

Key Interlock Operation

A White Paper by Kirk Key Interlock Company

Introduction

To understand keyed interlock systems – a group or series of interlocking devices applied to associated equipment in such a manner as to prevent, or allow, operation of the equipment in a prearranged sequence only – it is necessary to fully appreciate how a keyed interlock operates and how it works in conjunction with the equipment on which it is mounted.

Construction of a Keyed Interlock

A typical keyed interlock is comprised of a lock cylinder, a support housing, a movable locking bolt, and a cam arranged to move the bolt in response to operation of the correct key. Various styles of interlock housings are available and each style is designed to mount in a different way depending upon the equipment to which the interlock is to be installed.

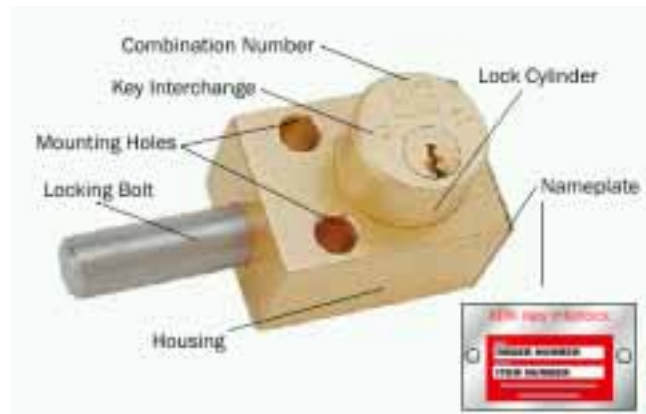


Figure 1. Overall view of an interlock.

One of the most important features of a keyed interlock is that the key cannot be removed from all positions of the lock bolt. A conventional lockset may allow free removal of the key regardless of the position of the lock bolt. The function of an interlock, however, dictates that the key be held in the lock cylinder unless the lock bolt is in a predetermined position. Possession of the key ensures that the associated device has been locked in a known, safe position.

How an Individual Interlock Typically Works

Figure 2 illustrates how an individual interlock typically works in conjunction with the equipment to which it is installed. In view (a), the controlled device (such as a switch)

cannot move from its normal position (whether open or closed) because of the position of the lock bolt. When the key is turned to withdraw the lock bolt (view (b)), the key becomes “trapped” and the controlled device can then be moved. Once the controlled device is moved, the key remains held because the lock bolt can no longer be physically extended so as to free the key (view (c)).

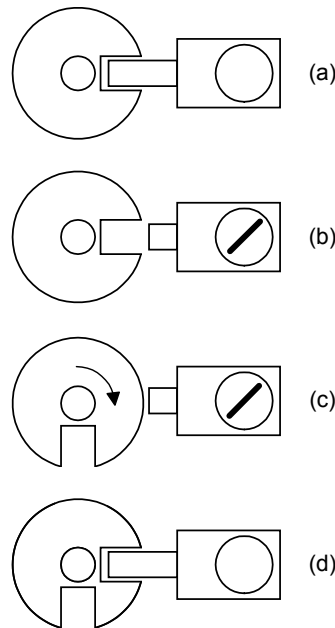


Figure 2. Operating principle of a simple key interlock mechanism.

The typical controlled device has two operating positions. If the intent is to lock the controlled device in either position, the arrangement of figure 2(a) may instead provide a recess on two opposite sides of the rotating member. In this manner, the lock bolt can be extended and the key released with the controlled device in either of two positions. Such an arrangement is described as L-O-C – locked open or closed (see figure 2(d)).

Or, if required, a separate interlock can be utilized for each position of the controlled device allowing a separate key to be released once the controlled device is locked open (described as L-O). Imagine a fuse compartment door that requires a key that must be obtained once the associated switch has been locked open. The first lock on the switch is keyed to match the upstream breaker and would be of the L-C type. The second interlock is keyed to match the fuse compartment door and would be of the L-O type. The associated breaker would be locked open, freeing the key to unlock the switch. Once the switch has been opened and locked in that position with the second interlock, its key is released allowing the fuse compartment door to be opened.

Most circuit breakers need to be locked only in the open position (L-O), to prevent reclosing. No need exists to lock it closed. That interlock is of the L-O type, freeing the key for use elsewhere in the interlock system only when the circuit breaker is locked open.

To summarize the description of the operating position of the device on which the interlock is mounted:

- (a) *Lock Open (L-O)*. This symbol on an interlock diagram indicates that the key is removable when the device (a circuit breaker, switch, valve, etc.) is locked in the open position.
- (b) *Lock Closed (L-C)*. This symbol indicates that the key is removable when the device is locked in the closed position.
- (c) *Locked Open or Closed (L-O-C)*. This symbol indicates the key is removable when the device is locked in either the open or closed position.

Key Removable Positions

All keyed interlocks must be described in terms of the lock bolt's relation to the key. A given key is removable from its lock only when the lock bolt is in one position – which is indicated on the interlock system plan. All keys must be in their respective locks in order to operate the lock bolt. Figure 3 below shows various interlocks and the key removable designations as “E” and “W”.

