

INSTRUCTION MANUAL
ABSOLUTE SHAFT ENCODER
MODEL AD375MA



QUALITY SYSTEM
ISO:9001
CERTIFIED

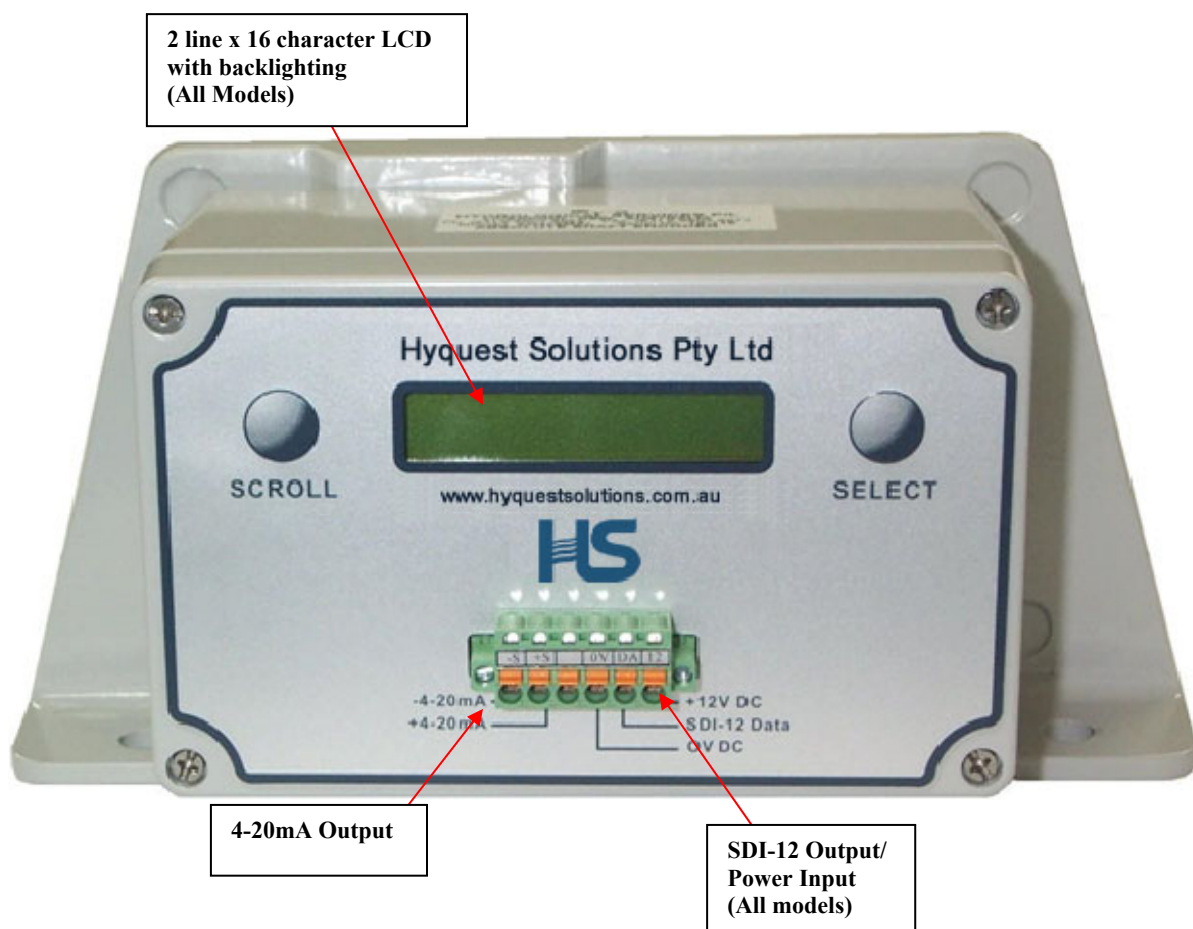
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1. Introduction

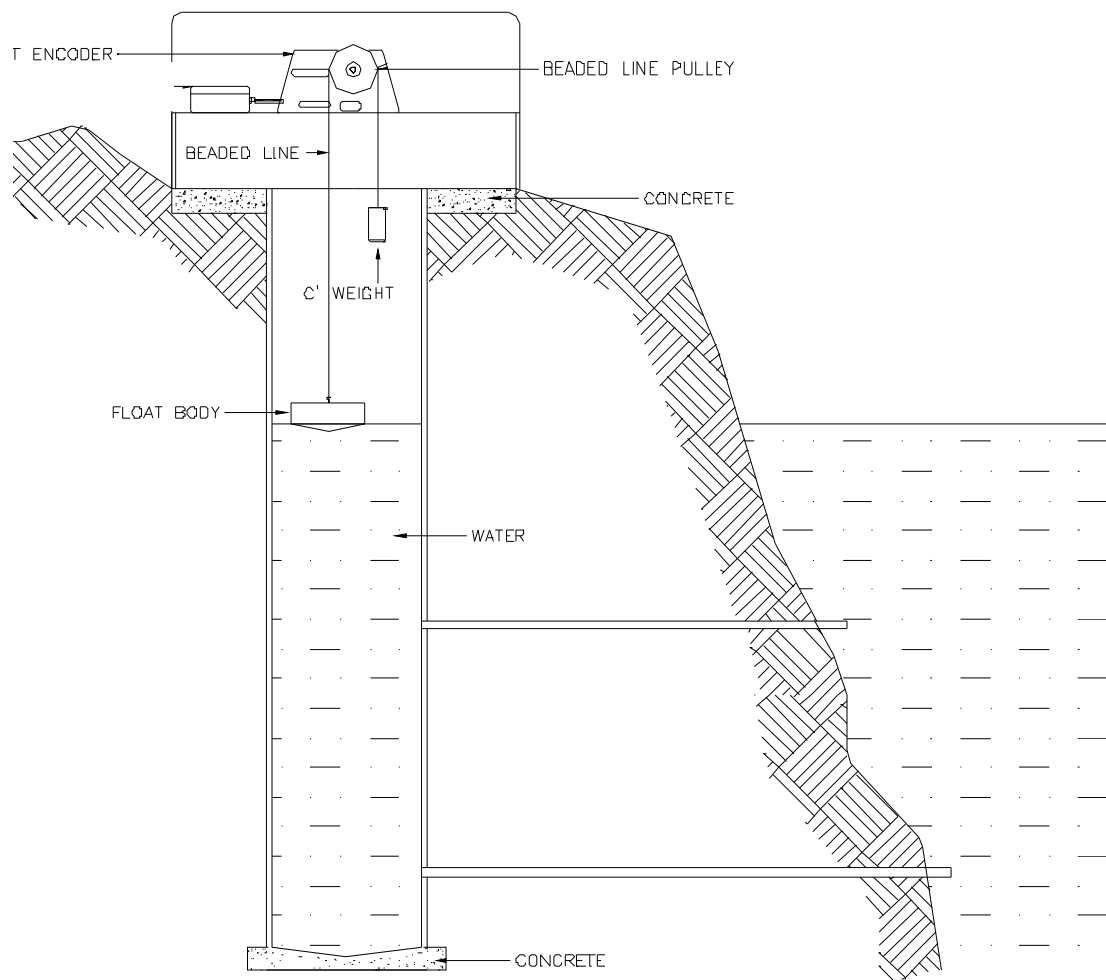
The Hyquest Solutions Absolute Shaft Encoder model AD375MA is a low power, microprocessor controlled shaft encoder designed for field operation to enable measurement of water level. The internal CMOS circuitry enables the encoder to output measured levels in absolute format as a 4-20mA and SDI-12 signal at the same time.



2. Installation

The encoder is readily adapted to float pulley wheels with beaded or borehole floatline, tape chain and sprockets and gear drives. Provided on the base of each encoder are two threaded holes for levelling screws.

