When a fault causes a short circuit, the shorting current will cause the electromagnet to attract the associated armature. The moving armature unlatches the trip mechanism, tripping all three poles of the breaker.

This trip action occurs very quickly (approximately 20 milliseconds); the only delay being the time that it takes for the contacts to physically open.

The thermal overload and instantaneous magnetic overcurrent protectors will trip the breakers of all three poles in a 3-phase system. This tripping cannot be prevented by the latch position being forced as the breakers have a trip free mechanism.

1.1.7 Motor Starter Protector Accessories

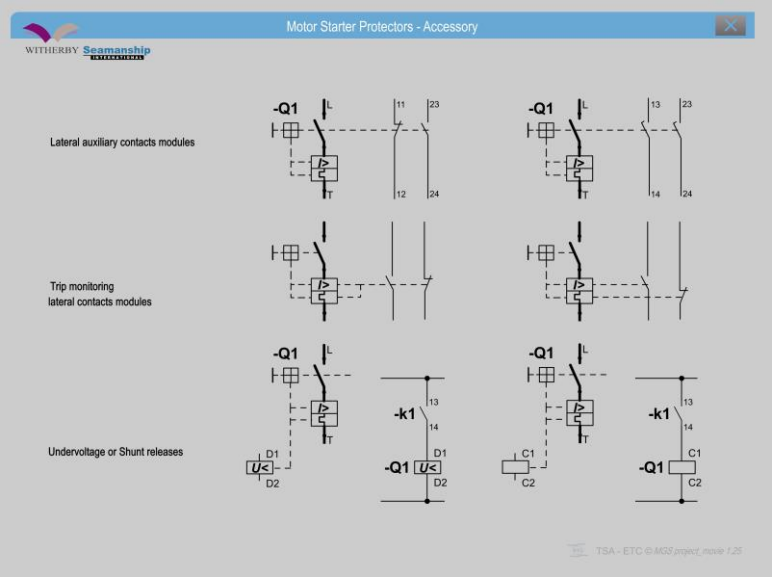

Figure 25: MSP accessory

Motor starter protectors can be integrated with different modules:

Lateral auxiliary contacts module
When the status of a motor starter protector, whether it is open, closed or tripped, is to be monitored, eg by using an alarm system, the normally open/normally closed lateral contacts module is used.

Trip indicating contact module
When it is important that the type of trip is known, a trip indicating auxiliary contact should be used. This contact indicates the causing actions, such as general trip, trip by voltage release overload release or short circuit release.

Early make contact module
A side mounted early-make contact module may also feature in the control diagrams. The working principle of these contacts is similar to the control relay early make contacts. When a motor starter protector is switched on, the early make contacts will close before the contacts of the motor starter protector. These early make contacts are used for interlock and load shedding circuits, as well as early make switching of the undervoltage release with the main switch and/or emergency stop applications.

Undervoltage release module
An undervoltage release module allows the motor starter protector to be controlled remotely by tripping the latching mechanism when the supply voltage drops significantly. This module prevents the motor starter from restarting automatically once it has been tripped, as it is impossible to re-set the motor starter protector and re-start the motor unless the release coil has been re-energised.

Shunt release module
A shunt release allows the motor protector to switch off immediately the coil is connected to supply voltage.

Only one out of these two releases is used for a single motor starter protector.

