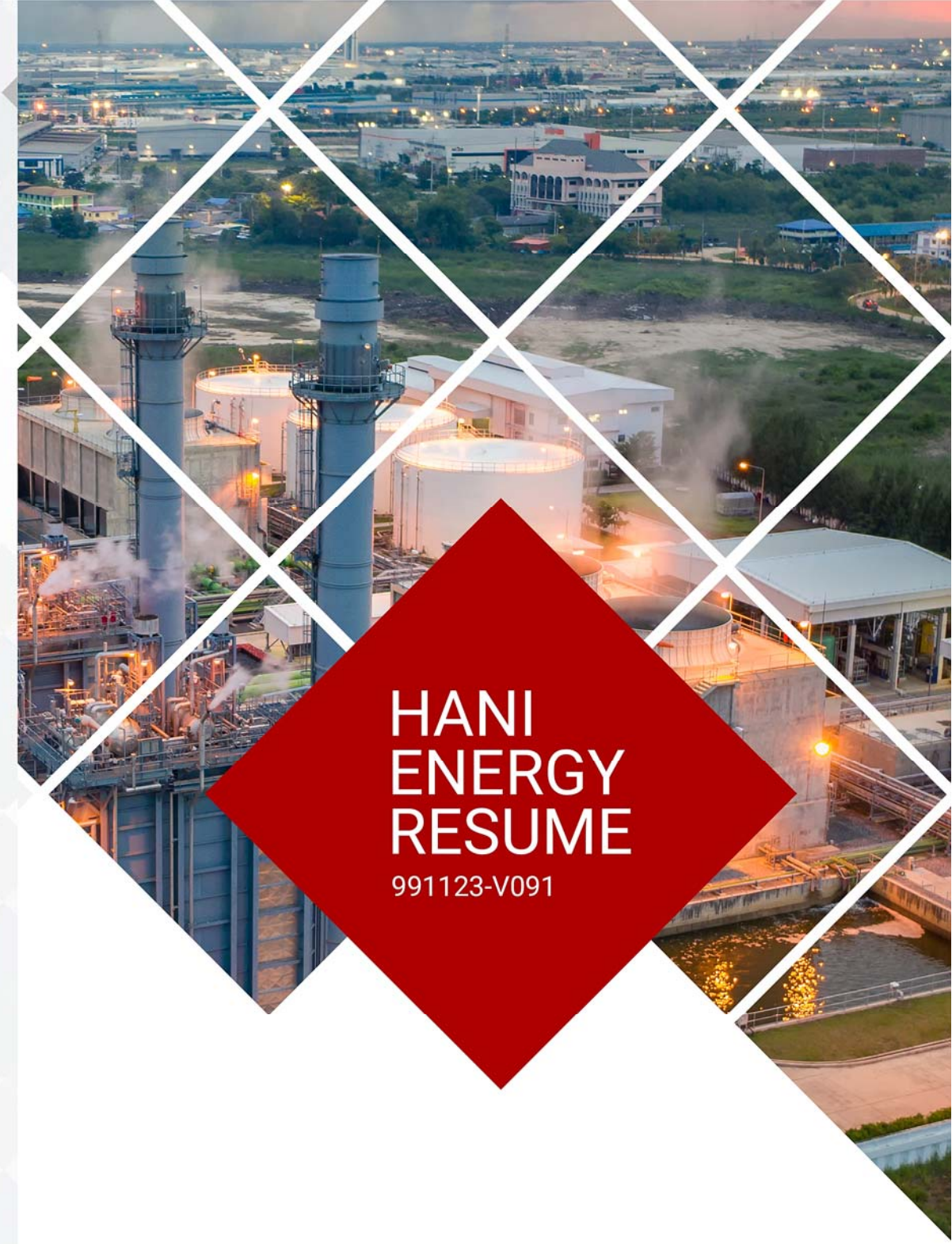
Hani
ENERGY



HANI ENERGY RESUME

991123-V091

Table of Content

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Introduction:

HANI ENERGY Company started its activity in the field of industrial automation in 2000. In the early years, along with other industrial projects, we also worked in the field of power plants and related industries. After six years, the company decided to expand its specialized activities in the field of the power plant and oil and gas industry services to become an expert in the power industry. Since then, we successfully provided our retrofit service to more than 3000MW (by early 2020) power generation units in power generation and oil and gas industries.
The fields of activity and expert teams of our company is divided into the following categories:

- Control and protection systems of gas power plant units and gas turbines.
- Control and protection systems of steam and combined cycle power plant units.
- Generator excitation and protection systems.
- Special industrial automation projects.

By adopting a successful research and development strategy, we deployed many projects to the best of customer satisfaction and achieved relevant technical expertise of these industries. We created technical teams with a scientific approach to provide high-quality service.
Our goal is to become a prominent player in the power plant retrofit industry in a global scale. We have put forward this goal based on our mature technology which has been tested on more than 3000MW power generation units and our competitive price which stems in our agility and advanced technology.

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Fields Of Activity

■ Gas turbine control unit

After years of studying the DCS control systems of gas turbines and by reviewing and modelling the General Electric 5001 and 5002 control and protection systems and optimizing them, the company was able to develop its comprehensive control and protection system called Gtech (stands for "Gas turbine control technology") in November 2011. Gtech is compatible with many types of turbines such as Hitachi, BBC, Siemens, etc.

