

**Technical Support  
Department  
ABB Analytical Instrumentation**



# **AW101 Testomat Water Hardness Analyser**



# Programme

**Brief description of water hardness application**

**Principle of measurement for water hardness**

**Operation of the AW101 Testomat**

**Details of the monitor functionality**

**Details of the display, keypad and parameter setup**

**Description of the diagnostics functions**



# AW101 Testomat Water Hardness Monitor



Replaces the the 6775 Testomat



# What is Hard Water?

## Water with high mineral content

Especially Calcium,  $\text{Ca}^{2+}$  and Magnesium,  $\text{Mg}^{2+}$  Salts

### Problems:

Clogs pipes

Forms insoluble precipitates with detergents so increases the amount of detergent required for laundry – 50% to 90% waste

Reduces efficiency of hot water and heating systems

Just 1.6mm (1/16”) of scale build-up can cause a 12% loss in efficiency

Causes the builds up of scale in boilers that can cause steam boiler to fail, shutting down plant production

Severe deposition known to cause fire and boiler explosion

The number of process issues caused by hardness are endless



# What is Water Hardness

**Total Hardness**  
As Measured by the AW101

**Temporary Hardness or  
Non-carbonate Hardness, e.g.  $(\text{HCO}_3)_2^-$**   
Hardness that is easy to remove  
by boiling or by precipitation  
with lime (calcium hydroxide)

**Permanent Hardness or  
Carbonate Hardness, e.g.  $\text{CaCO}_3$**   
Hardness that is not removed by  
boiling

## Hardness Units

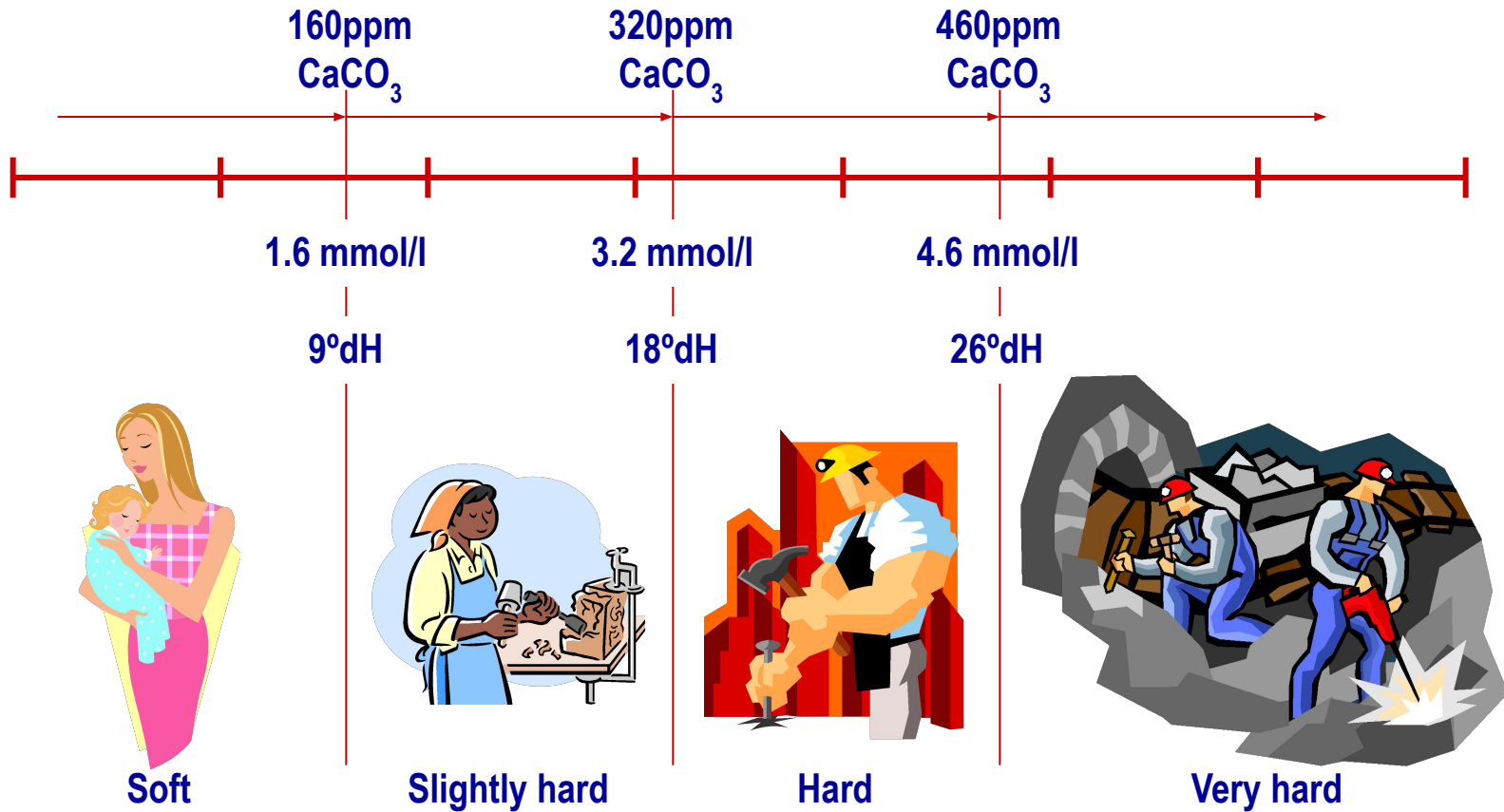
ppm  $\text{CaCO}_3$  – North America and U.K.

mmol/l – milli moles per litre (Internationally recognised units) = 100ppm  $\text{CaCO}_3$

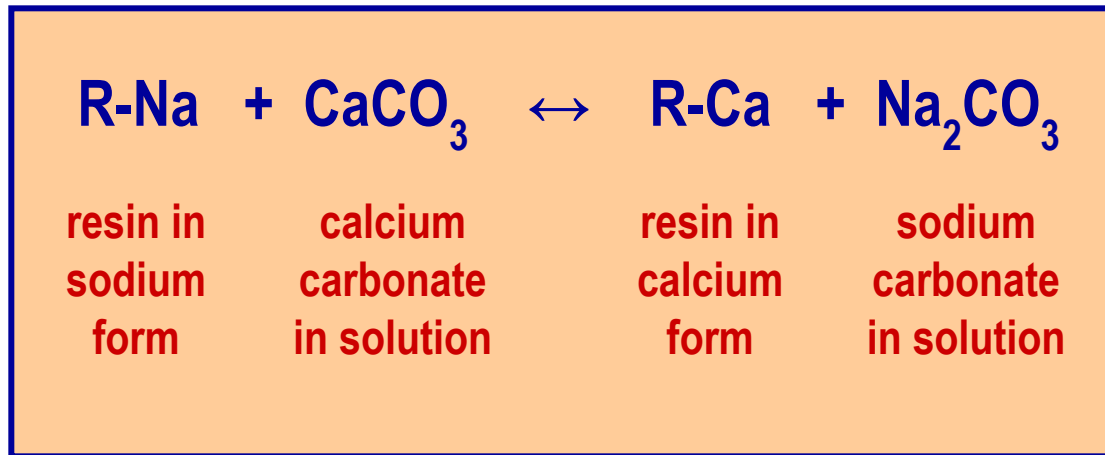
°dH – degrees hardness (Germany)

°df – degrees hardness (France)

