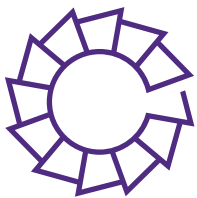
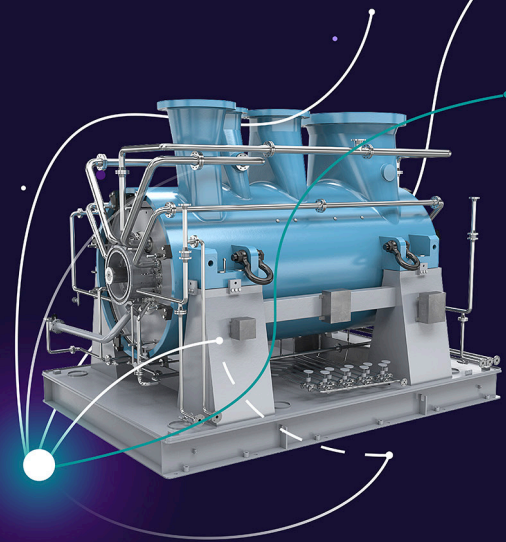


Compressor Train One Control

Load Sharing

[siemens-energy.com](https://www.siemens-energy.com)



As a top tier supplier of compressors Siemens Energy has the domain expertise and experience across the range of several well-known legacy brands of compressors including the Siemens legacy and the Dresser-

Rand legacy. This expertise comprises both the compressors themselves as well as the decades of experience in compressor control. The enhanced Compressor Train One Control (in the following abbreviated as One Control) core functions are used in both the worldwide leading SIMATIC PCS 7/S7 automation product family from Siemens Energy or the well-established Allen-Bradley.

Siemens Energy's One Control features a patented load sharing algorithm, which helps equalize surge margins and maximize system efficiency by sharing flow among multiple compressors that are connected to common suction and discharge lines.

Application

A compression process consists of one compressor or a network of multiple compressors. Controlled distribution of the transport capacities is necessary for stable and efficient operation. Compressor load sharing is used to maintain uniform throughput flow or share of capacity for compressor units operating in parallel, typically connected to common suction and discharge headers as shown in Figure 1.

The load sharing function is normally integrated as a function block into the PLC based unit control system.

Load Sharing Control

A higher-level plant control system usually provides a setpoint for the master controller of the load sharing control regarding the current process requirements. The setpoint can refer to a required header suction pressure or header discharge pressure or station flow for all the units.

The speed of the compressor driver, the inlet throttle valve position, or the inlet guide vane (IGV) position is used as a feedback signal to the load sharing controller. The load sharing master controller itself consists of the process control(s), such as suction pressure, discharge pressure or flow control.

The load sharing algorithm varies the throughput of the compressor by adjusting the driver speed on variable speed units or an inlet throttle valve or guide vane position on constant speed units.

The load sharing controller outputs have a defined rate of change that limits the rate of the corresponding actuator. This is used to limit the rate of control action for stability purposes, and to minimize negative interaction between load sharing controllers, surge controllers and other elements in the process.

