01013 | 1 | ✓ | ✓ | [1] Analog Input – Maximum Trim Value |
| 01015 | 1000 | ✓ | ✓ | [1] Analog Input – Minimum Trim Value Current |
| 01017 | 1000 | ✓ | ✓ | [1] Analog Input – Maximum Trim Value Current |
| 01019 | 10000 | ✓ | ✓ | [1] Analog Input – Lower Range Value |
| 01021 | 10000 | ✓ | ✓ | [1] Analog Input – Upper Range Value |
| 01031..01052 | | | | [2] Analog Input |
| 01061..01082 | | | | [3] Analog Input |
| 01091..01112 | | | | [4] Analog Input |
| 01121..01142 | | | | [5] Analog Input |
| | | | | |
| 01201 | 100 | ✓ | ✓ | [1] Analog Output – Current |
| 01203 | 100 | | | [1] Analog Output – Current Percent of Range |
| 01205 | 1 | ✓ | ✓ | [1] Analog Output – Variable Select |
| 01207 | 1000 | ✓ | ✓ | [1] Analog Output – Current Dampening Value |
| 01209 | 1000 | ✓ | ✓ | [1] Analog Output – Proportional Constant |
| 01211 | 1000 | ✓ | ✓ | [1] Analog Output – Integral Constant |
| 01213 | 1000 | ✓ | ✓ | [1] Analog Output – Derivative Constant |
| 01215 | 1000 | ✓ | ✓ | [1] Analog Output – Manual Percent Input |
| 01217 | 1000 | ✓ | ✓ | [1] Analog Output – PID Setpoint |
| 01219 | 1 | ✓ | ✓ | [1] Analog Output – Minimum Trim Value |
| 01221 | 1 | ✓ | ✓ | [1] Analog Output – Maximum Trim Value |
| 01223 | 1000 | ✓ | ✓ | [1] Analog Output – Minimum Trim Value Current |
| 01225 | 1000 | ✓ | ✓ | [1] Analog Output – Maximum Trim Value Current |
| 01227 | 10000 | ✓ | ✓ | [1] Analog Output – Lower Range Value |
| 01229 | 10000 | ✓ | ✓ | [1] Analog Output – Upper Range Value |
| 01231..01260 | | | | [2] Analog Output |
| 01261..01290 | | | | [3] Analog Output |
| 01291..01320 | | | | [4] Analog Output |
| 01321..01350 | | | | [5] Analog Output |
| 01351..01380 | | | | [6] Analog Output |
| 01381..01410 | | | | [7] Analog Output |
| 01411..01440 | | | | [8] Analog Output |
| 01441..01470 | | | | [9] Analog Output |
| | | | | |

| <i>ADDRESS (ABSOLUTE)</i> | <i>SCALE (LONG INT)</i> | <i>U</i> | <i>F</i> | <i>DESCRIPTION</i> |
|-------------------------------|---------------------------------|----------|----------|---|
| 01701 | 1 | | | [1] Port – Watchdog Counter |
| 01703 | 1 | | | [1] Port – Error Counter |
| 01705 | 1 | | | [1] Port – Invalid Command Counter |
| 01707 | 1 | | | [1] Port – Invalid Packet Counter |
| 01709 | 1 | | | [1] Port – Success Counter |
| 01711 | 1 | | | [1] Port – Number of Retries Counter |
| 01713..01724 | | | | [2] Port Counters |
| 01725..01736 | | | | [3] Port Counters |
| 01737..01748 | | | | [4] Port Counters |
| 01749..01758 | | | | [5] Port Counters |
| 01759..01768 | | | | [7] Port Counters |
| 01769..01778 | | | | [8] Port Counters |
| | | | | |
| 01851 | 1 | | | LOG – n |
| 01853 | 1 | | | LOG – maximum records per sector |
| 01855 | 1 | | | LOG – current sector |
| 01857 | 1 | | | LOG – number of possible sectors |
| 01859 | 1 | ✓ | ✓ | LOG – Sampling Period |
| 01861 | 1 | | | LOG – Index |
| | | | | |
| 01901..01940 | 1000 | ✓ | ✓ | Scratchpad |
| | | | | |
| 01951..01965 | 1 | | | ESN |
| 01967 | 1 | | ✓ | Serial Number – Measurement Section |
| 01969 | 1 | | ✓ | Serial Number – Power Board |
| 01971 | 1 | | ✓ | Serial Number – Processor Board |
| 01973 | 1 | | ✓ | Serial Number – Communications Board |
| 01975 | 1 | | ✓ | Serial Number – Analyzer Board |
| 01977 | 1 | | ✓ | Serial Number – Analog I/O Board |
| 01979 | 1 | | ✓ | Serial Number – Motherboard |
| 01981 | 1 | | ✓ | Serial Number – DC Board |
| 01983 | 1 | | ✓ | Serial Number – Oscillator |
| 01985 | 1 | ✓ | ✓ | Final Assembly Number |
| | | | | |
| 20001 | 1000 | ✓ | ✓ | [1] Flow Computer – Process Value (Water Content) |
| 20003 | 10 | ✓ | ✓ | [1] Flow Computer – Process Temperature |
| 20005 | 1000 | ✓ | ✓ | [1] Flow Computer – Pressure |
| 20007 | 1000 | ✓ | ✓ | [1] Flow Computer – Density |
| 20009 | 1000 | | | [1] Flow Computer – PDI Corrected Density |
| 20011 | 100 | ✓ | ✓ | [1] Flow Computer – Salinity |
| 20013 | 100000 | ✓ | ✓ | [1] Flow Computer – Meter Factor |
| 20015 | 100000 | ✓ | ✓ | [1] Flow Computer – Shrinkage |
| 20017 | 1000 | ✓ | ✓ | [1] Flow Computer – Oil Density |
| 20019 | 1000 | ✓ | ✓ | [1] Flow Computer – Oil Density @STP |

| <i>ADDRESS (ABSOLUTE)</i> | <i>SCALE (LONG INT)</i> | <i>U</i> | <i>F</i> | <i>DESCRIPTION</i> |
|-------------------------------|---------------------------------|----------|----------|---|
| 20021 | 1000 | ✓ | ✓ | [1] Flow Computer – Water Density |
| 20023 | 1000 | ✓ | ✓ | [1] Flow Computer – Water Density @STP |
| 20025 | 1000 | | | [1] Flow Computer – VCF Oil |
| 20027 | 1000 | | | [1] Flow Computer – VCF Water |
| 20029 | 1000 | | | [1] Flow Computer – Net Water Content |
| 20031 | 1000 | ✓ | ✓ | [1] Flow Computer – Total Flow Rate |
| 20033 | 1000 | | | [1] Flow Computer – Oil Flow Rate |
| 20035 | 1000 | | | [1] Flow Computer – Water Flow Rate |
| 20037 | 1000 | | | [1] Flow Computer – Gross Total |
| 20039 | 1000 | | | [1] Flow Computer – Gross Oil |
| 20041 | 1000 | | | [1] Flow Computer – Gross Water |
| 20043 | 1000 | | | [1] Flow Computer – Pulse Counter |
| 20045 | 1000 | | | [1] Flow Computer – Pulse Flow |
| 20047 | 1000 | | | [1] Flow Computer – Pulse Total |
| 20049 | 1000 | | | [1] Flow Computer – Net Flow Total |
| 20051 | 1000 | | | [1] Flow Computer – Net Flow Oil |
| 20053 | 1000 | | | [1] Flow Computer – Net Flow Water |
| 20055 | 1000 | | | [1] Flow Computer – Net Total |
| 20057 | 1000 | | | [1] Flow Computer – Net Oil |
| 20059 | 1000 | | | [1] Flow Computer – Net Water |
| 20061 | 1000 | ✓ | ✓ | [1] Flow Computer – α |
| 20073 | 1000 | | | [1] Flow Computer Gross Average Water Cut |
| 20075 | 1000 | | | [1] Flow Computer NET Average Water Cut |
| 20201..20262 | | | | [2] Flow Computer |
| 20401..20462 | | | | [3] Flow Computer |

10.8.3 MODBUS® DISCRETE IO / COIL TABLE

| ADDRESS (ABSOLUTE) | U | F | DESCRIPTION |
|-----------------------|---|---|---|
| 00001..00016 | ✓ | ✓ | Diagnostics |
| 00017..00032 | ✓ | ✓ | Extended Diagnostics |
| 00033 | ✓ | ✓ | Alarm |
| 00034 | ✓ | ✓ | Error |
| 00035 | | ✓ | Demo Mode |
| 00036 | ✓ | ✓ | Data Change Indicator (automatically clears when data is saved) |
| 00037 | | | Real Time Clock is Present |
| 00039 | | | Alarm High – Water Content |
| 00040 | | | Alarm Low – Water Content |
| 00041 | | | Alarm High – Temperature |
| 00042 | | | Alarm Low – Temperature |
| 00043 | | | Alarm High – Electronics Temperature |
| 00044 | | | Alarm Low – Electronics Temperature |
| 00050 | ✓ | ✓ | Lock & Lock Status |
| 00101 | ✓ | ✓ | Select Temperature Units Degree C |
| 00102 | ✓ | ✓ | Capture Oil Phase Data Record |
| 00104 | ✓ | ✓ | Ignore MODBUS® Data Exceptions |
| 00105 | ✓ | ✓ | Autosave on Pair Boundary in MODBUS® |
| 00106 | ✓ | ✓ | Force Hart Command Revision 5 |
| 00107 | ✓ | ✓ | Enable Current Loop Output |
| 00111 | | ✓ | Force Into Research Analyzer Mode |
| 00113 | | ✓ | Disable the Oscillator's Heater |
| 00115 | ✓ | ✓ | Enable Periodic Built-in Tests |
| 00116 | * | * | Perform Full Self-test |
| 00117 | * | * | System Reset |
| 00118 | ✓ | ✓ | Save the User Configuration |
| 00119 | ✓ | ✓ | Restore the User Configuration |
| 00120 | * | * | Restore Factory Defaults |
| 00123 | ✓ | ✓ | LOG – Enable Periodic Logging |
| 00124 | ✓ | ✓ | LOG – Enable Erase on Next Cycle |
| 00125 | ✓ | ✓ | LOG – Enable Configuration Logging |
| 00126 | ✓ | ✓ | LOG – Enable Error Logging |
| 00127 | * | * | System Restart |
| 00141 | * | * | Reset Totalizers |

Hart®



The Phase Dynamics Analyzer can communicate with HART® compatible hosts in a multi-drop or point-to-point network. This appendix specifies the protocol, setup and configuration settings.

HART® instruments communicate over a half-duplex network at 1200 baud, 8 bits, odd parity, and 1 stop bit. HART® 202 supports older current loops in either a point-to-point or multi-drop network. Phase Dynamics' implementation of HART® is user-selectable to communicate HART®□5 or HART®□6 according to the *Universal Command Specification Revision 5.2 or Revision 6.0* and the *Data Link Layer Specification Revision 8.1*. The transmitter revision is 2.

The three HART® Dynamic Variables are:

| VARIABLE | DESCRIPTION | UNIT |
|-----------|---------------------|--------|
| PRIMARY | Process (Water Cut) | % |
| SECONDARY | Temperature | °C |
| TERTIARY | Emulsion Phase | (None) |

A handheld device such as a Rosemount 275 communicator may be connected directly to the terminals HART on the motherboard.

Attention:

In order to save the configuration, the write-protect (Device Discrete #2) must be turned on after all configuration changes are complete. You may then turn it back off. This process will force the configuration in RAM to be stored to FLASH. On some hand-held units, there may be a communication error during the save, but simply retry to continue.

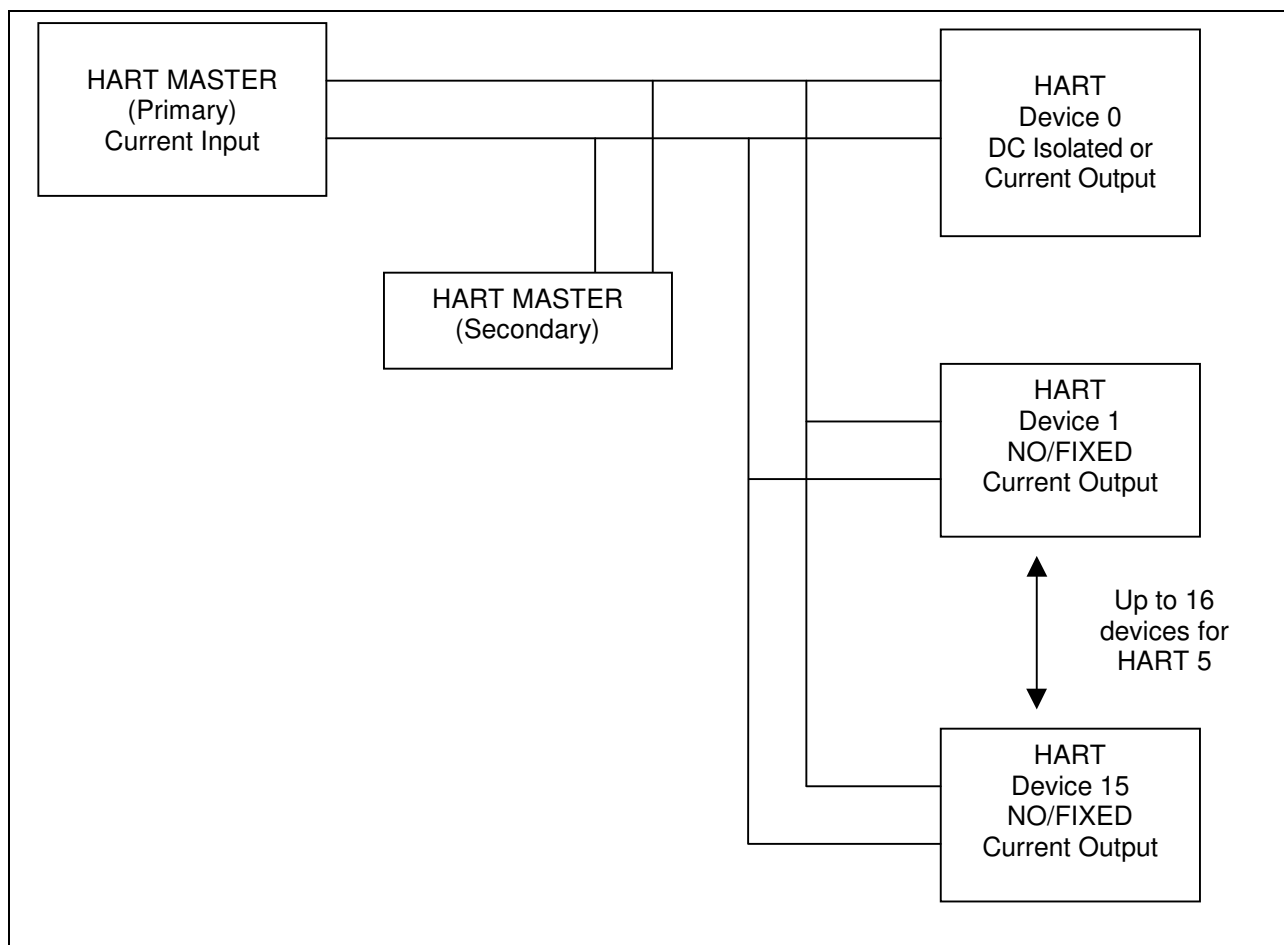


Figure 1 - Typical HART® Connection Diagram

10.9 Command 128: Read Floating-Point Device Parameters

This command allows a Master to request the value of up to four Floating-Point Device Parameters. In other words, a Master may request only 1, 2, 3, or 4 Floating-Point Device Parameters. The Field Device must answer these Master requests without returning Response Code 5, *Too Few Data Bytes Received*. If the Field Device receives 1, 2, or 3 Request Data Bytes, it must return only the corresponding number of Floating-Point Device Parameters (see table below).

For a list of Floating-Point Device Parameters, please refer to the *Floating-Point Device Parameter Table*.

Command 128 Response Based on Number of Floating-Point Device Parameters Requested

| Number of Device Parameters Requested | Number of Requested Data Bytes | Number of Response Data Bytes |
|---------------------------------------|--------------------------------|-------------------------------|
| 1 | 1 | 7 |
| 2 | 2 | 14 |
| 3 | 3 | 21 |
| 4 | 4 | 28 |

Request Data Bytes

| Byte | Format | Description |
|------|------------|--|
| 0 | Unsigned-8 | Slot 0: Floating-Point Device Parameter Code |
| 1 | Unsigned-8 | Slot 1: Floating-Point Device Parameter Code |
| 2 | Unsigned-8 | Slot 2: Floating-Point Device Parameter Code |
| 3 | Unsigned-8 | Slot 3: Floating-Point Device Parameter Code |

Response Data Bytes

| Byte | Format | Description |
|---------|------------|---|
| 0 | Unsigned-8 | Slot 0: Floating-Point Device Parameter Code |
| 1 | Enum | Slot 0: Floating-Point Device Parameter Variable Classification |
| 2 | Enum | Slot 0: Floating-Point Device Parameter Unit Code |
| 3 - 6 | Float | Slot 0: Floating-Point Device Parameter Value |
| 7 | Unsigned-8 | Slot 1: Floating-Point Device Parameter Code |
| 8 | Enum | Slot 1: Floating-Point Device Parameter Variable Classification |
| 9 | Enum | Slot 1: Floating-Point Device Parameter Unit Code |
| 10 - 13 | Float | Slot 1: Floating-Point Device Parameter Value |
| 14 | Unsigned-8 | Slot 2: Floating-Point Device Parameter Code |
| 15 | Enum | Slot 2: Floating-Point Device Parameter Variable Classification |
| 16 | Enum | Slot 2: Floating-Point Device Parameter Unit Code |
| 17 - 20 | Float | Slot 2: Floating-Point Device Parameter Value |
| 21 | Unsigned-8 | Slot 3: Floating-Point Device Parameter Code |
| 22 | Enum | Slot 3: Floating-Point Device Parameter Variable Classification |
| 23 | Enum | Slot 3: Floating-Point Device Parameter Unit Code |
| 24 - 27 | Float | Slot 3: Floating-Point Device Parameter Value |

Command-Specific Response Codes

| Code | Class | Description |
|-------------|--------------|-----------------------------|
| 0 | Success | No Command-Specific Errors |
| 2 | Error | Invalid Selection |
| 5 | Error | Too Few Data Bytes Received |
| 32 | Error | Device Busy |

10.10 Command 129: Write Floating-Point Device Parameter

This command allows a Master to set the value of one Floating-Point Device Parameter. The Floating-Point Device Parameter Unit Code received with this command does not affect the Floating-Point Device Parameter Units of the Field Device. The Floating-Point Device Parameter value will be returned in the same units as received.

For a list of Floating-Point Device Parameters, please refer to the *Floating-Point Device Parameter Table*.

Request Data Bytes

| Byte | Format | Description |
|-------|------------|---|
| 0 | Unsigned-8 | Floating-Point Device Parameter Code |
| 1 | Enum | Floating-Point Device Parameter Variable Classification |
| 2 | Enum | Floating-Point Device Parameter Unit Code |
| 3 - 6 | Float | Floating-Point Device Parameter Value |

Response Data Bytes

| Byte | Format | Description |
|-------|------------|---|
| 0 | Unsigned-8 | Floating-Point Device Parameter Code |
| 1 | Enum | Floating-Point Device Parameter Variable Classification |
| 2 | Enum | Floating-Point Device Parameter Unit Code |
| 3 - 6 | Float | Floating-Point Device Parameter Value |

Command-Specific Response Codes

| Code | Class | Description |
|------|---------|---------------------------------|
| 0 | Success | No Command-Specific Errors |
| 2 | Error | Invalid Selection |
| 3 | Error | Value too high |
| 4 | Error | Value too low |
| 5 | Error | Too Few Data Bytes Received |
| 7 | Error | In Write-Protect Mode |
| 12 | Error | Invalid Variable Classification |
| 18 | Error | Invalid Unit Code |
| 32 | Error | Device Busy |

10.11 Command 130: Read Discrete

This command allows a Master to read one Device Discrete value.

For a list of Device Discrete, please refer to the *Device Discrete Table*.

Request Data Bytes

| Byte | Format | Description |
|------|------------|----------------------|
| 0 | Unsigned-8 | Device Discrete Code |

Response Data Bytes

| Byte | Format | Description |
|------|------------|-----------------------|
| 0 | Unsigned-8 | Device Discrete Code |
| 1 | Bit – 0 | Device Discrete Value |

Command-Specific Response Codes

| Code | Class | Description |
|------|---------|-----------------------------|
| 0 | Success | No Command-Specific Errors |
| 2 | Error | Invalid Selection |
| 5 | Error | Too Few Data Bytes Received |
| 32 | Error | Device Busy |

10.12 Command 131: Write Discrete

This command allows a Master to write one Device Discrete value.
For a list of Device Discrete, please refer to the *Device Discrete Table*.

Request Data Bytes

| Byte | Format | Description |
|------|------------|-----------------------|
| 0 | Unsigned-8 | Device Discrete Code |
| 1 | Bit – 0 | Device Discrete Value |

Response Data Bytes

| Byte | Format | Description |
|------|------------|-----------------------|
| 0 | Unsigned-8 | Device Discrete Code |
| 1 | Bit – 0 | Device Discrete Value |

Command-Specific Response Codes

| Code | Class | Description |
|------|---------|-----------------------------|
| 0 | Success | No Command-Specific Errors |
| 2 | Error | Invalid Selection |
| 5 | Error | Too Few Data Bytes Received |
| 7 | Error | In Write-Protect Mode |
| 12 | Error | Invalid Value |
| 32 | Error | Device Busy |

10.13 Command 132: Read Integer Device Parameter

This command allows a Master to request the value of up to four Integer Device Parameters. In other words, a Master may request only 1, 2, 3, or 4 Integer Device Parameters. The Field Device must answer these Master requests without returning Response Code 5, *Too Few Data Bytes Received*. If the Field Device receives 1, 2, or 3 Request Data Bytes, it must return only the corresponding number of Integer Device Parameters (see table below).

For a list of Integer Device Parameters, please refer to the *Integer Device Parameter Table*.

Command 132 Response Based on Number of Integer Device Parameters Requested

| Number of Device Parameters Requested | Number of Requested Data Bytes | Number of Response Data Bytes |
|---------------------------------------|--------------------------------|-------------------------------|
| 1 | 1 | 5 |
| 2 | 2 | 10 |
| 3 | 3 | 15 |
| 4 | 4 | 20 |

Request Data Bytes

| Byte | Format | Description |
|------|------------|---------------------------------------|
| 0 | Unsigned-8 | Slot 0: Integer Device Parameter Code |
| 1 | Unsigned-8 | Slot 1: Integer Device Parameter Code |
| 2 | Unsigned-8 | Slot 2: Integer Device Parameter Code |
| 3 | Unsigned-8 | Slot 3: Integer Device Parameter Code |

Response Data Bytes

| Byte | Format | Description |
|---------|-------------|--|
| 0 | Unsigned-8 | Slot 0: Integer Device Parameter Code |
| 1 | Enum | Slot 0: Integer Device Parameter Variable Classification |
| 2 | Enum | Slot 0: Integer Device Parameter Unit Code |
| 3 – 4 | Unsigned-16 | Slot 0: Integer Device Parameter Value |
| 5 | Unsigned-8 | Slot 1: Integer Device Parameter Code |
| 6 | Enum | Slot 1: Integer Device Parameter Variable Classification |
| 7 | Enum | Slot 1: Integer Device Parameter Unit Code |
| 8 – 9 | Unsigned-16 | Slot 1: Integer Device Parameter Value |
| 10 | Unsigned-8 | Slot 2: Integer Device Parameter Code |
| 11 | Enum | Slot 2: Integer Device Parameter Variable Classification |
| 12 | Enum | Slot 2: Integer Device Parameter Unit Code |
| 13 – 14 | Unsigned-16 | Slot 2: Integer Device Parameter Value |
| 15 | Unsigned-8 | Slot 3: Integer Device Parameter Code |
| 16 | Enum | Slot 3: Integer Device Parameter Variable Classification |
| 17 | Enum | Slot 3: Integer Device Parameter Unit Code |
| 18 – 19 | Unsigned-16 | Slot 3: Integer Device Parameter Value |

Command-Specific Response Codes

| Code | Class | Description |
|------|---------|-----------------------------|
| 0 | Success | No Command-Specific Errors |
| 2 | Error | Invalid Selection |
| 5 | Error | Too Few Data Bytes Received |
| 32 | Error | Device Busy |

10.14 Command 133: Write Integer Device Parameter

This command allows a Master to set the value of one Integer Device Parameter. The Integer Device Parameter Unit Code received with this command does not affect the Integer Device Parameter Units of the Field Device. The Integer Device Parameter value will be returned in the same units as received.