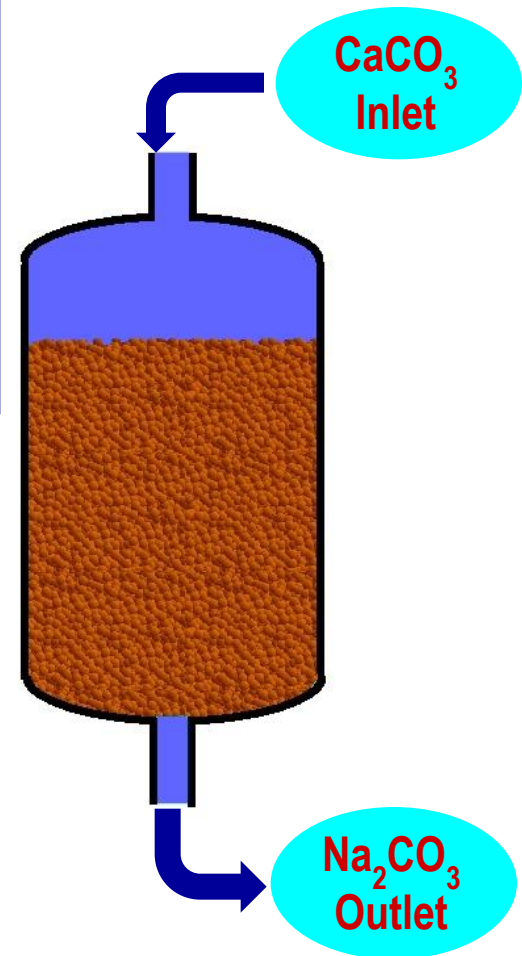
# Rule-of-thumb



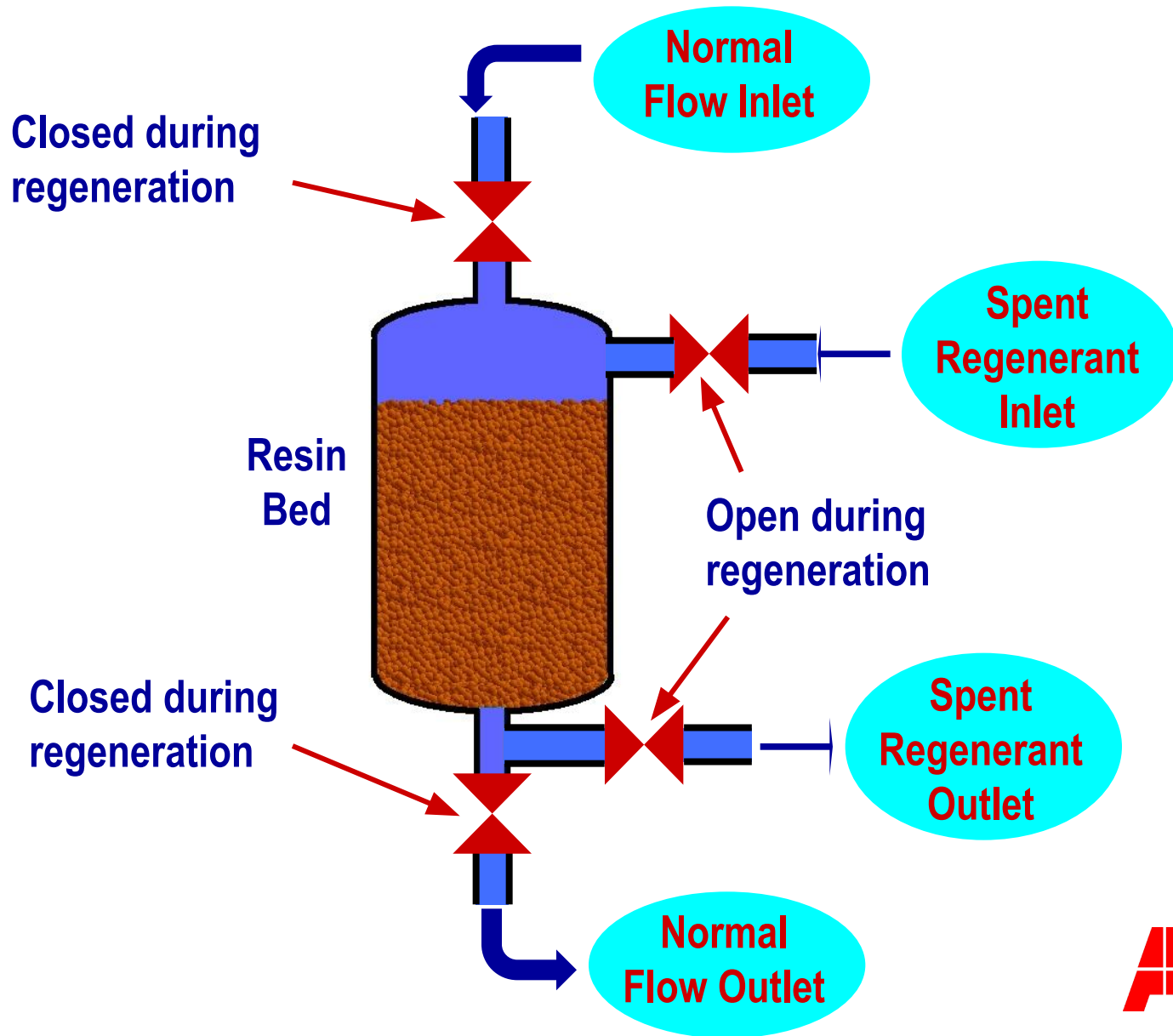
# Chemical Reactions in Softening Ion-exchange Resins



Vessel containing resin beads in the **Sodium** form (R-Na)