The Gtech includes comprehensive turbine control and protection system, which was first planned for gas units and specially designed for GE turbines 5001 and 5002, and then has been adapted and optimized for using in other kinds of turbines (Hitachi, BBC, Siemens, etc.). These products can be extended to other gas turbines, regardless of their applications as turbo generator, turbo-compressor and turbo-pump. This comprehensive technology has been developed by studying different types of turbines and adapting the initial designs for a wide range of customers with different turbine types and a variety of applications.

■ Optimization of turbine controllers

Based on our technical proficiency, one of the services which are provided by HANI ENERGY Company is the performance test and inspection of the turbine controller. After examining each controller and its performance coefficients, optimization is applied to the turbine, which reduces the costs of O&M (operation and maintenance) in the mechanical unit.

At first, we audit and investigate the turbine controller's working flow pattern in different operating modes and conditions of the turbine. Next, we examine all controller components one by one, and finally, the coefficients and their overall performance will be reviewed. This can have a significant impact on the optimization of the turbine performance and reduction in the O&M (operation and maintenance) cost of the mechanical unit.

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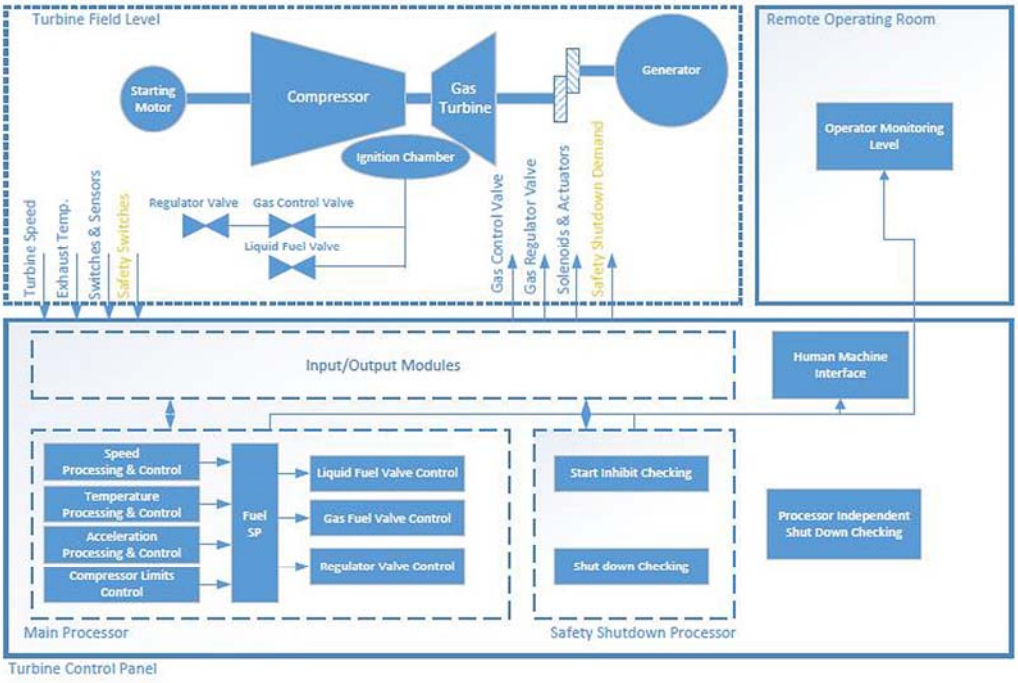
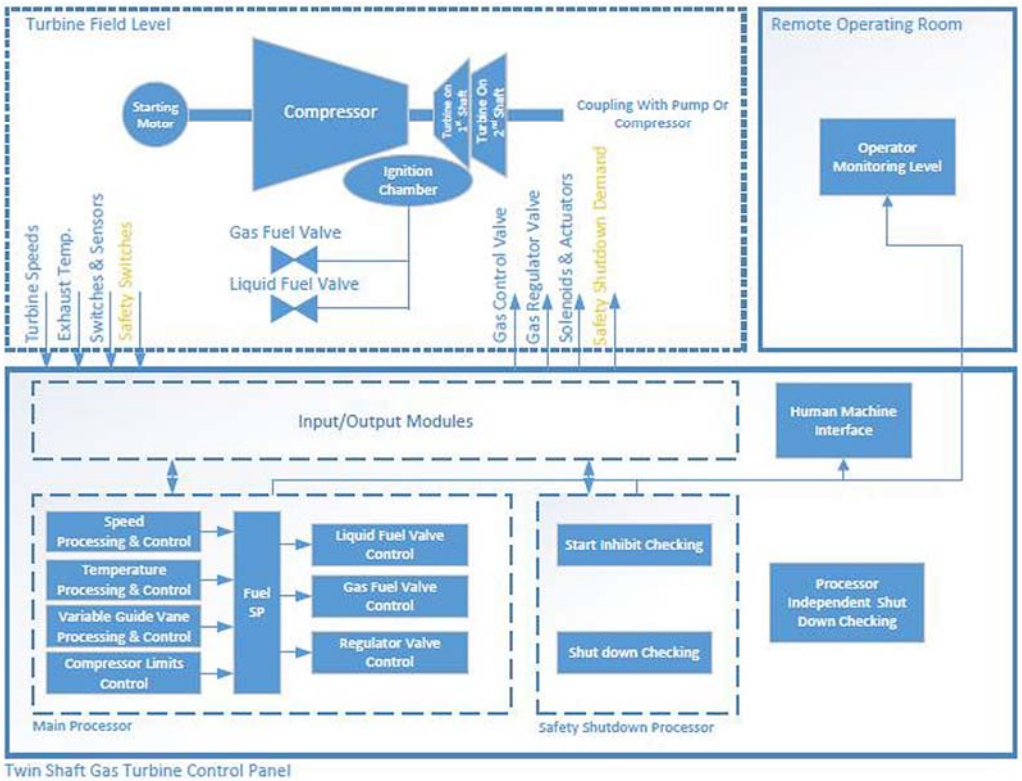
- The block diagram of this product for turbo-generator systems is as follows:



