Transfer Equipment Switching Means

Mechanical Switches

Contactor Type

Typical construction of the switching mechanism in a contactor type transfer switch is a pair of mechanically and electrically interlocked lighting or motor starting contactors as shown in **Figure 12**. Actuation is by individual solenoids included with each contactor. Contactors are electrically held, unless furnished with optional mechanical latches. If mechanically latched, a release mechanism is required for both electrical and manual operation. If electrically held, contactors may drop out if voltage dips, and contacts may chatter at lower than rated voltages and frequencies. Mechanical latching is required by NFPA standards for use in emergency systems. Lighting and motor starter contactors use contacts that are typically double break with spring tensioners, pulled closed by a constantly energized solenoid (electrically held). The contacts are not quick–break quick–make and are without an over–center mechanism.

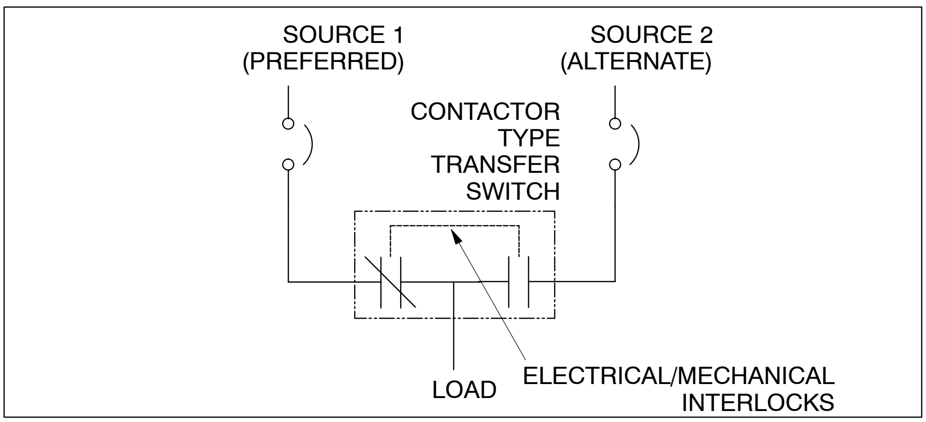


Figure 12. Contactor Style Transfer Switch.

High volume production of lighting and motor starting contactors result in an economical package for continuous current ratings below about 600 amps. To meet the temperature rise requirements of UL 1008, the continuous current rating of the contactors usually have to be substantially derated.

Because contactors are typically used in branch circuits in the lowest end of the distribution system, the short circuit ratings are relatively low. Contactor type transfer switches require external upstream overcurrent protection, and current–limiting fuses or special (high interrupting capacity or current limiting) circuit breakers are usually required to achieve higher withstand and closing ratings.

Circuit Breaker Type

Typical construction of the switching mechanism in a circuit breaker type transfer switch is a pair of electrically and mechanically interlocked molded case switches or circuit breakers as shown in **Figure 13**. Mechanical interlocking can be omitted for closed transition operation, which then requires reliable electrical con-

Circuit Breaker Type (cont'd)

trols to prevent out–of–phase paralleling. Individual motor operators with each switch or breaker actuate the switching mechanism.

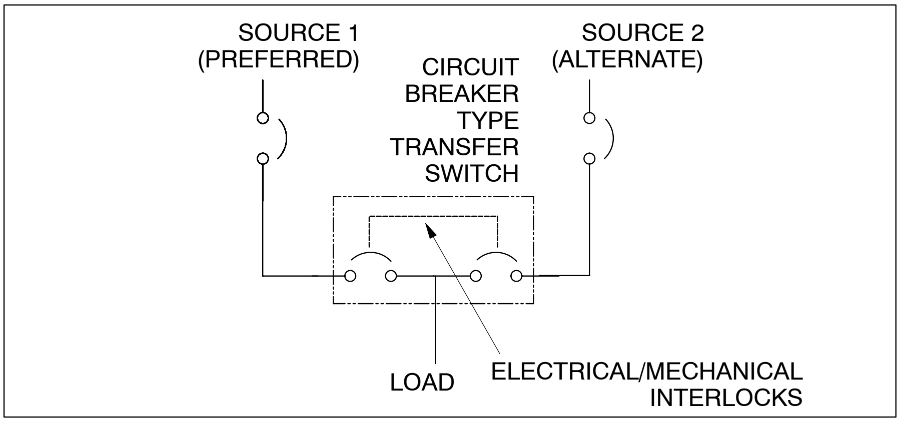


Figure 13. Breaker Type Transfer Switch.

