



MODEL 2100 and 2300 SERIES CONTINUOUS LEVEL MONITORS

User Manual

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Level-Ease Monitor



Continuous level monitoring of liquids and bulk solids

Over 30 years of Arjay's field proven HF capacitance technology has been applied to the Level-Ease 2000 monitors. This unique level system provides complete flexibility for one or more tank levels in one package.

- capacitance technology does not foul or require cleaning
- no moving parts
- remote alarm unit mounts safely away from pipe
- single, dual or multi-tank systems



2000 Series

The Level-Ease 2000 sensing probe monitors the capacitance field between the probe and its concentric shield or the tank wall. As the level of product increases the probe capacitance changes. This level signal is used to provide outputs, displays, and relay control.

■ Features and Benefits

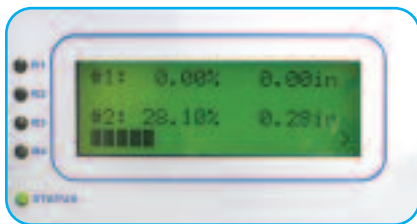
- no moving parts
- remote electronics via standard twisted pair
- available with Intrinsic Safety Barrier for Hazardous Locations
- high corrosion resistant Teflon and stainless steel wetted parts
- HF capacitance technology does not require routine cleaning
- easy calibration and control set-up
- standard unit can accept two probe inputs
- scanner system monitors multiple probe inputs

■ Technical Specifications - Control Unit

Operating Temperature	0°C to 50°C
Power Input	24 vdc or 110 vac or 220 vac
Analog Output	4-20 mA proportional to level
Interface	RS-485 Modbus available
Display	backlit display of tank levels
Alarm Relays	4 x 10 amp, SPDT, dry
Standards	UL, CSA, CE
Enclosure	Type 4X, IP65

■ Technical Specifications - Probe

Process Temperature	-60°C to 260°C
Ambient Temperature	-60°C to 50°C
Approval	CSA Class 1, Zone 1 and 2, Div 1 and 2, Groups A,B,C,D (also available with an Intrinsic Barrier option) ABSA-CRN #OF07450.2



The four line backlit display provides menu driven set-up functions and a display of up to two probe inputs.



All calibration, control relays and power wiring is available at the main control unit. This can be safely mounted up to 1 km away from the vessel.



The unique PMC circuit design, exclusive to Arjay, immediately converts the sensor signal to a frequency pulse for furtherance to the controller.

Arjay SS-06



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MANUAL DESCRIPTION

This manual describes the features, installation, setup, and usage of Arjay's 2100 and 2300 series of Level Controllers.

The 2100 series includes models 2110, 2112, and 2114.

The 2300 series includes models 2310, 2312, and 2314.

FEATURE TABLE

MODEL	LCD / KEYPAD	mA Output	Number of Relays
2110	Yes	Yes	None
2112	Yes	Yes	2
2114	Yes	Yes	4
2310	No	Yes	None
2312	No	Yes	2
2314	No	Yes	4

All 2300 series controllers lack a display and keypad (are "Blind") and are typically used in systems where more than one controller is installed; such as tank farms. For these applications the 2300 series is a lower cost alternative to the 2100 family.

Since there is no user interface, a Central Access Panel (CAP) or a Handheld Calibrator is required to setup and calibrate 2300 series controllers. The CAP or Handheld Calibrator communicates with each 2300 series controller via a RS-485 / modbus network. Multiple 2300 series controllers may be networked on the RS-485 link. Each 2300 series controller comes factory set with a preset network address or node number so the CAP or Handheld can communicate with each controller on the network. The node number is marked on the enclosure of each 2300 controller in the system.

The Arjay RS-485 / modbus network may be used to link all other members of the Arjay 2000 series level controllers including 2100, 2200, 2300, and 2400 series members. The only requirement for being on the network is that each controller must have a unique node address (unique to the particular network).

2300 SERIES CONTROLLERS

Since the 2300 series controllers have no display or keypad, this manual assumes a Handheld or CAP unit is being used for these models.

For the most part, the CAP or Handheld LCD screen and Keypad provide an identical menu and display as the 2100 series models which have an integral LCD and keypad.

1.0 INSTRUMENT OVERVIEW

1.1 FEATURES

- 2 Point automatic calibration
- Galvanically isolated probe inputs
- 2 Point automatic calibration
- RF Technology
- Arjay pulse card system for simple, safe, remote control, calibration and maintenance
- Up to 4 Differential Alarm relays (SPDT 10A contacts) field mappable to either probe
- Isolated mA output per probe Independently selectable as Direct / Inverse & 4-20 / 0-20mA output with offset capability
- RS-485 Modbus protocol
- No moving parts
- For use with any Arjay Capacitance probe

1.2 DESCRIPTION

The unit senses level using a RF capacitance measurement technique for very high-resolution measurements. A probe mounted in a vessel forms a capacitor with the vessel wall, or with a concentric shield around the probe for non-metallic vessels (ground reference). The capacitance of this arrangement is directly proportional to the level of material in the tank and may be measured to provide signals and controls.

Probe inputs and mA outputs are all galvanically isolated to minimize electrical interference.

The Arjay Level-Ease 2000 Series system uses RF (radio Frequency) methodology to measure the vessel capacitance. This technique minimizes the effects of other electrical properties of the probe, vessel, and vessel contents and focuses only on the vessel capacitance. The controller may be located up to one km away from an Arjay probe via inexpensive 2 wire shielded cable.

Model 2100 series controllers offer a 20 character by 4 line LCD and 16 key membrane keypad offer detailed data displays plus ease of calibration and setup. Level is displayed in percentage fill and in user selectable engineering units. In addition a bar graph gives a quick indication of level.

Model 2300 series controllers are “blind” and have no display or keypad.

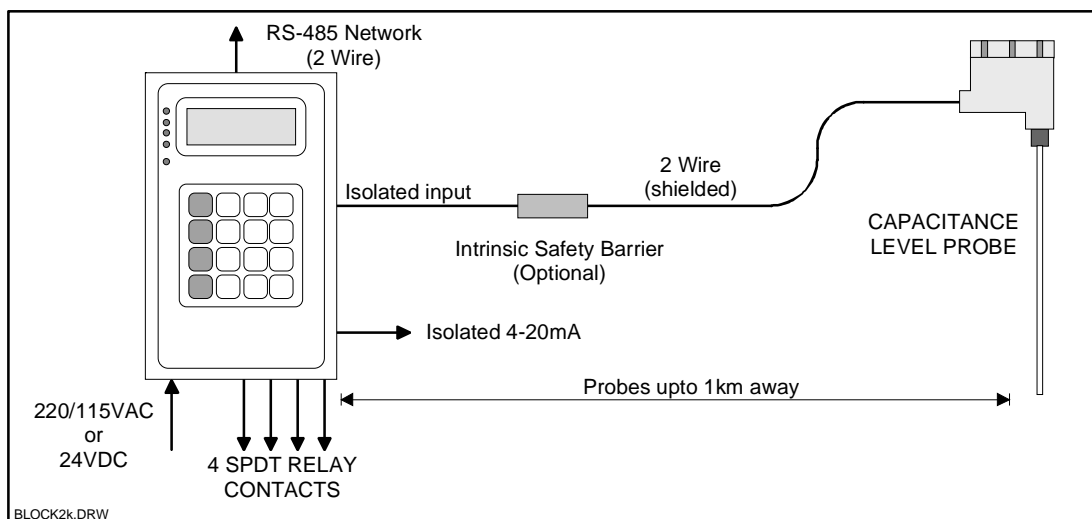


Figure 1.0

OPERATION

The unit senses level using a RF Capacitance measurement technique for very high-resolution measurements. A probe mounted in a vessel forms a capacitor with the vessel wall (or with a concentric shield around the probe for non metallic vessels). The capacitance of this arrangement is directly proportional to the level of material in the tank and may be measured to provide signals and controls.

USER INTERFACE

Note: only the 2100 series controllers have a display and keypad. The 2300 series members are "blind" and require a Central Access Panel (CAP) or a Handheld Calibrator for setup and calibration.

Display	4 line X 20 Character LCD with backlight + bar graph.
Keypad	4x4 Membrane type matrix.
Network	RS-485 / modbus protocol

PERFORMANCE

The unit measures capacitance in pF. Capacitance to Level translation depends on the tank geometry and the type and temperature variance of the material being measured. The resolution figures for Capacitance are guaranteed. Level Measurement figures are for typical applications.

Range	0-1000pF recommended for the resolution figures listed below. 0-10,000pF may be measured with less resolution and accuracy.
Resolution	Capacitance: 0.03 % of Full Scale worst case. Typical: 0.01%. Level: 0.02% of Full Scale (6ft concentric shield probe in water)
Accuracy	±0.2% of Full Scale

INPUTS

2 wire plus shield connection to an Arjay PMC-2000 module located in any Arjay Capacitance probe head.

OUTPUTS / RELAYS

mA output	0.05% resolution, sourced into 900 Ohms maximum load.
Relays	up to 4 SPDT 10A/120VAC contacts (applies to the 2XX2 or 2xx4 models only). Each relay may be set for differential control (hi and low setpoints) Programmable time delay: 0 - 99 seconds. Hi Fail-safe selectable.