TYPICAL WATER LEVEL RECORDING CONFIGURATION FOR STILLING WELL



TWLR_DWG 2

Beaded Float Line

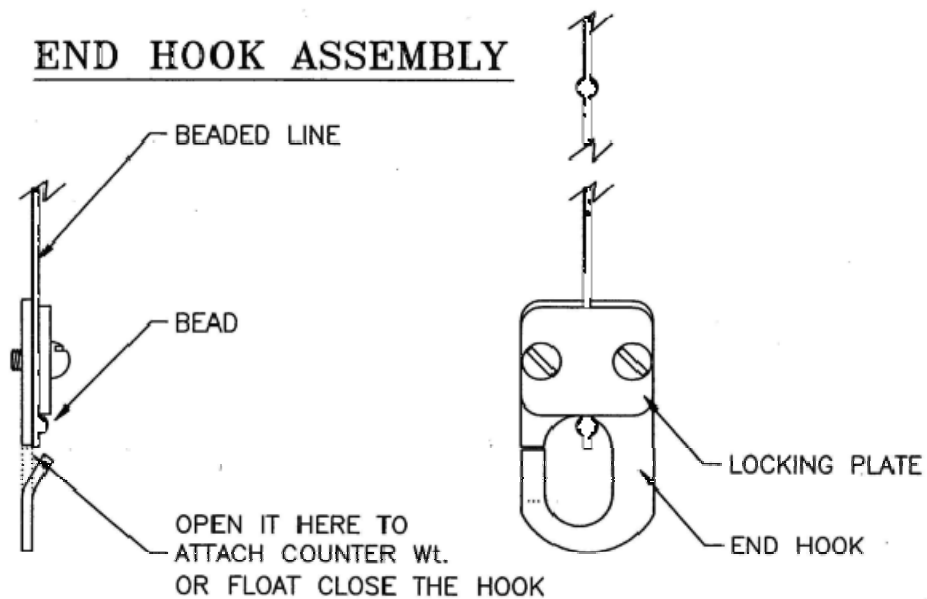
- Two adjustable end hooks (part EH01) are provided for attaching the beaded float line to the float and the counterweight. The length of the float line should be such that the counterweight will not run into the shelf or pulley when the float is at a low stage or strike the bottom of the float well when the float is at the highest stage. Float and counterweight should pass each other and should have adequate clearance from the sides of the stilling well.
- Beaded line should be cut about 1/16 inch past a bead to prevent fraying.
- Attach the float line to the float and lower it to the water. Pass the float line over the pulley making sure that the cable beads (or tape perforations) engage the respective recessed (or spines) on the pulley. Attach the counterweight and lower it into position.

Borehole Float Line

- Attach borehole guide pulleys to mounting bracket. Ensure guide sheave grooves line up with float pulley groove.
- Two adjustable end hooks (part EH01) are provided for attaching the float line to the float and the counterweight. The length of the float line should be such that the counterweight will not run into the shelf or pulley when the float is at a low stage or strike the bottom of the float well when the float is at the highest stage. Float and counterweight should pass each other and should have adequate clearance from the sides of the Borehole.

End Hook Assembly

- Cut the beaded line approximately 2 mm (1/16") past a bead to prevent fraying. Attach end hook by :-
- Unscrew the plate from the adjustable hook.
- Place the beaded line between the two plates and then tighten the screws on the plate.
- Allow for a bead to be trapped just below the locking plate. Make sure that the line is sitting perpendicular to the plate.



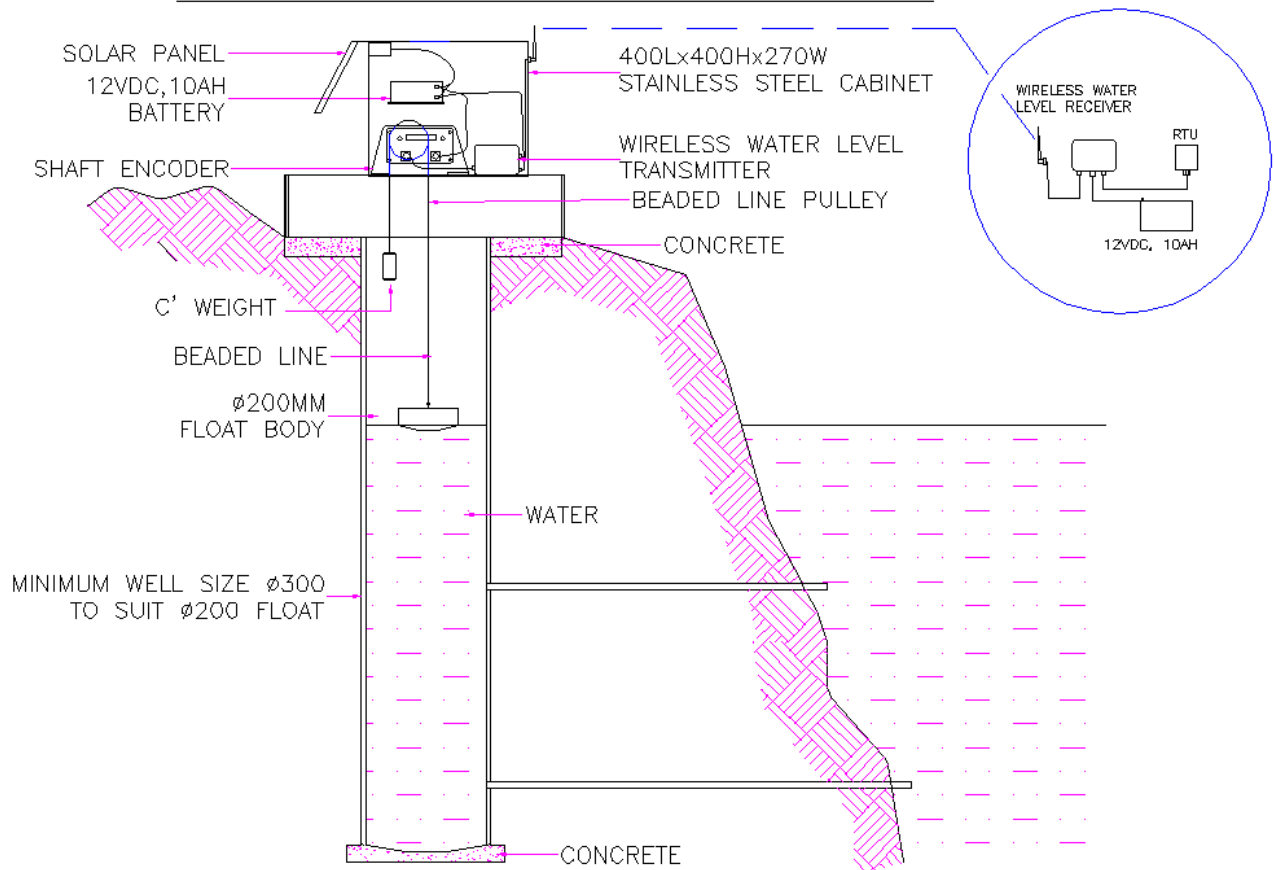
Electrical Installation

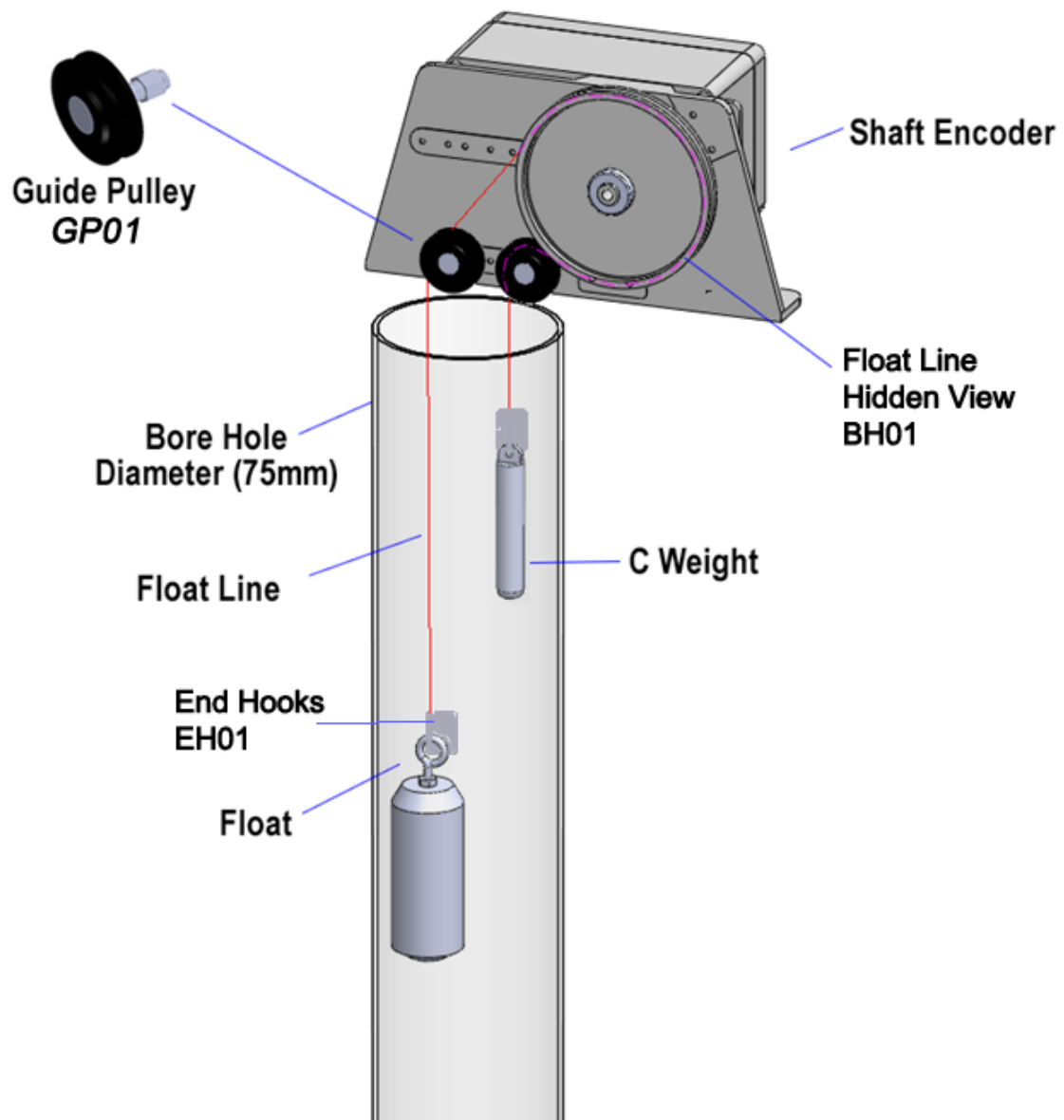
A +12V power source must be connected to the SDI-12 / Power port as shown on page 8, to provide power to the AD375MA electronics.

