

ANALITE 390 Series Turbidity Probes

User Manual

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OBSERVATOR
instruments

ABN 56 007 283 963
8 - 10 Keith Campbell Court, PO Box 9039
Scoresby, VIC 3179 AUSTRALIA
Tel: +61 3 8706 5000; Fax: +61 3 8706 5049
Email: info.au@observator.com
Web: www.observator.com



ANALITE 390 Series Turbidity Probes

Introduction

The ANALITE 390 series of microprocessor based turbidity probes are designed for monitoring and process applications where turbidity levels of up to 1,000NTU may be encountered (up to 5,000NTU for special versions). Available ranges within the probe are 40NTU, 100NTU, 400NTU and 1,000NTU, which can be set by the user. Currently there are two probes types available in the ANALITE 390 series, namely the NEP390 and the NEP395. Specifically the NEP390 probe is designed for applications where bio-fouling will not be a problem such as short monitoring deployment or placement in fast and cold running water. The NEP395 probe however, with its integral wiper assembly, is designed where bio-fouling or sedimentation build-up is likely. Wiping can be initiated automatically (periodically), via a direct RS232 or SDI-12 command or manually as required.

The ANALITE 390 series probes may be submerged to a depth rating of 100 meters (approx. 330 feet). This pressure rating applies to static (non-flowing) water.

All ANALITE 390 series probes use 90° optics and employs infrared light in accordance with ISO7027. All probes use a unique modulation technique that ensures almost total rejection of ambient light conditions. The salient differential features of the ANALITE 390 series probes are table below.

Feature	NEP390	NEP395
RS232 Interface	Yes	Yes
SDI-12 Interface	Yes	Yes
Integral Wiping	No	Yes

The probes may be calibrated at any time or have later firmware uploaded by the user but only via the RS232 interface.

Applications

The applications that the ANALITE 390 series probes are so extensive and too numerous to elaborate on in this document but generally they include:

- 1) Monitoring of streams and rivers.
- 2) Monitoring of water storage bodies including stratification studies.
- 3) Intermediate and final effluent treatment monitoring.
- 4) Hydrological run off studies.
- 5) Ground and bore water analysis.
- 6) Drinking water filtration efficiency.
- 7) Industrial process monitoring.
- 8) Sludge and dredge monitoring.
- 9) Sediment load monitoring.

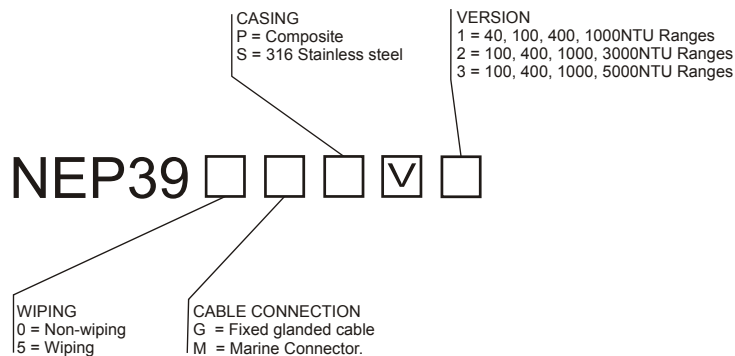
Which model is best used is dependent on the application, the measuring environment, the logging equipment and the monitoring period (deployment times) required.

Although advanced digital processing in the ANALITE 390 series will effectively measure the true turbidity of water when large particle are passing by the optical face, it is recommended that steps be taken to protect the optical face from possible abrasive effects these particles may cause. Measuring turbidity under such potentially abrasive circumstances may require a stilling well to allow the sand or other hard particles to settle away from the optic sensor in the probe tip.

Specifications

Technique	90° Infra-Red (ISO7027).		
Range	40, 100, 400 and 1,000NTU – range selection set by user, initially set at 100NTU. Other range values available at additional cost up to 5,000NTU.		
Resolution	Range	RS232/SDI-12	Analogue
	40NTU	±0.01NTU	±0.06NTU
	100NTU	±0.02NTU	±0.15NTU
	400NTU	±0.1NTU	±0.60NTU
	1,000NTU	±0.2NTU	±1.50NTU
	<p>V2 variants are normally calibrated to 100NTU, 400NTU, 1,000NTU and 3,000NTU</p> <p>V3 variants are normally calibrated to 100NTU, 400NTU, 1,000NTU and 5,000NTU</p> <p>Specifications relating to resolution, repeatability, linearity and temperature coefficient do not necessarily apply to V2 and V3 variants. Consult the factory for details.</p>		
Repeatability	±1% at 25°C.		
Linearity	Better than 1% for 40NTU, 100NTU and 400NTU, 3% for 1,000NTU (using 3 point calibration).		
Temperature Coefficient	Better than ±0.05%/°C.		
Outputs	RS232 - 1200BPS, 7 data bits, even parity, one stop bit. SDI-12 Protocol (V1.3).		
Measurements	<p>RS232 and SDI-12 interfaces</p> <p>Latest turbidity measurement -1 sample.</p> <p>Mean and Sample Variance (over 100 samples).</p> <p>Median (over 100 samples).</p> <p>Minimum (over 100 samples).</p> <p>Maximum (over 100 samples).</p> <p>Probe supply voltage.</p> <p>Probe internal temperature.</p>		
Calibration	<p>2 or 3 point calibration for each range.</p> <p>May be set by the user only through the RS232 interface and for the range selected.</p> <p>Can revert back to factory calibration settings after user calibration.</p> <p>Factory calibration is 2 point for 40NTU, 100NTU and 400NTU ranges.</p>		
Power	9.6 - 28V dc, 35mA ON. 60mA ON and wiping (NEP395). 1.5mA STANDBY.		
Wiping	Initiated by wipe or autowipe \$ commands under the RS232 interface, the M8 command under SDI-12 or externally initiated by bringing the RS232RX conductor to the 0V conductor.		
Wipe Time	8 seconds nominal.		
Weight	<p>NEP390 500gms – probe only plus 70gms per meter of cable.</p> <p>NEP395 550gms – probe only plus 70gms per meter of cable.</p>		
Dimensions	<p>NEP390M - 250mm long unmated, 321mm long mated to end of protective boot, 32m dia.</p> <p>NEP390G - 292mm long including glanding and strain relief assembly, 32mm diameter.</p> <p>NEP395M - 256mm long unmated, 327mm long mated to end of protective boot, 32m dia.</p> <p>NEP395G - 299mm long including glanding and strain relief assembly, 32mm diameter.</p>		

Construction	Delrin (P) or stainless steel (S) casing. Cable connection via a fixed cable gland directly from the rear of the probe incorporating an integrated plastic strain relief (G) or 7-way waterproof, marine grade connector (M).
Cable	Multi- core + mesh shield, 6.5mm dia. PUR (to be ordered separately as NEP-CBL per meter). Conductor resistance 75 ohms per km max.
Cable Length	To order – up to 100m. Consult the factory if longer lengths are required.
Depth Rating	100m (330ft) water column.
Operating Temp.	-10°C to 40°C.
Storage Temp.	-20°C to 50°C.
Ordering Details:	Probe as per nomenclature below:



Cable assembly to suit the NEP390M/395M²
Cable for NEP390/395 per meter
RS232 Interface Adaptor