- Also, the product diagram for turbo-pump and turbo compressor systems (with two shafts) is as follows:



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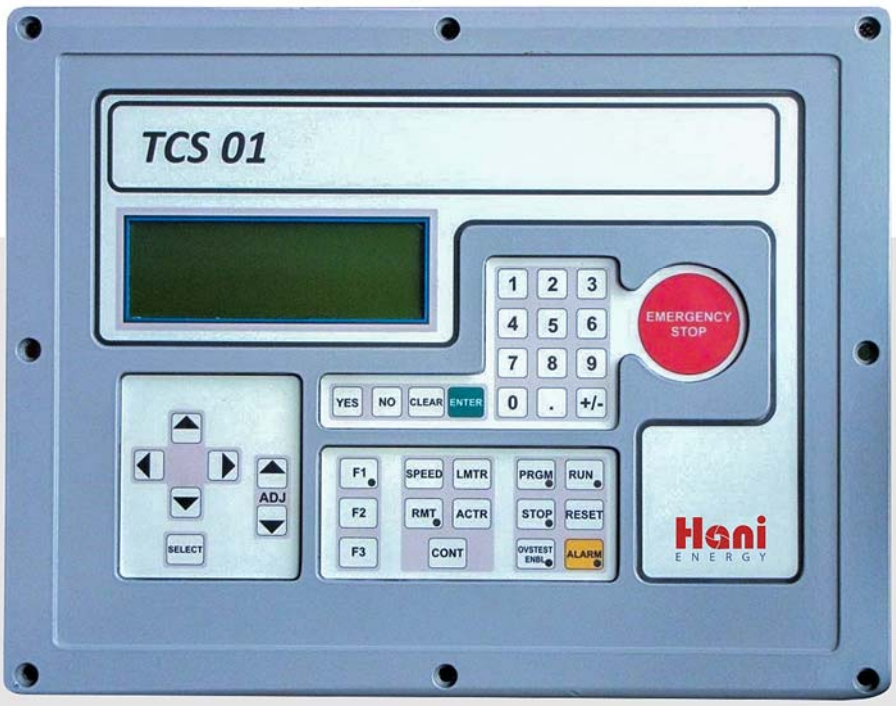
Control and protection of steam and combined units

By increasing of Gtech capabilities, we extend the scope of this turbine controller to a variety of steam turbines, including the LMZ Russian turbine generators. To obtain control technology for steam units, HANI ENERGY performed numerous research projects in steam plants that cover a wide range of processes. The following processes in a steam plant are among the main units included in our controllers:

- Turbine control of steam units
- Control of fuel cycle, air and vacuum (fuel, tail and suction)
- drum level control with three-parameter algorithms
- Superheat Steam Temperature Control (ABZ)
- Burner Controls (Complete BMS Cycle Includes Logic and Control)
- Condenser level control
- Injectors control
- Control of the cooling cycle
- Control of full cycle of water and steam and related tanks
- Increase the safety and reliability of the unit by implementing 2 of 3 logic.



The simpler product of this family is named Gtech 401, as an alternative to every electronic governor controller, to install and control small steam turbines on turbo steam pumps, etc.

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Generator Excitation Systems

Hani Energy company has nearly two decades of experience in development of various types of electronic cards, excitation system components and cards. We have recently developed a complete excitation control and protection systems for generators. The design and implementation of all power electronic parts and control parts of the system and its implementation as a DCS system are parts of our technical capabilities in this field.

The most important features of this system include the followings:

- Configuration of Siemens hardware and software-based controls, based on PCS7 300 and 400 class.
- High processing speed of control loops (less than 2 milliseconds).
- Ability to implement the system through hot redundancy in the control, power and cooling systems.
- Reduction of generator losses by placing its working point at the nominal working point which results in better generator efficiency.
- Ability to communicate with the proxy bus network and industrial Ethernet network.
- The ability to change the power of the excitation system from the dynamic to the static mode and the removal of the middle power generators.
- Full control over the generator by various control modes.
- Voltage control in automatic mode or AVR (automatic voltage regulator).
- FCR (Field Current Regulator) flow control.
- Reactive power control and generator power factor in PF (power factor).
- Transmission without mutants between control modes.
- Reactive flow regulator and the ability to determine the line drupe or reactive power drill.
- Soft power generator startup voltage to prevent sudden spin on triggering.