Once external power is connected, press the "Scroll" button and step to the "Battery Voltage" display. Press and hold the "Select" button until the display shows "Lithium Backup" – No. Press the "Select" button again and the "No" will start flashing. Press the "Scroll" button to change the No to a "Yes". Press the "Select" button to stop the Yes from flashing. Press the "Scroll" button to step back to the main displays.

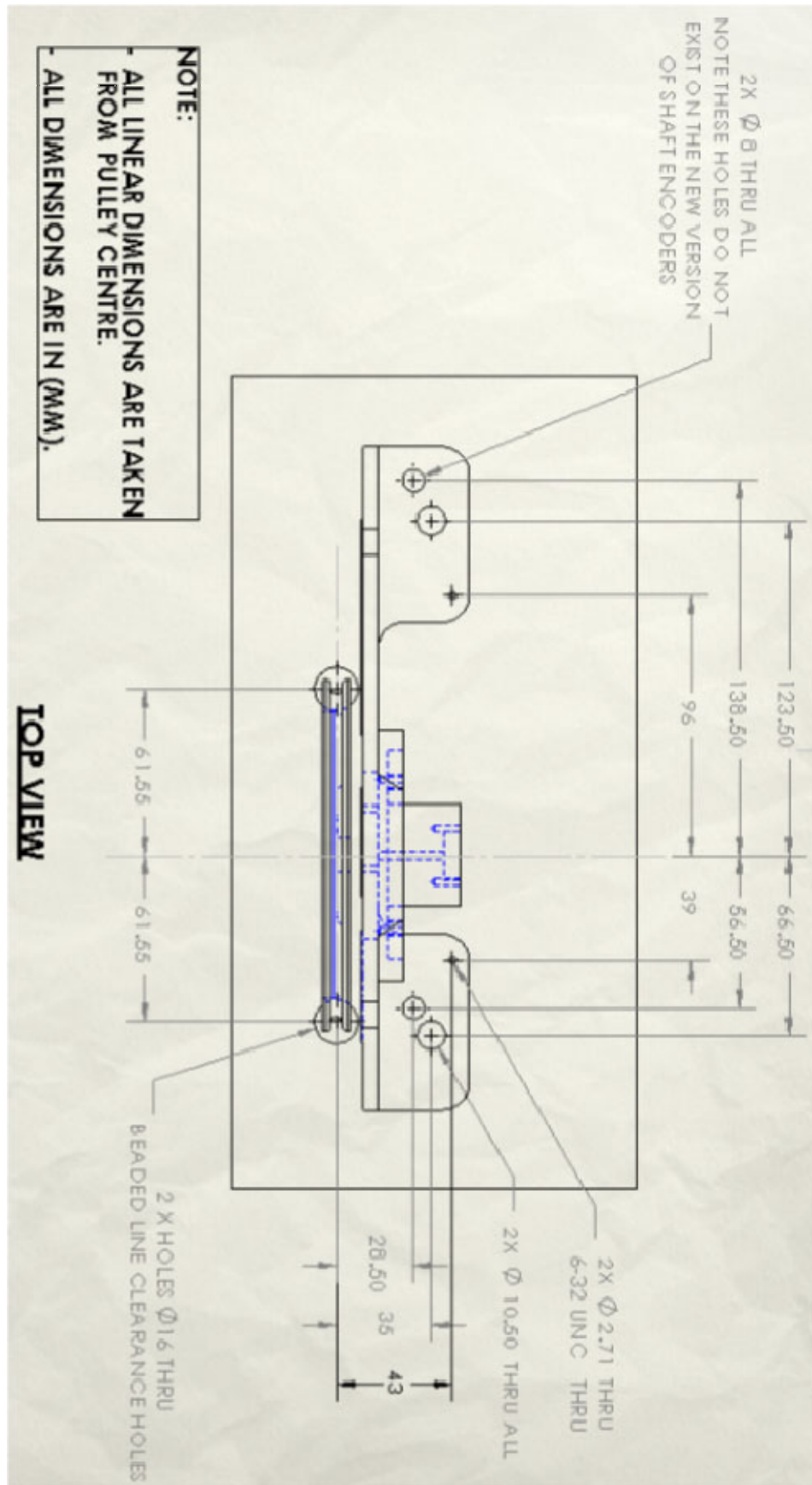
(The internal lithium battery is used to power the internal electronics during transport, but it doesn't power the circuitry to monitor the shaft rotation position. If this were selected while external 12V power wasn't present, the battery would only last for about 1 to 2 months. So with Lithium Backup set to "Yes", the lithium battery will allow the water level to be tracked in the unlikely event that the external 12V power is not present.)