Circuit breakers and molded case switches have quick–make quick break contacts and over–center mechanisms. Contact transfer time, the duration of source–to–source operation, of circuit breaker type transfer switches can be relatively slow, particularly in larger equipment.

If using molded case switches, an external upstream overcurrent device for short circuit protection is required.

If using circuit breakers with integral overcurrent protection, an external upstream overcurrent device is not required for transfer switch short circuit protection, which can allow use of the transfer switch as utility service entrance equipment, if rated and marked as suitable for use as service equipment. If applied with upstream overcurrent devices for cable protection, the integral overcurrent protection of the circuit breaker type transfer switch must be selected or set such that it will not operate without the upstream device also operating under short circuit conditions.

Depending on the type of circuit breaker used; molded case, insulated case, or power frame, the short circuit ratings range from high to very high because the circuit breaker design is intended to interrupt fault level current. Insulated case and power frame circuit breakers may have extended withstand ratings, up to 30 cycles.

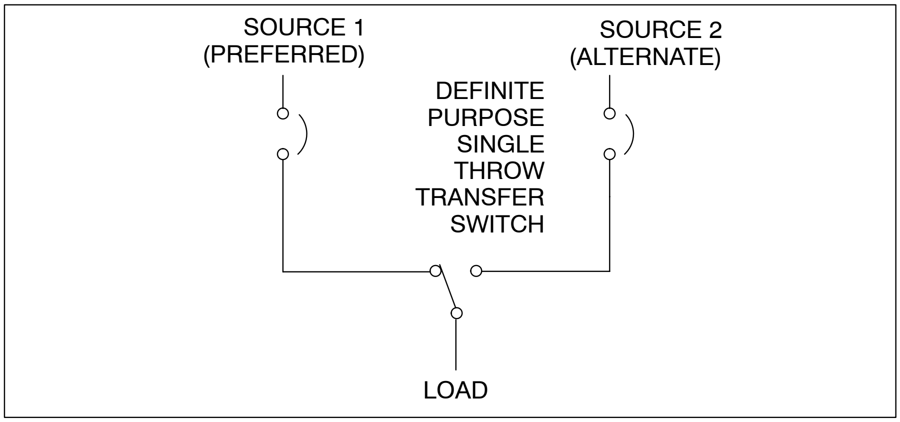
Circuit breaker transfer switches with thermal–magnetic molded case and some solid–state molded case circuit breakers may require continuous current derating to 80% of the breaker frame rating.

Definite Purpose Type

The switching mechanism construction is designed specifically for switching between two power sources, which may be 180° out of phase with twice rated potential across the contacts. These mechanisms can be either single or double throw as shown in **Figure 14**. Single throw mechanisms are inherently interlocked to prevent source–to–source interconnection. Single throw mechanisms also provide fast open transition contact transfer time only. Double throw mechanisms can provide fast or slow contact transfer time, open or closed transition,

Definite Purpose Type (cont'd)

and load shed capability. A source–to–source mechanical interlock is required for double throw transfer switches designed for open transition only to prevent source–to–source short circuit. Double throw mechanisms have quick–make quick break contacts and over–center mechanisms.



