

## TECHNICAL NOTE

# ABB smart coil technology, programming and EMC testing

Production of certain ABB medium voltage circuit breakers employs smart coil switch technology (SmartCS). The SmartCS functions in a circuit as an older style coil would, except with added benefits for monitoring and increased reliability as opposed to a standard coil.

The smart coil has a high impedance input due to the onboard electronics. This high impedance gives the device a lower current draw than conventional coils thus having a higher than expected voltage drop (~60 V for 125 V system) across the coil during coil supervision. The reduced power consumption (<100 mA @125 V) of the SmartCS during supervision make it suitable for constant 24/7 monitoring with the main device in the open or closed position. This also leads to a reduced battery bank size when used with backup systems.

Additionally, SmartCS has a much faster response time than a standard coil in that it triggers off a voltage threshold for actuation where standard coils require a large current increase in the circuit to create the necessary magnetic force for activation.

ABB SmartCS is used in the following MV products:

- eVD4 (Vacuum CB with embedded IED RBX615)
- GSec (Indoor SF6-Insulated Load Break Switch)
- HD4 (SF6 – MV primary distribution)
- HD4/R (SF6 CB – MV secondary distribution)
- VD4 (Vacuum CB - MV primary distribution)
- VD4 ANSI (ANSI version of VD4 - ADVAC)
- VD4 HD 40kA with Twin EL
- VD4/R (Vacuum CB - MV secondary distribution)
- VMAX (Vacuum CB)
- VMAX ANSI (ANSI version of VMAX)



The SmartCS is composed of two parts:

- Electromagnetic coil



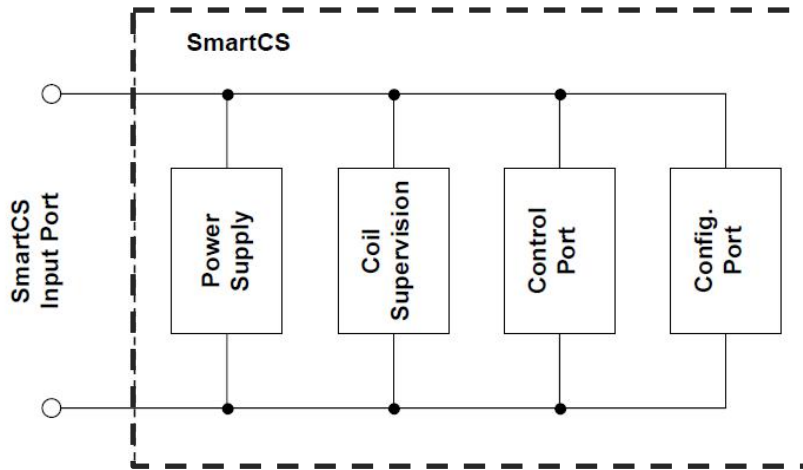
- Electronic board enclosed in a plastic box.



During manufacture of the electronic board, the main operating program for the SmartCS is flashed on to the processor and can never be updated or changed for the life of the coil except for 12 configurable parameters. This ABB proprietary firmware performs all on board monitoring and control functions during operation. The functions performed for increased reliability are as follows:

- Noise immunity
- Watchdog timer of controller
- Fast time response i.e. coils operate off voltage and not current
- Controls coil current for a specific magnetic force independent of voltage and temperature
- Impedance checks of coil winding and electronic circuits
- Over-current, short-circuit and over temperature protections

The SmartCS has a single two pin input (middle third pin not used) which is used for both programing of reconfigurable settings and operation after the coil has been assembled. This input consists of four ports as seen below.



**Power supply**

The power supply input port provides power to the SmartCS board and the electromagnet coil connected to it. The SmartCS comes in two variations, a high voltage (HV) and a low voltage (LV) variation. Each variation is programed for its applicable nominal voltage that the device will be applied. Table 1 lists the electrical characteristics of the power supply input with reference to the two variants.

**Table 1**

Variant	AC/DC	Nominal voltage	Recommended operating voltage	Max peak operating voltage
LV	DC	24	12 to 75 VDC	160 V
		48		
		60		
	AC	48	24 to 72 VAC	
60				
HV	DC	110	55 to 300 VDC	450 V
		125		
		220		
		250		
	AC	110	55 to 288 VAC	
		120		
		127		
		220		
		240		