POWER

115VAC @ 10VA or 220VAC or 24VDC @ 0.4A max. (specify at time of order)

MECHANICAL SPECIFICATIONS

Enclosure	sub plate mount, (optional wall Mount Type Nema 4X enclosure).
Dimensions	5.3" x 8.5" x 2.5" (Wall Mount Nema 4X: 14" x 12" x 7").
Weight	2.2 kg (5lb) max. (Wall Mount Nema 4X: 6kg (13lbs)).

ENVIRONMENTAL SPECIFICATIONS

Operating Temp.	-20 to 60 Deg. C for Controller only. Probe Head: -40 to 80 Deg. C
Relative Humidity	90% max. with no condensation.

2.0 INSTALLATION

NOTE: If any damage to the instrument is found, please notify an Arjay Engineering representative as soon as possible prior to installation.

2.1 PROBES

Capacitance probes may be selected from a variety of styles for use with liquids, liquid interfaces, and granular materials. The probe length is customer specified for the height of material desired to be measured. Usually Teflon coated probes are used.

2.2 PROBE INSTALLATION

Standard probe entry into a tank is via a 3/4" NPT opening (standard probes) or 1" NPT opening (heavy duty probes). Flanges and concentric shields are available as options. The entrance configuration may vary depending on the application requirements.

TO SCREW IN PROBE (THREADED ENTRY) USE WRENCH ON LOWER HEX. The probe fittings are compression type with Teflon ferrules assembled by applying torque between the two hex sections. The fittings are sealed at the factory to provide a compression seal capable of withstanding high pressures. Once opened they cannot be reassembled without new ferrules.

The probe should be mounted vertically and parallel to a reference ground surface, which is typically the vertical wall of the tank or a concentric shield around the probe. The following points are important when installing the probe:

- 1- **Reference ground:** This is VERY IMPORTANT and is typically the metal walls of the tank. For non-metallic tanks, a concentrically shielded probe is required in which case the shield provides its own Ground. **IMPORTANT:** For standard threaded entry and flange entry probes (without concentric shields), make sure the fittings are clean to ensure a **GOOD ELECTRICAL CONNECTION BETWEEN THE PROBE HEAD ENCLOSURE AND THE TANK (REFERENCE GND).**
- 2- **The distance between the probe and the ground reference:**
This only applies to probes without concentric shields. The closer the distance to the tank wall, the greater the sensitivity of measurement; too close and bridging problems may occur.
- 3- **The degree of parallelism between the probe and the reference ground:**
The probe must be parallel to the reference ground for a linear output signal. Note: that the concentric shield option is inherently linear due to the concentric shield.
- 4- **The measurement accuracy can be affected by the temperature change of the material in the tank.** The amount of measurement error depends on the material. If the temperature change is excessive, temperature correction may be required. Contact the Arjay representative for more information.
- 5- **Agitators or moving objects in the tank:**
Moving objects in the tank close to the probe such as agitator blades, moving baffles etc. appear as moving ground references to a capacitance probe and will cause measurement errors. In applications where these objects are present, a concentrically shielded probe must be used.