For a list of Integer Device Parameters, please refer to the *Integer Device Parameter Table*.

Request Data Bytes

| Byte | Format | Description |
|-------|------------|--|
| 0 | Unsigned-8 | Integer Device Parameter Code |
| 1 | Enum | Integer Device Parameter Variable Classification |
| 2 | Enum | Integer Device Parameter Unit Code |
| 3 - 4 | Integer-16 | Integer Device Parameter Value |

Response Data Bytes

| Byte | Format | Description |
|-------|------------|--|
| 0 | Unsigned-8 | Integer Device Parameter Code |
| 1 | Enum | Integer Device Parameter Variable Classification |
| 2 | Enum | Integer Device Parameter Unit Code |
| 3 - 4 | Integer-16 | Integer Device Parameter Value |

Command-Specific Response Codes

| Code | Class | Description |
|------|---------|---------------------------------|
| 0 | Success | No Command-Specific Errors |
| 2 | Error | Invalid Selection |
| 3 | Error | Value too high |
| 4 | Error | Value too low |
| 5 | Error | Too Few Data Bytes Received |
| 7 | Error | In Write-Protect Mode |
| 12 | Error | Invalid Variable Classification |
| 18 | Error | Invalid Unit Code |
| 32 | Error | Device Busy |

10.15 Command 134: Read Device Variables

This command allows a Master to request the value of up to four Device Variables. In other words, a Master may request only 1, 2, 3, or 4 Device Variables. The Field Device must answer these Master requests without returning Response Code 5, *Too Few Data Bytes Received*. If the Field Device receives 1, 2, or 3 Request Data Bytes, it must return only the corresponding number of Device Variables (see table below).

For a list of Device Variables, please refer to the *Device Variable Table*.

Command 134 Response Based on Number of Device Variables Requested

| Number of Device Variables Requested | Number of Requested Data Bytes | Number of Response Data Bytes |
|--------------------------------------|--------------------------------|-------------------------------|
| 1 | 1 | 9 |
| 2 | 2 | 17 |
| 3 | 3 | 25 |
| 4 | 4 | 33 |

Request Data Bytes

| Byte | Format | Description |
|------|------------|------------------------------|
| 0 | Unsigned-8 | Slot 0: Device Variable Code |
| 1 | Unsigned-8 | Slot 1: Device Variable Code |
| 2 | Unsigned-8 | Slot 2: Device Variable Code |
| 3 | Unsigned-8 | Slot 3: Device Variable Code |

Response Data Bytes

| Byte | Format | Description |
|---------|------------|---|
| 0 | Bits | Extended Field Device Status |
| 1 | Unsigned-8 | Slot 0: Device Variable Code |
| 2 | Enum | Slot 0: Device Variable Classification |
| 3 | Enum | Slot 0: Device Variable Unit Code |
| 4 – 7 | Float | Slot 0: Device Variable Value |
| 8 | Bits | Slot 0: Device Variable Status |
| 9 | Unsigned-8 | Slot 1: Device Variable Code |
| 10 | Enum | Slot 1: Device Variable Classification |
| 11 | Enum | Slot 1: Device Variable Unit Code |
| 12 – 15 | Float | Slot 1: Device Variable Value |
| 16 | Bits | Slot 1: Device Variable Status |
| 17 | Unsigned-8 | Slot 2: Device Variable Code |
| 18 | Enum | Slot 2: Device Variable Variable Classification |
| 19 | Enum | Slot 2: Device Variable Unit Code |
| 20 – 23 | Float | Slot 2: Device Variable Value |
| 24 | Bits | Slot 2: Device Variable Status |
| 25 | Unsigned-8 | Slot 3: Device Variable Code |
| 26 | Enum | Slot 3: Device Variable Variable Classification |
| 27 | Enum | Slot 3: Device Variable Unit Code |
| 28 – 31 | Float | Slot 3: Device Variable Value |
| 32 | Bits | Slot 3: Device Variable Status |

Command-Specific Response Codes

| Code | Class | Description |
|-------------|--------------|-----------------------------|
| 0 | Success | No Command-Specific Errors |
| 2 | Error | Invalid Selection |
| 5 | Error | Too Few Data Bytes Received |
| 32 | Error | Device Busy |

10.16 Command 135: Read Integer Device Variables

This command allows a Master to request the value of up to four Integer Device Variables. In other words, a Master may request only 1, 2, 3, or 4 Integer Device Variables. The Field Device must answer these Master requests without returning Response Code 5, *Too Few Data Bytes Received*. If the Field Device receives 1, 2, or 3 Request Data Bytes, it must return only the corresponding number of Integer Device Variables.

For a list of Integer Device Variables, please refer to the *Integer Device Variable Table*.

Command 135 Response Based on Number of Integer Device Parameters Requested

| Number of Device Parameters Requested | Number of Requested Data Bytes | Number of Response Data Bytes |
|---------------------------------------|--------------------------------|-------------------------------|
| 1 | 1 | 5 |
| 2 | 2 | 10 |
| 3 | 3 | 15 |
| 4 | 4 | 20 |

Request Data Bytes

| Byte | Format | Description |
|------|------------|---------------------------------------|
| 0 | Unsigned-8 | Slot 0: Integer Device Parameter Code |
| 1 | Unsigned-8 | Slot 1: Integer Device Parameter Code |
| 2 | Unsigned-8 | Slot 2: Integer Device Parameter Code |
| 3 | Unsigned-8 | Slot 3: Integer Device Parameter Code |

Response Data Bytes

| Byte | Format | Description |
|---------|-------------|--|
| 0 | Unsigned-8 | Slot 0: Integer Device Parameter Code |
| 1 | Enum | Slot 0: Integer Device Parameter Variable Classification |
| 2 | Enum | Slot 0: Integer Device Parameter Unit Code |
| 3 – 4 | Unsigned-16 | Slot 0: Integer Device Parameter Value |
| 5 | Unsigned-8 | Slot 1: Integer Device Parameter Code |
| 6 | Enum | Slot 1: Integer Device Parameter Variable Classification |
| 7 | Enum | Slot 1: Integer Device Parameter Unit Code |
| 8 – 9 | Unsigned-16 | Slot 1: Integer Device Parameter Value |
| 10 | Unsigned-8 | Slot 2: Integer Device Parameter Code |
| 11 | Enum | Slot 2: Integer Device Parameter Variable Classification |
| 12 | Enum | Slot 2: Integer Device Parameter Unit Code |
| 13 – 14 | Unsigned-16 | Slot 2: Integer Device Parameter Value |
| 15 | Unsigned-8 | Slot 3: Integer Device Parameter Code |
| 16 | Enum | Slot 3: Integer Device Parameter Variable Classification |
| 17 | Enum | Slot 3: Integer Device Parameter Unit Code |
| 18 – 19 | Unsigned-16 | Slot 3: Integer Device Parameter Value |

Command-Specific Response Codes

| Code | Class | Description |
|------|---------|-----------------------------|
| 0 | Success | No Command-Specific Errors |
| 2 | Error | Invalid Selection |
| 5 | Error | Too Few Data Bytes Received |
| 32 | Error | Device Busy |

10.17 HART® Tables

10.17.1 HART® Dynamics Variables

The following table lists the Dynamic Variables that are available using the HART® protocol.

Table 1 - HART® Dynamic Variable Table

| <i>Dynamic Variable Number</i> | <i>Description</i> |
|------------------------------------|---|
| 0 - PRIMARY | Process (Water Cut) |
| 1 - SECONDARY | Temperature |
| 2 - TERTIARY | Emulsion Phase – 0.0 = Oil continuous, 1.0 = Water continuous, 2.0 = Undetermined |

10.17.2 HART® Device Parameters – Floating-Point

The following table lists the Floating-Point Device Parameters that are available to be read and written using the HART® protocol. Command 128 reads one through four Floating-Point Device Parameters and Command 129 writes one Floating-Point Device Parameter.

Table 2 - HART® Floating-Point Device Parameter Table

| <i>Parameter Number</i> | <i>Description</i> |
|-------------------------|--|
| 0 | Salinity – based on Stream Number |
| 1 | Oil Adjust (Cal. Factor) – based on Stream Number |
| 2 | Oil Frequency Index |
| 3 | Water Adjust – based on Stream Number (Only use in Full Range Analyzers) |
| 4 | Water Frequency Index (Only use in Full Range Analyzers) |
| 5 | Alarm Relay Set Point – based on Stream Number (Standard Electronics Only) |
| 6 | Output Loop 4 mA Point |
| 7 | Output Loop 20 mA Point |
| 8 | Temperature Adjust |
| 9 | Oil P0 |
| 10 | Oil P1 |
| 11 | Oil Low Frequency |
| 12 | Oil High Frequency |
| 13 | Water Low Frequency (Only use in Full Range Analyzers) |
| 14 | Water High Frequency (Only use in Full Range Analyzers) |
| 15 | Auto-Cal Oil Value |
| 16 | Auto-Cal Water Value (Only use in Full Range Analyzers) |
| 17 | Calibration API |
| 18 | Density Correction A1 Coefficient |
| 19 | Density Correction A0 Coefficient |
| 20 | 4 mA API Density |
| 21 | 20 mA API Density |
| 22 | 4 mA kg/m3 Density |
| 23 | 20 mA kg/m3 Density |

10.17.3 HART® Device Discrete

The following table lists the Device Discrete items that are available to be read and written using the HART® protocol. Command 130 reads one Device Discrete and Command 131 writes one Device Discrete. A value of 0 = OFF and 1 = ON.

Table 3 - HART® Device Discrete Table

| <i>Discrete Number</i> | <i>Description</i> |
|------------------------|--|
| 0 | Alarm Relay (Standard Electronics - Read Only) |
| 1 | Error Relay (Standard Electronics - Read Only) |
| 2 | Write Protect |
| 3 | Clear Gross Fluid Accumulators |
| 4 | Restore Factory Defaults |
| 5 | Restore Stream (Well) Defaults |
| 6 | Master Reset |
| 7 | Clear Analyzer Diagnostics |
| 8 | Clear Analyzer Error Code |
| 9 | Built-In Test Enable |
| 10 | Alarm Relay Greater Than or Equal to Set Point |
| 11 | Stream Select Mode (Standard Electronics) |
| 12 | Error Relay Normally Closed |
| 13 | Temperature in degrees C |
| 14 | Use HART® Universal Command Revision 5 |
| 15 | Active Current Loop Mode |
| 16 | Capture Oil Auto-Cal Data |
| 17 | Capture Water Auto-Cal Data |
| 18 | MODBUS® Enable |
| 19 | Dual Pulsed Relays |
| 20 | Emulsion Phase Relay |
| 21 | Temperature Averaging |
| 22 | Data Change Indicator |
| 23 | Save Configuration |

10.17.4 HART® Device Parameters - Integer

The following table lists the Integer Device Parameters that are available to be read and written using the HART® protocol. Command 132 reads one through four Integer Device Parameters and Command 133 writes one Integer Device Parameter.

Table 4 - HART® Integer Device Parameter Table

| <i>Parameter Number</i> | <i>Description</i> |
|-------------------------|-------------------------------|
| 0 | Stream Number |
| 1 | Samples to Average |
| 2 | Phase Holdover Cycles |
| 3 | Alarm Relay Delay |
| 4 | Flow Meter Type |
| 5 | Flow Volume Units |
| 6 | Flow Rate Time Units |
| 7 | Counts Per Flow Unit |
| 8 | 20 mA Maximum Flow Rate Input |
| 9 | Accumulator Display Format |
| 10 | 4 mA D/A Counts |
| 11 | 20 mA D/A Counts |
| 12 | HART Response Delay |
| 13 | Number of Response Preambles |
| 14 | Reference Current Mode |
| 15 | Oil Auto-Cal Samples |
| 16 | Water Auto-Cal Samples |
| 17 | Density Correction Mode |
| 18 | MODBUS® Slave Address |
| 19 | MODBUS® Baud Rate |
| 20 | MODBUS® Parity |
| 21 | MODBUS® Stop Bits |
| 22 | MODBUS® Response Delay |

10.17.5 HART® Device Variables

The following table lists the Device Variables that are available to be read using the HART® protocol. Command 134 reads one through four Device Variables. Command 135 reads one through four Integer Device Variables.

Table 5 - HART® Device Variable Table

| Variable Number | Description |
|-----------------|---|
| 0 | Water Cut |
| 1 | Temperature |
| 2 | Emulsion Phase – 0.0 = Oil-continuous, 1.0 = Water-continuous, 2.0 = Undetermined |
| 3 | Analyzer Diagnostics |
| 4 | Analyzer Error Code |
| 5 | Oil Oscillator Frequency |
| 6 | Oil Oscillator Incident Power |
| 7 | Oil Oscillator Reflected Power |
| 8 | Water Oscillator Frequency |
| 9 | Water Oscillator Incident Power |
| 10 | Water Oscillator Reflected Power |
| 11 | Gross Oil Accumulator (Flow Meter Required) |
| 12 | Gross Water Accumulator (Flow Meter Required) |
| 13 | Gross Total Fluids Accumulator (Flow Meter Required) |
| 14 | Oil Flow Rate (Flow Meter Required) |
| 15 | Water Flow Rate (Flow Meter Required) |
| 16 | Total Fluid Flow Rate (Flow Meter Required) |
| 17 | Internal Temperature (Stand-alone Electronics Only) |
| 18 | Analog Input 1 |
| 19 | Analog Input 1 Percent of Range |
| 20 | Analog Input 2 |
| 21 | Analog Input 2 Percent of Range |
| 22 | Analog Input 3 |
| 23 | Analog Input 3 Percent of Range |
| 24 | Analog Input 4 |
| 25 | Analog Input 4 Percent of Range |
| 26 | Analog Input 5 |
| 27 | Analog Input 5 Percent of Range |
| 28 | Analog Output 1 |
| 29 | Analog Output 1 Percent of Range |
| 30 | Analog Output 2 |
| 31 | Analog Output 2 Percent of Range |
| 32 | Analog Output 3 |
| 33 | Analog Output 3 Percent of Range |
| 34 | Analog Output 4 |
| 35 | Analog Output 4 Percent of Range |
| 36 | Analog Output 5 |
| 37 | Analog Output 5 Percent of Range |
| 38 | Analog Output 6 |
| 39 | Analog Output 6 Percent of Range |

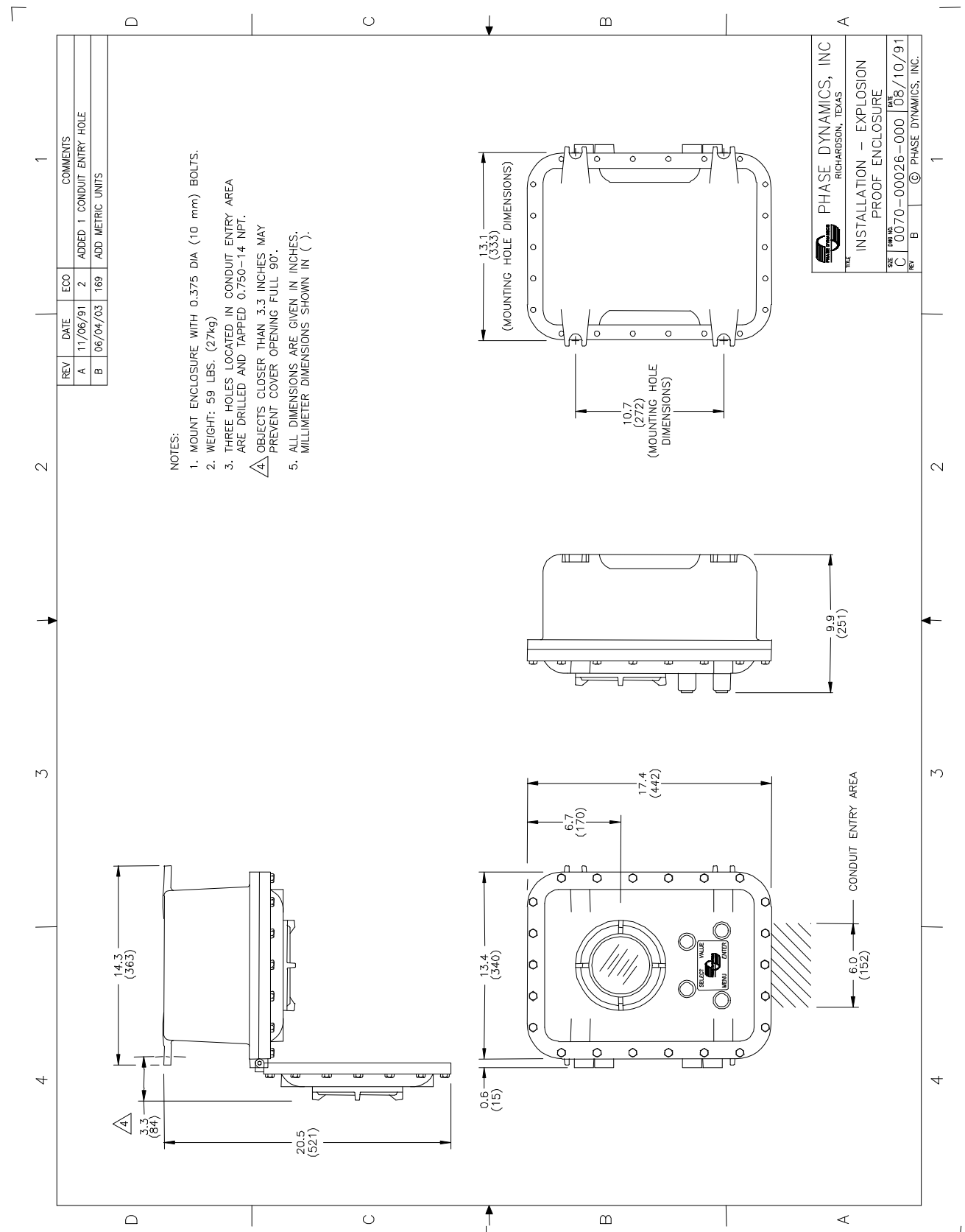
| | |
|-----|---------------------------------------|
| 40 | Analog Output 7 |
| 41 | Analog Output 7 Percent of Range |
| 42 | Analog Output 8 |
| 43 | Analog Output 8 Percent of Range |
| 44 | Analog Output 9 |
| 45 | Analog Output 9 Percent of Range |
| 46 | Flow Computer 1 – Pulse Frequency |
| 47 | Flow Computer 1 – Water Content |
| 48 | Flow Computer 1 – Temperature |
| 49 | Flow Computer 1 – Pressure |
| 50 | Flow Computer 1 – Salinity |
| 51 | Flow Computer 1 – Density |
| 52 | Flow Computer 1 – Oil Density |
| 53 | Flow Computer 1 – Water Density |
| 54 | Flow Computer 1 – Oil Flow Rate |
| 55 | Flow Computer 1 – Water Flow Rate |
| 56 | Flow Computer 1 – Total Flow Rate |
| 57 | Flow Computer 1 – Gross Oil |
| 58 | Flow Computer 1 – Gross Water |
| 59 | Flow Computer 1 – Gross Total |
| 60 | Flow Computer 1 – Net Oil |
| 61 | Flow Computer 1 – Net Water |
| 62 | Flow Computer 1 – Net Total |
| 63 | Flow Computer 1 – Net Flow Rate Oil |
| 64 | Flow Computer 1 – Net Flow Rate Water |
| 65 | Flow Computer 1 – Net Flow Rate Total |
| 109 | Stream Select |
| 110 | Salinity |

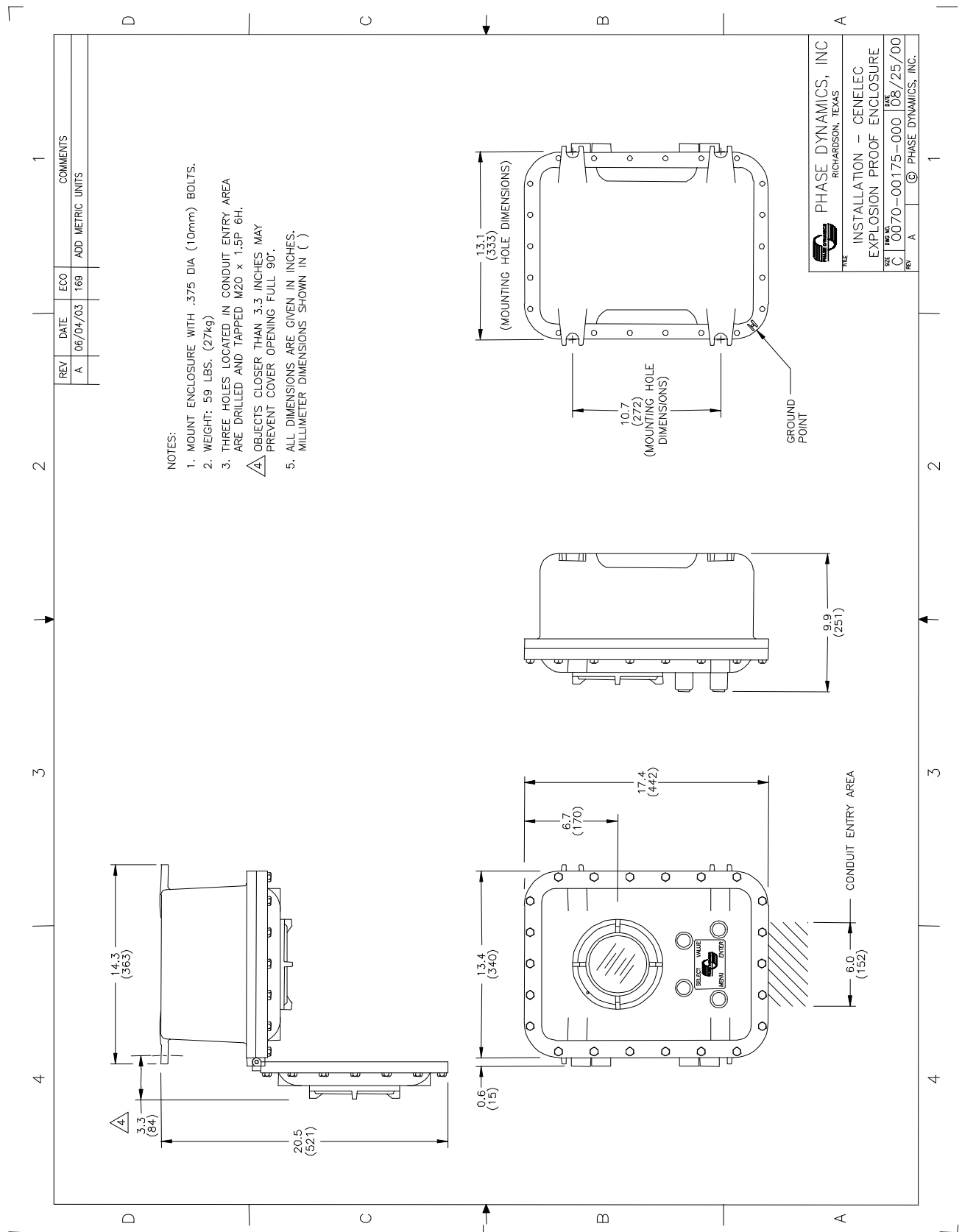
Table 6 - HART® Integer Device Variable Table