1.1.8 Moulded Case Air Circuit Breakers

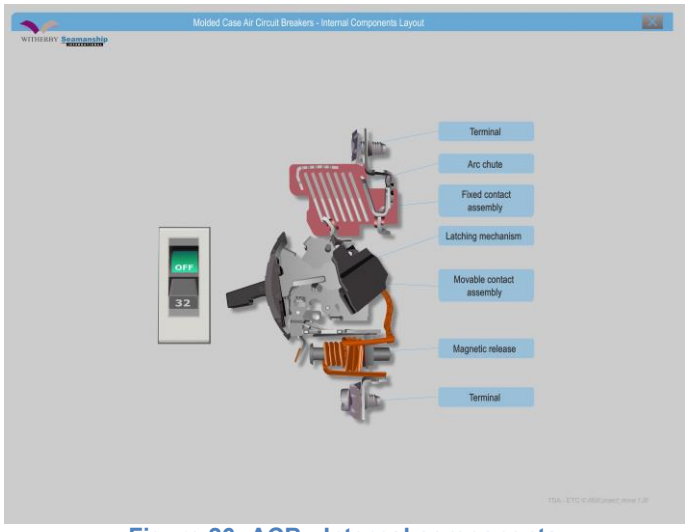

Figure 26: ACB - Internal components

Moulded case air circuit breakers, also known as MCCB or ACB, may be used to protect motor starters in various applications. The tripping mechanism and contacts are assembled together in a moulded case that adds high dielectric and mechanical strength to the circuit breaker. In addition, an arc chute is provided that will suppress and extinguish arcs to prevent arcing damage to the breaker contacts.

Moulded case circuit breakers can incorporate a class 10 or class 20 adjustable thermal release, that will protect the circuit against overload, and an instantaneous magnetic release protecting against a short circuit.

If a fault occurs, the short circuit current will cause the electromagnet to attract the armature. This action unlatches the mechanism and trips the breaker's three poles.

It should be noted that both the thermal and magnetic releases actuate a tripping mechanism that will trip the breaker. This tripping mechanism is also known as a latching mechanism.

When tripped, the mechanism's handle will move midway between the closed and opened positions. To reset the system after tripping, the handle must be moved to the opened position first to reset the latching mechanism and then moved to the closed position again.

The latching mechanism has a trip free feature ensuring that the tripping action cannot be prevented by holding the operating handle in the closed position.

Figure 27: Air circuit breaker

Moulded case breakers may have the following components as accessories:

In Figure 27, click on one of the front cover screw heads to open the cover. Simulation of power on and off is controlled by clicking on the undervoltage release, found under the cover.

Latch monitoring auxiliary contacts
Latch monitoring contacts provide any required safety features through the control circuits.

Trip monitoring auxiliary contacts
Trip monitoring contacts are used with integrated alarm systems to indicate the specific type of trip, ie general trip, trip by voltage release, overload or short circuit release.

Early make auxiliary contacts
Early make auxiliary contacts are used for interlock and load shedding circuits, as well as for early application of the control voltage for undervoltage release and/or emergency stop applications.

Undervoltage release
Undervoltage release is a solenoid that has a magnetic system linked with the kinematic latch of the breaker. It is most often incorporated for power network safety purposes, where it opens the circuit breaker if there is a significant dip in the power supply voltage or if there is a power failure. Once a breaker has tripped due to an undervoltage release, it can only be closed again under the condition that the power supply is applied across the undervoltage release terminals.

The power supply for undervoltage release is fed from either the supply side of the circuit breaker or from an independent source routed through the output contacts of the various safety devices, such as power management systems, emergency stop buttons, safety relays, etc.

Shunt Release

A shunt release is a solenoid that has a magnetic system linked with the kinematic latch of the breaker. It is similar to the undervoltage release and allows the switchgear to be tripped using a remote control.

Undervoltage release and shunt release cannot be mounted together.