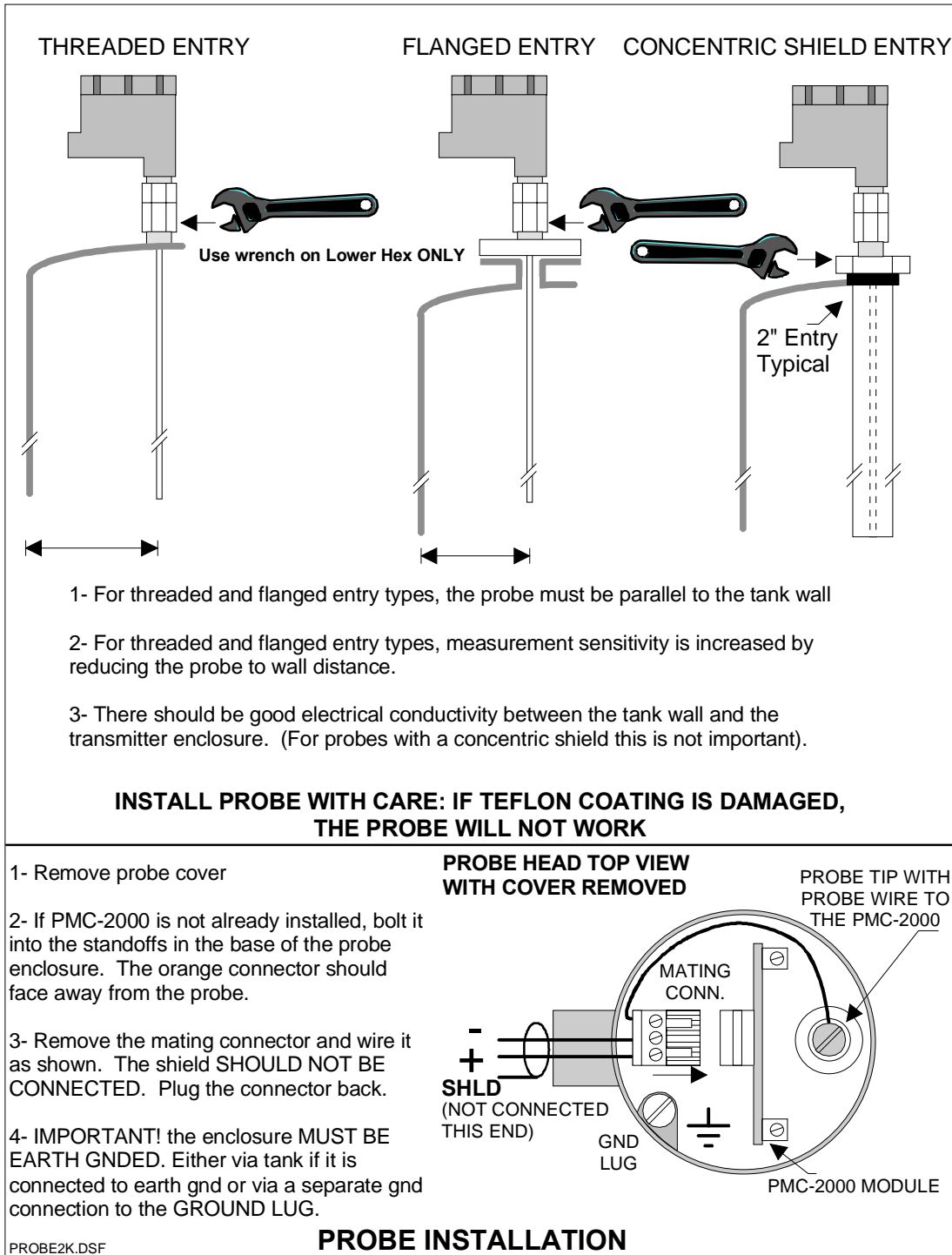


Figure 2.0

2.3 MECHANICAL INSTALLATION

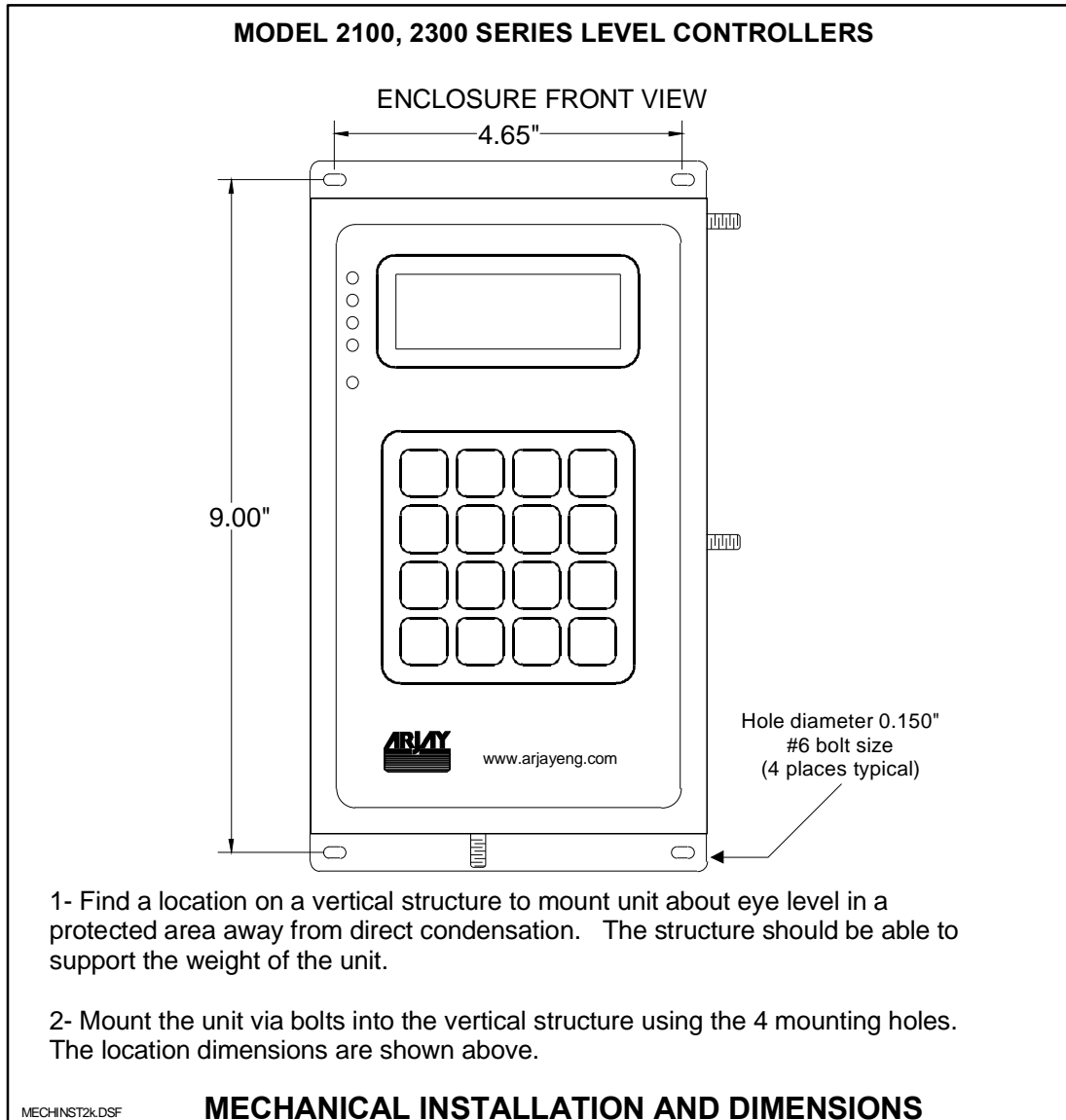


Figure 2.1

2.4 ELECTRICAL INSTALLATION

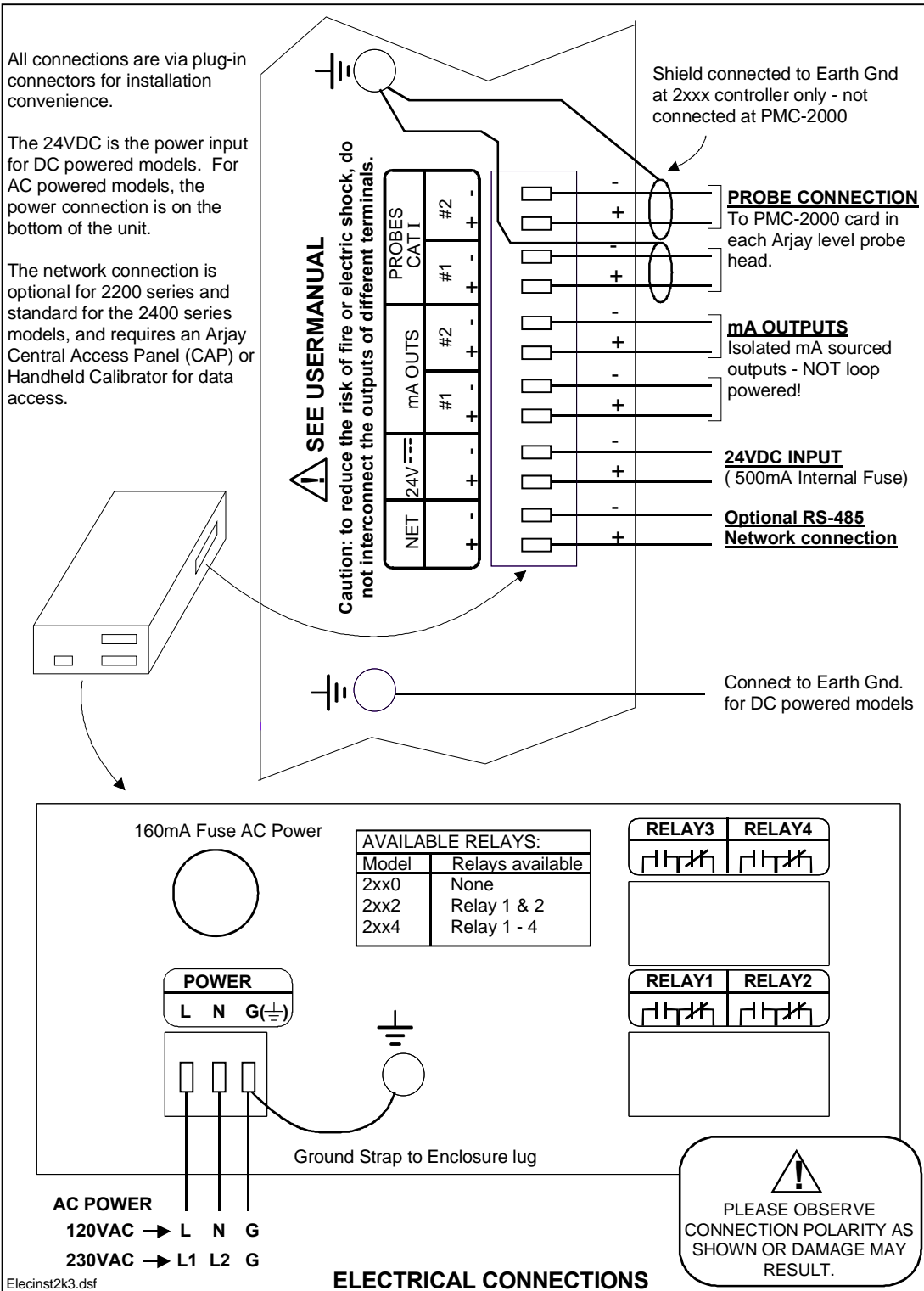


Figure 2.2

3.0 STARTUP AND CALIBRATION

This Section is provided for minimum setup. For a more detailed description of features please refer to Section 4.0.

2300 SERIES MODELS: An Arjay Central Access Panel (CAP) or Handheld Calibrator is required to access the “blind” 2300 series models. In either case, the keypad and LCD are as shown in Figure 3.0.

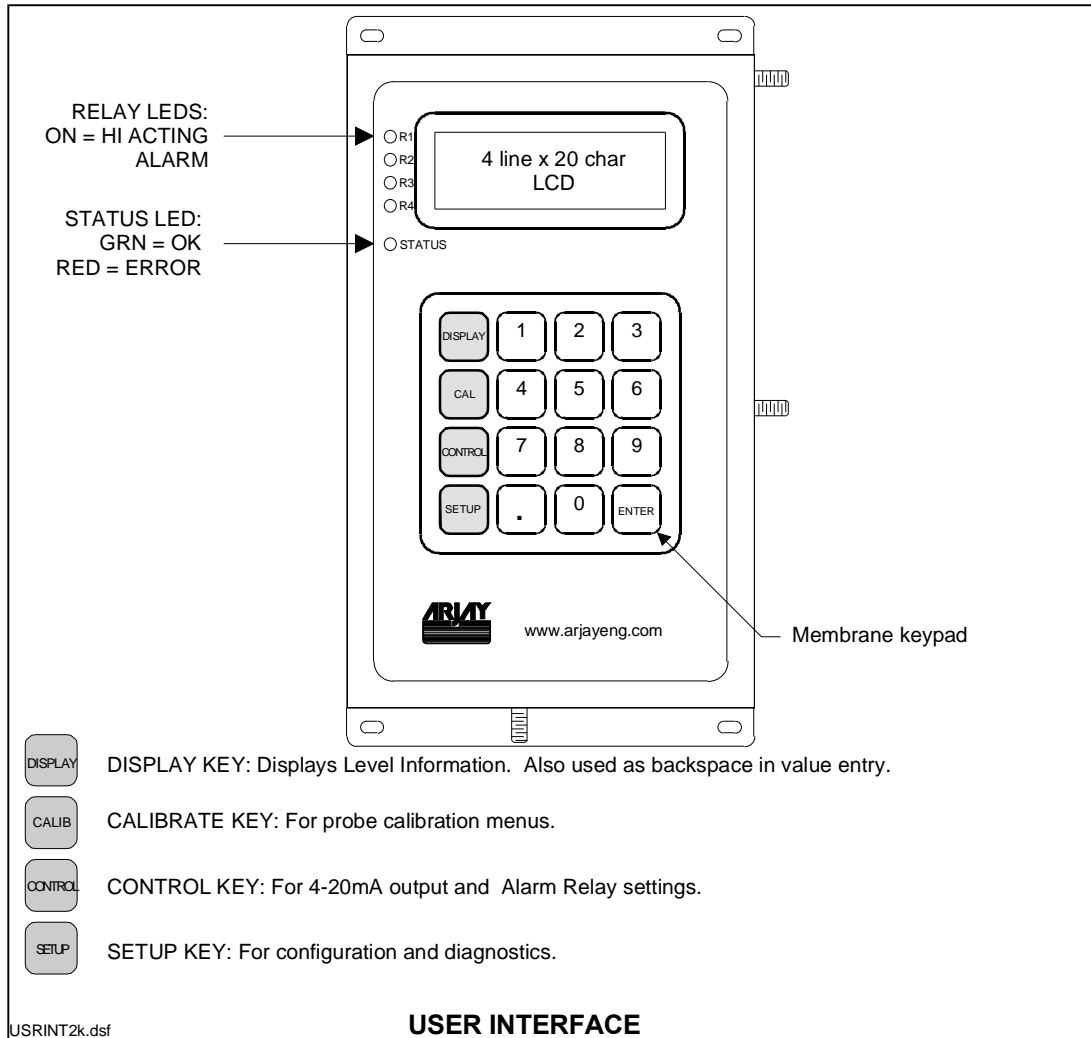


Figure 3.0

3.1 NOTES ON VALUE ENTRY

When entering in numeric values, the cursor can be backspaced to correct mistakes by pressing the DISPLAY key. This is only true if the cursor is not at the beginning of the displayed value, in which case the DISPLAY menu is entered.

