STEP 7 AGA Gas Library

SIMATIC STEP 7

Library • November 2010

Applications & Tools

SIEMENS

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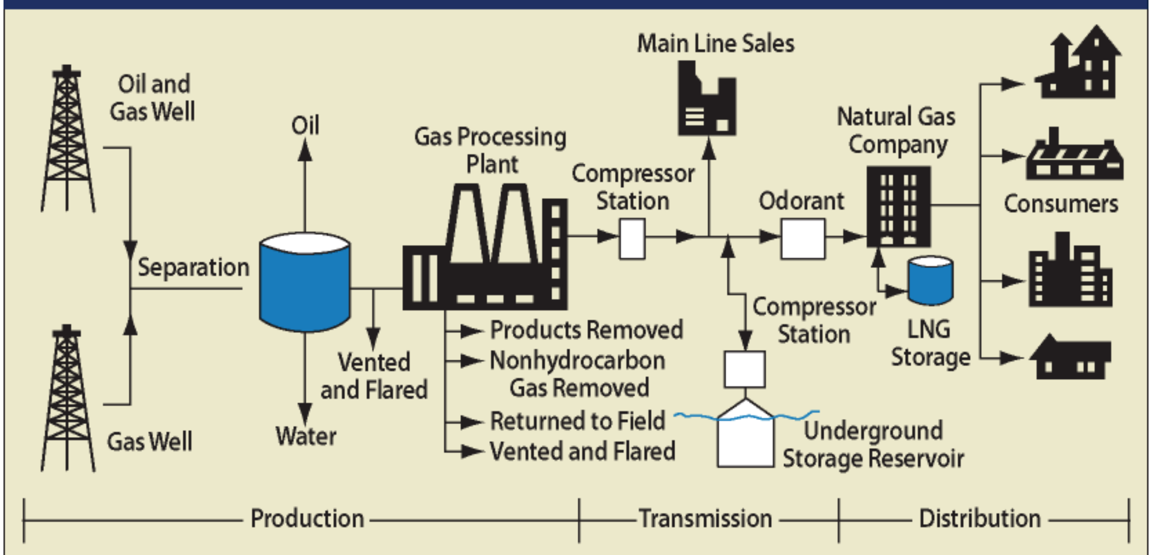


Source: U.S. Energy Information Administration.

Natural gas is moved by pipelines from the producing fields to consumers. Since natural gas demand is greater in the winter, gas is stored along the way in large underground storage systems, such as old oil and gas wells or caverns formed in old salt beds. The gas remains there until it is added back into the pipeline when people begin to use more gas, such as in the winter to heat homes.

When chilled to very cold temperatures, approximately -260 degrees Fahrenheit, natural gas changes into a liquid and can be stored in this form. Liquefied natural gas (LNG) can be loaded onto tankers (large ships with several domed tanks) and moved across the ocean to deliver gas to other countries. Once in this form, it takes up only 1/600th of the space that it would in its gaseous state. When this LNG is received it can be shipped by truck to be held in large chilled tanks close to users or turned back into gas to add to pipelines.

When the gas gets to the communities where it will be used (usually through large pipelines), the gas is measured as it flows into smaller pipelines called "mains". Very small lines, called "services", connect to the mains and go directly to homes or buildings where it will be used.

Gas flow metering

A gas meter is used to measure the volume of fuel gases such as natural gas and propane. Gas meters are used at residential, commercial, and industrial buildings that consume fuel gas supplied by a gas utility. Gases are more difficult to measure than liquids, as measured volumes are highly affected by temperature and pressure. Gas meters measure a defined volume, regardless of the pressurized quantity or quality of the gas flowing through the meter. Temperature, pressure and heating value compensation must be made to measure actual amount and value of gas moving through a meter.

Several different designs of gas meters are in common use, depending on the volumetric flow rate of gas to be measured, the range of flows anticipated, the type of gas being measured and other factors.

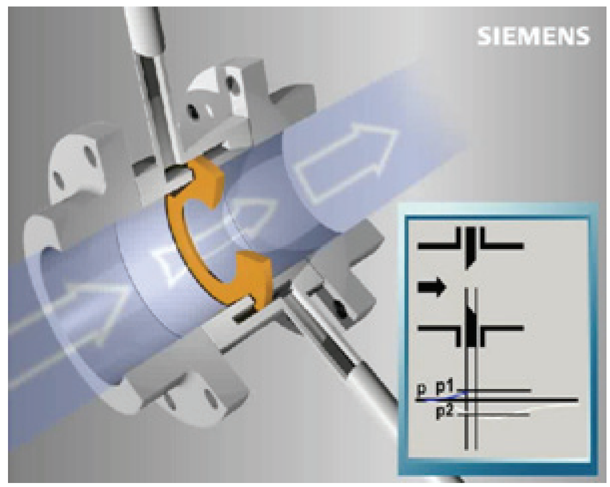
Typical industrial natural gas flow meters

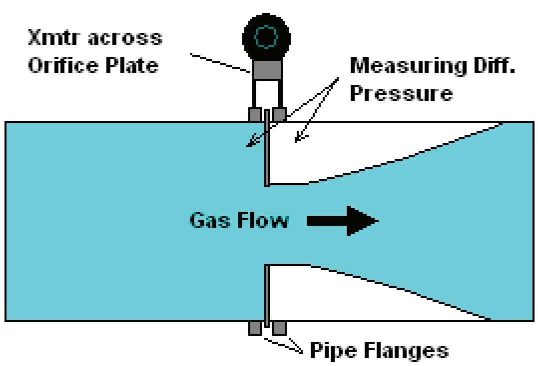
Orifice plate flow meters

Orifice plate flow meters include a venturi nozzle design to restrict the gas flow through the meter and take a differential pressure measurement on both sides of the orifice plane. The differential pressure measurement is then applied to Bernoulli's principle resulting in an accurate flow calculation; that is, when pressure decreases the velocity (flow) increases and vice versa. The available signal from the transmitter is most often an analog 4-20mA signal.

Orifice plate flow meter: external view

Orifice plate flow meter: internal view





Suggested Siemens SITRANS F Orifice Plate flow meters

Model/Series	Description
7ME1110*	SITRANS F O delta p orifice plates
7MF4433-.....-1...	SITRANS P DS III, HART, 4-20 MA transmitter for differential pressure and flow PN 32/160 gas 1/liquids 1 art. 3.3 sep
7MF4434-.....-1...	SITRANS P DS III PROFIBUS PA,transmitter for differential pressure and flow PN 32/160
7MF4533-.....-1...	SITRANS P DS III, HART, 4-20 mA transmitter for differential pressure and flow PN 420
7MF4534-.....-1...	SITRANS P DS III PROFIBUS PA,transmitter for differential pressure and flow PN 420

For more information on SITRANS F flow meters see:

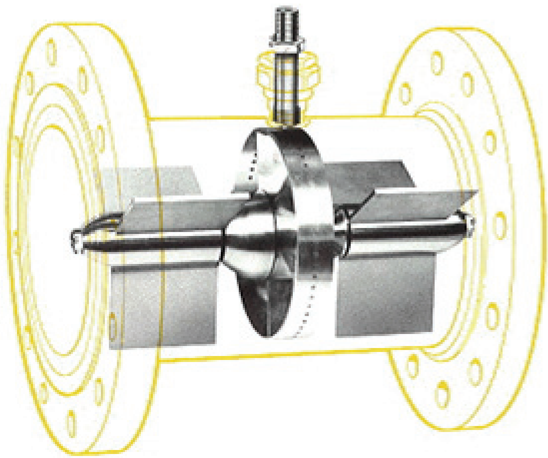
http://www.sea.siemens.com/us/Products/Process-Instrumentation/Process-Sensors-Transmitters/Pages/Flow-measurement.aspx

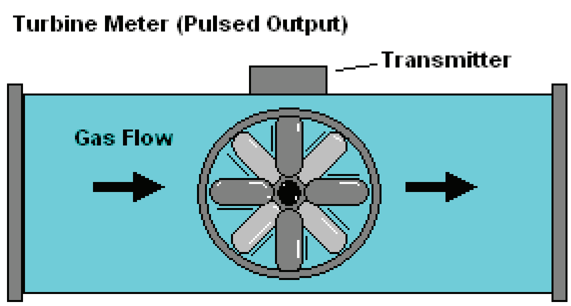
Turbine flow meters

Turbine flow meters includes a turbine rotating on an axis positioned in the path of flowing gas. The rotational speed of the turbine is proportional to the velocity (flow) of the gas passing around it. A turbine meter most often provides a pulse-train output signal that can be used to calculate its flow rate.