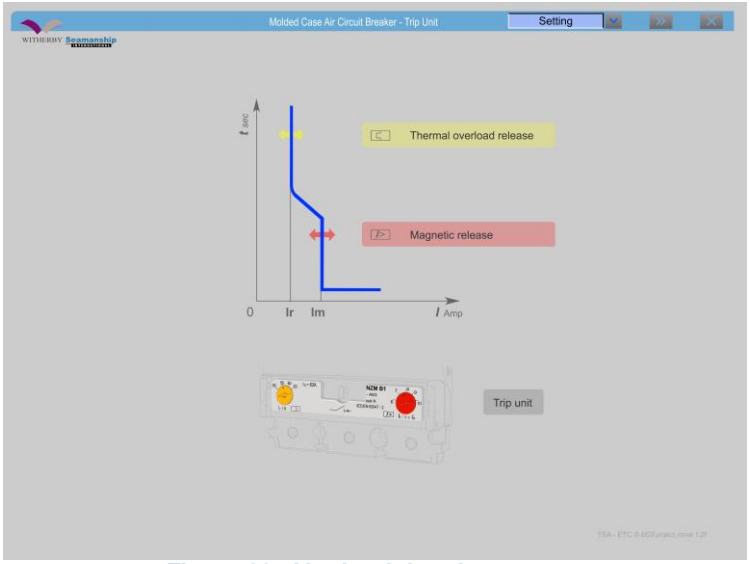

Figure 28: Air circuit breaker – curve

To determine the time delay of the breaker trip at a given current, manufacturers provide time/current curves. The horizontal axis represents the current in amperes and the vertical axis represents time in seconds. The top part of the time/current curve, Ir, shows the performance of the overload trip component of the breaker. The bottom part of the time/current curve, Im, shows the performance of the instantaneous magnetic trip component of the circuit breaker.

By adjusting the thermal and magnetic trip components, the curve changes, displaying the performance for the changed settings.

1.1.9 Timers (timer relays)

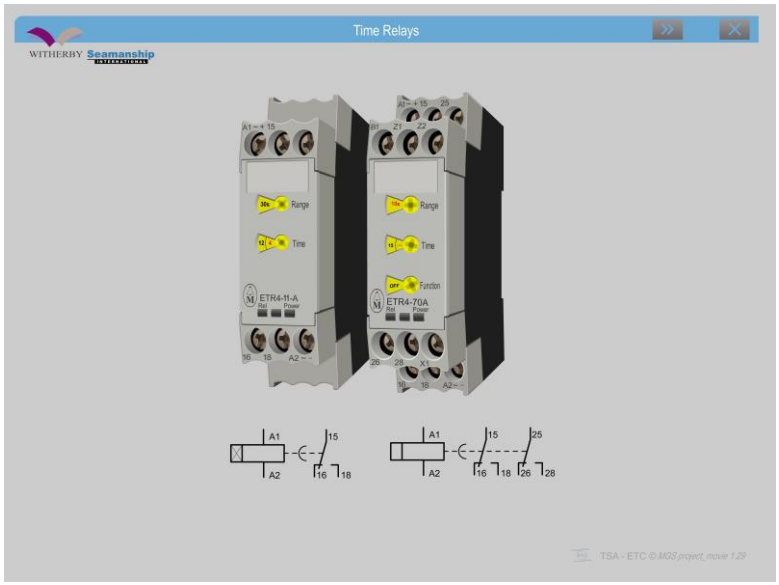

Figure 29: Timers

Many different types of timers operate on board in a variety of locations, although they have several features in common.

When troubleshooting control circuits where timers are used, it is important to understand what initiates the time delay from when the timed sequence starts to when the coil of the output relay is energised and activates the contacts.

Timer relay contacts are identified as changeover contacts with an umbrella symbol. This illustrates the direction the time delay operates, ie on energising or de-energising.

