SMTS-RT 6000
Synchronous Machine Transient Simulator – Real Time

Synchronous Machine Transient Simulator – Real Time (SMTS-RT 6000) simulates a generator / motor, its turbine / load and the grid. The simulator is connected to an Automatic Voltage Regulator (AVR) or a Static Excitation System (SES) for closed-loop test to analyze its stationary and transient behavior. SMTS-RT 6000 can reduce the testing time of your machine, save costs and serve as a perfect training tool for maintenance and operation personnel.

The simulator

The simulation can be done for any machine at any load and covers various static and transient network conditions. SMTS-RT 6000 includes a precise model of a synchronous machine acc. to IEEE Std. 1110-2002 (Fig. 1, 1), complemented with a simplified turbine and governor representation 2. The machine is connected through a machine breaker 3, a step-up transformer 4 and a transmission network 5 to an infinite bus 6.
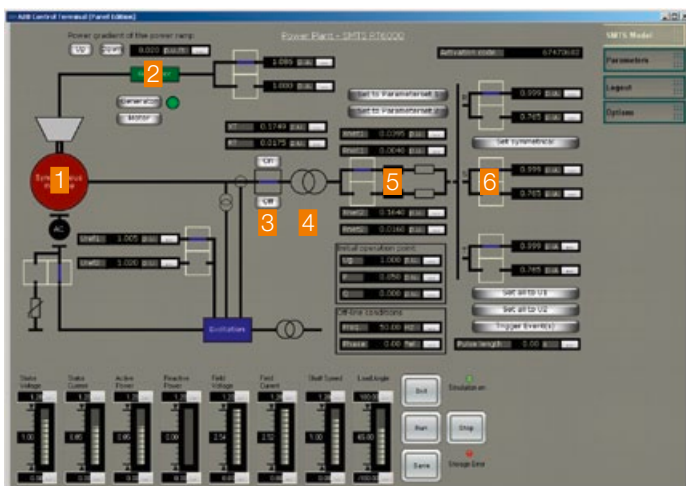
The simulation supports both generator and motor operation including start-up. A dedicated load model provides mechanical load simulation at motor shaft. SMTS-RT 6000 supports both static excitation and rotating exciters (of any type) and contains a model for linear or non-linear field-discharge.

For computation, SMTS-RT 6000 is using UNITROL® 6000 control platform hardware. The Human Machine Interface is provided with SMTS Operate and ECT software tools. Both tools can be installed on Excitation Control Terminal (ECT) or a laptop (Fig. 2).
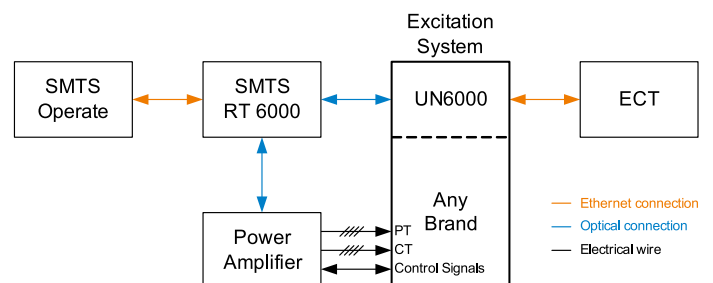

Fig. 1 | SMTS Operate user interface

Fig. 2 | Block diagram of the closed-loop simulation

Power and productivity
for a better world™

Wide application range

SMTS-RT 6000 can be used:

I) As integrated function of UNITROL 6000 AVR/SES
II) As stand-alone unit for closed-loop tests of UNITROL 6000 AVR/SES in the factory or at site
III) Complemented with power interface (available soon) as stand-alone unit to be connected to 100/110 V and 1/5 A inputs of AVR/SES of any brand.

