April, 2019

Case Study

One of Basler's First SSE's Still Carrying the Load of a 2MW Generator

From the early days of rotating exciters to today's digital static excitation systems using power semiconductors, Basler's generator excitation systems have made great strides in innovation and efficiency while always maintaining their reputation for legendary reliability.

History

Prior to 1974, static excitation systems were of the compound type. Because these compound exciters were complex and each generator application was unique, these systems required a substantial level of engineering. The design's heavy reliance on matched transformers and reactors made these systems expensive to produce. Each system consisted of a power current transformer (PCT) for each generator phase, a power potential transformer (PPT) with a dc control winding, and linear reactors placed in series with the PPT primary winding. The PPT's dc control winding controlled the output (saturation) of the PPT which was summed vectorially with the output of the PCTs. This combined three-phase output was converted by a semiconductor rectifier bridge into dc excitation power that was supplied to the generator field. An analog voltage regulator monitored the generator output voltage and modulated the PPT dc control winding to maintain the desired value of generator voltage.

Figure 1 - The SSE was originally shipped as loose components that the end user would mount inside their cabinets as shown in Figure 4.

Figure 2 - The control chassis was typically mounted in a separate cabinet but closely coupled with the cabinet containing the rectifier bridge.

A key advantage of the compound static exciter was its ability to provide fault current support for relay tripping. Prior to the early 1970s, many municipalities operated independently of the transmission system and used their own power plants to supply the community with electricity. Without a compound source static exciter during a fault, the generator output would collapse during the overload and deep voltage sags would occur when starting large motors.

In the early 1970s, the dynamics of the electric power generation grid began to change as municipalities no longer operated independently. Instead, both large and small power producers were connected together to create the one master grid in place today. Municipalities no longer needed to supply their own fault current but could rely upon fault current sourced from many interconnected plants operating together. When a fault occurred, the fault could be supported for relay tripping from any location.

The interconnection of electric power providers changed the static excitation system design. The expensive compound static exciter gave way to the shunt static exciter. The shunt static exciter eliminated the need for the PCTs required by the compound static exciter. With a properly-sized kVA PPT, the shunt static exciter could provide field forcing capability that could drive the generator field to 150% or more for support during a severe voltage dip on the transmission system. This new excitation strategy was simple, more affordable, and easy to install.

Basler Innovation

In 1974 Basler Electric introduced a new generation of shunt static exciter, the SSE. This system was designed as an easy replacement and maintenance solution for both rotating exciters and compound-type exciters. The SSE consisted of three elements: a PPT, a three-phase silicon controlled rectifier (SCR)-controlled power rectifier bridge, and a control chassis. The PPT and power bridge were sized according to the generator field requirements.

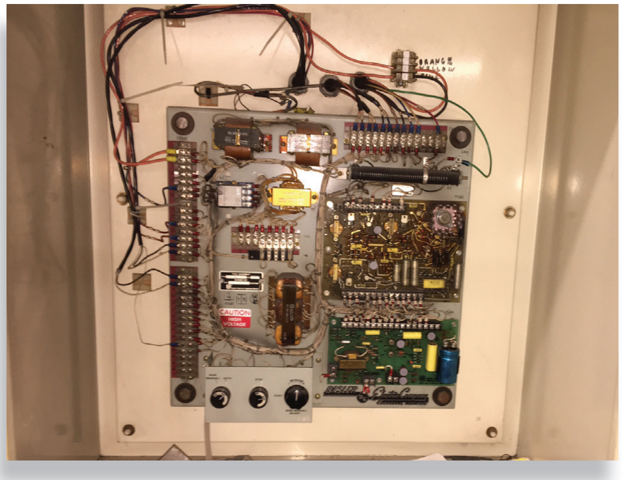

Figure 3 - The control chassis contains the voltage regulator and firing circuit to control the firing of the SCRs and regulate the generator terminal voltage.

The control chassis contained an analog voltage regulator, manual excitation control, and a firing circuit to control power bridge SCR firing. The SSE was manufactured with readily available components that enabled fast, emergency replacement of a failed rotary exciter. These systems were compatible with fields requiring up to 200 Adc at 125 Vdc or 250 Vdc and generator voltages of 480 Vac, 2,400/4,160 Vac, or 13,800 Vac. Over time, the SSE's current capacity expanded and accessories were introduced. These accessories included underexcitation limiters, overexcitation limiters, and protection options.

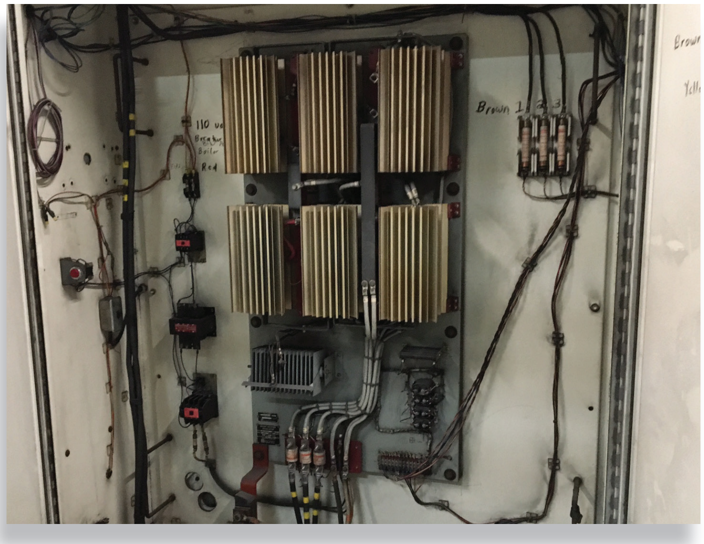

Figure 4 - The rectifier bridge consists of three (3) SCR and three (3) diodes to form a three-phase semi converter bridge.

Commitment to Quality

Today, many of the original SSE systems from 1974 are still in operation. The reliability found in the SSE is also evident in other past Basler products including the first solid-state voltage regulators, the SRA and KR, introduced in the 1960s. This enduring quality, along with the innovation found in the DECS-250E, DECS-400, and DECS-2100 Digital Excitation Control Systems, make Basler today's leader in excitation control.