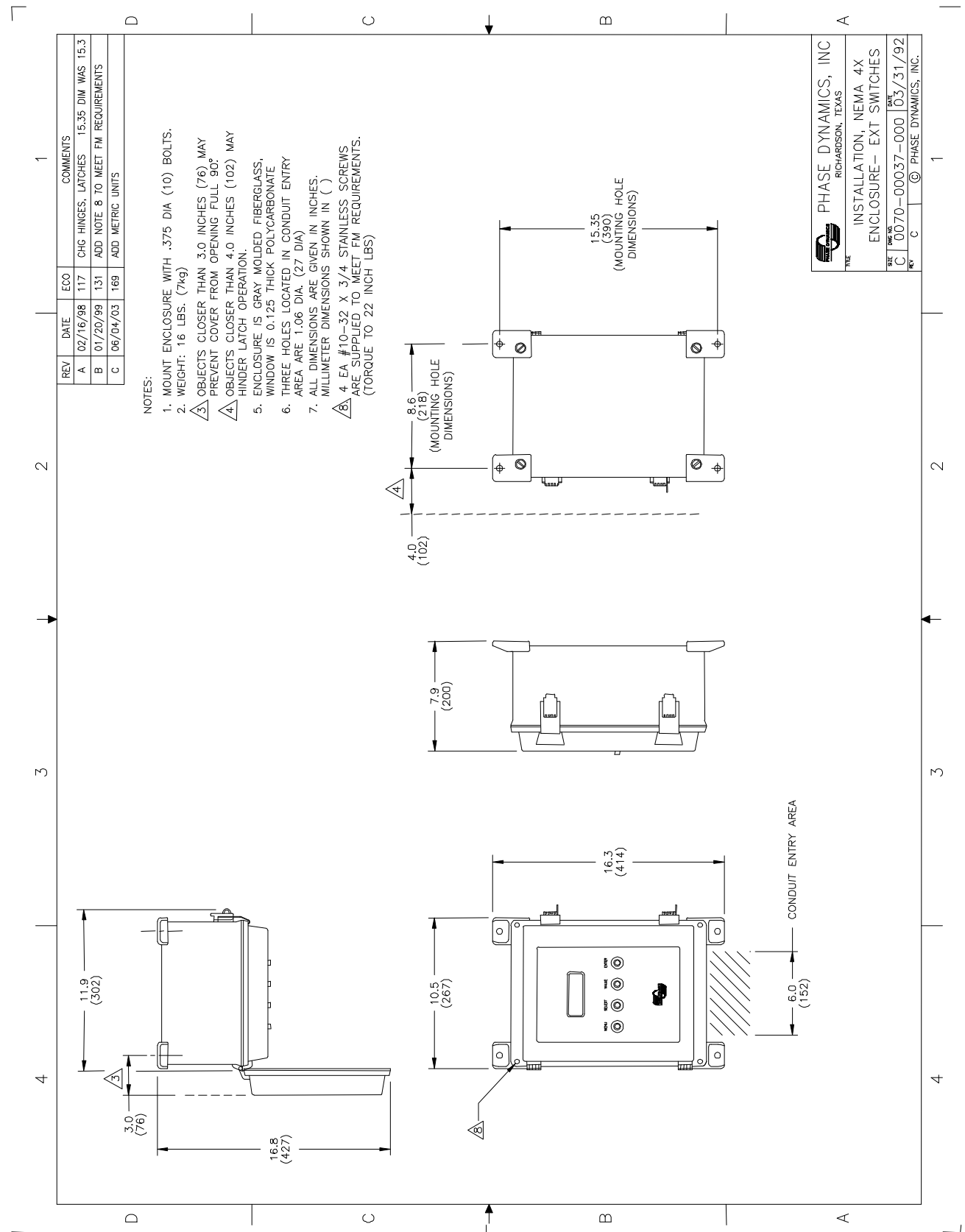
| <i>Variable Number</i> | <i>Description</i> |
|------------------------|---|
| 0 | HART [®] Diagnostics |
| 1 | Analyzer Diagnostics |
| 2 | Analyzer Error Code |
| 3 | Emulsion Phase 0 = Oil-continuous, 1 = Water-continuous, 2 = Undetermined |
| 4 | Analyzer Diagnostics Enumerated |

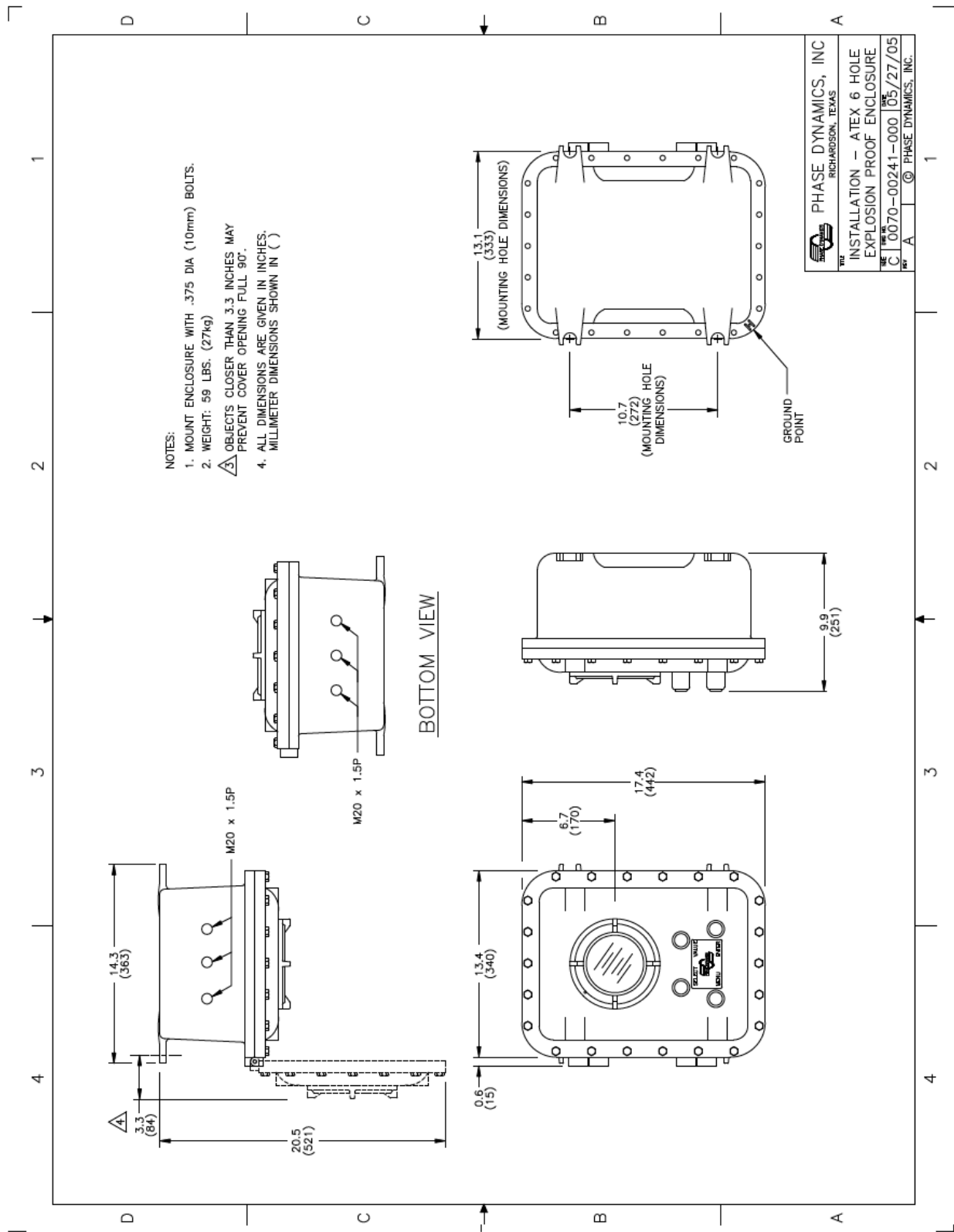
11 Dimensional Installation Drawings

Attached are various installation drawings needed for proper mounting and installation of the Low Range Phase Dynamics Water in Hydrocarbon Analyzer. Please consult the factory for other drawings not included.

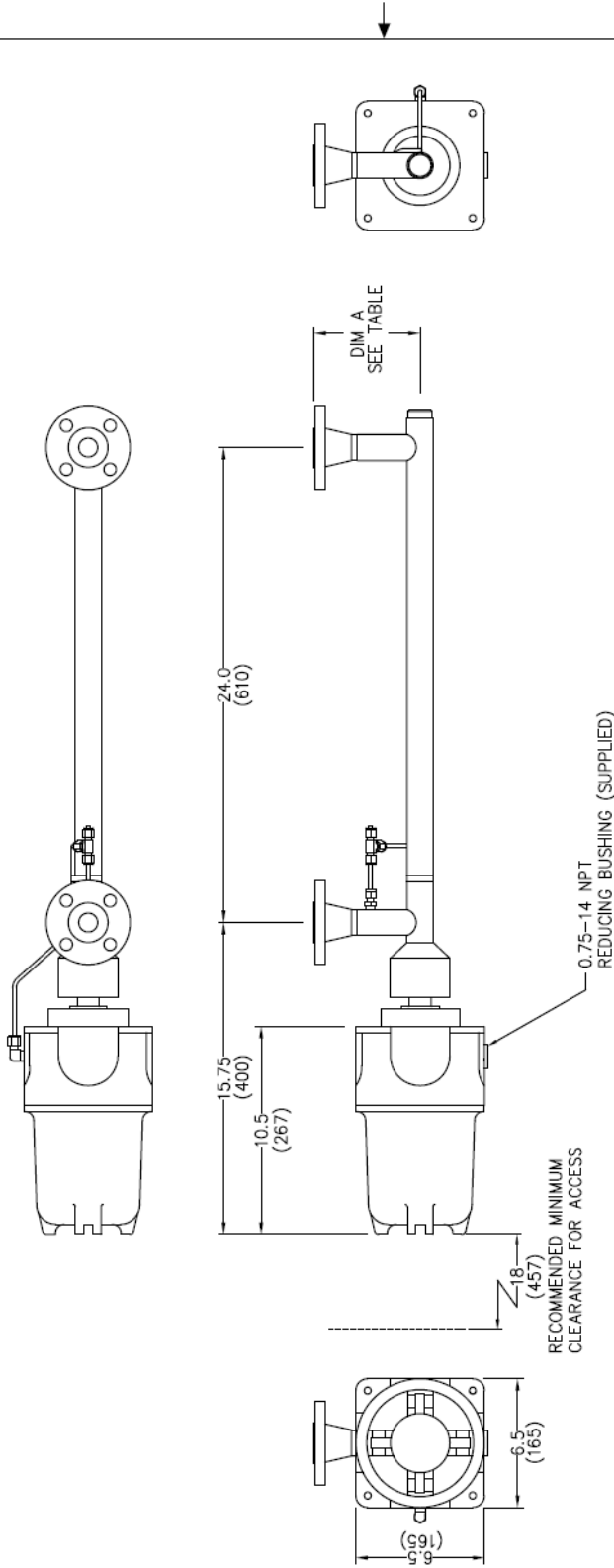








| REV | DATE | ECO | COMMENTS |
|-----|----------|-----|--------------------------|
| A | 09/04/03 | 168 | ADD METRIC UNITS |
| B | 09/02/15 | 307 | ADD 316 TO NOTES 2 AND 3 |



- NOTES:
- 1 ALL DIMENSIONS GIVEN IN INCHES
MILLIMETER DIMENSIONS SHOWN IN ()
 - 2 FLANGES ARE 1 INCH RAISED FACE
SCHEDULE 80 BORE, 316/316L STAINLESS
STEEL
 - 3 PIPE IS 1 INCH, SCHEDULE 80,
316/316L STAINLESS STEEL
 - 4 WEIGHT: SEE TABLE

| FLANGE SIZE | DIMENSION "A" | WEIGHT (LBS) | WEIGHT (KG) |
|----------------|------------------|-----------------|----------------|
| ANSI 150 | 5.3 (135) | 32 | 15 |
| ANSI 300 | 5.6 (142) | 35 | 16 |
| ANSI 600 | 5.9 (150) | 35 | 16 |
| ANSI 900 | 6.3 (160) | 44 | 20 |

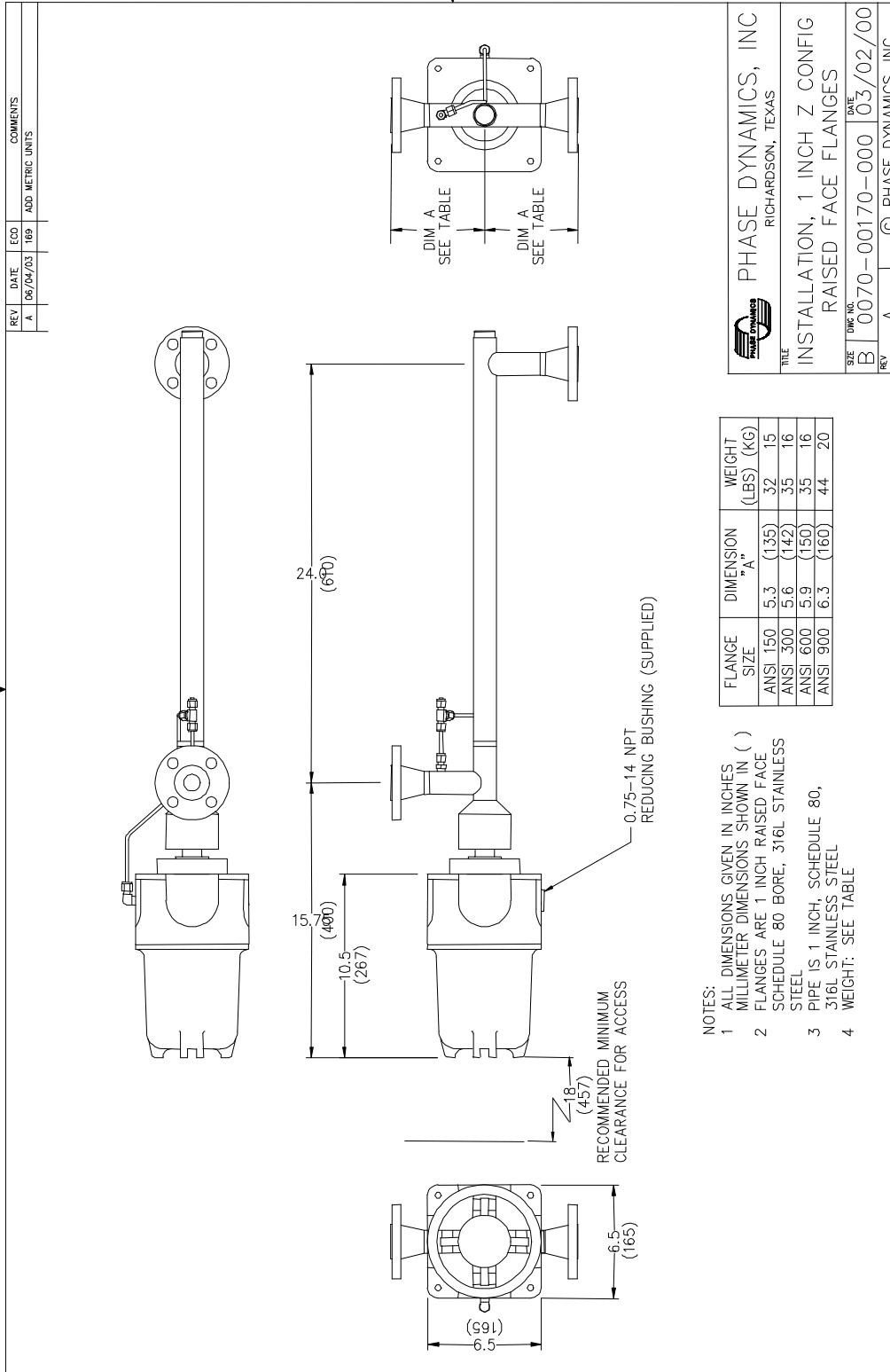
PHASE DYNAMICS, INC.
RICHARDSON, TEXAS

TITLE
INSTALLATION, 1 INCH U CONFIG
RAISED FACE FLANGES

SIZE
B 0070-00169-000

DATE
03/02/00


REV
B © PHASE DYNAMICS, INC.

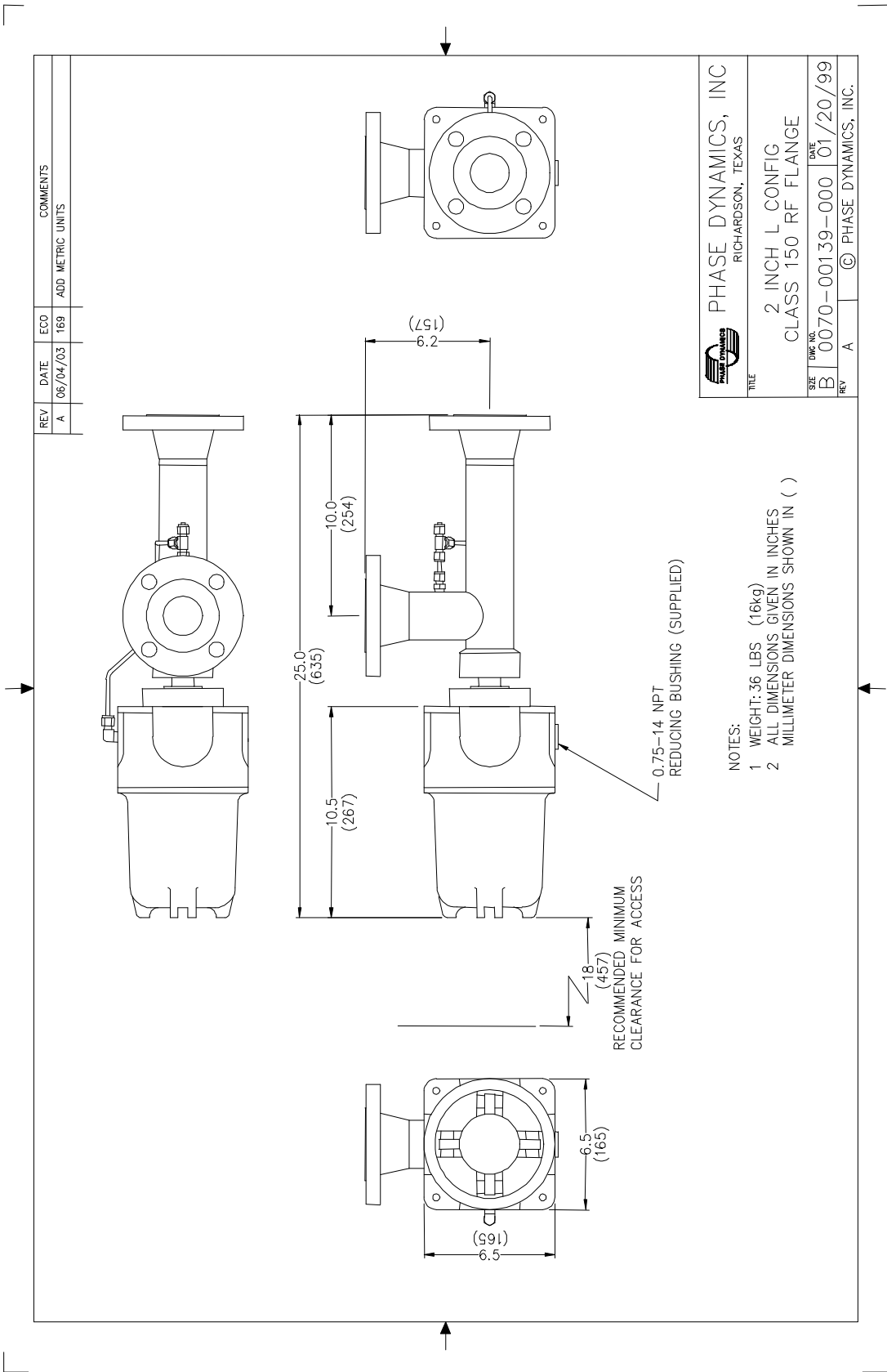


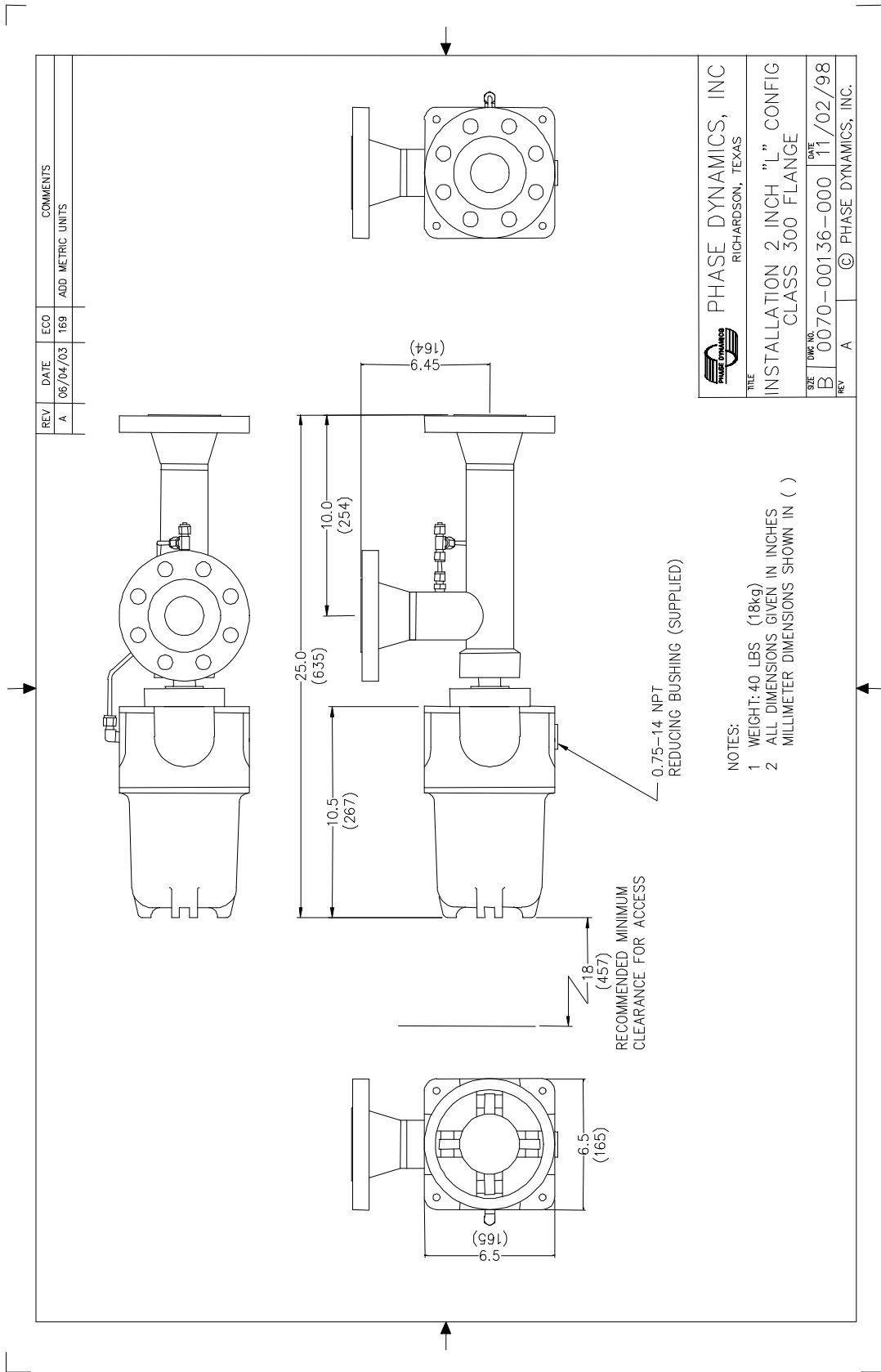
NOTES:

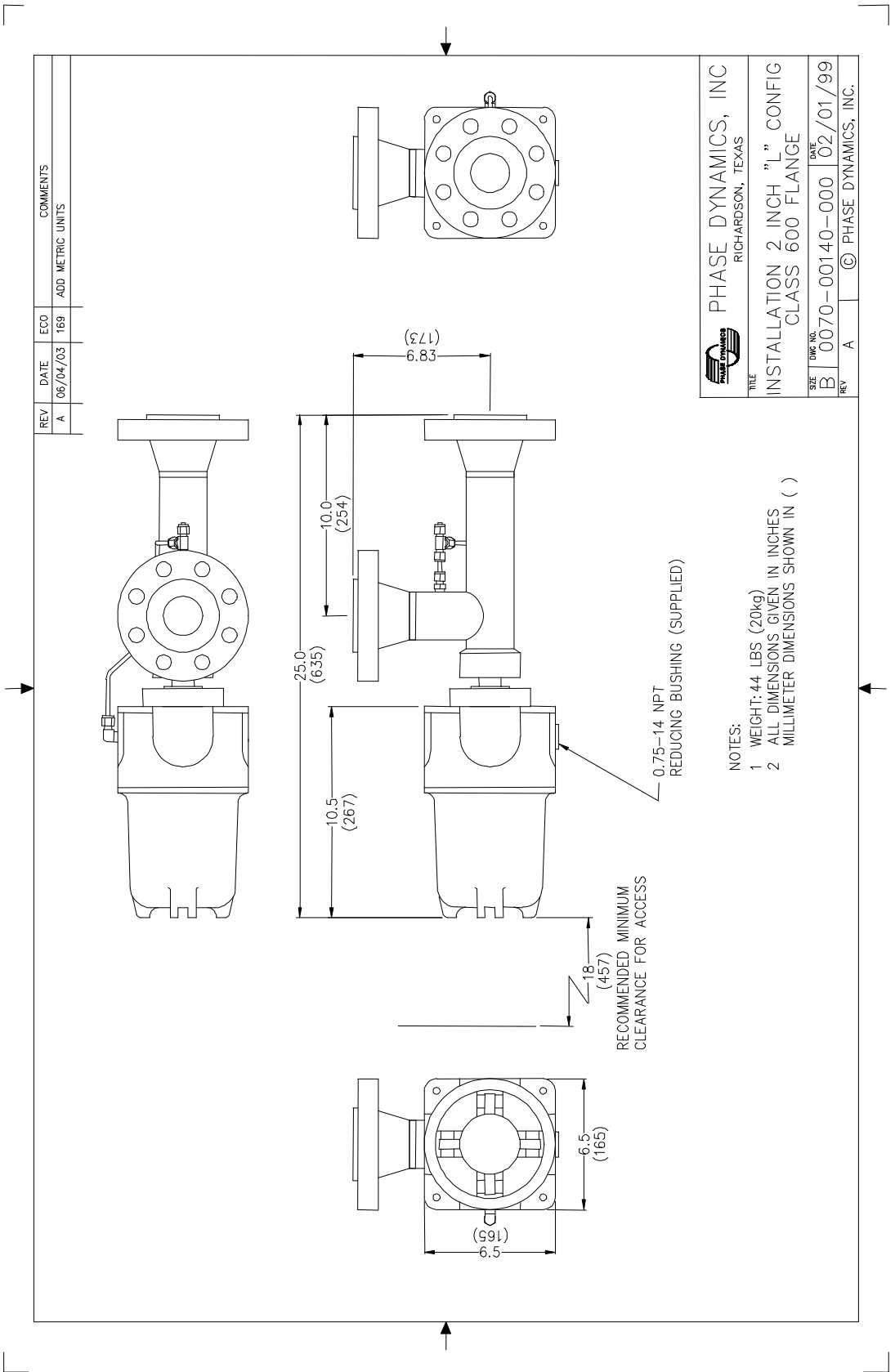
- 1 ALL DIMENSIONS GIVEN IN INCHES
- 2 MILLIMETER DIMENSIONS SHOWN IN ()
- 3 FLANGES ARE 1 INCH RAISED FACE
- 4 SCHEDULE 80 BORE, 316L STAINLESS STEEL
- 5 PIPE IS 1 INCH, SCHEDULE 80, 316L STAINLESS STEEL
- 6 WEIGHT: SEE TABLE


| FLANGE SIZE | DIMENSION "A" | WEIGHT (LBS) | WEIGHT (KG) |
|-------------|---------------|--------------|-------------|
| ANSI 150 | 5.3 (135) | 32 | 15 |
| ANSI 300 | 5.6 (142) | 35 | 16 |
| ANSI 600 | 5.9 (150) | 35 | 16 |
| ANSI 900 | 6.3 (160) | 44 | 20 |

| | |
|--|--|
|  PHASE DYNAMICS, INC. RICHARDSON, TEXAS | |
| TITLE | INSTALLATION, 1 INCH Z CONFIG RAISED FACE FLANGES |
| SIZE | DWG NO. 0070-00170-000 |
| REV | A |
| DATE | 03/02/00 |
| © PHASE DYNAMICS, INC. | |

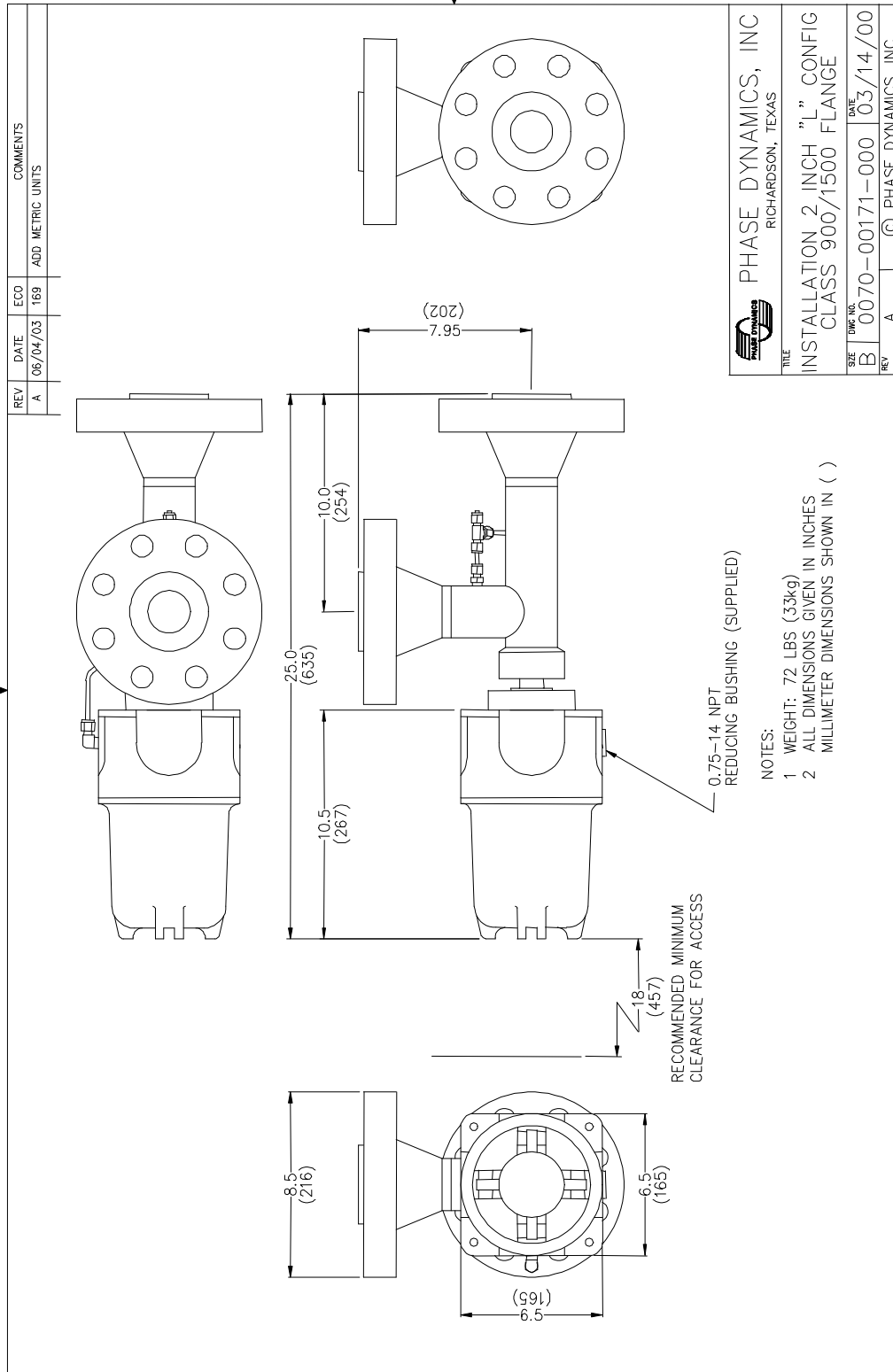


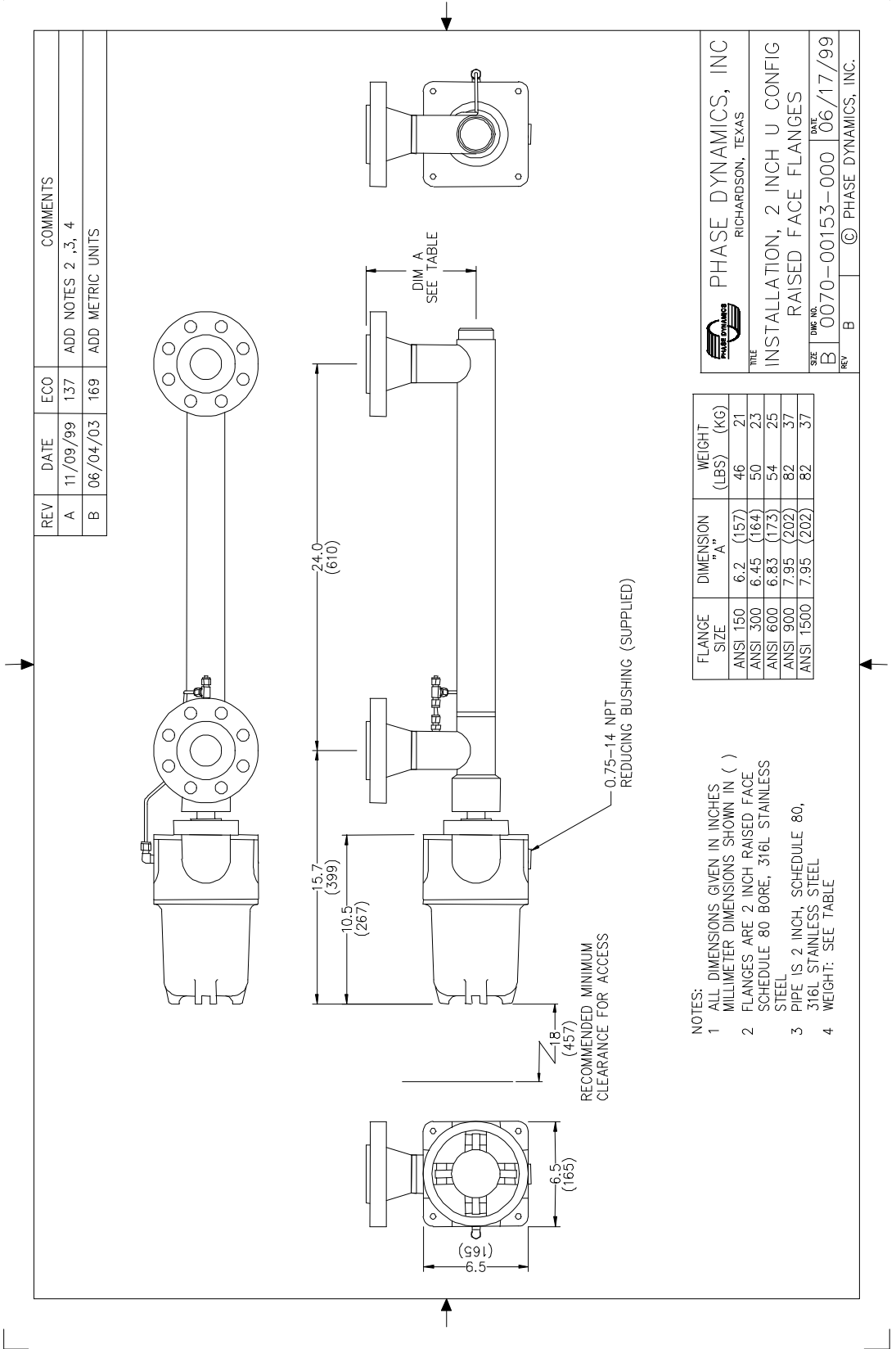





| | | | |
|---|----------------|---|------------------|
|  | | PHASE DYNAMICS, INC. RICHARDSON, TEXAS | |
| REV | DATE | ECO | COMMENTS |
| A | 06/04/03 | 169 | ADD METRIC UNITS |
| TITLE INSTALLATION 2 INCH "L" CONFIG CLASS 600 FLANGE | | | |
| SIZE | DWG NO. | DATE | |
| B | 0070-00140-000 | 02/01/99 | |
| REV | A | © PHASE DYNAMICS, INC. | |

- NOTES:
- 1 WEIGHT: 44 LBS (20kg)
 - 2 ALL DIMENSIONS GIVEN IN INCHES
MILLIMETER DIMENSIONS SHOWN IN ()



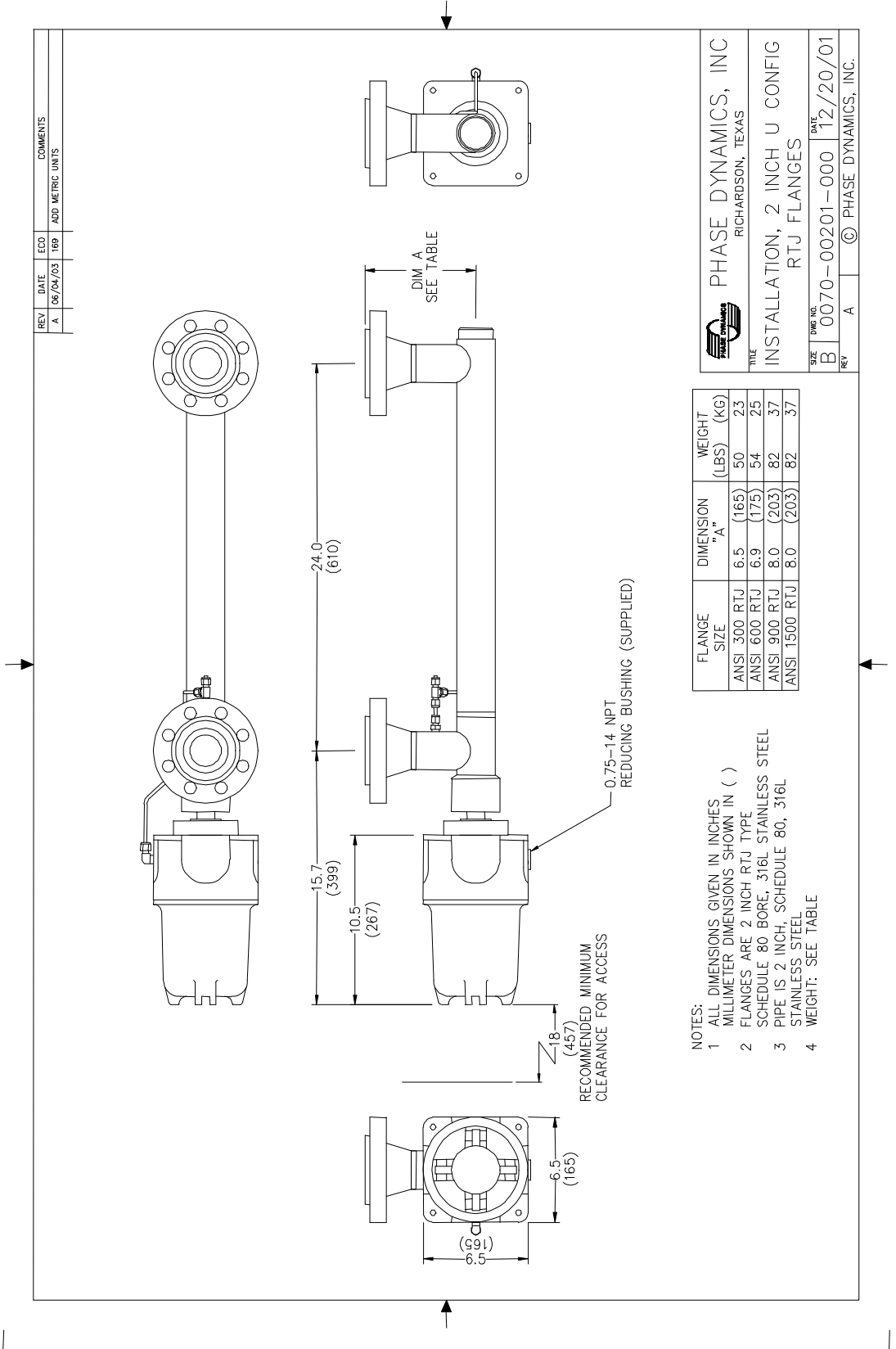


| REV | DATE | ECO | COMMENTS |
|-----|----------|-----|-------------------|
| A | 11/09/99 | 137 | ADD NOTES 2 ,3, 4 |
| B | 06/04/03 | 169 | ADD METRIC UNITS |

| | | | |
|---|----------------|--|-----|
|  PHASE DYNAMICS, INC RICHARDSON, TEXAS | | INSTALLATION, 2 INCH U CONFIG RAISED FACE FLANGES | |
| SIZE | DWG NO. | DATE | REV |
| B | 0070-00153-000 | 06/17/99 | B |
| | | © PHASE DYNAMICS, INC. | |

| FLANGE SIZE | DIMENSION "A" | WEIGHT (LBS) | WEIGHT (KG) |
|-------------|---------------|--------------|-------------|
| ANSI 150 | 6.2 (157) | 46 | 21 |
| ANSI 300 | 6.45 (164) | 50 | 23 |
| ANSI 600 | 6.83 (173) | 54 | 25 |
| ANSI 900 | 7.95 (202) | 82 | 37 |
| ANSI 1500 | 7.95 (202) | 82 | 37 |

- NOTES:
- 1 ALL DIMENSIONS GIVEN IN INCHES
MILLIMETER DIMENSIONS SHOWN IN ()
 - 2 FLANGES ARE 2 INCH RAISED FACE
SCHEDULE 80 BORE, 316L STAINLESS
STEEL
 - 3 PIPE IS 2 INCH, SCHEDULE 80,
316L STAINLESS STEEL
 - 4 WEIGHT: SEE TABLE

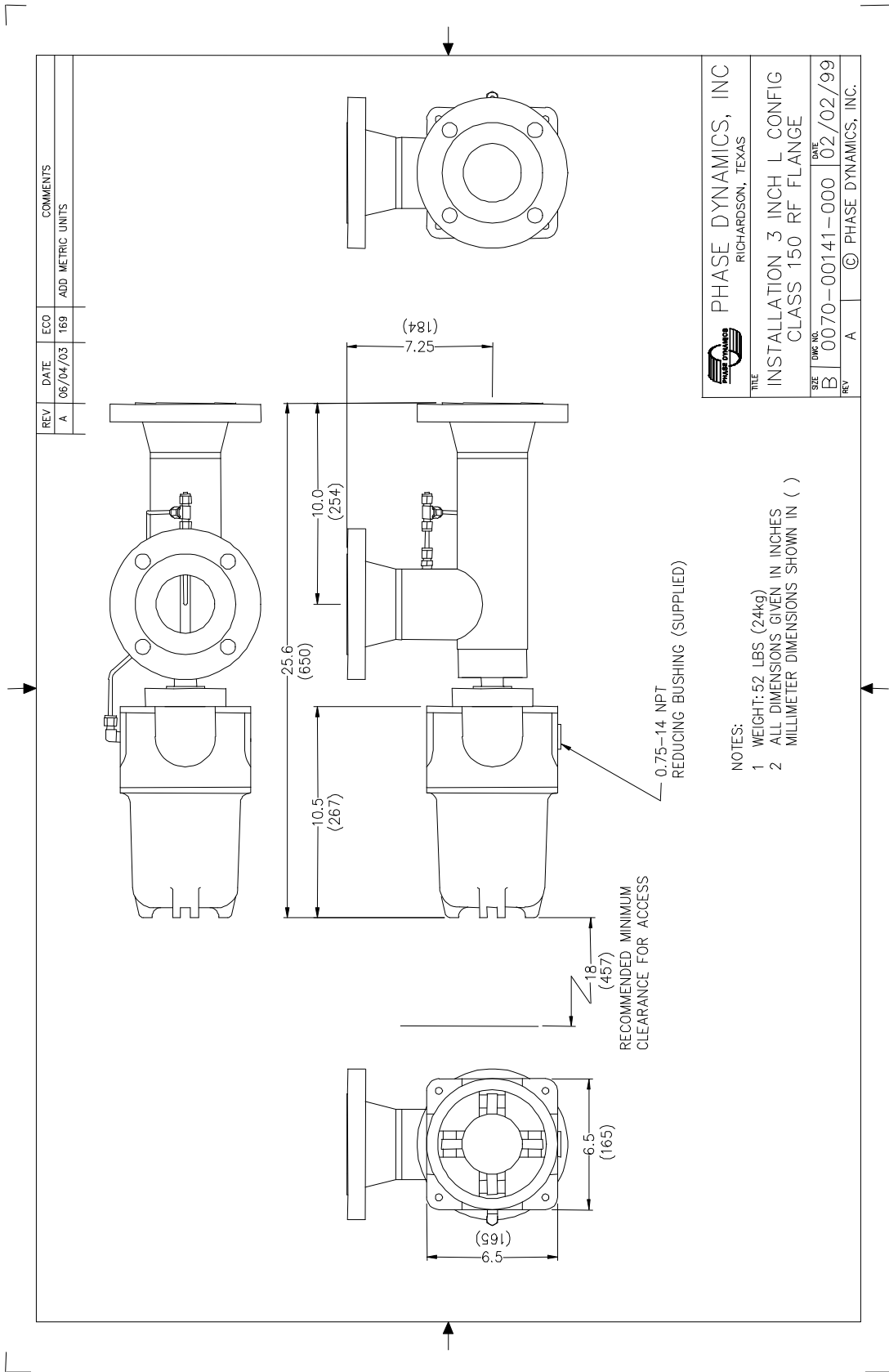


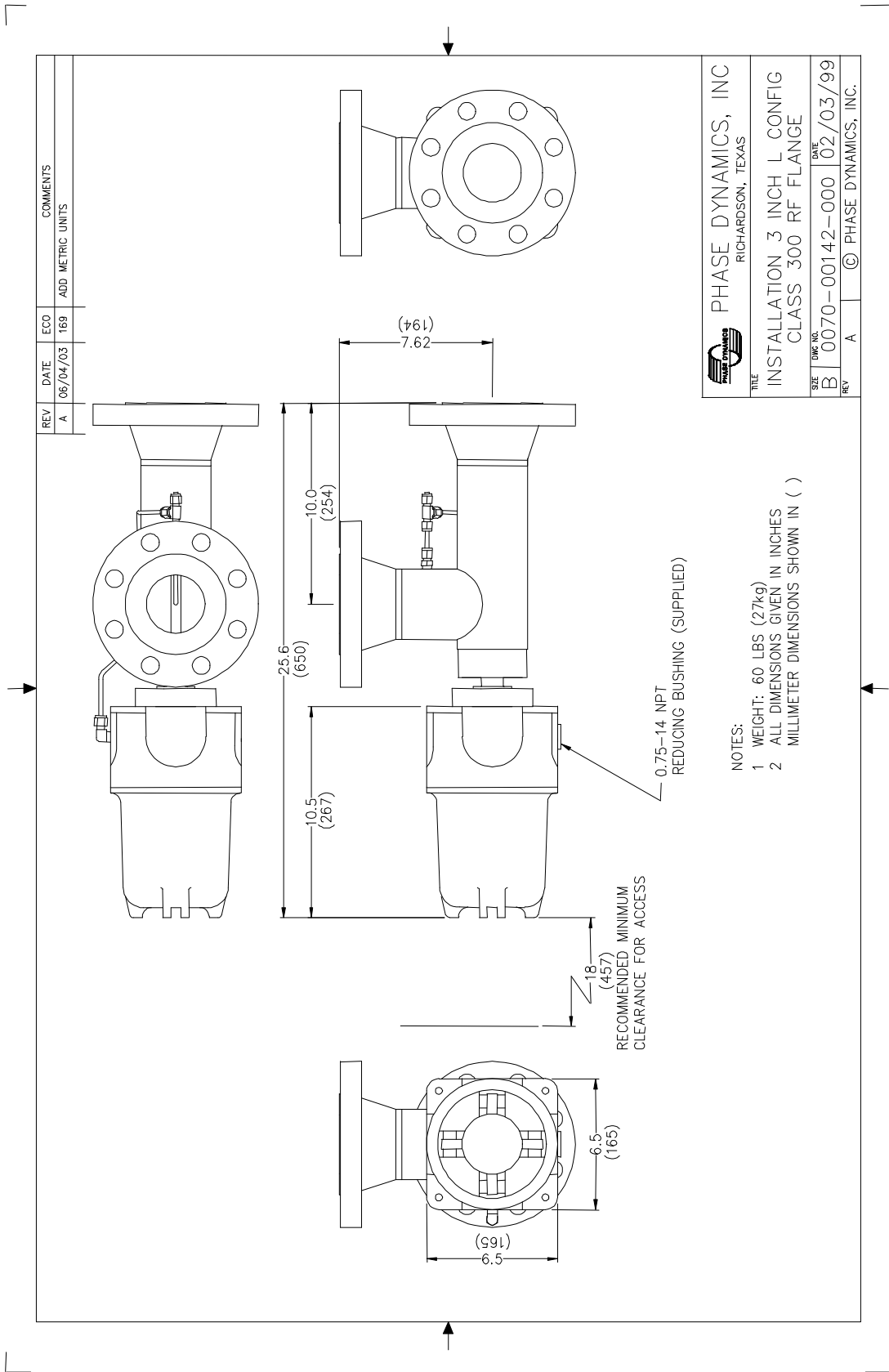
| | | | | | |
|-----|--|----------|-----|------------------|--|
| REV | | DATE | ECO | COMMENTS | |
| A | | 06/04/03 | 169 | ADD METRIC UNITS | |