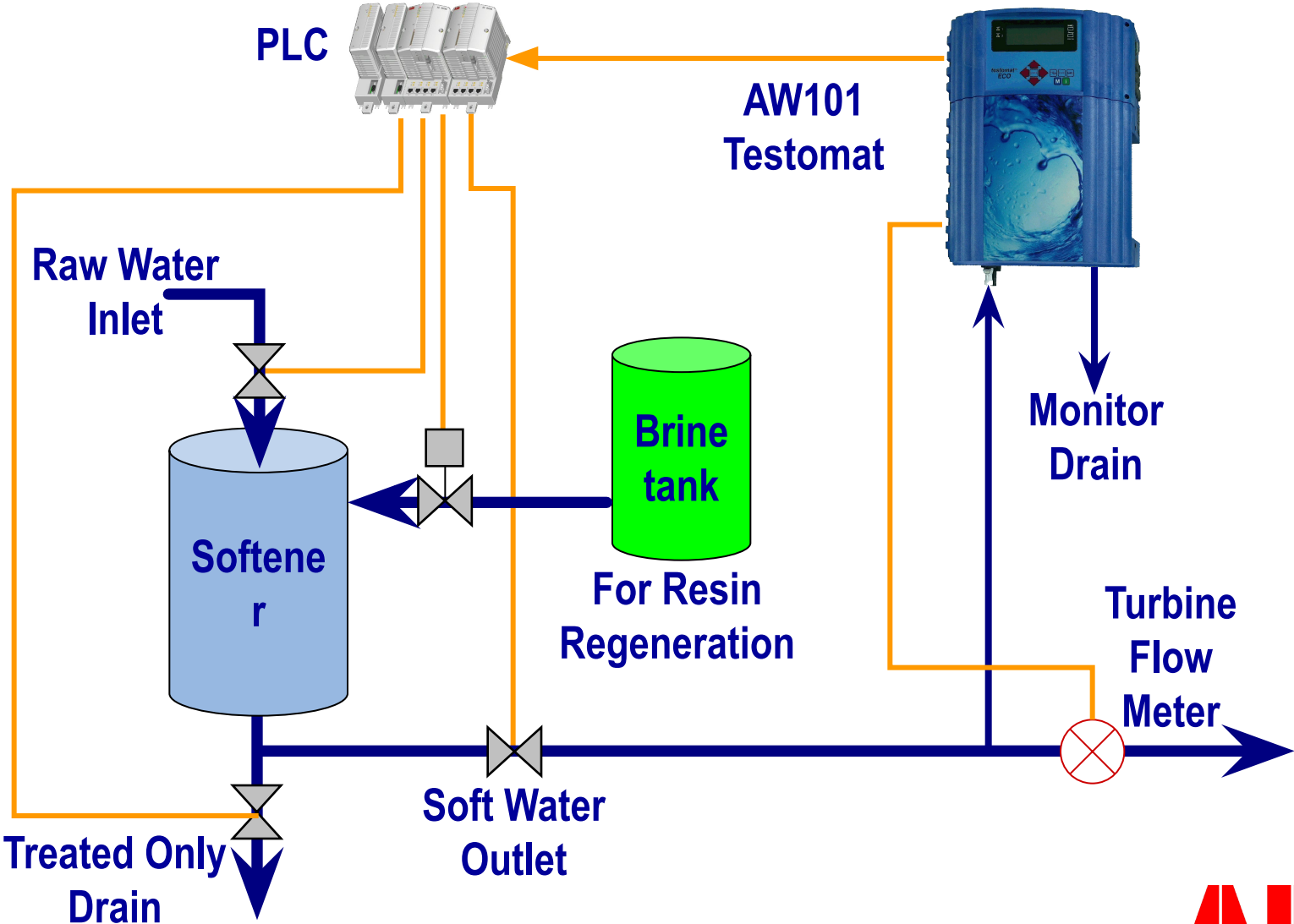


# Softener Resin Bed Regeneration





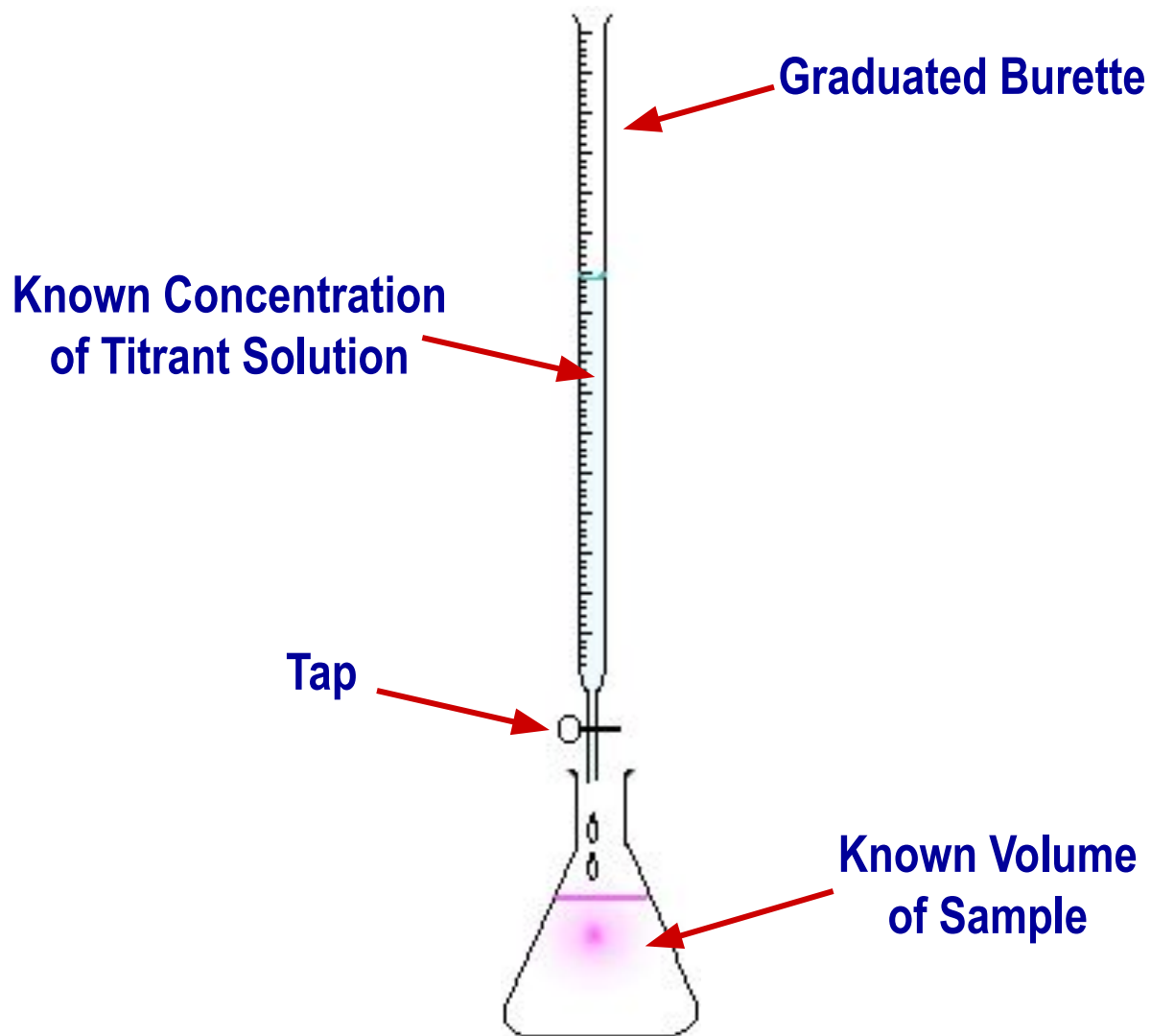
# Softener Control Application



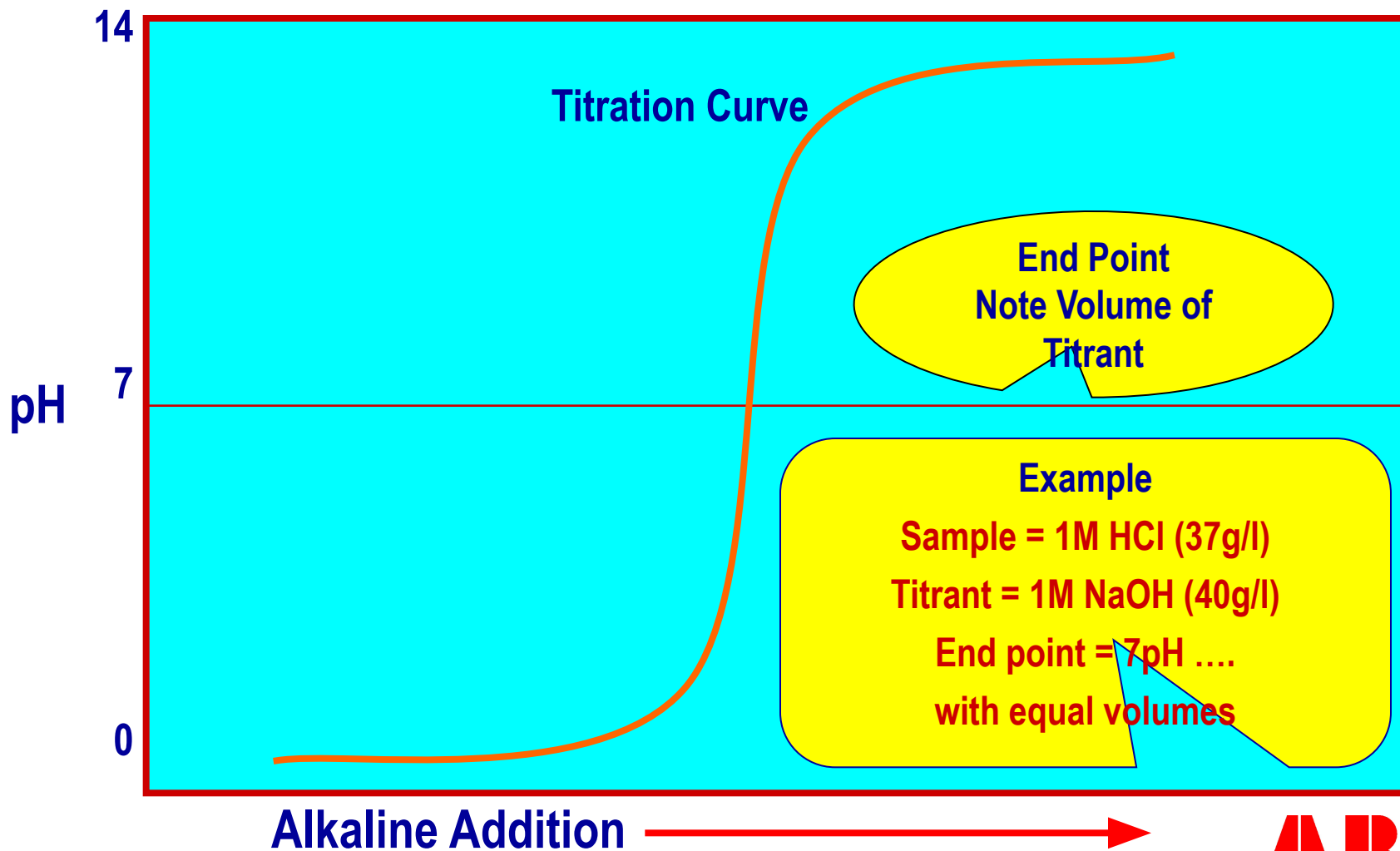
# AW101 Testomat Total Water Hardness Monitor



# What is Chemical Titration ???



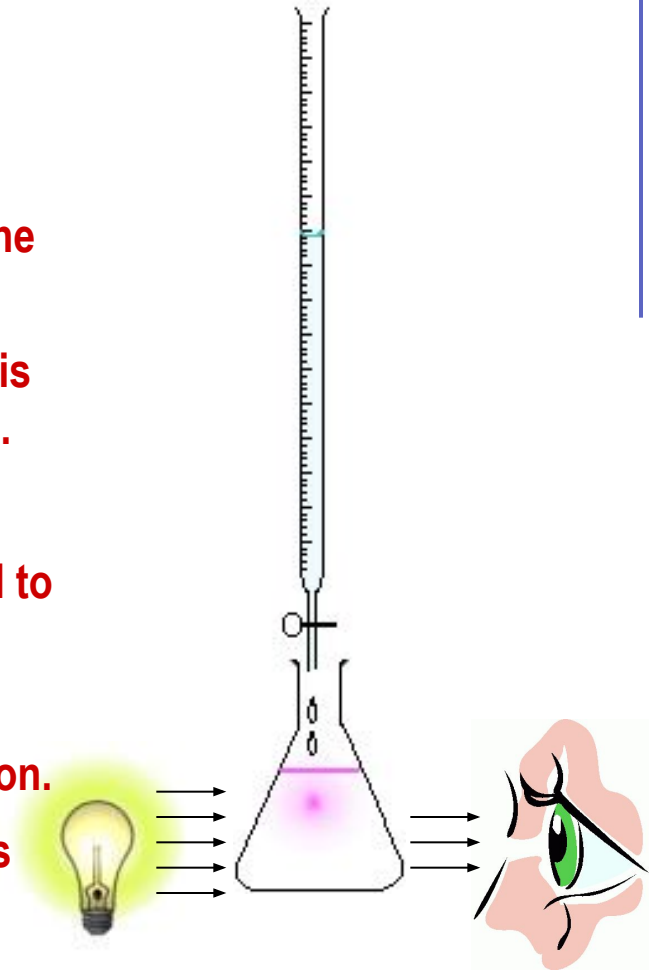
# A Simple Titration of an Acid Sample Using an Alkali Titrant



