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Static Metering Technology

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A specifically designed programme for

Da Afghanistan Breshna Sherkat (DABS)
Afghanistan





Coverage

- **Why electronic meters?**
- **What is an energy meter?**
- **What's inside?**
 - **Voltage and current sensing technologies**
 - **Multiplier Technologies**
 - **Electronic meter (typical)**
 - **Display types**
 - **Memories**
 - **Real time clocks**
 - **Power Supplies**
- **Applications of electronic meters**
- **Connections of meters**

Why electronic meters?

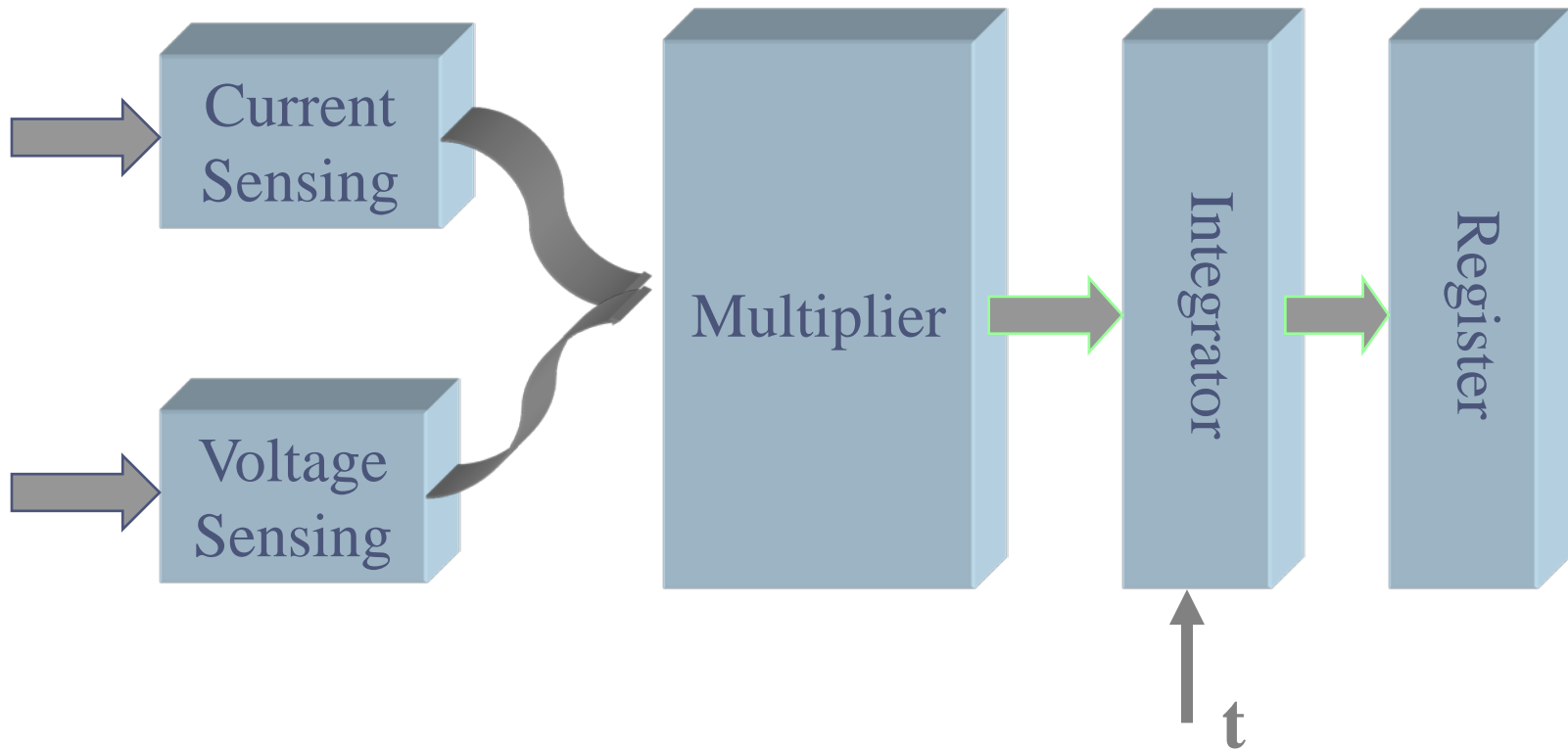


Electronic Meter information affects almost every aspect of distribution management business

Electronic Meters

- Electronic Meters provide the power of information
- Managing energy needs harnessing this information
- Real advantage of electronic metering can be harnessed by deploying appropriate IT infrastructure

What is an energy meter?



