



## *Breaker Basics*



# Breaker Basics

- Product Fundamentals
- Applications
- Electrical Standards



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- Applications
- Electrical Standards



# Product Fundamentals

- A circuit breaker is a device designed to open and close a circuit using a non-automatic (manual) means, as well as opening the circuit (tripping) automatically at a predetermined over-current level, without injury to itself when properly applied within its rating





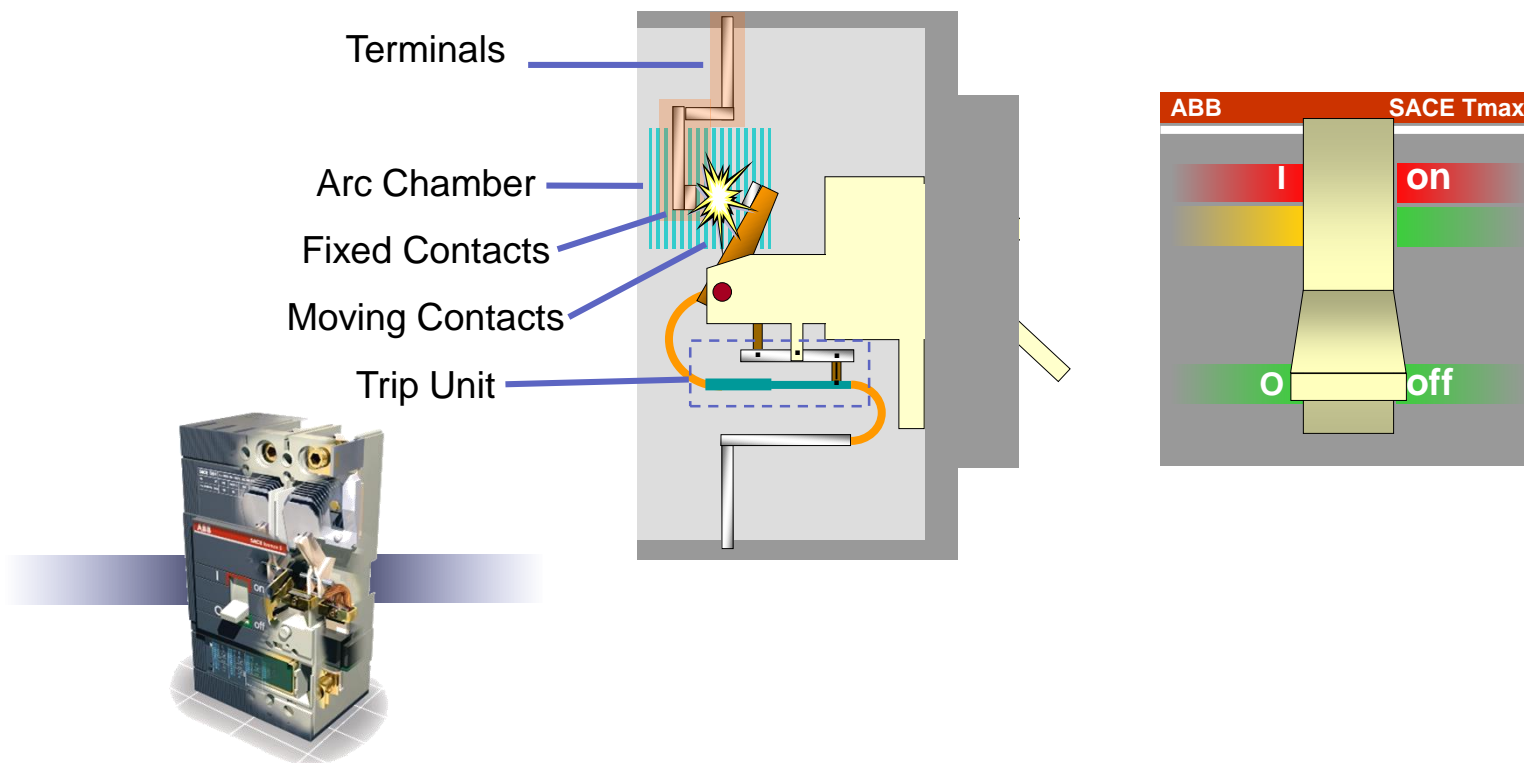
# Product Fundamentals

- Basic ratings
  - Current
    - Frame Size
    - Continuous Rated Current (size of load)
    - Maximum Interrupting Rating
  - Voltage
    - Rated Voltage