Values may be entered with any number of places of decimal.

If the entered value is out of the allowed limits, the system displays the limiting value for 2 seconds. For example if the mA Span value is entered as 5000.0% then **MAX. 100** are displayed for 2 seconds then entry is allowed again. The current value is not changed unless the entered value is within limits.

During value entry, the capacitance and level are still being constantly updated in the background. Apart from the CALIBRATION menu and the DIAGNOSTICS menu, in all other menus, the Alarm relays and the mA output are also updated.

3.2 2300 SERIES USER INTERFACE

Please skip this Section for 2100 series models which have an integral keypad and LCD.

As described, the 2300 series models lack an LCD and keypad. To access these models, an Arjay Central Access Panel or Handheld Calibrator is required.

The CAP or Handheld communicates with any 2000 series level controller via a multidrop RS-485 / modbus protocol. For models with an integral keypad and LCD, the network is optional. For 2300 series models, the network is standard.

Up to 100 2000 series level controllers may be connected to the network. Each must have a unique node address i.e. any number from 1 to 100.

The CAP or Handheld Calibrator accesses any desired 2300 series level controller on the network for data access, calibration, and setup. The display on the CAP or the Handheld is identical to the menu's and displays described below except for 2 major differences:

1. The node address and model number of the currently accessed 2000 series level controller is always displayed on the topmost line of the LCD.
2. The node address may be changed (i.e. another controller on the network may be accessed) by pressing the ENTER key from the top level of any main menu. The top level is the first menu after pressing any main menu key. There are 4 main menus: Display, Calibration, Control, and Setup. Pressing ENTER from a top level menu, brings up the following screen:

REMOTE XMTR SELECT
Address: 1

Where the Address on the 2nd line prompts with the currently selected node address. Enter the new address and press the ENTER key to confirm the entry. The unit automatically reverts to the previous menu.

The Handheld Calibrator runs on a 9V battery and therefore includes a Low Battery warning which is displayed on the LCD. The warning is only displayed in the normal DISPLAY mode.

Refer to the figure below for connecting the Handheld Calibrator to the 2300 series models.

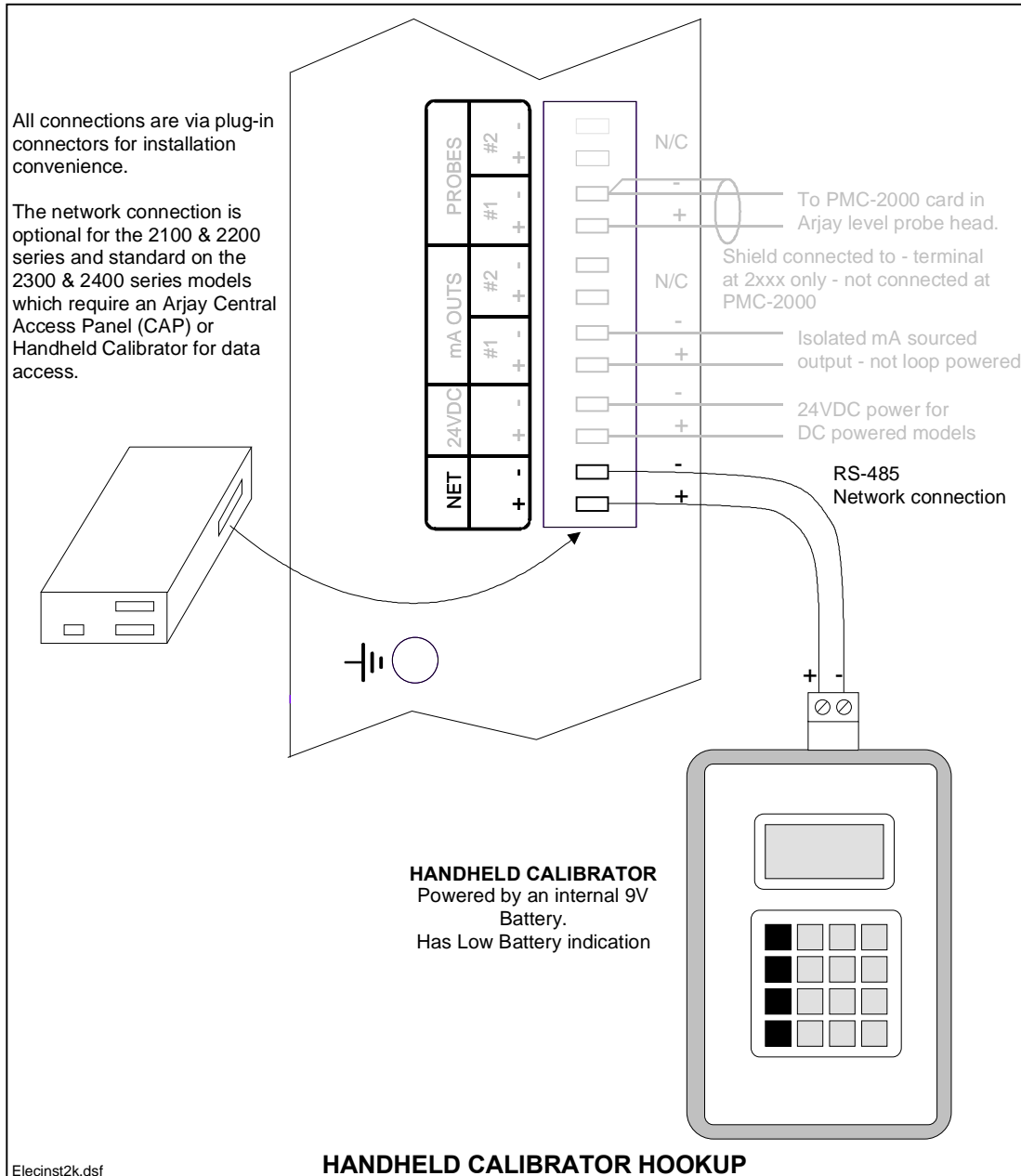


Figure 3.1

3.3 POWERUP DISPLAY

After mechanical and electrical installations of the probe(s) and the controller have been successfully completed, power up the unit. The following startup screen will be displayed for about 3 seconds:

Arjay Engineering
Level-Ease 2000
Rev: 3.00 / 2057_28
S/N: 001234

The Rev. line displays the Hardware Revision followed by the Software Revision separated with a “/”. The Serial Number is displayed by itself on the bottom line.

After the startup screen, the LCD should show a screen similar to:

```

LEVEL
10.00 in
13.88 %
  □□

```

NOTE: The shown values are for example only.

The 2nd line shows the vessel capacity in engineering units. One of 8 engineering units may be selected in the configuration menu as described in the next sub-section.

The 3rd line shows the vessel capacity in percent. This value is independent of the engineering units.

The 4th line displays a bar graph of the percent capacity. The resolution is 5%.

The Status Indicator (see figure 3.0) should be green. If this is red then the LCD displays the kind of System Error. See the troubleshooting guide for details.

3.4 MINIMUM SETUP

3.4.1 XMTR VALUES

- Press the SETUP key, then 1 for PMC 2000, then 2 for Manual. This menu enters the PMC-2000 level transmitter module's calibration parameters. These parameters are printed on a label attached to the PMC-2000 transmitter connector. These values should also be noted down in the SETTINGS table located at the end of this manual. On pressing 2 for Manual:

```

** PMC 2000 SETUP **
Enter xmtr A value:
0.03316

```

- Enter the PMC-2000 module A value then press Enter. The unit will prompt for the K and C values. Enter these followed by pressing the Enter key in each case.

3.4.2 DATA FILTER (SMOOTHING)

- Press the SETUP KEY if not already in the Setup menu), then press 3 for Settings, then 1 for Filter.

```

*****SETTINGS*****
Enter filter time
in seconds:
0.0

```

- Enter the data response time in seconds for the unit to respond to a sudden change followed by the Enter key. For example a 5 second setting means the calculated value of the vessel capacitance and resulting values of level in % and engineering units will take 5 seconds to respond to an actual sudden change in vessel level.

3.4.3 ENGINEERING UNITS

One of 8 units may be selected. These units do NOT cause any change in internal calculations, but are only used for clarity. For example, if the vessel is cylindrical with a vertical axis then the volume is proportional to the depth. In this case, volume (or mass) units may be selected such as Liters or gallons. However, switching between liters to gallons does NOT change the displayed value:

- Press the SETUP KEY if not already in the Setup menu), then press 3 for Settings, then 2 for Units:

```

** SELECT UNITS **
1-in 2-ft 3-m 4-cm
5-lb 6-kg 7-L 8-gal

```

Current: gal

- Press the number for the desired units.