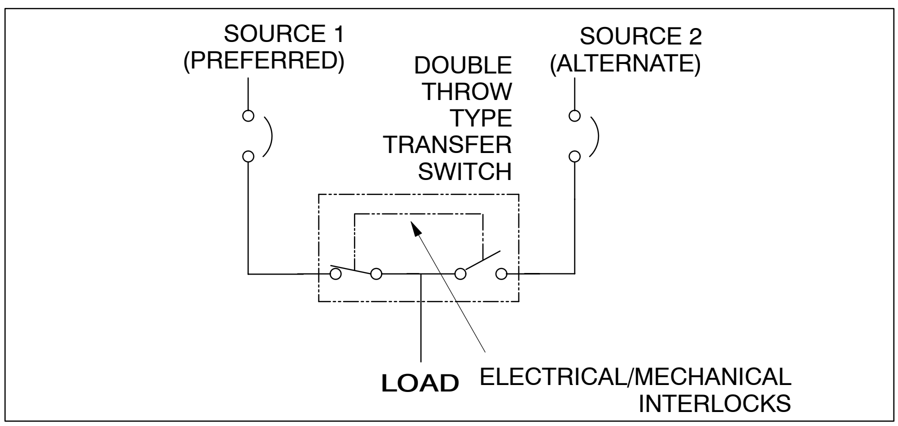


Figure 14. Single and Double Throw Definite Purpose Transfer Switches.

Integral overcurrent protection is not included in this type of transfer switch (IEC Type PC), and external upstream overcurrent protection is required. The dedicated purpose transfer switch contacts are designed to both remain closed during short circuits and close into fault level currents until an external upstream overcurrent device opens.

The contact transfer time, from one source to the other, of this type transfer switch can be fast, six cycles or less, depending on the size of the equipment.

Solid State

Solid state switches are available in several configurations and sizes and use SCRs or transistors as the switching means. A basic two source switch is shown in **Figure 15**. These switches have been used in solid state UPS equipment and are now available as dedicated and listed transfer switches. These devices are considerably more costly than equivalently sized mechanical switches (up to 4 times higher). These switches are typically used in an open transition mode with a total transfer time of ¼ cycle or less. This is an attractive feature when used to

Solid State (cont'd)

transfer between two available sources, such as during system testing and re-transfer. Most loads will not be impacted by this short disconnect time and loads like motors, VFD's and UPS subject to misoperation or damage during fast out–of phase transfer are not affected due to the essentially instantaneous transfer provided the two power sources are essentially synchronized when both are available.

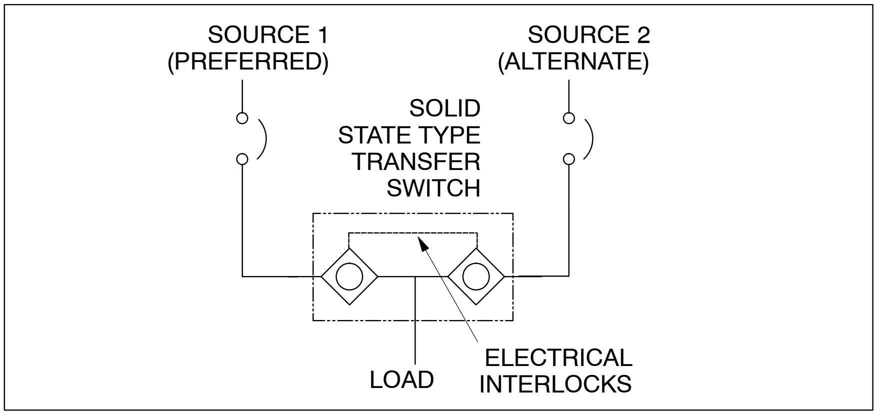


Figure 15. Solid State Transfer Switch.

Solid state switches can be damaged, however, when transferring between out–of–phase sources. These switches include a transfer inhibit function that requires the sources to be within some acceptable phase shift, around 15 degrees. Although this is of no consequence when these switches are used to transfer between synchronized utility sources, it can be an issue when transferring between a generator and a utility source. In this case, it is necessary to have at least a slight frequency difference between utility and generator in order for the sources to achieve momentary synchronism. The greater the frequency difference, the faster the sources will move in and out of phase. Problems are avoided if the frequency differential is maintained within limits since solid state switches complete the transfer very fast (less than ¼ cycle), not allowing the sources to drift out of phase. This is also beneficial for motor load transfer. The inductive motor load terminal voltage should lack adequate time to drift out of phase from the source in the short time it takes to transfer. Potential problems can still occur even with fast transfer, however, when transferring from a utility to a generator source. If the generator is hit with a very large sudden load change during the short transfer time, a sudden phase shift could result and the motor could be connected out of phase to the generator, resulting in a sudden inrush current.