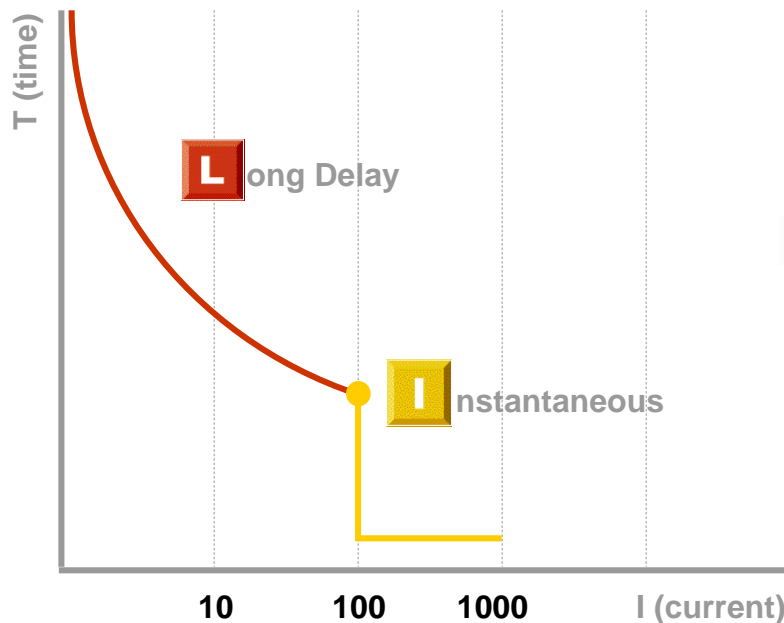
# Product Fundamentals

- Breaker Operation – Non-automatic (manual) operation
  - Using the operating lever to open and close the circuit




# Product Fundamentals

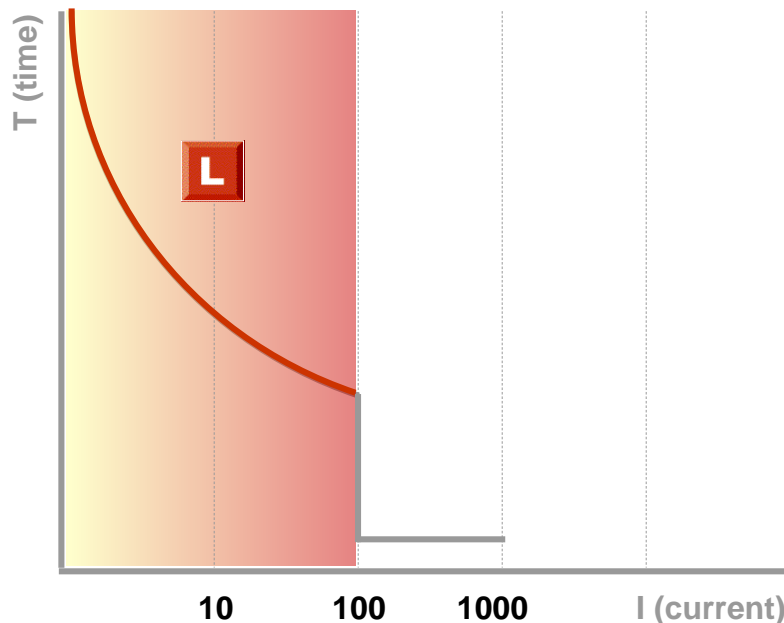
- Breaker Operation – Automatic means (over-current protection)
  - Basic Trip curve – illustrates the relationship between response (trip) time and current





# Product Fundamentals

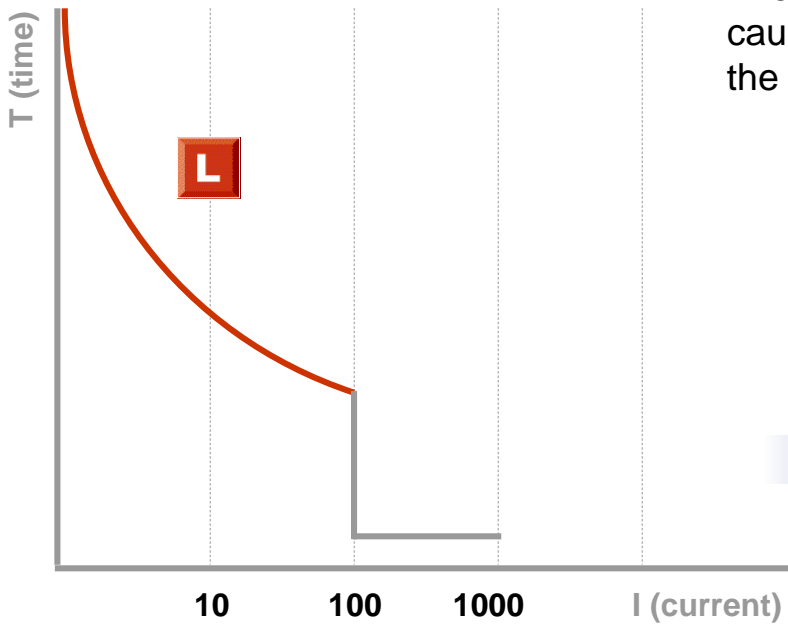
- Breaker Operation – Automatic means (over-current protection)
  - Overload Condition – excessive current condition resulting from an increase in the load applied (beyond a set limit)
    - Correlates to the first part of the trip curve (  ong Delay)