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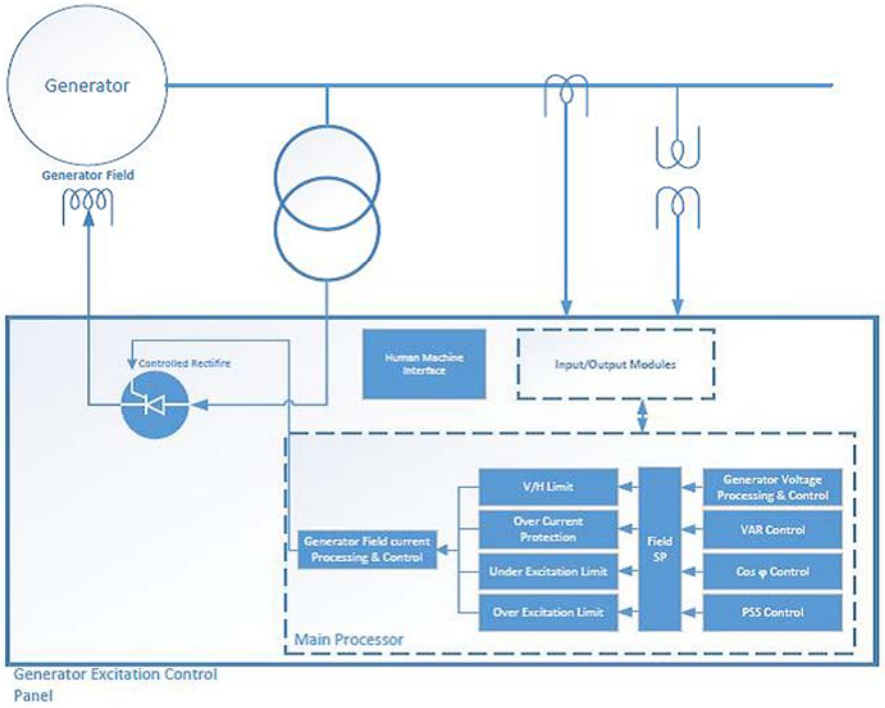
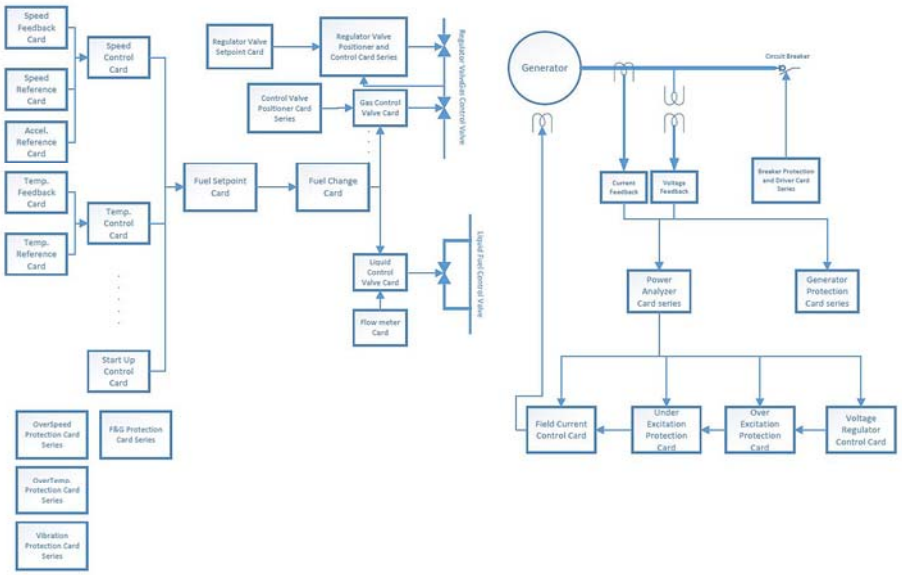
- Contains UEL (under excitation limiter), OEL (overexcitation limiter) limiting stator current limiter (SCL) and limiting volts per Hz (V/Hz).
- Display of the generator's work point in the generator's power generation curve on the HMI.
- Design of the power sector in two ways to increase the speed of the De-excitation.
- Monitoring the position of rotating diodes in the system of dynamic stimulation and the state of the thyristors in the static excitation system.

The use of this system will reduce the cost of repairing and maintenance and long-term after-sales service. The block diagram of this product is as follows:





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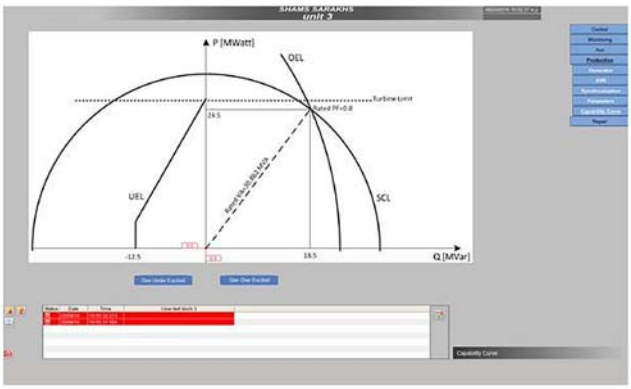
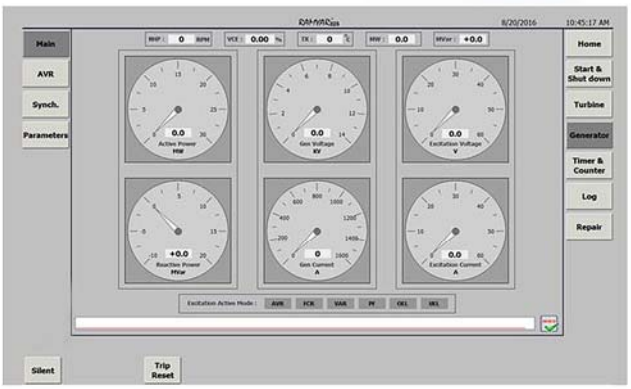
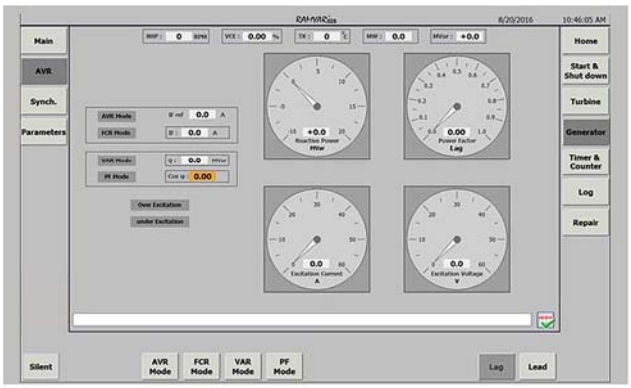
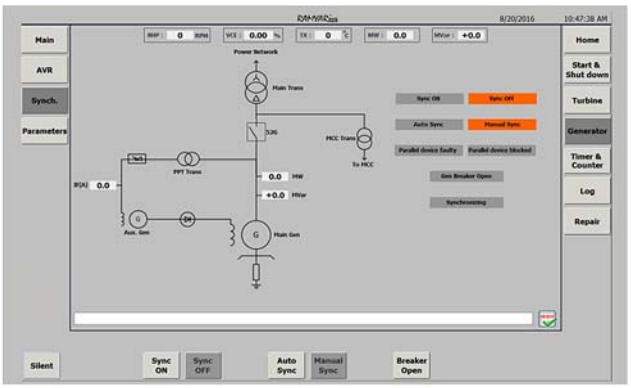
Several examples of the monitoring page of the excitation system implemented in recent projects have shown in the following figures:









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■ Over Speed Protection System

Ryan's advanced over-speed protection system is designed to display and protect the instantaneous speed of rotating equipment. This system has a modular structure that ultimately facilitates the transportation, installation, and supply of spare parts. The most important features of this system are:

- It has three independent speed protection modules
- Ability to receive input from three independent sensors in each module
- Ability to configure two out of three algorithms at the level of each module
- Ability to configure two out of three algorithms for all three modules
- Ability to configure two trip methods of two of the three cards with two independent voters simultaneously
- Availability is very high
- Compatible with a variety of magnetic pickup sensors, proximity, and Hall effect
- Ability to detect sensor error
- Possibility of latching trip
- Easy user interfaces for setting parameters (Oraspid setpoint, hysteresis definition, etc.)
- Show speed online
- Periodic validation operation in each module
- Design based on IEC61508, SIL3 standard
- 4-20mA analog output proportional to speed (optional)
- Possibility of communication through Profibus
- Repeater signal for monitoring use
- Response time <15msec in the occurrence of Oraspid
- Measurement accuracy of 1Hz at 20KHz

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■ Design and production of electronic cards in different areas

Many cards have been ordered for retrofit purposes and we have redesigned the technology to increase the reliability of the cards. The following steps are taking place in our card design section for any new retrofit card to have the same functionality higher reliability.

■ Studying the accuracy of the layout with the card in cases where the card's layout is available and otherwise extraction of the card layout even for multi-layer boards.

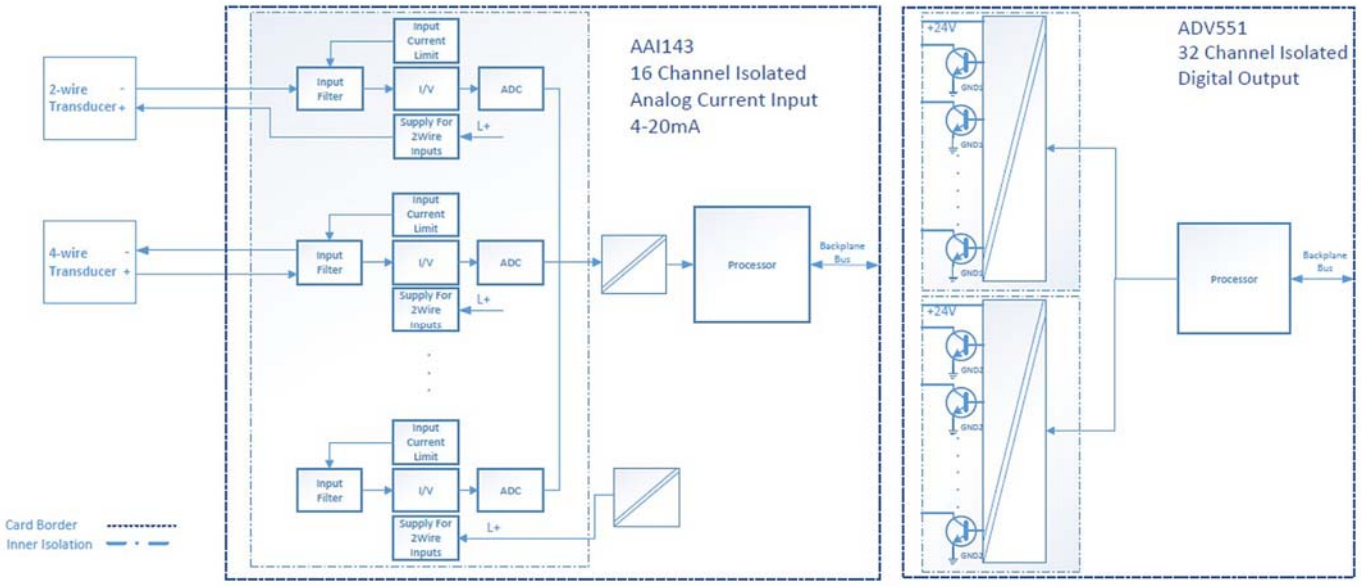
■ Studying and analyzing card function and card design in simulation software and comparing the results of analysis and simulation.

