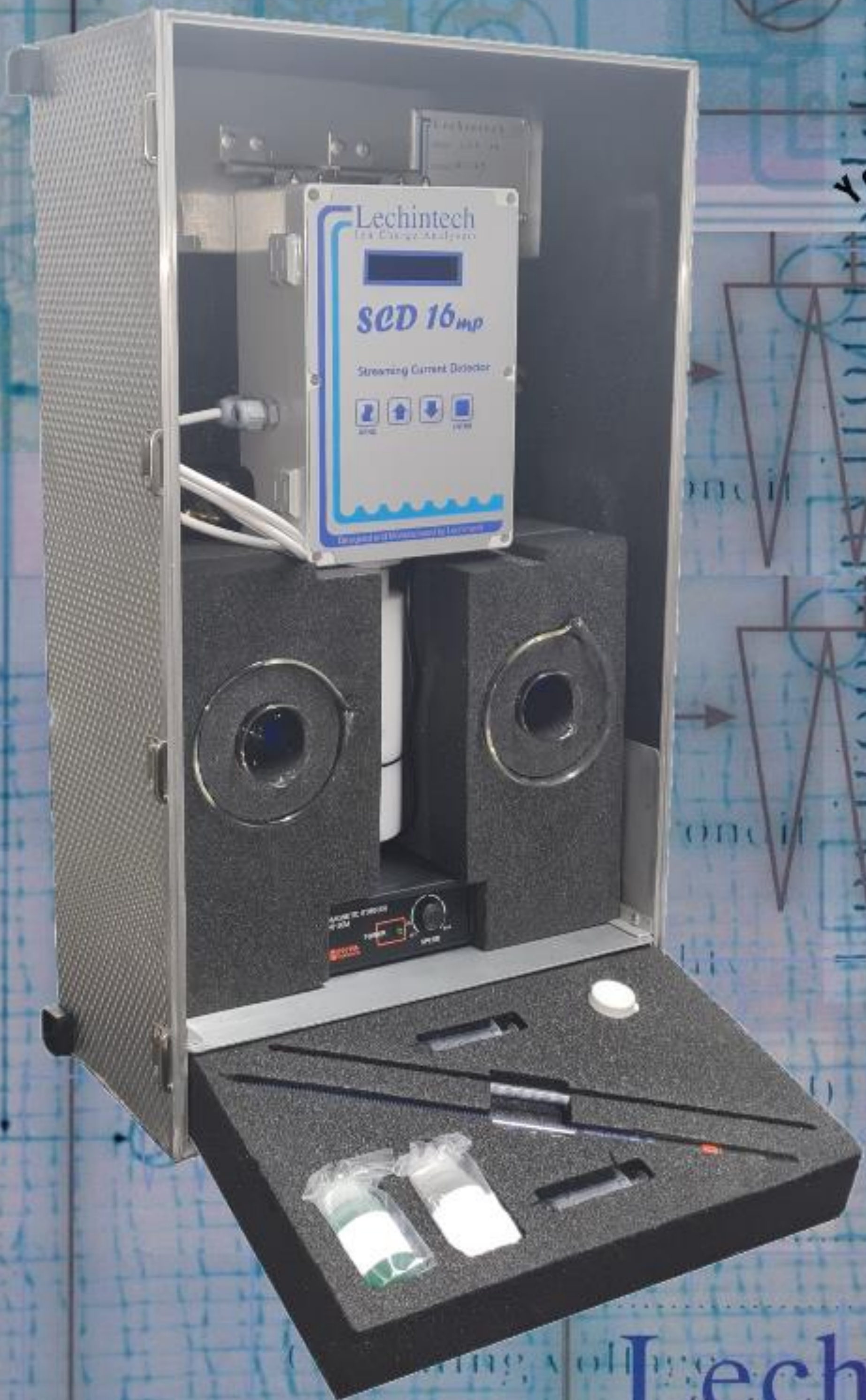
The Lechintech LDT 16mp



Your window on Colloidal Chemistry

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Lechintech

LDT 16mp LABORATORY DEMAND TITRATOR

OPERATING AND INSTRUCTION MANUAL

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Due to our policy of continuous improvement, we reserve the right to change or modify design without incurring any obligation to furnish or install such changes or modifications on products previously or subsequently sold.

1. INTRODUCTION

The Lechintech LDT 16mp (Laboratory Demand Titrator) is a self contained laboratory unit consisting of a SCD 16mp instrument and titration accessories for determining Cationic or Anionic demand of samples related to the water treatment and paper pulp industries. The SCD 16mp has been developed to indicate the state of the chemistry in water particulate suspensions. The chemistry of these systems can be monitored by measuring the surface charge of the suspended particles in the fluid medium. The instrument determines the surface charge of the suspension by the streaming current technique, whereby; a current is developed due to the potential induced between two electrodes by the forced movement of the charged particles past the electrodes.

The SCD 16mp instrument probe has been designed for use as a laboratory instrument, or as a splash proof field instrument either for the on line measurement and control of a system, or just system monitoring. The ion charge is displayed on a two-line 16-digit liquid crystal display, with two decimal accuracy.

The ion charge measured is available as a 4-20 mA output, allowing integration with most standard field instrumentation and recording.

The cost saving benefits are realized when confirming the chemical dose required for the actual plant process Cationic or Anionic demand.

1.1 *Symbols Used*

Warning: Instructions must be followed for personal safety. Injury may result if instructions not followed.

Caution Caution: Instructions must be followed for correct equipment operation. Damage may result if instructions not followed.

Note Note: Important features for correct operating procedure regarding equipment or a process.

1.2 Acronyms and Definitions Used

ICA – ion charge analyzer
LDT – laboratory demand titrator
SCD – streaming current detector (also known as, SCM – streaming current monitor)

ICu – ion charge units (Lechintech units of measurement)

NO – normally open (contact open when relay inactive)
NC – normally closed (contact closed when relay inactive)

2. WHAT IS CHARGE ANALYSIS?

Charge analysis is the measurement of the electro kinetic charge of a solution due to the presence of charged particles. The electrokinetic charge can be measured by a number of different methods.

2.1 *Applied Electric Field*

Measure: The relative mobility of the solid or liquid phase, e.g. Electrophoresis

This is the first method developed for calculating the Zeta potential. The motion of charged particles under the influence of an electric field was observed and the potential required to achieve certain particle mobility was measured. A cell consisting of two flat plates separated by approximately 0.1 mm and having an electrode at each end of this cell, as shown in Figure 1, is filled with water containing suspended matter. When an electrical potential is applied to the electrodes, the particles can be observed to drift towards one of the electrodes. This is confirmed by reversing the polarity of the electrodes and observing the reverse drift of the particles.

The speed of drift is measured, and from this, the Zeta potential can be calculated. It is effectively then, a measure of the charge on the particles observed.

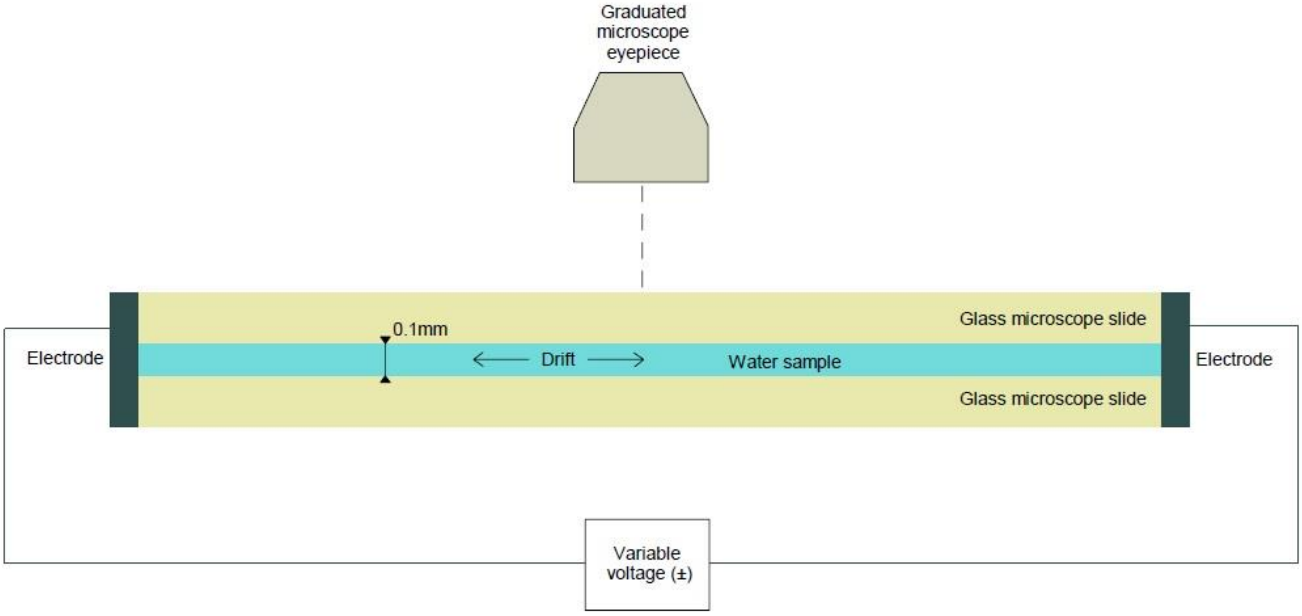


Figure 1: Measurement of Zeta potential using an applied electrical potential

2.2 Induced Electric Potential

Measure: The potential developed as a result of the forced movement of particles in the solution, e.g. Sedimentation potential or Streaming potential (used by Lechintech).

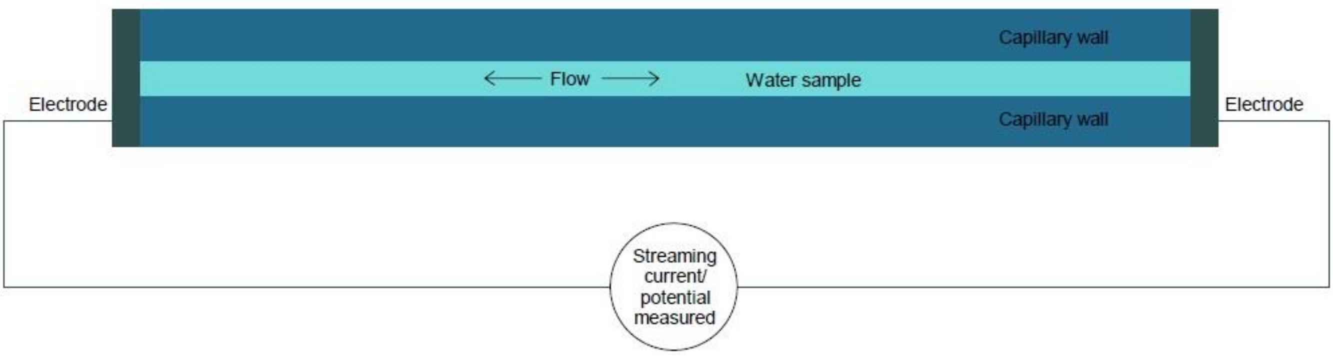


Figure 2: Measurement of Streaming current/potential using generated flow

3. THE LECHINTECH ION CHARGE ANALYSER

Just as a generator is to a motor, so the streaming current measurement is to the mobility of charged particles in the presence of an applied potential. The Lechintech streaming current detector works on the principle of generating a current by forcing a flow of charged particles between two electrodes.