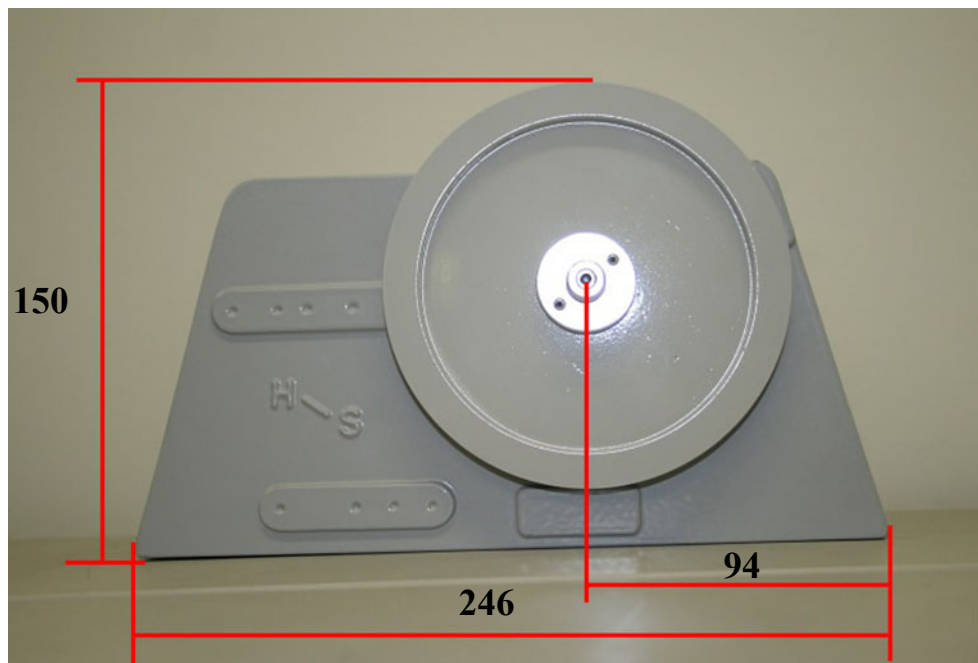
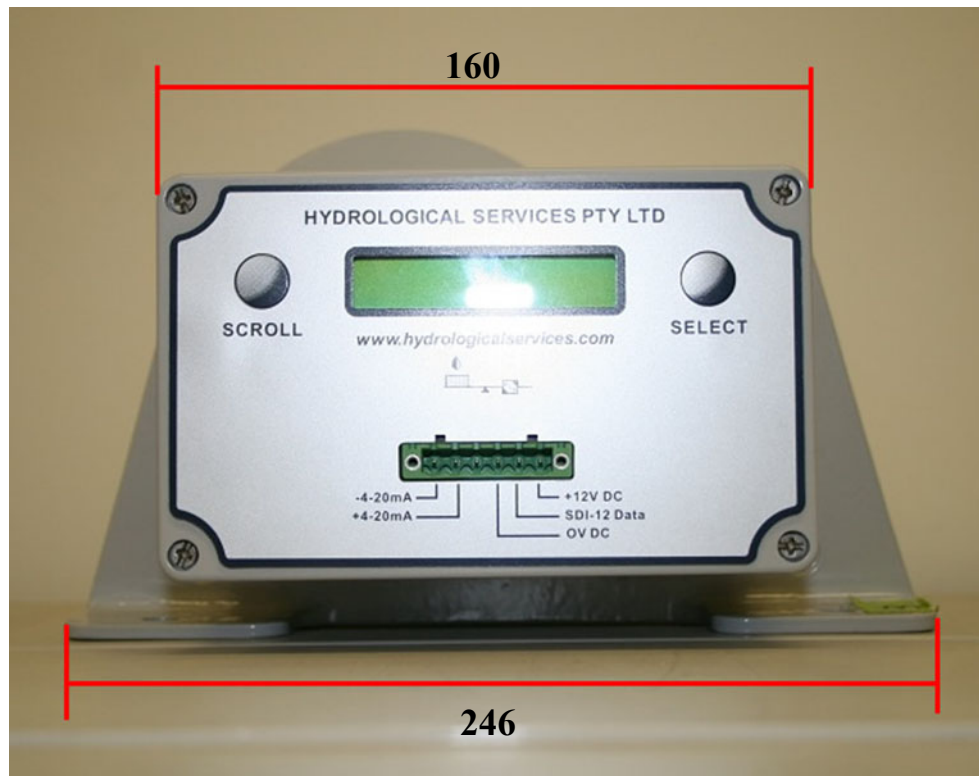
TYPICAL WATER LEVEL INSTALLATION USING SHAFT ENCODER

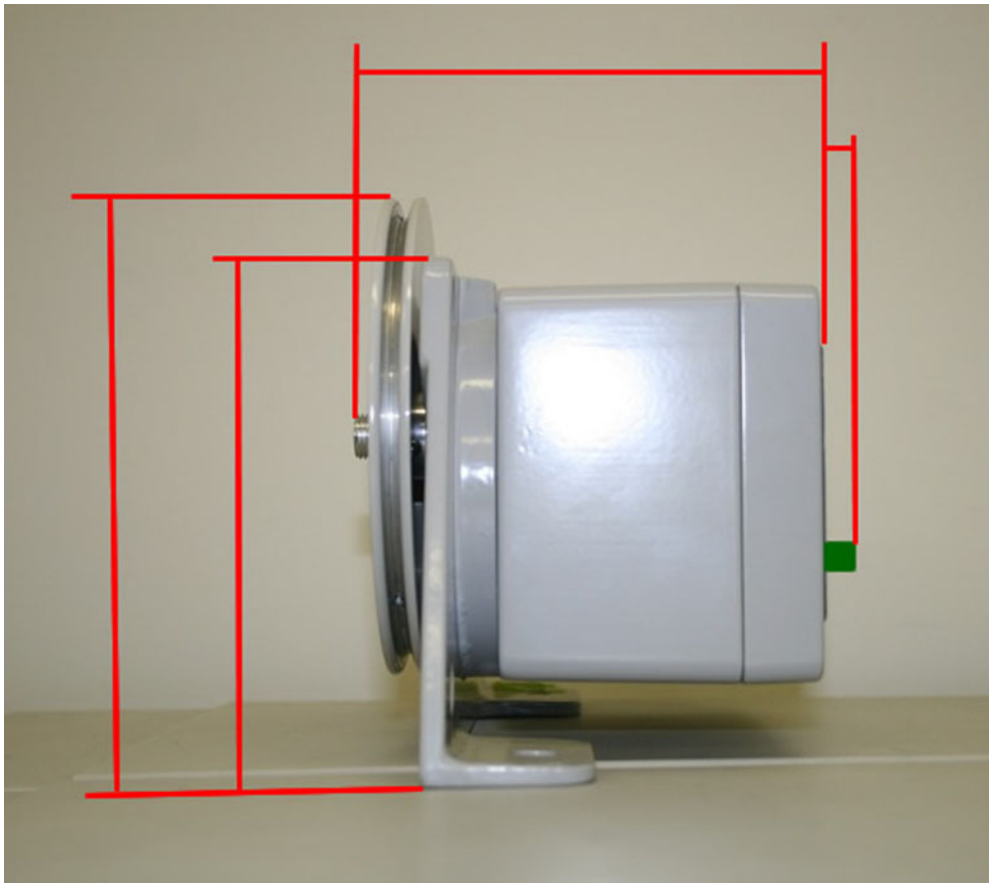




Shaft Encoder Typical Bore Hole Set Up Using Guide Pulleys



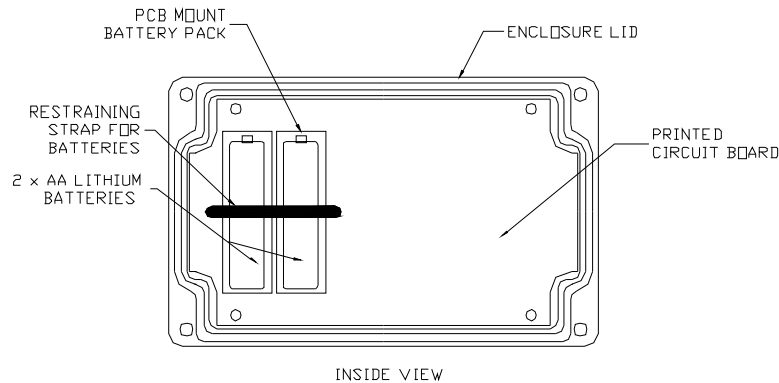




3. Maintenance

The AD375MA (as well as AD37.5MA, AD150MA and AD100MA) Shaft Encoders require no maintenance, however all connected mechanical equipment should be periodically checked for cleanliness and ease of operation.

Internal 3.6V Lithium AA batteries should be replaced every 2 years.

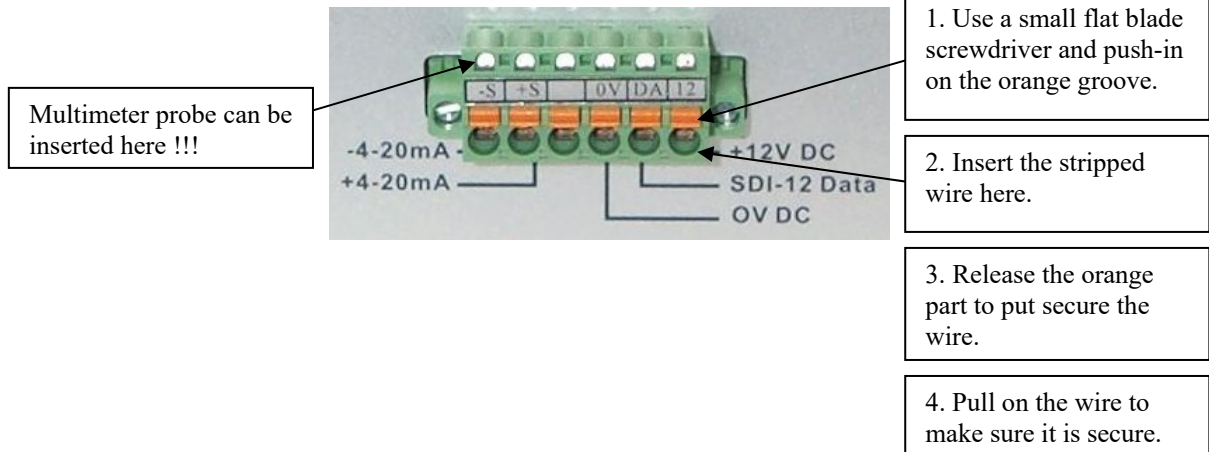


Internal Batteries Replacement Instruction:

- Loosen the 4 screws on the enclosure lid
- Remove the lid
- Cut restraining strap
- Remove and replace batteries one at a time (ensuring polarity is correct) to ensure processor is not interrupted (use a 3.6v Lithium battery -AA package)
- Fit a new restraining strap (150mm cable tie)
- Replace enclosure lid ensuring a proper fit
- Tighten the 4 screws

Screwless Terminals

The plug in terminal block shown is a screwless terminal that keeps a constant tension on the wire that is inserted. (The mating socket on the front panel of the AD375MA is sealed with a waterproofing gasket.)