Alternative Arrangements and Configurations

Bypass Isolation

Bypass–Isolation automatic transfer switch equipment is configured with a manual bypass transfer switch in parallel with an automatic transfer switch. The parallel connections between the bypass switch and ATS are made with isolating contacts such that the automatic transfer switch can be drawn out for service and repair and power is fed to the load through the bypass switch. The bypass–Isolation automatic transfer equipment available from Cummins is the non–load break type as shown in **Figure 16**, meaning there is no power interruption to the load when the equipment operates.

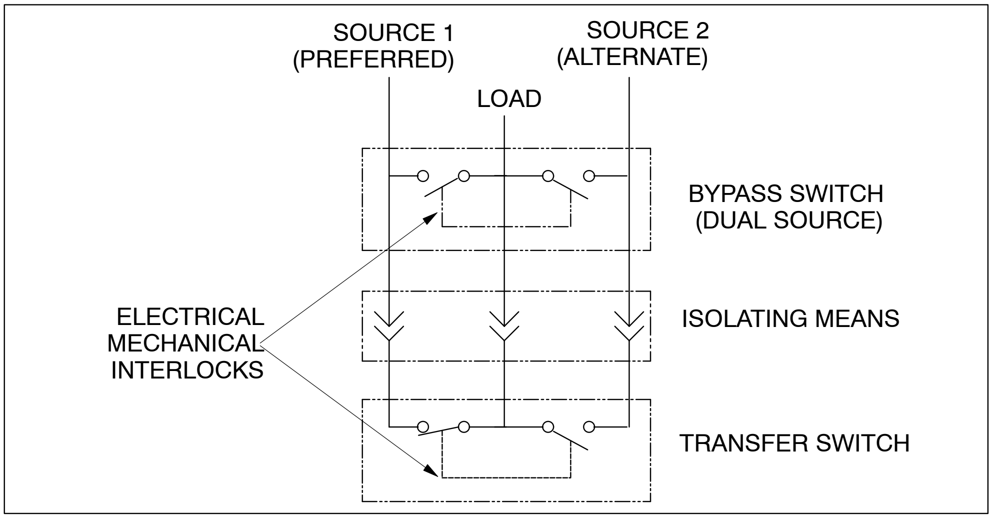


Figure 16. Non Load Break Bypass Isolation Transfer Switch.

Also available from other manufacturers is load break isolation–bypass equipment as shown in **Figure 17**, which isolates the load from both power sources before bypassing the ATS. The bypass–isolation equipment available from Cummins is two–source bypass, meaning the bypass switch can be operated to either source (if power is available). Also available from other manufacturers is single–source bypass, meaning the bypass can be operated to only one source, typically the normal source.

Bypass Isolation (cont'd)