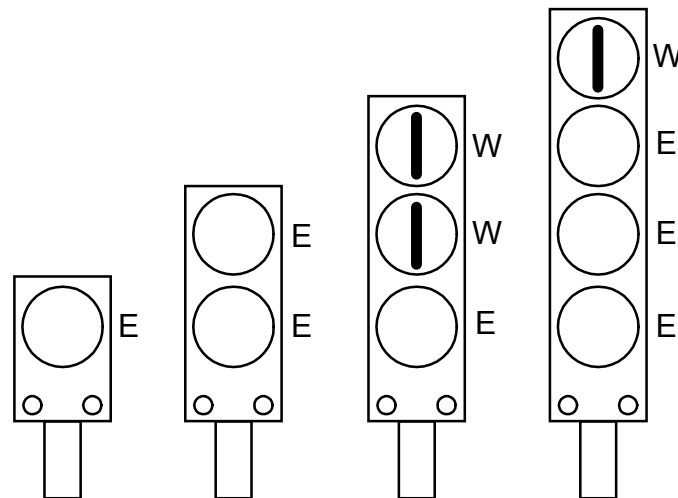


Figure 3. Key removable positions.

E – Lock Bolt Extended, Key Removable (also Bolt Withdrawn, Key Held)

W – Lock Bolt Withdrawn, Key Removable (also, Bolt Extended, Key Held)

Bolt Travel and Projection

The normal length of travel for the lock bolt from the withdrawn position to the extended position is $\frac{3}{4}$ ". The projection of the lock bolt when in the withdrawn position is

normally 0", ¼", 3/8", ½", 5/8", ¾", 1", 2", and 3", but any length is possible. Please note that key interlocks are referred to by the length of the lock bolt in the withdrawn position.

Key Interchanges and Lock Numbering

Each interlock in an interlocking system has a key (or keys) that interchange with other interlocks. When ordering an interlock system it is important that the various "key interchanges" are specified by designations such as A1, B1, B2, et cetera. All A1 locks have the same combination, all A2 have the same combination, and so on (see Figure 1. for an example of a stamped key interchange on an interlock cylinder). The key interchange designation can be stamped on the lock cylinder and the key if required.

Unless directed to match existing lock numbers, the interlock manufacturer will assign lock numbers to each key interchange upon receipt of interlock orders. It is of utmost importance that the name and location of the ultimate user is supplied with each interlock order so that the proper lock numbers can be assigned. This ensures that duplicate lock cylinders do not exist in the same facility by accident.

Multiple Cylinder Interlocks

In addition to the common practice of trapping the key in a single lock until the lock bolt has been either extended or withdrawn, interlock systems may also utilize multiple lock cylinders to control a single lock bolt. The bolt will not move until all keys have been inserted and turned. This accommodates a situation in which several devices must be locked safe before another device can be allowed to open or operate.

Multiple cylinder interlocks are also utilized to allow any number of secondary keys to be released once any number of primary keys have been inserted and turned. This allows a continuation of one or more sequences after extending or withdrawing the lock bolt on a multiple cylinder interlock.

Transfer Blocks

A transfer block (see figure 4) is a multiple cylinder interlock that does not utilize a lock bolt to connect it to any controlled equipment. Its function is to make one or more keys available only when one or more other keys have been inserted, turned, and therefore become trapped. The use of transfer blocks is beneficial when multiple scenarios are required in an interlocking scheme. For example, a large line-up of switchgear may have many rear access doors. But those doors cannot be allowed to open until various circuit breakers are locked open. A transfer block can be utilized to allow only certain doors to be unlocked when the appropriate associated circuit breakers are locked open.



Figure 4. Three-cylinder transfer block – keyed E-W-W.

Door Interlocks – Key Retaining Feature

A typical door interlock is designed to work in conjunction with a latch block (see figure 5). The door interlock is designed so that the key is trapped in the main body until the door has been fully closed against the latch block. Note that the lock bolt length of a door interlock is 0” in the withdrawn position so that the interlock will function with the latch block.



Figure 5. Door interlock and latch block.

Imagine an interlock system that contains a circuit breaker and an associated key interlocked rear access door. The circuit breaker is normally closed and the key is held in the breaker interlock. The circuit breaker must be locked open, thereby freeing the key to allow the access door to be unlocked and opened. As long as the access door is open, the key is held in the access door interlock and cannot be returned to the breaker for reclosing.

Another common door interlock contains two lock cylinders. The first cylinder requires a key from an upstream device (such as a circuit breaker) in order to unlock the door interlock. The second lock cylinder holds a key that is trapped until the door is unlocked and opened via the key from the circuit breaker. Once the door is opened, the second key is released and can be put in the pocket of the maintenance person ensuring that the door cannot be closed and locked as long as he holds the second key. Upon completion of his tasks, the second key is returned to the door interlock allowing the door to be closed and locked which frees the first key allowing it to be returned to the circuit breaker for reclosing.

Key Control

In order to ensure correct operation of an interlock system it is necessary to remove all loosely or removable held keys before operating the equipment on which the interlocks are mounted. Each interlock system requires only a certain number of keys held in specific interlocks during the normal operation of the equipment. All other keys must be removed.

Keys removed from interlocks should be destroyed or retained by authorized personnel for use as spare keys. The spare keys must not be normally available to operating personnel, since the use of these keys, where not specifically required, will result in incorrect operation of the equipment on which the interlocks are mounted. Any spare keys should be given to operating personnel only, if and when, the corresponding operating key has been destroyed.

Additional keys will be provided only with proper authorization from the ultimate user to which the specific key combination has been assigned.

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