

# TechTopics No. 117

## MOC / TOC switches

Certain questions seem to arise often, even on topics that have been recognized in the industry for decades. One of these is the question of mechanism-operated cell (MOC) and truck-operated cell (TOC) switches, where there still is uncertainty as to what they are and why they exist.

Users are familiar with circuit breaker mounted auxiliary switches, typically referred to as 52a and 52b switches. IEEE Std C37.2 (as does IEEE Std C37.20.2) defines the meaning of 52a and 52b switches, which (paraphrased) are:

- 52a a circuit breaker operating mechanism actuated switch that is closed when the main contacts are closed.
- 52b a circuit breaker operating mechanism actuated switch that is closed when the main contacts are open.

These switches are actuated by the circuit breaker operating mechanism directly, and are mounted on the circuit breaker. In Siemens' circuit breakers, the auxiliary switches are mechanically linked to the main rotating shaft of the circuit breaker, so they faithfully mimic the condition of the main contacts.

Typically, a circuit breaker has a limited number of auxiliary switches, usually eight. Of these, several are used in the control circuit of the circuit breaker, with three or four auxiliary switches unused and available for use in the user's control circuits. All of the auxiliary switch stages that are connected to circuits off of the circuit breaker itself must be connected through secondary disconnect contacts. The limitation of the number of secondary disconnect contacts available also limits the number of auxiliary switch contacts available on the circuit breaker.

Historically, specifiers of switchgear for complex continuous process applications (such as in petro-chem facilities, steel mills, or utility generating stations) requested a large number of additional auxiliary switches for use in their external overall system control schemes. These auxiliary switches could not be accommodated on the circuit breaker removable element itself, as the number of secondary disconnect contacts was limited.

To provide the effective number of auxiliary switch contacts that users requested, the MOC switch was created. IEEE Std C37.2 (and IEEE Std C37.20.2) describe the MOC switch as a mechanism-operated contact or mechanism-operated cell switch, that is mounted in the stationary housing (cubicle) and includes the necessary linkage so that the switch positions mimic those of the 52a / 52b switches. So, the corresponding definitions are:

- 52MOC-a an auxiliary switch (installed in the stationary housing) that is closed when the circuit breaker main contacts are closed.
- 52MOC-b an auxiliary switch (installed in the stationary housing) that is closed when the circuit breaker main contacts are open.

Siemens' standard practice is to arrange the MOC switches so they are operated only in the connected position, not in the test position. Historically, many users preferred to have the MOC switches operated through a linkage that operates the switches when the circuit breaker is in the connected position, and when the circuit breaker is in the test position. However, this can be a problem for certain control schemes, as a circuit breaker that is in the test position and closed is not "closed" on the main power circuit, and the external control scheme must not sense this as a closed circuit breaker.

Therefore, when the MOC switches are operated in the connected as well as in the test position, the 52MOC-a switches usually need to be in series with a 52TOC-a switch that corresponds to the position of the circuit breaker inside the compartment, and the 52MOC-b switches need to be in parallel with a 52TOC-b switch. This is why the function of a TOC switch is needed.

IEEE Std C37.2 and IEEE Std C37.20.2 describe the TOC switch as a truck-operated contact or truck-operated cell switch, mounted in the stationary housing (cubicle) and arranged to indicate the position of the circuit breaker in the circuit breaker compartment. So, the corresponding definitions are:

- 52TOC-a an auxiliary switch (installed in the stationary housing) that is closed when the circuit breaker removable element (truck) is in the connected position, and open when the circuit breaker removable element (truck) is not in the connected position.
- 52TOC-b an auxiliary switch (installed in the stationary housing) that is open when the circuit breaker removable element (truck) is in the connected position, and closed when the circuit breaker removable element (truck) is not in the connected position.

In this issue of TechTopics, Siemens uses the designations from IEEE Std C37.2, as above. It should be noted that some users prefer to refer to these switches with alternate forms, 52S for the 52MOC switch, and 52H for the 52TOC switch.

Siemens' standard practice is to operate the MOC switches only in the connected position, not in the test position. This has the advantage of eliminating the need for a 52TOC-a switch in series with the 52MOC-a switch, as the 52MOC-a switch will not be actuated when the circuit breaker is in the test position and closed. Similarly, the need for 52TOC-b switch contacts in parallel with 52MOC-b switches is eliminated.

However, if specified by the purchaser, Siemens can arrange the MOC switches so that they are operated by the circuit breaker in both the connected and the test positions inside the circuit breaker compartment. Some users prefer that the MOC switch be operated in both test and connected positions so as to allow for complete system checks during commissioning.

One of the major advantages of use of MOC and TOC switches is that the circuit breaker is simplified. As an example, if the user has complex external control scheme requirements that relate to the main circuit breaker and to the tie circuit breaker, but fewer requirements for auxiliary switches on feeder circuit breakers, the additional control circuit MOC and TOC switches can be provided only in the main and tie circuit breaker compartments, and not in the feeder circuit breaker compartments. This reduces the purchase cost of the switchgear. Also, the circuit breakers need not be unique for the main and tie circuit breaker compartments.

Assuming that the circuit breakers have the same ratings, the feeder circuit breakers and main and tie circuit breakers will all be interchangeable and all will have the operating linkage for the MOC and TOC switches.

The TOC switches are often used for motor circuits, to energize space heaters in the motor. In this usage, the circuit breaker 52b (or, more frequently, the 52MOC-b) switch is wired in parallel with a 52TOC-b switch so that when the circuit breaker is in the connected position and open, the motor space heater is energized by the 52b (or 52MOC-b) switch, and when the circuit breaker is removed from the connected position, the motor space heater is energized through the 52TOC-b switch. Again, the TOC switch not be required if the 52MOC-b switch only operates when the circuit breaker is in the connected position.

This is an area of switchgear technology in which users have been slow to accept the changes made possible by modern electronic protection relays and programmable controllers. Many years ago, when it was not uncommon to have nine or even more relays on a main circuit breaker compartment panel (three overcurrent, three differential, and three voltage) and automatic-transfer schemes used a number of discrete devices and multiple circuit breaker auxiliary switches, all of these MOC and TOC switches were necessary.

With today's electronic multifunction protection relays, bay controllers and programmable controllers, the electronic devices do not need the number of auxiliary contacts required by the historic schemes, and the need for MOC and TOC switches has decreased dramatically.

Unfortunately, old habits die hard, and many user specifications still call for a great number of MOC and TOC switches, unnecessarily complicating the engineering and manufacture of the switchgear, the commissioning process, and equipment maintenance.

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