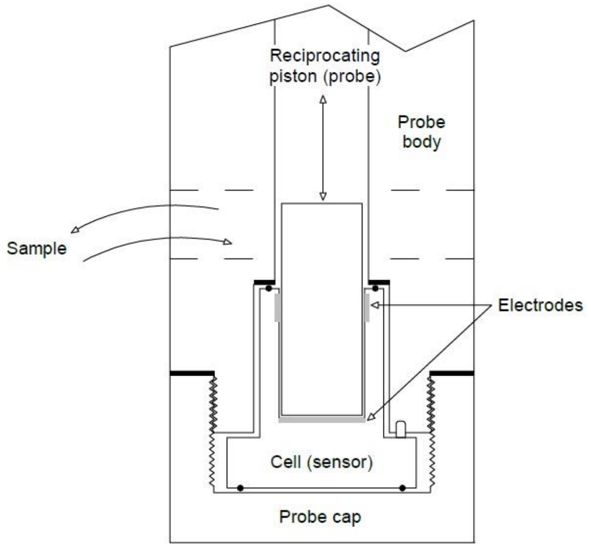
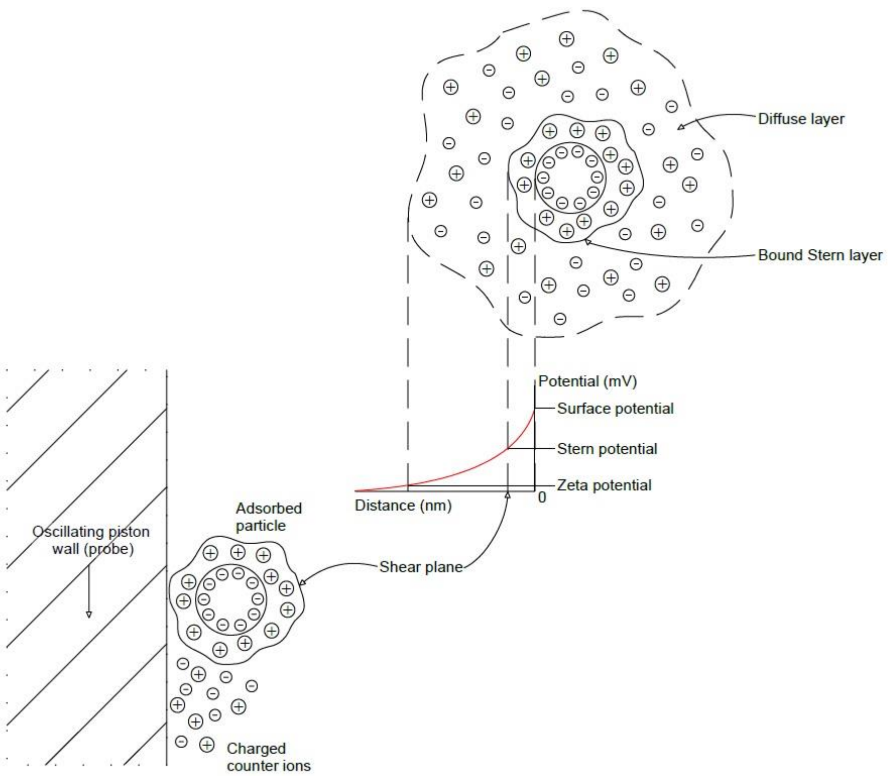


Figure 3 shows a schematic of the Lechintech streaming current detector. A continuous sample is directed into an annulus inside which a displacement piston, or probe, oscillates at a fixed frequency. The oscillating movement of the piston causes the liquid sample to flow along the wall of the cell.

Figure 3: The Lechintech Streaming Current Detector

Suspended particles are adsorbed onto the walls under the action of Van der Waal's and electrostatic forces, see Figure 4. As the sample is moved rapidly back and forth, mobile counter ions surrounding the charged particles, or colloids, are sheared near the surface of the particle and moved past the electrodes.



As potential difference is induced between two electrodes at the top and base of the cell. The resultant potential developed, proportional to charge is electronically processed to give a reading of the streaming current in ICu, ion charge units.

The streaming current detector has been calibrated so as to give a negative reading if the particles in suspension are negatively charged, and similarly a positive reading for a positively charged system. The greater the magnitude of the current, the higher the charge of the system being measured, and consequently the greater the mutual repulsion between the particles in the suspension.

Figure 4: Streaming Current Development

This fact is fundamental to the use of the instrument, as it allows the on-line measurement of the ionic charge of a water system, and decisions can be made as to the dosage required to maintain the best water quality.

4. DESCRIPTION OF THE LDT 16mp UNIT

The Lechintech Laboratory Demand Titrator (LDT) unit consists of the following;

a. Aluminum rigidized carry case
b. SCD 16mp ion charge analyser
c. Magnetic stirrer
d. Titration equipment and Cationic chemical standard

4.1 The Carry Case

The LDT 16mp carry case dimensions are 680mm high by 380mm wide 250mm deep.
The rigidised aluminium frame and panels with dust and moisture proof door seals and high density foam inserts allow for increased protection during storage and transport in the field.

The carry case has clip-in door hinges and recessed lockable catches. The carry case door may be unhinged and clipped in horizontally beneath the carry case for stability in the field.

Note	The LDT 16mp will require IEC Type M BS546 3-pin dual power socket for operation. Depending on the destination country the power socket installed may differ.

4.2 The SCD 16mp

The SCD 16mp instrument is mounted onto the carry case by swing hinges. The SCD 16mp can be unhinged by horizontal movement to release the hinge locating pins. The SCD 16mp requires 85 to 264 VAC single phase supply at 12 VA. The power cable is normally supplied with an IEC Type M BS546 3-pin plug.
For more detail on the SCD 16mp please see Section 5.

4.3 The Magnetic Stirrer

The magnetic stirrer with magnetic bead allows for agitation to keep the sample solution homogenous.
The designs are compact and have speed adjustment.
The magnetic stirrer requires 220 VAC single phase supply. The power cable is normally supplied with an IEC Type M BS546 3-pin plug. A 110 VAC option is available on request.
The Lechintech Mag. Stir was supplied with pre-2017 LDT 16mp models.
The Hanna Instruments HI 190M-2 magnetic stirrer is supplied with post-2017 LDT 16mp models.

4.4 The Titration Equipment

The measuring beakers are housed in the high density packing foam surrounding the SCD 16mp and the pipettes, syringes, magnetic bead and chemical bottles are seated in the foam tray at the bottom of the carry case.

- 2 of 100 ml low-form glass beakers
- 2 of 1000 ml low-form glass beakers
- 1 of 1 ml graduated glass pipette
- 1 of 10 ml graduated glass pipette
- 2 of 50 ml Polyethylene (PE) chemical bottles (Anionic and Cationic)
- 2 of 5 ml Polypropylene (PP) Luer slip syringes
- 1 of Polytetrafluoroethylene (PTFE) low friction coated leak proof magnetic bead

5. DESCRIPTION OF THE SCD

The Lechintech Streaming Current Detector (SCD) has three distinct parts;

e. The body that houses the cell and probe
f. The mechanical drive
g. The electronic pack

5.1 The Body

Caution The body has a removable cap, two rubber gaskets, a set of O-rings, and a cell and probe set. The cell contains two electrodes between which a potential is developed due to the motion of the probe in the cell interacting with the water and suspended matter. The frequency of the alternating signal is ± 4 Hz, and the AC signal is sent via the signal cable to the electronics pack. To completely remove the cell from the body, the cable must be disconnected from the terminals on the PCB and the cable pulled through the length of the body. To replace the cell the reverse procedure must be followed. When replacing the cell after opening the end cap, care must be taken to ensure that the locating pin is seated correctly so as not to kink or damage the signal cable. A further consideration is the correct location of the three O-rings and two flat seals before securing the cell in place, and ensuring that there is no moisture on the cell base and in the body cap. Due to the fine tolerance to which the cell and probe are machined, it is important to ensure that grit particles do not enter the cell area as this will accelerate wear. See Section 11 for further detail.

Caution The probe tip is removed by loosening it with the PVC spanner supplied with the replacement kit. The cell and the probe tip should be replaced as a set. To replace the probe tip, insert the tip into the PVC spanner and screw it firmly onto the probe shaft, making sure that it is not over tight (do not use any other tools for this job). The probe setting has been done in the workshop prior to dispatch. If the probe shaft and connecting rod are removed from the SCD then set the depth of the probe to protrude past the end of the body, using a straight edge, to a distance of approximately 1 mm. Replace the cell and cap. Turn the cam by hand to ensure that the probe does not bottom on the cell electrode; this will cause the mechanism to jam. If the probe does bottom out, remove the cap and cell and adjust by turning the probe in one turn. Assemble and check for free operation. The overall length of the probe and adjustment shaft should measure 196 mm. This length is set at the factory but can be adjusted by loosening the nut and screwing the rod into, or out of, the plastic probe section. Ensure that new tab washers are used if adjustments are made and that the locking nut is tightened and secured if an adjustment is made. See Section 11 for further detail.

Replacement of the cell and probe is necessary when either one or both of these parts show extreme scoring, or when the span calculation fails when the unit is calibrated in standard positive calibration solution.

5.2 The Drive Mechanism

The drive mechanism includes a 12 VDC motor and gearbox combination, a mounting bracket and a cam and follower assembly. Mounted on a bracket are the motor and cam adjustment screws. On the sensor card (which is secured to the stainless steel device plate), is mounted a photo interrupter which is activated by the slotted wheel at the end of the cam.
The signal derived from this mechanism is used for:

a. The logic part of the instrument that actuates the motor trip relay when the signal is less than 2 Hz.
b. The sample trigger circuit used in the signal generation.