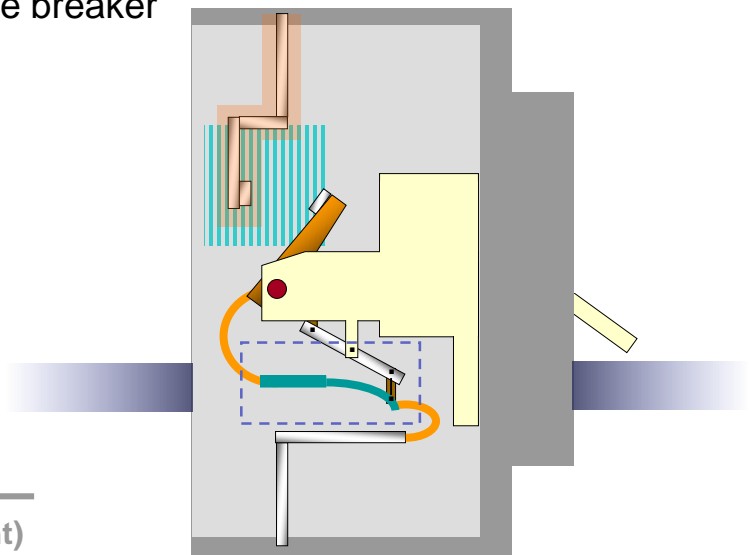
- During an overload, the excessive current through the breaker will generate heat
- The greater the overload condition, the greater the current and the greater the heat generated
- The higher the heat, the shorter the trip time (inverse time characteristic)

# Product Fundamentals

- Breaker Operation – Automatic means (over-current protection)
  - Overload Condition – excessive current condition resulting from an increase in the load applied (beyond a set limit)
    - Correlates to the first part of the trip curve ( **L**ong Time Delay)

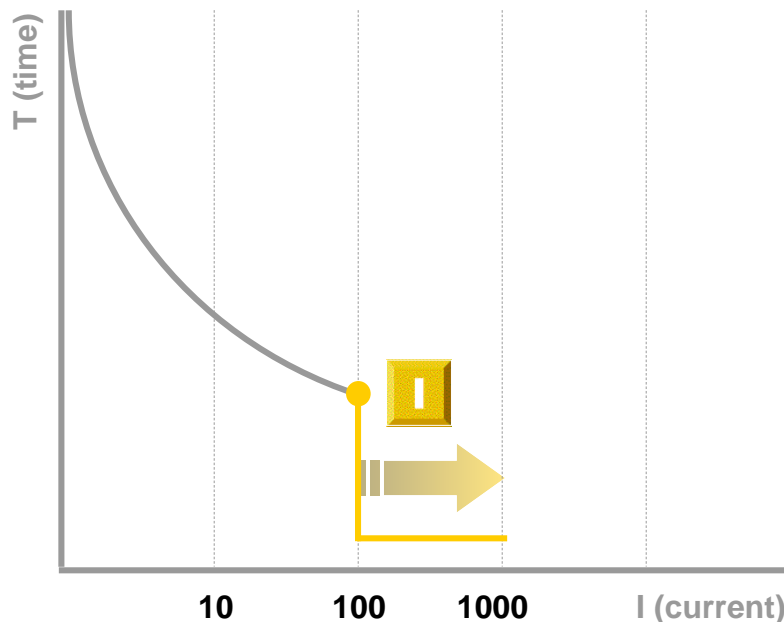


- The heat generated from an overload condition causes the bi-metallic element to bend, tripping the breaker



# Product Fundamentals

- Breaker Operation – Automatic means (over-current protection)
  - Short Circuit condition – excessive current condition resulting from two or more phases making contact with one another
    - Correlates to the second part of the trip curve (Instantaneous)