$$Power = \int_0^{2\pi} P(t).dt = VI \cos \phi$$

$$Energy = \int_{t1}^{t2} P.dt$$



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Sensors

Voltage and Current

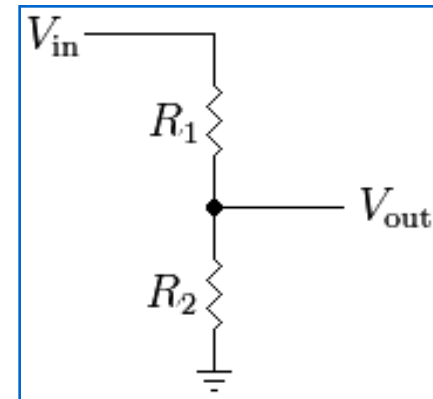
A good sensor

- **Should have**
 - Minimum Ratio Error
 - Minimum Phase Error
- **Should not be influenced by**
 - Temperature
 - Frequency
 - Magnetic Field (AC or DC)
 - Harmonics and distortions

Voltage sensing technologies Potential Dividers

- ✓ They are inexpensive
- ✓ They are linear over long voltage ranges
- ✓ They are not influenced by frequency
- ✓ Very little influence of temperature variation
- ✓ Do not introduce any phase error

- ✗ They do not provide isolation
- ✗ They are sensitive to burden variation



$$V_{out} = \frac{R_2}{R_1 + R_2} \cdot V_{in}$$

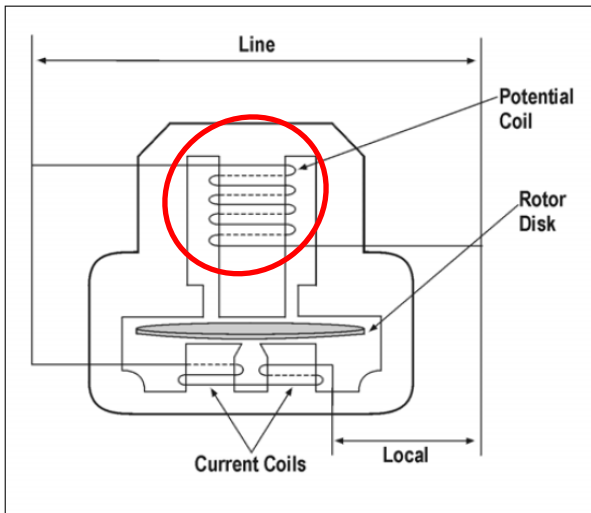
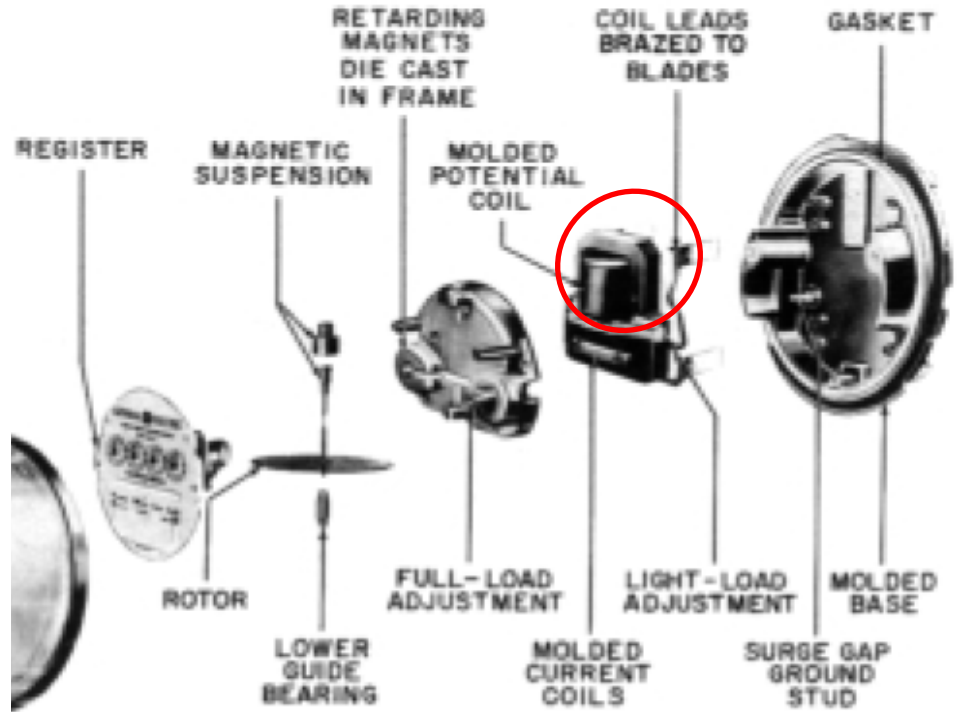
Voltage transformers

- ✓ **They provide isolation**
- ✗ **However, HF transients tend to jump the coils**
- ✗ **They are relatively expensive**
- ✗ **They are non linear over long ranges**
- ✗ **They introduce phase errors**
- ✗ **They are frequency sensitive**
- ✗ **They are influenced by temperature variation**

Generally only used where potential isolation is a key issue.