The motor speed is adjusted automatically by the microprocessor based speed control program. The motor direction of rotation must be anticlockwise for the equipment to function correctly. To change motor direction, reverse the polarity of the motor leads at the mascon plug on the motor board. The cam is pressed onto the gearbox drive shaft and located by means of a 4 mm grub screw. The slotted detector plate has been set at the factory and should not be moved under any circumstances. The probe connecting rod is screwed into the bottom of the cam follower and tightened into place by a lock nut and tab washer. A small amount of silicone grease can be used to lubricate the cam and follower and the lips of the probe connecting rod seal. See Section 11 for further detail.

5.3 The Electronics Pack

The electronics pack is made up of the motherboard and the display board. This, along with the mechanical drive section is mounted into an ABS enclosure, which is splash proof, with IP 53 rating. The digital display and function keys are mounted onto the hinged front cover of the instrument. The side of the box is provided with two cable glands, for the power and signal connections to the motherboard terminals via a Lechintech terminal box with IP68 cable connectors.

Electrical connections are shown in Section 6.4 of this manual.

5.4 Manufacturer and Distributors

Company:

South Africa:
Lechintech (Pty) Ltd, Reg. No. 2014/218640/07
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6. SPECIFICATIONS AND SAFETY NOTES

6.1 Technical and Material Specification

Measuring Sensor:	Lechintech Ion Charge Analyser model SCD 16mp.
	Resolution: 14 bit (13 bit + sign) for Ion Charge range -5.00 ICu to + 5.00 ICu.
	Accuracy: Ion Charge ± 0.1 ICu, Cationic Demand (ppm) ± 1 %
	Response Time: 2 to 5 seconds dependent on sample. Stabilization of readings can take up to 1 minute in some samples.
Power Supply:	SCD 16mp – 85-264 VAC, 47-63 Hz at 12 VA, additional feature 24 VDC, fused 1 A. A solid earth connection is essential.
	Magnetic Stirrer – 220 VAC, 50 Hz. 110 VAC, 60 Hz available on request.
Signal Outputs:	SCD 16mp – O/P – Ion Charge analogue 4-20 mA output, 12bit D/A resolution, scaled process value dependent on span setting, default setting -5.00 ICu to +5.00 ICu.
	SCD 16mp – TRIP – Trip relay output, normally open (NO) contact 250 VAC, 2 A rating, Contact - closed when SCD motor running, open when SCD motor stalled or fault.
Signal Input:	SCD 16mp – CAL – Calibrate digital input, 5 VDC sense voltage, requires potential free contact. Input – ON, perform automatic calibration. Requires automation of calibration procedure.
Indication and Controls:	SCD 16mp – LCD, 2-line, 16-digit, backlit.
	SCD 16mp – Keypad, 4 buttons, Menu, Increment, Decrement and Enter.
	SCD 16mp – Electronics, LCD and keypad ABS enclosure IP53 rated.
Probe:	SCD 16mp – Immersible to depth of 120 mm in sample.
	SCD 16mp – Material HDPE and POM.
	SCD 16mp – Wetted materials - HDPE, POM, Stainless Steel, Neoprene, ABS.

Dimensions:	SCD 16mp dimensions – 445 mm height x 160 mm width x 100 mm depth.
Weight:	SCD 16mp complete unit – 4.5 kg.
Magnetic Stirrer:	Compact ABS magnetic stirrer with speed adjustment. Speed range 100 rpm (minimum) to 1000 rpm (maximum). Maximum stirring capacity is 1 litre.
Equipment:	2 x 100 ml low-form glass beakers 2 x 1000 ml low-form glass beakers 1 x 1 ml graduated glass pipette 1 x 10 ml graduated glass pipette 2 x 50 ml Polyethylene (PE) chemical bottles (Anionic and Cationic) 2 x 5 ml Polypropylene (PP) Luer slip syringes 1 x 1 of Polytetrafluoroethylene (PTFE) low friction coated leak proof magnetic bead
Case/Enclosure:	Carry Case – Rigidised Aluminum with dust and moisture proof seals on door/lid, clip in hinges and recessed lockable catches. High density foam packaging. Case not IP rated. Pull out handle and wheel accessories available on request.
	SCD 16mp – ABS material, IP53.
	Magnetic Stirrer – ABS material, IP51.
Overall Dimensions:	LDT 16mp – 380 mm W x 680 mm H x 250 mm D.
Overall Weight:	LDT 16mp – 15 kg
Guarantee Period:	1 year for instruments.

Note All specifications subject to change without prior notice.

6.2 Safety Schedule

Do not undertake any work or maintenance on this equipment if you are not qualified or trained to do so. Use only specified components to carry out repairs and maintenance.

1. The mains power point and possibly the alarm contact connector are supplied from voltage sources external to the instrument. Consider all terminals live until all sources of supply have been disconnected.
   a. Isolate the incoming power by switching the instrument off and removing the plug from the socket.
   b. With the SCD open check there is no external supply to the alarm contact connectors.

2. Before removing the securing screws and front covers from the SCD, ensure the supply has been isolated. This is necessary to ensure the rotating cam and follower is stationary and cannot start whilst working in the instrument. The rotating cam should be considered a hazard if operating without the front cover in place.

3. DO NOT allow the SCD to run in an upside-down position. Possible ingress of moisture into the electronics could cause a risk of electric shock as well as damage to the electronics.

4. Only remove the front cover from the SCD to carry out routine instrument calibration. (Removing the cover allows for access to output connections to facilitate measurement of the mA signals for calibration purposes). Replace the cover securely before placing the instrument into service.

5. When carrying out routine maintenance and cleaning of the SCD adhere to all safety rules and conditions applicable to the work being carried out. Use components for replacement supplied by Lechintech only. When cleaning scale from the instrument sensor and body using the mild HCI or NaOH (3 – 5 % concentration) solutions described in the manual, strict adherence to standard safety precautions is required.

6.3 Environmental Operating Limits

1. Ambient Temperature 0 °C to 40 °C
2. Sample Temperature 5 °C to 60 °C
3. Maximum Humidity 90 %
4. SCD 16mp – IP53 Rating
5. Magnetic Stirrer – IP51 Rating

Note To ensure that no moisture enters the cell electrode connections, the O-rings and flat seals should be changed every six months or if they are deformed or damaged.

6.4 Electrical Installation

Power supply and signal connections to be made to terminals provided on the SCD motherboard or to Lechintech terminal box (if supplied) as in Figure 5 below.

Take care to provide a good earth connection to the unit to minimize the effect of 50 Hz interference. This is normally provided with the 220V/110V input, if fed off a mains three-pin connection. It is recommended to utilize a clean instrument power supply, UPS supply or the installation of an inline mains filter for the unit

If any external devices are connected to the 4-20 mA output from the unit, e.g. recorders, controllers, the total loop resistance should not exceed 500 Ohms. Also, the current input circuits of any externally connected devices must be floating with respect to that of the unit's earth. We would recommend the use of signal isolators between the instrument output and the plant DCS or recording device.

Cable entry glands are provided on the side of the box (size PG9).

Note	Unused glands must be plugged to maintain the splash proof rating of the box.

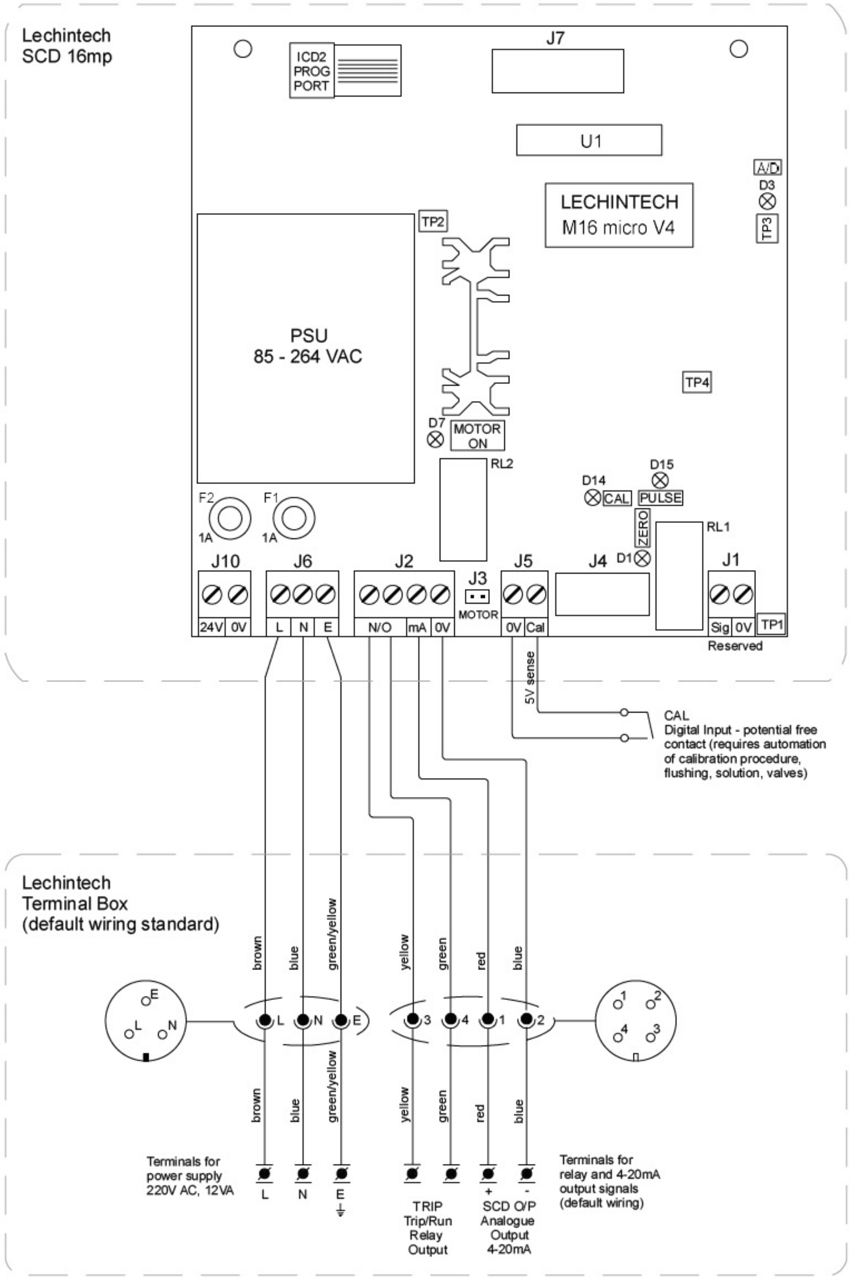


Figure 5: SCD 16mp PCB and Terminal Box electrical connections

7. CALIBRATION AND TEST PROCEDURES

7.1 Chemical Calibration

Calibration should be carried out on a regular basis, depending upon the application, using a standard commercially available cationic polymer.