Turbine flow meter: external view

Turbine flow meter: internal view



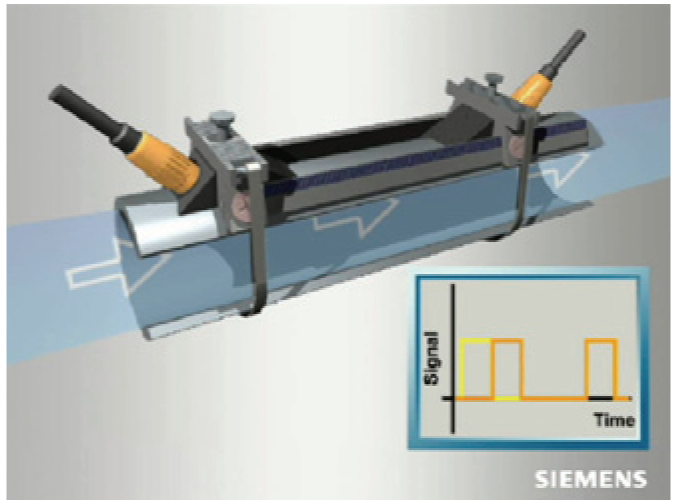


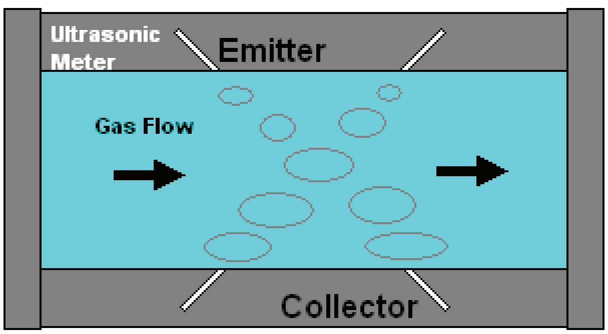
Ultrasonic flow meters

Ultrasonic flow meters include ultrasonic sensors that use sound reflection technology to measure the flow of gas through a pipe. These are most often clamped to an existing pipe and are not required to be installed within the actual gas flow and include no moving parts making them easy to install and maintain. Ultrasonic flow meters most often provide a pulse-train output signal or a Modbus RTU serial communication signal that can be used to calculate its flow rate.

Ultrasonic flow meter: external view

Ultrasonic flow meter: internal view





Suggested Siemens SITRANS F Ultrasonic flow meters

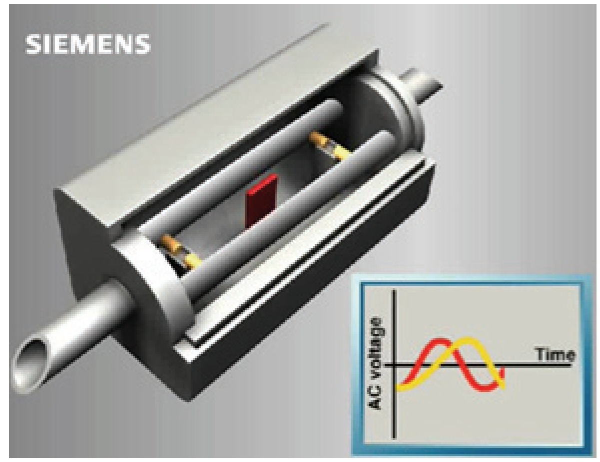
Model/Series	Description
7ME3610-....0-....	SITRANS FUG1010 Gas clamp-on Ultrasonic Flow meter, IP65 (NEMA 4X)
7ME3611-....0-....	SITRANS FUG1010 Gas clamp-on Ultrasonic Flow meter, IP65 (NEMA 7) compact
7ME363.-.....-0...	SITRANS FUT 1010 Gas clamp-on Ultrasonic Flow meter, spool version

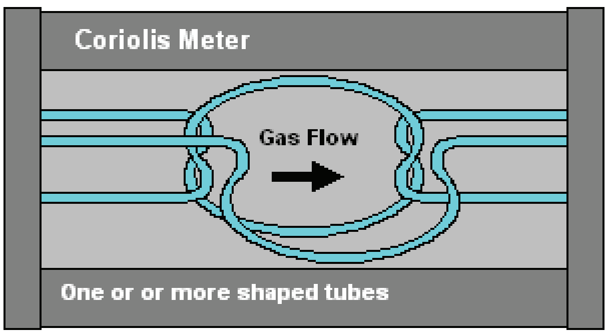
For more information on SITRANS F flow meters see:
http://www.sea.siemens.com/us/Products/Process-Instrumentation/Process-Sensors-Transmitters/Pages/Flow-measurement.aspx

Coriolis flow meters

Coriolis flow meters, often called Mass flow meters, include one or more internal tubes within the flow of gas that are used to measure the mass of the traveling gas past a fixed point per unit time. The internal tube(s) provide a vibration signal which can be used to derive gas flow rate based on their frequency. Coriolis flow meters most often provide a pulse-train output signal or a Modbus RTU serial communication signal that can be used to calculate its flow rate.

Coriolis flow meter: external view **Coriolis flow meter: internal view**





Suggested Siemens SITRANS F Coriolis flow meters

Model/Series	Description
7ME4100-.....-....	SITRANS F C MASSFLO MASS2100 Standard without heating jacket
7ME411.-.....-....	SITRANS F C MASS 6000 Transmitter

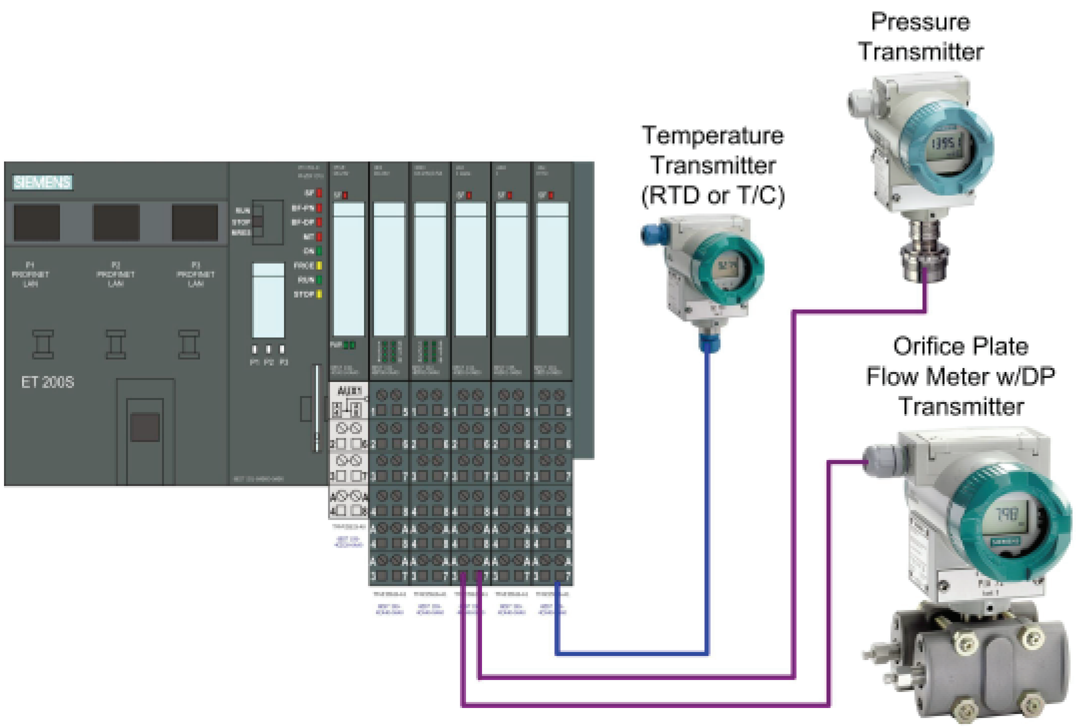
For more information on SITRANS F flow meters see:
http://www.sea.siemens.com/us/Products/Process-Instrumentation/Process-Sensors-Transmitters/Pages/Flow-measurement.aspx