3.4.4 TAG NUMBER

THE TAG NO.s ARE USED ONLY FOR NETWORK APPLICATIONS AND ARE USUALLY FACTORY SET. To communicate on a network, each controller must have a unique Tag Number (also called node address).

Important: if multiple units on a network have the same address, network errors will result.

An Arjay Central Access Panel (CAP) is required to communicate with 2000 series level controllers on a network. The CAP allows data to be viewed from and remote calibration / set of any 2000 series level controller on the network from a central location.

- Press the SETUP KEY if not already in the Setup menu, then press 3 for Settings, then 3 for Tag #.
- Enter the desired tag number.

3.4.5 mA SETTINGS

- Press the CONTROL key:

****CONTROL SETTINGS****
1-Relay Settings
2-mA Settings

- Press 2 to setup the mA output:

*****SET mA OUT*****
Zero (% Lvl) 0.0
Span (% Lvl) 100.0

- Enter the level in percent for Zero and Span values followed by the Enter key in each case. After the Enter key is pressed for the Span value, the following menu is displayed for additional mA settings:

*****SET mA OUT*****
Action: Direct
Type: 4-20mA
Press 1 to change

- The cursor will be on the Action setting line. Pressing 1 toggles between Direct and Inverse action. Direct action causes the 4mA to be output when the level is at the Zero setting and 20mA to be output when the level is at the Span setting. Inverse action is the reverse of Direct action. Press the ENTER key when done.
- The cursor now drops to the Type setting line. Pressing 1 toggles between 4-20mA and 0-20mA. The 0-20mA as the name implies, outputs a signal between 0-20mA instead of 4-20mA. The 0-20mA setting generally offers a little better measurement resolution.

3.4.6 RELAY SETTINGS

For help in selecting the relay settings please refer to Sections 4.3.2 - 4.3.4.

- Press the CONTROL key if not already in the Control Settings menu (see mA Settings display above). The press 1 for Relay Settings:

**** RELAY SETTINGS ****
1-Relay1 2-Relay2

3-Relay3 4-Relay4
5-Disable Alrms (ENA)

- Disable relays. Pressing 5 toggles between Enabling (ENA) and Disabling (DIS) alarms. The current state is displayed on the right extreme of the bottom line of the LCD. A Disable setting will disable Alarm relay alarms even if an Alarm condition exists. The factory default setting is ON (ENA) which allows Alarm relays activation. **Relays can be enabled AFTER calibration and setup are complete.**

- Press 1 to setup Relay1 (of 4):

*** RELAY 1 SETTINGS ***

Action: HI (1 for LO)
FIsafe: OFF(1 for ON)

- Next select the Alarm Action by pressing 1 to toggle between High and Low action. See Section 4.3.2 – 4.3.4 for help in selecting this value. Press ENTER after selecting Action.
- Next select the Failsafe type by pressing 1 to toggle between On and Off. See Section 4.3.2 – 4.3.4 for help in selecting this value. Press ENTER after selecting the Failsafe type.
- After selecting the Failsafe setting the following menu is displayed.:

*** RELAY 1 SETTINGS ***
Hiset (%lvl) 20.00
Loset (%lvl) 15.00
On Delay (sec): 0

- Enter the High and Low alarm (Hiset and Loset) values in percent level. Press Enter after each entry.
- If Differential control is not desired then set the High and Low alarms to the same value.
- Finally, set the ON delay in seconds. This is how long an alarm condition must exist before the corresponding relay is switched to an alarm condition.

The following table shows the effect of the Relay Action and Failsafe settings. See also Sections 4.3.2 – 4.3.4 for further details.

Relay Action	Failsafe Setting	Effect
High	No	Alarm condition when process level rises above the High Setpoint for at least the alarm delay period. Alarm condition remains active until the process level drops below the Low Setpoint. No action is taken when the process level is between the High and Low Setpoints. In the alarm condition, the corresponding alarm LED is turned ON, and the relay is energized.
High	Yes	Alarm condition set and reset as above. In the alarm condition, the corresponding alarm LED is turned ON, but the relay is de-energized.
Low	No	Alarm condition when process level drops below the Low Setpoint for at least the alarm delay period. Alarm condition remains active until the process level rises

		<p>above the High Setpoint.</p> <p>No action is taken when the process level is between the High and Low Setpoints.</p> <p>In the alarm condition, the corresponding alarm LED is turned ON, and the relay is energized.</p>
Low	Yes	<p>Alarm condition set and reset as above.</p> <p>In the alarm condition, the corresponding alarm LED is turned ON, but the relay is de-energized.</p>

- The Relay Settings menu is now displayed from which other relays may be selected to be set up. Set the remaining relays 2 – 4 in the same way.

Note: For models 2xx0 and 2xx2 which have 0 and 2 relays respectively, the front panel LED's are still present for visual indication of alarms even though the corresponding relays are not installed.

3.4.7 CALIBRATION

If this is a new installation and a calibration has not been successfully done before, then the most convenient form of calibration is the Auto Cal feature. This requires that the level in the vessel be changed by at least 10% and the actual two levels in % be entered in the controller. The actual levels in the vessel must be measured or determined independently and as accurately as possible. NOTE: the more the level is changed between the 2 calibration points the better. For example a 1% error in the entered level values for a 25% change translates to a 4% error at Full Scale.

- Press the CALIBRATION key

***** CALIBRATION ******
1-Auto 2-Manual
3-Slope/Off 4-FS val

- Press 1 for Auto Cal.
- ACCURATELY MEASURE THE PERCENT LEVEL in the vessel (2 decimal places) and enter it here followed by the Enter key. The tank capacitance (raw signal) is displayed on the bottom line of the LCD. This is for observation only and may be used to confirm that the level in the tank is stable.
- The unit now prompts for the 2nd level. RAISE OR LOWER THE LEVEL BY AT LEAST 10%. Less than 10% is allowed but may reduce accuracy. ACCURATELY MEASURE THE NEW LEVEL IN PERCENT and enter it (again 2 decimal places) followed by the Enter key. Again, the tank capacitance is displayed on the bottom line of the LCD.
- If the calibration was not successful, an error message is flashed on the screen for 2 seconds. Common problems are either the level in the tank was not changed or that the 2nd level value in % was entered identical to the 1st.
- At the end of a calibration, the unit calculates 2 parameters, which it uses to determine level: SLOPE and OFFSET. The Slope is the amount of capacitance change per percent level change (sensitivity) and the Offset is the capacitance of the empty tank. These values may be displayed by pressing 4 for Man. 2 option from the CALIBRATION menu. RECORD these values for later reference in Section 6 of this manual. These values may be re-entered instead of recalibrating the vessel using Auto Cal.

For more calibration details, see Section 4.2.

3.4.8 FULL SCALE VALUE

This is the maximum capacity of the vessel IN THE ENGINEERING UNITS CHOSEN IN Section 3.4.3.

- Press the CALIBRATION key to get to the CALIBRATION menu, then 4 for FS Value.
- The unit prompts for the maximum capacity of the vessel in the already chosen engineering units. Enter the vessel maximum value then press Enter.

3.4.9 ENABLE ALARM RELAY CONTROL

- If the Alarm Relays are being used, now that calibration has been successfully completed, the Alarm Relay control may be re-enabled.
- Press the CONTROL key to get to the CONTROL menu, then 1 for Relay Settings then 5 to Enable.
- The right, bottom corner of the display should show ENA for enabled.
- Press the DISPLAY key to go back to the Display menu.

THIS COMPLETES THE SETUP AND CALIBRATION PROCEDURE
NO FURTHER SETUP OR CONFIGURATION IS REQUIRED
THE NEXT SECTION (4) IS FOR REFERENCE ONLY

4.0 OPERATION

IN THE FOLLOWING TEXT A MENU WILL BE DISPLAYED AS A PATH. FOR EXAMPLE THE AUTOCAL MENU: [CALIB\ 1]. (CALIB key then 1 for AUTOCAL).
 SETTINGS MENU: [SETUP\3] (SETUP key then 3 for SETTINGS).

The 2000 Level Monitor uses a high precision and highly repeatable RF technique to measure capacitance, which in turn is used to calculate level. The capacitor formed by the level probe (usually mounted vertically into the vessel) and a ground reference (metallic vessel wall or probe shield for concentrically shielded probes) changes its capacitance in proportion to the level of the material in the vessel. In addition, the capacitance is directly proportional to the dielectric constant of the material in the vessel and inversely proportional to the distance between the probe and the ground reference. In other words, THE GREATER THE DIELECTRIC, OR THE SMALLER THE GAP BETWEEN THE PROBE AND THE GROUND REFERENCE, THE HIGHER THE MEASURED CAPACITANCE AND THE GREATER THE CHANGE OF CAPACITANCE AS THE LEVEL CHANGES. The dielectric constant is a physical property of matter and is different for different materials. Water has a dielectric constant of 80 as compared to 3 for most oils. Therefore, water gives a much higher change in capacitance than oils which makes measuring the level of water much more precise as compared to oils. For a linear response, the CAPACITANCE LEVEL PROBE MUST BE PARALLEL TO THE GROUND REFERENCE. The closer the distance between the probe, the greater the change in capacitance as the level changes. This may be used to advantage when measuring materials which have a low dielectric, and which, therefore give a low change of capacitance as the level changes. Arjay's method of measuring capacitance gives better than 0.1pF resolution for typical applications.