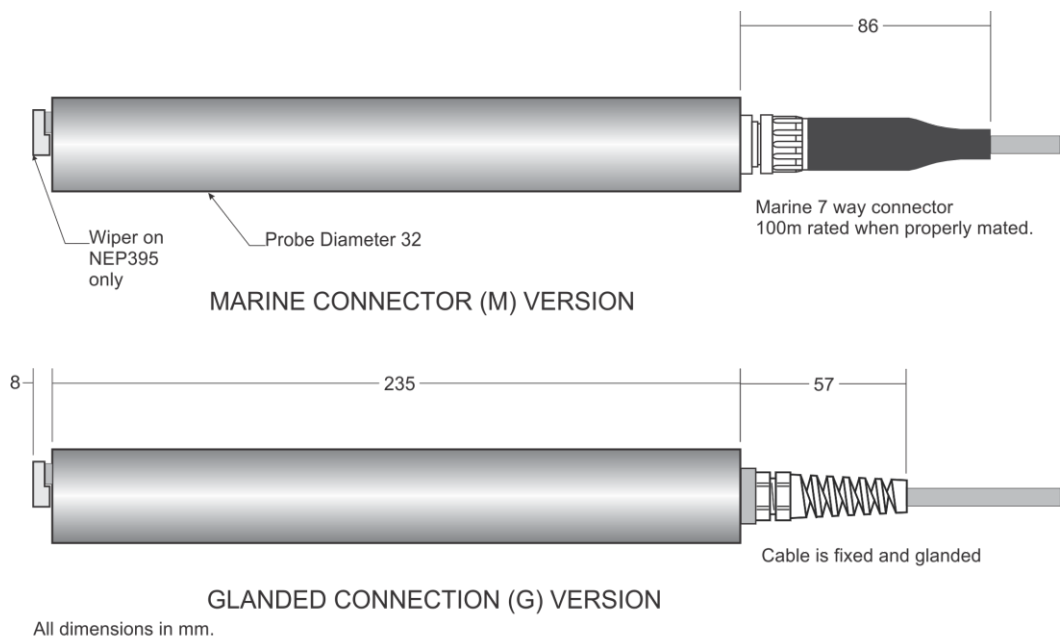
NEP390-CA-xx where xx is length in meters
NEP-CBL
NEP390-RS232

¹Add the either **G** suffix to turbidity probe part numbers for fixed and glanded cable or the **M** suffix for the connector..

¹Cable lengths must be specified at time of order.

²Cable assemblies for connector version (M) include a terminated mating connector to suit the turbidity probe.

Physical Dimensions



Installation

There are three aspects to consider when preparing to install an ANALITE 390 series probe in the field.

- 1) Installation of the probe proper into the environment where measurements are to take place.
- 2) Cabling considerations.
- 3) Connection of the probe into the data collection and control system.

Probe Installation

The probe is normally installed with the optics pointing downwards or in a horizontal alignment. In a simple application the probe is simply immersed into the water to the desired depth, but within the depth rating of the probe. Please note the depth rating is based on static water. Allowances must be made for the effect of flowing water to ensure the static depth rating is not exceeded. If the probe is to be installed downwards then it is recommended to install it a few degrees away from the vertical to allow bubble to escape easily.

It is important that the optic end of the probe is kept clear of obstruction such as the river bed. The minimum distance between the optic head and any object should be 50mm (2").

The casing of the ANALITE 390S series probe is made of 316 stainless steel but the optic face is made of composite materials and so should be protected from accidental scratching or abrasion. To avoid crevice corrosion on the 316 stainless steel casing in salt water deployments it is strongly recommended that the probe be thoroughly washed in clean water after deployment and prior to storage. Failure due to crevice corrosion is not covered under warranty. A composite casing option is available for such applications but the pressure rating is reduced to 30 meters and the probe diameter increases to 34mm. Please call the factory or your ANALITE distributors for more information on the composite casing option.

If the probe body is to be installed in a glanded fitting (for insertion into a pipe etc.) then care must be taken to ensure the sealing surface pressures offered by the gland fitting are not excessive so as to not cause distortion of the probe casing and force leakage. The ANALITE 390 series probes are thin wall instrument and so glanding pressure must be minimal and spread over the largest possible area. Do not cut or damage the outer sheath of the cable. Water may enter the probe through holes or cuts in the cable sheath.

Cabling Considerations

Physical

All NEP390 series probe cable is a specially selected PUR sheathed cable selected for strength, chemical and exceptional resistance to cuts, nicks and abrasion.

Never the less, care should be taken during the installation process of the probe and its cabling to ensure that the cable is not subjected to persistent pulling, snagging or abrasion. This is particularly important for the probes with fixed and glanded cable as any water penetration through the cable sheath may find its way into the probe proper affecting the accuracy of the readings and possibly causing irreparable damage.

For probes fitted with connectors care must be taken to ensure the connectors are properly mated to ensure a seal yet not screwed together too tightly so as to make their disconnection difficult after a long deployment. Prior to mating make sure both the probe and cable connectors are dry in the termination area otherwise erratic operation may occur due to moisture.

Electrical

Because long cable lengths are common several electrical factors should be taken into account and these are discussed below.

All NEP390 series probes have an RS232 interface. Technically an RS232 interface has a cable limitation of 50 feet but the NEP390 series has been successfully tested with cable lengths up to 100m using the NEP390-RS232 adaptor. It is strongly recommended that the NEP390-RS232 adaptor only be terminated to the cable supplied with

the probe. Termination of the NEP390-RS232 to extension cabling is not recommended and the satisfactory results cannot be assured.

The NEP390/395 probes include an SDI-12 compliant interface. The SDI-12 interface specification has a cable limitation of 200 feet. Again the NEP390/395 has been successfully tested to beyond 200 feet but performance is only warranted on original supplied cable to 200 feet.

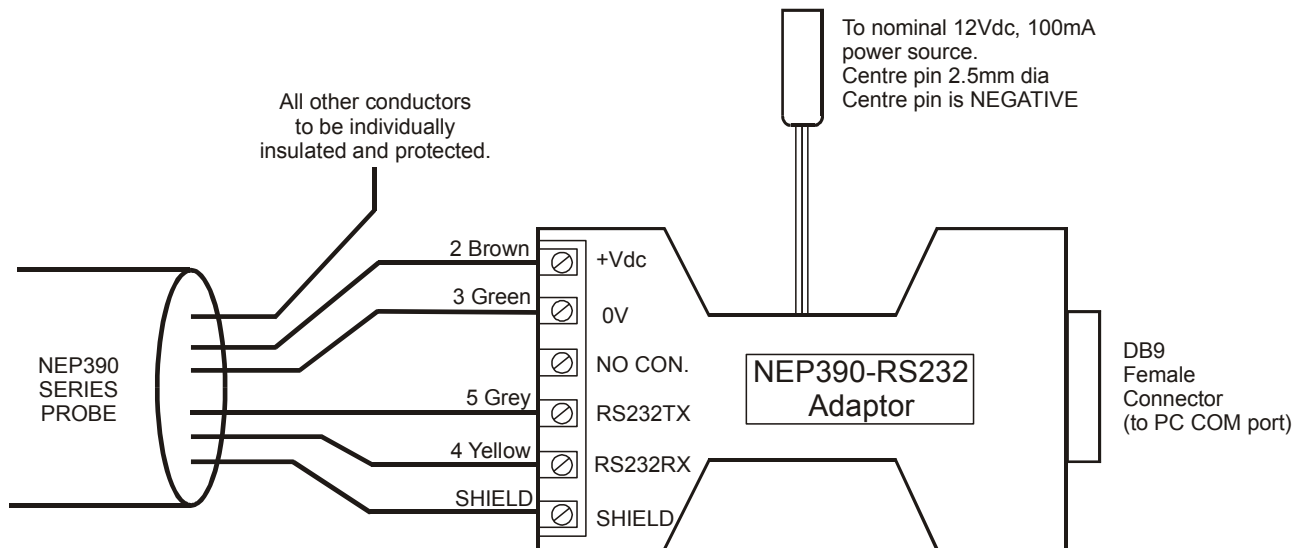
Surge and lightning protection may also have to be considered given that most installations are "in the wild". It is important to note that the NEP390S series probe with the stainless steel casing has its case terminated to the cable shield. There is no electrical contact between the casing and the probe electronics.