Typical SIMATIC controller gas flow system configurations

Single orifice plate flow meter configuration

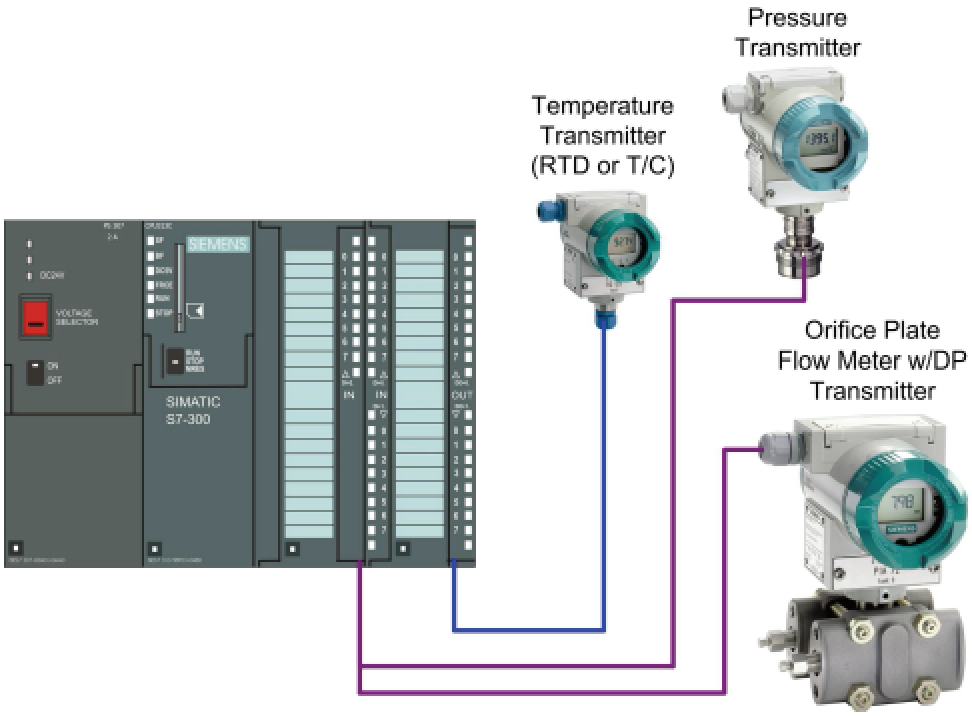
A single or multiple orifice plate flow meter configuration is probably the most common retrofit application because of the large installed base of existing orifice plate meters. Most often each meter is combined with a pressure transmitter and a temperature transmitter. All signals are used to calculate the gas flow rate.

Minimum ET200S CPU-based system configuration



Qty	Part Number	Description
1	6ES5710-8MA11	Stand. mount. rail, length 483 mm (f. 19" cab.)
1	6ES7131-4BF00-0AA0	Electronics module, 8DI, 24 V DC, standard (1 unit)
1	6ES7132-4BF00-0AA0	Electronics module, 8DO, 24 V DC/0.5A, standard (1 unit)
1	6ES7134-4GB01-0AB0	Electronic module, 2AI, I, standard, for 2-wire-MU
1	6ES7134-4JB51-0AB0	Electronic module, 2AI, RTD, standard
1	6ES7135-4GB01-0AB0	Electronic module, 2AO, I
1	6ES7138-4CA01-0AA0	Power module PM-E DC 24V for electronic modules
1	6ES7151-8AB00-0AB0	IM 151-8 CPU PN/DP with PROFINET controller
1	6ES7193-4CD20-0AA0	Terminal module for AUX1 supply screw connection
5	6ES7193-4CA40-0AA0	Universal terminal module screw connection

Minimum S7-300-based system configuration

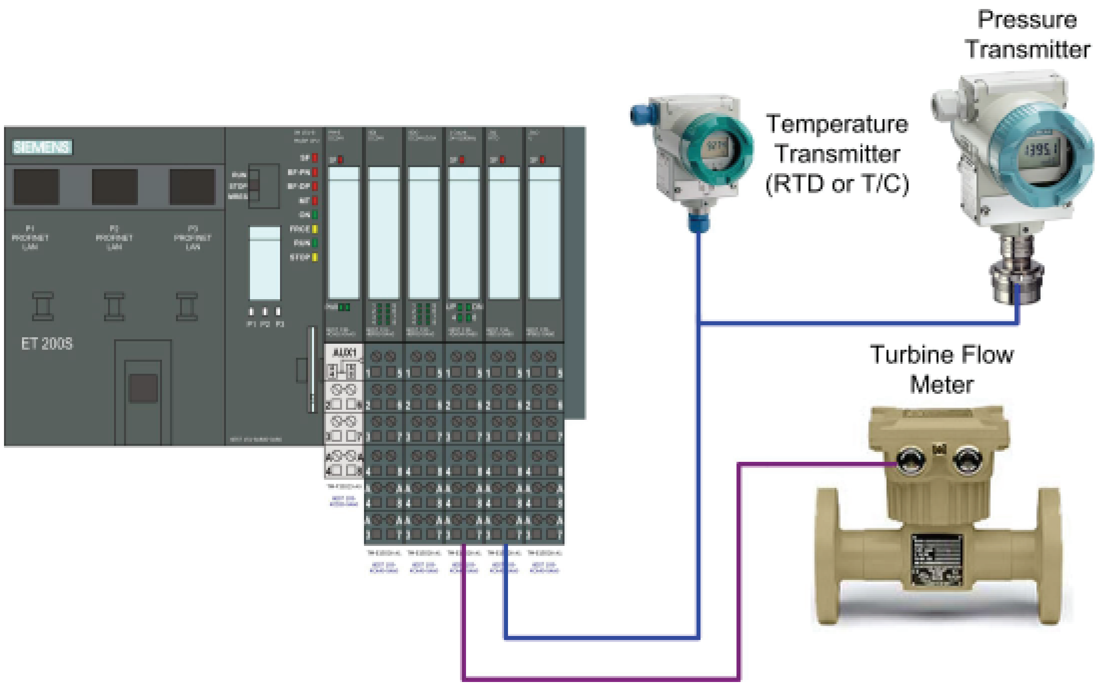


Qty	Part Number	Description
1	6ES7307-1BA01-0AA0	Load power supply PS 307 AC 120/230V, DC 24V, 2A
1	6ES7313-5BF03-0AB0	Central module CPU313C (24DI, 16DO, 4AI, 2AO, 1 PT100)
1	6ES7390-1AB60-0AA0	Mounting rail 160 mm
2	6ES7392-1AM00-0AA0	Front connector, 40-pole, with screw contact
1	6ES7953-8LF20-0AA0	Micro Memory Card for S7-300/C7/IM151 CPU, 64KB

Single turbine flow meter configuration

A single or multiple turbine flow meter configuration are common in applications on pipelines with a lower flow capacity because of the speed limitations of the mechanical turbine included in the meter. Most often the turbine meter interfaces to an input on a High-speed Counter module on the PLC and is combined with a pressure transmitter and a temperature transmitter with all signals being used to calculate the gas flow rate.