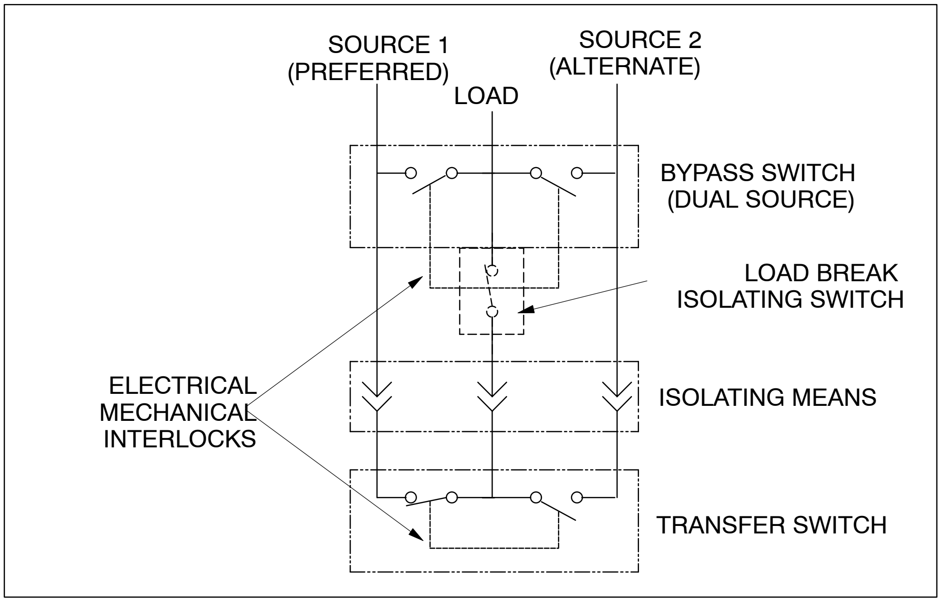


Figure 17. Load Break Bypass Isolation Transfer Switch.

Closed Transition

Mechanical transfer switch equipment may be configured for either open transition or closed transition operation. Open transition equipment transfers the connected load between power sources with a momentary interruption in power, when both sources are available, as the switch contacts open from one source and close to the other source. This momentary power interruption is called Contact Transfer Time; and without intentional delay during transition, has a duration of 6 cycles or less depending on the size of the equipment. A mechanical interlock is provided to prevent interconnection of the two power sources.

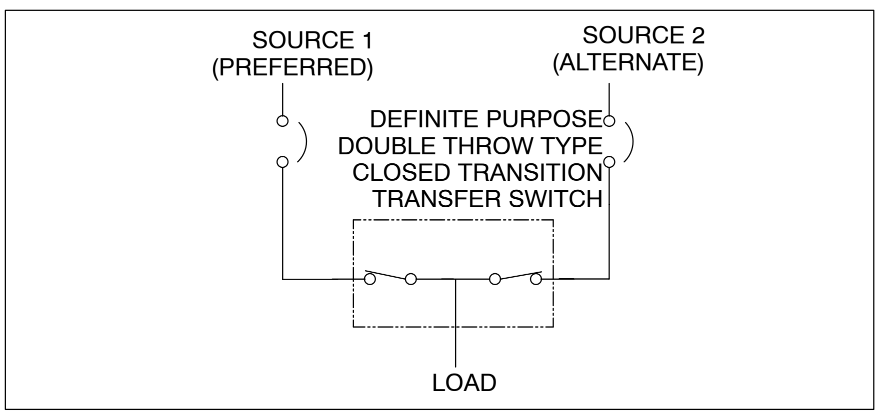


Figure 18. Closed Transition Transfer Switch.

With both sources available, closed transition transfer equipment parallels the power sources either momentarily or for an adjustable duration sufficient to ramp load onto and off of the generator set. Closed transition operation requires double throw type mechanical switches to allow either source to be closed independent of the other and does not include source–to–source mechanical interlocks as shown in **Figure 18**. Closed transition transfer equipment can either actively synchronize both power sources before paralleling them, or passively check for synchronism before allowing paralleling. Closed transition equipment

Closed Transition (cont'd)

operates in open transition when one of the sources has failed, and closed transition when both sources are present. Closed transition operation prevents the momentary interruption in power when both sources are present, such as exercise, test, and retransfer. Closed transition transfer equipment does not substitute for an uninterruptible power supply where one is required by the load equipment.

Automatic Mains Failure

This is an arrangement that is very popular outside of North America. Basically, the generator set and transfer equipment controls are integrated into a mains failure panel that typically also includes the transfer switch mechanism. This arrangement is generally used to provide total facility standby power and is interconnected at the main service entrance. In the event of a utility outage detected by the mains failure panel, the generator set is signaled to start and the mains panel transfers the entire facility connected load to the generator. Some form of automatic or manual controls may be required for those situations where the total connected load exceeds the generator capacity.