All Level-Ease 2000 Series Controllers and Transmitters are intelligent and can perform a number of tasks simultaneously (multitasking software). This means that even while in another menu, the capacitance is always be measured in the background. For example if the Filter value is being set in the SETTINGS submenu (SETUP\SETTINGS menu), the level value, relay alarms and mA outputs are still being updated. This is important since keypad entries are typically slow and sometimes an operator might forget to return the unit to the normal DISPLAY menu: in this case Alarm relays and mA output are still updated. In some menus however, the mA output and or the Alarm Relays are not updated on purpose; for example while in the calibration menu, the unit assumes that the unit is being calibrated and so the calculated level may be erroneous. In this case, the mA and Alarm Relays are set to the inactive states.

Periodically, (every 5-10 seconds) the unit does a self-diagnostic. If major errors are found they are displayed on the LCD. These error messages take precedence over the level information in the DISPLAY menu ONLY. All other menus may be entered and parameters viewed or changed. In case of errors, this allows the user to enter the DIAGNOSTICS menu and check the capacitance or frequency etc.

4.1 DISPLAY MENU [DISP]

This is the default or normal operating screen. It shows:

```

LEVEL
3454 lbs
50.3%
□□□□□□□□□□

```

The 2nd line shows the vessel capacity in engineering units. The value is calculated as level % times Full Scale Engineering Units value.

The 3rd line shows the vessel capacity in percent fill.

The 4th line shows a bar graph of the level in percent fill. The resolution is 5%.

4.2 CALIBRATION [CALIB]

The unit may be calibrated 3 different ways: Automatic Calibration and 2 Manual Calibrations. Pressing the CALIBRATION key enters the CALIBRATION menu:

***** CALIBRATION *****
1-Auto 2-Manual
3-Slope/Off 4-FS val

4.2.1 AUTOMATIC CALIBRATION [CALIB\1]

This is typically done for a new installation. It involves entering the independently and ACCURATELY MEASURED level in the vessel, changing the level by some amount, then entering the new ACCURATELY MEASURED level. The unit then calculates 2 parameters: SLOPE and OFFSET by correlating the 2 entered percentage levels with the corresponding measured capacitance. The SLOPE is the change in capacitance in pF per percent change in level. The OFFSET is the calculated empty vessel capacitance in pF. The Automatic Calibration procedure is already described in Section 3.4.5.

NOTE: The accuracy of the calibration depends in large part on the accuracy of the 2 measured levels entered during calibration. The resolution of measurement should be 2 decimal places to get the best accuracy. This is also why a minimum of 10% change in level is recommended for the 2 calibration points, since the larger the difference, the less affect the inaccuracies of entered levels has on the calibration. For example, a 1% error in entered values over a 10% change translates to a 10% error at Full Scale (100%).

NOTE: if the SLOPE and OFFSET parameters are already known, they may be entered directly by selecting SLOPE/OFF (item 3 from the Cal menu). This can save a lot of time. Also, FOR CONCENTRICALLY SHIELDED PROBES, THE SLOPE AND OFFSET ARE INDEPENDENT OF THE VESSEL GEOMETRY AND FOR A GIVEN MATERIAL IN THE VESSEL, THE SLOPE AND OFFSET MAY BE FACTORY DETERMINED, THUS SAVING CALIBRATION TIME ONSITE.

4.2.2 MANUAL CALIBRATION [CALIB\2]

This option is used to fine-tune the SLOPE and OFFSET values after a successful Automatic Calibration or when the capacitance at 2 differing percent levels is known. For example if the capacitance and corresponding levels in % have been recorded over some time then these can be used to recalibrate the unit by using two levels which are furthest apart (and their corresponding capacitance values). The procedure is as follows:

At any time, to view the measured capacitance:

- Press the SETUP key then 2 for Diags:
- Read the capacitance in pF on the 2nd line from the top.
- Determine the actual level in percent in the vessel: (2 places of decimal accuracy)
- The above steps must be repeated for one other level, which is different from the first by at least 10%.

TO CALIBRATE USING MANUAL CALIBRATION:

- Press the CALIBRATION key to get to the CALIBRATION menu then 2 for Manual.
- Enter the 1st level in percent (2 decimal places) then press the Enter key.
- Enter the 1st (corresponding) capacitance
- The unit then prompts for the 2nd level in percent and the 2nd capacitance. After entering these values the unit will calculate the SLOPE and OFFSET. Use the Slope/Off menu item described below to view and record these values for future reference.

4.2.3 SLOPE AND OFFSET [CALIB\3]

Use this feature to view and or modify the SLOPE and OFFSET calibration values directly.

- Press the CALIBRATION key to enter the CALIBRATION menu then 3 for Slope/Off.
- Enter the desired SLOPE and OFFSET. If no change is desired just press the Enter key in each case or a Menu key to go to another menu such as the DISPLAY menu.

4.2.4 FULL SCALE VALUE [CALIB\4]

The 2000 series level controller displays the level in both percent and in engineering units. For example if depth in feet is desired or if the material capacity in pounds is desired, the appropriate units are chosen from the Settings submenu of the FUNCTION menu. The unit calculates the level in engineering units by multiplying the level in percent by the full-scale engineering units value. The user must set this value. For example if the units chosen are feet and the maximum height of the tank (internal) is 15.0 feet then 15.0 is the FULL SCALE VALUE, or if the units chosen are pounds and the maximum tank capacity is 10,000 lbs then 10,000 is the FULL SCALE VALUE. Entry of this value is described in Section 3.4.6. NOTE: This revision of software assumes a linear relationship between level % and tank capacity. If the engineering units chosen are for depth (feet, inches or cm) then this assumption is always true, but if the units are for volume or mass then the relationship may not be true. For example the mass or volume contents of a cylindrical tank on its side are not linearly related to the level in % (linear depth). Arjay can provide custom software based on a customer's tank dimensions to display the volume or mass (or other units).

4.3 CONTROL MENU [CONT]

The CONTROL menu allows the setup of the mA output and the Control Relays.

NOTE: The Control Relays and the mA output are set to their OFF states when in the CALIBRATION menu [CALIB]. In the DIAGNOSTICS menu [FUNCTION \ 2], the mA output may be set manually by the operator to 4mA or 20mA. In this case the mA output does not reflect the level value.

4.3.1 mA SETTINGS

The mA output Zero and Span settings may be set anywhere within the measurement range. For example, if the Zero is set to 30% level and the Span is set at 60% level then the mA output is scaled between these two points with the mA output indicating low level at 30% and high level at 60%.

NOTE: the Span value (% level) must be at least 1% greater than the Zero value.

The mA output may also be set to Direct or Inverse Acting. In Direct Action, the mA output is 4mA when the level is at the Zero level and 20mA when at the Span level. In Inverse Action, the mA output is 20mA when the level is at the Zero level and 4mA when at the Span level.

4.3.2 RELAY SETTINGS

Arjay Level controllers may be used to control devices such as pumps, valves and other equipment based on level values.

Arjay controllers allow 5 parameters:

1. HIGH ALARM (or CONTROL) POINT. This value is specified in % level. Above this value, relay action is taken depending on the Relay Action and Failsafe settings.
2. LOW ALARM (or CONTROL) POINT. This value should be less than the High control point. Below this value, relay action is taken depending on the Relay Action and Failsafe settings.
3. RELAY ACTION. High or Low Action. Selecting high action will energize the relay when the level exceeds the high control point for at least the time delay period. An LED on the front panel

for the appropriate relay indicates the alarm condition. The relay is de-energized (with no delay) when the level falls below the low control point. Selecting low action will energize the relay when the level falls below the low control point for at least the time delay period. The relay is de-energized (with no delay) when the level rises above the high control point.

4. **FAILSAFE.** Failsafe typically means that the relay is normally (when not in an alarm condition) held in an energized state. In an alarm condition, the relay is de-energized i.e. identical to when the instrument power is shut off. The rationale is that the alarm condition should match the Power Fail condition.
5. **RELAY DELAY.** Minimum time in seconds for an alarm to exist before the corresponding relay is set to its alarm state. The relay alarm state depends on the Relay Action and Failsafe settings.

4.3.3 RELAY SETTINGS SELECTION

1. Identify the positive action required in the control application such as turning on a pump, opening a valve, or sounding an alarm. Note: the time delay is applied to the start of the positive action; also, the corresponding LED is turned on to indicate the positive action.
2. Identify if Fail Safe condition is required in an alarm condition. For control applications (relay used to control pump etc.), the positive action may also be viewed as the opposite state desired in the event of a power or instrument failure. For alarm applications (relay used to indicate an abnormal condition such as a high tank level), the positive action may be the same state desired in the event of a power or instrument failure.
3. Identify the type of relay action required: if the positive action is required when the level exceeds the high control point then select High Action for the relay. If the positive action is required when the level falls below the low control point then select Low Action.
4. Identify the relay contacts to use (either Normally Open or Normally Closed). The contacts used are dictated by the failsafe setting and if the positive action requires the application of power or removal of power to the controlled device.