Minimum ET200S CPU-based system configuration



Qty	Part Number	Description
1	6ES5710-8MA11	Stand. mount. rail, length 483 mm (f. 19" cab.)
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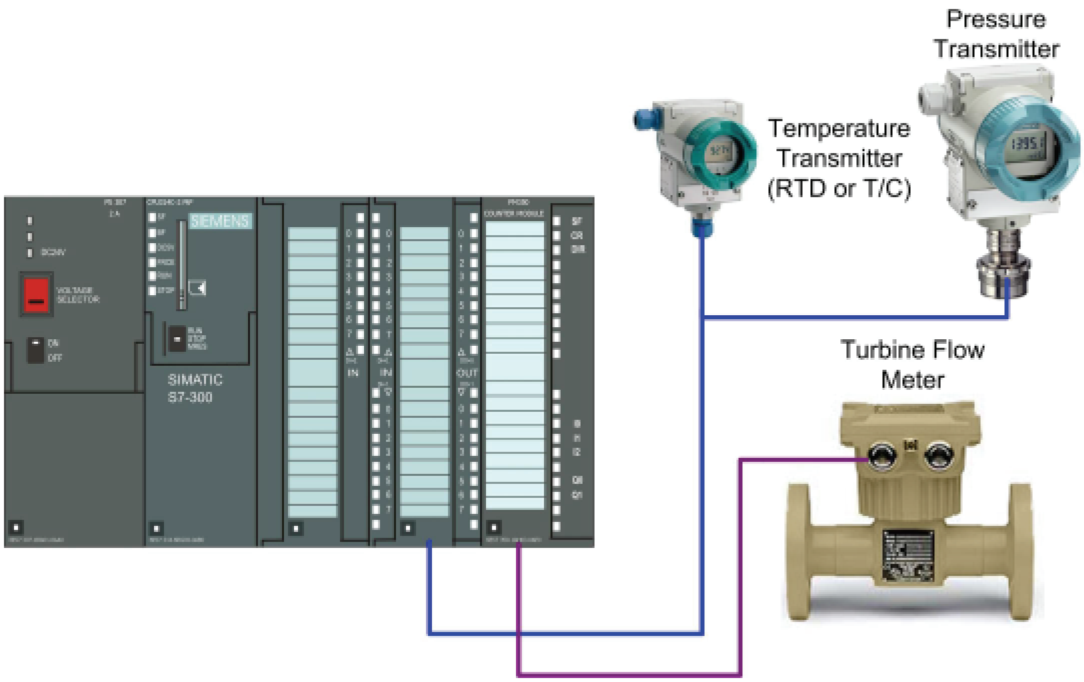
1	6ES7132-4BF00-0AA0	Electronics module, 8DO, 24 V DC/0.5A, standard
1	6ES7134-4JB51-0AB0	Electronic module, 2AI, RTD, standard
1	6ES7135-4FB01-0AB0	Electronic module, 2AO, U
1	6ES7138-4CA01-0AA0	Power module PM-E DC 24V for electronic modules, with diagn.
1	6ES7138-4DA04-0AB0	1 Count 24V/100kHz for counting and measuring tasks
1	6ES7151-8AB00-0AB0	IM 151-8 CPU PN/DP with PROFINET controller
5	6ES7193-4CA40-0AA0	Universal terminal module screw connection
1	6ES7193-4CD20-0AA0	Terminal module for AUX1 supply screw connection

Minimum S7-300-based system configuration

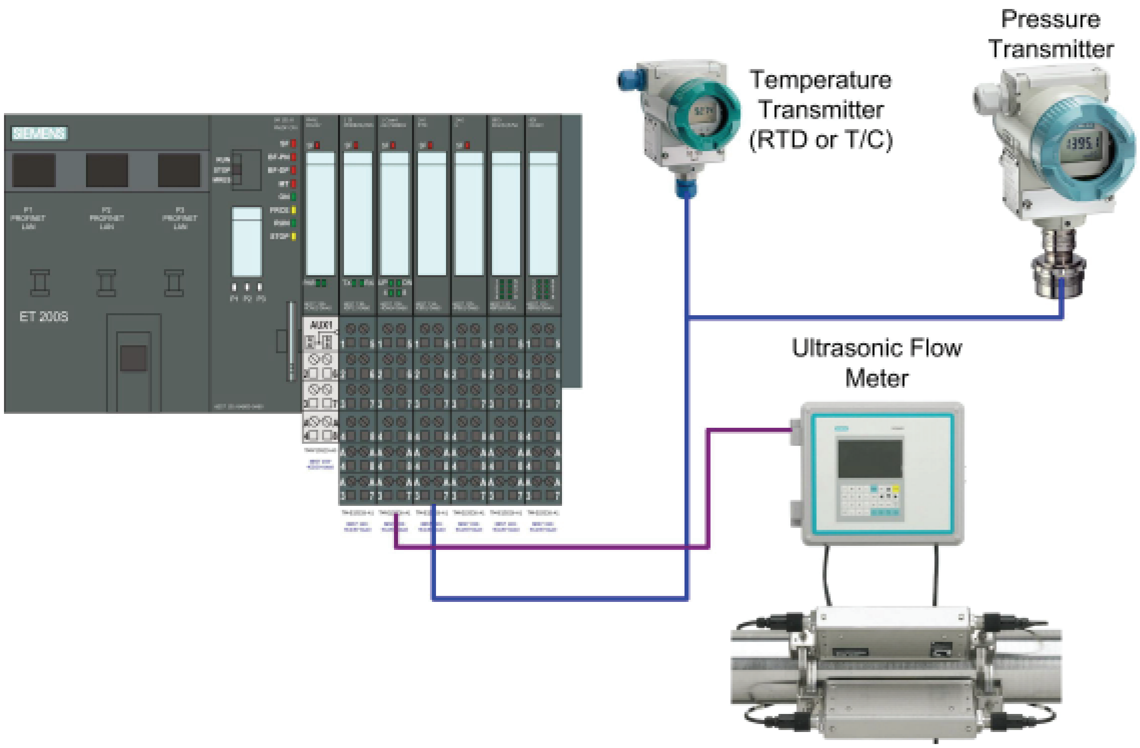


Qty	Part Number	Description
1	6ES7307-1BA01-0AA0	Load power supply PS 307 AC 120/230V, DC 24V, 2A
1	6ES7314-6BG03-0AB0	Central module CPU314C (24DI, 16DO, 4AI, 2AO, 1 PT100)
1	6ES7350-1AH03-0AE0	Counter module FM 350-1 (1 channel up to 500 kHz) incl. conf. pack.
1	6ES7390-1AB60-0AA0	Mounting rail 160 mm
2	6ES7392-1AM00-0AA0	Front connector, 40-pole, with screw contact
1	6ES7953-8LF20-0AA0	Micro Memory Card for S7-300/C7/IM151 CPU, 64KB

Single ultrasonic flow meter configuration

A single or multiple path ultrasonic flow meter configuration is common in applications on pipelines that require the flow meters to be clamped onto an existing pipe. Most often the ultrasonic meter interfaces to an input on a High-speed Counter module on the PLC or occasionally includes a serial communication interface supporting Modbus RTU Slave protocol. The flow meter signal is then combined with a temperature transmitter and pressure transmitter with all signals being used to calculate the gas flow rate.