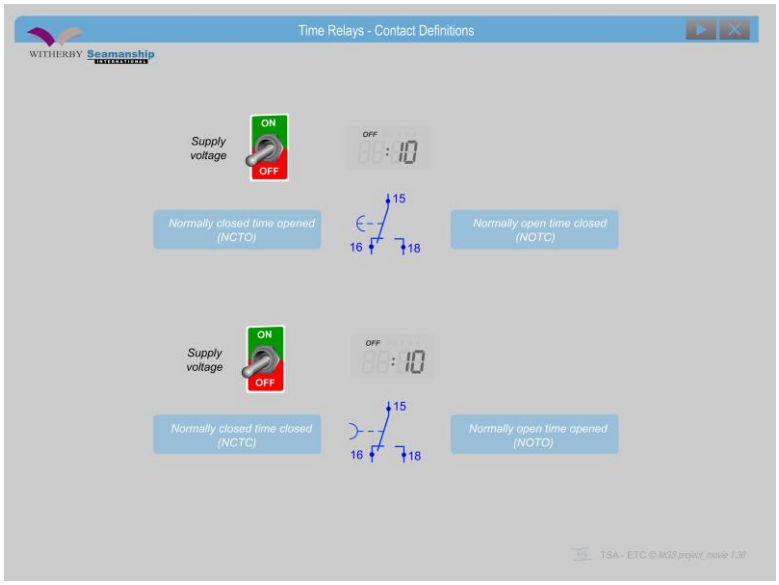

Figure 30: Contacts definition

Unlike the changeover contacts of miniature relays that are marked with reference numbers, such as 11, 12 and 14, the timer relay contacts have the reference numbers 15, 16 and 18 for the first group of contacts and 25, 26 and 28 for the second group. The window symbol to the left of the coil's symbol, and the umbrella sign adjacent to the actual contacts symbol, indicate the timer function.

The four basic types of time dependant operated contacts are:

Normally Open Timed Closed (NOTC)
The NOTC contact is coded with the reference digits 15 and 18. It also has an umbrella symbol indicating the side that the contact closes. This type of contact will be open when the coil of the relay is de-energised. The contact closes when power is applied to the relay terminals A1 and A2, but only after the relay has been continuously powered for a specific amount of time, known as a time delay. This means that the direction of the contact motion is identical to a regular normally open contact, but there will be a delay in the closing direction when the coil of the relay energises. This type of contact is also known as a 'normally open on delay' contact.

Normally Open Timed Opened (NOTO)
The NOTO contact is also coded with the reference digits 15 and 18 and has an umbrella symbol indicating the side that the contact opens. As it is open when the coil of the relay is de-energised, it will close immediately when the coil of the relay is energised. The timing action occurs when the relay is de-energised, ie delaying the contact's opening. This contact is also known as a 'normally open off delay' contact.

Normally Closed Timed Opened (NCTO)
The NCTO contact is coded with the reference digits 15 and 16 and has an umbrella symbol indicating the side that the contact opens. When in the closed position, the relay is de-energised and will open when the coil of the relay is continuously powered for a specific amount of time. The direction of the contact motion is identical to a regular normally closed contact, but there will be a delay when it opens. This type of contact is also known as a 'normally closed on delay' contact.

Normally Closed Timed Closed (NCTC)
The NCTC contact is also coded with the reference digits 15 and 16 and has an umbrella symbol indicating the side that the contact closes. It is in the closed position when the coil of the relay is de-energised and opens immediately when the relay is energised. The timing action occurs when the relay is de-energised, delaying the closing of the contact. This contact is also known as a 'normally closed off delay' contact.

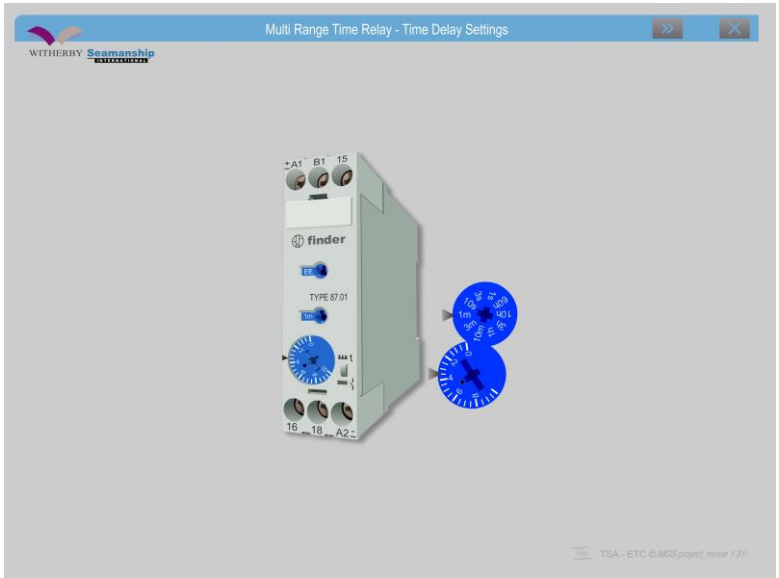

Figure 31: Multi-range timer *(reproduced with kind permission from Finder)*