The initial laboratory calibration has been carried out before the unit has left our works, and therefore only a routine calibration check should be necessary. Every SCD 16mp leaving the Lechintech factory is calibrated to give a reading of + 5.30 ICu when placed in a 100 ppm (100 mg/litre) of a standard cationic polymer X. A 100 ppm solution represents a saturated solution of the chemical as shown in Figure 6.
The charge curve flattens out as the concentration of polymer is increased and a charge reading of + 5.30 ICu is recorded.

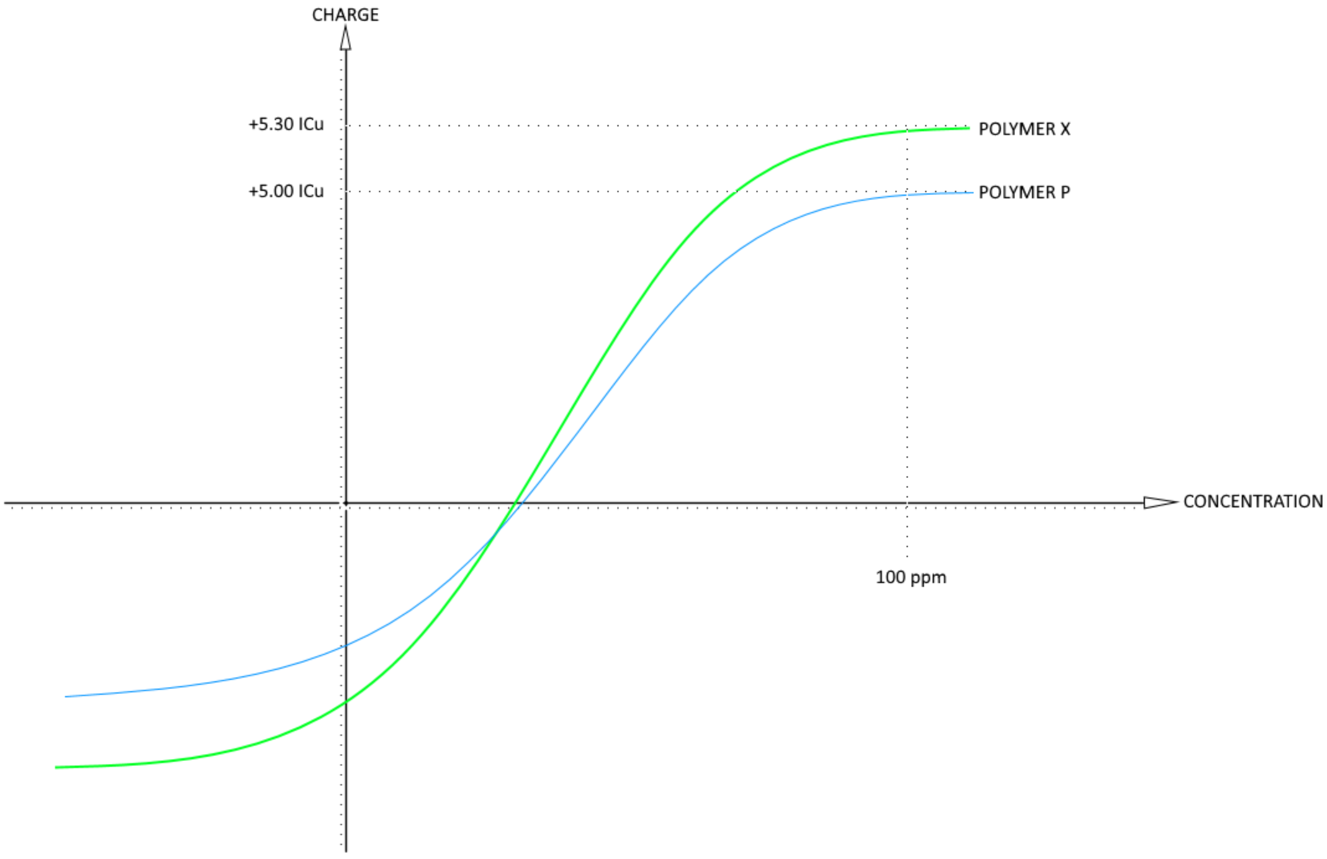


Figure 6: Characteristic charge vs chemical concentration curves for Polymer X and Polymer P

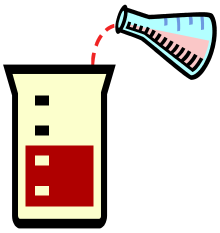
Any other cationic polymer may be used to calibrate the SCD, however its characteristic charge/chemical concentration curve will be different. It is necessary to standardize the polymer against Polymer X (used in the Lechintech laboratory) by determining the charge reading for a 100 ppm solution. This charge value can be established by comparison and the reading obtained can be used as the cationic standard for further calibrations, e.g. 100 ppm of Polymer P has a standard charge of + 5.00 ICu. Should the situation arise that there is no cationic standard of known strength available to standardize a given cationic chemical, an acceptable alternative would be to make up a 100 ppm solution of the chemical and calibrate the charge analyzer to read + 5.00 ICu. All readings after this will be relevant to this initial cationic standard used as the calibration agent.

Calibration Solution: This is a 100 ppm solution of the proposed cationic polymer, made up by placing 100 mg of chemical in 1 liter of tap water.

Note	The solution should be allowed to stand for one hour after preparing before use, to allow the chemical to activate, otherwise unstable readings may result, due to a non-homogeneous mixture.

1. Add 1ml cationic standard to 1 litre of distilled/potable water and mix well for 2 to 3 minutes.

2. Now add 100 ml of the solution to 900 ml of distilled water and mix well.
Allow the solution to stand for one hour before calibrating the SCD.

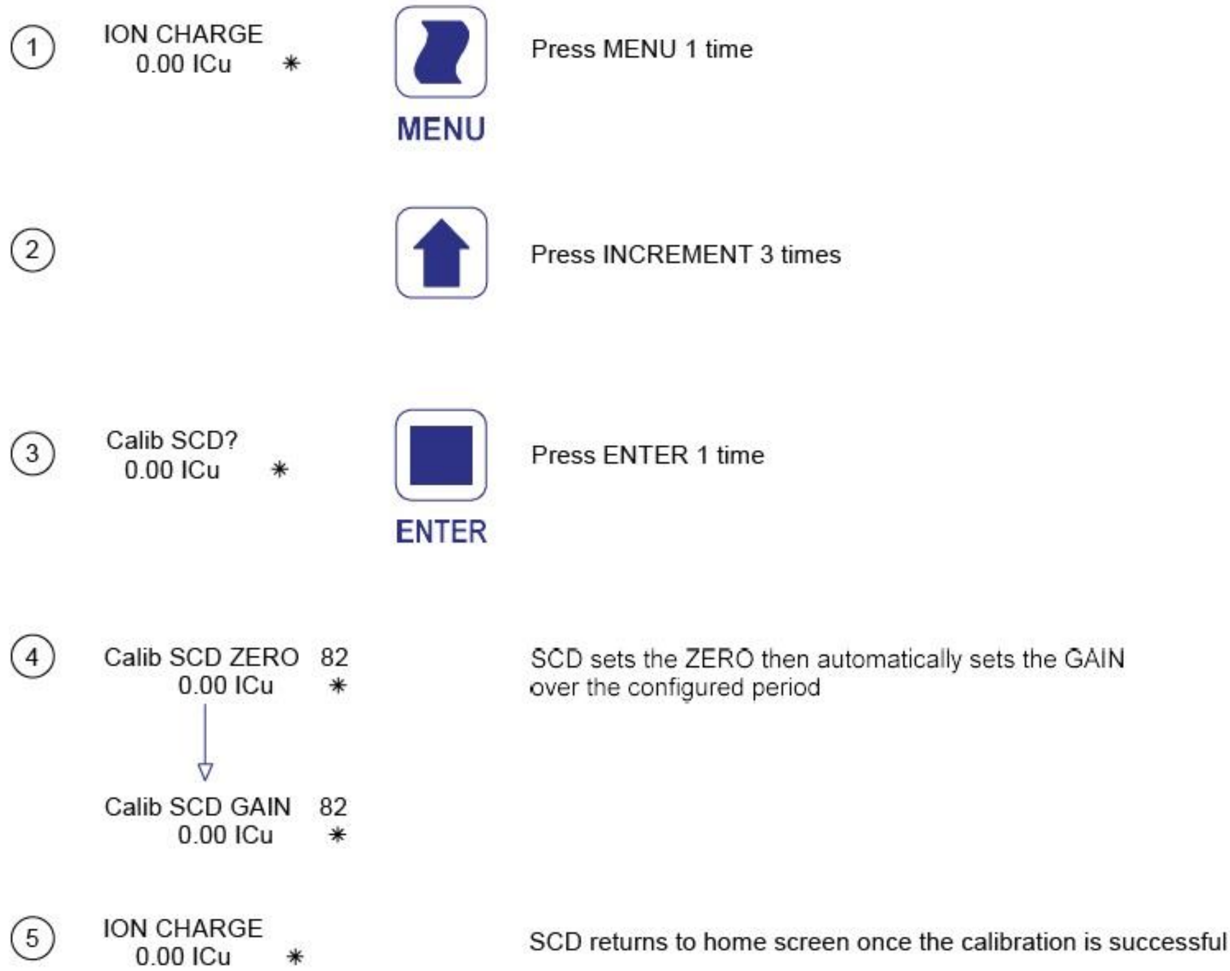


3. Rinse the SCD 16mp probe in tap water prior to immersing in the first beaker of calibration solution (500 ml).

4. Allow the ICu reading to stabilize in the calibration solution.
Replace the 500 ml of solution with a fresh 500 ml of 100 ppm cationic calibration solution.
Allow the ICu reading to stabilize, and using the menu prompts, calibrate the instrument.
Rinse the SCD 16mp probe in fresh water once the calibration routine has been completed and reinstate in plant operation.

7.2 Calibration Procedure

1. Rinse the SCD 16mp probe out with fresh water.
2. Run the SCD 16mp in a beaker of fresh water for a short period (two to three minutes).
3. Place the SCD 16mp in a beaker of calibration solution and allow to stand for one minute.
4. Place the SCD 16mp in a fresh calibration solution and allow the ICu reading to stabilize.
5. Using the menu prompts, initiate the calibration of the SCD 16mp from the keypad.