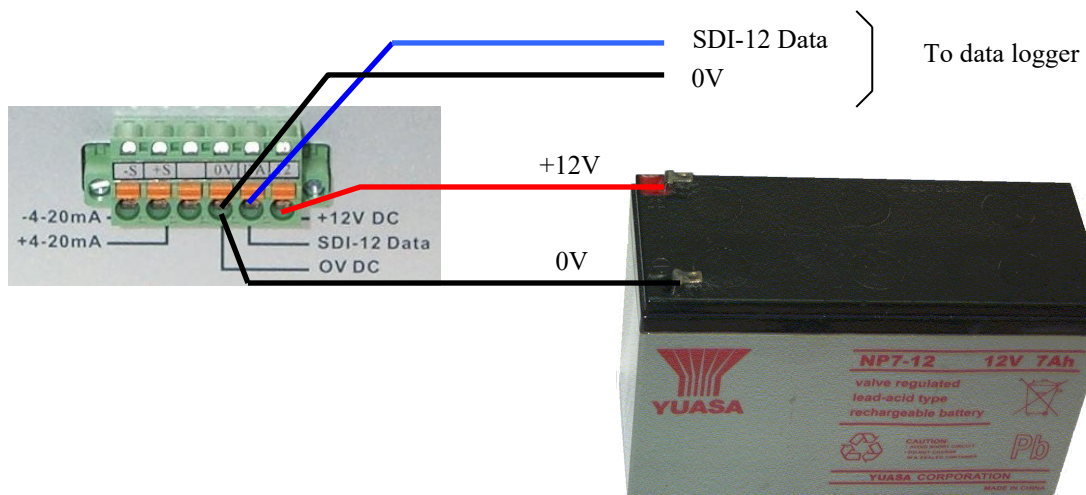


External Power

Even though the Shaft Encoder's have an internal lithium battery, **the unit should only be operated if +12VDC (9.0V to 16VDC) power is connected.** This guarantees continuing correct pulse counting and SDI-12 operation. (The internal lithium batteries are for backup purposes only – it will allow the water level to be continuously measured for up to 2 months with no external +12V !)

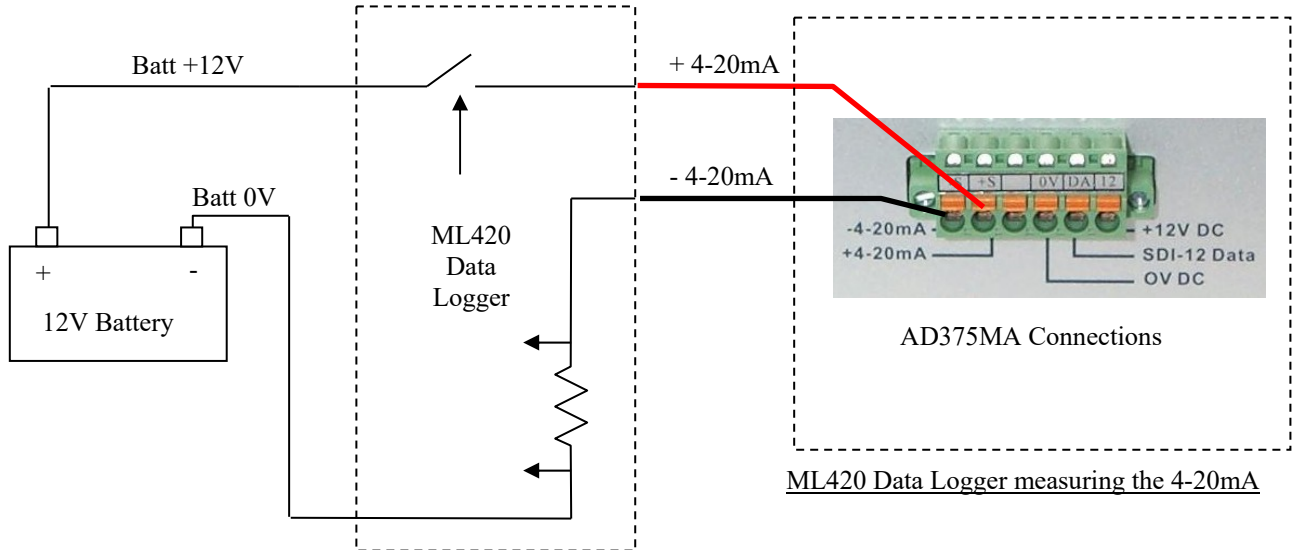
An adequate 12VDC (9 to 30VDC) battery and charger option should be used if the optically isolated 4-20 mA current loop is to be powered continuously and independently of the telemetry module or data logging equipment.

The AD375MA **must** have +12VDC power (9.0V to 16V DC) connected for correct operation.



4-20mA Interface

The 4-20mA interface in the AD375MA is optically isolated from the 0V and +12VDC on the right hand end of the connector. The 4-20mA circuitry must be powered by the loop.



To conserve power, the data logger switches power to the 4-20mA circuit only when it wants to make a measurement.
(The 4-20mA current will be ready to read 200mS after applying loop power.)

(See Section 4.1 for configuring the 4-20mA interface.)

4. LCD Screen

There are 7 LCD screens available. Some screens display internal data and some allow parameters to be changed. The screens are:

LCD SCREEN	DESCRIPTION
AD375MA S/W 5.1 Level: 9.392 m	Display model, S/W Rev and present river level
Battery Voltage 3.6V / 12.8V	Display internal and external battery voltage. NOTE : Press 'Select' to go to "Lithium Backup" menu
Lithium Backup No	Internal lithium battery backup can be enabled by setting this option to yes. (See Electrical Installation on Page 6)
Sensor Addr: 2 Sensor ID: 12345	Display Sensor SDI-12 address and external d 5 digit ID
Comms Type: SDI-12	Allows the comms type of the SDI-12 port to be selected SDI-12. (When RS232 is selected the critical timing is removed)
4mA/20mA Level: 5.0 / 25.0 m	Allows the 4mA level and 20 mA level to be viewed and changed. (Select button must be pressed and held for 10 secs to enter "Set 4mA Level" mode)
Quad Direction: Normal	Allows the quadrature direction for "rising"water to be changed. (Normal / Reversed)
Set Level: 12.392 m	Allows the present River Level to be preset

RS 232/SDI-12 SELECTION

The SDI-12 protocol has very strict timing requirements. The operator may use the SDI-12 to RS232 adaptor cable and then communicate to the SDI-12 port using the RS232 from a PC. The "RS232" option must be selected via LCD screens. In this mode all of the timing/break requirements of the SDI-12 are removed. Commands may be typed from a terminal program such as "Hyperterm".

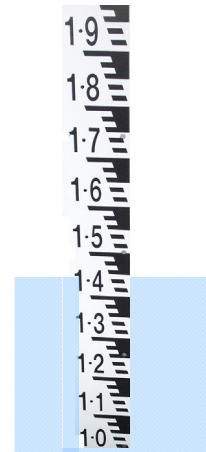
Note you must select 1200 baud, 7 bits, even parity and no handshaking.

If communications is via an SDI-12 device, you **MUST** select the SDI-12 option via the LCD screen.

4.1 Configuring the AD375MA

1. If using the SDI-12 interface, set the required address by stepping to the “Sensor Addr” menu, and pressing the “Select” button and then use the “Scroll” button to set the address from 0 to 9.
2. If using an SDI-12 logger, make sure the “Comms Type” is set to SDI-12. If using an RTU with an SDI-12 to RS232 adapter then set the “Comms Type” to RS232.
3. Use the staff gauge in the river to measure the water level (1.450m)
4. Step to the “Set Level” menu and set it to 1.450m

If operating in SDI-12 mode, setup is complete.



If operating in 4-20mA mode then continue with step 5.