Let us compare with EM meter

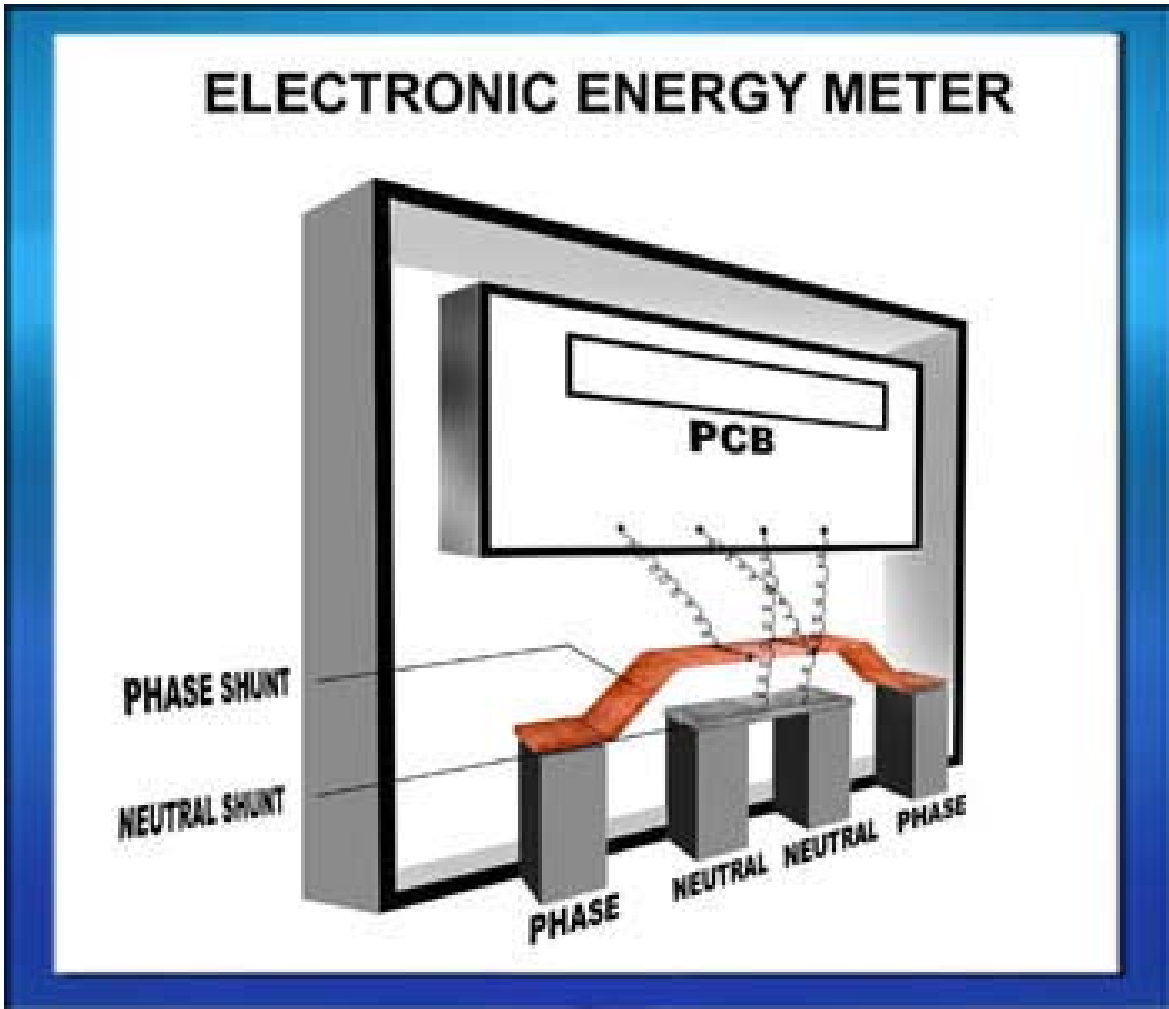


Potential Coil

Current sensing technologies

Current shunts





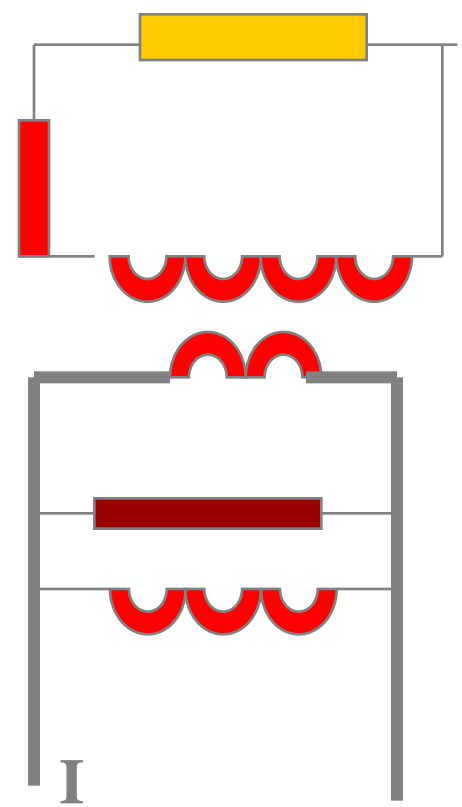
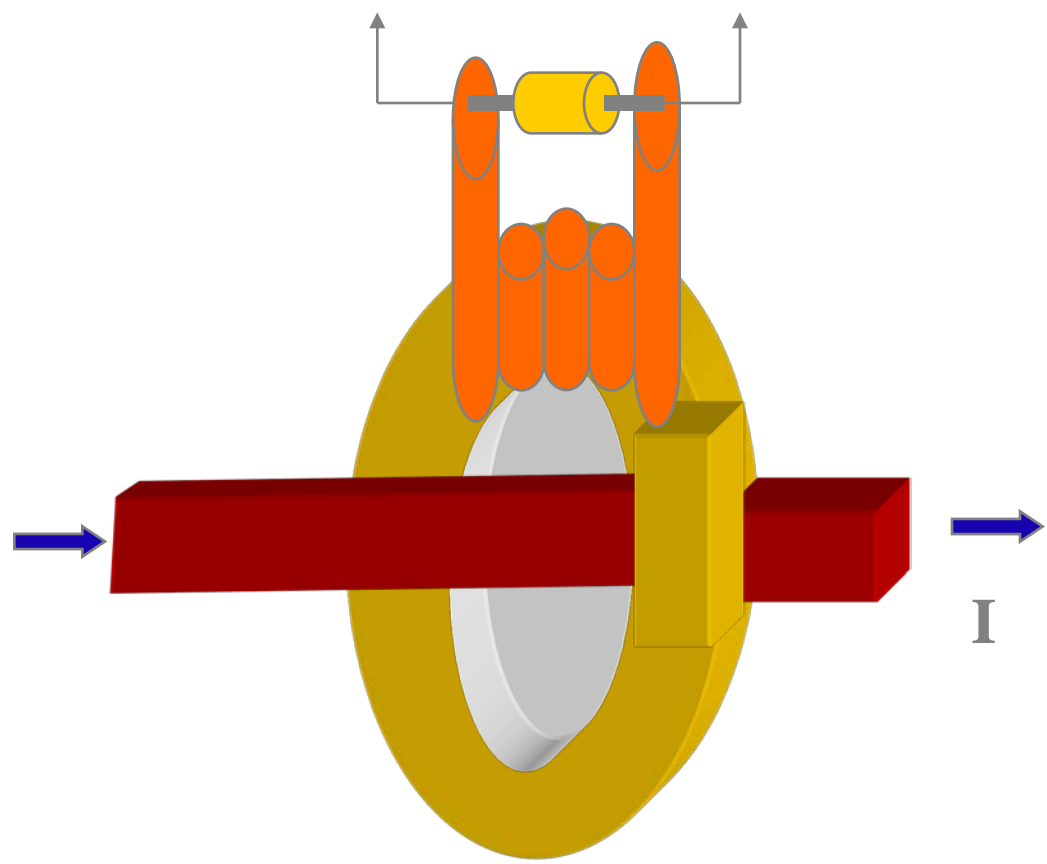
Current shunts

- ✓ **Shunts are relatively cheaper**
- ✓ **They are fairly linear**
- ✓ **They are not affected by frequency**
- ✓ **They are not affected by magnetic fields**
- ✓ **They do not introduce phase errors**

- ✗ **They are prone to temperature variations**
- ✗ **They are prone to junction ageing**
- ✗ **They do not provide isolation**