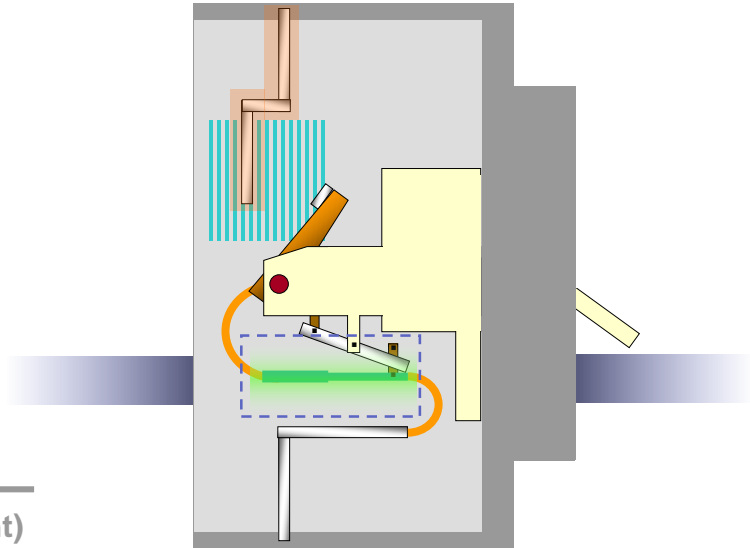
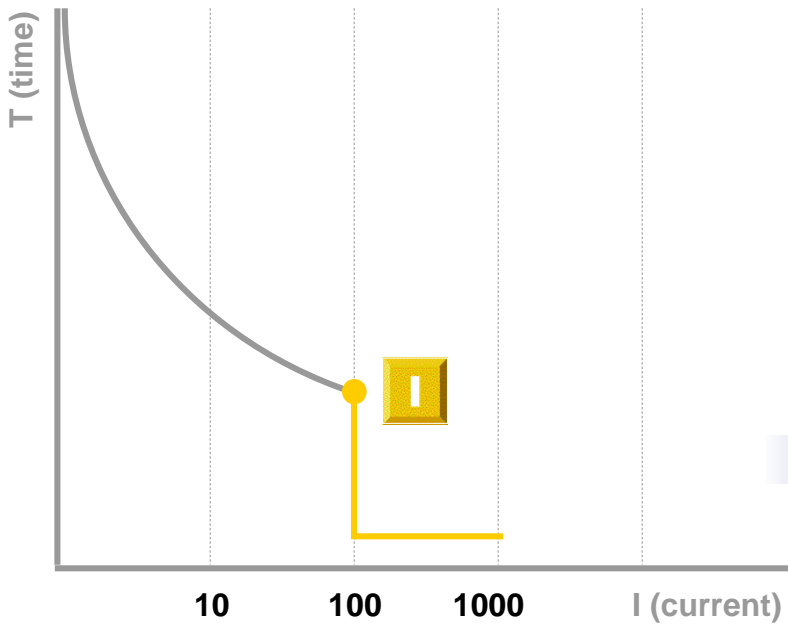


- During a short, current flow can become thousands of times greater than the normal operating amperage
- A breaker's Short Circuit Current rating indicates the amperage value at which the breaker trips instantaneously (usually expressed in **kA**)
- Reaching current levels greater than the Short Circuit Current rating will still result in an instantaneous trip

# Product Fundamentals

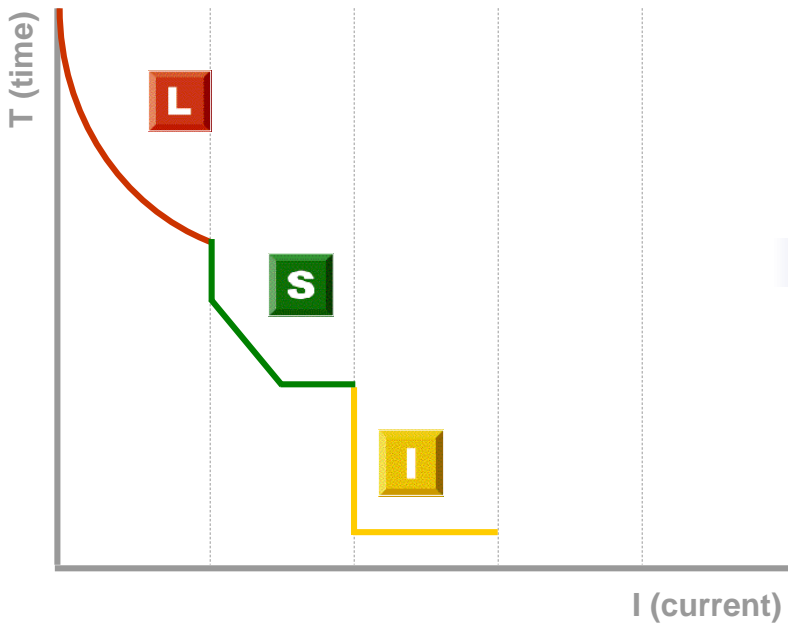
- Breaker Operation – Automatic means (over-current protection)
  - Short Circuit condition – excessive current condition resulting from two or more phases making contact with one another
    - Correlates to the second part of the trip curve (Instantaneous)

- The magnetic field generated from a short circuit attracts the trip mechanism to the element, tripping the breaker