5. Estimate the range over which the water level will change.
(eg. Min level = 1.000m : Max Level = 8.000m)
6. Step to the “4mA / 20mA Level” menu
Set the 4mA level to 1.000m
Set the 20mA level to 8.000m

When the water level is at 1.000m the 4-20mA current will be 4.000mA
When the water level is at 4.500m the 4-20mA current will be 12.000mA
When the water level is at 8.000m the 4-20mA current will be 20.000mA
7. The range in this example is $8.000 - 1.000 = 7.000\text{m}$
Set the logger range to 7.000m (eg. ML420 range is set with TxR=7.000)
8. The offset in this example is 1.000m
Set the logger offset to 1.000m (eg. ML420 offset is set with RvHR=1.000)
9. Set the logging interval and transducer warmup period in the data logger.
(eg. Say ML420 interval is 15mins and warmup is 1 sec then TXI=015/01)
(The AD375MA 4-20mA current is ready 200mS after loop power is applied)

NOTE : Setting the 4-20mA range to the smallest possible will give the best resolution on a 4-20mA interface !

5. SDI-12 Compliant Commands

SDI-12 V1.3 COMPLIANT COMMAND SET (CRC commands are implemented)

(Please **note** the letter ‘a’ in the commands below refer to the SDI-12 address 0, 1, 2,...9)

Name	Command	Response
Break	Continuous spacing for at least 12 milliseconds	None
Acknowledge Active	a!	a<CR><LF>
Send Identification	aI!	allccccccmmmmmmvvvxxx...xx<CR><LF> (Refer Note 1.)
Change Address from a to b	aAb!	b<CR><LF>
Address Query	?!	a<CR><LF>
Start Measurement	aM! or aMC!	atttn<CR><LF>
Send Data	aD0!	a<value><CR><LF> or a<value><CRC><CR><LF>
Start Verification	aV!	atttn<CR><LF> (Refer Note 2)
Start Concurrent Measurement	aC! or aCC!	atttnn<CR><LF>
Continuous Measurements	aR0! or aRC0!	a<value><CR><LF> a<value><CRC><CR><LF> (same as the D commands)

**** SEE SAMPLE SDI-12 COMMS SESSION ON PAGE 18 ****

Note 1.

a13HydrServAD375M5.312345<CR><LF>

- - - - -

| | | | |

| | | | | --- 5 digit Sensor ID (eg 12345)(as set in aX4 cmnd)

| | | | | ----- S/W Revision (eg 5.3)

| | | | | ----- Model (eg. AD375MA)

| | | | | ----- Company ID (HydrServ)

| | | | | ----- SDI-12 Version V1.3 Compliant

| | | | | ----- Unit Address

SPECIAL SDI-12 X COMMANDS

aXn! Return data associated with command 'n'. Quadrature Shaft Encoder will reply with a0001<CR><LF> **The aDO! command must be issued to get the actual data.**

aXn+xxxx! Set parameter for command 'n'. Quadrature Shaft Encoder will reply with a0001<CR><LF> **The aDO! command must be issued to get the actual data.**

Set/Get Current Value

aX0! Get the river level.

aX0+0012.345! Set the river level to +12.345 m.

(NOTE : AD100A only uses 2 decimal places)

Set/Get 4mA Level

aX2! Get the water level when 4mA will be output on 4-20mA loop

aX2+0005.0! Set the 4mA Level to 5.0m (Acceptable values are 0000.0 to 9999.9)

(Value should be less than the 20mA Level)

Set/Get 20mA Level

aX3! Get the water level when 20mA will be output on the 4-20mA loop

aX3+0025.0! Set the 20mA level to 25.0m (Acceptable values are 0000.0 to 9999.9)

(Value should be greater than the 4mA Level)

Set/Get ID Number

aX4! Get the Shaft Encoder ID.

aX4+12345! Set the Shaft Encoder ID. Acceptable values 0-65535. This value appears in the Identify command.

Set/Get Quadrature Direction

aX8! Get the Quadrature Direction.

aX8+0! Set the Quadrature Direction (0=>Normal : 1=>Reversed)

Set/Get Lithium Battery Backup Mode (S/W Rev 5-3 and higher)

- aX16! Get the Lithium backup mode (0=NO (off) : 1=YES (on)).
- aX16+0! Set the Lithium Battery Backup mode to NO
- aX16+1! Set the Lithium Battery Backup mode to YES
(When set to YES and no external 12V is present – the internal lithium battery will continue to power the sensor to measure water level. The lithium battery can only power the sensor for 1 to 2 months !)

Set/Get Battery Voltages Measure Feature (S/W Rev 5-3 and higher)

- aX17! Get the BattV measure feature state (0=off : 1=on).
- aX17+0! Set the BattV measure feature to OFF (default from factory)
(Result of aM! is a0001<CR><LF>
and aD0! is a+0001.234<CR><LF>
where +0001.234 is the water level)
- aX17+1! Set the BattV measure feature to ON
(Result of aM! is a0003<CR><LF>
and aD0! is a+0001.234+3.6+12.8<CR><LF>
where +0001.234 is the water level
+3.6 is the internal lithium battery and
+12.8 is the external battery voltage)

Increment the 4mA Calibration

- aX96+00! Examine the present 4mA Calibration without altering it.
(This also saves the calibration)
- aX96+05! Increment the 4mA Calibration by 5 steps
- (This should be done while accurately measuring the current on the 4-20mA loop)
(If the calibration is changed, always finish by sending aX96+00! to save it)

Increment the 20mA Calibration

- aX97+00! Examine the present 20mA Calibration without altering it.
(This also saves the calibration)
- aX97+03! Increment the 20mA Calibration by 3 step
- (This should be done while accurately measuring the current on the 4-20mA loop)
(If the calibration is changed, always finish by sending aX97+00! to save it)

6. Specification

6.1 Hardware Specification

Mechanical

Follow Rate: 10 metres per minute
Pulses/Rev: 375 pulses per revolution (AD375MA)
Resolution: AD375MA - 1mm (375 pulses/rev)
AD150MA – 2.5mm (150 pulses/rev)
AD100MA – 0.01ft (100 pulses/rev)
AD375MA – 10mm (37.5 pulses/rev)
Can be used in any size bore down to 100mm diameter.

Electrical

Operating Voltage: 9.0 to 16VDC (SDI-12 port)
(12 VDC sealed lead acid 7Ah min)
Current Drain: 5.0 mA average @ 12V input
Output: 4-20mA and SDI-12 simultaneously.
4-20mA Port: Optically isolated from internal electronics – requires loop power.
Battery Backup: Data integrity is guaranteed by 2 internal AA lithium 3V batteries
(2 months backup operation without external 12V).
Range: Up to ± 9999.999 m
Resolution: 1mm
Max Error: ± 1 mm

LCD Display

Screen: 2 lines x 16 characters LCD
Backlight: Powered via SDI-12 port (9.0 to 16 VDC)
Display: Current water level and battery voltage.
Parameters: User selectable via push buttons on the shaft encoder housing

