Canadian Standards Association
Mississauga, Ontario
To the Part I Committee

Subject No. 3063 Chair: S.J. Coles Date: December 30, 2002

Title: Use of Semiconductor Switching Devices, Rule 14-700

Submitted by: Roy Kampmeyer of Power Electronic Systems Inc., 9 Morningside Drive, Lansdale, PA, 19446, USA on April 5, 2002.

Proposal: Revise Rule 14-700 to read as follows:

> **14-700 Solid State Devices Restriction of Use.** Solid state devices are allowed only if they meet all the requirements for a reliable switch and can be demonstrated as such by the equipment manufacturer when required for certification.

Reasons for Request:

The following is a discussion as to why the use of semiconductors for switching elements should be allowable as part of the CEC.

A. Semiconductors have been utilized as components in power switching since their inception after WWII. The use of silicon in their manufacture has allowed greater heat buildup and higher off resistance. Since a semiconductor is as it is spelled – almost a conductor but with a higher on resistance than say copper, some reservation must be used in its application.

When a semiconductor switch is turned "on" in order to connect two circuits, it places an "on" resistance in series with the circuits. This must be a low enough value to be of no consequence. Today's devices have this characteristic, enhancing their usage.

When a semiconductor is turned "off" to open-circuit the system, it goes to a high resistance state, allowing a small leakage current to pass through itself. This has been a point of consternation among users because they want an "open" circuit, not a leaky one. Older devices have been characterized as having milliamps of leakage; new ones now have microamps of leakage at high junction temperatures. This improvement has allowed innovative methods to be designed into a switch to bypass this small current away from the open circuited load, so that no output voltage shows up at the user end of the line. Thus, when the semiconductor is in the "off" state, no power is delivered to the load, and it is essentially "off".

B. Why are we going to the trouble of describing the preceding action? The reason is one of reliability. The semiconductor is much more reliable a switching device than a relay or circuit breaker. It is fabricated as a permanent life part, whereas the relay/circuit breaker is assembled with mechanical parts which have a limited life span because they are loosely fabricated of moving parts. Metal moving parts can weld together due to metal migration between the contacts. Contacts can pit and burn. Failure rate is high. All this is eliminated by a semiconductor.

Most experienced electronic engineers know this. The USA Federal government knows it, and military usage is apportioned accordingly.

C. Lets look at a comparison of a semiconductor and a relay failure rates. Assuming a similar application, such as environment and current rating, the USA government has invested millions of dollars in reliability studies to produce something called MIL-HDBK-217E, a reliability analysis handbook used by electronic researchers and analysts. We want to compare a power MOSFET semiconductor switch to a relay in a normal switching application.

MOSFET: plastic device, operating at 50% power stress, ambient temp. +60C.

Relay: DPDT, 20A rating, commercial part, less than 10 cycles per hour operation, ambient temp. +60C.

The nomenclatures here are definitions normal to the MIL HDBK.

Using equations given in the HDBK, the MOSFET failure rate is 4 failures per million hours. The relay is 88 failures per million hours. Quite a bit different. Note that this is failure rate, not the number of failures in a given amount of time.

D. We feel that all standards group should realize that a semiconductor can replace a relay any time, and should be allowed. Otherwise, there will be no future to the switching industry. The future allows improvements. There are limits, of course. Semiconductors must withstand the voltage, current and power requirements of the application. Ambient temperatures must be considered as they effect parameters of the semiconductor. A misapplication of the semiconductor will lead to failure. You must not deny its use under controlled circumstances, however.

E. It is proposed that the offending clause be changed to allow semiconductors for switching only if they meet all the requirements for a reliable switch, and can be demonstrated as such by the equipment manufacturer when required for certification by CSA. This will allow opening up an impressive market for modern reliable devices and equipment, but still controlling their manufacture in a sensible way.

Chair's Comments: As far as I can tell, no solid state device can qualify as an isolating switch or a disconnecting means. It requires power to function, and cannot be locked in the open position.

Recommend rejection of this proposal.

Subcommittee Deliberation:

a)	Agree with submission	0
b)	Agree with submission with comments	0
c)	Agree with Chair's proposal	5
d)	Agree with Chair's proposal with comments	4
e)	Disagree with Chair's proposal	0

Comments from Members:

1) The CEC does not disallow semiconductor devices for specific uses as is suggested in Paragraph D of the submission, but only as an isolating switch or as a disconnecting means in accordance with Rule 14-700.
2) Semiconductors are more reliable than they used to be, but they are still susceptible to short circuit damage, and need an upstream means of isolation.
3) Another member feels the submitter is confused about the difference between switching controls, isolation and disconnecting a circuit.
4) Another member feels that many aspects of Rule 28-602 would be violated, particular Rule 28-602(4). Industry requires padlock lockout. While he agrees that the solid state device has superior performance as a switching device, the problem of using it as an isolation device would prohibit it at the present time. Maybe the CSA Part 2 product standards committees could advise if any standard exists for solid state switches intended for isolation application, and if so what would the performance criteria need to be.

Subcommittee Recommendation: Subcommittee has reached consensus to uphold the Chair's proposal to reject the submitter's proposal.