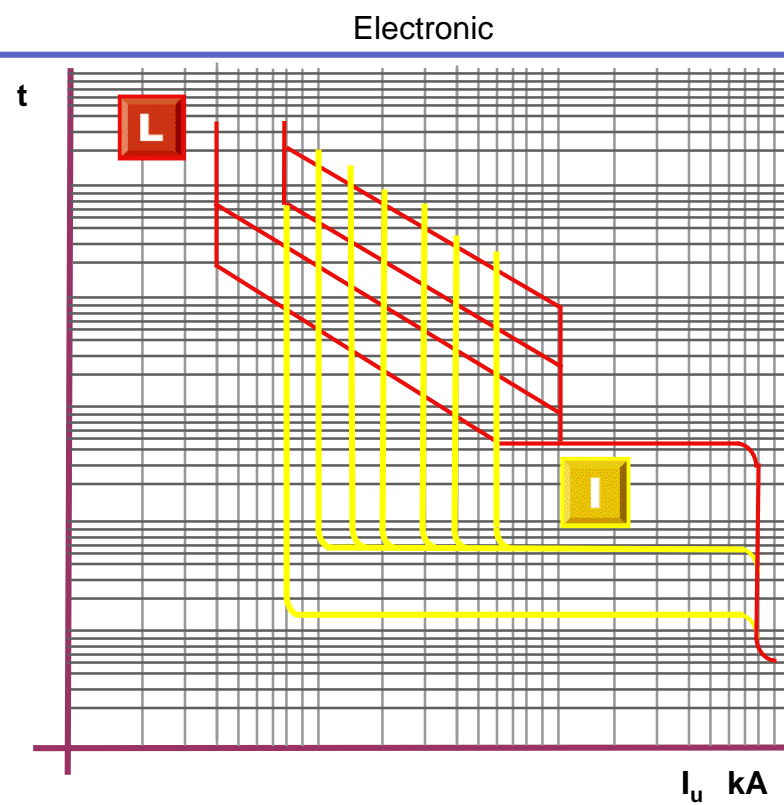
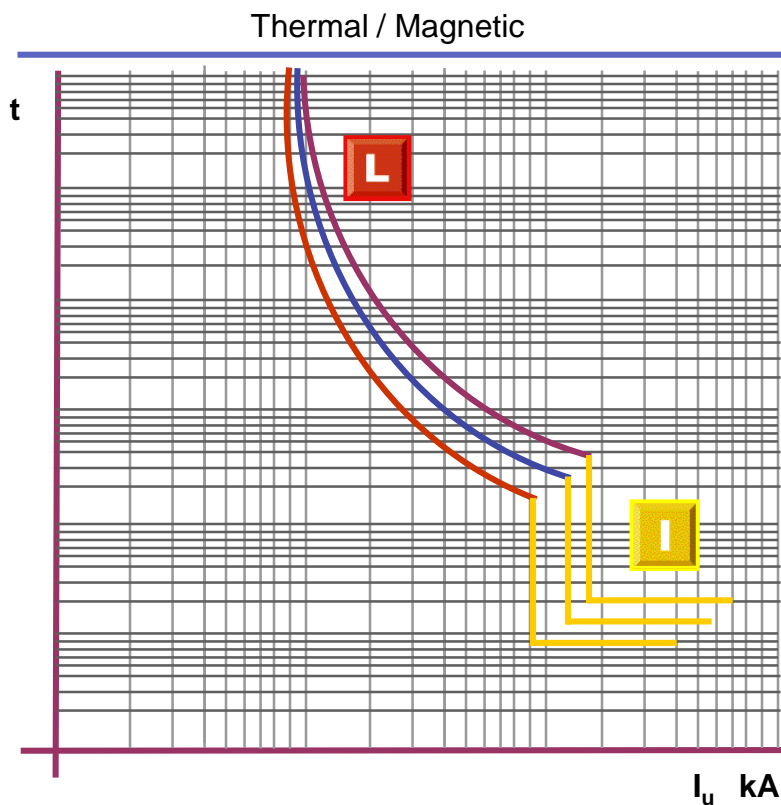
# Product Fundamentals

- Breaker Operation – Automatic means (over-current protection)
  - Additional Trip curve ranges:
    - **S**hort Time Delay - Protection against a short circuit with a short time delay trip function. If the fault current exceeds the set threshold value, the protection trips. Typically used in selective coordination applications.