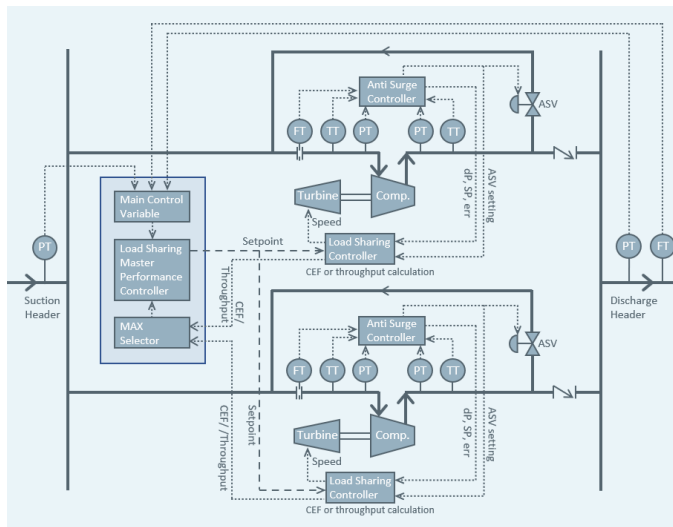


Figure 1a: General control schematic

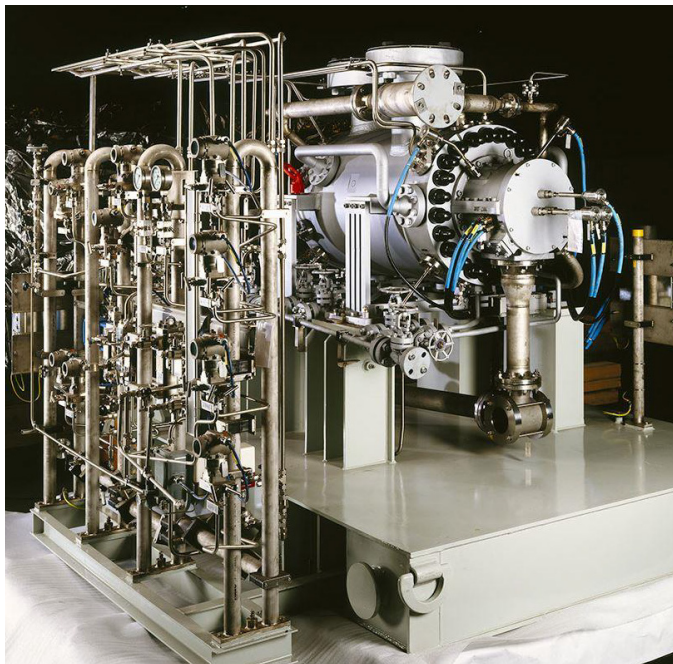


Figure 2: Siemens Energy compressor STC SV

For example, during low flow conditions, if the speed of a unit is being decreased so rapidly as to cause the flow to decrease below the anti-surge control line, the ramp down of speed will be temporarily stopped long enough to allow the surge control action to open the recycle valve to increase flow above the limit. This action prevents the speed of the unit from being decreased so rapidly as to drive the compressor into a surge condition. The highest of the compressor throughput flow signals from the units is used as a feedback signal to the master controller.

Since the load sharing controller for each unit has the same input setpoint from the master controller, the units share the total load equally. This equal sharing of the total load creates a balanced operation and increases the efficiency of all units.

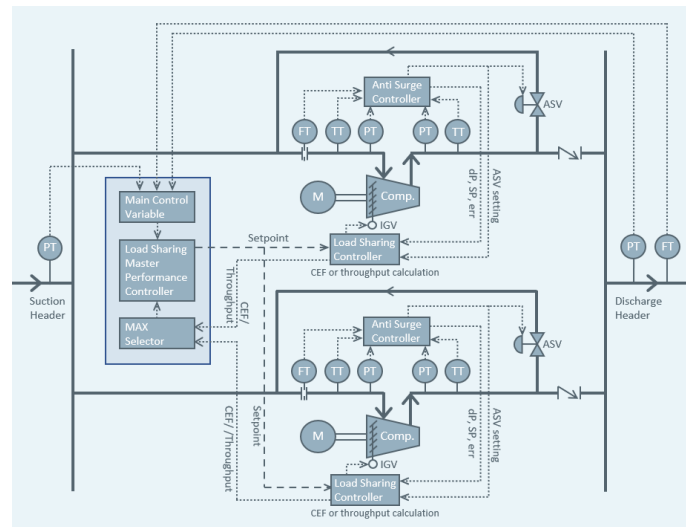


Figure 1b: General schematic with inlet guide vane (IGV)

Compressor trains with identical capacities

A master performance controller is used to provide a common setpoint for each compressor load sharing controller and does consist of one or more process controllers controlling suction or discharge header pressures or station flow for all the units.

Since the load sharing controller for each unit has the same input setpoint from the master controller, the units are caused to share the total load equally. This equal sharing of the total load creates a balanced operation and increases the efficiency of all the units.

Compressor trains with different capacities

When compressor trains with different capacities are load sharing, the Load Sharing Control ensures an equalization of relative surge margins of the operating point of each compressor on its performance curve using the CEF value. Hence, the controller can manage and optimize load sharing between multiple operating compressor trains even with different compressor capacities.

Coefficient of Export Flow (CEF)

Conventional load sharing algorithms are based upon the relationship between compressor inlet flow Q_{in} and the surge control setpoint Q_{sp} . This limits the load sharing range to the surge control line, at which point Q_{in} becomes meaningless because it does not account for recycled flow Q_{rec} .

The compressor throughput flow Q_{tp} is a calculated value consisting of the compressor inlet flow minus the recycle flow depending on the recycle valve position.