■ Designing a new card and comparing its performance with the old card.

■ Performing relevant functional and non-functional tests on the new card such as: Environmental tests according to IEC60068, other cold tests required in the laboratory and hot tests on units.

■ Retrofit services

Block Diagram of Some of the produced electronic cards are as follows:



■ Highlights of our activities in electronic card section

- All cards of Speedtronic Mark I gas control units (more than seventy types).
- All cards of Speedtronic Mark II gas control units (more than seventy types).
- All Hitachi Generator excitation cards.
- Part of AEG generator excitation cards.
- Generators excitation cards for Westinghouse units.
- All Bently Nevada 7200 Series vibration cards.
- Part of control system of Fuji's excitation system.
- K2 and K3 cards for Siemens power driver.
- Overflow protection cards for BBC Breakers.

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- Cutler-hammer Driver Cards for 3 KW Breakers.
- Steam turbine controller system based on the Woodward 505 performance.
- Protection system against the maximum speed of the turbine based on the speed protection function of the E16 model of the German Brown.
- I/O modules from the YOKOGAWA with full compatibility and updated hardware software protocols.

We have provided above products to customers around the globe to countries such as Scotland, Ghana, Afghanistan, Emirates, South Korea and USA

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Highlights of the completed projects

Design and Installation of Gas Turbine Control and Protection System

2010 25 Mega Watt Alstom

The first version of this system installed on an Alstom unit in 2010. In this project along with the acquisition of all of the mathematical functions, and multi-loop control, parameters have been reviewed and optimized. The project is not limited to reverse engineering and the turbine set; is simulated as well. Then, based on the information obtained, new sections, including exhaust temperature correction based on compressor pressure added to the previous controller. This includes the algorithm for calculating turbine speed, speed protection algorithm, thermocouple error detection algorithm and unit setup cycle. One important feature of the designed system is redundancy in all parts of the controller as well as compliance with the SIL3 standard of the IEC61508 standard. In this system, the protection section has been implemented with logic 2 of 3 and independent of hardware.

Project	Design and installation of control and protection system for gas turbine
Unit name	Alstom
Used Technology	DCS SIEMENS PCS7
Estimated time	24 Month
Unit capacity	25 Mega Watt
Delivery Date	2011 December

2012 25 Mega Watt Alstom

The next Gtech control system installed in 2012. The old control system was the brand-new Speedtronic system. This system was designed and installed with independent SIL III protection system.

Project	Design and installation of control and protection system for gas turbine
Unit name	Alstom
Used Technology	DCS SIEMENS PCS7
Estimated time	3 Month
Unit capacity	25 Mega Watt
Delivery Date	2013 April

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■ 2012 25 Mega Watt Alstom

A similar system to the previous project installed in 2012.

Project	Design and installation of control and protection system for gas turbine
Unit name	GE Unit
Used Technology	DCS SIEMENS PCS7
Estimated time	3 Month
Unit capacity	25 Mega Watt
Delivery Date	2013 April

■ 2015 25 Mega Watt Alstom

The next example of this system was installed in March of 2015.

Project	Design and installation of control and protection system for gas turbine
Unit name	GE (Alstom)
Used Technology	DCS SIEMENS PCS7
Estimated time	7 Month
Unit capacity	25 Mega Watt
Delivery Date	2015 March

■ 2015 32 Mega Watt Asec

This system has been designed and implemented for 40 megawatts of Acec unit and replaced the old pneumatic control system. This control system has implemented in 2012.

Project	Design and installation of control and protection system for gas turbine
Unit name	Asec 2(Westinghouse)
Used Technology	DCS SIEMENS PCS7
Estimated time	18 Month
Unit capacity	32 Mega Watt
Delivery Date	2015 November

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2016 25 Mega Watt Alstom

The next sample of this system was installed in April 2016.

Project	Design and installation of control and protection system for gas turbine
Unit name	F5 Gas Unit
Used Technology	DCS SIEMENS PCS7
Estimated time	3 Month
Unit capacity	25 Mega Watt
Delivery Date	2016 April

2017 32 Mega Watt Asec

Another sample of Gtech installation with its technical specification

Project	Design and installation of control and protection system for gas turbine
Unit name	Acec (Westinghouse)
Used Technology	DCS SIEMENS PCS7
Estimated time	7 Month
Unit capacity	32 Mega Watt
Delivery Date	2017 December

2017 25 Mega Watt Alstom

In this project, only the turbine and generator in the mechanical sector has purchased by the power plant owner and all other equipment supplied and installed by Hani Energy Company. The parts that were designed and manufactured by the company include turbine control and protection system, AVR system and generator protection, MCC key set, charger battery, thermocouples and some field-level equipment. This project ignited the development of Hani Energy excitation control system (Extech).