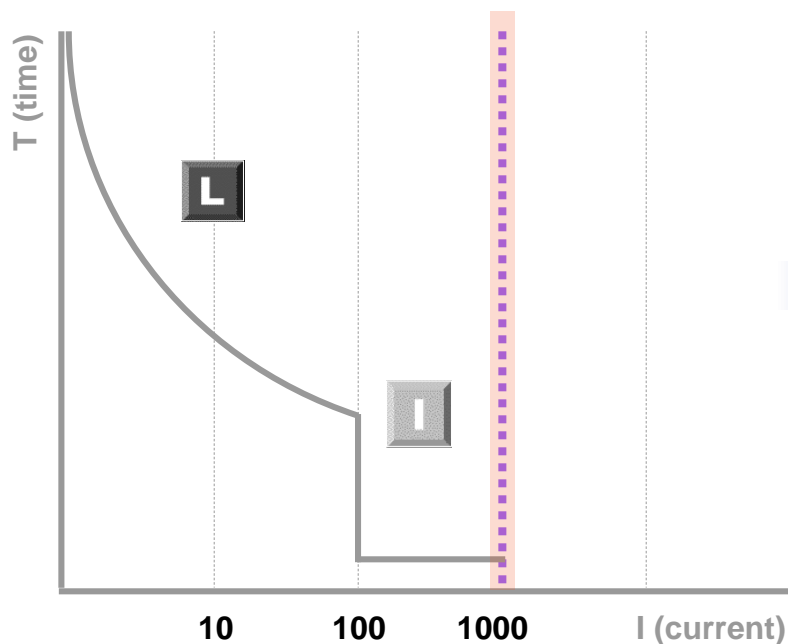
# Product Fundamentals

- Breaker Operation – Automatic means (over-current protection)
  - Trip curves for Thermal-Magnetic and Electronic Trip Units



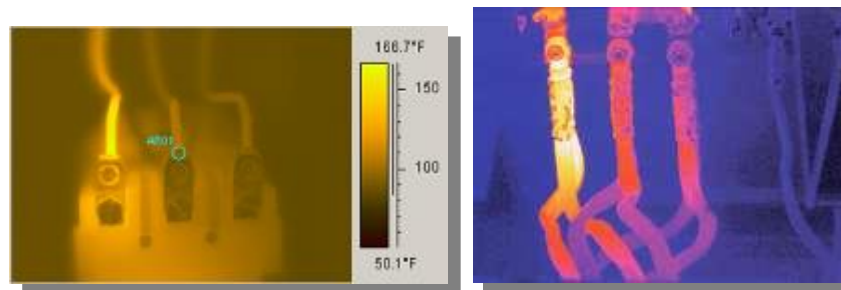
# Product Fundamentals

- Breaker Operation – Automatic means (over-current protection)
  - Maximum Interrupting Rating – maximum current level the breaker can safely interrupt when properly applied within its ratings



# Product Fundamentals

- Let-through Energy ( $I^2t$ )
  - High  $I^2t$  levels can result in:
    - Thermal Damage
      - Discoloration or melting of conductor insulation, terminals and/or components
    - Mechanical Stresses (from magnetic force created)
      - Broken or deformed Bus Bars / Bus Bar Insulators
      - Loose terminations
      - Reduced dielectric clearances due to the movement of the conductors





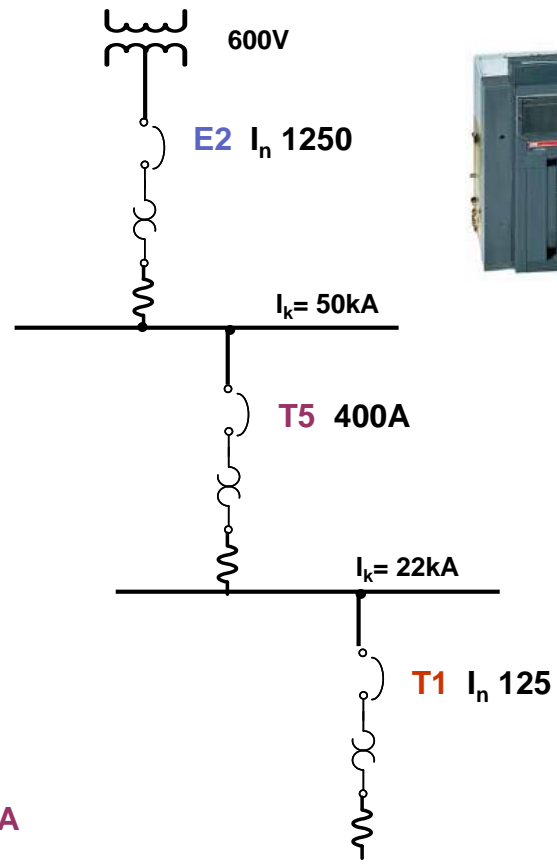
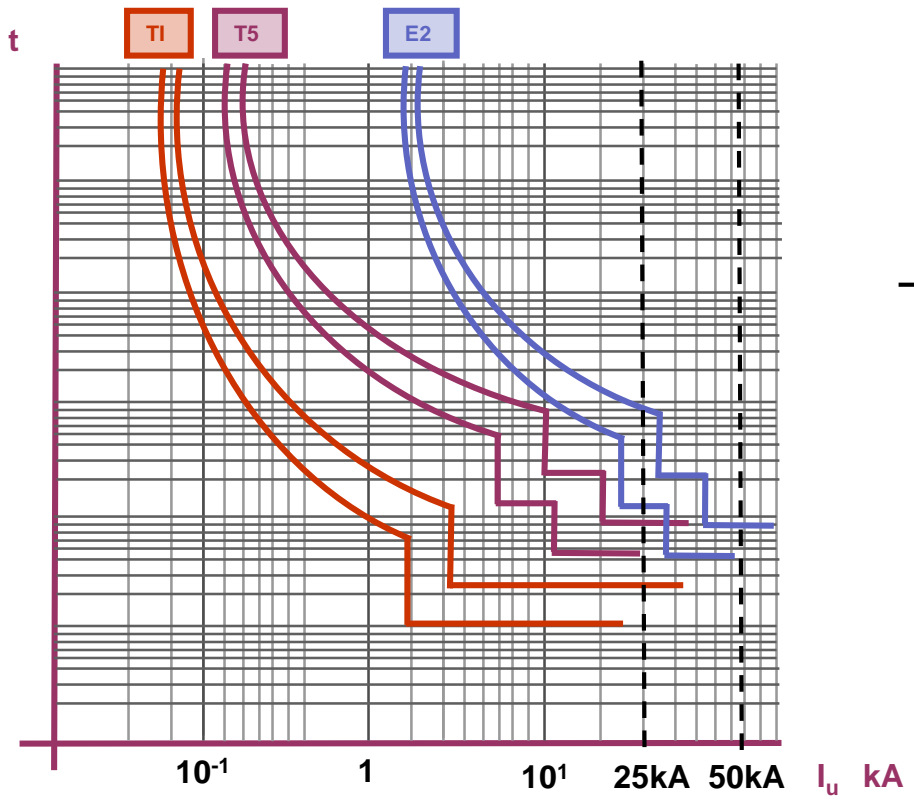
# Product Fundamentals