Probe Connection

Typical RS232 Connection.

All ANALITE 390 series probes have an RS232 interface. Connection between a probe and an RS232 port on a PC or RS232 logger is best done using the NEP390-RS232 adaptor as it provides simple connection as well as a convenient means to power the probe using an external 12Vdc supply or ac adapter. The NEP390-RS232 adaptor may be ordered separately using the part number NEP390-RS232.

Connection using the NEP390-RS232 adaptor is as shown below.



The adaptor requires power from an external 12Vdc power source. This powers the probe only and is in no way connected to the DB9 connector. The DB9 connector end of the adaptor is plugged into a PC COM port (also called the serial or RS232 port). A specification of an ac adapter that is suitable is near the back of this manual.

Communications with the probe can then be set up using common communication software normally supplied with most operating systems. Refer to the Operating System documentation for details on setting up a communication port and configuring its parameters. For Windows 95/98/2000/XP, you can use HyperTerminal. Set the communications parameters to 1200BPS, 7 data bits, even parity, one stop bit and Flow Control set to NONE.

With the communications setting properly configured and the probe connected to the selected COM port and the communication program running you can apply power to the adaptor. The following response from the probe should be observed:

```
Analite Turbidity Probe, McVan Instruments
Firmware: <ReleaseDate> <ReleaseTime>
013McVan---NEP39x-1.3-SN####
Range 2
Ready
```

Where NEP39x represents the probe model, <ReleaseDate> is the firmware release date in the format mmm dd yyyy and <ReleaseTime> is the firmware release time in the 24 hr format hh:mm:ss. The numeral ##### is the probe's serial number as set in the factory. The probe is released from the factory defaulted to range 2 (100NTU) but this can be changed by the user.

The probe is now ready to receive RS232 commands (and SDI-12 commands if it is a NEP390/395 probe).

To test the probe, enter the **status** command followed by the Enter (↵) key. This will indicate if the probe is operating normally. The response from the probe should be similar to that below:

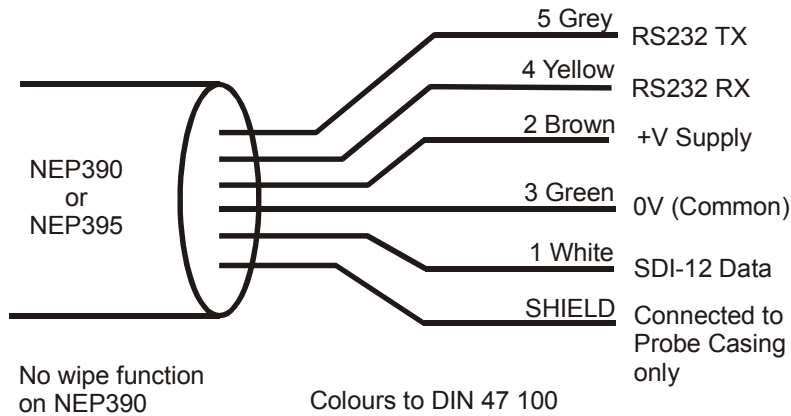
```
VCC = +5.0 V
12V = +15.5 V
Mot = 0 mA
Int = +23.6 C
Ext = +23.6 C
```

Where **VCC** is the regulated voltage supply within the probe. It should be between 4.9 to 5.1 volts. The **12V** parameter is the supply voltage at the probe. It should be between 9.6 to 28V dc. **Mot** represents the wiper motor current and should be 0mA when not operating or not fitted. **Int** and **Ext** represent the internal temperature of the probe and should realistically reflect the probes environmental situation. The temperature measurement is used for temperature correction over the range -10°C to +40°C. Other parameters may also be present and may have no relevance.

NEP390 and NEP395 SDI-12/RS232 Probes

The NEP390/395 probe is designed to operate with data loggers and DAS systems that are SDI-12 compliant or have a RS232 interface. Examples of SDI-12 compliant loggers including units manufactured Campbell Scientific and dataTaker.

The ANALITE 390 and 395 conductor assignment is as shown below. All other conductors from the cable should be individually insulated and protected so as not to cause accidental connection to other conductors.



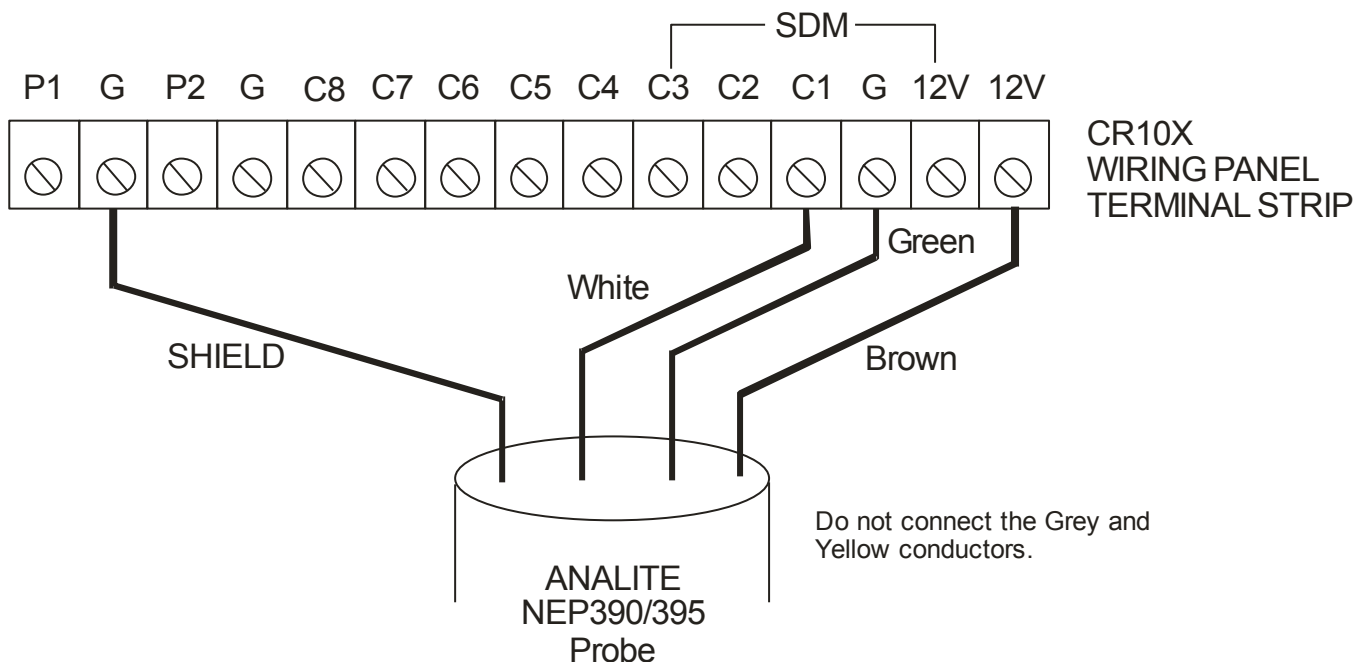
Ensure the RS232TX and RS232RX conductors are also individually insulated when operating in SDI-12 mode and likewise ensure the SDI-12 Data conductor is insulated when connected in RS232 mode.