Project	Design and installation of control and protection system for gas turbine
Unit name	Alstom
Used Technology	DCS SIEMENS PCS7
Estimated time	5 Month
Unit capacity	25 Mega Watt
Delivery Date	2017 May

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85 Mega Watt Mitsubishi

Hani Energy Company has retrofitted control and protection system of gas turbines which was previously working with Mitsubishi technology in this project.

Project	Design and installation of control and protection system for gas turbine
Unit name	Mitsubishi
Used Technology	DCS SIEMENS PCS7
Estimated time	6 Month
Unit capacity	85 Mega Watt
Delivery Date	Ongoing

4 Mega Watt Typhoon

Designing and replacing the control systems of 8 turbo-pumps of the pump stations of an oil's pipelining company was deposited to our company

Project	Design and installation of control and protection system of turbo-pump
Unit name	Typhoon
Used Technology	DCS SIEMENS PCS7
Estimated time	12 Month
Unit capacity	4 Mega Watt
Delivery Date	Ongoing

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20 Mega Watt GE

The project related to the change of a power plant control system. The whole design, implementation and installation phases of this project took four months. Working under time constraints become a routine at HANI ENERGY Company due to the limited possibility of power plants in out phasing of their units.

Project	Design and installation of control and protection system for gas turbine
Unit name	GE
Used Technology	DCS SIEMENS PCS7
Estimated time	4 Month
Unit capacity	20 Mega Watt
Delivery Date	Ongoing

20 Mega Watt GE

Replacing the control system of a power plant at the time of the overhaul and at the end of the year is a method to relax time constrains. However, the implementation, testing and commissioning before the completion of repairs are of great importance. This project delivered to the customer under such circumstances.

Project	Design and installation of control and protection system for gas turbine
Unit name	GE 3
Used Technology	DCS SIEMENS PCS7
Estimated time	4 Month
Unit capacity	20 Mega Watt
Delivery Date	Ongoing

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2019 7.5 Mega Watt C7

Design and replacement of Westinghouse turbine control system unit C7 of the gas refinery have been assigned to this company under a contract.

Project	Design and installation of control and protection system for gas turbine
Unit name	C7
Used Technology	DCS SIEMENS PCS7
Estimated time	8 Month
Unit capacity	7.5 Mega Watt
Delivery Date	Ongoing

2019 25 Mega Watt Hitachi

During field visits to projects carried out by the company, the design and replacement of Hitachi control systems has been entrusted to the company under a contract.

Project	Design and installation of control and protection system for gas turbine
Unit name	Hitachi
Used Technology	DCS SIEMENS PCS7
Estimated time	6 Month
Unit capacity	25 Mega Watt
Delivery Date	Ongoing

2020 127 Mega Watt Mitsubishi

Design and replacement of two-unit Mitsubishi turbine control system have been assigned to this company under a contract.

Project	Design and installation of control and protection system for gas turbine
Unit name	Hitachi
Used Technology	DCS SIEMENS PCS7
Estimated time	6 Month
Unit capacity	127 Mega Watt
Delivery Date	Ongoing

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Highlights of the completed projects

Design and Installation Control and Protection System of Steam Turbine

■ 2015 320 Mega Watt LMZ

In the first Gtech steam project, the old turbine control from the LMZ Company of Russia, was successfully replaced by Gtech control system. The new system is based on the latest DCS Siemens PCS7, and with 400H grade LCDs, and it is designed to control a 320 MW steam turbine.

The most important features of the new DCS system are:

Implementation of a Startup Mode and Automated Shut Down modes.

Implementation of an Intelligent Troubleshooter.

Implementation of automated thermal tension management system.

Increasing the system response time

Adding protection against maximum speed with logic 2 of 3

Implementation of the data connection with the boiler control system

Possibility to set up the unit in both models of the following turbine, boiler

Project	Designing and replacing LMZ steam turbine's control system
Unit name	The 6th unit
Used Technology	DCS SIEMENS PCS7
Estimated time	15 Month
Unit capacity	320 Mega Watt
Delivery Date	2015 November

■ 2016 320 Mega Watt LMZ

The second installment of the system on another LMZ turbine.

Project	Designing and replacing LMZ steam turbine's control system
Unit name	The 5th unit
Used Technology	DCS SIEMENS PCS7
Estimated time	15 Month
Unit capacity	320 Mega Watt
Delivery Date	2016 November

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2014 1.5 Mega Watt Gtech 401

Project	Designing and replacing steam turbo-pump's control system
Unit name	Amin circulation unit
Used Technology	Gtech 401 C
Estimated time	10 Month
Unit capacity	1.5 Mega Watt
Delivery Date	2014 February

This product is designed to replace with any turbine controller with sensitive or rotary machines. In this product, all the needs of steam turbines, including control and protection, has been predicted and the system parameters are regulated in accordance withby the state-of-the-art technology. This system is designed according to the environmental standards, being corrosion, moisture and dust-resistant. In this system, the three processors are simultaneously active and havethey independent protection from the main controller and thus it is more reliable than the original Woodward's system by design.