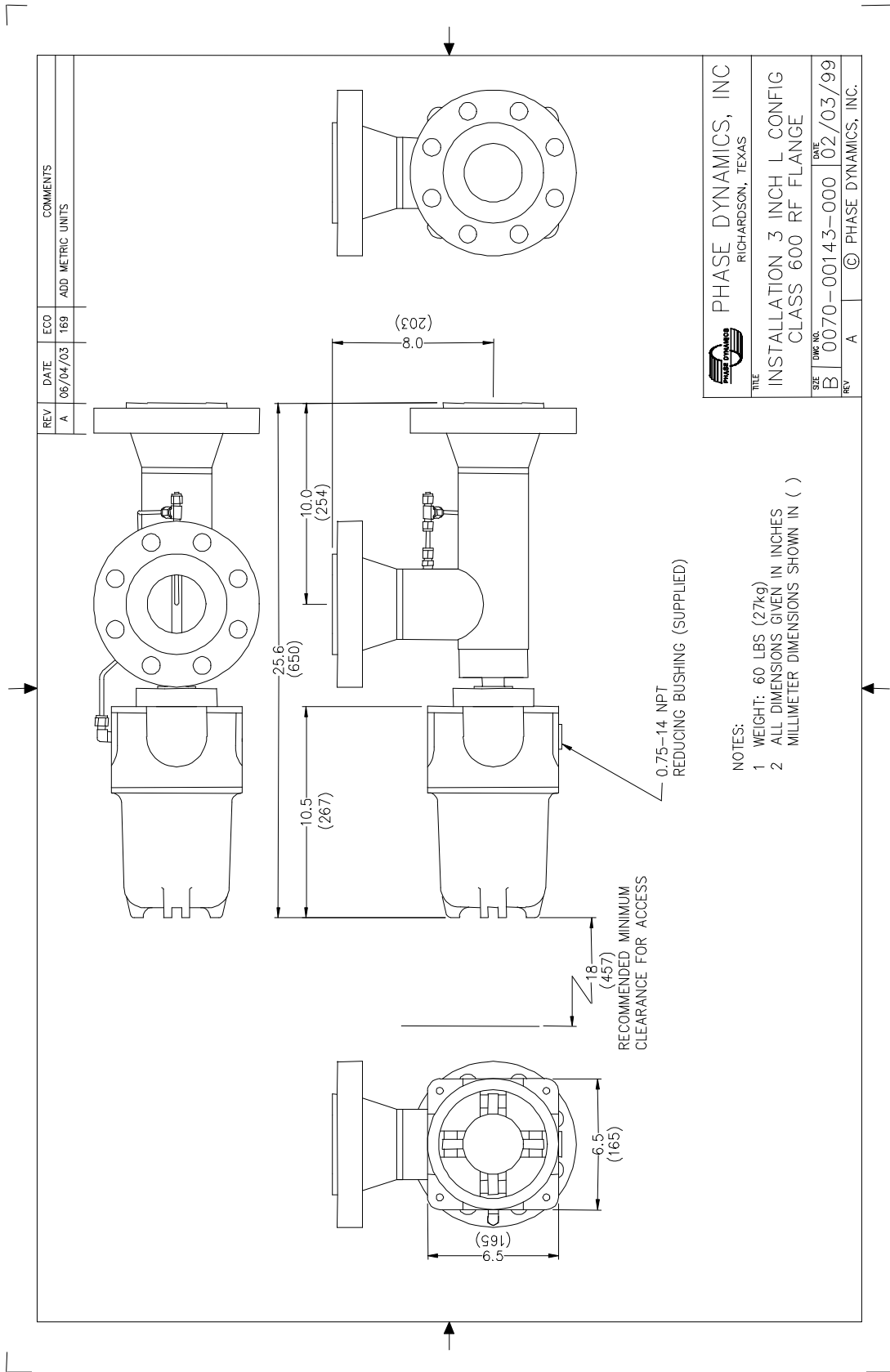
| | | | |
|---------------------|----------------|---|--|
| PHASE DYNAMICS, INC | | RICHARDSON, TEXAS | |
| TITLE | | INSTALLATION, 2 INCH U CONFIG RTJ FLANGES | |
| SIZE | PAGE NO. | DATE | |
| B | 0070-00201-000 | 12/20/01 | |
| REV | A | © PHASE DYNAMICS, INC. | |

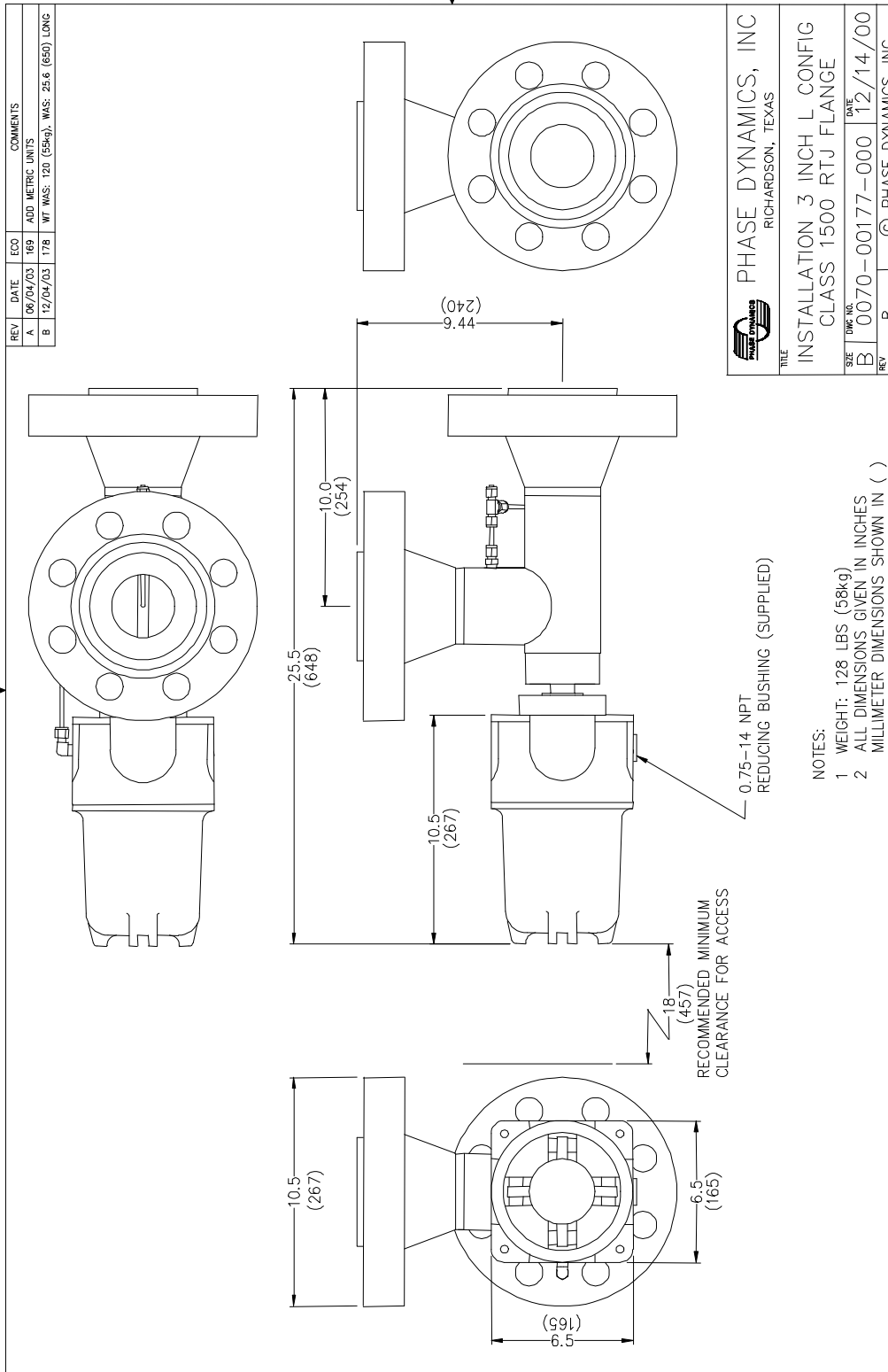
| FLANGE SIZE | DIMENSION "A" | WEIGHT (LBS) | WEIGHT (KG) |
|---------------|---------------|--------------|-------------|
| ANSI 300 RTJ | 6.5 (165) | 50 | 23 |
| ANSI 600 RTJ | 6.9 (175) | 54 | 25 |
| ANSI 900 RTJ | 8.0 (203) | 82 | 37 |
| ANSI 1500 RTJ | 8.0 (203) | 82 | 37 |

- NOTES:
- 1 ALL DIMENSIONS GIVEN IN INCHES
 - 2 MILLIMETER DIMENSIONS SHOWN IN ()
 - 3 FLANGES ARE 2 INCH RTJ TYPE
 - 4 SCHEDULE 80 BORE, 316L STAINLESS STEEL
 - 5 PIPE IS 2 INCH, SCHEDULE 80, 316L STAINLESS STEEL
 - 6 WEIGHT: SEE TABLE

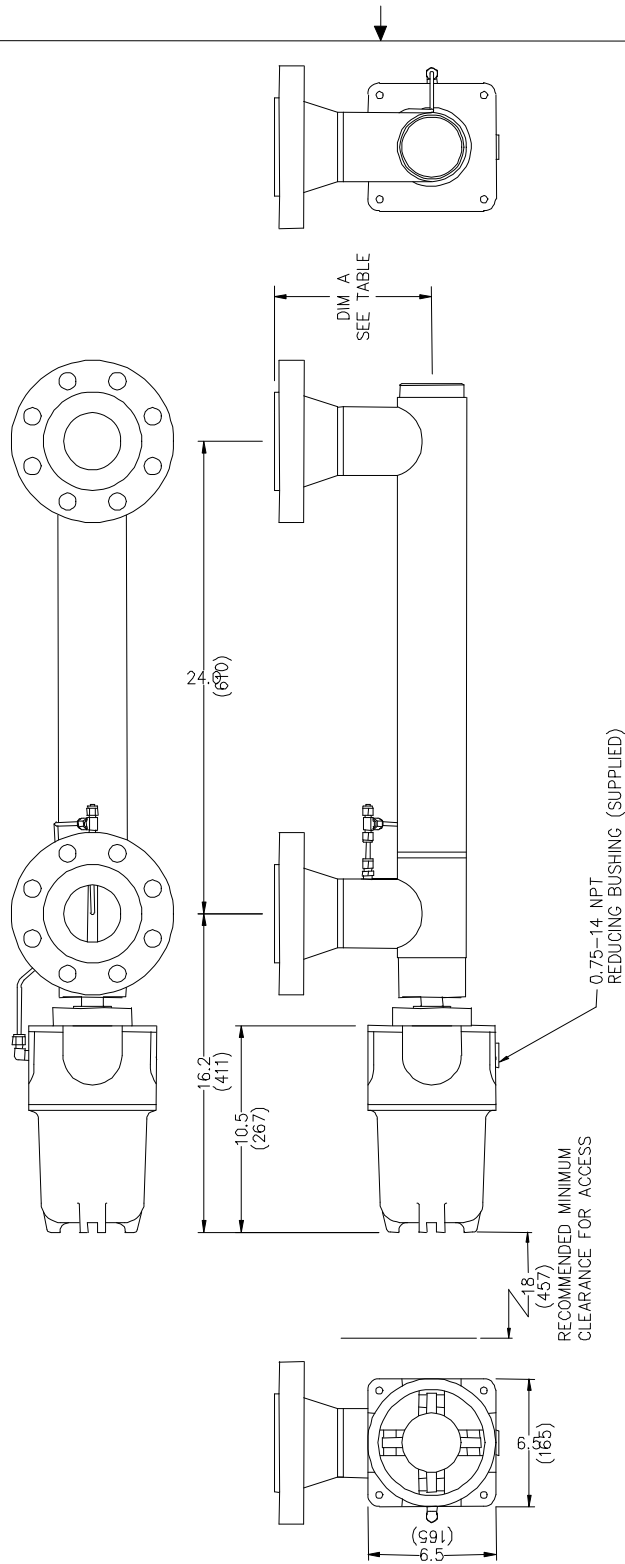








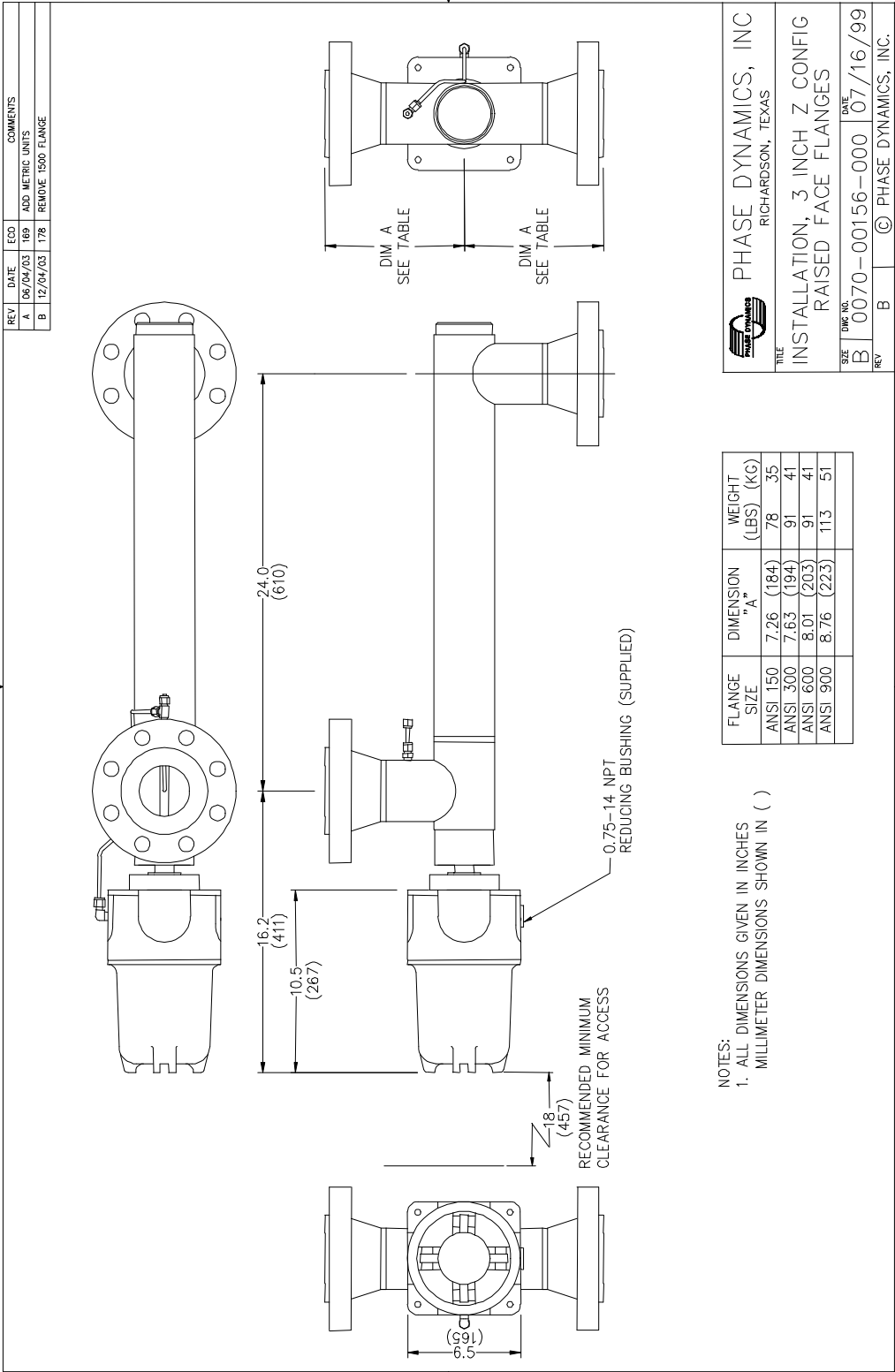
| REV | DATE | ECO | COMMENTS |
|-----|----------|-----|--------------------|
| A | 06/04/03 | 169 | ADD METRIC UNITS |
| B | 12/04/03 | 178 | REMOVE 1500 FLANGE |

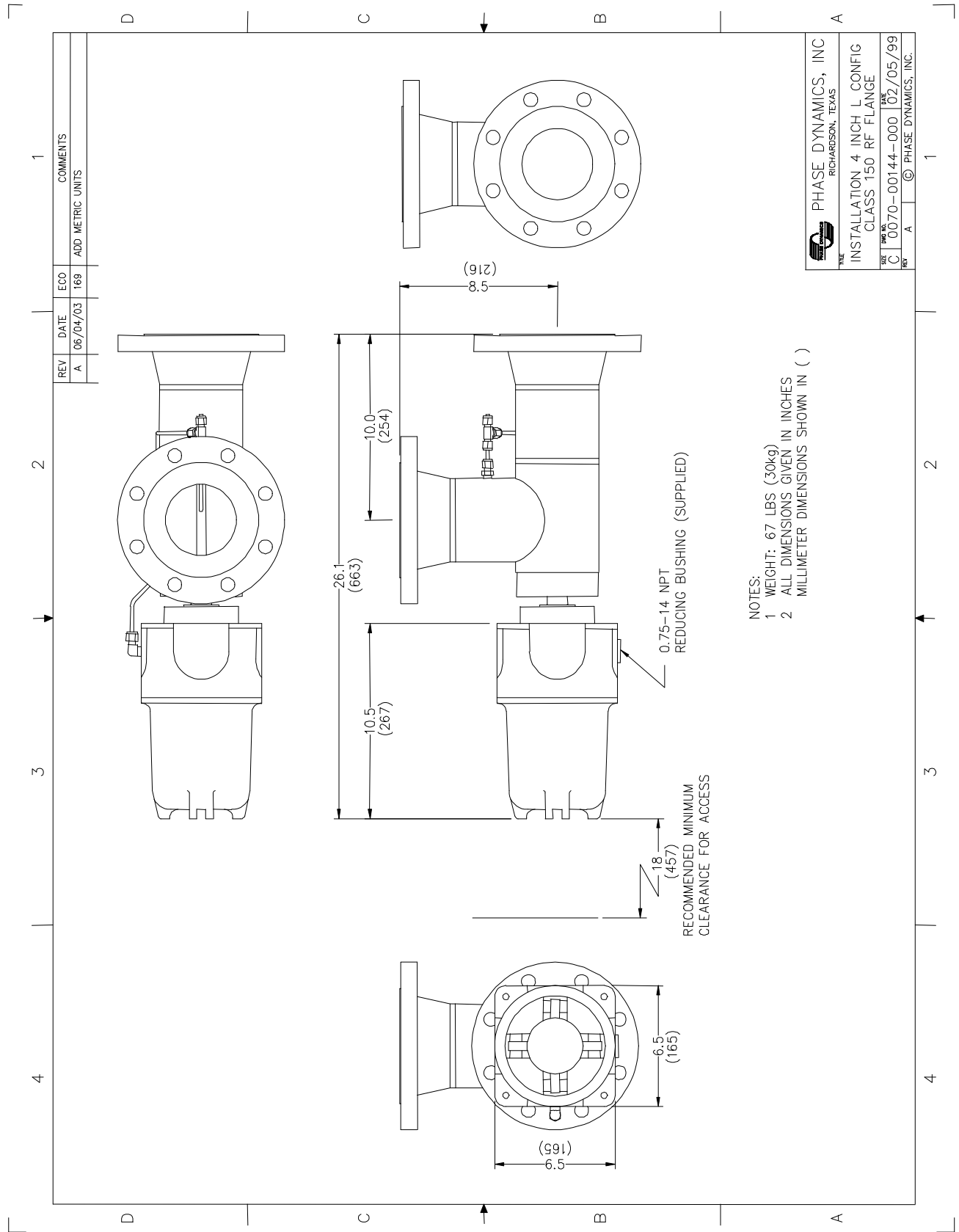


| | | |
|---|----------------|--|
|  PHASE DYNAMICS, INC RICHARDSON, TEXAS | | TITLE |
| | | INSTALLATION, 3 INCH U CONFIG RAISED FACE FLANGES |
| SIZE | DWG NO. | DATE |
| B | 0070-00155-000 | 06/19/99 |
| REV | B | © PHASE DYNAMICS, INC. |

| FLANGE SIZE | DIMENSION "A" | WEIGHT (LBS) (KG) |
|----------------|------------------|----------------------|
| ANSI 150 | 7.26 (184) | 78 35 |
| ANSI 300 | 7.63 (194) | 91 41 |
| ANSI 600 | 8.01 (203) | 91 41 |
| ANSI 900 | 8.76 (223) | 113 51 |