Maximum cable length stated in the SDI-12 specification is 60 meters (200 feet).

Typical SDI-12 Logger Connections for NEP390/395.

Campbell Scientific CR10X

Below is a sketch showing a typical connection to a Campbell Scientific CR10X logger.



The logger will supply the necessary power for the ANALITE 390 or 395 probe.

A typical CR-10X program to operate and collect data from a NEP395 probe is listed below. This program should also work for the CR510 and CR23X models. The program assumes the probe has the address of 1 and the program is configured to wipe and then measure every 15 minutes.

```
;{CR10X}
;
; Sample program to measure Analite NEP390
; & NEP395 turbidity sensors using SDI-12
;
; In this example -
; Sensor Address is set to 0001
; CR10X uses Control Port 1 for SDI-12 communications
;

; Take a measurement every 15 minutes

*Table 1 Program
01: 900      Execution Interval (seconds)

; Activate wiper prior to measurement

1:  SDI-12 Recorder (P105)
1: 0001      SDI-12 Address
2: 8         Start Measurement (aM8!)
3: 01        Port
4: 1         Loc [ WipeCode ]
5: 1.0       Mult
6: 0.0       Offset

; Take Turbidity measurement

2:  SDI-12 Recorder (P105)
1: 0001      SDI-12 Address
2: 3         Start Measurement (aM3!)
3: 01        Port
4: 2         Loc [ Turbidity ]
5: 1.0       Mult
6: 0.0       Offset

; Store Hourly Average, Max, Min Turbidity plus Max Wipecode
; to Final Storage

3:  If time is (P92)
1: 0000      Minutes (Seconds --) into a
2: 60        Interval (same units as above)
3: 10        Set Output Flag High (Flag 0)

; Store Time stamp

4:  Real Time (P77)^18262
1: 1110      Year,Day,Hour/Minute (midnight = 0000)

5:  Average (P71)^5600
1: 1         Reps
2: 2         Loc [ Turbidity ]

6:  Maximum (P73)^20824
1: 1         Reps
2: 00        Time Option
3: 2         Loc [ Turbidity ]

7:  Minimum (P74)^692
1: 1         Reps
2: 00        Time Option
3: 2         Loc [ Turbidity ]
```

```

8: Maximum (P73)^29775
1: 1      Repts
2: 00     Time Option
3: 1      Loc [ WipeCode ]

```

```

*Table 2 Program
  02: 0.0000      Execution Interval (seconds)

```

```

*Table 3 Subroutines

```

```

End Program

```

```

-Input Locations-

```

```

1 WipeCode  1 1 1
2 Turbidity 1 3 1
3 _____ 0 0 0
4 _____ 0 0 0
5 _____ 0 0 0
6 _____ 0 0 0
7 _____ 0 0 0
8 _____ 0 0 0
9 _____ 0 0 0
10 _____ 0 0 0
11 _____ 0 0 0
12 _____ 0 0 0
13 _____ 0 0 0
14 _____ 0 0 0
15 _____ 0 0 0
16 _____ 0 0 0
17 _____ 0 0 0
18 _____ 0 0 0
19 _____ 0 0 0
20 _____ 0 0 0
21 _____ 0 0 0
22 _____ 0 0 0
23 _____ 0 0 0
24 _____ 0 0 0
25 _____ 0 0 0
26 _____ 0 0 0
27 _____ 0 0 0
28 _____ 0 0 0

```

```

-Program Security-

```

```

0000
0000
0000

```

```

-Mode 4-

```

```

-Final Storage Area 2-

```

```

0

```

```

-CR10X ID-

```

```

0

```

```

-CR10X Power Up-

```

```

3

```

```

-CR10X Compile Setting-

```

```

3

```

```

-CR10X RS-232 Setting-

```

```

-1

```

```

-DLD File Labels-

```

```

0

```

```

-Final Storage Labels-

```

```

0,Year_RTM,18262

```

```

0,Day_RTM

```

```

0,Hour_Minute_RTM

```

```

1,Turbidity_AVG~2,5600

```

```

2,Turbidity_MAX~2,20824

```

```

3,Turbidity_MIN~2,692

```

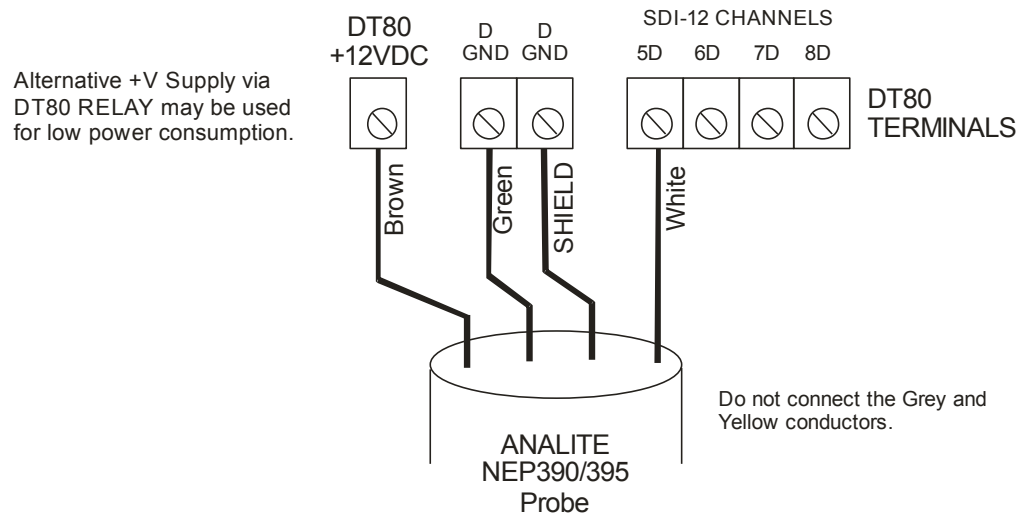
```

4,WipeCode_MAX~1,29775

```

dataTaker DT80

The example below is a typical connection to a dataTaker DT80 logger.



The logger will supply the necessary power for the ANALITE 390 or 395 probe.

A typical DT80 program to operate and collect data from a NEP395 probe is listed below. This assumes the probe has the address of 0, connected to Channel 5 and the program is configured to wipe and then measure every 15 minutes.

```
begin"Turbid"
'=====
'
'   This code is to read an ANALITE NEP395G Turbidity Probe.
'
'   For more detail contact support@datataker.com.au
'   30 Jan 2006
'=====
'
'   SDI-12Address Is 0
'   Connected to digital input 5
'   Register

'Report results of schedule A every 15 Minutes ra15m

'Activate wiper: Read Channel 5 as SDI-12, address0, Register 8
5sdi12(ad0,r800,"Wipe")

'Read turbidity: Read Channel 5 as SDI-12, address0, Register 3
5sdi12(ad0,r300,ff2,"Turbidity (A0)")

logon    'Log results
end
```

Command Set

All ANALITE NEP390 series probes allow for RS232 connection and share a common RS232 Command Set.

The NEP390 and NEP395 allows for two command protocols. The first is RS232 and the second is SDI-12 (compliant to V1.3) consistent with SDI-12 loggers on the market today.