Accessories

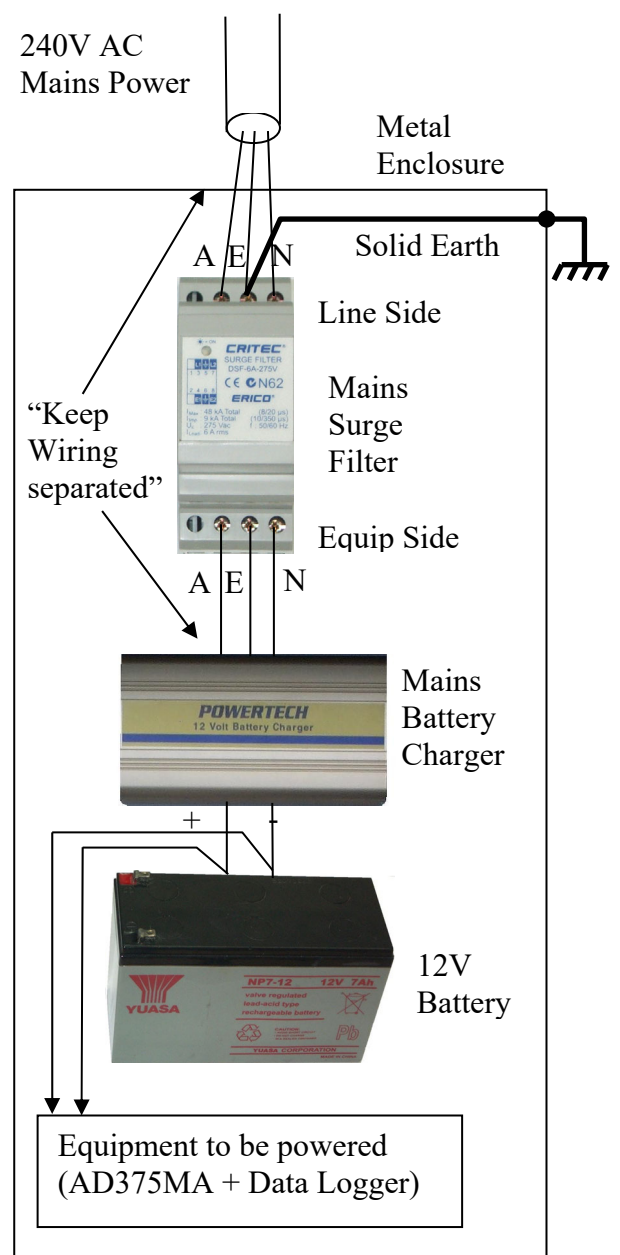
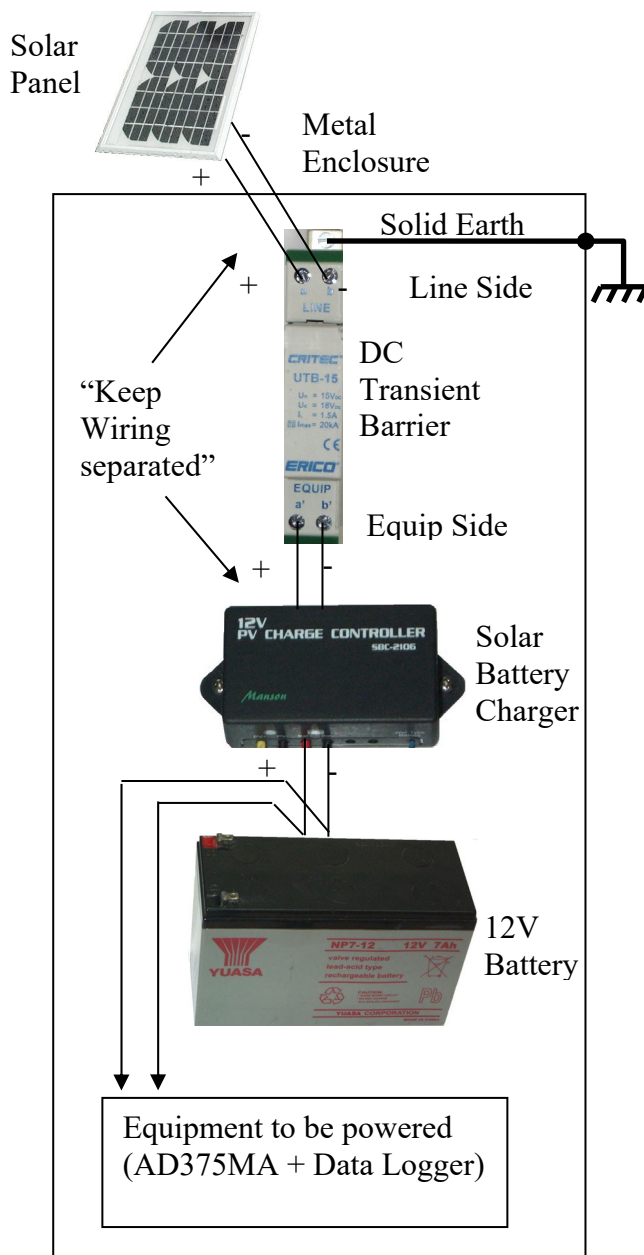
- Floats and Counterweights
- Float Pulley Wheels
- Beaded or Borehole Float Line
- Wire Gate Mounting Kits
- Chain and Sprocket
- Gear Drives
- Mechanical Counter Kit

Packing Details

Dimensions: 270mm (L) x 170mm (H) x 200mm (D)
Weight: 2.0 kg

Appendix A Surge Protection

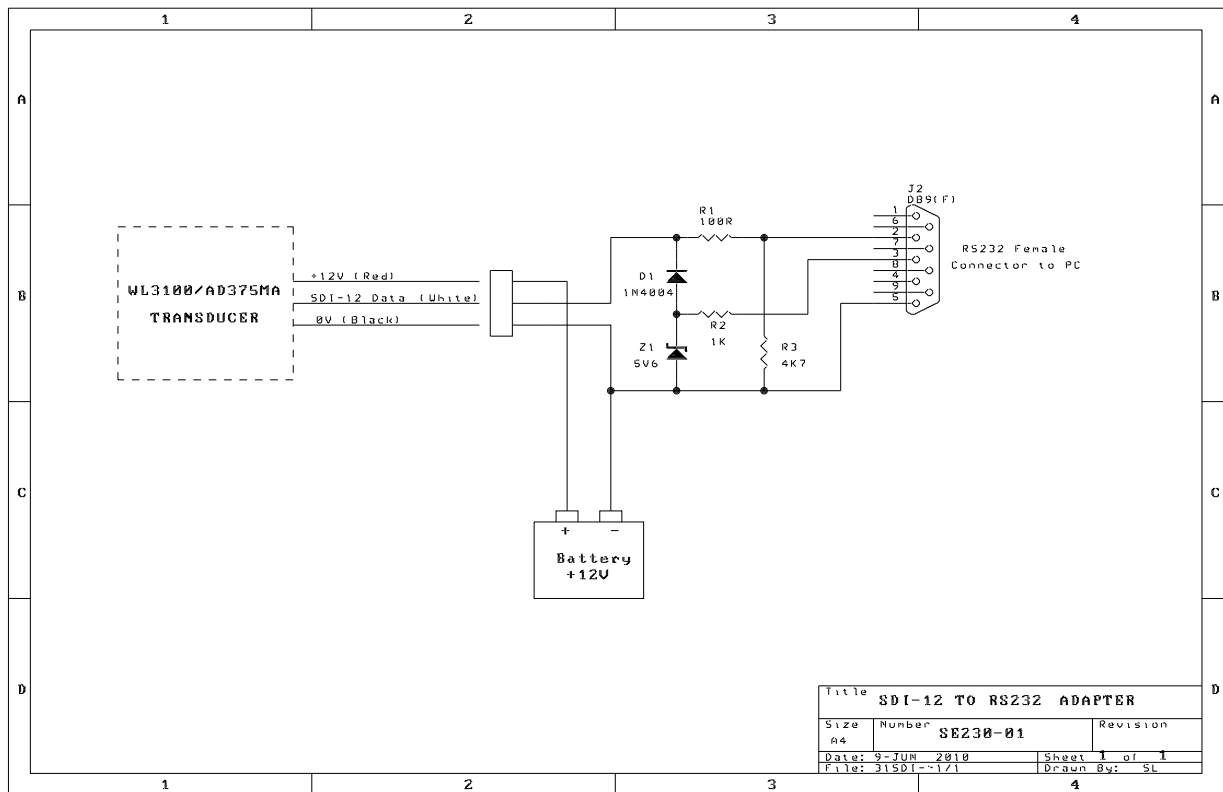
When any electronic equipment is installed at remote exposed locations, it is recommended that lightning / surge protection is installed to protect the equipment from surges that may occur during electrical storms and enter equipment on cables connected to the outside world. So it is this wiring we should focus our attention on protecting. The following diagram shows how to connect a transient suppressor to solar powered equipment and to mains powered equipment. Different suppressors are required, depending on the voltage to be protected. The transient suppressors and the metal cabinets should also be connected to a solid earth at the site.

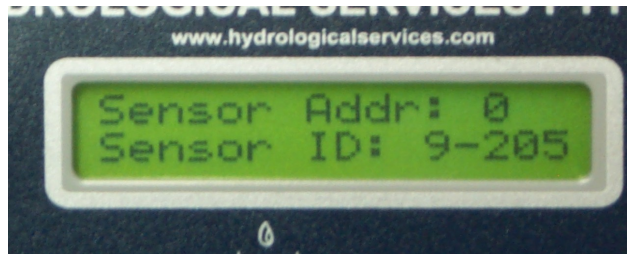


Appendix B SDI-12 to RS232 Interfacing

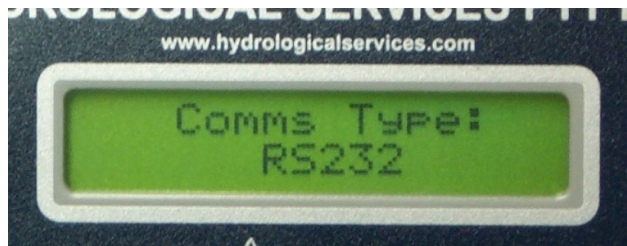
The following schematic is for an SDI-12 to RS232 adapter that can be used for any Hyquest Solutions SDI-12 transducer.