- UL Current Limiting
  - Substantially limits the peak let through current and thermal energy ( $I^2t$ ) during high level faults. The  $I^2t$  value must be less than  $\frac{1}{2}$  cycle wave of the symmetrical prospective current.
  - ABB UL Current Limiting Breakers:
    - UL489 Tmax T2H, T4H, T4V, T5H(400A), T5V(400A)
  - Typical uses:
    - Feeder device for UL508 control panel
    - Sensitive electronic loads



# Selectivity

- Selective Coordination
  - Minimizes the effects of an electrical fault by ensuring the breaker nearest the fault will trip first



- Mounting Configurations
  - Fixed
    - Bolted connection
    - Cable Lugs or Bus Bar electrical connections
    - Breaker mounting to equipment of enclosure
    - Cannot be removed without de-energizing the system



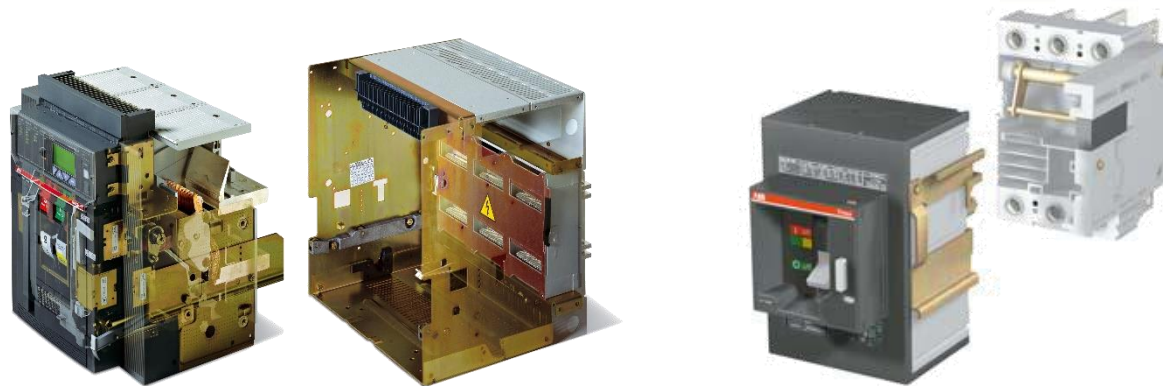
- Mounting Configurations
  - Plug-in
    - An assembly that provides a quick change means without disturbing power connections.
    - Used primarily in critical power and marine applications
    - Tmax breaker (T2 – T5)
    - Field installable



- Mounting Configurations

- Drawout

- A racking system that provides a quick change means without disturbing power connections.
    - Widely used in critical power, industrial, marine and utility power applications
    - Emax, T4-T7 Breakers



# Product Fundamentals

## ■ Undervoltage trip –

- A relay coil in the breaker that is energized by control power.
- When line power drops below a particular level, the coil de-energizes and trips open the breaker.
- The breaker cannot reclose until the voltage returns to a particular level.

## ■ Auxiliary contacts –

- Normally open or closed contact that mimics the state of the breaker



- **Shunt Trip**
  - Field installable in standard molded case or power breaker
  - Used to remotely trip the breaker
- **Bell alarm contact**
  - Field installable in standard molded case or power breaker.
  - Normally open contact that changes state only when a breaker opens due to a fault condition.