**Control port**

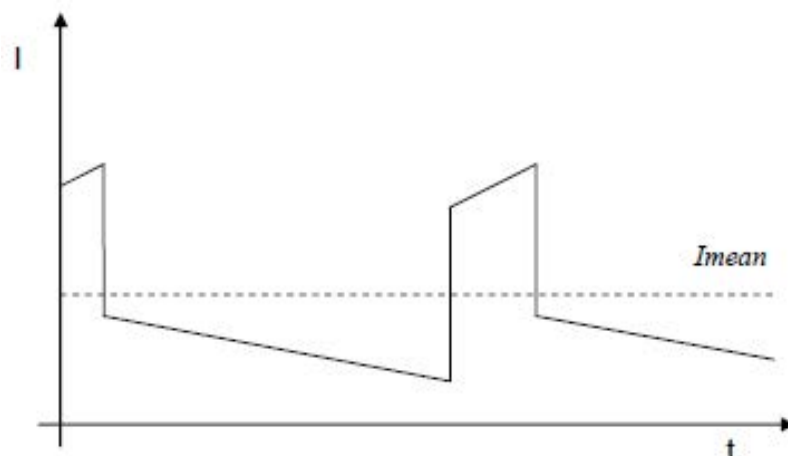
The control port measures the input voltage and determines launch and release of the electromagnetic coil. The coil is launched when the input voltage is greater than the

programed launch threshold (i.e. 65% of the nominal voltage for MO coils); the coil is released when the input voltage is lower than the release threshold.

### Coil supervision

The coils supervision port allows for detecting of failures in the coil winding and electronic board of the SmartCS. This port is compatible with common trip circuit supervision (TCS) relays. Supervision of the coil is done by impedance check of the coil. This check is then communicated by a low impedance feedback (LZF) to the input. LZF is an ABB patent technology for trip circuit supervision. Should any of the onboard checks done by the controller fail this will be indicated by a high impedance on the input "open circuit". During supervision of the SmartCS the coil will pulse the current on the supervision circuit to send indication to an advanced relay that all on board monitoring checks have passed verification.

Should an over temperature condition be detected the coil will enter a low power mode and stop the pulsation of the current while remaining active, checking the temperature every 10 seconds until it returns to normal operation.



### Configuration Port

The configuration port allows setting of twelve parameters of the SmartCS software. These include the thresholds to launch and release the coil with a timing launch delay. It also allows writing and reading back the serial number and product information. The configuration port interfaces with an ABB proprietary software that utilizes programming over power (POP) configuration tool during configuration of the settable parameters. This configuration port is disabled immediately after the SmartCS has successfully been configured. Therefore, this port is not working during normal operation of the coil. A jumper must be installed on the board to reactivate this port during programming to erase and then reprogram settable parameters. To gain access to the jumper location the coil must be removed from the installed device.

All hardware and software used for programming of the SmartCS is not commercially available for customer use. Present firmware revision of the SmartCS at time of this document is Rev 6.

The SmartCS has successfully passed the following EMC testing:

- MIL STD-461F Conducted emission 120Hz to 10KHz, & 150KHz to 30MHz
- MIL STD-461F Conducted Susceptibility 120Hz to 150KHz & 10KHz to 400MHz
- MIL-STC-471F Radiated Susceptibility 30Hz to 100KHz & 20MHz to 1GHz (10V/m)
- IEC 60533:1999-11 Electrical and electronic installations in ships – Electromagnetic compatibility
- STANDARD FOR CERTIFICATION No. 2.4 DNV / Environmental Test Specification for Instrumentation and Automation Equipment, April 2006. Refer to §3.4.10
- Bureau VERITAS Rules for the Classification of Steel Ships / PART C – Machinery, Electricity, Automation and Fire Protection / Chapters 2 – 3, July 2011. Refer to Table 1, no. 20
- Rina Rules 2008 Pt C, Ch. 3, Sec 6. Refer to Table 1, no. 20
- Lloyd's register Type Approval, Test Specification Number 1. July 2013. Refer to Section no. 30.
- IEEE Std C.37.90.1-2012 IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- IEEE Std C.37.90.2-2004 IEEE Standard for Withstand Capability of Relay Systems to radiated Interference from Transceivers
- IEC 61000-4-3: 2010-04 Electromagnetic Compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
- IEC 61000-4-4: 2012-04 Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test
- IEC 61000-4-5: 2005-11 Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
- IEC 61000-4-6: 2008-10 Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radiofrequency fields
- IEC 61000-4-8: 2009-03 Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Damped oscillatory wave immunity test
- IEC 61000-4-16: 2002-07 Electromagnetic compatibility (EMC) - Part 4-16: Testing and measurement techniques - Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz
- IEC 61000-4-18: 2011-03 Electromagnetic compatibility (EMC) - Part 4-18: Testing and measurement techniques - Damped oscillatory wave immunity test
- IEC 61000-4-29 Voltage dips, short interruptions and voltage variations on DC input power port immunity
- CISPR Conducted emission Group 1, class A
- CISPR Radiated emission Group 1, class A



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