# Basic Operation for Water Hardness Measurement by Titration

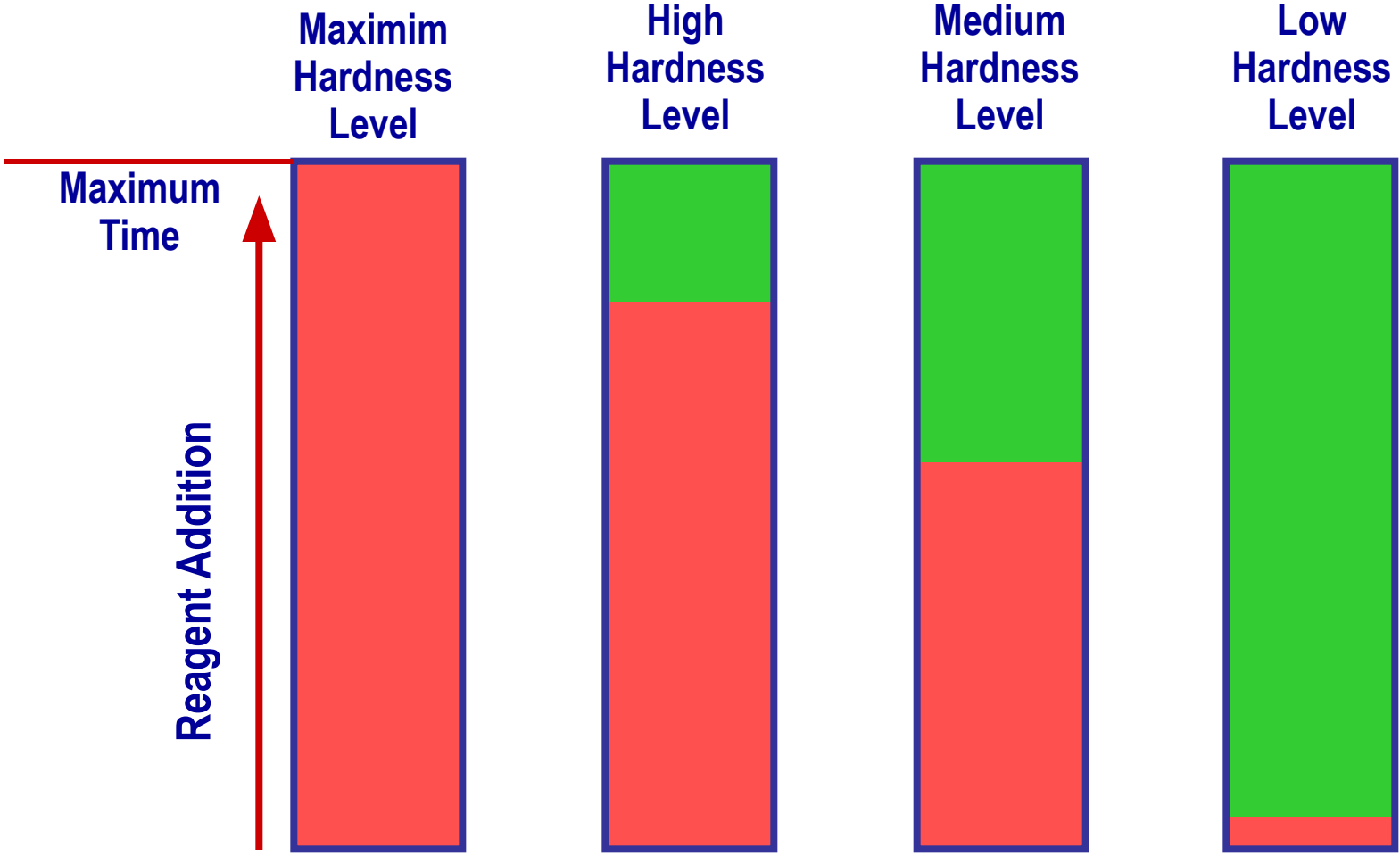
## Chemical Sequence

1. A known volume of sample is contained in the measurement chamber.
2. Red light from an LED is passed through the sample in the measurement chamber.
3. The chemical reagent, consisting of a complexing agent is added, to the measurement chamber via a piston pump.
4. The reagent also contains a red indicator.
5. The end-point is reached when sample changes from red to green.
6. The change in colour is detected by a photoelectric cell because red light does not pass through a green solution.
7. The volume of reagents is used to calculate the hardness value in the sample