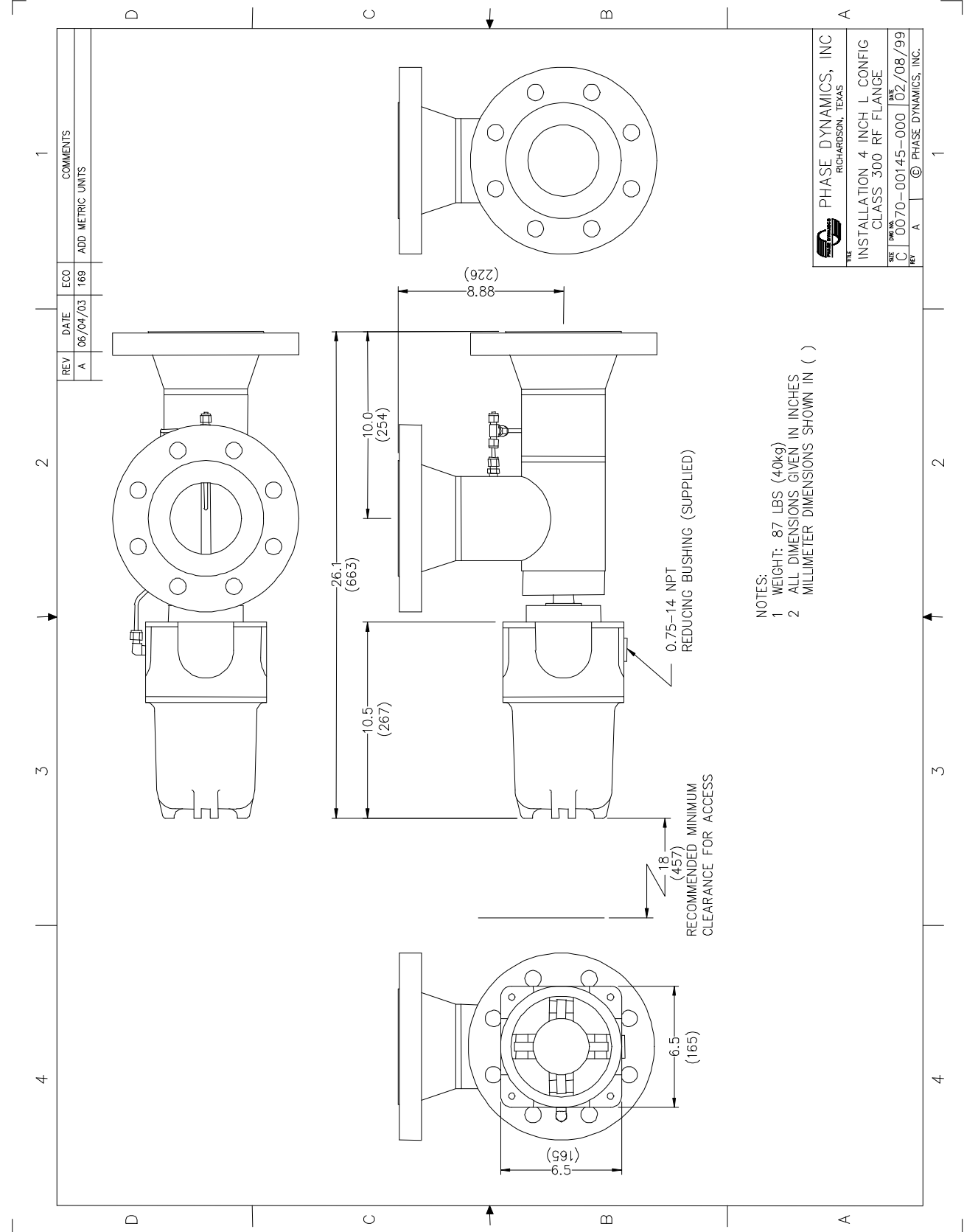
NOTES:
1. ALL DIMENSIONS GIVEN IN INCHES
MILLIMETER DIMENSIONS SHOWN IN ()





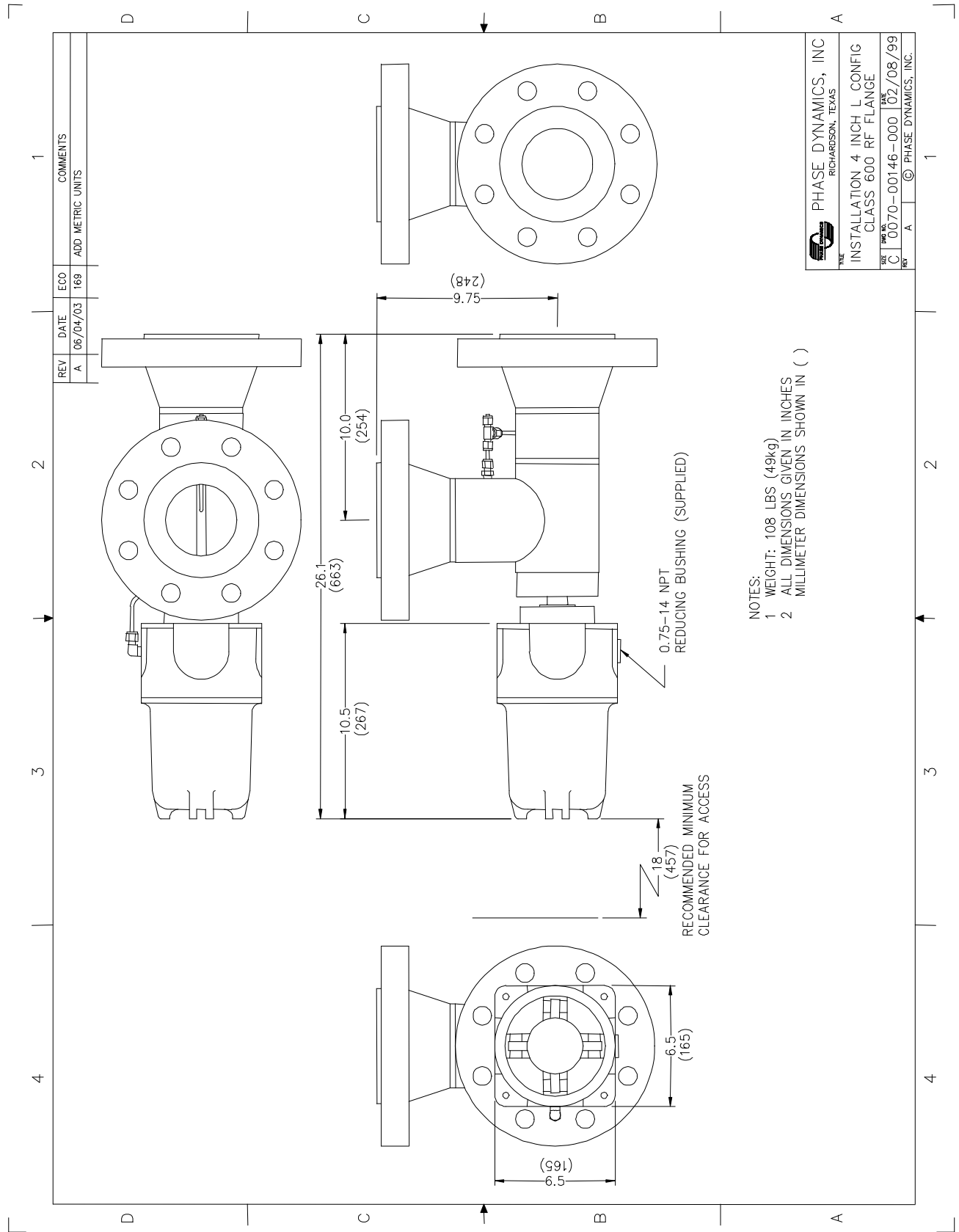
| REV | DATE | ECO | COMMENTS |
|-----|----------|-----|------------------|
| A | 06/04/03 | 169 | ADD METRIC UNITS |

| | | |
|---|------------------|--|
| | | PHASE DYNAMICS, INC. RICHARDSON, TEXAS |
| INSTALLATION 4 INCH L CONFIG CLASS 150 RF FLANGE | | |
| SIZE C 0070-00144-000 | DATE 02/05/99 | REV A |




- NOTES:
- 1 WEIGHT: 87 LBS (40kg)
 - 2 ALL DIMENSIONS GIVEN IN INCHES
MILLIMETER DIMENSIONS SHOWN IN ()

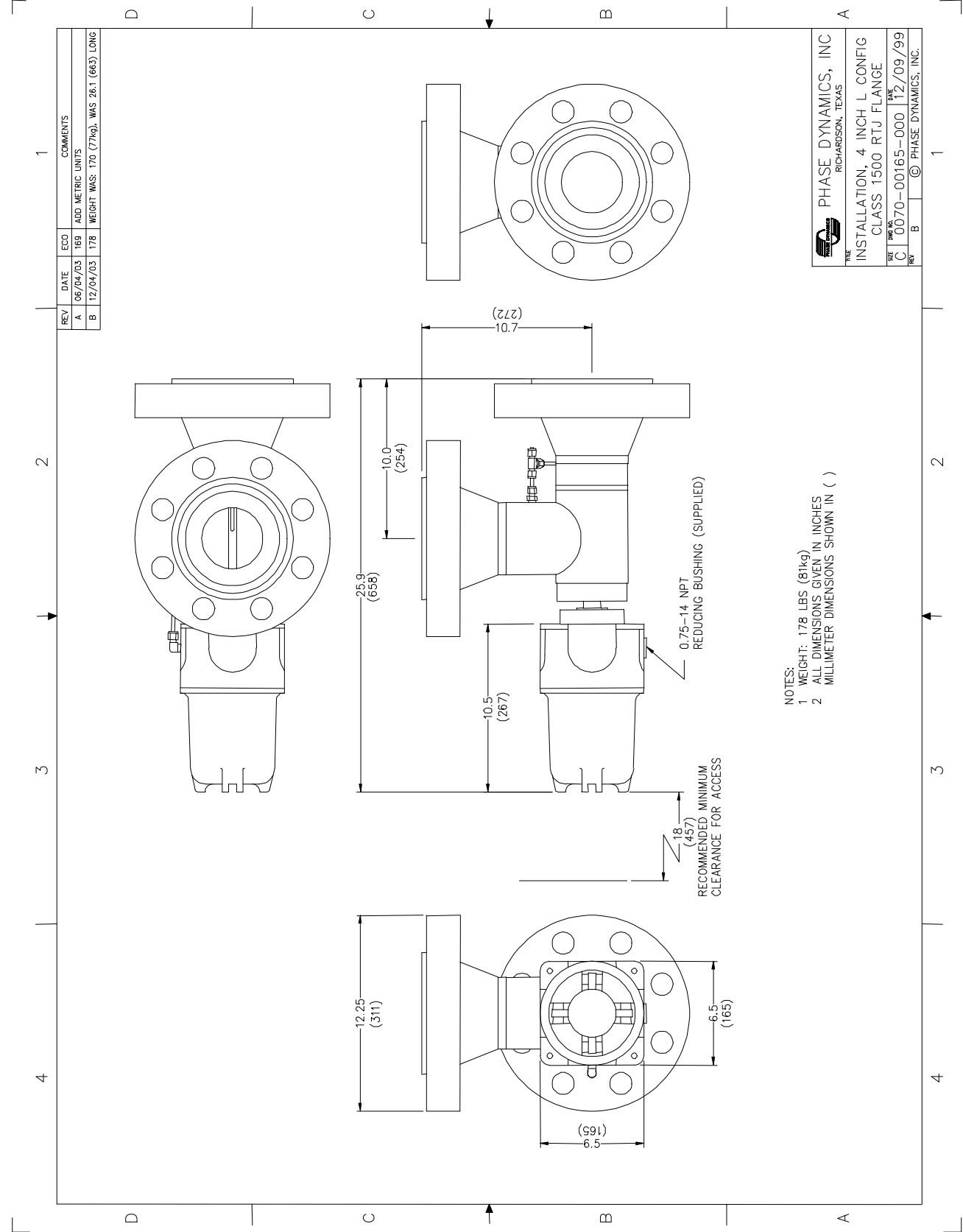
| | |
|---|------------------------|
| PHASE DYNAMICS, INC. RICHARDSON, TEXAS | |
| INSTALLATION 4 INCH L CONFIG CLASS 300 RF FLANGE | |
| SIZE 4 IN | DATE 02/08/99 |
| REV C | 0070-00145-000 |
| REV A | © PHASE DYNAMICS, INC. |



| REV | DATE | ECO | COMMENTS |
|-----|----------|-----|------------------|
| A | 06/04/03 | 169 | ADD METRIC UNITS |

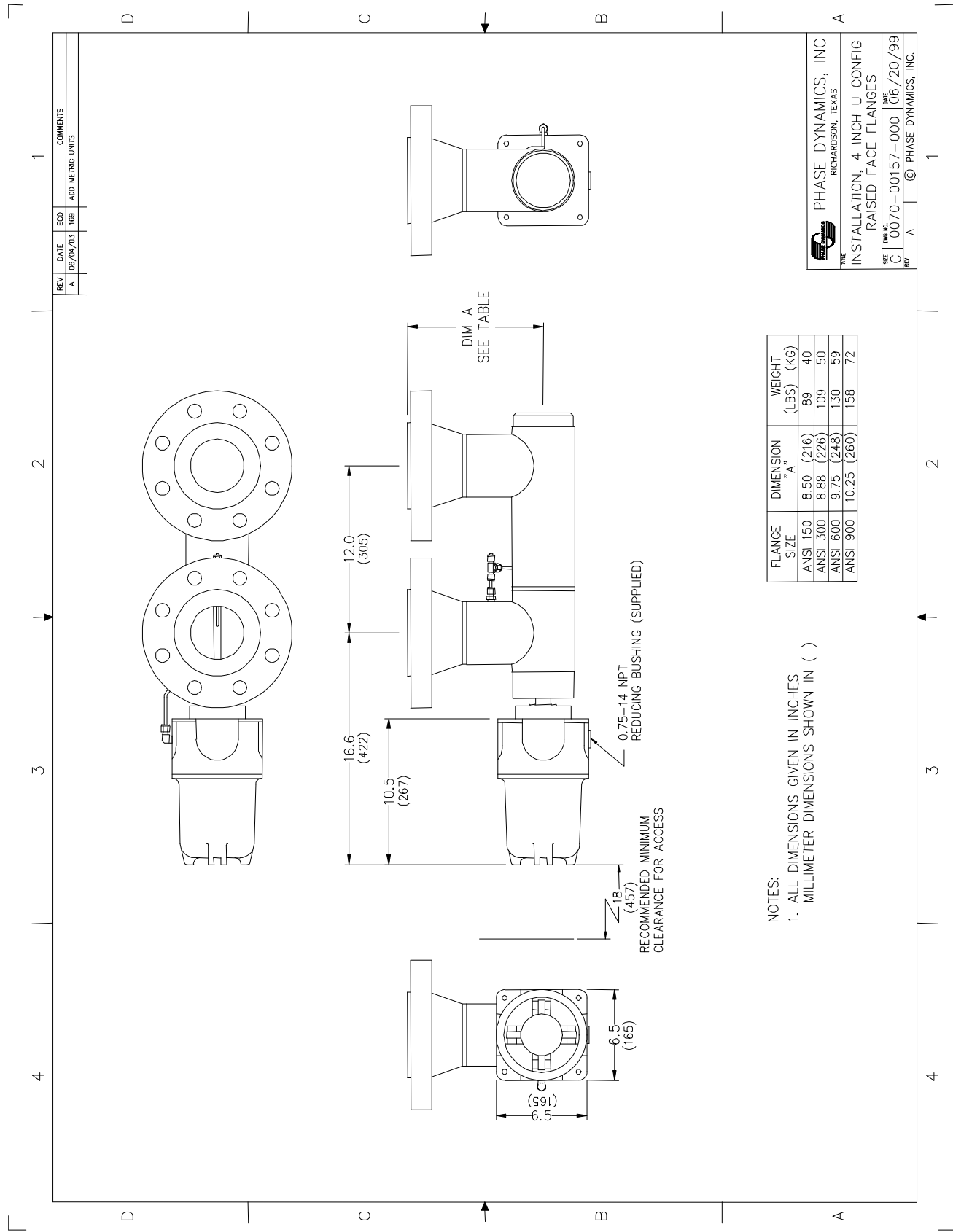
| | |
|--|------------------------|
|  PHASE DYNAMICS, INC. RICHARDSON, TEXAS | |
| INSTALLATION 4 INCH L CONFIG CLASS 600 RF FLANGE | |
| SIZE C 0070-00146-000 | DATE 02/08/99 |
| REV A | © PHASE DYNAMICS, INC. |

- NOTES:
- 1 WEIGHT: 108 LBS (49kg)
 - 2 ALL DIMENSIONS GIVEN IN INCHES
MILLIMETER DIMENSIONS SHOWN IN ()




| REV | DATE | ECD | COMMENTS |
|-----|----------|-----|---|
| A | 06/04/03 | 189 | ADD METRIC UNITS |
| B | 12/04/03 | 178 | WEIGHT WAS: 170 (77kg), WAS 26.1 (643) LONG |

| | | |
|-------------------------------|----------|------------------------|
| | | PHASE DYNAMICS, INC. |
| RICHARDSON, TEXAS | | |
| INSTALLATION, 4 INCH L CONFIG | | |
| CLASS 1500 RTJ FLANGE | | |
| SIZE | TYPE | DATE |
| C 0070-00165-000 | 12/09/99 | |
| REV | B | © PHASE DYNAMICS, INC. |



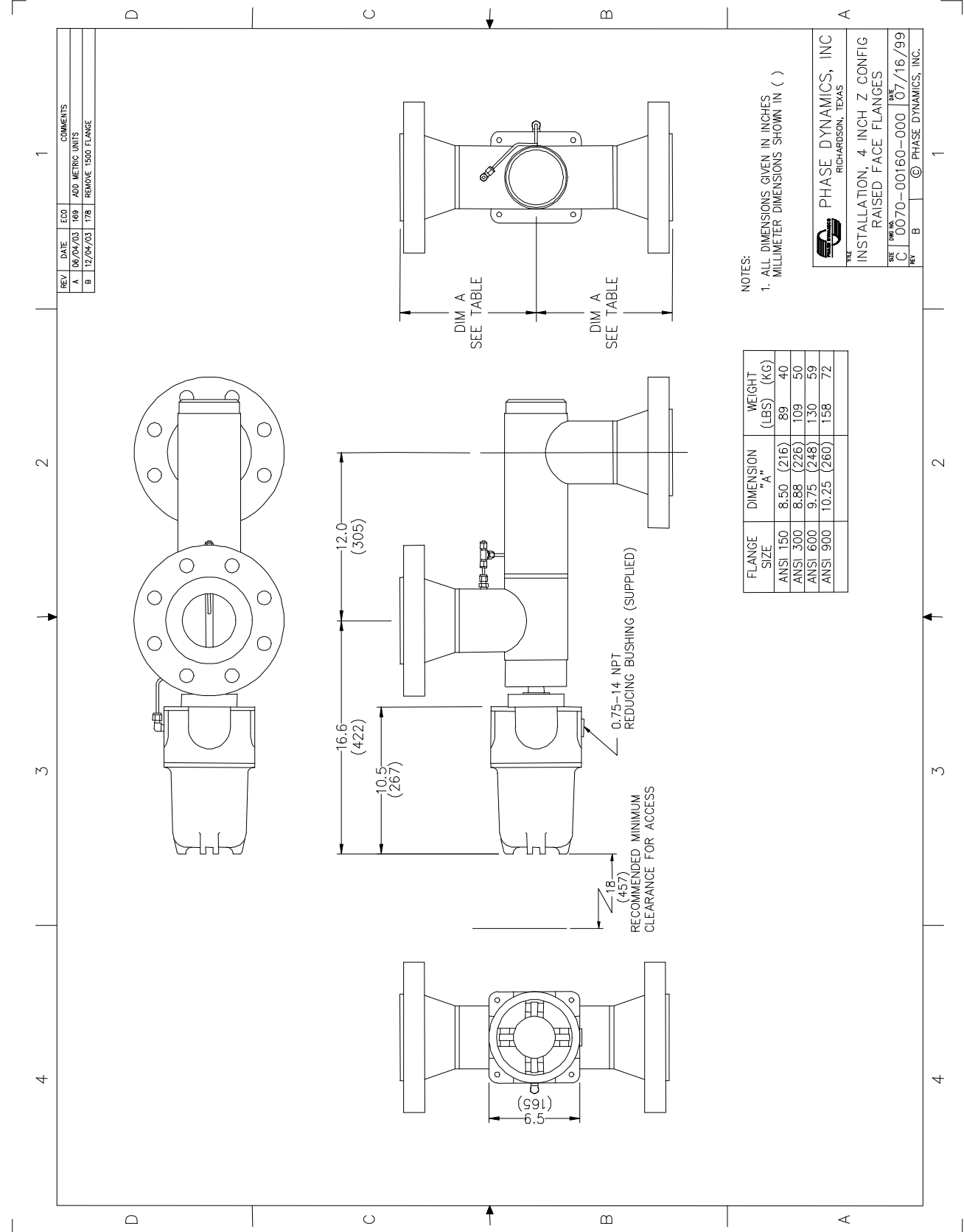
| FLANGE SIZE | DIMENSION "A" | WEIGHT (LBS) | WEIGHT (KG) |
|-------------|---------------|--------------|-------------|
| ANSI 150 | 8.50 (216) | 89 | 40 |
| ANSI 300 | 8.88 (226) | 109 | 50 |
| ANSI 600 | 9.75 (248) | 130 | 59 |
| ANSI 900 | 10.25 (260) | 158 | 72 |

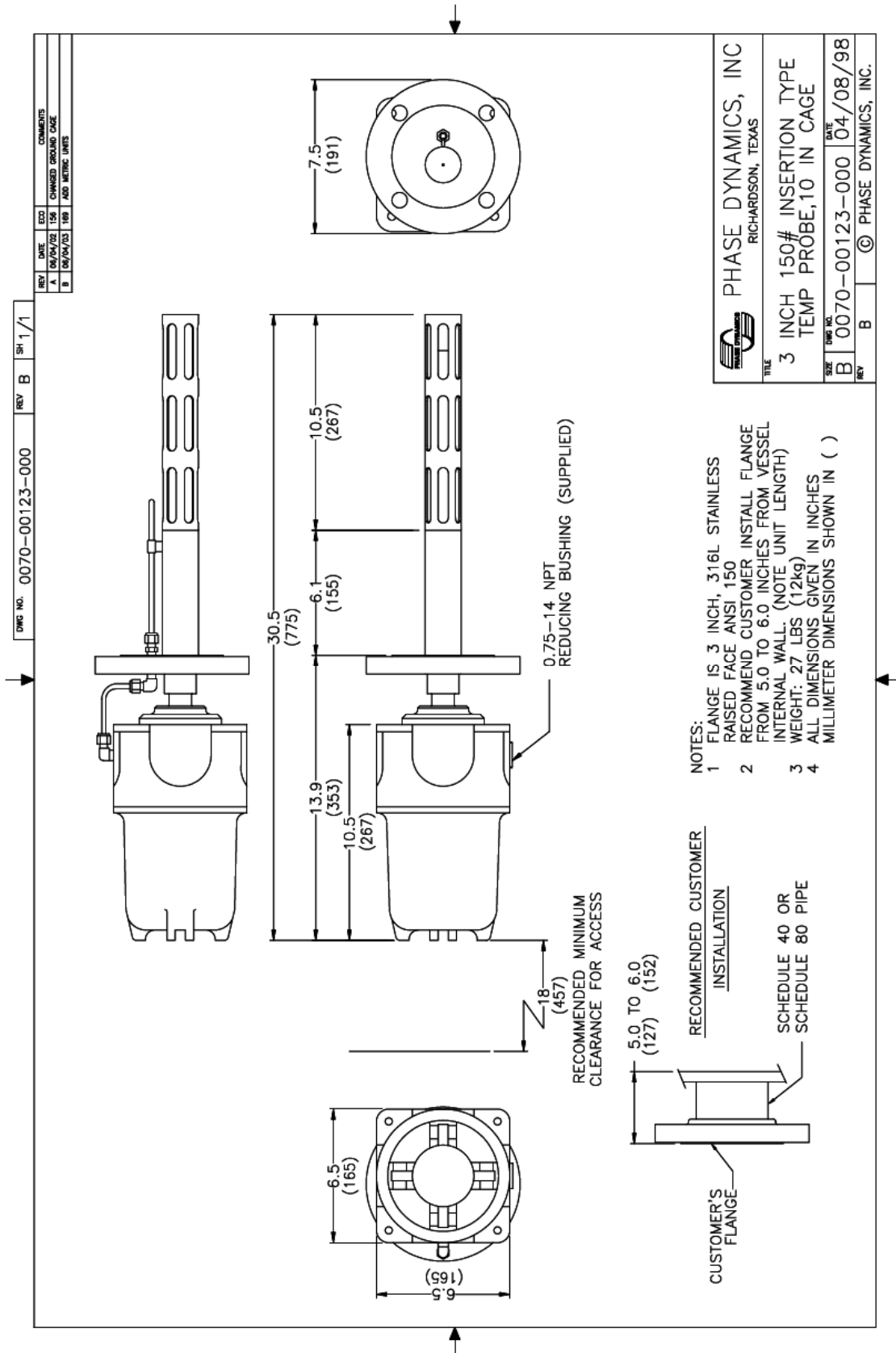
NOTES:
1. ALL DIMENSIONS GIVEN IN INCHES
MILLIMETER DIMENSIONS SHOWN IN ()