They are generally more suited to single phase meters

Current transformers





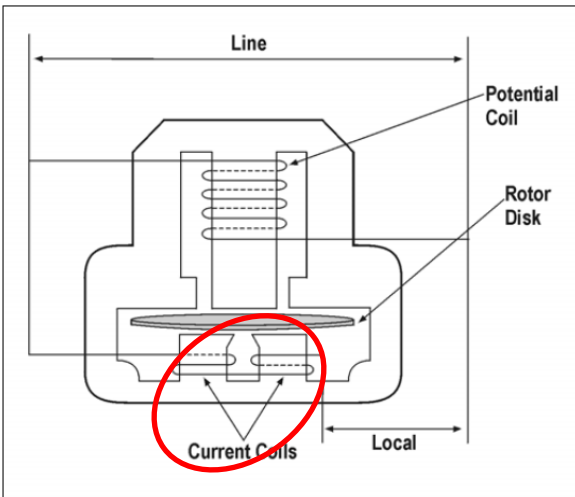
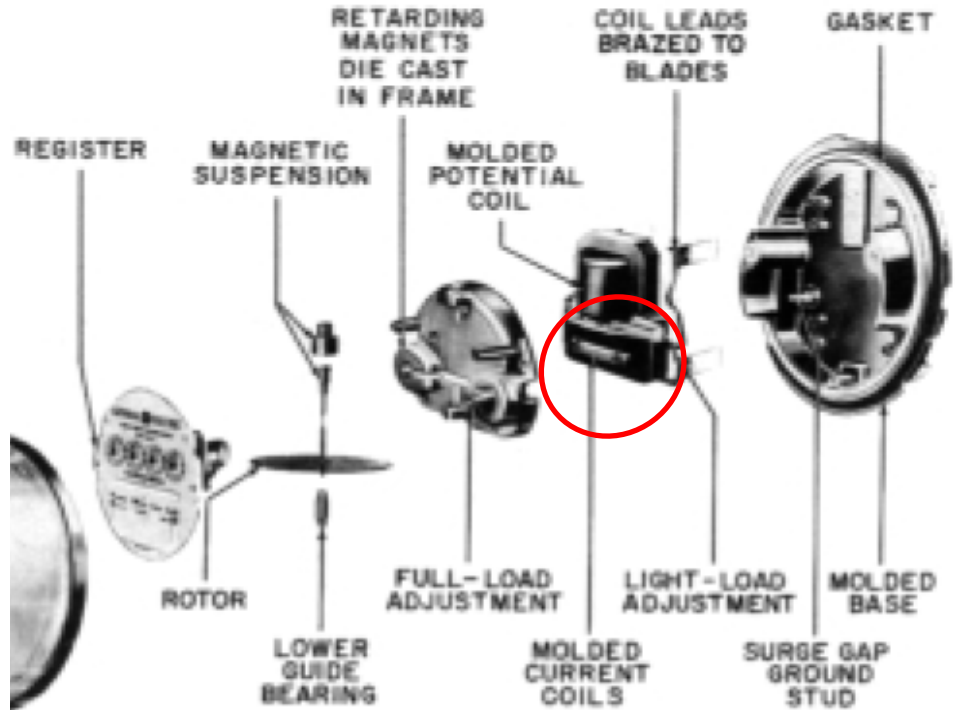
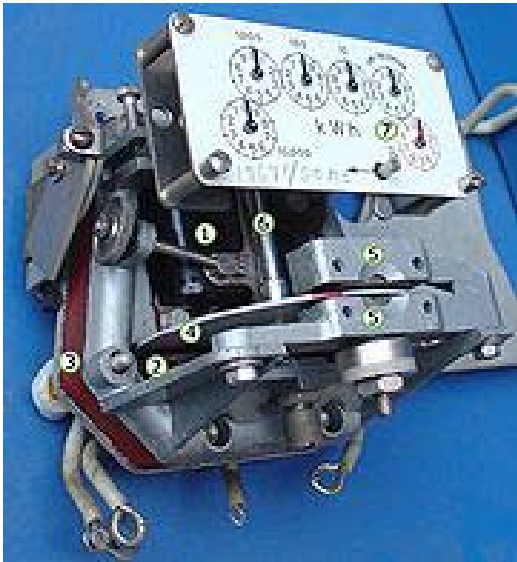
Current transformers

- ✓ They provide isolation
- ✗ They are relatively expensive
- ✗ They are nonlinear – depending upon core material
- ✗ They introduce phase errors
- ✗ They are susceptible to magnetic fields
- ✗ They are influenced by frequency variations, temperature variations
- ✗ They can be saturated by DC content in current

Yet, in general, they are the best choices for 3 phase applications



Let us compare with EM meter



Current Coil

Multiplier Technologies

- **Analog ‘log – antilog’ multipliers**
- **Mark space amplitude (MSA) multipliers**
- **Hall effect multipliers**
- **Direct digital sampling and multiplication**