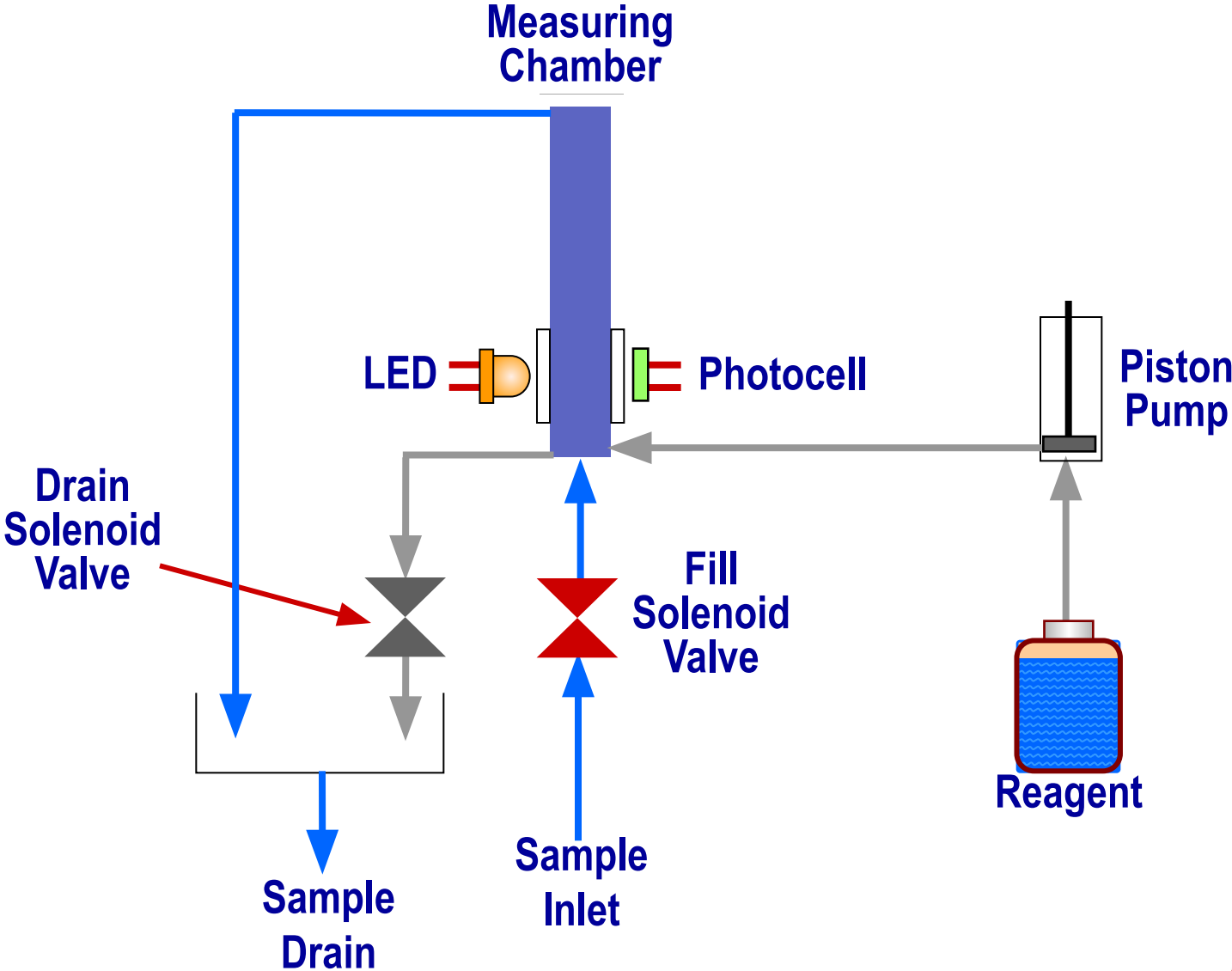


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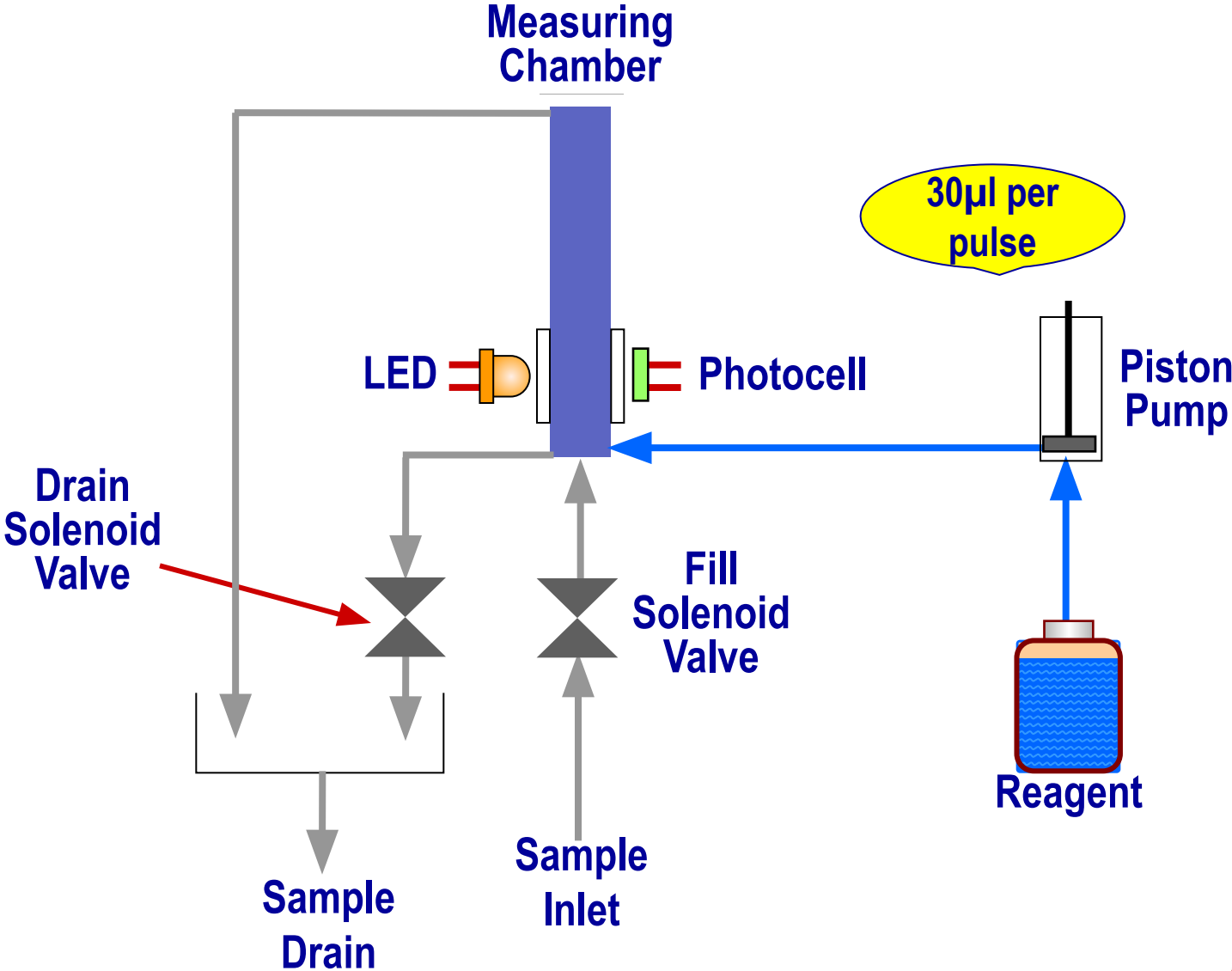
# Adding the Reagent to Determine the Hardness Level