The RS232 Command Set allows for the setting up and calibration of the ANALITE 390 series probes as well as obtaining sensor data. RS232 connection between a probe and a PC is best implemented using the interface adapter (part number NEP390-RS232) as well as connection to a nominal DC 12V power source – refer to the **Installation** section of this manual.

RS232 Command Set

The RS232 interface operates only on 1200BPS, 7 data bits, even parity and one stop bit. All RS232 commands are lower case. All commands (SDI-12 or RS232) should result in a response from the probe. Using the Enter (↵) key before entering another command should terminate entry of an incorrect or mistyped command.

Command	Function	Comment
status	Show internal probe conditions.	Typical return (may vary): VCC = +5.0 V Probe supply 12V = +15.5 V Input voltage supply Mot = 0 mA Motor current Int = +23.6 C Internal probe temp' Ext = +23.6 C Internal probe temp'
single	Take single turbidity measurement.	Returns a single turbidity measurement.
measure	Take 100 measurements.	Returns 100 measurements in sequence followed by their minimum, maximum, mean, median and sample variance.
wipe	Perform one wiper rotation.	NEP395 and NEP396 only. Forces a single wipe rotation. Probe will return a single numeric 0, 1 or 2. 0 = Okay 1 = Motor current exceeded (>60mA). 2 = Wiper time exceeded (>8secs). A manual wipe may be initiated by momentarily bringing the RS232RX conductor to 0V for longer than 100mSec.
autosingle \$	Set auto single measurement period	Allows the return of single measurement data at predetermined interval \$. \$ can take the range of 0 to 65,500 seconds where 0 represents the instruction to never measure automatically. The save command must be used to permanently change to the selected interval.
sstats	Outputs statistic of last 100 autosingle data	Returns the minimum, maximum, mean, median and sample variance of the last 100 measurements taken under the autosingle command. Should the internal buffer not yet have 100 measurements the probe will return the response INSUFFICIENT DATA POINTS.

autowipe \$	Set auto wipe period.	<p>NEP395 and NEP396 only.</p> <p>Sets the automatic wipe time within the probe. This will ensure a wipe at regular interval. The period timer is reset after each wipe whether initiated by the autowipe command or by the wipe command. \$ can take the range of 0 to 65,500 seconds where 0 represents the instruction to never wipe automatically. The save command must be used to permanently change to the selected range.</p> <p>A manual wipe may be initiated by momentarily bringing the RS232RX conductor to 0V for longer than 100mSec.</p>
automeas \$	Set auto measure period.	<p>Allows the return of data at predetermined intervals \$. \$ can take the range of 0 to 65,500 seconds where 0 represents the instruction to never measure automatically.</p> <p>The save command must be used to permanently change to the selected interval.</p>
range \$	Select range of measurement (0 to 3).	<p>Sets the probes measurement range:</p> <p>0 = 1,000NTU 1 = 400NTU 2 = 100NTU 3 = 40NTU</p> <p>Factory default is 2 (100NTU).</p> <p>The save command must be used to permanently change to the selected range.</p>
anavspan \$	Sets analogue output voltage span	<p>For NEP391 and 396 only.</p> <p>Sets the analogue output voltage span:</p> <p>0 = 0 –1 volt 1 = 0 – 2.5 volt.</p> <p>Factory default is 0 (0 – 1 volt).</p> <p>The span corresponds to the range selected using the range command.</p> <p>The save command must be used to permanently change to the selected range.</p>
anaispan \$	Sets analogue output current span	<p>For NEP391 and 396 only.</p> <p>Sets the analogue output current span:</p> <p>0 = 0 – 20mA 1 = 4 – 20mA.</p> <p>Factory default is 1 (4 – 20mA).</p> <p>The span corresponds to the range selected using the range command.</p> <p>The save command must be used to permanently change to the selected range.</p>

temp \$	Set temperature compensation, % per degree.	Sets the probes temperature compensation. Normally set at about 0.43%/°C. It is recommended that this NOT be altered unless thorough temperature compensation tests have been conducted. The save command must be used to permanently change to the selected compensation setting.
zero	Set zero NTU calibration point for selected range.	Calibration command. Sets the zero calibration point.
low \$	Set low NTU calibration point for selected range.	Calibration command. Sets the middle calibration point – used for 3-point calibration only.
high \$	Set high NTU calibration point for selected range.	Calibration command. Sets the high-end calibration point – used in both 2-point and 3-point calibrations.
calibrate	Apply new calibration points (3 point calibration).	Activates the new calibration points for 3-point calibration but does not save them.
calibrate2	Apply, ignoring middle point (2 point calibration).	Activates the new calibration points for 2-point calibration (disregards the low \$ point) but does not save them.
save	Save calibration to non-volatile memory.	Saves permanently the calibrations points set up by the user using the calibrate2 and calibrate commands. Also permanently saves any changes to the range , automeas , autosingle , autowipe , anavspan , anaispan and temp parameters.
factory	Restore factory calibration.	Returns probe to factory calibration points.

(note: \$ stands for a decimal value that must be supplied)

For an Analite NEP390 and NEP395 probe, the SDI-12 commands may also be used when in RS232 mode but RS232 commands are not available in SDI-12 mode.

SDI-12 Command Set

The SDI-12 Command Set is tabled below and is Version 1.3 compliant and downward compatible with V1.1 and V1.2 loggers. For more details on the SDI-12 Interface Standard, its command set and its electrical interface requirements refer to the document “SDI-12 A Serial-Digital Interface Standard for Microprocessor-Based Sensors” available from the SDI-12 Support Group at their website www.sdi-12.org. The probe address is “a”

The SDI-12 Command Set will also operate when in RS232 mode for the NEP390 and NEP395 probes only.

When supplied direct from the factory, the ANALITE 390 or 395 probe has the default SDI-12 address of 0 (zero).

Command	Title	Comment
a!	Acknowledge active	Command to ensure a sensor will respond to logger command. The sensor will respond with its own address (a in this case).
a!	Send identification	Queries sensors as to their SDI-12 compatibility level. The response from an ANALITE 395 sensor will be like: a13McVan----NEP395-1.1##### where ##### is the ANALITE probe's serial number.
aAb!	Change address	Changes sensor address of an unlocked sensor– from a to b in this case.
?!	Address query	To determine the address of a sensor. The ANALITE 390 or 395 probes will respond with its address a<CR><LF>.
aV!	Start verification	Requests a defined response indicating the proper electronic operation of the ANALITE390 or 395 probe. For proper operation the returned defined response should be +1.
aM!	Measure	Instructs sensor to take a measurement. See below for more detail.
aMC!	Measure, crc	Instructs sensor to take a measurement incorporating a cyclic redundancy check. See below for more detail.
aM#!	Measure (see below)	Instructs sensor to take a measurement. See below for more detail.
aMC#!	Measure, crc	Instructs sensor to take a measurement incorporating a cyclic redundancy check. See below for more detail.
aC!	Concurrent measure	Instructs the sensor to take a concurrent measurement and returns the time until all measurements will be ready and the number of measurements it will take. The aD0! must be issued to collect the measurements.
aCC!	Concurrent measure, crc	As per aC! but incorporating a cyclic redundancy check.
aC#!	Concurrent	Instructs the sensor to take a concurrent measurement and returns the time until all measurements will be ready and the number of measurements it will take. The aD0! must be issued to collect the measurement(s). See below for more detail.
aCC#!	Concurrent, crc	As per aC#! but incorporating a cyclic redundancy check.
aR#!	Continuous data	Returns data from the sensor as a consequence the last M, MC, C and CC command. See below for the data returned depending on the value of #. in the aR#! command.
aRC#!	Continuous data, crc	As per aR#! but incorporating a cyclic redundancy check.