6. When the calibration is complete, rinse the probe in fresh water.

7.3 SCD 16mp Calibration Details

An auto calibration facility is provided for on the SCD 16mp and may be initialized locally from the menu system via the keypad and LCD display or remotely by momentarily shorting J5 terminals, 0V and Cal as shown in Figure 5.
It is important to set the calibration reference equal to the calibration solution used (or the output value of the portable calibrator) prior to calibration. Once calibration has been initialized, the microcontroller will carry out the following calibration sequence:

1. Activate auto zero relay, RL1 (Figure 5). The LCD display will indicate Calib SCD Zero 80 on the top line. The value on the right is a countdown timer for the calibration time. This timer is required to allow for the response of the low pass signal filter. The calibration time is measurable but is limited to a minimum of the filter time constant (FTC) value x 8. The Calib Time and SCD FilterTC parameters are set in units of 250ms.
2. Once the timer has elapsed the micro controller will calculate the required zero offset value of the SCD 16mp input signal and save it in EEPROM as the parameter SCD Offset.
3. De-activate the zero relay and start the gain calibration. The LCD will indicate Calib SCD Gain 80 on the top line. The calibration timer will count down again after which the gain required to obtain a value equal to the calibration reference is calculated and saved in EEPROM as the parameter SCD Gain.
4. The LCD display top line will clear and display ION CHARGE if the calibration was successful. If the calibration failed due to excessive gain, the SCD motor will stop and the error message Calib FAILED will be displayed. If the calibration fails the gain will not be saved in EEPROM, which will allow the SCD unit to be restarted with the previously saved gain value.

Caution The SCD Gain and SCD Offset parameters may be viewed and modified in the configuration mode. However, care should be exercised in modification of these parameters as they directly affect the calibration of the SCD!

Zero SCD: An auto zero facility is provided to zero the SCD 16mp ICu signal. This function is only available locally from the menu. The SCD 16mp will automatically zero the ICu signal on power restart or system reset.

7.4 Analogue Output Calibration

The analogue output signal may be calibrated by viewing and modifying the mA signal digital to analogue converter (DAC) values directly from the menu system via the LCD display and keypad. The parameters Calib 4mA and Calib 20mA are used for calibration of the output signal. The DAC has 12 bit resolution, where values are set between 0 and 4095.

When Calib 4mA is selected from the menu, its digital value may be increased or decreased using the INC and DEC buttons while the mA analogue output is measured across J2 terminals, mA and 0V (Figure 5) or in series with dosing control system connection, with a multimeter. Once the 4mA output has been calibrated, the keypad ENTER button is pressed to save the parameter in EEPROM.

The Calib 20mA parameter is calibrated/set similarly to the 4mA calibration.

Zeroing the SCD 16mp should give 12 mA across J2 terminals, mA and 0V (Figure 5) for confirmation of linearity.

7.5 SCD 16mp Configuration Mode

Configuration mode is activated by pressing the MENU keypad button while holding down/in the INC and DEC keypad buttons. A “C” will be displayed in the leftmost position of the bottom line of the LCD.

Table 1: Configuration mode allows the following parameters to be viewed and modified

Item	Parameter	Default	Unit	Range	Read/ Write	Description
1	Calib 4mA	39		0 to 4095	R/W	Ion charge measurement DAC value for 4mA output
2	Calib 20mA	3708		0 to 4095	R/W	Ion charge measurement DAC value for 20mA output
3	ZERO SCD					Auto Zero sequence
4	Calib SCD					Auto Calibration sequence
5	Calib Ref	+5.30	ICu	-10.00 to 10.00	R/W	Ion charge calibration reference for cationic 100mg/l solution
6	SpdCon O/P	1035*		0 to 4095	R	Output of motor speed controller
7	SpdCon SP	131		1 to 255	R/W	Motor speed controller setpoint
8	SpdCon Gain	30		1 to 255	R/W	Motor speed controller gain
9	SCD Offset	-16*		-10000 to 10000	R/W	SCD input signal offset
10	SCD Gain	836*		0 to 10000	R/W	SCD input signal gain
11	SCD Max Gain	10000		0 to 32767	R/W	Maximum allowed SCD gain
12	SCD O/P Max	+5.00	ICu	0 to 10.00	R/W	SCD signal corresponding to 20mA.
13	SCD Filter TC (FTC)	10	250ms	0 to 255	R/W	Time constant of input low pass filter
14	Calib Time	84	250ms	FTC x 8 to 255	R/W	Calibration timer
15	Stall Time	12	250ms	1 to 255	R/W	Motor stall monitor time
16	Set mA limit	0.20	mA	0 to 1	R/W	Analogue output mA over/under limit e.g. analogue output mA limited at 20.2mA maximum and 3.8mA minimum for 0.20mA setting

Note * These parameter values are determined by the SCD 16mp mechanical and electrical components.

Note In normal mode only the first 5 parameters are visible. Normal mode is entered by pushing the MENU button only. See Appendix C for further detail.

7.6 SCD 16mp Motor Speed Control

The microcontroller controls the measuring cell motor speed by adjusting the motor voltage via a 12 bit DAC and a LM317 voltage regulator. The motor speed is derived from the chopper plate pulses. The motor speed control setpoint is adjustable via the keypad and LCD display. The number displayed is a scaled number between 0 and 255. The factory default is 131, which equates to a motor speed of 240rpm.

To optimize motor load regulation a potentiometer P2 is provided between the DAC output and the adjust pin of the LM317. P2 is adjusted such that the DAC output is near its lower limit under no load conditions. A utility is provided on the LCD display to view the 12 bit DAC value, which is the speed controller output. The electrical output range of the DAC is between 0.6 and 4.4 V, which equates to a DAC value range of 0 to 4095. A typical value for P2 adjustment is 1035.

The microcontroller monitors the motor speed and provides a stall projection function.
There are two stall modes -

a. Sudden total stall i.e. motor or probe and cell jammed
b. Motor under speed i.e. electrical fault or mechanical wear/friction

A stall time parameter determines the time in 250 ms units to trip the motor control circuit.
Motor under speed is determined by accumulating the speed error and tripping the motor control circuit once this has exceeded a value equal to the stall time parameter x 250 ms.
The factory default for the stall time parameter is 12.

8. OPERATIONAL AND MAINTENANCE CHECKS

8.1 Weekly Checks Include:

1. Isolate the instrument.
2. Remove the SCD 16mp from the carry case and wipe down/rinse the probe body with tap water.
3. Replace the SCD 16mp in the carry case.
4. Check zero and perform chemical calibration if necessary as discussed under Section 7.2 and 7.3 of this manual.

8.2 Monthly Checks Include:

1. Isolate the instrument and remove it to a stable work surface.
   Remove the instrument front cover and open the face (quarter turn screws).
2. Check for play on the gearbox output shaft by gently moving the cam and follower up and down.
   Maximum play should be movement of about 1 mm at the end of the cam. Replace the motor/gearbox combination should the wear be excessive.
3. Rotate the cam by turning on the slotted wheel, the probe shaft will oscillate up and down. The rotation should be smooth with no tight/friction spots. Uneven wear of the cam or follower will require replacing the cam and follower set.

8.3 Biannual Checks Include:

Six monthly maintenance includes a complete mechanical service and electronic and chemical calibration. All worn parts to be replaced as necessary. The servicing should only be carried out by trained technicians.

A service includes the following:
1. Strip and clean SCD 16mp probe body, probe and sensor cell – Section 11.
2. Replace O-rings and gaskets in probe body – Section 11.
3. Replace probe shaft seal and grease – Section 11.
4. Strip motor gearbox and oil – Section 11.
5. Reassemble SCD 16mp and perform chemical calibration – Section 7.
   The chemical calibration results can determine if the cell and probe require replacement.
6. Perform electronic calibration of analogue output (4-20 mA) – Section 7.

9. TROUBLESHOOTING

9.1 SCD 16mp

Table 2: Troubleshooting the SCD 16mp

Problem	Cause	Solution
"–" "+" "✳" symbols not changing on LCD display	Cell blocked Motor trip Motor burnt out Motor speed low Cam jammed Failed optic sensor card	Clean out cell Press rear enclosure door reset button Call instruments department Factory inspection required Call instruments department Call instruments department
LCD not working	Power off Unit trip Damaged (water?)	Switch power on Power down, power up Call instruments department
Motor will not reset	Electronic card failure Motor burnt out Gearbox seized Relay stuck	Factory inspection required Call instruments department Call instruments department Call instruments department
Calibration failed	Calibration solution not prepared correctly or cationic polymer used has diminished strength Worn probe and/or cell sensor gain outside allowed limit values	Remake calibration solution Replace probe and/or cell sensor
SCD diminished sensitivity	Worn probe and/or cell sensor Motor speed low	Replace probe and/or cell sensor Call instruments department

9.2 Sample

Table 3: Troubleshooting sample issues

Problem	Cause	Solution
SCD diminished sensitivity	No sample or sample level not covering probe port	Use more sample, 500 ml volume should be sufficient. Volume required will depend size of sample beaker used
High wear on cell and probe	Sediment or grit entering probe port	Filter sample with 200 µm screen (wire or metal mesh)

10. DETERMINING CATIONIC DEMAND

10.1 Setting up the Laboratory Demand Titrator Unit

1. Release the catches and remove the door/lid.
2. For greater stability when operating in the field without laboratory facilities, the lid can be used as a support base for the unit. The carry case can be fastened to the lid using the clips located on the carry case base.
3. Remove the foam packing from around the SCD 16mp and magnetic stirrer.
4. The unit is now free for operation. The SCD 16mp is mounted by detachable hinges. Hence it can be removed for cleaning or utilized in on-line applications should the requirement arise.
5. After use, dry out the SCD 16mp probe body with an absorbent towel. Clean and dry the used equipment (e.g. beakers). Repack the equipment back into the foam inserts or foam tray and replace inside the carry case.

Note The LDT 16mp will require IEC Type M BS546 3-pin dual power 220 VAC socket for operation. Depending on the destination country the power socket installed and voltage may differ.

10.2 Using the Laboratory Demand Titrator Unit

This section gives some helpful guidelines for carrying out titrations. Regarding the paper pulp industry, extensive research has shown that the charge of the fines in a fibre system is representative of the entire system. Fibre fines originate from the cell walls of the fibre and as such the potential determining surface of the fibre fines is similar to the surface of the fibre [1].

Caution The SCD 16mp will be damaged if it is placed in a sample where the particulate size is too large. The maximum particle size for water suspensions of silt, sand and clay is 100 µm. Pulp fibre suspensions should be filtered through a 200 µm screen (wire or metal screen, not filter paper).