The following table summarizes the settings for all possible requirements:

#	DESIRED CONTACT CONDITIONS			DO THIS		
	BELOW LOW SETPOINT	ABOVE HIGH SETPOINT	INSTRUM. Or PWR FAILURE	FAILSAFE SETTING	RELAY ACTION	USE CONTACTS
1	Open	Closed (PA)	Open	No	High Acting	NO
2	Open	Closed (PA)	Closed	Yes	High Acting	NC
3	Closed (PA)	Open	Open	No	Low Acting	NO
4	Closed (PA)	Open	Closed	Yes	Low Acting	NC
5	Open (PA)	Closed	Closed	No	Low Acting	NO
6	Open (PA)	Closed	Open	Yes	Low Acting	NC
7	Closed	Open (PA)	Closed	No	High Acting	NO
8	Closed	Open (PA)	Open	Yes	High Acting	NC

- (PA) = positive action desired such as turning on a pump.

- Conditions 1, 3, 5, 7 are typically for control applications where the positive action i.e. turning on a pump, should be shut off during a power failure to the Arjay level controller.
- Conditions 2, 4, 6, 8 are typically for alarm applications where the positive action i.e. sounding an alarm if the level is at a high level, should also be in place during a power failure to the Arjay level controller.

4.3.4 RELAY SETTINGS EXAMPLES

- 1- ***A Pump is desired to be turned on to pump out the contents of a tank when the level exceeds 90% and then turned off when the level drops below 20%. In the event of the Arjay unit failing or a power failure, the pump should be shut off to prevent it from pumping dry.***

Settings:

High control point: 90%

Low control point: 20%

Failsafe: No

Relay action: High acting

Contacts used: Normally Open

Explanation:

In this case the positive action is turning on a pump.

Since the pump should be turned off if the Arjay unit fails or in the event of a power failure i.e. the positive action state is not the same as the failure state, the failsafe setting should be No.

Since the positive action is desired when the level exceeds the high control point then the relay setting should be High Acting.

Since the pump starter requires power to turn on the pump and the failsafe is No, the normally open contacts should be used.

The time delay may be set to some convenient value to minimize relay chatter. Even with no time delay, relay chattering due to the level fluctuating around the high control point is in this case not a problem since the once the relay is energized, it is not de-energized until the level drops below the 20% level.

- 2- ***A receiving tank must be filled by turning on a pump when the level drops below 20%. The tank must then be filled to a capacity of 90% before the pump is shut off. In the event of an instrument or power failure, the pump should be shut off to prevent overfilling the receiving tank.***

Settings:

High control point: 90%

Low control point: 20%

Failsafe: No

Relay action: Low acting

Contacts used: Normally Open

Explanation:

In this case the positive action is turning on a pump.

Since the pump should be turned off if the Arjay unit fails or in the event of a power failure i.e. the positive action state is not the same as the failure state, the failsafe setting should be No.

Since the positive action is desired when the level drops below the low control point, the relay setting should be Low Acting.

Since the pump starter requires power to turn on the pump, the normally open contacts should be used.

As per example 1, the time delay is optional to turn on the pump.

- 3- ***An alarm buzzer and light must be turned on if the level in a tank exceeds 97% or in the event of an instrument or power failure.***

Settings:

High control point: 97%

Low control point: 97%

Failsafe: Yes

Relay action: High acting

Contacts used: Normally Closed

Explanation:

In this case the positive action is turning on a buzzer and light.

Since the buzzer / light should also be turned on if the Arjay unit fails or in the event of a power failure i.e. the positive action state is the same as the failure state, the failsafe setting should be Yes.

Since the positive action is desired when the level rises above the high control point, the relay setting should be High Acting.

Since the buzzer / light require power to turn on, and the failsafe setting is Yes, the normally closed contacts should be used.

The High and Low control points are set to be identical. The low point can be set a little lower i.e. 95% to provide some dead band.

In an alarm application, the alarm time delay should be set as low as possible.

4.4 SETUP MENU [SETUP]

The SETUP menu is used for one-time setup and for Diagnostics.

*******SETUP*******
1-PMC 2000 2-Diags
3-Settings

4.4.1 PMC 2000 (Manual) [SETUP \ 1 \ 2]

This menu is to calibrate the 2000 series controller for the particular PMC-2000 level transmitter module located at the probe head. There are 3 calibration parameters: A, K, C. These values are used to calculate the capacitance from the frequency signal received from the PMC-2000. The parameters may be calibrated manually or automatically. Automatic Calibration is performed at the factory on each PMC-2000 module. A label listing the A, K, C values is then affixed to the PMC-2000 connector. AUTOMATIC CALIBRATION IS ONLY TO BE PERFORMED BY AUTHORIZED PERSONNEL AND IS BEYOND THE SCOPE OF THIS MANUAL. IF PROBLEMS ARE ENCOUNTERED, OR IF THE A, K, C VALUES ARE NOT KNOWN, PLEASE CONTACT AN ARJAY REPRESENTATIVE.

Manual entry of the A, K, and C values is described in Section 3.4.1

4.4.2 DIAGNOSTICS [SETUP \ 2]

This menu displays the received frequency signal from the PMC-2000 module at the probe head and the calculated capacitance. Both of these values are useful in determining calibration or performance problems.

******DIAGNOSTICS******
12.04pF 4461.48Hz
1-4mA 2-20mA 3-Other

Pressing key 1 forces the mA output to 4mA. Similarly pressing key 2 forces the mA output to 20mA. Any other value between 0 and 20 may be set by pressing 3 for "Other" then entering the desired mA output value.

This feature is convenient to check the performance of external recorders or PLC's, which read the mA output. The mA output reverts back to its actual level when the normal Display Menu is selected.

4.4.3 SETTINGS MENU [SETUP \ 3]

This menu sets the digital filter and the engineering units. In addition the mA output may be trimmed for maximum accuracy. Also the Tag number and Software revision may be viewed:

******* SETTINGS *******
1-Filter 2-Units
3-Tag # 4-mA Trim
2114 Rev:2057_28

mA TRIM:

This procedure trims the mA output for maximum accuracy by compensating for the mA output circuitry tolerances. THIS PROCEDURE IS PERFORMED ON EVERY TRANSMITTER AT THE FACTORY AND IS TO BE PERFORMED BY AUTHORIZED PERSONNEL ONLY. IF IMPROPERLY DONE, THE ACCURACY OF THE mA OUTPUT IS AFFECTED.

Under certain conditions this procedure may be undertaken in the field with Arjay's permission:

- Press the SETUP key, then 3 for Settings and then 4 for mA Trim. The unit will put out what it thinks is 20.0mA.
- Disconnect any load connected to the mA output of the transmitter.
- With an ACCURATE MULTIMETER MEASURE THE mA OUTPUT. The Multimeter should have at least one place of decimal.
- Enter this value at the prompt and press the Enter key. A maximum tolerance adjustment of 3% is allowed i.e. the entered value must be in the range of 19.4mA to 20.6mA. If a value out of this range is entered an error is flashed on the screen. If this occurs, contact an Arjay representative for assistance.

FILTER, ENGINEERING UNITS, TAG #:

These settings are described in Section 3.4.2, 3.4.3, and 3.4.4 respectively.