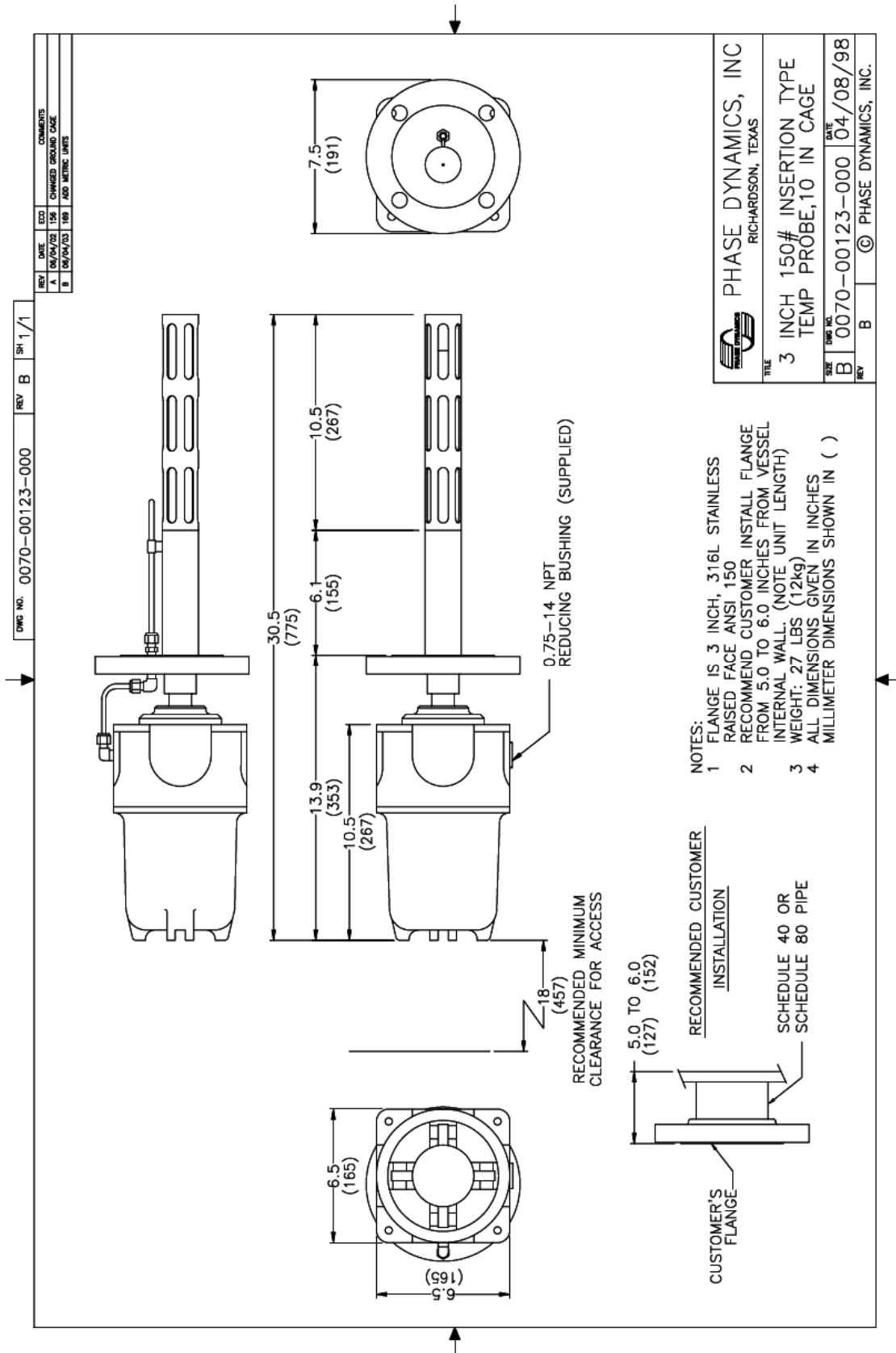

PHASE DYNAMICS, INC.
 RICHARDSON, TEXAS

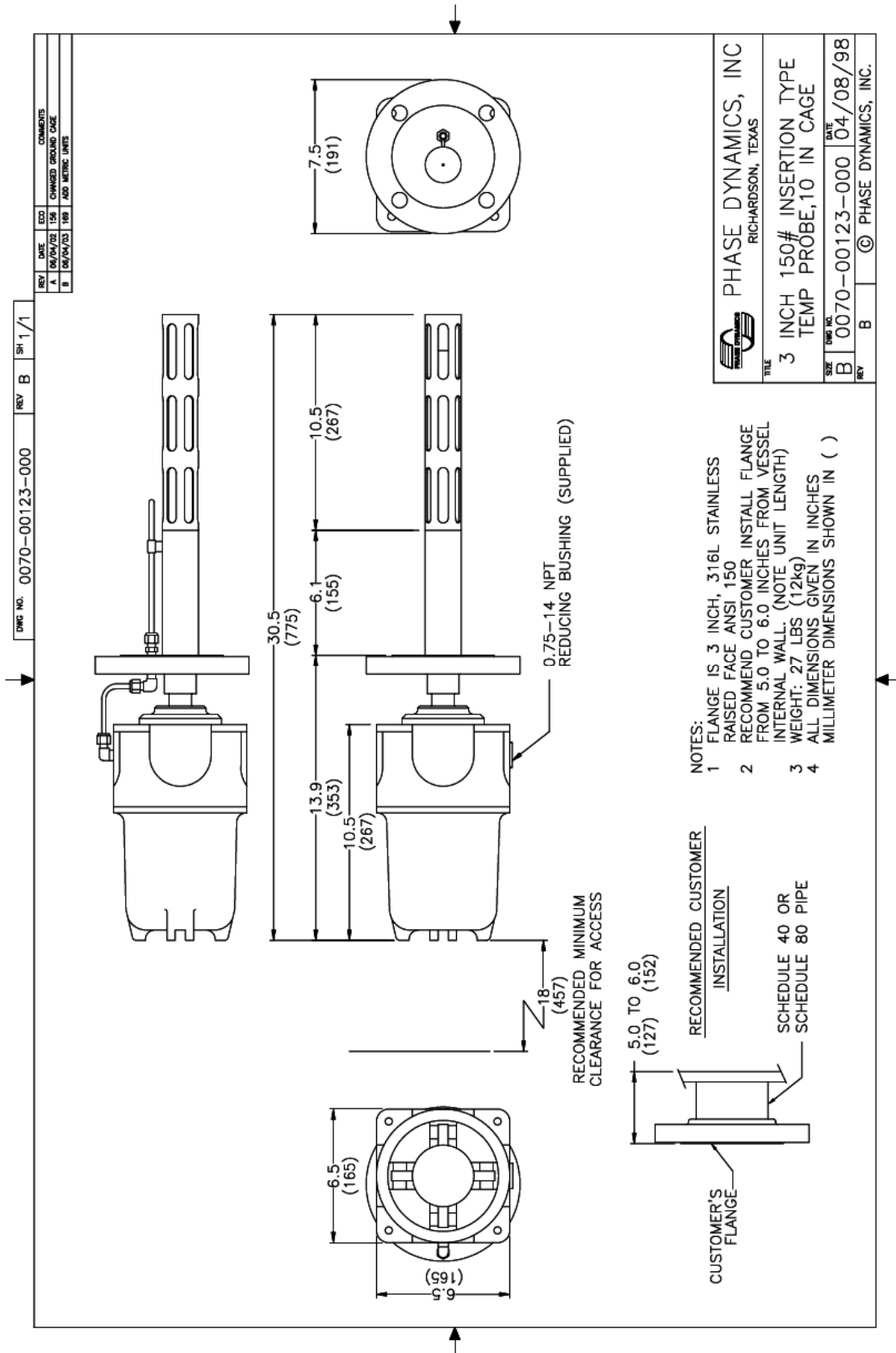
INSTALLATION, 4 INCH U CONFIG
 RAISED FACE FLANGES

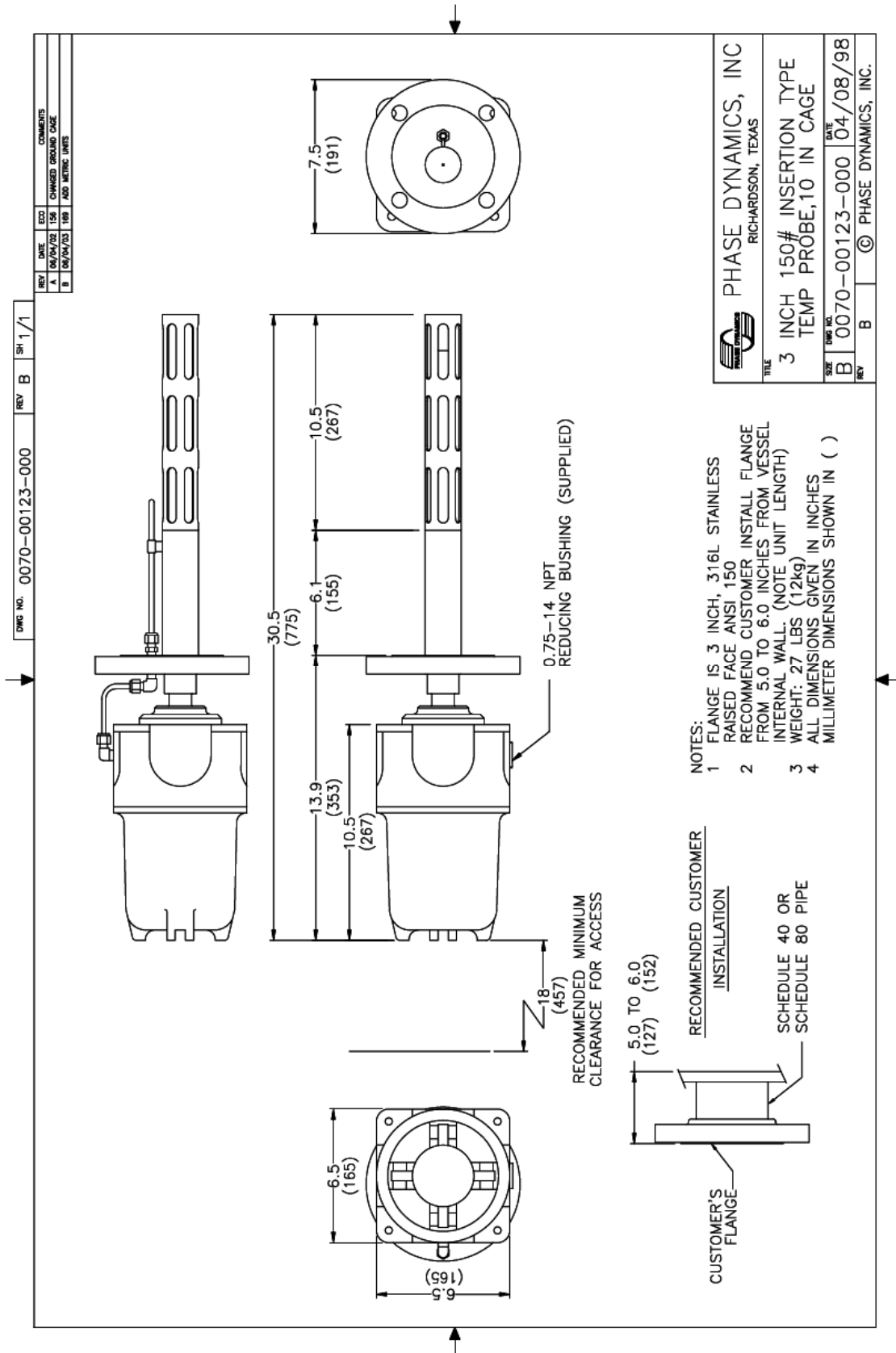
| | | | | |
|------|----------|----------|----------|----------|
| SIZE | 150 | 300 | 600 | 900 |
| DATE | 06/20/99 | 06/20/99 | 06/20/99 | 06/20/99 |
| REV | A | A | A | A |