Features of this system include:

Controller system with adjustable parameters for each working environment and every steam turbine

Upgraded control panel

Easy structure and operation

Ability to change and set parameters remotely

Independent speed protection system

Communication with LAN cable

Insulation level against moisture and sulfur

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Highlights of the completed projects

Design and production of generator excitation systems

2017 25 Mega Watt Alstom

The project has carried out as a comprehensive excitation system with all the operators' requirements.

Project	Designing and Replacing Excitation System cards
Unit name	Alstom Gas
Used Technology	DCS SIEMENS PCS7
Estimated time	8 Month
Unit capacity	25 Mega Watt
Delivery Date	2017 June

2017 100 Mega Watt GE

The company has fully designed and completely replaced a 1,000-ampere dynamic excitation system to a static system.

Project	Designing and Replacing Generator Excitation System
Unit name	GE steam
Used Technology	DCS SIEMENS PCS7
Estimated time	6 Month
Unit capacity	100 Mega Watt
Delivery Date	2017 December

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60 Mega Watt Skoda

The excitation system of a power plant was a static type-thyristor that was used in 60 thyristors, but because of being old and the failure of the automation system, it was put aside from operators were actuating the unit work cycle manually. The old system replaced by our Extech system.

Project	Designing and Replacing generator Excitation System
Unit name	Skoda Gas
Used Technology	DCS SIEMENS PCS7
Estimated time	5 Month
Unit capacity	60 Mega Watt
Delivery Date	Ongoing

85 Mega Watt Mitsubishi

This project involves designing and implementing protection related to generator, transformer unit.

Project	Designing and Replacing Generator Excitation System
Unit name	Mitsubishi 6
Used Technology	SIEMENS SIPROTEC 4
Estimated time	5 Month
Unit capacity	85 Mega Watt
Delivery Date	Ongoing

20 Mega Watt GE

This project includes all the issues of excitation and protection of the generator.

Project	Designing and Replacing Generator Excitation System
Unit name	GE 2
Used Technology	DCS SIEMENS PCS7
Estimated time	4 Month
Unit capacity	20 Mega Watt
Delivery Date	Ongoing

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20 Mega Watt GE

This project includes all the issues of excitation and protection of the generator.

Project	Designing and Replacing Generator Excitation System
Unit name	GE 3
Used Technology	DCS SIEMENS PCS7
Estimated time	4 Month
Unit capacity	20 Mega Watt
Delivery Date	Ongoing

2018 25 Mega Watt GE

This project includes all the issues of excitation and protection of the generator.

Project	Designing and Replacing Generator Excitation System
Unit name	GE
Used Technology	SIEMENS PCS7
Estimated time	7 Month
Unit capacity	25 Mega Watt
Delivery Date	2018 October

8 Mega Watt Westing House

This project includes Designing and Implementation of the Generator Protection system.

Project	Designing and Replacing Comprehensive Turbine Control System
Unit name	WestingHouse
Used Technology	SIEMENS PCS7
Estimated time	8 Month
Unit capacity	8 Mega Watt
Delivery Date	Ongoing

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■ 400 Mega Watt ANSALDO

This project includes Designing and Implementation of a Static Excitation System without Transformer for 320 MW Units.

Project	Designing and Replacing Comprehensive Turbine Control System
Unit name	ANSALDO
Used Technology	SIEMENS PCS7
Estimated time	14 Month
Unit capacity	400 Mega Watt
Delivery Date	Ongoing

■ 2018 25 Mega Watt Hitachi

This project includes all the issues of stimulation and protection of the generator.

Project	Designing and Replacing Comprehensive Turbine Control System
Unit name	Hitachi
Used Technology	SIEMENS PCS7
Estimated time	6 Month
Unit capacity	25 Mega Watt
Delivery Date	2018 May

■ 2020 25 Mega Watt Alstom

This project is the purchase and installation of a generator protection system and AVR turbine control system GE-F5

Project	Designing and Replacing Comprehensive Turbine Control System
Unit name	Alstom
Used Technology	SIEMENS PCS7
Estimated time	3 Month
Unit capacity	25 Mega Watt
Delivery Date	2020 Jun

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■ 2020 60 Mega Watt Skoda

The purchase of the Ashkoda excitation system was assigned to this company under a contract

Project	Designing and Replacing Comprehensive Turbine Control System
Unit name	Alstom
Used Technology	SIEMENS PCS7
Estimated time	3 Month
Unit capacity	25 Mega Watt
Delivery Date	2020 Jun

■ 2020 60 Mega Watt Skoda

The purchase of the Ashkoda excitation system was assigned to this company under a contract

Project	Designing and Replacing Comprehensive Turbine Control System
Unit name	Skoda
Used Technology	SIEMENS PCS7
Estimated time	1.1 Month
Unit capacity	60 Mega Watt
Delivery Date	2020 April

■ 2020 320 MEGA watt LMZ

Changing the excitation system from dynamic to static mode

Project	Designing and Replacing Comprehensive Turbine Control System
Unit name	LMZ
Used Technology	SIEMENS PCS7
Estimated time	1.20 Month
Unit capacity	320 Mega Watt
Delivery Date	2020 April

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