5.0 TROUBLESHOOTING

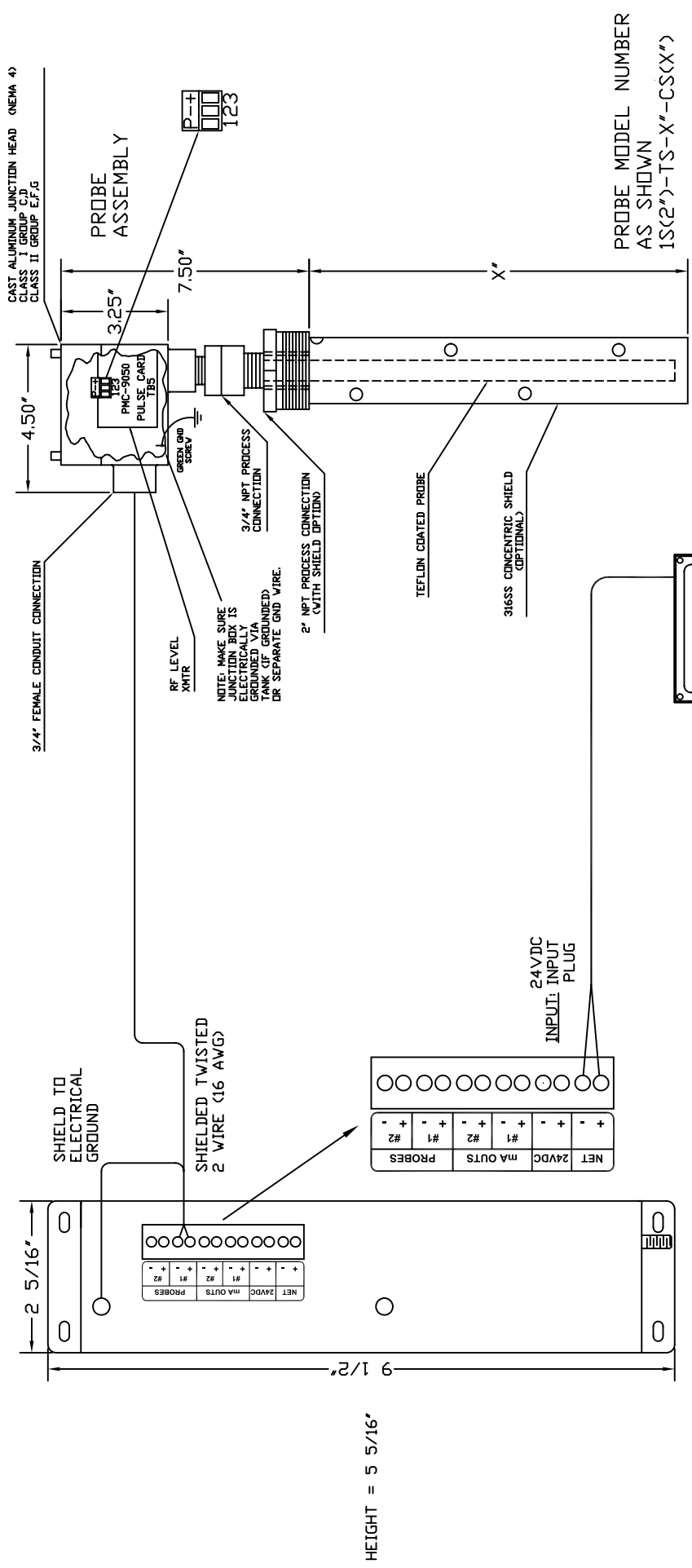
CONDITION	DO THIS
<p>1. DISPLAY MENU SHOWS: Error: No Xmtr Signal</p>	<p>The unit is not receiving a frequency signal from the remote PMC-2000 level transmitter in the probe head: Check wiring.</p> <p>If wiring checks out: call Arjay Technical Support. An adjustment may be made at the controller.</p>
<p>2. DISPLAY MENU SHOWS: Error: Setup Values Bad</p>	<p>This indicates that one of the calibration or setup parameters has been corrupted. Compare ALL parameters with the table in Section 6 to find out which one. Re-enter it.</p> <p>Call Arjay Technical Support</p>
<p>3. DISPLAY MENU SHOWS: Error: pF out of range</p>	<p>The calculated capacitance is out of the legal range: Check if the A,K,C values in the unit correspond to the A,K,C values of the PMC-2000 transmitter.</p> <p>Check the integrity of the Teflon sheath of the probe. If this has been damaged, water could cause an electrical short circuit between the probe within the Teflon sheath and the ground reference. In this case a very high capacitance is usually registered. Check the Xmtr frequency in the Diagnostics menu. If the frequency is much below 19,000Hz then a short circuit should be suspected. To confirm: Open the probe head and disconnect the blue wire from the probe to the PMC-2000. Using a DVM, measure the resistance between the enclosure case and the probe tip. It should read infinite resistance or OL. Make sure that fingers and hands do not touch the metal portion of the probes of the DVM since this could show a lower resistance: 1-10mohms.</p> <p>Contact an Arjay Representative.</p>
<p>4. The level reading is erratic or unstable</p>	<p>Check the Slope value. If this is lower than about 0.5pF per percent then check if the level displayed agrees with the actual level in the vessel at a number of different levels. If so, then check if the probe is being splashed by incoming liquid or if there are moving mixer parts (especially metallic) close to the probe. If this is true, then try increasing the Filter time setting. If this is not enough, and the cause of the disturbance cannot be rectified then a concentrically shielded probe must be used.</p>
<p>5. Readings are not accurate i.e. the displayed values are not accurate as the level moves away from the calibration points.</p>	<p>For probes without a factory supplied concentric shield, make sure the probe is parallel to its ground reference which may be the tank wall or the inside of a stilling pipe (if probe is installed in a pipe). See Probe Installation SECTION 2.2 for more details.</p> <p>For probes with a factory supplied concentric shield, make sure the pressure equalizing slots / holes in the shield are unobstructed i.e. the liquid level inside and outside the shield are always the same.</p>

6.0 CONTROLLER SETTINGS SHEET

Checked by	
Model Number	
Serial Number	
Software Rev.	

PARAMETER	DESCRIPTION	FACTORY SETTING	USER SETTING
Probe A value	Probe PMC-2000 level transmitter calibration value		
Probe K value	Probe PMC-2000 level transmitter calibration value		
Probe C value	Probe PMC-2000 level transmitter calibration value		
Slope	Result of a successful Calibration: Capacitance change per % change. Used by unit to calculate the level in % and Eng. Units from the measure capacitance.		
Offset	Result of a successful Calibration: Calculated capacitance of an empty vessel. Used by unit to calculate the level in % and Eng. Units from the measure capacitance.		
FS Value	Full Scale Engineering Units value: used to calculate Eng. Units value from level %.	100.0	
Zero	Zero Level value for mA output	0.0%	
Span	Full Scale Level value for mA output.	100.0%	
mA Action	Direct (20mA when level at Span) or Inverse (4mA when level is at Span)	DIR	
Relay1 Hi Set	Alarm Relay 1 High Setpoint: Alarm condition if level is above this value.	20.0%	
Relay1 Lo Set	Alarm Relay 1 Low Setpoint: Alarm conditions cleared if level is below this value.	15.0%	
Relay1 Action	Set for high or low acting (see Sections 4.3.2 – 4.3.4 for details)	High	
Relay1 Failsafe	Set for Failsafe or Non Failsafe	Off	
Relay 1 Alarm Delay	Amount of time the level must be in an alarm condition (based on Relay 1 High and Low Setpoints and Action settings) before Relay 1 is set to the alarm condition (relay alarm condition	0 sec	

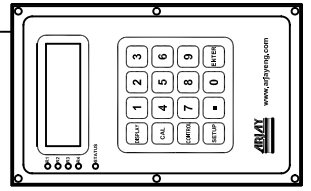
	set by Relay 1 Failsafe setting).		
Relay2 Hi Set	Alarm Relay 2 High Setpoint: Alarm condition if level is above this value.	40.0%	
Relay2 Lo Set	Alarm Relay 2 Low Setpoint: Alarm conditions cleared if level is below this value.	35.0%	
Relay2 Action	Set for high or low acting (see Sections 4.3.2 – 4.3.4 for details)	High	
Relay2 Failsafe	Set for Failsafe or Non Failsafe	Off	
Relay 2 Alarm Delay	See Relay 1 Alarm Delay description.	0 sec	
Relay3 Hi Set	Alarm Relay 3 High Setpoint: Alarm condition if level is above this value.	60.0%	
Relay3 Lo Set	Alarm Relay 3 Low Setpoint: Alarm conditions cleared if level is below this value.	55.0%	
Relay3 Action	Set for high or low acting (see Sections 4.3.2 – 4.3.4 for details)	High	
Relay3 Failsafe	Set for Failsafe or Non Failsafe	Off	
Relay4 Hi Set	Alarm Relay 4 High Setpoint: Alarm condition if level is above this value.	80.0%	
Relay4 Lo Set	Alarm Relay 4 Low Setpoint: Alarm conditions cleared if level is below this value.	75.0%	
Relay4 Action	Set for high or low acting (see Sections 4.3.2 – 4.3.4 for details)	High	
Relay4 Failsafe	Set for Failsafe or Non Failsafe	Off	
Alarm Enable	Master Alarm Relay Enable: If Off this will prevent relays from being reflecting the Alarm condition. The relay will remain in the non alarm condition base on the Fail-safe switch setting on the relay modules	ON	
Filter	Digital Filter response time in seconds. Used to smooth out level fluctuations caused by splashing etc.	0 sec	
Engineering Units	Eng. units chosen to display level information in addition to the level in %.	in	
Tag Number	For network applications only. All Arjay 2000 series controllers connected to a network must have a unique Tag Number between 1 and 100	1	



ALL DIMENSIONS ARE IN INCHES

REV	DATE	DESCRIPTION	REVISIONS
1	02/26/04	CHANGED TITLE BOX	CHKD/APPD

	ARJAY ENGINEERING LIMITED	PROJECT:
DRG. STATUS DRAWN: C.M.P. 3/1/01 CHECKED: APPROVED:	DATE 3/1/01	TITLE 2300/2400 SERIES LEVEL CONTROLLER WITH HAND HELD CALIBRATOR
SCALE N.T.S.	REF. DWGS.	DWG. NO. 200122
REV. 1	REV. 1	REV. 1

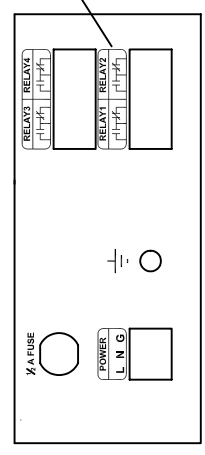


HAND HELD CALIBRATOR

HEIGHT = 5 5/16"



NOTE:
 R1, R2, R3 & R4 CONNECTIONS
 10 AMP AT 120 VAC
 10 AMP AT 24 VDC
 RESISTIVE LOAD
 DRY CONTACTS



NOTE:
 POWER CONNECTION
 120 VAC OR 220 VAC
 AS PER MODEL NUMBER