Minimum ET200S CPU-based system configuration



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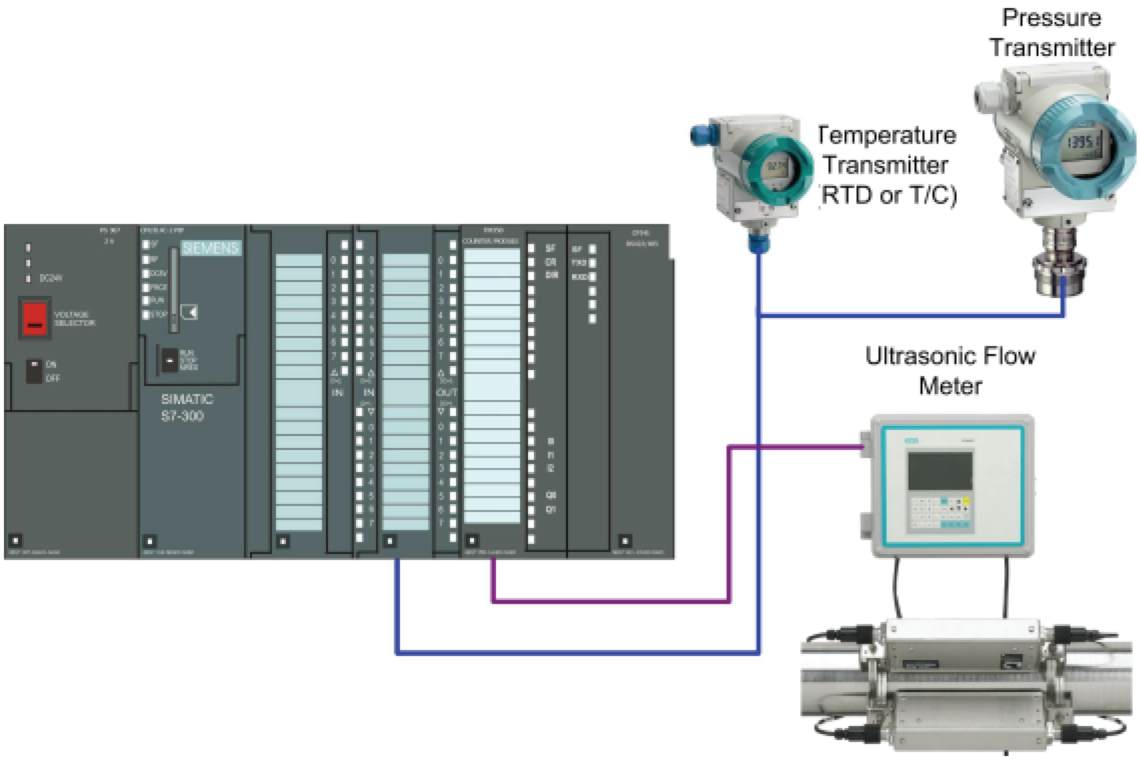
1	6ES7132-4BF00-0AA0	Electronics module, 8DO, 24 V DC/0.5A, standard
1	6ES7134-4JB51-0AB0	Electronic module, 2AI, RTD, standard
1	6ES7135-4FB01-0AB0	Electronic module, 2AO, U
1	6ES7138-4CA01-0AA0	Power module PM-E DC 24V for electronic modules, with diagn.
1	6ES7138-4DA04-0AB0	1 Count 24V/100kHz for counting and measuring tasks
1	6ES7151-8AB00-0AB0	IM 151-8 CPU PN/DP with PROFINET controller
5	6ES7193-4CA40-0AA0	Universal terminal module screw connection
1	6ES7193-4CD20-0AA0	Terminal module for AUX1 supply screw connection
1	6ES7138-4DF11-0AB0	SI Serial interface module Modbus/USS Optional substitute for Counter Module

Minimum S7-300-based system configuration



Qty	Part Number	Description
1	6ES7307-1BA01-0AA0	Load power supply PS 307 AC 120/230V, DC 24V, 2A
1	6ES7314-6BG03-0AB0	Central module CPU314C (24DI, 16DO, 4AI, 2AO, 1 PT100)
1	6ES7350-1AH03-0AE0	Counter module FM 350-1 (1 channel up to 500 kHz) incl. conf. pack.
1	6ES7390-1AB60-0AA0	Mounting rail 160 mm
2	6ES7392-1AM00-0AA0	Front connector, 40-pole, with screw contact
1	6ES7953-8LF20-0AA0	Micro Memory Card for S7-300/C7/IM151 CPU, 64KB
1	6ES7341-1CH02-0AE0	CP 341 with 1 interface RS 422/485 Optional substitute for Counter Module

Single Coriolis flow meter configuration

A single or multiple coriolis flow meter configuration is used to measure the mass of the traveling gas past a fixed point per unit of time. Most often the coriolis meter interfaces to an input on a High-speed Counter module on the PLC or occasionally includes a serial communication interface supporting Modbus RTU Slave protocol. The flow meter signal is then combined with a temperature transmitter and pressure transmitter with all signals being used to calculate the gas flow rate.

Minimum ET200S CPU-based system configuration

Qty	Part Number	Description
1	6ES5710-8MA11	Stand. mount. rail, length 483 mm (f. 19" cab.)
1	6ES7131-4BF00-0AA0	Electronics module, 8DI, 24 V DC, standard
1	6ES7132-4BF00-0AA0	Electronics module, 8DO, 24 V DC/0.5A, standard
1	6ES7134-4JB51-0AB0	Electronic module, 2AI, RTD, standard
1	6ES7135-4FB01-0AB0	Electronic module, 2AO, U
1	6ES7138-4CA01-0AA0	Power module PM-E DC 24V for electronic modules, with diagn.
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1	6ES7193-4CD20-0AA0	Terminal module for AUX1 supply screw connection
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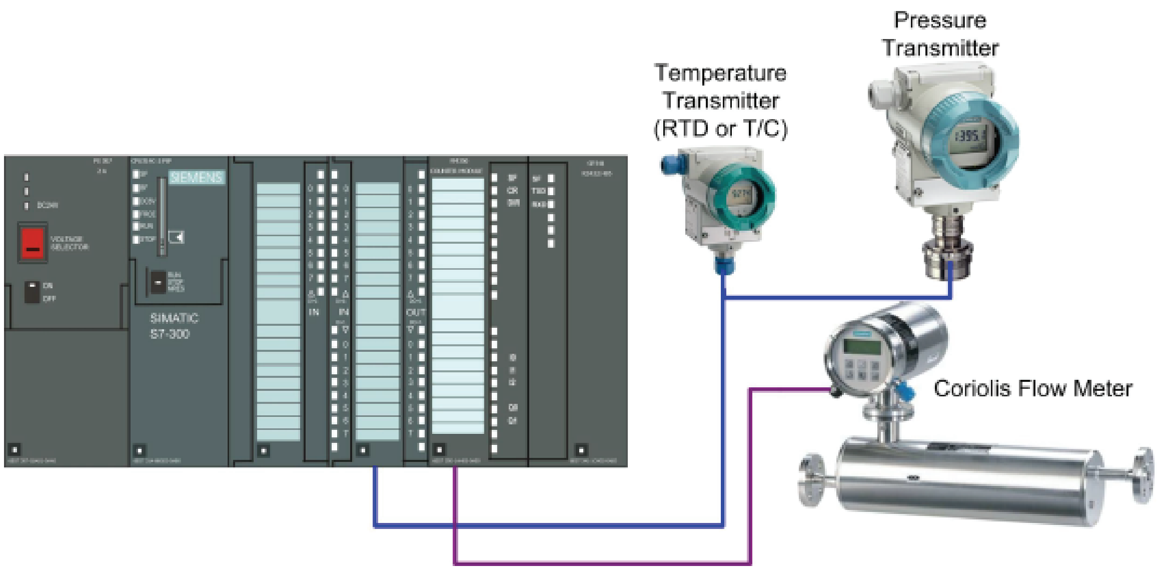
Minimum S7-300-based system configuration



Qty	Part Number	Description
1	6ES7307-1BA01-0AA0	Load power supply PS 307 AC 120/230V, DC 24V, 2A
1	6ES7314-6BG03-0AB0	Central module CPU314C (24DI, 16DO, 4AI, 2AO, 1 PT100)
1	6ES7350-1AH03-0AE0	Counter module FM 350-1 (1 channel up to 500 kHz) incl. conf. pack.
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2	6ES7392-1AM00-0AA0	Front connector, 40-pole, with screw contact
1	6ES7953-8LF20-0AA0	Micro Memory Card for S7-300/C7/IM151 CPU, 64KB
1	6ES7341-1CH02-0AE0	CP 341 with 1 interface RS 422/485 Optional substitute for Counter Module

STEP 7 AGA Function Blocks

Overview

The Siemens AGA function block library for STEP 7 provides function blocks for calculating flow rate of natural gas for various types of metering. Also included are three function blocks for calculating compressibility and supercompressibility. The supercompressibility or compressibility of the gas under given conditions is a required input for the flow rate calculation function blocks. All calculations are derived from AGA standards.