Note The Anionic demand would be determined in exactly the same manner as outlined here; only using an Anionic titrant instead.

1. Check the consistency of the sample is not greater than 1%.

$$Total\ Consistency\ (\%) = \frac{Dry\ weight\ of\ sample}{Total\ weight\ of\ sample} \times 100\ \%$$

$$Consistency\ Units: 1\ \%\ Cs = 10\ {}^{g}/_{l} \quad [2]$$

If the consistency is greater than 1 %, it should be filtered through 200 µm screen. A titration can now be done on the filtrate or white water sample to determine the amount of a given Cationic chemical required to neutralize the sample charge to zero.

2. Place 500 ml of the sample in a beaker.

3. Hinge the SCD 16mp forward and place the probe body inside the beaker of sample. Hinge the SCD 16mp backwards with the beaker until vertical, allowing the beaker to stand on top of the magnetic stirrer.

4. Place the magnetic bead inside the sample and run the stirrer to provide agitation throughout the titration.

5. A fixed volume of a known concentration of chemical titrant is added to the 500ml sample. Each time this volume (aliquot) of titrant is added the concentration (ppm) of the chemical in the sample increases by a fixed amount.

6. Prepare a titrant using the Cationic chemical to be used as the standard. The concentration of the titrant depends on the required increase in Cationic demand for each aliquot of titrant added.

   Table 3: Titrant guidelines for Cationic demand ranges

Guidelines for titration measuring range dependant on titrant chemical concentration						
Titration Concentration	**Titrant Aliquot**	**Resolution per Aliquot**	**Sample Volume**	**Cationic Demand Range**	**Maximum**	**Minimum**
250 ppm	2 ml	1 ppm	500 ml	Very low	20	0
2500 ppm	1 ml	5 ppm	500 ml	Low	75	0
2500 ppm	2 ml	10 ppm	500 ml	Medium	300	0
10000 ppm	1 ml	20 ppm	500 ml	High	750	0

7. It is suggested that for each titrant aliquot added to the 500 ml sample, 2 ml volume be titrated using the graduated pipette. A rough titration can be done using the syringe to add each aliquot.

8. The titration is carried out until the required charge end point is reached on the SCD 16mp. Usually a zero charge end point.

9. The Cationic demand curve can then be plotted and compared to the initial charge on the SCD 16mp at zero titration.

10. Contamination of titrant chemicals and samples <u>must</u> be avoided.

11. The SCD 16mp probed body should be rinsed in clean water before titrating the next sample.

12. It is good to condition the SCD 16mp probe body (measurement) by running it in some sample prior to carrying out the actual titration.

Note The increase in concentration of chemical in a sample after each aliquot is dependent on the volume of the sample, the volume of the aliquots added and titrant concentration.

For example:

a. For a 500ml sample, a 20 ppm increase in Cationic concentration could be effected by adding a 1 ml aliquot of 10000 ppm titrant solution.

b. For a 500ml sample, a 1 ppm increase in Cationic concentration could be effected by adding a 1 ml aliquot of 500 ppm titrant solution.

11. MODEL SCD 16mp SERVICE PROCEDURE

The requirements and procedure for a standard SCD 16mp service is described here.

11.1 Requirements

1. Instrument screwdriver 3 mm flat
2. Instrument screwdriver 3 mm Philips
3. Lechintech PVC probe installation tool
4. Spanners 5.5 mm, 7 mm and 10 mm
5. Allen keys, 2 mm and 4 mm
6. Long nose pliers
7. Cell and probe set (new)
8. Shaft seal (new)
9. Set of three O-rings (new)
10. Set of two gaskets (new)
11. Cleaning brushes, cleaning agents (mild)
12. Hydraulic oil (for motor gearbox)

11.2 Disassembly

The SCD 16mp needs to be stripped before any servicing is conducted.

1. Disconnect the 220 VAC power and SIGNAL cables from the Terminal Box or remove the cables from the SCD 16mp enclosure if no Terminal Box installed.

2. Remove the instrument from the carry case and conduct the rest of the procedure on a stable work surface.

3. Open the front cover of the unit by turning the six quarter-turn screws anti-clockwise.

4. Disconnect the cell sensor signal cable from the SCD 16mp PCB, J1 terminals, SIG (brown) and 0V (white), Figure 5.

5. Unplug the 10-way ribbon cable from the optic sensor board mounted on the vertical device plate. Loosen the 3 mm wing nut and remove the optic sensor board.

6. Unscrew the body cap from SCD 16mp probe body and pull out cell, completely removing the signal cable from the body.

7. Within the instrument casing, straighten the tab washer locking the M6 nut, which is located on the underside of the cam follower (the 6mm stainless steel shaft is connected to the cam follower).
   Loosen the M6 nut using a 10 mm spanner.

8. Fit the Lechintech supplied PVC probe tool over the probe tip and turn anti-clockwise to unscrew the probe shaft from the cam follower and remove the M6 nut.
   This will now allow the probe tip, together with the probe shaft, to be removed from the probe body.

9. There are six M3 screws holding the probe body to the ABS box. Four of these screws also hold the motor bracket in place. Remove these screws using a 5.5 mm spanner.

10. Disassembly now allows for the cleaning of the probe body, cell and probe, as well as access to the motor and gearbox for inspection and cleaning.

11.3 Motor and Gearbox

1. Check the drive chain and cam and follower for wear. Check for play on the gearbox output shaft by gently moving the cam up and down. Maximum play should be movement of about 1 mm at the end of the cam. Replace the motor/gearbox combination should the wear be excessive.

2. Rotate the cam by turning on the slotted wheel. The rotation should be smooth with no tight spots. The following reasons could be the cause of tight spots in the rotation:
   a. Motor or gearbox component wear or failure - Replace the motor/gearbox unit.
   b. Uneven wear of the cam or follower – Replace the cam and follower set.

3. If the motor and gearbox combination is in good condition, then only the gearbox needs servicing. To do this, remove the cam and follower by loosening the 4 mm grub screw holding the cam onto the motor shaft.

   Caution Do not loosen or unscrew the 4 mm Allen key bolt holding the chopper plate on the end of the cam. The position of the two parts are calibrated in the factory at synchronization of the sinusoidal measurement peak and the chopper plate trigger of the optic sensor.

   Remove the black gearbox cover by loosening the four M3 screws. Flush the gearbox with degreaser or thinners and dry with a lint free cloth or tissue paper. Once dry, recoat the surface of the gears with light general-purpose oil and ensure that the complete unit is running freely.

4. Reinstate the drive mechanism to normal state. Ensure that the cam adjustment screws are not binding on the follower. The adjustment of the runner's screws is made by loosening the M4 lock nut and adjusting the length of the screw, then retighten lock nut. The above can only be done when the SCD 16mp is completely reassembled.

11.4 Cell and Probe

1. Clean the probe body and cap with a suitable light abrasive cloth/pad and soap solution. Use a bottlebrush to clean the inside recesses of the probe body. In severe cases a mild acid solution is required (remember the necessary safety precautions when using chemical cleaners). The probe body should then be rinsed thoroughly in clean water and then dried.

2. Use the Lechintech PVC probe tool to unscrew the probe tip from the probe shaft. Clean the probe tip of any build up but do not use anything to scrape off any residue as this will damage it. Rinse the probe thoroughly after cleaning

3. The inside of the sensor cell can be cleaned using a thin bottlebrush. Pay careful attention to the stainless steel electrodes. These must be free of tarnish. Rinse the cell after cleaning.

Note During a service the sensor cell and probe tip may require replacement as determined by damage from wear and tear and/or by calibration failure.

4. Replace the two O-rings on the cell sensor, the two flat gaskets on the probe body and the single O-ring on the probe cap.

5. Replace the shaft seal located at the top of the probe body and add a light instrument grease to the inside of the shaft seal.

6. Use the Lechintech PVC probe tool to refit the probe tip onto the probe shaft. Finger tighten only.

11.5 Reassembly

1. Position the probe body onto the instrument casing by fitting only the two right hand M3 screws. Do not tighten them fully as you still need to line up the motor bracket.

2. Next fit the motor bracket using the four remaining M3 screws and tighten all six screws.

3. Insert the probe shaft from the bottom of the probe body through the top shaft seal carefully. As the tip of the stainless shaft passes through the seal, fit the M6 locking nut followed by the tab washer (the long tab is bent and should lie against the cam follower). Thereafter screw the shaft into the cam.

4. Push the cell sensor cable through the 4 mm hole in the body and install the cell sensor in position. Ensuring that the O-rings, gaskets and dowel pin locates correctly and that the cable is not kinked or pinched.

5. Reconnect the cell cable ensuring correct polarity to SCD 16mp PCB, J1 terminals, SIG (brown) and 0V (white), Figure 5.

6. Replace the probe body cap (hand tighten only).
   The length of the probe in the probe body cavity must be set as follows:
   a. Manually turn the cam using the chopper plate to check if the probe is touching the bottom of the cell sensor.
   b. If the above is true then use a long nose pliers to turn the stainless shaft into the cam to decrease the overall length. If not, then the shaft must be screwed out until the probe just bottoms in the cell.
   c. Repeat the above two steps until the probe just touches the bottom of the cell.
   d. Now turn the shaft a full turn into the cam watching the M6 nut turn one revolution.
   e. Lock the M6 nut against the cam and fold the tab washer down over the nut to keep it in place (note that the long side of the tab washer should be against the cam).
   f. Refit the optic sensor board with the 3 mm wing nut and check the chopper plate rotates centrally without touching the optic sensor channel sides.

7. Close the front cover of the unit by depressing (push down) and turning the six quarter-turn screws clockwise.

8. Reconnect the power and signal cables to the Terminal Box or PCB.

9. Calibration of the SCD 16mp <u>will be required</u>. After the SCD 16mp has been running in a tap water sample for about thirty minutes, perform the cationic standard calibration (Section 7).