aD#!	Send data	This command is used to collect data from a sensor. This command is issued after an M, MC, C, CC or V command and returns the requested data. The value of # in the aD#! must be from 0 to 9 but it does not affect the content of the data returned as this is determined solely by the # parameter in the M, MC, C, CC or V command issued earlier.
aU OPEN!	Unlock address	Unlocks the sensors probe address so that it may be changed using the Change address command aAb!.
aL!	Lock address	Locks the address of the sensor. Address changes can only occur after the Lock is released using the Unlock address command aU OPEN!, where a is the current probe address.
aXR#!	Set range (temporarily)	SDI-12 extended command. Allows for a temporary range change where # corresponds to the range number. After a power down the probe will return to the range previously selected using the RS232 range command.

where a, b and # stands for a character argument:

aM!	aR0!	aC!	Battery, temperature, mean, sample variance
aM1!	aR1!	aC1!	Mean, variance, median, minimum, maximum
aM2!	aR2!	aC2!	Median, minimum, maximum
aM3!	aR3!	aC3!	Single turbidity measurement.
aM4!	aR4!	aC4!	Not Used.
aM5!	aR5!	aC5!	Mean, sample variance
aM6!	aR6!	aC6!	Battery voltage
aM7!	aR7!	aC7!	Internal probe temperature
aM8!	aR8!	aC8!	Wipe command or return of wipe status.
aM9!	aR9!	aC9!	Not Used.

The data returned by an aM8! (or aR8! or aC8!) wipe command is a code resulting from the wipe action. They are:

0	Okay – operation was successful and within defined current and timing limits.
1	60 mA current limit exceeded.
2	8 sec timeout exceeded.

The return 0 is normal, whereas 1 or 2 are regarded as a fault conditions requiring user attention to determine the reason for over current or time over run. In most cases it is simply a dirty wiper pad that needs replacing or the wiper pad has been allowed to dry and has “adhered” to the probe face.

Measurements requesting crc

Refer to the to the document “SDI-12 A Serial-Digital Interface Standard for Microprocessor-Based Sensors” available from the SDI-12 Support Group at their website www.sdi-12.org for a complete discussion of measurements incorporating a Cyclic Redundancy Check (crc).

Calibration and Solutions

The ANALITE 390 series probes are factory calibrated in all ranges but may be recalibrated by the user. Calibration may be either 2-point or 3-point and can only be done using the RS232 command set. For most applications, particularly when using the 40, 100 and 400NTU ranges, a 2-point calibration will be adequate. However, for the most critical applications and for the 1,000NTU range, a 3-point calibration may be required. Please note that factory calibration is 2 point on all ranges using zero and the end range values as calibration points, so for example for the 100NTU range the two points set were zero and 100NTU.

A 2-point calibration assumes the probe transfer curve is linear following the general equation $y=bx+c$, whereas the 3-point calibration assumes it to be a second order polynomial with the general equation $y=ax^2+bx+c$.

2-point calibration of a selected range

Enter selected range to be calibrated (e.g. 0 - 40NTU - range 3)

range 3 ↵

The probe will respond:

Range 3 selected.

Place the probe into the ZERO NTU calibration solution and then enter

measure ↵

A typical probe response may be:

```
+5.78 NTU      1710 raw
+5.34 NTU      1577 raw
```

A TOTAL OF 100 readings are taken and displayed

```
+5.75 NTU      1702 raw
+5.96 NTU      1765 raw
```

```
+5.23 NTU min
+6.39 NTU max
+5.69 NTU mean
+5.69 NTU median
+0.0388 NTU2 variance
```

Assign the average of the raw data to be equal to ZERO NTU turbidity by entering:

zero ↵

Probe response:

Raw 1685 = +0.00 NTU

Next place the probe into the 40NTU calibration solution and then enter

measure ↵

A typical probe response may be:

```
+83.76 NTU      24719 raw
+83.76 NTU      24728 raw
```

A TOTAL OF 100 readings are taken and displayed

```
+83.33 NTU      24615 raw
+83.58 NTU      24679 raw
```

```
+82.78 NTU min
+84.34 NTU max
+83.58 NTU mean
+83.61 NTU median
+0.0746 NTU2 variance
```

Assign the average of the raw data to be equal to 40 NTU by entering:

high 40↵

Probe response:

```
Raw 24697 = +40.00 NTU
```

Complete the 2-point calibration by entering:

calibrate2↵

Probe will respond with:

```
Applying
```

Test each reference point again, read the turbidity of each by placing the probe into each solution and then enter:

single↵

The result should be a reading very close to the calibration solution value. After confirming the correct calibration of the range, the calibration constants may be stored into the probes permanent memory by entering the command:

save ↵

Probe response is:

```
Saved
```

If the **save** command is not executed then the new calibration points will be lost when the probe is powered down.

Repeat the above procedure for all the ranges to be calibrated. Make sure that the save command is followed by the correct response. Repeat the procedure for range 2 (0 - 100NTU) using a zero solution and the 100NTU solution, range 1 (0 - 400NTU) using a zero solution and the 400NTU solution and range 0 (0 – 1,000NTU) using a zero solution and the 1,000NTU solution. Other calibration reference points may be used but it is recommended that they are not far away from the selected range limit; for example in the 100NTU range, calibration solution values of 60 to 100NTU should be acceptable

3-point calibration of a selected range

For the purposes of this example we will use the 40NTU range and use ZERO, 8NTU and 40NTU as the calibration solutions. The “low” value solution should be no more than 20% of the “high” value solution.

Enter selected range to be calibrated (e.g. 0 - 40NTU, range 3)

range 3↵

Probe response is:

```
Range 3 selected
```

Place the probe into the ZERO calibration solution and then enter

measure↵

Probe response is typically:

```
+5.78 NTU      1710 raw
+5.34 NTU      1577 raw
```

A TOTAL OF 100 readings are taken and displayed

```
+5.75 NTU      1702 raw
+5.96 NTU      1765 raw
```

```
+5.23 NTU min
+6.39 NTU max
+5.69 NTU mean
+5.69 NTU median
+0.0388 NTU2 variance
```

Assign the average of the raw data to be equal to ZERO NTU by entering:

zero↵

Probe response is:

```
Raw 1685 = +0.00 NTU
```

Place the probe into the 8NTU (low) calibration solution and then enter

measure↵

Probe response is (typically):

```
+8.25 NTU      5523 raw
+8.20 NTU      5989 raw
```

TOTAL OF 100 readings are taken and displayed

```
+8.22 NTU      5501 raw
+8.30 NTU      6052 raw
```

```
+8.05 NTU min
+8.50 NTU max
+8.15 NTU mean
+8.20 NTU median
+0.6620 NTU2 variance
```

Assign the average of the raw data to be equal to 8NTU by entering:

low 8↵

Probe response is:

```
Raw 5485 = +8.00 NTU
```

Place the probe into the 40NTU (high) calibration solution and then enter
measure ↵

Typical probe response may be:

```
+83.76 NTU      24719 raw
+83.76 NTU      24728 raw
```

A TOTAL OF 100 readings are taken and displayed

```
+83.33 NTU      24615 raw
+83.58 NTU      24679 raw
```

```
+82.78 NTU min
+84.34 NTU max
+83.58 NTU mean
+83.61 NTU median
+0.0746 NTU2 variance
```

Assign the average of the raw data to be equal to 40 NTU by entering:

high 40 ↵

Probe response is:

```
Raw 24697 = +40.00 NTU
```

Complete the Three Point calibration by entering:

calibrate ↵

Probe response:

```
Applying
```

Test each reference again, read the turbidity of each by placing the probe into each solution and then by entering:

single ↵

After confirming correct calibration of the range has been achieved the calibration factors are stored into the probes permanent memory by entering the command:

save ↵

Probe response is:

```
Saved
```

If the **save** command is not executed then the new calibration points will be lost when the probe is powered down.