Metering types and corresponding flow function blocks

The flow rate functions blocks calculate flow rate for the following types of metering:

Type of metering	Function block
Orifice	AGA3-85, AGA3-92
Turbine	AGA7
Ultrasonic	AGA9
Coriolis	AGA11

Compressibility function blocks

The compressibility functions fall into two categories: NX-19 and AGA8. The AGA8 compressibility functions are further separated into an AGA8-Gross function, which can be used under most conditions, and the AGA8-Detail functions which is used in certain temperature and pressure ranges, or for gasses with specific composition characteristics. The flow rate function blocks require supercompressibility or compressibility factors as input. The relationship between the three compressibility function blocks and the flow rate function blocks is depicted below:

Compressibility function block	Can be used to supply super-compressibility/compressibility for:
NX-19	AGA3-85, AGA7
AGA8-Gross	AGA3-85, AGA3-92, AGA7, AGA9, AGA11
AGA8-Detail	AGA3-92, AGA7, AGA9, AGA11

In addition to the flow rate function blocks, the library includes a function block for calculating the energy of natural gas under given conditions, AGA5.

Minimum requirements

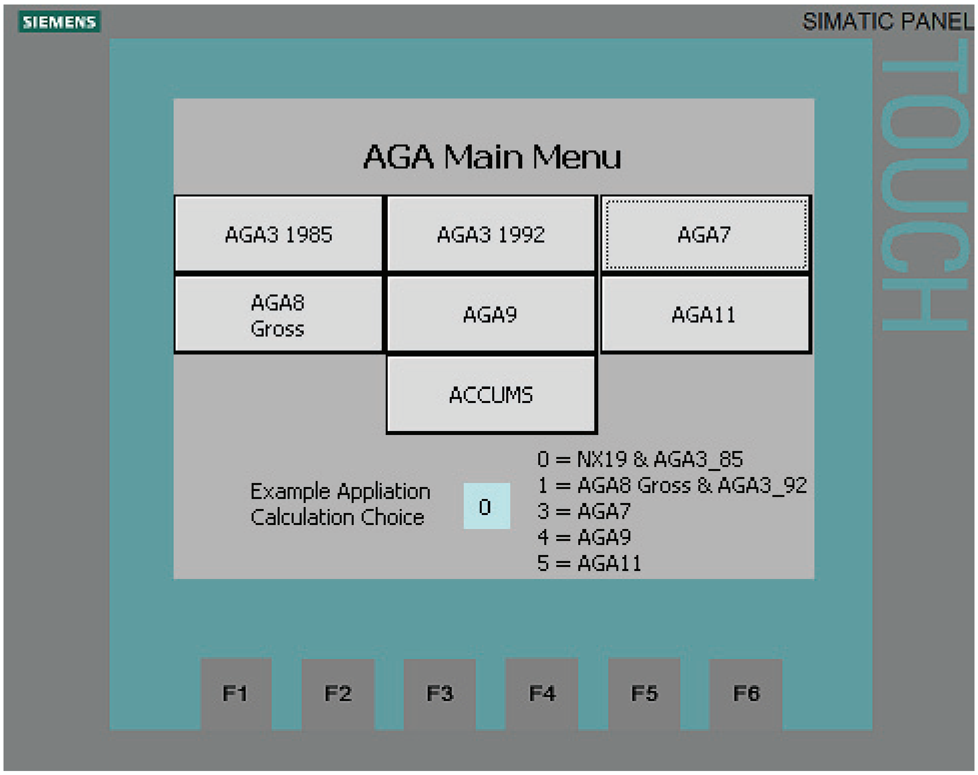
The minimum requirements for the STEP 7 AGA gas libraries and WinCC Flexible screens are as follows:

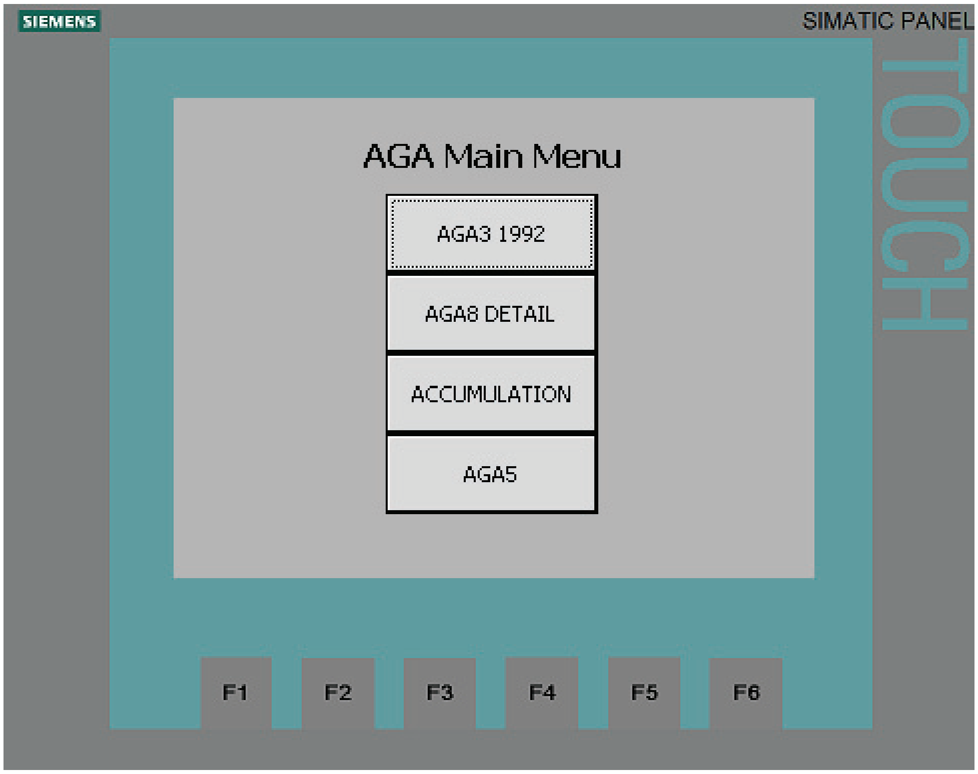
- STEP 7 V5.4
- WinCC Flexible 2008 SP2

Sample STEP 7 program and WinCC Flexible Screens

Your installation CD also includes two sample STEP 7 programs that show usage of the AGA library functions. One sample program illustrates all of the function blocks except AGA8-Detail, and the other shows AGA3-92 with AGA8-Detail. In each sample program, examine OB35 to understand programming with the AGA library functions.

The sample programs also include WinCC Flexible Screens that you can use for data entry of function block inputs. You can also modify them as necessary for your specific application. When you run the screens with WinCC Runtime, you start with the Main Menu screen. Here you can enter the type of calculation you need to perform, and you can click a button to enter input values for a specific AGA function block. You can also access the ACCUMS screen, which provides volumetric calculations from the flow rate results. OB35 in the sample programs reads the calculation choice and then performs the specified calculation. The WinCC Flexible Screen for the main menu of each sample program is shown below:




SIEMENS
SIMATIC PANEL
TOUCH
AGA Main Menu
AGA3 1992
AGA8 DETAIL
ACCUMULATION
AGA5
F1
F2
F3
F4
F5
F6

Supercompressibility calculation using FB201 "NX-19"

Description

FB201 “NX-19” calculates supercompressibility factor of natural gas. The output, Fpv, is used in AGA3 calculations for the flow rate of gas through an orifice and AGA7 calculations for turbine metering flow.