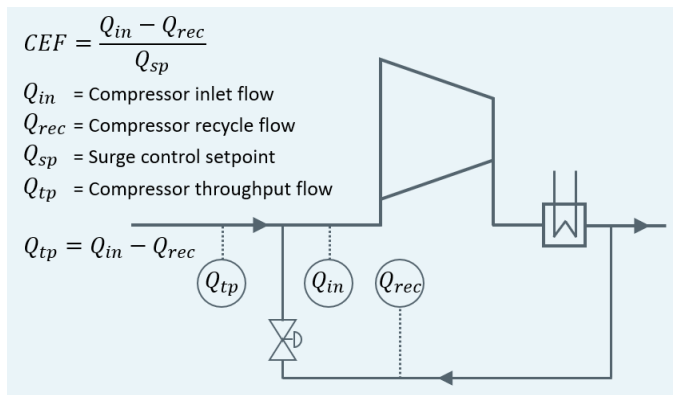


Figure 3: Calculation of Coefficient of Export Flow (CEF)

To eliminate this problem, One Control's algorithm uses the patented Coefficient of Export Flow (CEF), that represents the ratio of the unit export flow of the process to the surge control line. This value accounts for any flow being recycled through the anti-surge valves and allows for effective load sharing over the entire operating range of the compressor.

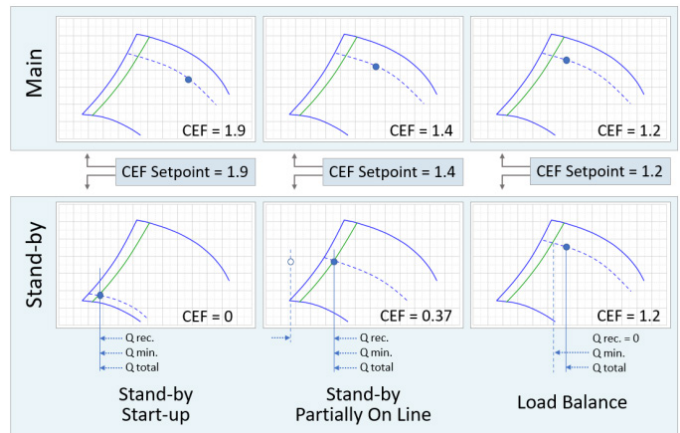


Figure 4: Example of load balancing operation

Decoupling from Anti-Surge Controller

When the operating point reaches the control line, interaction between anti-surge controllers and load sharing controllers (LSC) can lead to destabilization. To prevent this, the load sharing controllers are decoupled from anti-surge controllers when flow approaches the surge line. By communicating with anti-surge controllers, the Load Sharing Controller can stabilize the process if the flow moves beyond the surge control line.

Dedicated Master Controller

A traditional master controller is used to control load sharing controllers of parallel units in a control system, as shown in Figure 1. The master controller is often located separately from the units being controlled.

Floating Master Controller

The Floating Master Controller (FMC) allows the master controller to be embedded into each of the units (see below) providing additional functionality to 'float' the master between the units, perform data synchronization and fault detection.

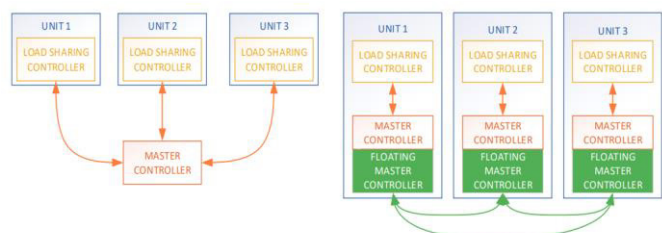


Figure 5: Units with dedicated and Floating Master Controller

The redundant master controllers in the other units track the active master (local/remote setpoints, manual demand and tuning values) using soft link communications.

If the active master controller fails, there is an automatic bumpless transfer to the backup master controller residing in another unit, which then become the new active master.



Load Sharing Features – in a nutshell

- Patented load sharing algorithm
- Automatic balancing to give an equal load share to each participating machine
- Accounts for any flow being recycled
- Ideally suited for compressors with identical capacities (throughput) or different capacities (CEF)
- Maintain the operating points of all compressor trains at the same margin from the surge control line
- Floating master and dedicated master principle
- Decoupling of anti-surge and load sharing controllers to avoid dynamic instabilities
- Load sharing control architecture can be customized to meet specific control requirements
- Maximize system efficiency by minimizing recycle flows
- Provide fully automatic operation and plant load optimization by using an integrated load sharing strategy encompassing multiple compressor trains



Product performance

Siemens Energy Load Sharing Control provides (among others)

- Optimized use with Siemens Energy compressors
- Flexible location of the master performance controller, “self-organizing” concept with Floating Master concept
- Efficiency maximization

Remote support

Siemens Energy is also able to offer local advice, support, and intervention, provided by specialist personnel in our engineering centers, based on fleet and technical knowledge as an OEM. In line with our Service Agreements, our Competence Center will assist you with different kinds of technical issues and provide online troubleshooting with secured access to the control system.

Siemens Energy Global GmbH & Co. KG
Transformation of Industry
Siemens promenade 9
91058 Erlangen, Germany

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Transformation of Industry
4400 N Alafaya Trail
Orlando, FL 32826, USA

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