Direct Digital Sampling

- Analog voltage and current signals converted into digital values
- Sample and hold circuits are employed
- Sampling frequency (f_s) is important
- Signals up to frequency component of $f_s/2$ are measured accurately

Digital sampling

- Most commonly deployed technology
- Important parameters –
 - ADC linearity
 - ADC conversion speed
 - Sampling speed
 - ADC effective bits
- Allows easy integration to digital systems
- Digital calibration and compensation is possible
- Basic parameters are available for computation



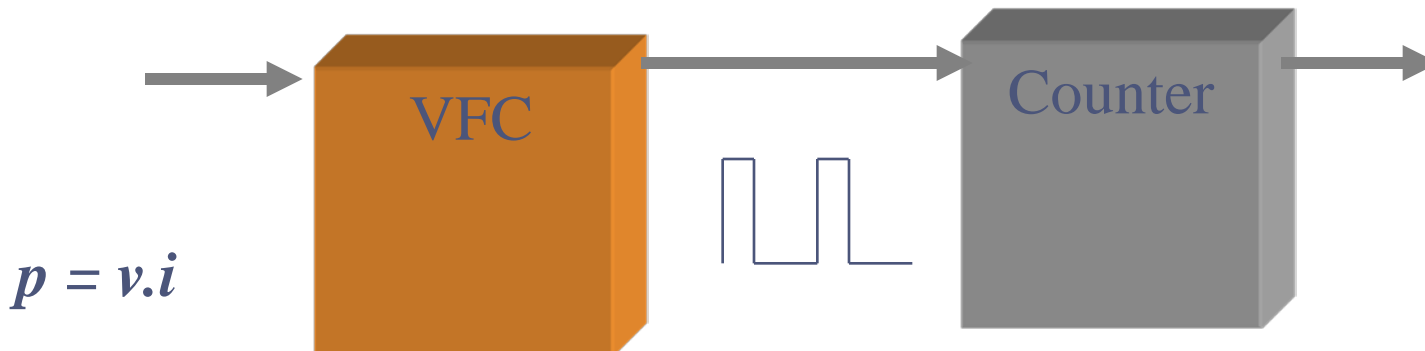
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Integrators and Registers

Integrator

- Often the power signal is converted to frequency and counted to give “integrated” output.