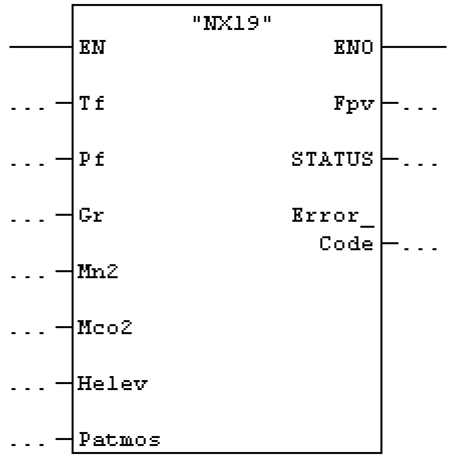
Parameters

Parameter	Declaration	Data type / Value range	Description
Tf	IN	Real	Scaled and conditioned transmitter temperature of the flowing gas in degrees F
Pf	IN	Real	Scaled and conditioned transmitter pressure of the flowing gas in PSIG
Gr	IN	Real	Specific gravity of the flowing gas, and is the ratio of the density of the gas to that of dry air at standard conditions
Mn2	IN	Real	Mole Percent of N2 in Gas Stream
Mco2	IN	Real	Mole Percent of CO2 in Gas Stream
Helev	IN	Real	Height of meter in feet above sea level
Patmos	IN	Real	Atmospheric pressure in PSIA. If input Patm is not supplied, input Helev is used to calculate the atmospheric pressure.
Fpv	OUT	Real	Supercompressibility factor of the gas
STATUS	OUT	Boolean 0: Error 1: No error	Indicator whether error occurred
Error_Code	OUT	Int 0: No error 1: Invalid pressure input 2: Invalid specific gravity input 3: Invalid N2 input 4: Invalid CO2 input	Error value

STEP 7 programming

Follow these steps to use the NX-19 compressibility calculation in your user program:

1. Open the AGA_V1_0 library in the SIMATIC Manager and copy Symbols from the AGA8 folder into your S7 program.
2. Create a cyclic interrupt OB with a scan time of 1000 ms and open it in the LAD editor.
3. In the LAD editor, drag the NX-19 (FB201) function block from the AGA_V1_0 library to a network in your user program. Create DB201 for the instance data block.
4. Program the inputs to NX-19 from I/O or operator-entered data values.



When executed, NX-19 produces an Fpv output that can be used in other gas flow calculations.

Example: AGA3-85 with NX-19

WinCC Flexible Screen

See the AGA3-85 or AGA7 WinCC Flexible Screen for NX-19 operator inputs or inputs from I/O.

Supercompressibility calculation using FB206 "AGA8-Gross"

Description

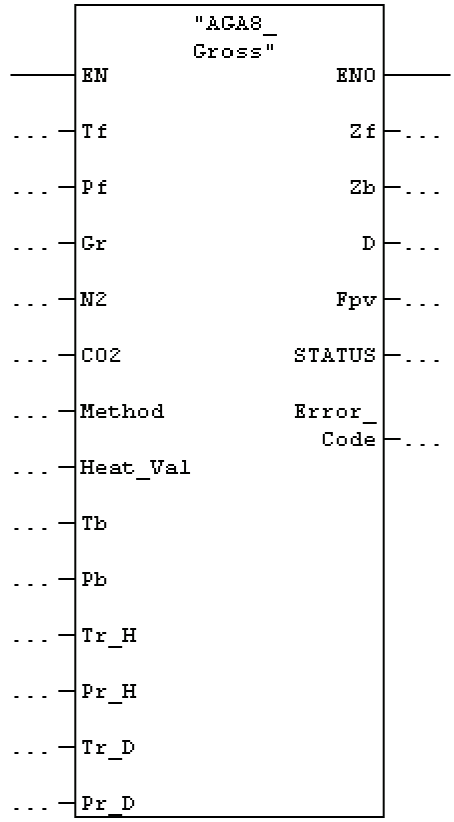
FB206 “AGA8-Gross” calculates the compressibility factors of natural gas and is used to provide inputs for AGA gas flow calculations.

Parameters

Parameter	Declaration	Data type / Value range	Description
Tf	IN	Real	Scaled and conditioned transmitter temperature of the flowing gas in degrees F
Pf	IN	Real	Scaled and conditioned transmitter pressure of the flowing gas in PSIG
Gr	IN	Real	Specific gravity of the flowing gas, and is the ratio of the density of the gas to that of dry air at standard conditions
N2	IN	Real	Mole Percent of N2 in Gas Stream
CO2	IN	Real	Mole Percent of CO2 in Gas Stream
Method	IN	Int 1: Heating value,	Heat Value or Density

Parameter	Declaration	Data type / Value range	Description
		relative density, MCO2 2: Relative density, MN2, MCO2	
Heat_Val	IN	Real	Gross heating value in BTU/SCF
Tb	IN	Real	Base temperature in degrees F
Pb	IN	Real	Base pressure in PSIA
Tr_H	IN	Real	Reference temperature for heating value in degrees F (default = 60)
Pr_H	IN	Real	Reference pressure for heating value in PSIA (default = 14.73)
Tr_D	IN	Real	Reference temperature for density value in degrees F (default = 60)
Pr_D	IN	Real	Reference pressure for density in PSIA (default = 14.73)
Zf	OUT	Real	Compressibility factor at flowing conditions
Zb			Compressibility factor at base conditions
D	OUT	Real	Molar density
Fpv	OUT	Real	Supercompressibility factor of the gas.
STATUS	OUT	Boolean 0: Error 1: No error	Indicator whether error occurred
Error_Code	OUT	Int 0: Calculation is complete 1: Calculation in progress	Completion status

STEP 7 programming



Follow these steps to use the AGA8-Gross compressibility calculation in your user program:

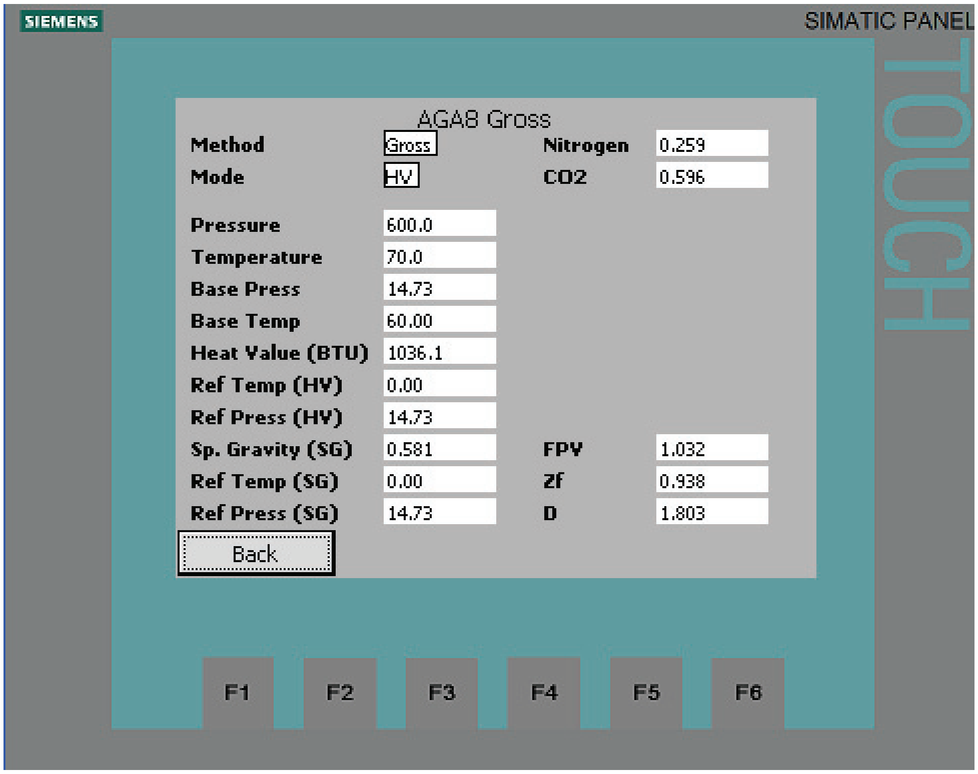
1. Open the AGA_V1_0 library in the SIMATIC Manager and copy Symbols from the AGA8 folder into your S7 program.
2. Create a cyclic interrupt OB with a scan time of 1000 ms and open it in the LAD editor.
3. In the LAD editor, drag the AGA8Gross (FB206) function block from the AGA_V1_0 library to a network in your user program. Create DB206 for the instance data block.
4. Program the inputs to AGA8-Gross from I/O or operator-entered data values.

When execution completes, AGA8-Gross produces a Zf and Zb output that can be used for function blocks that require Zf and Zb inputs. If you use AGA8-Gross to supply compressibility for the AGA3-85 function block, then you can use the AGA8-Gross Fpv output Fpv for the AGA3-85 Fpv input.

AGA8-Gross requires multiple scans to complete. Your user program must wait for Error_Code to equal 0 before using the Zf and Zb outputs.