Repeat the above procedure for all the ranges to be calibrated. Make sure that the save command is followed by the correct response. Repeat the procedure for range 2 (0 - 100NTU) using a zero solution and two other values, range 1 (0 - 400NTU) using a zero solution and two other values and range 0 (0 - 1,000NTU) using a zero solution and two other values.

Calibration Solutions

Because a turbidity probe is inherently an optical device, care must be taken during calibration to ensure that external optical effects are kept to a minimum. This is best implemented by placing calibration solutions in dark, leak proof bottles with a non-reflective finish such as Nalgene® 2106 bottles in amber. These are available with wide necks and a nominal capacity of 1000ml (our part NEP-BTL).

Another important factor is cleanliness. Any debris or water that makes its way into the calibration solutions will affect its value and adversely affect the proper calibration of an instrument. It is therefore a good practice to have an ample supply of distilled de-ionized water and a means of properly drying the probe end (clean compressed air is ideal). Probes should be flushed in two containers of distilled water with thorough drying in between and before insertion into a calibration solution. Also where ever possible, calibration should commence at a lower value (usually zero) and work up in value to further minimize the effects of cross contamination.

10NTU, 20NTU, 100NTU, 400NTU, 1000NTU, 3000NTU and 5000NTU neutral-density polymer-based turbidity standards are available from Observator Instruments and their distributors or directly from the manufacturer¹ for US customers only. We recommend the use of these standards and distilled de-ionized water (for ZERO) for a 2 or 3 point calibration. These turbidity standards should not be diluted, as this will reduce the effect of the anti-fungal agent contained in the solutions.

When inserting the ANALITE 390 series probe into a calibration solution ensure that its optic is at least 50mm from the base and all sides of the bottle. This is particularly important for low turbidity solutions below 200NTU. Hold the probe a few degrees from the vertical and gently tap it on the bottle rim so as to dislodge any air bubble on the optic face. If the probe is properly placed the measurement value will not vary if the probe is gently moved a few millimeters in any direction.

Although the user selects the calibration solution values, two points should be kept in mind when selecting the calibration solution values.

1. To ensure the selected range is useful the high point calibration solution should have a value near the full-scale range limit.
2. The zero point must always be ZERO NTU. In a 3-point calibration, the low point solution value should be no more than 20% of the high point high point solution value. Using a low point value that is outside the guideline band may result in a **Bad Calibration Data** message from the probe during calibration. If a **Bad Calibration Data** message is received the calibration process is not complete and under no circumstances should the range be used or saved until a valid calibration has been completed.

Below is a table of suggested calibration solution values. The user may use other values dependent on the application and the turbidity measurements anticipated.

Range	Low Point (3-point only)	High Point (2 and 3 point)
40NTU	5NTU	40NTU
100NTU	20NTU	100NTU
400NTU	80NTU	400NTU
1,000NTU	200NTU	1,000NTU

Formazin-based turbidity standards can also be used to calibrate the system. These standards can either be prepared as described in Standard Methods for the Examination of Water and Wastewater or by volumetric dilution of 4,000 NTU Formazin standard solutions.

CAUTION: Formazin contains material that can cause cancer. If you use this material for a calibrant, be certain to pay close attention to the warnings provided by the supplier.

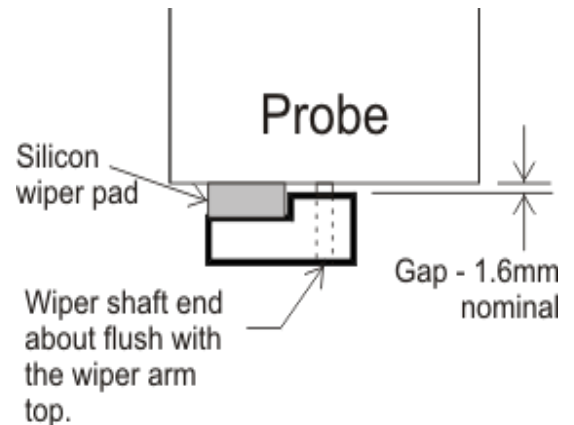
¹ GFS Chemicals, Columbus, Ohio, USA.

Wiper Replacement

Applies to NEP395 probes only.

The effectiveness of the wiper in maintaining a clean optical surface will eventually be compromised, the rate being dependent on the water under investigation and the number of wiping cycles carried out. We recommend periodic inspection of the wiper's silicon pad to determine if the wiper material is deteriorating or if there is an excessive buildup of material from bio-fouling. In addition, as a precaution, we recommend changing the wiper prior to each long term deployment. The wiper is a consumable item. Wiper kits are available from Observator Instruments or their distributors (Part No. NEPSILWIPE)

To change the wiper, loosen the set screw on the old wiper with the 1.5mm hex key provided until the wiper can be removed from the shaft. Place a new wiper on the shaft in the same position as the wiper just removed so that the set screw in the new wiper faces the flat on the probe's wiper shaft. Very gently press the silicon rubber pad of the wiper against the face of the probe and then tighten the set screw. It is crucial that the wiper arm body does not make contact with the probe face – only the silicon pad should be in contact. A gap of 1.6mm between the wiper arm body and the probe face is typical when a new wiper has been properly installed.



CAUTION: Do not over-tighten the set screw or manually attempt to rotate the wiper arm once set onto the shaft.

Firmware Upgrades

The ANALITE 390 series probes are microprocessor based turbidity sensors and have been designed so that any firmware upgrades can be uploaded to replace the existing resident program within the probe. This means that as Observator Instruments improves the operation of the probe by enhancing the firmware, users can upload these improvements using a very simple procedure. The NEP390-RS232 adaptor is required to implement these upgrades, as communications with a PC is required.

Firmware upgrades will be made available on the Observator Instruments website as they are released. The files that are download from our website will be zipped files. When unzipped, there will be at least one file. One file will have the name structure **NEP390V###.exe** where **###** is the firmware version number. Other files (if included) may include text information on the upgrade details or additional User Manual information and these should be consulted before proceeding with the firmware upgrade.

Extract the **NEP390V###.exe** file and place it in a suitable directory – we suggest c:\NEP390. We will assume for the purpose of example below that the extracted file is located in the directory c:\NEP390.

Set up the ANALITE probe using the NEP390-RS232 adapter and connect it to a COM port on the PC. You can apply power to the probe as well. Make sure all communication software programs that will take control of the selected COM port are shutdown (such as Windows HyperTerminal).

Next we enter the command prompt mode. This can be done by clicking on the **Start** button at the bottom left hand side of normal Windows desktop display. Select **Run..** and enter the text **cmd** followed by the ↵ (Enter) key. This will open the Command Prompt window showing a typical DOS command prompt cursor.

At the DOS cursor, change to the directory where the ANALITE Upgrade firmware file is located, eg:

```
cd c:\NEP390↵
```

The resultant prompt should now confirm that you are in the selected directory, eg:

```
c:\NEP390 >_
```

Next enter the firmware upgrade file followed by a space and the selected COM port (in this case COM1), eg:

```
NEP390V### COM1↵
```

The program will respond:

```
crc: 0xae3b
Waiting for target. (Connect to rs232 and cycle probe power.)
```

The characters following the **crc:** text may vary depending on the firmware version. Momentarily disconnect and reconnect the power to the ANALITE 390 or 395 probe.