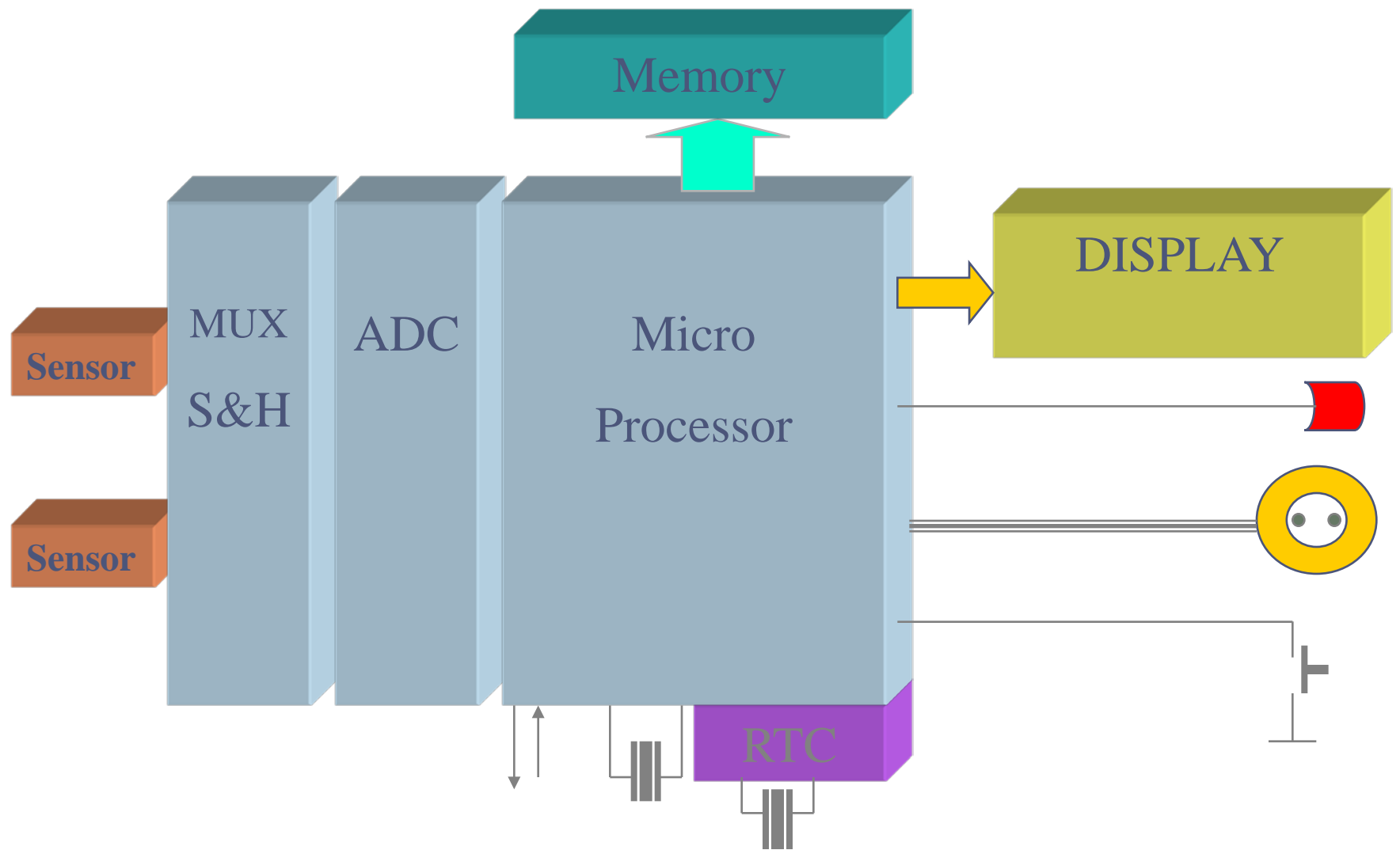


Integrators

- Digital systems deploy discrete integration in digital domain

$$P = (1/N) \sum_{n=1}^N \{V_n \cdot I_n\}$$

Electronic Meter (Typical)



Display types

- **Impulse Counter**
 - Influenced by magnetic fields
 - Mechanical wear and tear – short life
- **Light emitting diodes (LED)**
 - Good visibility in low ambient light
 - Difficult to customize icons and symbols
 - Higher power consumption
- **Liquid Crystal Displays (LCD)**
 - Temperature is an important issue
 - TN / STN displays
 - Often used with backlight
- **Vacuum fluorescent display (VFD)**
 - Excellent visibility
 - High power consumption
 - Expensive



Memories

- **Program memory (Non volatile)**
 - ROM (Mask, OTP, OTP Flash)
- **Data memory**
 - RAM (battery backed)
 - EEPROMs
 - FRAM
- **Scratch pad memory**
 - RAM
- **Registers**
 - RAM (battery backed)
 - EEPROMs
 - FRAM

Real Time Clocks

- **What are RTC's ?**
 - Frequency dividers, counters and RAM
- **High stability crystals**
 - RTC time accuracy depends on crystal stability
 - Crystal frequency varies as negative square of temperature
 - Therefore time will always get slower with change of temperature from nominal
 - Time has to be periodically set
- **Mains frequency based time**
- **GPS time synchronization**

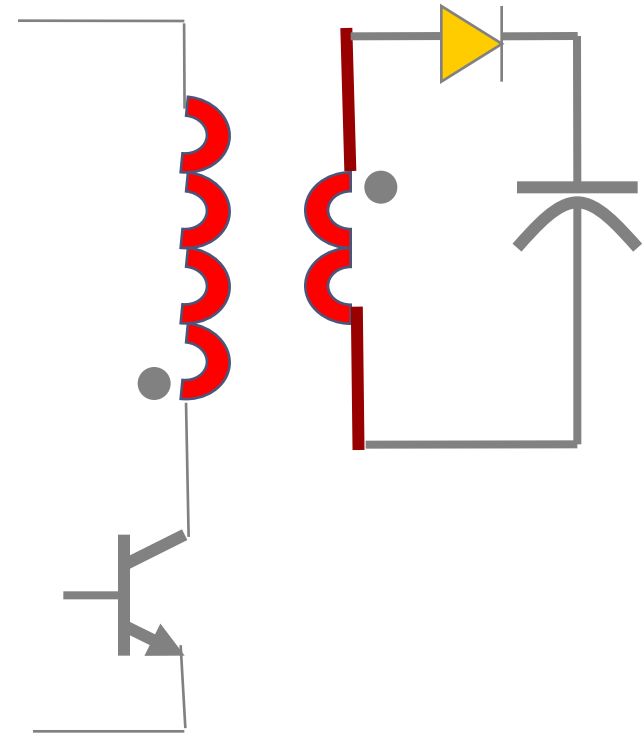
Power Supplies

- **The most critical component of an electronic meter**
- **Key issues to consider are:**
 - **Output voltages and isolation levels**
 - **Burden delivered to the load**
 - **Burden of the supply itself**
 - **Voltage range of operation**
 - **Immunity to magnetic fields**
 - **Surge immunity**
 - **Fast transient burst immunity**
 - **Conducted and radiated emissions**
 - **Sustained long term performance**
 - **Efficiency**