# Breaker Basics

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- Applicable Standards
  - UL Standards
    - UL489
      - This standard covers low voltage molded case circuit breakers and ground fault interrupters, fused circuit breakers and accessory high-fault protectors. These circuit breakers are specifically intended to provide service entrance, feeder, and branch circuit protection in accordance with the National Electrical Code. This standard also covers instantaneous-trip breakers specifically intended for use a part of a combination motor controller.



- 100% Rated Circuit Breakers (UL 489)

**Q Series:** SUITABLE FOR CONTAINING OPERATIONS AT 100 PERCENT OF RATING ONLY IF USED IN A CUBICLE SPACE 20.5 BY 16.6 BY 7.9 INCHES (520 x 420 x 200 mm)

- A standard circuit breaker is intended for use at no more than 80% of its rated current on continuous loads (3 hrs or more).
- Special label requiring additional thermal testing and larger enclosure
- Tmax 15A – 3000A
- Benefits
  - Smaller frame size breaker which could reduce the overall size of the panel
  - Smaller conductors (conductors are sized to “toggle” rating)



- Applicable Standards

- UL Standards

- UL1066

- This standard covers low voltage power circuit breakers. These circuit breakers are intended for installation in Low Voltage Switchgear, Switchboard and other equipment.
      - Drawout-mounted devices are intended for use with specific adapters or receiving equipment.



- UL1558 Low Voltage Switchgear
  - Metal enclosed assemblies containing low-voltage power circuit breakers, switches, instrumentation and metering, protective and regulating equipment

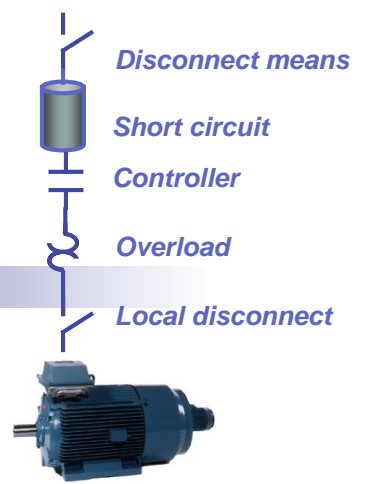


- UL891 Switchboards
  - A large dead-front panel rated 600V or less having rms symmetrical short-circuit currents of not more than 200,000A on which may be mounted meters, pilot lights, fixtures for illumination, manually or automatically operated switches, circuit breakers, overcurrent protective devices, bus bars or the like and the necessary wiring.



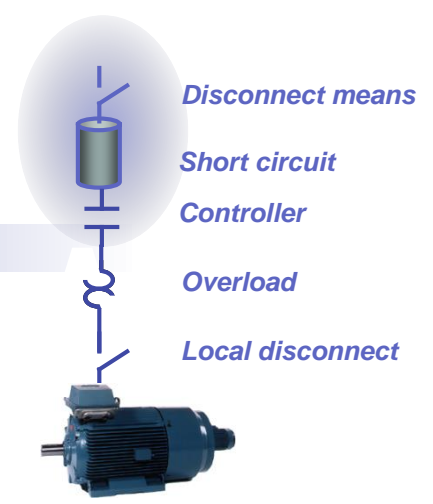
# Applications

- **UL67 Panelboards**
  - Are electrical distribution devices that convert incoming electrical power into several smaller circuits and provide short circuit and/or overload protection in the form of fuses or circuit breakers.
- **Industrial Control Equipment**
  - Industrial control devices and accessories for starting, stopping, regulating, controlling, or protecting electric motors



# Applications

- Motor Circuit Protector (MCP)
  - Intended for use as part of a combination motor controller
  - Provides short-circuit (instantaneous) protection only
    - Does NOT provide overload protection



*Disconnect means*  
*Short circuit*  
*Controller*  
*Overload*  
*Local disconnect*

- Molded Case Switches (MCS)
  - Used as a manual disconnecting means
  - Does not provide over-current, overload or ground fault protection
  - Benefits:
    - Can be enhanced with accessories: shunt trips, aux contacts, undervoltage etc..





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- Applicable Standards
  - IEC Standards
    - IEC60947-2 Low-voltage switchgear and controlgear - Part 2: Circuit Breakers
      - This standard applies to circuit breakers, the main contacts of which are intended to be connected to circuits, the rated voltage of which does not exceed 1000VAC or 1500VDC.



# Electrical Standards

- Applicable Standards

- CE – European Conformity

- The European Union has set up rules for selling certain types of products within the European Union. The CE mark represents company quality certifications for machines with moving parts, electronic devices, medical devices, etc.



- CCC – China Compulsory Certification

- Effective May 2002, the CCC mark is a Safety and Quality mark for many products sold in the Chinese market. The CCC mark replaces the two old marks, CCIB, CCEE used in the two old inspection systems



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for a better world™