# Flow Schematic – Flush and Fill Sequence

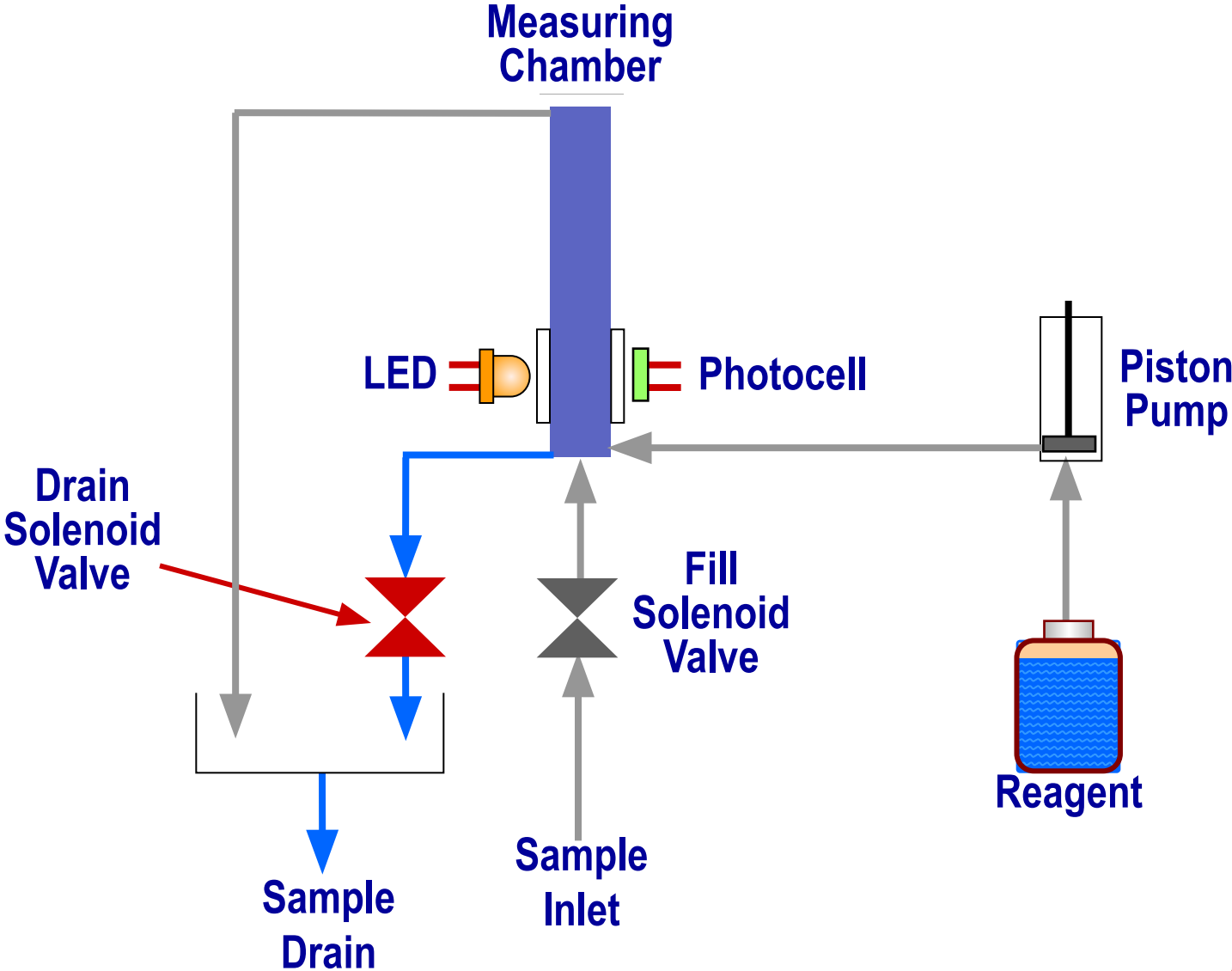


# Flow Schematic – Analysis Sequence

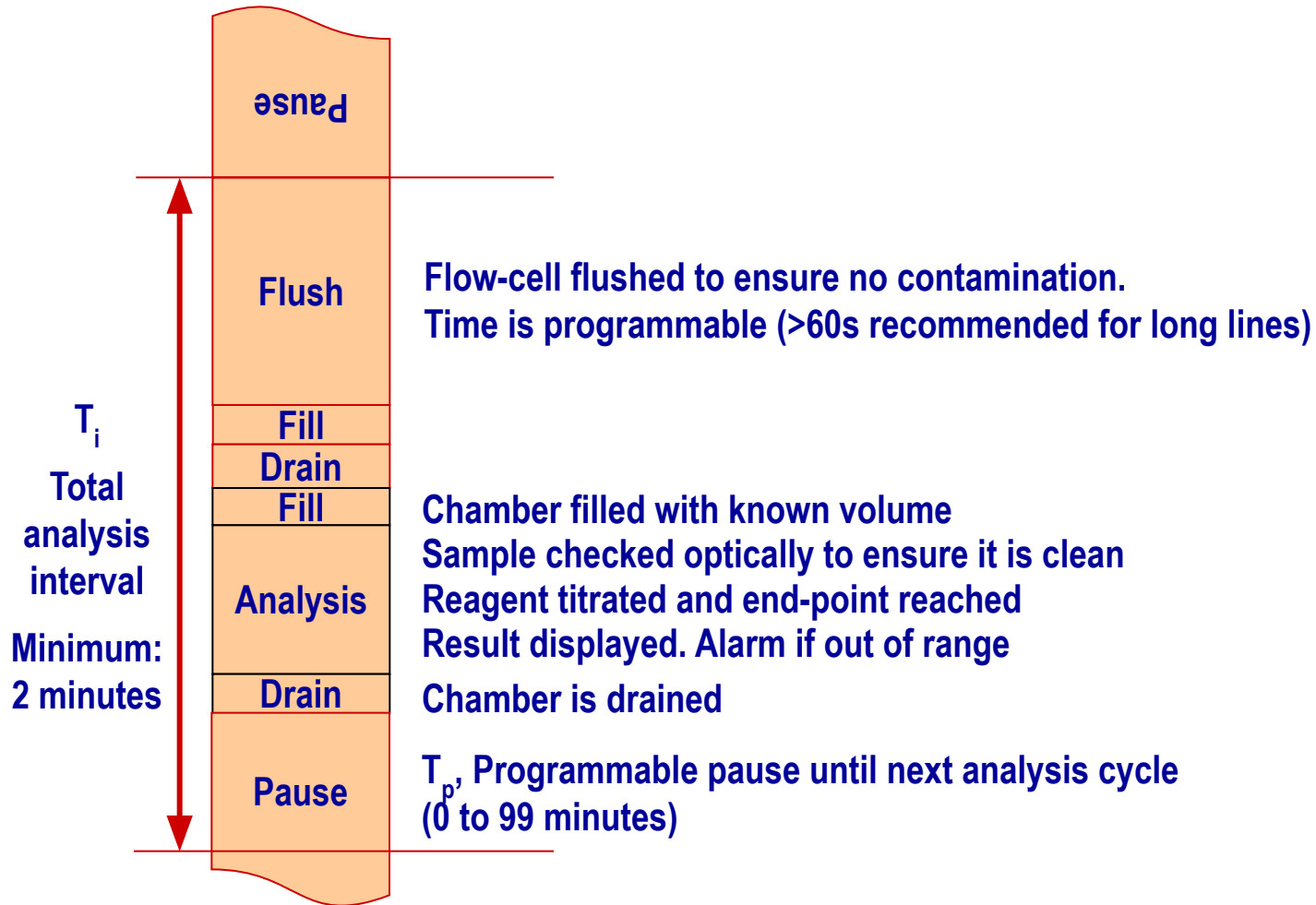




# Flow Schematic – Drain Sequence



# Details of the Analysis Cycle



# Monitor with the Chemical Door Open

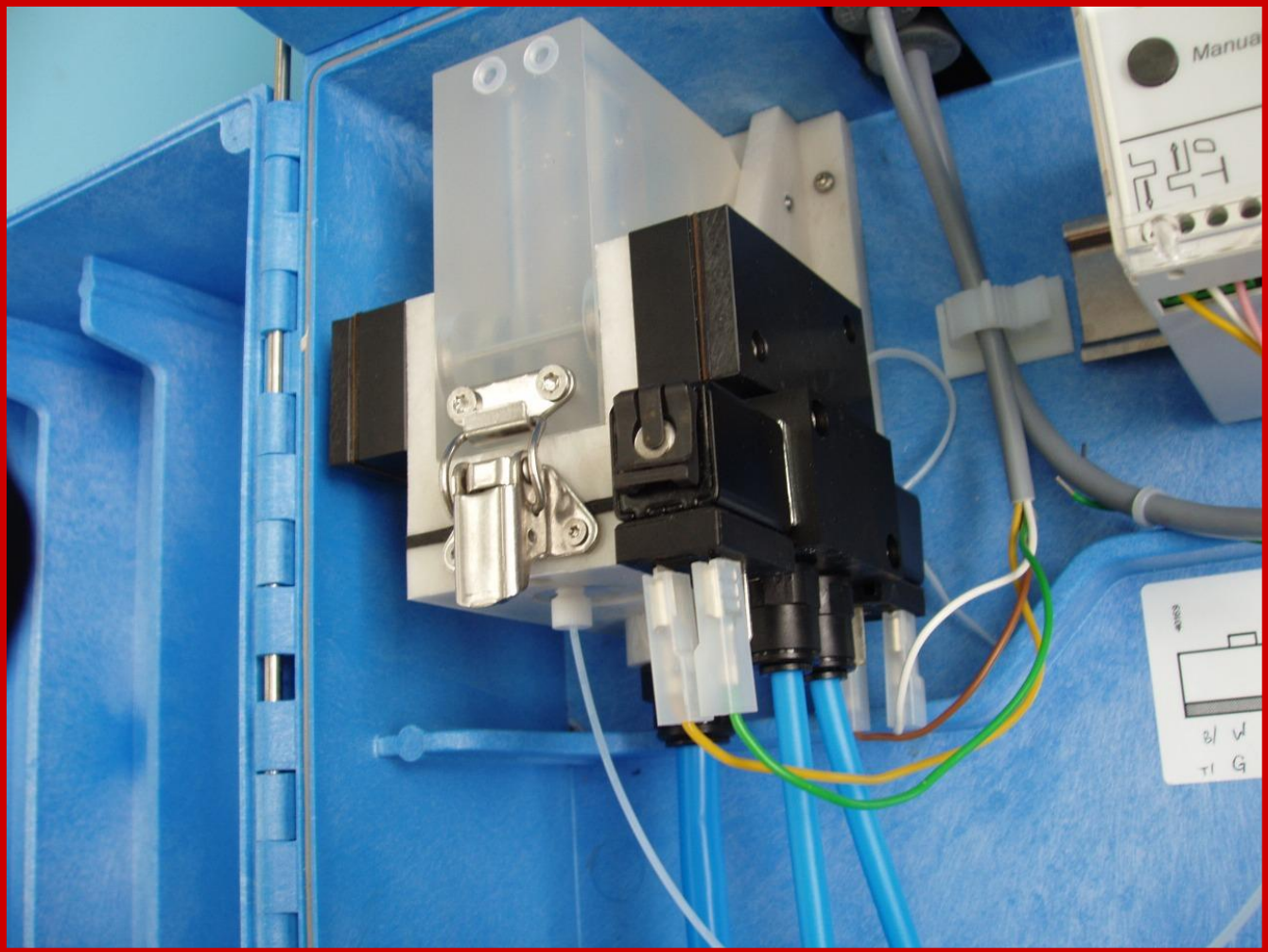


# Close-up of Piston Pump

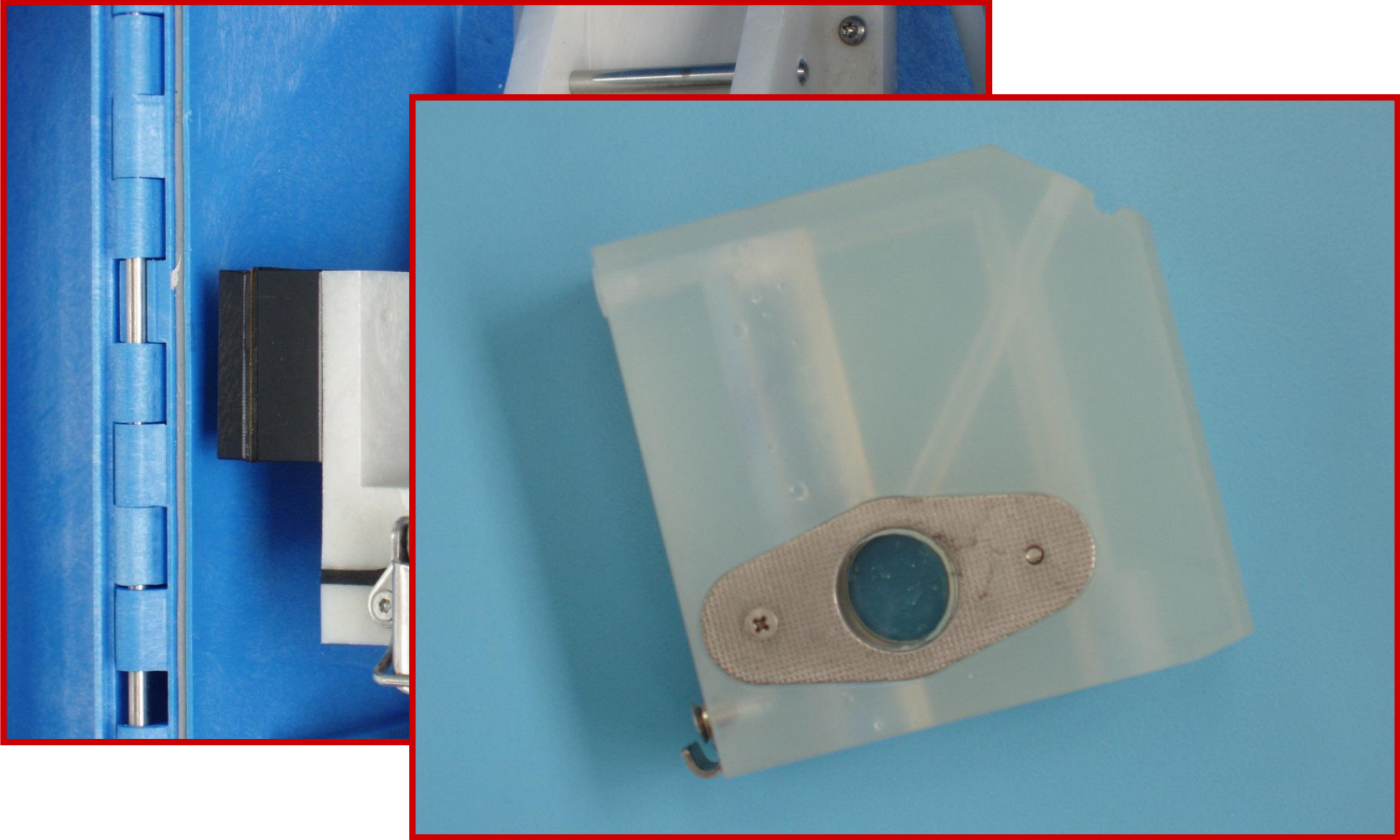




# Close-up of Measuring Chamber



# Light Path Through Measuring Chamber



# Display and Keypad



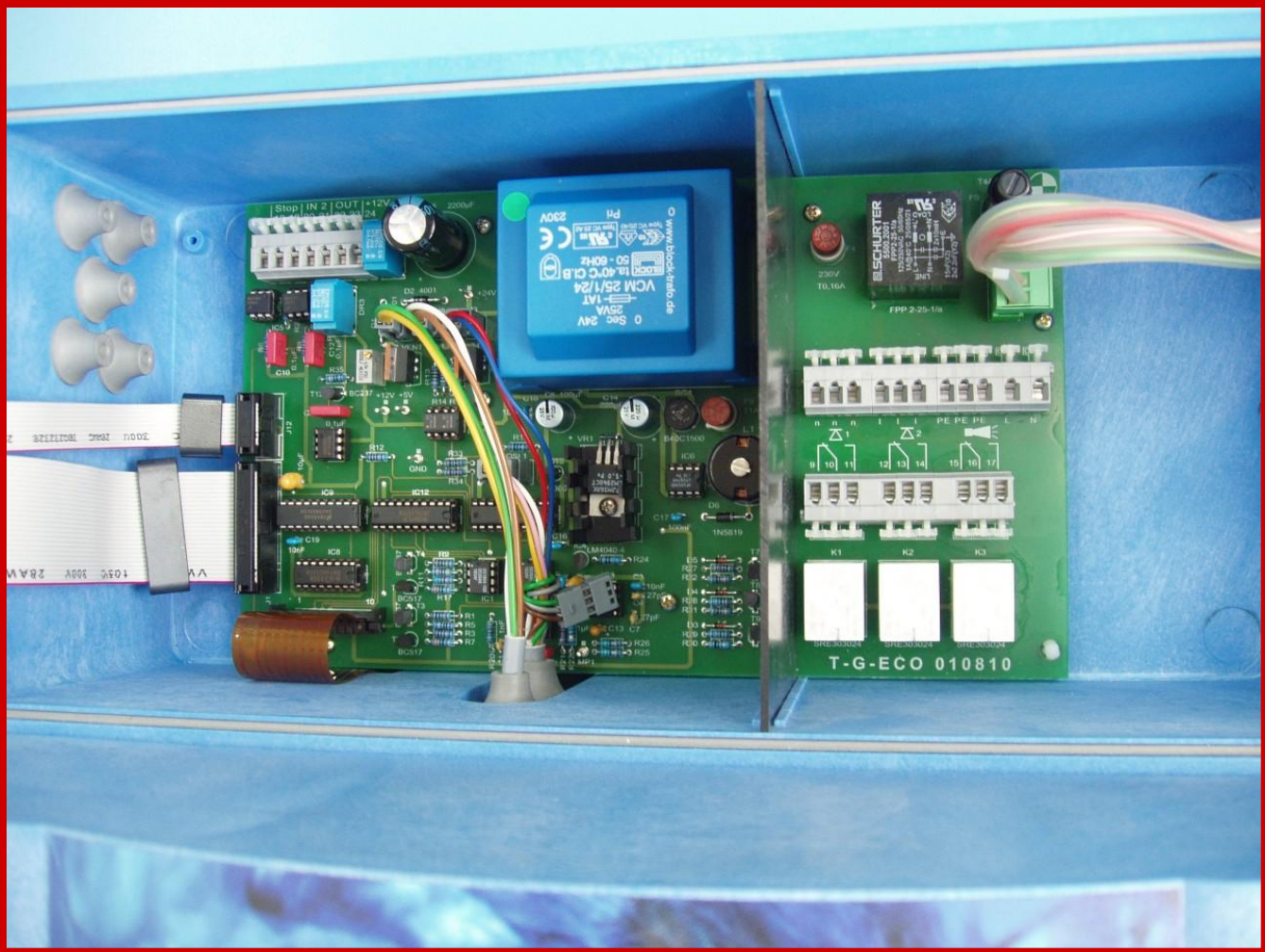


# Access to Electronics





# External Terminations



# Electrical Inputs and Outputs

**Water meter Input (IN)**

**For flowmeter  
or turbine meter**



**12V Supply**

**To power  
turbine meter**



**Stop**

**To halt analysis**



**Alarm 1 Relay (LV1)**



**Alarm 1 Relay (LV2)**



**Fault Alarm,**



**Current Output (OUT)**

**0 to 20 or 4 to 20mA**



**Supply**

**110, 240 or 24V**



# Configurable Measurement Cycle

Automatic intervals (programmable 0 to 99 minutes)

OR

External flow signal (1 to 9999 litres)



Contact Water Meter or  
Turbine Flow-meter



# Secure Operation Without Supervision (BOB Operation)

The AW101 Testomat conforms to standards for safety in some steam boilers installations (mainly in Germany), for unsupervised boiler operation.

The requirement for this standard include:

**Programmable Low-level reagent alarm**

**Alarm if reagent quantity is less than required for**

**72 hours usage**



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# Instrument Range vs Reagent Type

Reagent Units	AW101 901	AW101 902	AW101 903	AW101 904
ppm CaCO <sub>3</sub>	0.89 – 8.93	4.47 - 44.7	17.9 - 179	44.7 - 447
mmol/l	0.01 – 0.09	0.04 – 0.45	0.18 – 1.79	0.45 – 4.48
°dH	0.05 – 0.50	0.25 – 2.50	1.0 – 10.0	2.5 – 25.0
°df	0.09- 0.89	0.45 – 4.48	1.79 – 17.9	4.48 – 44.8



500 ml (0.88 pts)  
Extended operation

Expected Reagent Life: 1 year

Number of Analysis per Bottle: 3500 to 5000 (depends on hardness level)