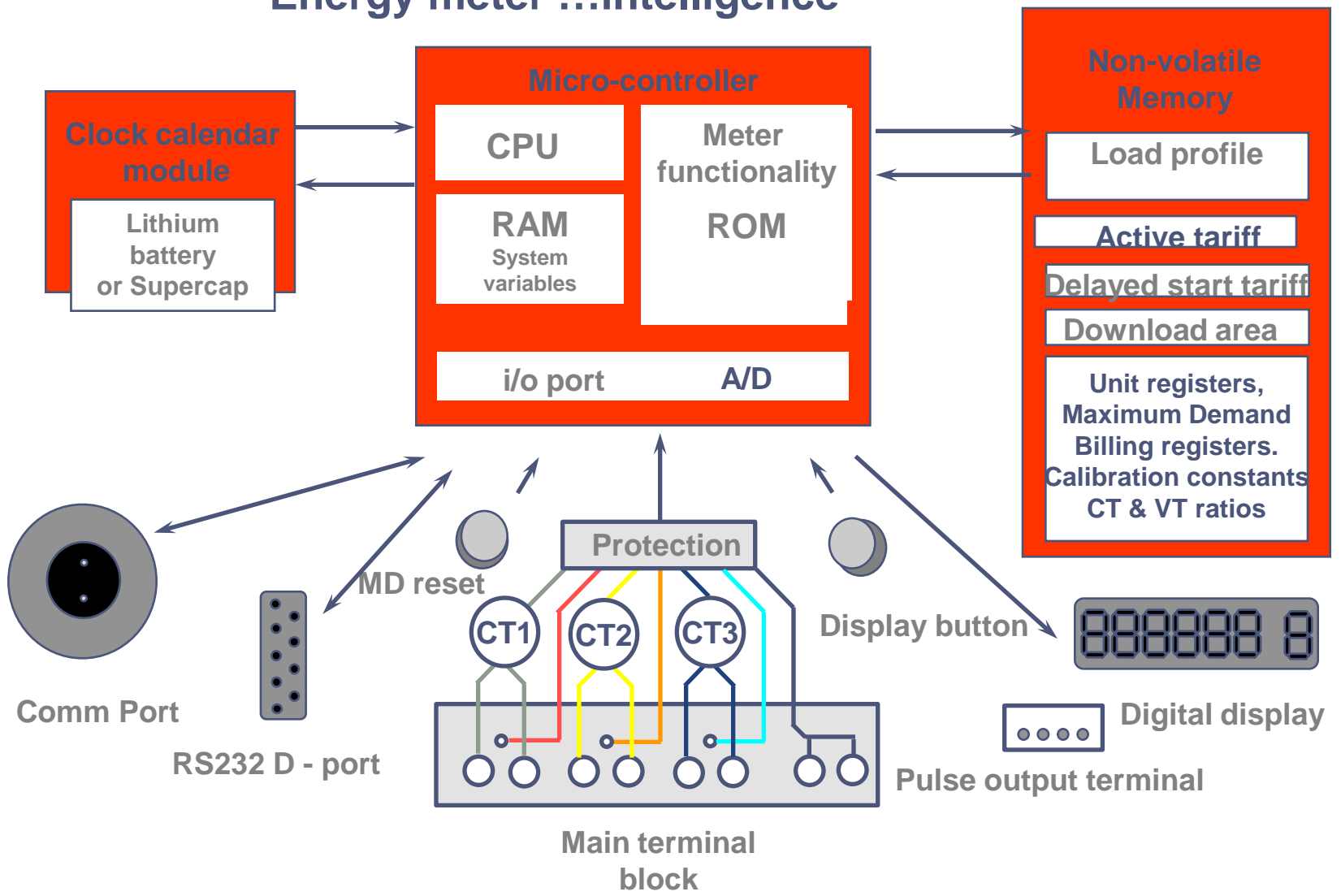
Power supplies

Switched mode power supply (SMPS)

- More expensive
- Very good line and load regulation
- Very high efficiency
- Higher conducted and radiated noise
- Low source burden
- Multi voltage output
- Full bridge configuration in 3 phase circuits



Energy meter ...intelligence



Applications of Electronic Meters

- Billing and AMR
- Payment Systems
- Load Control and Demand Response
- Load profiling
- Revenue Protection (Detect, prevent and create evidence against fraud)
- Power Quality and Event logging
- Energy Accounting
- Energy Monitoring and management

**Thanks
Any questions?**