The adapter will allow a transducer to be connected to a PC, and will communicate at 1200 baud, 7 bits and even parity. To bypass the strict timing requirements of SDI-12, simply change the “Comms Type” on the LCD to RS232.





Set SDI-12 Address to 0

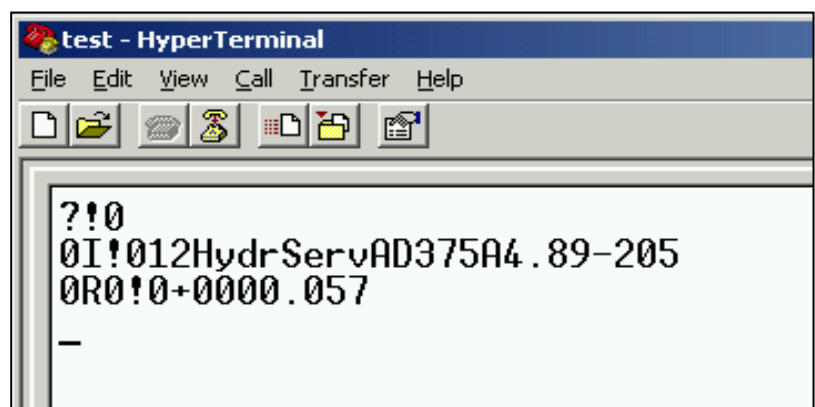
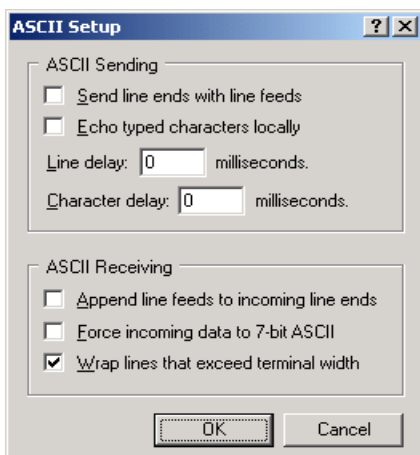
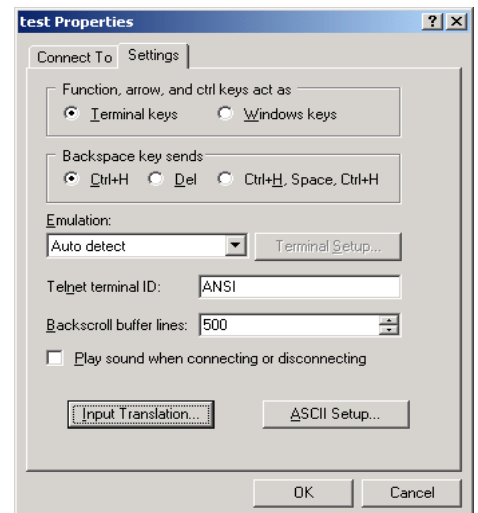
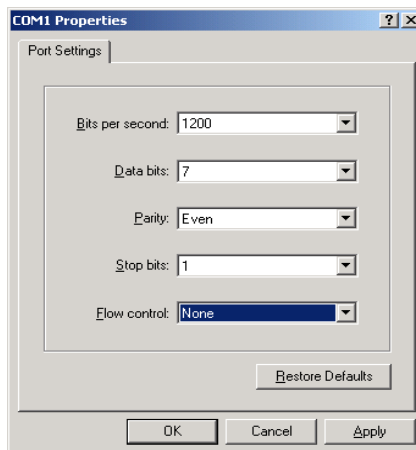


Set Comms Type to RS232

Settings for Hyperterminal



Comm Port depends on your PC



Sample comms session entering : ?! 0I! 0R0!

Sample SDI-12 comms session:

(commands sent to the AD375MA are in “red” and the AD375MA replies are in “black”)

(Parameter X17 is set to 0 when unit is supplied from the factory – BattV measure is OFF)

?! 0 (What address are you ? reply indicating 0)
0I! 013HydrServAD375M5.3A-001 (ID command – product ID reply)

0M! 00001 (Measure command – reply indicating 1 measurement ready in 0 secs)
0D0! 0+0001.234 (Data command – reply indicating water level is 1.234m)

0R0! 0+0001.234 (Contin Measure – same result as an M and D command combination)

(Compliance with SDI-12 Spec V1.3 (implementing CRC) occurs in AD375MA S/W Rev 5.0 and higher)

0MC! 00001 (Measure command with CRC request – reply 1 meas ready in 0 secs)
0D0! 0+0001.028Kb| (Data command – reply indicating water level is 1.028m with a CRC of “Kb|” according to the SDI-12 specification)

0RC0! 0+0001.028Kb| (Continuous measure with a CRC request – same result as an M and D command combination with a CRC of “Kb|”)

0X17+1! 00001 (Set X17 parameter to 1 – sets BattV measure to ON
(X17 is implemented in S/W Rev 5.3 and higher)
0M! 00003 (Measure command – reply indicating 3 measurements ready in 0 secs)
0D0! 0+0001.234+3.6+12.8 (Data command – reply is :)
(water level, lithium battV and external battV)
(+1.234m +3.6V +12.8V)

0R0! 0+0001.234+3.6+12.8 (Contin Measure – same result as an M and D command)

Appendix C Changing Pulley Sizes

The Absolute Shaft Encoder comes in 4 standard models :

- AD375MA 375 steps/rev (= 375mm circumference) (1mm resolution)
- AD150MA 150 steps/rev (= 375mm circumference) (2.5mm resolution)
- AD37_5MA 37.5 steps/rev (= 375mm circumference) (1cm resolution)
- AD100MA 100 steps/rev (= 1.00ft circumference) (0.01ft resolution)

However, for software Rev 5.2 and above, a menu option can also be accessed to allow it to be used with other pulley circumferences.

CUSTOM Configuration Options :

(Metric) 1 to 1000 steps/rev = 0.001 m/rev to 1.000 m/rev (each step represents 1mm)

(Imperial) 1 to 1000 steps/rev = 0.01 ft/rev to 10.00 ft/rev (each step represents 0.01ft)

Custom Examples :

1. If the pulley is 12" = 1.00 ft circumference, then set to Custom, 100 steps/rev, imperial.
2. If the pulley is 24" = 2.00 ft circumference, then set to Custom, 200 steps/rev, imperial.
3. If the pulley is 450mm circumference, then set to Custom, 450 steps/rev, metric.
4. If the pulley is 200mm circumference, then set to Custom, 200 steps/rev, metric.

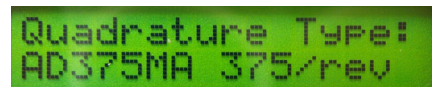
Navigating the menus – example for “Custom” :

1. Press the “scroll” button and step to the menu displaying the Model and S/W Rev.



AD375MA S/W 5.6
Level: 1.536m

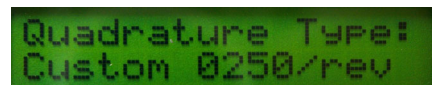
2. Press and **hold** the “select” button until the display changes to “Quadrature Type:” then release the button. (The button will need to be held for about 10 secs)



Quadrature Type:
AD375MA 375/rev

3. Press the “select” button again and the model will start flashing.

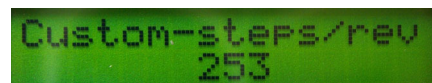
4. Press the “scroll” button to step through the different model types until “Custom” is selected.



Quadrature Type:
Custom 0250/rev

5. Press the “select” button to stop the model flashing.

6. Press the “scroll” button to step to the next menu displaying the number of steps/rev.



Custom-steps/rev
253

7. Press the “select” button to start the number of steps flashing.
8. Press the “scroll” button to increment the number of steps by 1. (**Hold** the “scroll” button to make it increment faster. When the numbers reach 1000, they will return to 1)
9. Press the “select” button to stop the number of steps flashing.
10. Press the “scroll” button to step to the units menu.
11. Press the “select” button to start the units flashing.
12. Press the “scroll” button to select either *imperial* or *metric*.
13. Press the “select” button to stop the units flashing.
14. Press the “scroll” button until you return to the main menu. The model will now be ADxxxxMA where xxxx is the steps per rev.
(Eg. A 400mm circumference pulley will be model AD0400MA)