Operating Temperature: < 40°C

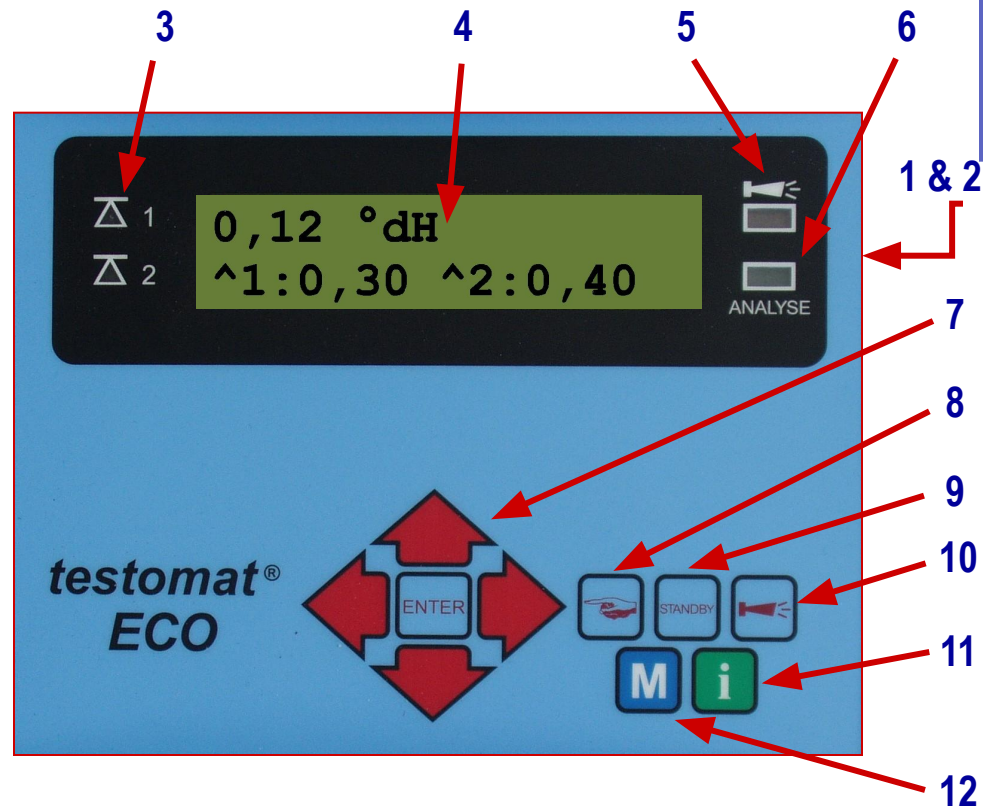
Storage: In Fridge



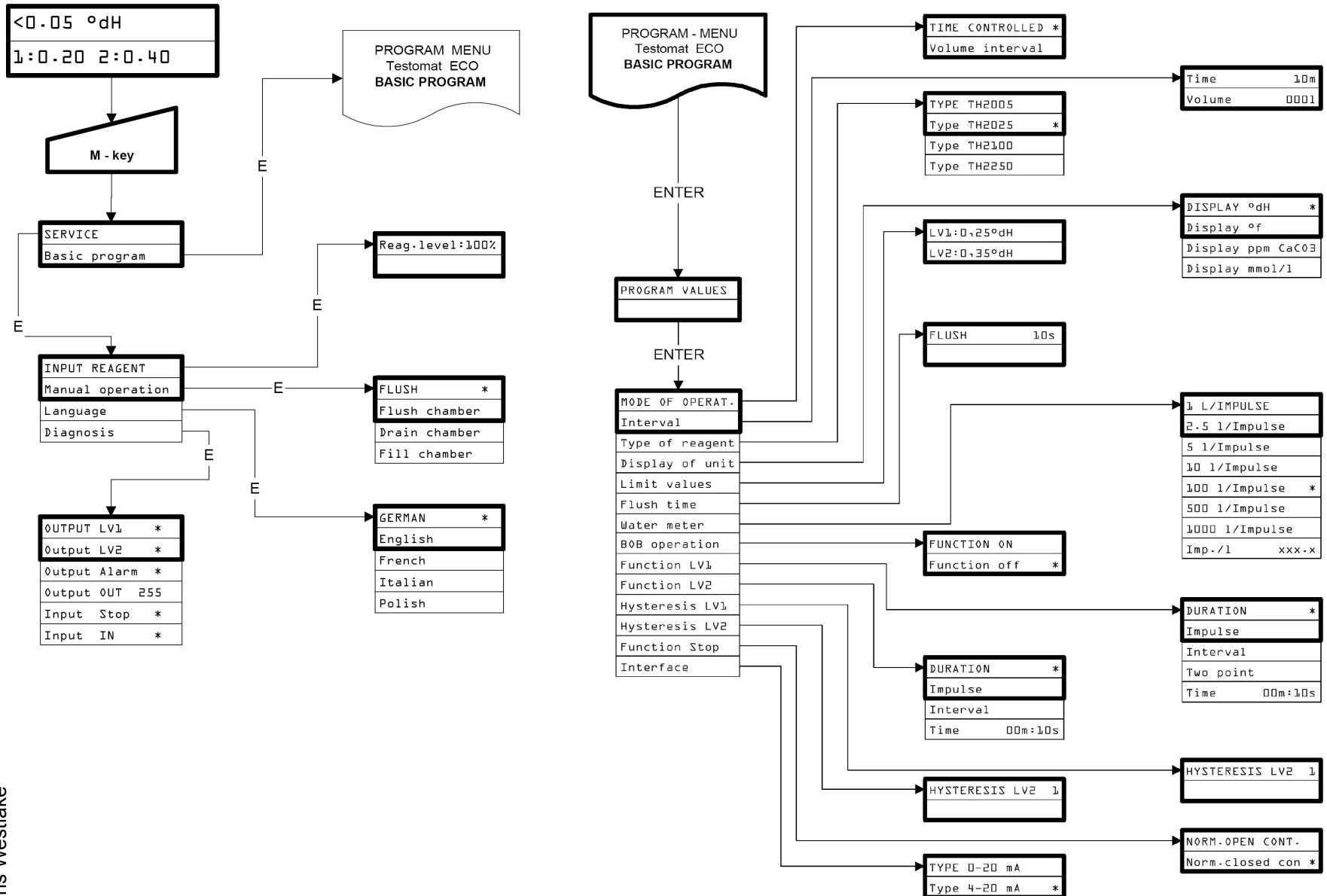


# Keypad and Display

1. Power Switch (right hand side of case)
2. Power Supply Fuse (right hand side of case)
3. Concentration Alarm Relay States
4. Text Display
5. Diagnostic Alarm State
6. Analysis Display
7. Cursor and Enter Keys
8. Manual Start of Analysis
9. Manual Analysis Stop / Standby
10. Cancels Alarm Message
11. Enter Information Function
12. Enter Menu Function

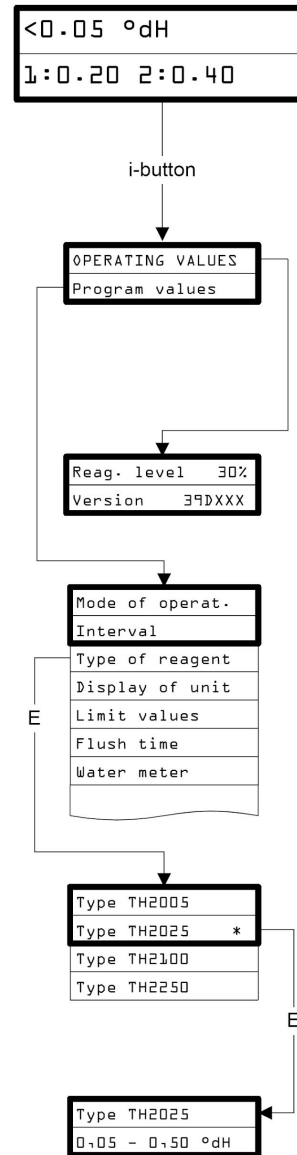


# Programming Scrolls – Menu (“M” Key) Functions



# Programming Scrolls – Information (“I” Key) Functions

Note: These parameters can only be read





# Diagnostic Messages

Displayed Message	Comment
Measuring Range Exceeded	Select appropriate reagent
Reagent Low	Check level and replace if required
Low Water Pressure	No sample flow to measuring chamber
Mf. Turbid	Sample high in turbidity
Mf. Dirtiness	Dirty optical windows
Mt. Analysis	Old or incorrect reagent Incomplete addition or mixing of reagent in measuring chamber
Ff. Outlet to Drain	Water Remains in measuring chamber
Ff. Dosing Fault	Dosing inaccuracy of dosing pump
Ff. Dosing Pump	Dosing pump defective No feedback signal from pump
Ff. Optics	Faulty optical component or electronic board

Ff = Function fault

Mf = Measuring fault



# Recommended Maintenance Schedule

Twice per year:

**Filter block:**

**Replace the filter and seal at the base of the filter block**

**Mixing chamber:**

**Clean the windows**

**Ensure breather hole is free otherwise won't fill/empty correctly – use a paper clip**

**Replace two seals in chamber holder**



**Optional filter housing**

# Sample Conditions

**Sample pH in the range 4 – 10.5 pH**

**Sample temperature between 10 & 40°C:**

**Higher temperature can cause physical damage (use sample cooler if required)**

**Lower temperature can cause condensation on the optical windows**

**Heavy metals in the sample:**

**Less than 0.5mg<sup>l</sup><sup>-1</sup> Iron (Fe)**

**Less than 0.1mg<sup>l</sup><sup>-1</sup> Copper (Cu) or Aluminium (Al)**

**Less than 100mg<sup>l</sup><sup>-1</sup> carbon dioxide (CO<sub>2</sub>):**

**High levels of CO<sub>2</sub> can be removed by a suitable sample de-aerator**



# AW101 Testomat - A Unique Water Hardness Monitoring System with Superior Performance

Automatic on-line monitoring of residual / total water hardness, ideal for water softening and potable water plants.

Simple menu-driven, programmable functions with clear LCD text display.

Few internal components, easy to maintain.

Choice of measurement units, mmol/l, ppm, dH or dF.

Sample turbidity compensated.

Analogue current output of hardness concentration.

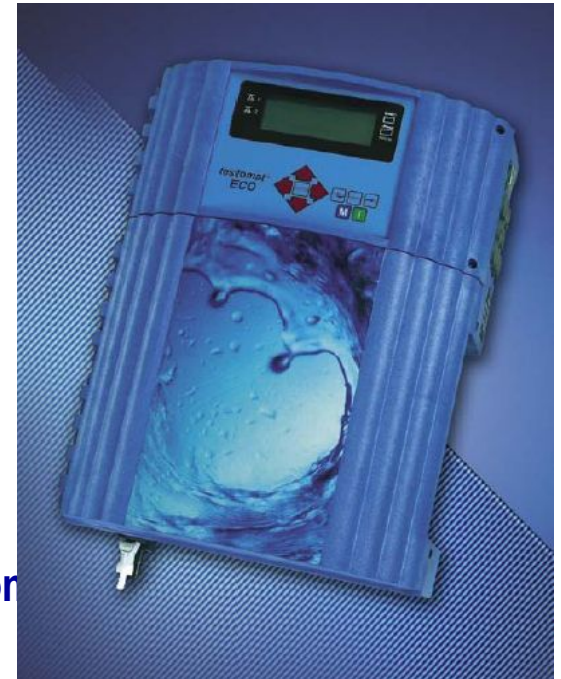
Two fully adjustable concentration alarms outputs.

Remote diagnostic alarm output.

Configurable initiation of analysis - automatic intervals, or from external flow signal.

Adjustable measurement cycle time reduces reagent and sample consumption.

Replacement for 6775 unit.



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