12. REFERENCES

[1] Strazdins E. Tappi Press, 1994

[2] http://www.tappi.org/content/events/11papercon/documents/271.429%20ppt.pdf

APPENDIX A: SCD 16mp PARTS DETAIL

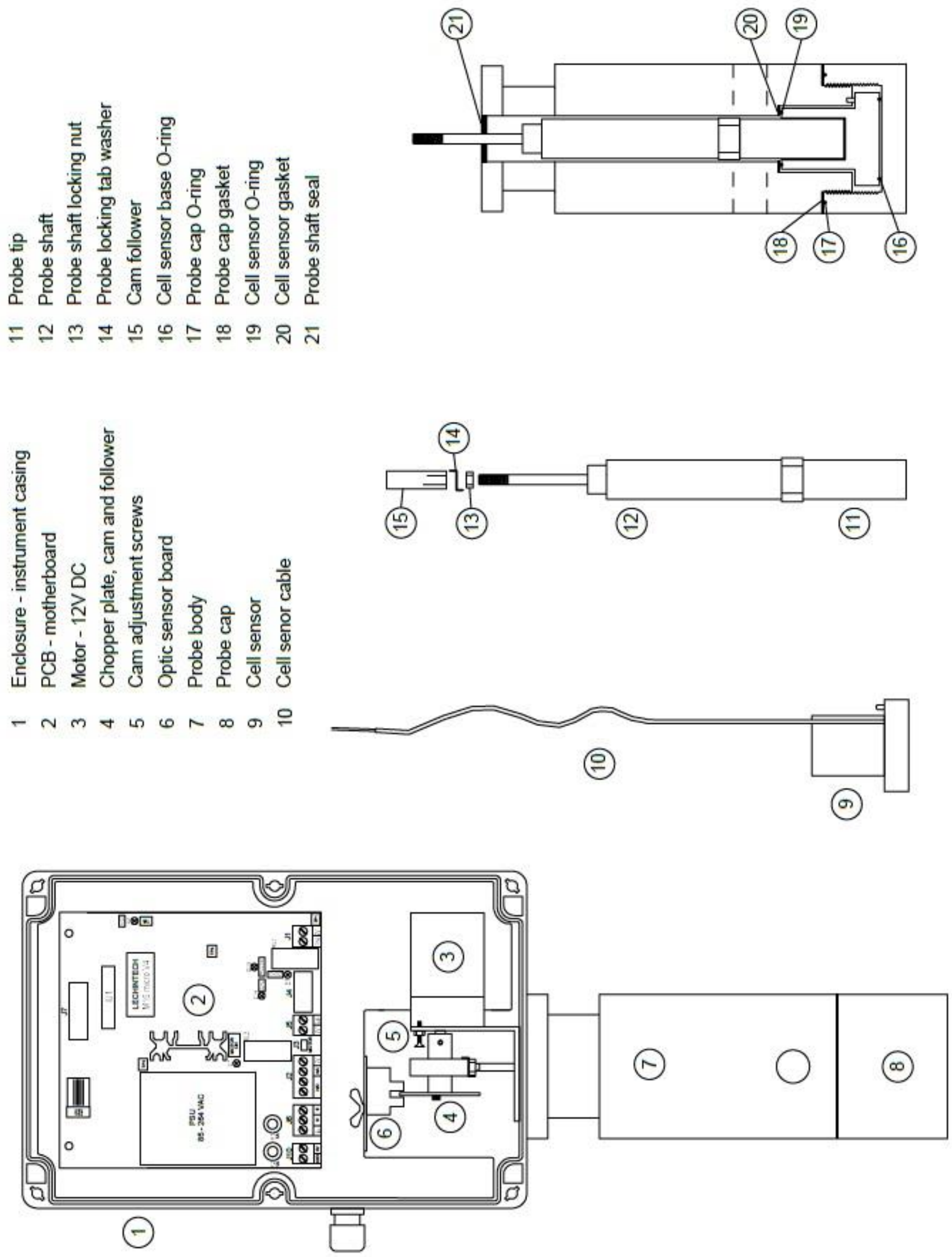


Figure 7: SCD 16mp part details

APPENDIX B: SCD 16mp SPARES

Part No.	**Description**
DM-12-10:1	SCD drive motor 12 VDC
DM-12-GB10	10:1 gearbox for SCD drive motor
05-001-CP	Cell and probe set
05-001-CPK	Cell and probe set with PVC probe tool and seal kit
05-001-SK	Seal kit - 3 O rings, 2 flat gaskets, 1 shaft seal
05-003-CF	Cam and follower with chopper plate
05-004-IH	SCD 16mp enclosure housing complete with enclosure face (door), hinges, glands, device plate and motor/gearbox bracket*
05-004-01	SCD 16mp enclosure face (door) with keypad
05-004-02	Enclosure door hinges set
05-004-03	PG9 glands and nuts each
05-004-04	Stainless steel back plate for SCD 16mp with screws
05-001-P	Probe body, stainless steel shaft, 2 locking nuts and tab washers
05-mp-RC01	Display ribbon cable for SCD 16mp
05-mp-RC02	Optic sensor board ribbon cable for SCD 16mp
05-mp-001	Complete SCD 16mp motherboard
05-mp-002	Complete SCD 16mp display board
05-mp-SB	Optic sensor board and rubber, with screw and wing nut

Note

* Depending on SCD 16mp versions (year of manufacture) the replacement housing may require measurements of older versions of the SCD 16mp for direct replacement.

APPENDIX C: SCD 16mp MENU FLOWCHARTS

C1 – SCD 16mp Menu Navigation Flowchart

C2 – SCD 16mp Configuration Menu Navigation Flowchart

C3 – SCD 16mp 4-20mA Calibration Navigation Flowchart

C4 – SCD 16mp Calibration Navigation Flowchart

The following flowchart pages use the button descriptions below.