The response in the Command Prompt window should then display:

```
boot mode
rs232 detected
ok
Programming
Page # of y
Verifying
Page # of y
Done
```

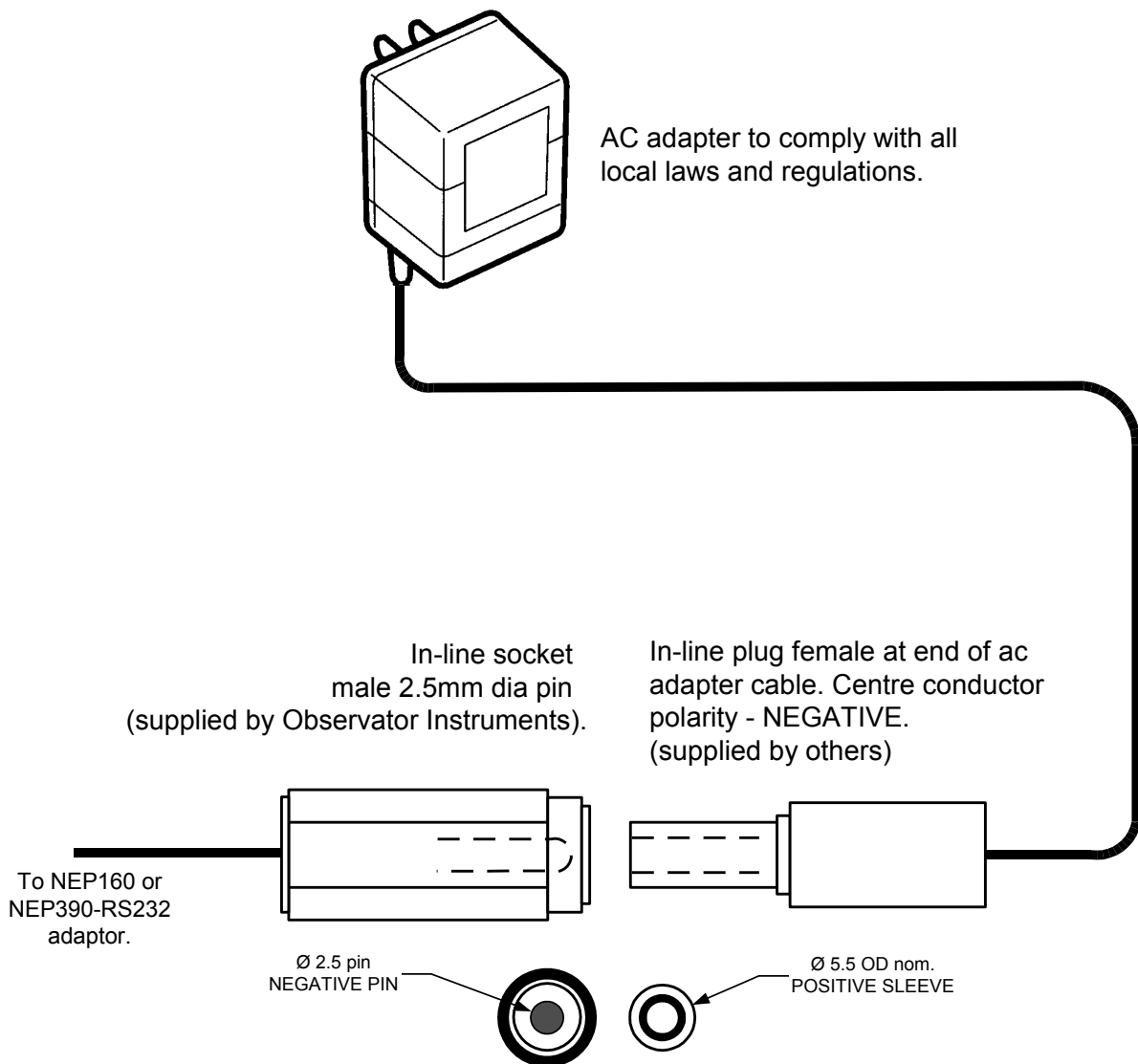
The ANALITE 390 series probe has been reprogrammed with the version of firmware embodied in the file **NEP390V###.exe**

All user set and calibration constants that have been saved using the RS232 save command earlier are retained during a firmware upgrade. Factory calibration constants are also retained.

AC Adapter Specifications

The AC adapter shall have the following specifications to ensure proper operation of the ANALITE NEP160 or NEP390 series probes (via the NEP390-RS232 adaptor) whenever it is powered by the AC adapter. Operation also includes the charging of the internal 6V NiMH battery assembly. The NEP160 ac adapter may be used with the NEP390-RS232.

Output voltage:	10Vdc (min) to 16Vdc (max) over output current range.
Output Current:	Not less than 400mA (100mA for NEP390/395) capacity. Output voltage must remain between 10Vdc and 16Vdc over current range 0 to 400mA (100mA for ANALITE 390 series probes).
Connection:	In-line plug female for 2.5mm centre pin (see drawing below).



Warranty

The ANALITE 390 series turbidity probes are warranted against defects in material and workmanship for one year from date of purchase. The warranty does not cover the wiper arm assembly, corrosion or leakage due to corrosion. Unauthorized service, tampering or abuse will void this warranty. Damage as a result of improper installation and care will also void this warranty.

Should you require service (under warranty or otherwise) please contact the Observer Instrument distributor from whom you purchased the probe, or our Service Centre. If the probe is being returned for service under warranty please supply proof of purchase.

Observer Instrument's Service Centre
8 Keith Campbell Court
Scoresby, VIC 3170
AUSTRALIA
Tel: (+61-3) 8706 5000, Fax: (+61-3) 8706 5049

Electrical Conformity

EC DECLARATION OF CONFORMITY ACCORDING TO COUNCIL DIRECTIVE 89/336/EEC

WE, MCVAN INSTRUMENTS PTY LTD, DECLARE UNDER OUR SOLE RESPONSIBILITY THAT THE PRODUCT:

ANALITE NEP390 SERIES OF TURBIDITY PROBES AND ACCESSORIES,

MANUFACTURED BY:

MCVAN INSTRUMENTS PTY LTD

TO WHICH THIS DECLARATION RELATES, ARE IN CONFORMITY WITH THE PROTECTION REQUIREMENTS OF COUNCIL DIRECTIVES 89/336/EEC ON THE APPROXIMATION OF THE LAWS RELATING TO ELECTROMAGNETIC COMPATIBILITY.

THIS DECLARATION OF CONFORMITY IS BASED UPON COMPLIANCE OF THE PRODUCT WITH THE FOLLOWING HARMONISED STANDARDS:

EMISSIONS: EN61000-6-3
IMMUNITY: EN61000-6-2

SIGNED BY:



JOHN VAN DE VREEDE – DIRECTOR

DATE OF ISSUE: 1 JULY 2003

PLACE OF ISSUE: MCVAN INSTRUMENTS PTY LTD
58 GEDDES STREET, MULGRAVE
VIC. 3170 AUSTRALIA



NOTES

NOTES:

ABN 56 007 283 963
8 - 10 Keith Campbell Court, PO Box 9039
Scoresby, VIC 3179 AUSTRALIA
Tel: +61 3 8706 5000; Fax: +61 3 8706 5049
Email: info.au@observator.com
Web: www.observator.com