For applications I) and II), the connection between the simulator and the UNITROL 6000 excitation controller is done with a safe and fast 10 Mbit optical link. UNITROL 6000 AVR/SES system is prepared to replace analog to digital converter data by real time simulated data samples at 40 kilo samples/second rate for 3-phase generator voltage and current. This set-up enables a complete closed-loop control simulation including all stages of signal processing (i.e. filtering).
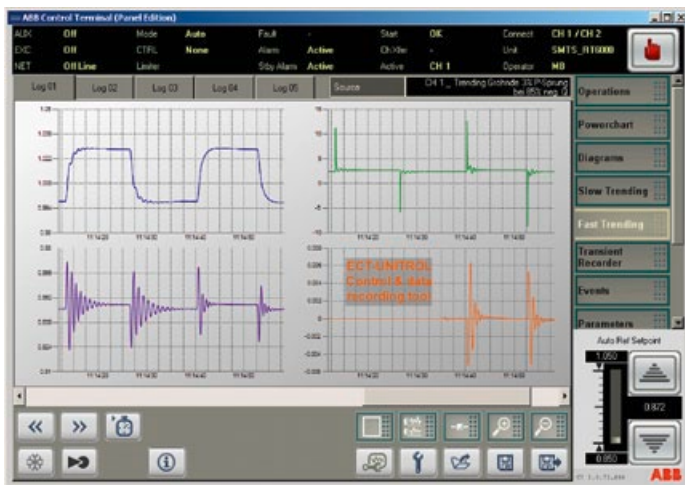

Fig. 3 | ECT software tool user interface

Potential for significant savings

The use of SMTS-RT 6000 during initial commissioning or periodical maintenance significantly reduces the testing time and thus offers potential for earlier commercial operation and savings. It is also very convenient for hands-on training of commissioning/maintenance personnel or plant operators.

Real-time simulations

SMTS-RT 6000 allows to analyze and verify tuning and performance of AVR/SES with its limiter circuits and Power System Stabilizer (PSS). Additionally it allows to simulate typical load variations or system disturbances, such as:

– Load rejections
– 3-phase short circuits at generator terminals
– 3-phase short circuits at high-voltage side of step-up transformer
– Field suppression from a defined initial load or fault condition
– Faulty synchronizing
– Load variations and sudden changes; e.g. from parallel grid to island operation

Main features

– User-friendly interface, based on UNITROL platform
– Very easy and fast setup
– For simulation mode in applications I) and II), only one parameter in UNITROL 6080/6800 channels has to be reset
– Graphical and numerical output function of the ECT tool provides numerical data recording and storage (e.g. fast trending)
– SMTS Operate provides data storage/recall of simulations, i.e. stationary generator/turbine/network data and dynamic event data
– Creation of separate "snapshot" files for easy repetition of the simulated cases
– Simulated case can include the configuration of subsequent events; e.g. event series as illustrated in Fig. 4
– SMTS Operate includes several "snapshots" for reference or training purposes, where a precise simulation of a given plant and/or specified disturbance may not be required
– No programming knowledge required for setting up simulation cases
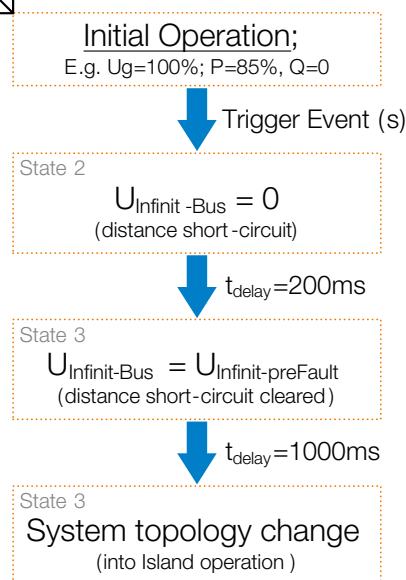
Start condition

Initial Operation;
E.g. Ug=100%; P=85%, Q=0

Trigger Event (s)

State 2
$U_{Infinit\text{-}Bus} = 0$
(distance short-circuit)

t_{delay}=200ms

State 3
$U_{Infinit\text{-}Bus} = U_{Infinit\text{-}preFault}$
(distance short-circuit cleared)

t_{delay}=1000ms

State 3
System topology change
(into Island operation)

Fig. 4 | Simulation of subsequent events

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