MENU button


INCREMENT button

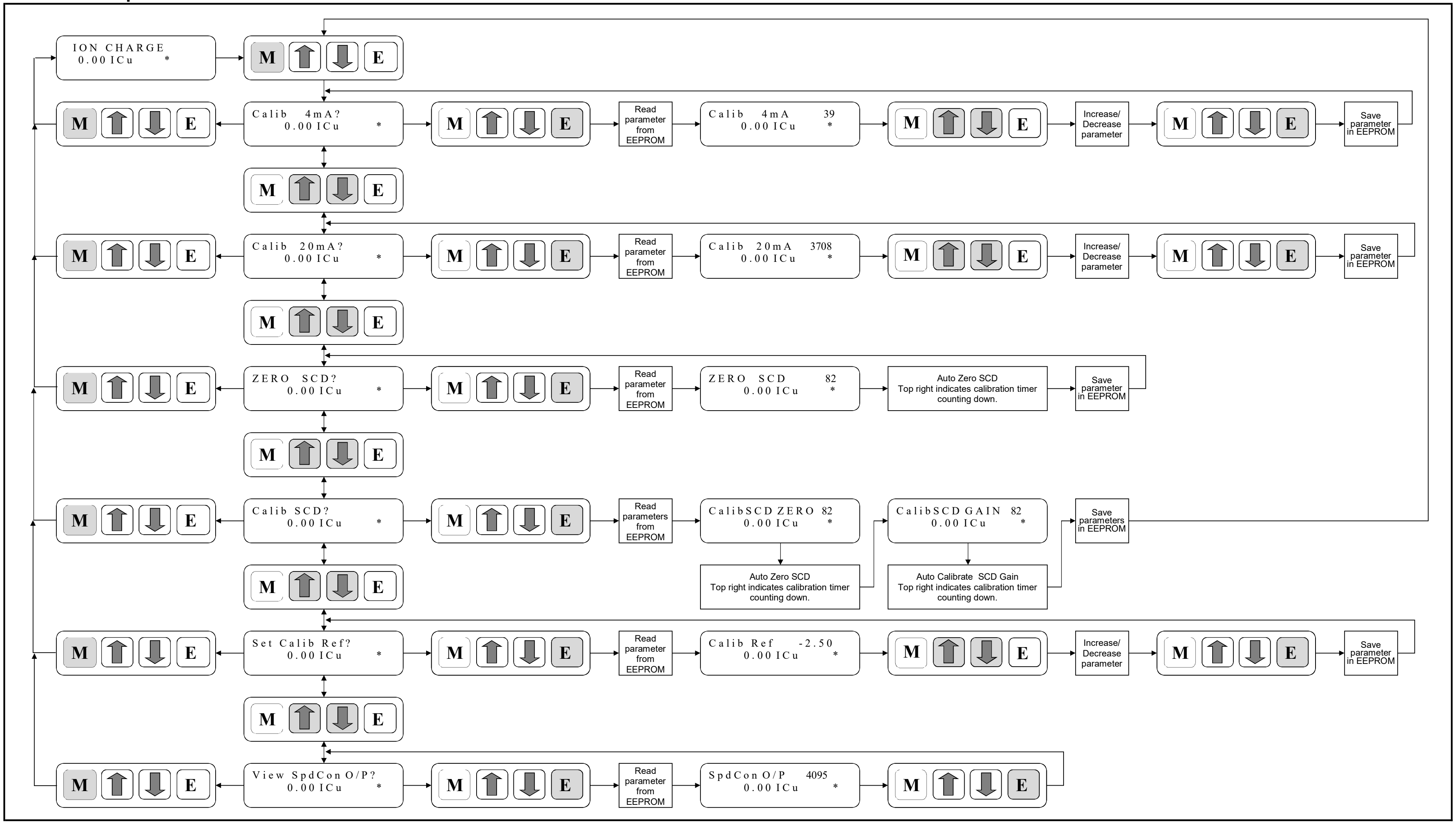

DECREMENT button

ENTER button

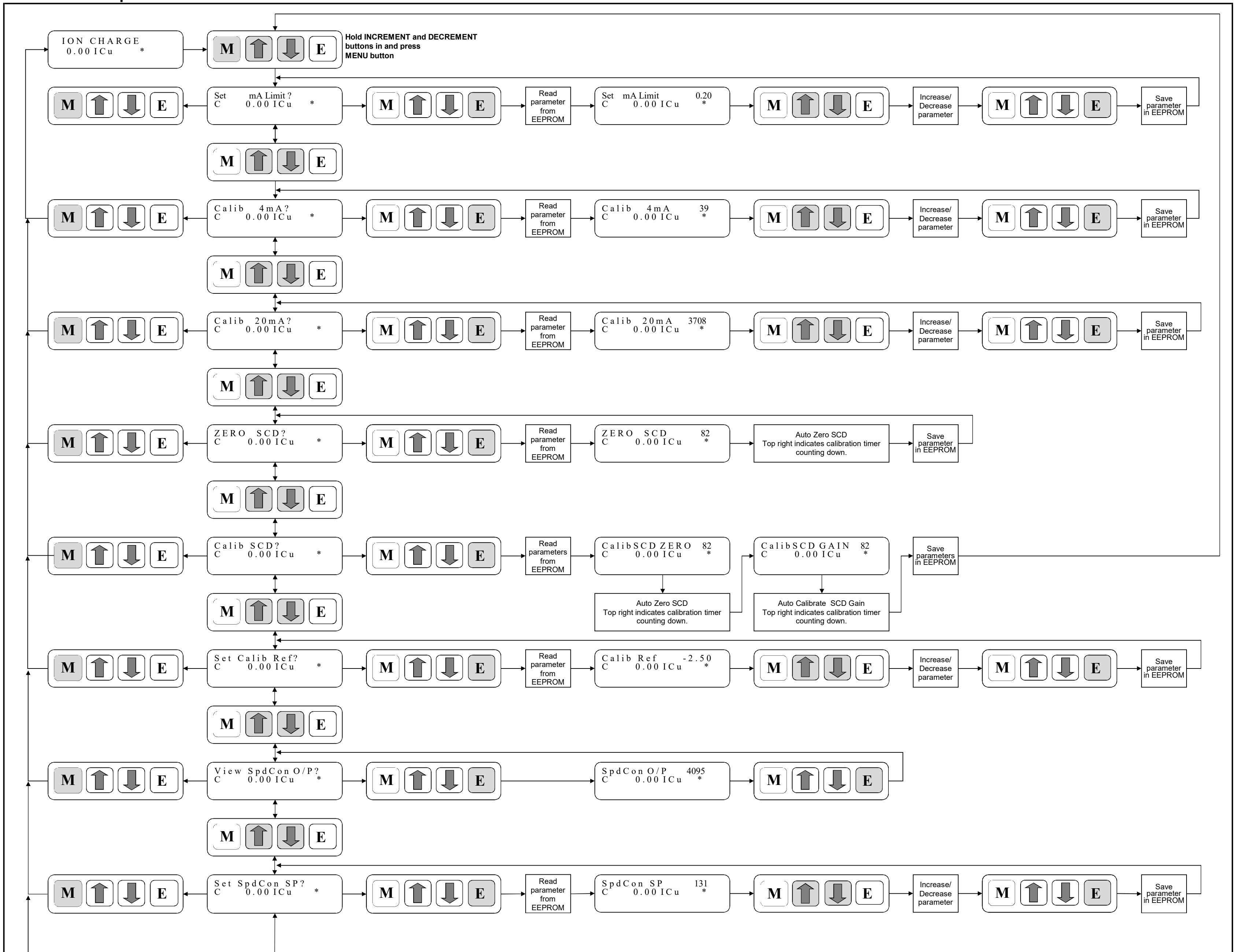
When the buttons are shown with a grey background, it means they are to be pressed for either navigation, a value change or accepting/saving a value.

The INCREMENT and DECREMENT buttons are both generally shown with grey backgrounds as shown below, a user can use the buttons to ascend/descend the menu navigation or change a value up/down.

C1 - SCD 16mp MENU NAVIGATION FLOWCHART



C2.1 - SCD 16mp CONFIGURATION MENU NAVIGATION FLOWCHART



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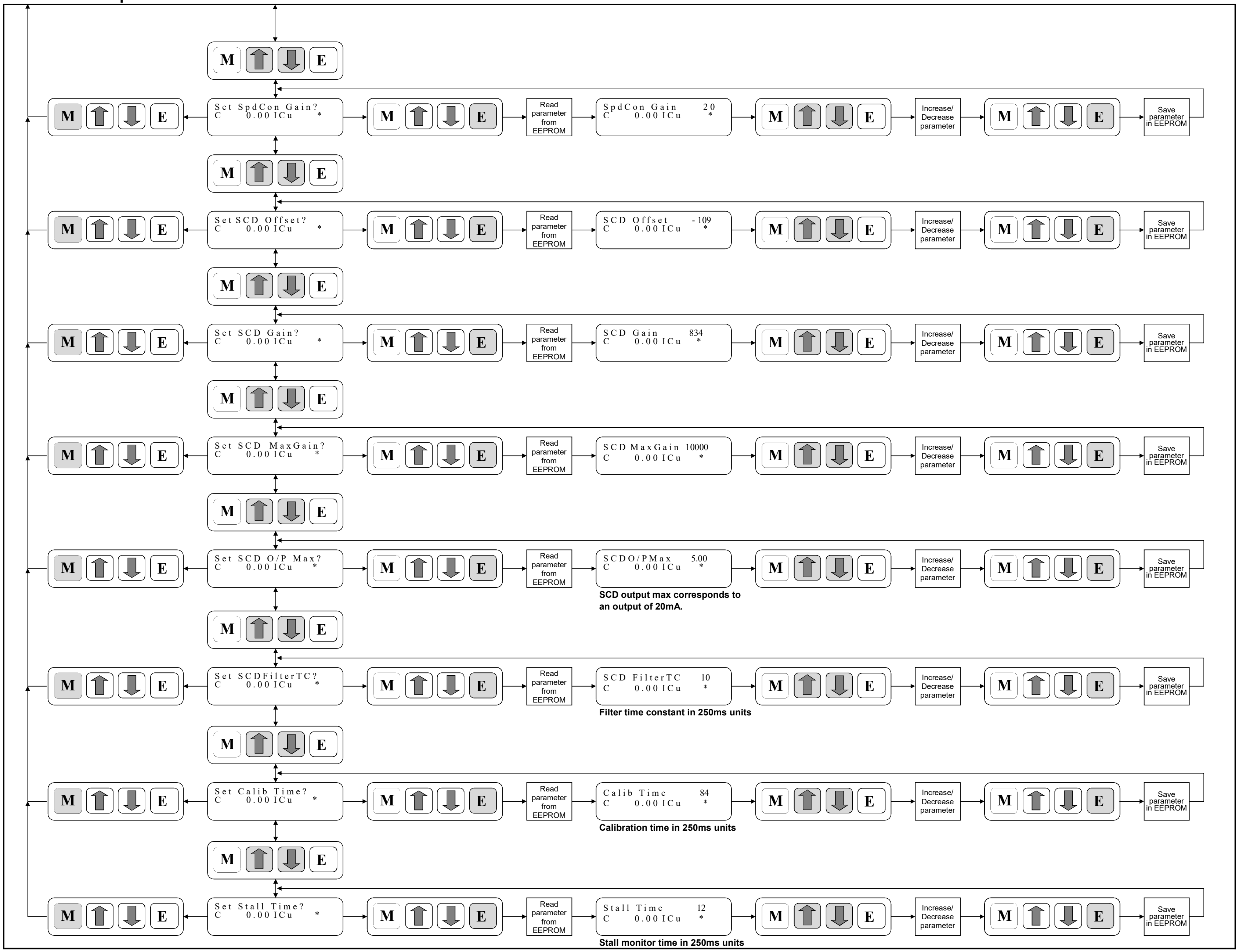
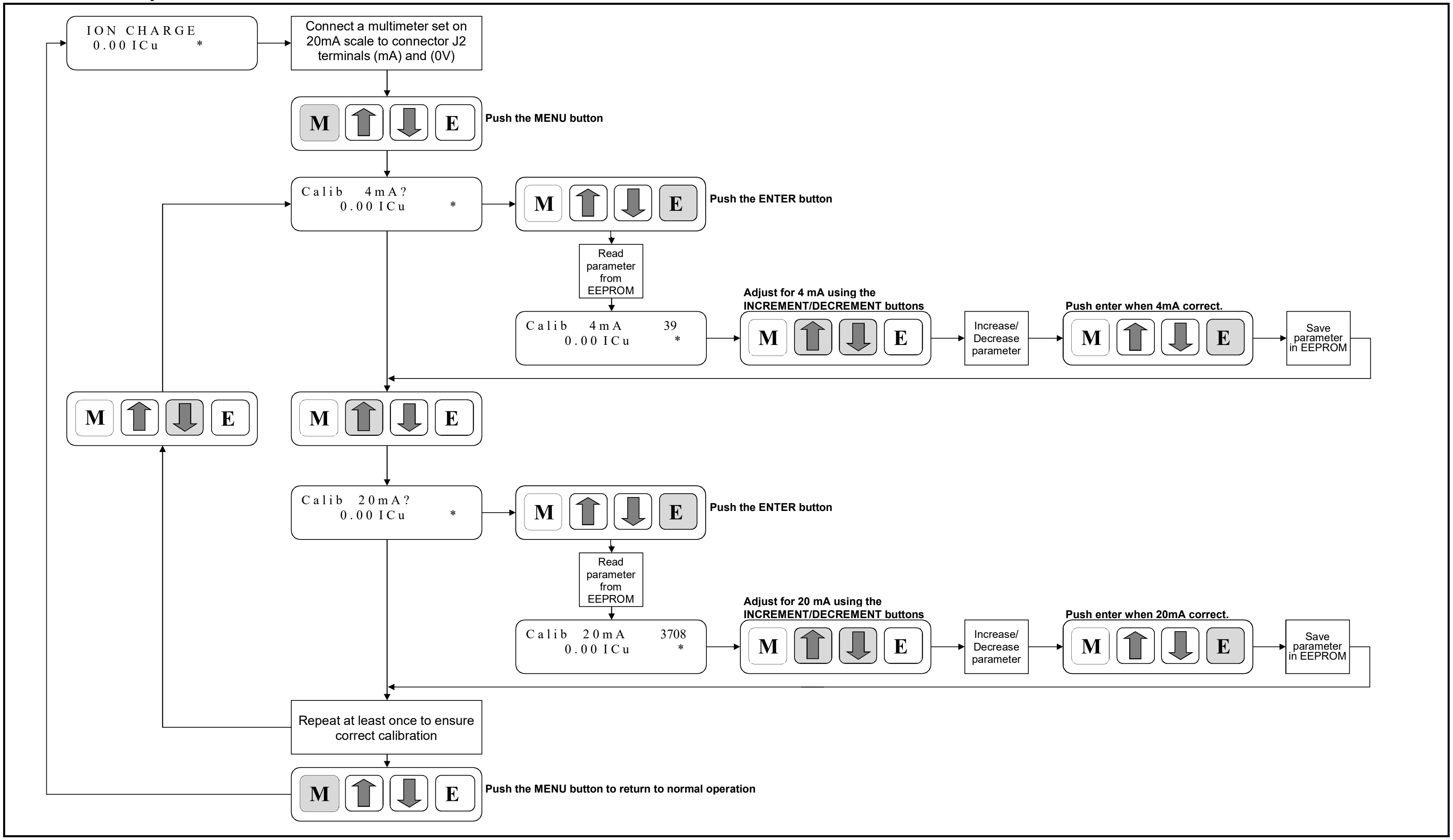
C2.2 - SCD 16mp CONFIGURATION MENU NAVIGATION FLOWCHART



C3 - SCD 16mp mA OUTPUT CALIBRATION FLOWCHART



C4 - SCD 16mp AUTO CALIBRATION FLOWCHART