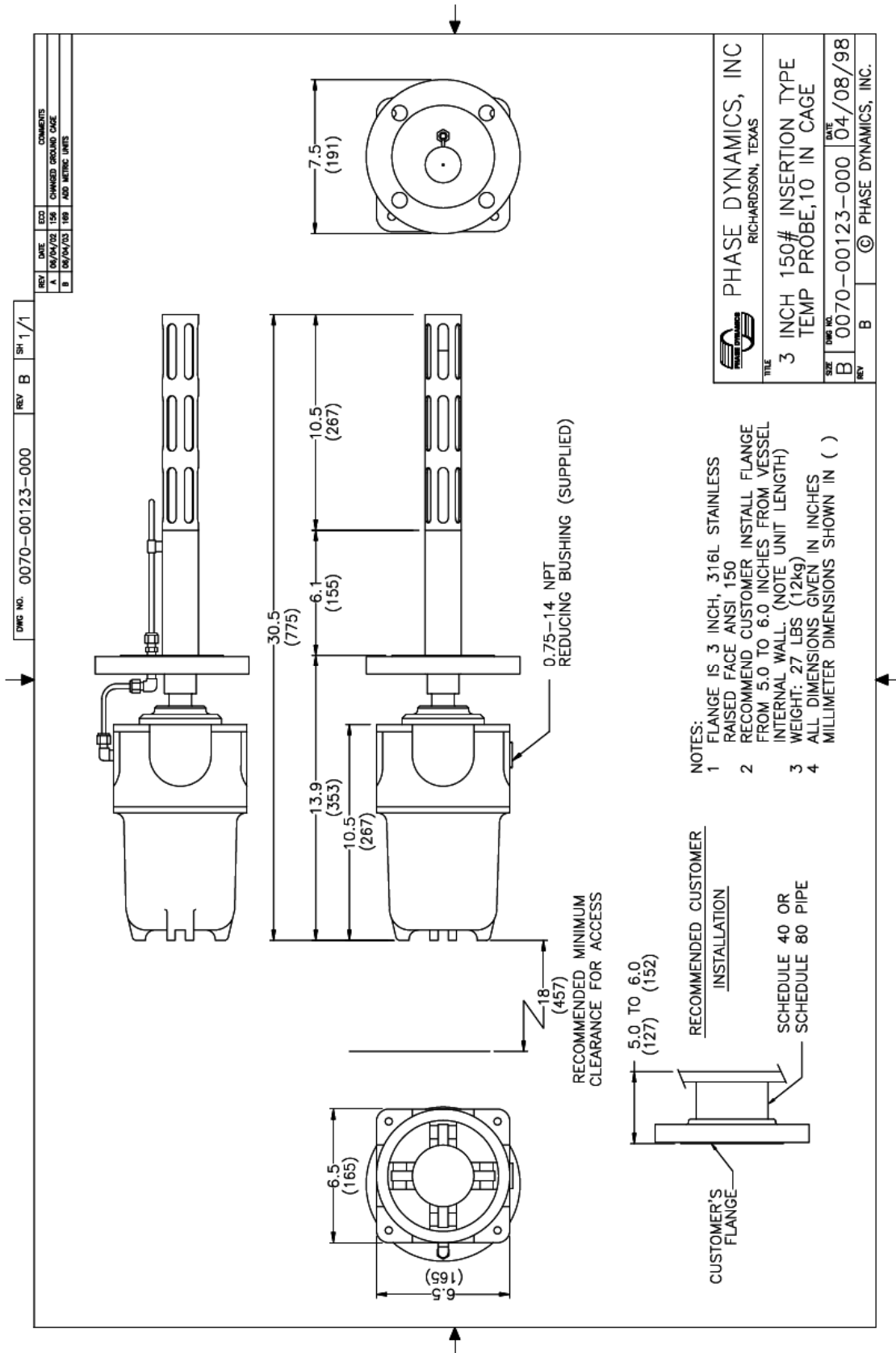


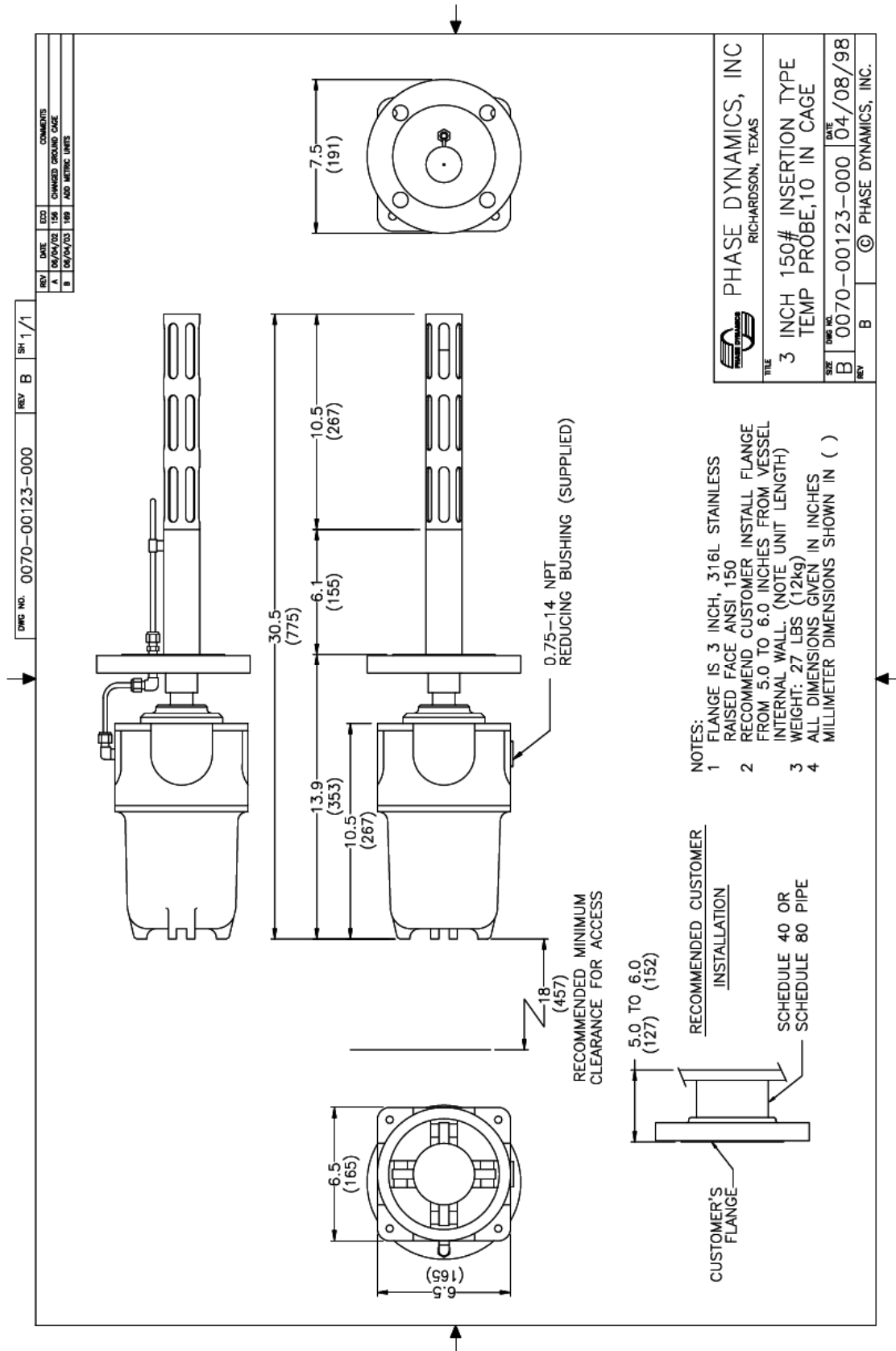


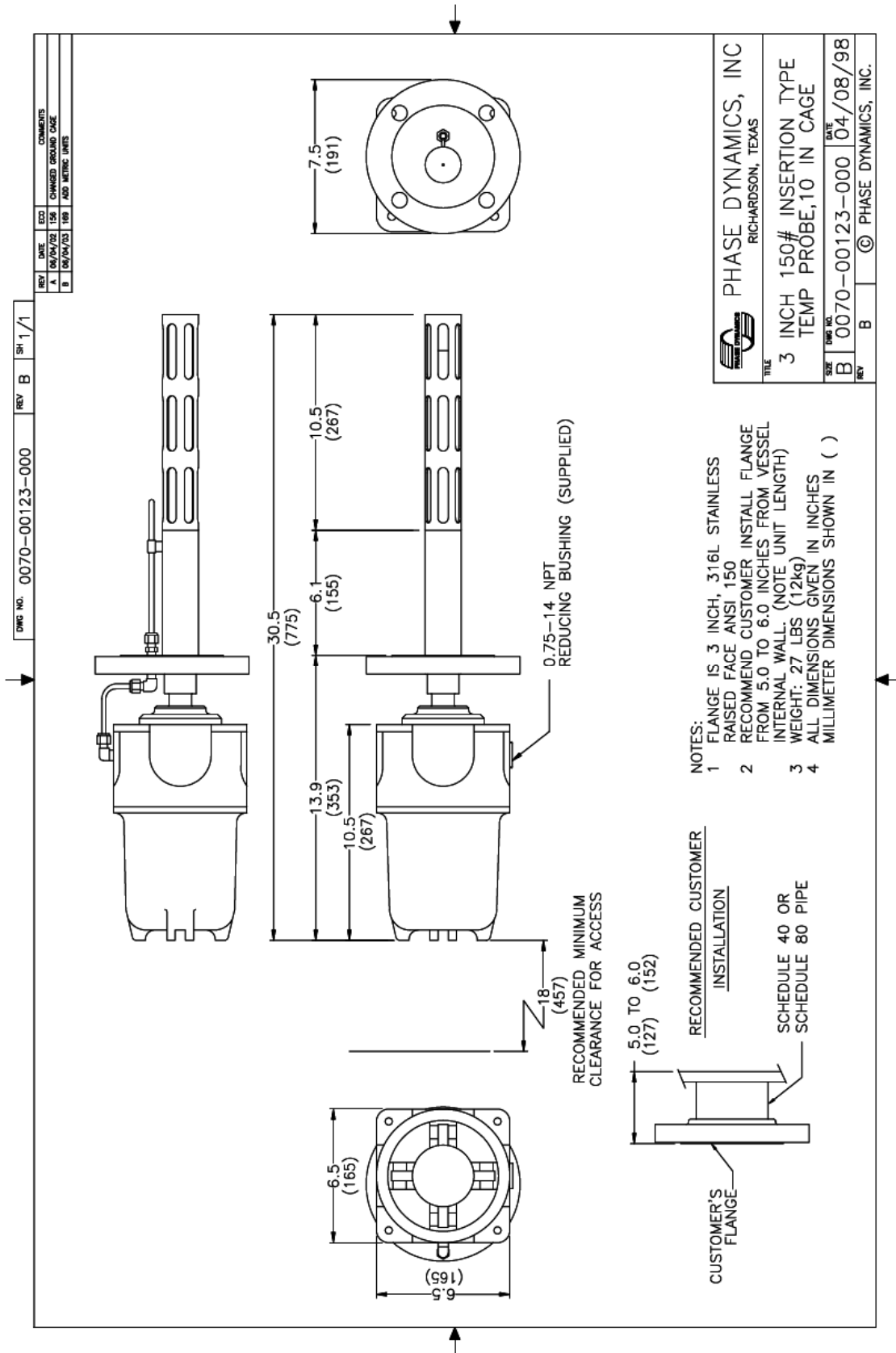


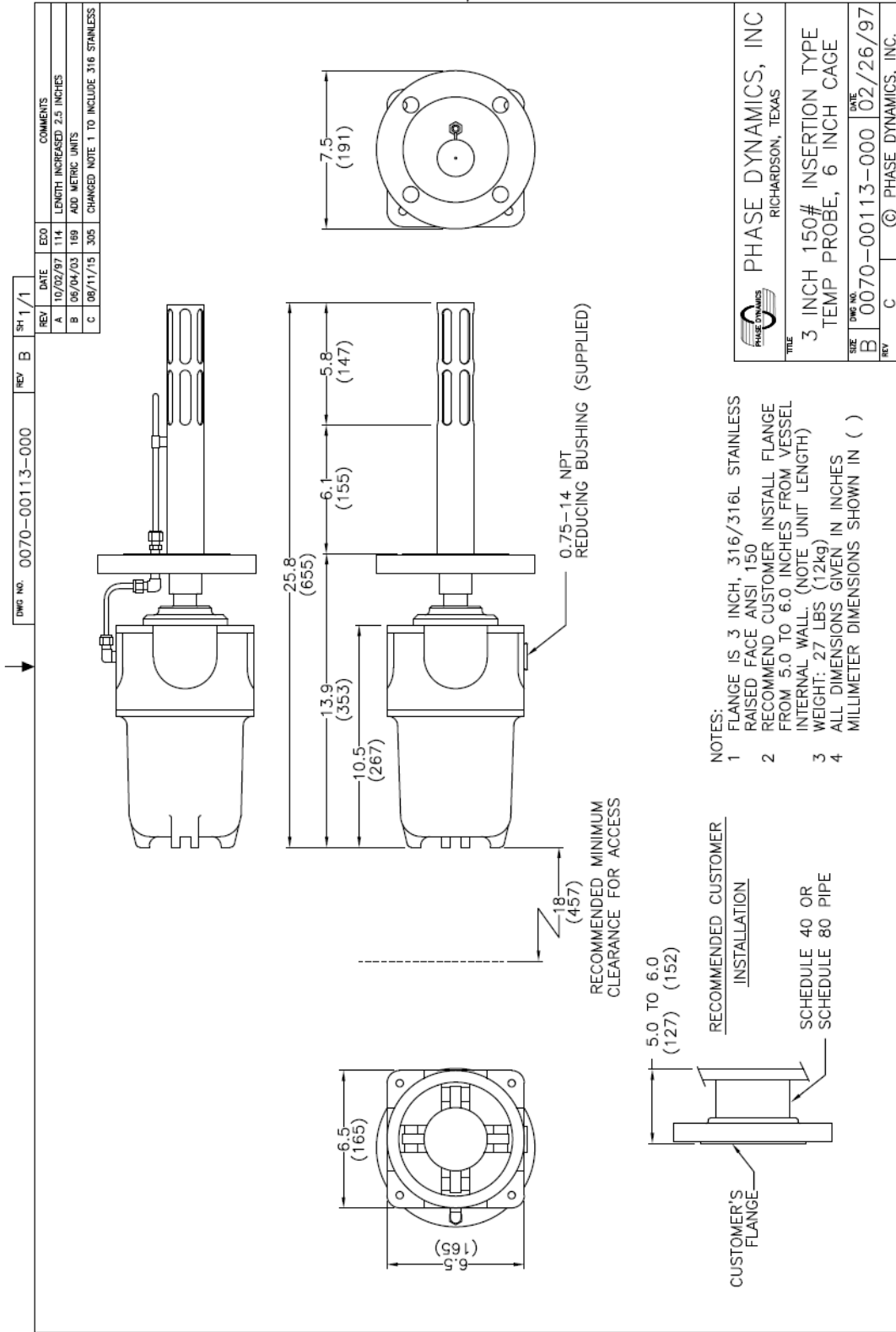


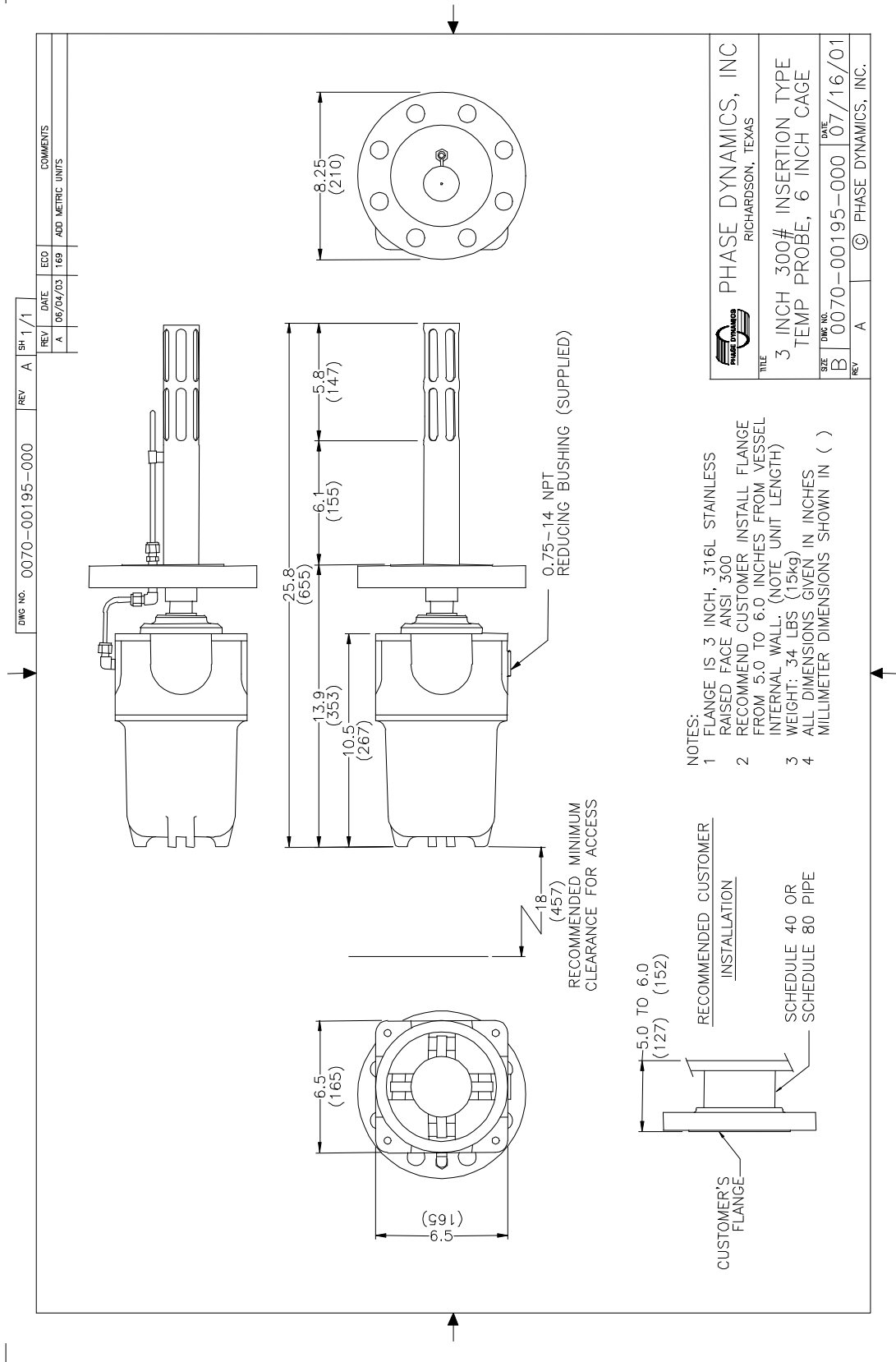


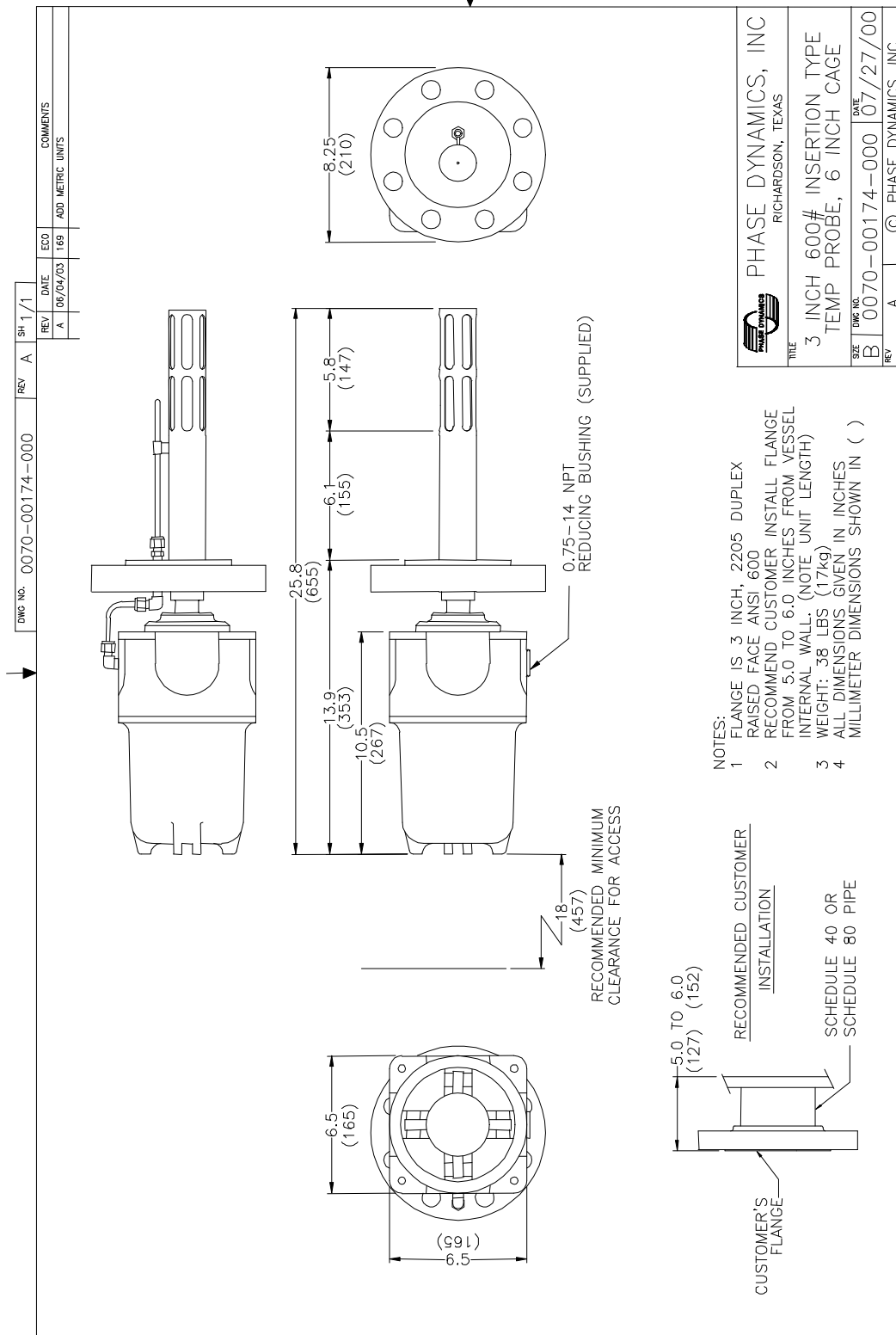


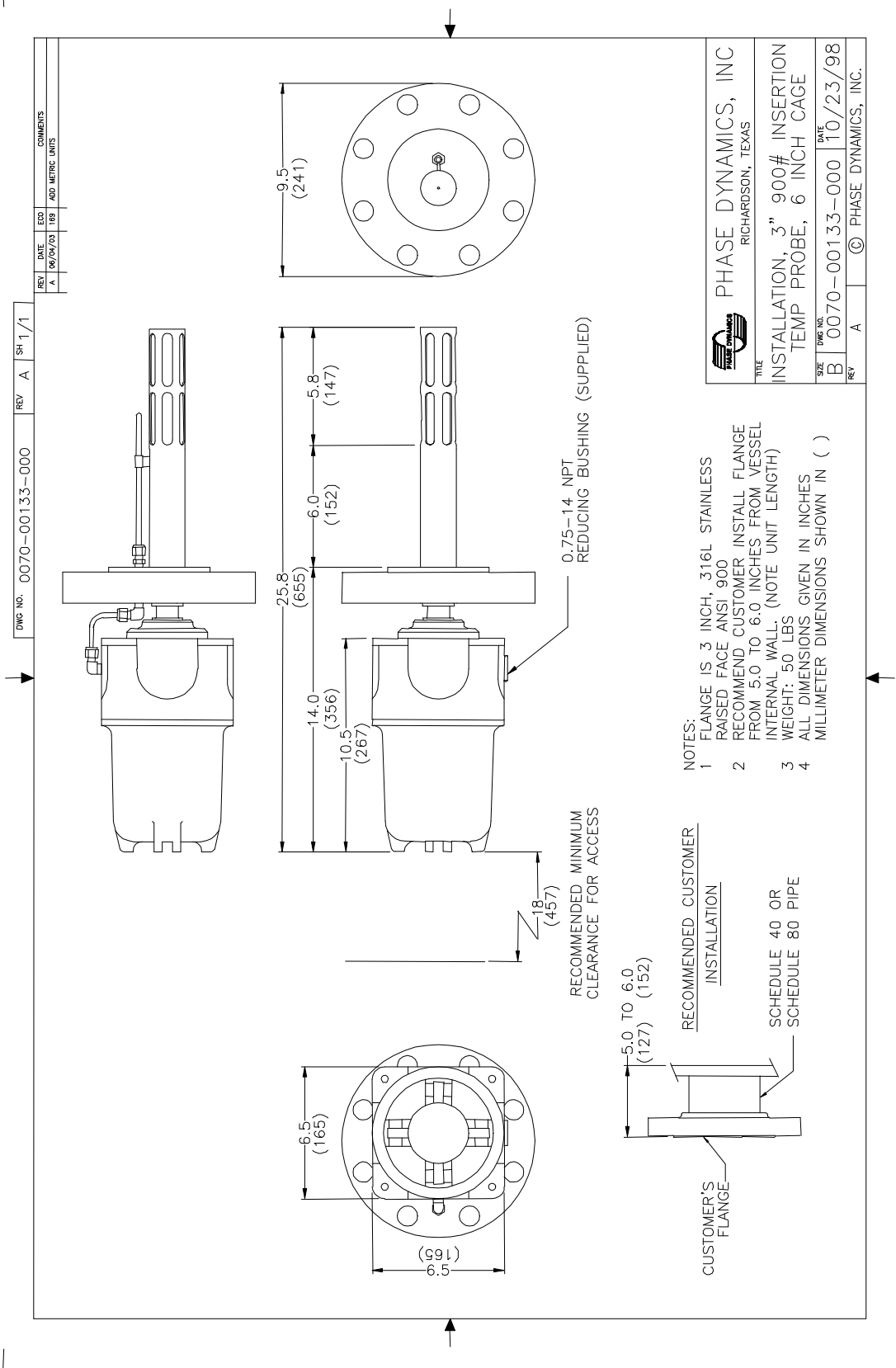





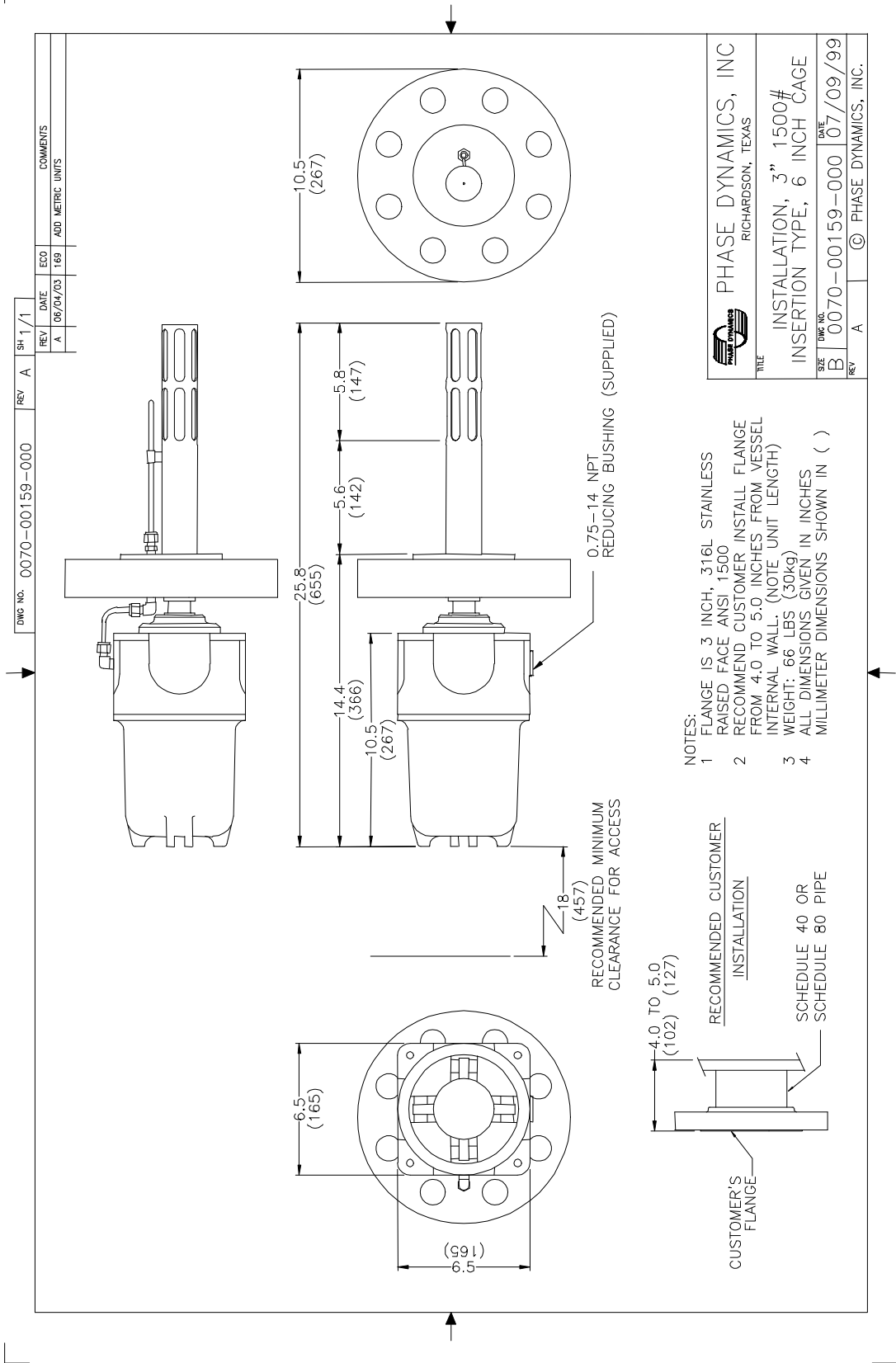


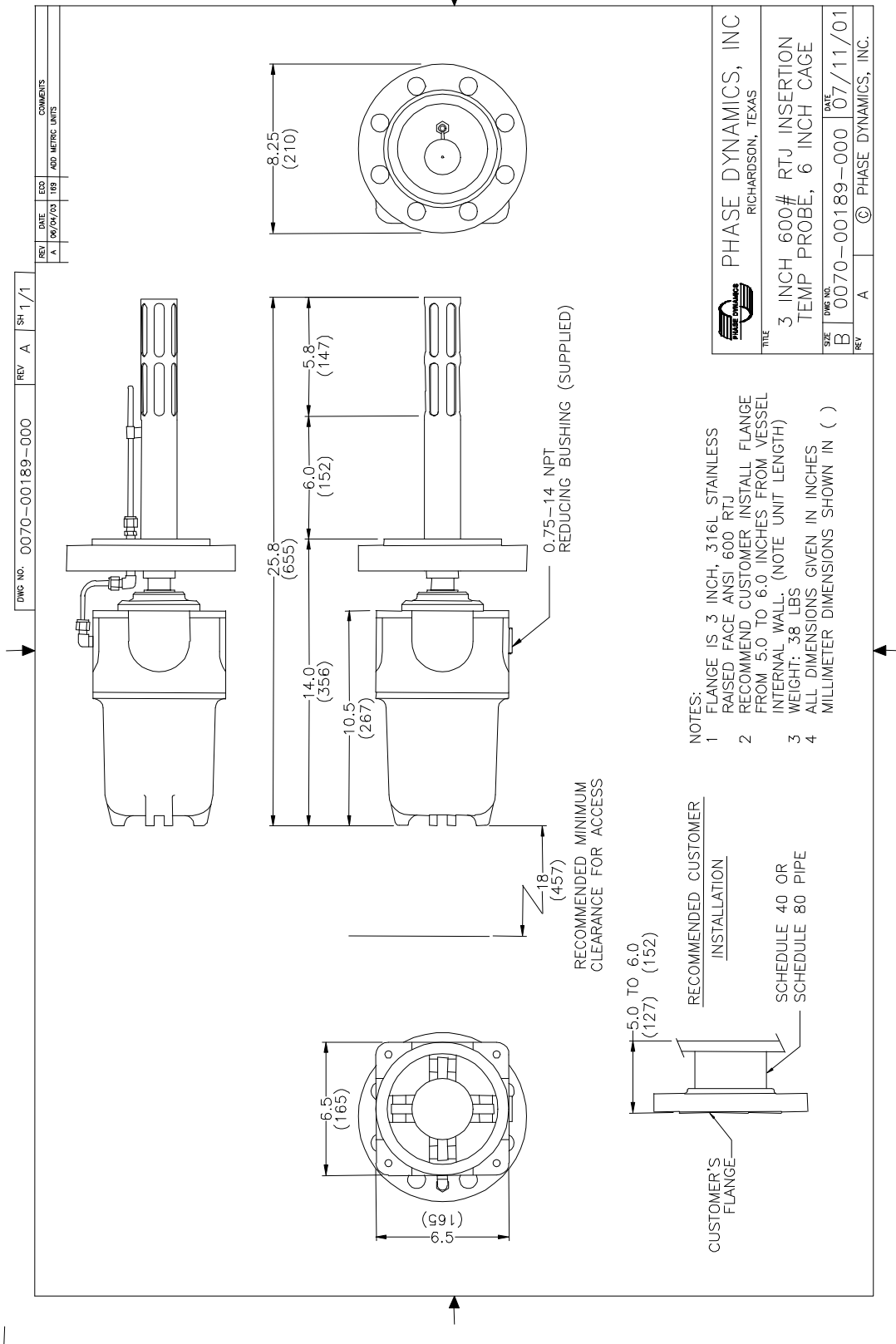






| | | | |
|---|----------------|--|-----|
|  | | PHASE DYNAMICS, INC. RICHARDSON, TEXAS | |
| TITLE | | INSTALLATION, 3" 900# INSERTION TEMP PROBE, 6 INCH CAGE | |
| SIZE | DWG NO. | DATE | REV |
| B | 0070-00133-000 | 10/23/98 | A |
| © PHASE DYNAMICS, INC. | | PHASE DYNAMICS, INC. | |





RECOMMENDED CUSTOMER INSTALLATION

SCHEDULE 40 OR SCHEDULE 80 PIPE

CUSTOMER'S FLANGE

5.0 TO 6.0 (127) (152)

- NOTES:
- 1 FLANGE IS 3 INCH, 316L STAINLESS RAISED FACE ANSI 600 RTJ
 - 2 RECOMMEND CUSTOMER INSTALL FLANGE FROM 5.0 TO 6.0 INCHES FROM VESSEL INTERNAL WALL. (NOTE UNIT LENGTH)
 - 3 WEIGHT: 38 LBS
 - 4 ALL DIMENSIONS GIVEN IN INCHES MILLIMETER DIMENSIONS SHOWN IN ()

| | | | |
|---|----------------|---|-----|
|  | | PHASE DYNAMICS, INC RICHARDSON, TEXAS | |
| SIZE | DWG NO. | DATE | REV |
| B | 0070-00189-000 | 07/11/01 | A |
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