Example: AGA3-92 with AGA8-Gross

WinCC Flexible Screen



See AGA3-85 for AGA8-Gross operator input parameters as well as AGA3-85 operator input parameters.

Supercompressibility calculation using FB210 "AGA8-Detail"

FB210 “AGA8-Detail” calculates the supercompressibility and compressibility factors of natural gas when the temperature, pressure, or gas composition is outside of the normal range. The compressibility factors are used to provide inputs for AGA gas flow calculations.

When the temperature, pressure, and gas characteristics are within the normal range, use the AGA8-Gross method.

Ranges for gas composition characteristics

	Normal Range	Expanded Range
Temperature	32 deg F to 130 deg F	
Pressure	0 to 1200 PSIA	
Relative Density*	0.554 to 0.87	0.07 to 1.52
Gross Heating Value**	477 to 1150 BTU/SCF	0 to 1800 Btu/scf
Gross Heating Value***	18.7 to 45.1 MJ/m^3	0 to 66 MJ/m^3
Mole Percent Methane	45.0 to 100.0	0 to 100.0
Mole Percent Nitrogen	0 to 50.0	0 to 100.0
Mole Percent Carbon Dioxide	0 to 30.0	0 to 100.0
Mole Percent Ethane	0 to 10.0	0 to 100.0
Mole Percent Propane	0 to 4.0	0 to 12.0
Mole Percent Total Butanes	0 to 1.0	0 to 6.0

	Normal Range	Expanded Range
Mole Percent Total Pentanes	0 to 0.3	0 to 4.0
Mole Percent Hexanes Plue	0 to 0.2	0 to Dew Point
Mole Percent Helium	0 to 0.2	0 to 3.0
Mole Percent Hydrogen	0 to 10.0	0 to 100.0
Mole Percent Carbon Monoxide	0 to 3.0	0 to 3.0
Mole Percent Argon	0	0 to 1.0
Mole Percent Oxygen	0	0 to 21.0
Mole Percent Water	0 to 0.05	0 to Dew Point
Mole Percent Hydrogen Sulfide	0 to 0.02	0 to 100.0

*Reference condition: Relative density at 60 deg F, 14.73 PSIA

**Reference conditions: combustion at 60 deg F, 14.73 PSIA; density at 60 deg F, 14.73 PSIA

***Reference conditions: combutsion at 25 deg C, 0.101325 Mpa; density at 0 deg C, 0.101325 MPa

Parameters

Parameter	Declaration	Data type / Value range	Description
Tf	IN	Real	Scaled and conditioned transmitter temperature of the flowing gas in degrees F
Pf	IN	Real	Scaled and conditioned transmitter pressure of the flowing gas in PSIG
C_1	IN	Real Range: 45.0 to 100.0	Mole Percentage Methane
C_2	IN	Real Range: 0 to 10.0	Mole Percentage Ethane
C_3	IN	Real Range: 0 to 4.0	Mole Percentage Propane
I_C4	IN	Real Range: 0 to 1.0	Mole Percentage I-Butane
N_C4	IN	Real Range: 0 to 0.3	Mole Percentage N-Butane
I_C5	IN	Real Range: 0 to 0.3	Mole Percentage I-Pentane
N_C5	IN	Real Range: 0 to 0.3	Mole Percentage N-Pentane
N_C6	IN	Real Range: 0 to 0.2	Mole Percentage N-Hexane
N_C7	IN	Real Range: 0 to 0.2	Mole Percentage N-Heptane
N_C8	IN	Real Range: 0 to 0.2	Mole Percentage N-Octane
N_C9	IN	Real Range: 0 to 0.2	Mole Percentage N-Nonane

Parameter	Declaration	Data type / Value range	Description
N_C10	IN	Real Range: 0 to 0.2	Mole Percentage N-Decane
N2	IN	Real Range: 0 to 50.0	Mole Percentage Nitrogen
CO2	IN	Real Range: 0 to 30.0	Mole Percentage Carbon Dioxide
H2S	IN	Real Range: 0 to 0.02	Mole Percentage Hydrogen Sulfide
O2	IN	Real Range: 0 to 21.0	Mole Percentage Oxygen
H2O	IN	Real Range: 0 to 0.05	Mole Percentage Water
He	IN	Real Range: 0 to 0.2	Mole Percentage Helium
Ar	IN	Real Range: 0 to 1.0	Mole Percentage Argon
H2	IN	Real Range: 0 to 10.0	Mole Percentage Hydrogen
CO	IN	Real Range: 0 to 3.0	Mole Percentage of Carbon Monoxide
Tb	IN	Real	Base temperature in degrees F
PB	IN	Real	Base pressure in degrees F
Fpv	OUT	Real	Supercompressibility factor of the gas.
Zf	OUT	Real	Compressibility factor at flowing conditions
Zb	OUT	Real	Compressibility factor at base conditions
D	OUT	Real	Molar density at flowing conditions
Ddb	OUT	Real	Molar density at base conditions
STATUS	OUT	Boolean 0: Error 1: No error	Indicator whether error occurred
Error_Code	OUT	Int 0:Calculation is complete 1: Calculation in progress	Completion indicator

STEP 7 Programming

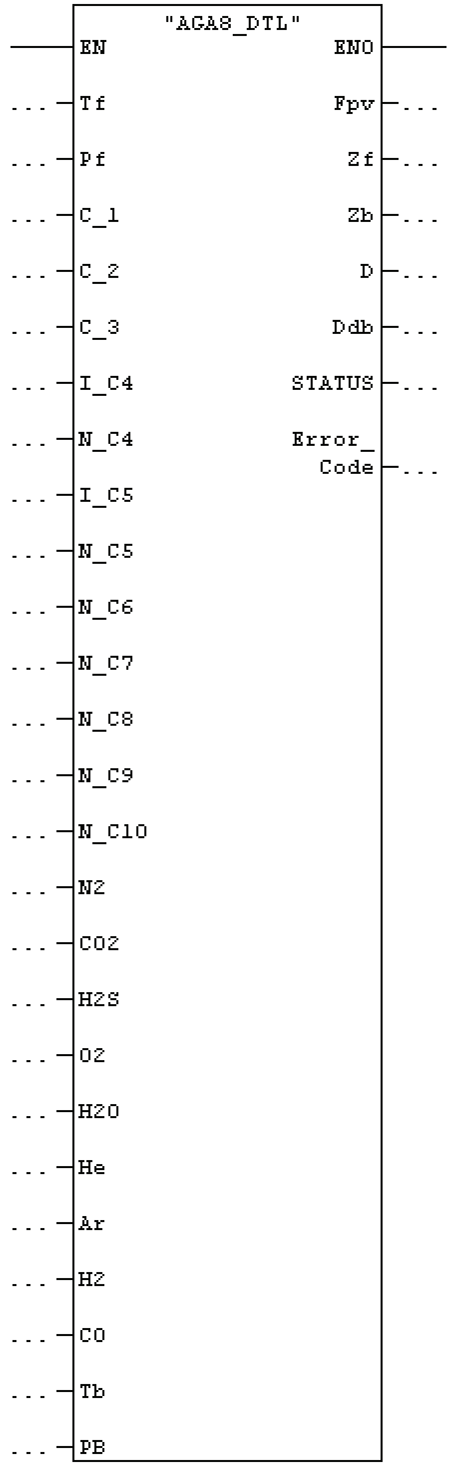
Follow these steps to use the AGA8-Detail compressibility calculation in your user program:

1. Open the AGA library in the SIMATIC Manager and copy UDT217 FB210 – FB216, DB210 – DB216, and FC210 into the Blocks folder of your program. Also copy Symbols from the AGA8_Detail folder into your user program.
2. In your Blocks folder, create an instance data block (DB217) based on UDT217.
3. Create a cyclic interrupt OB with a scan time of 1000 ms and open it in the LAD editor.
4. In the LAD editor, drag the AGA8-Detail (FB210) function block from the AGA_V1_0 library to a network in your user program. Use DB210 for the instance data block.
5. Program the inputs to AGA8-Detail from I/O or operator-entered data values.

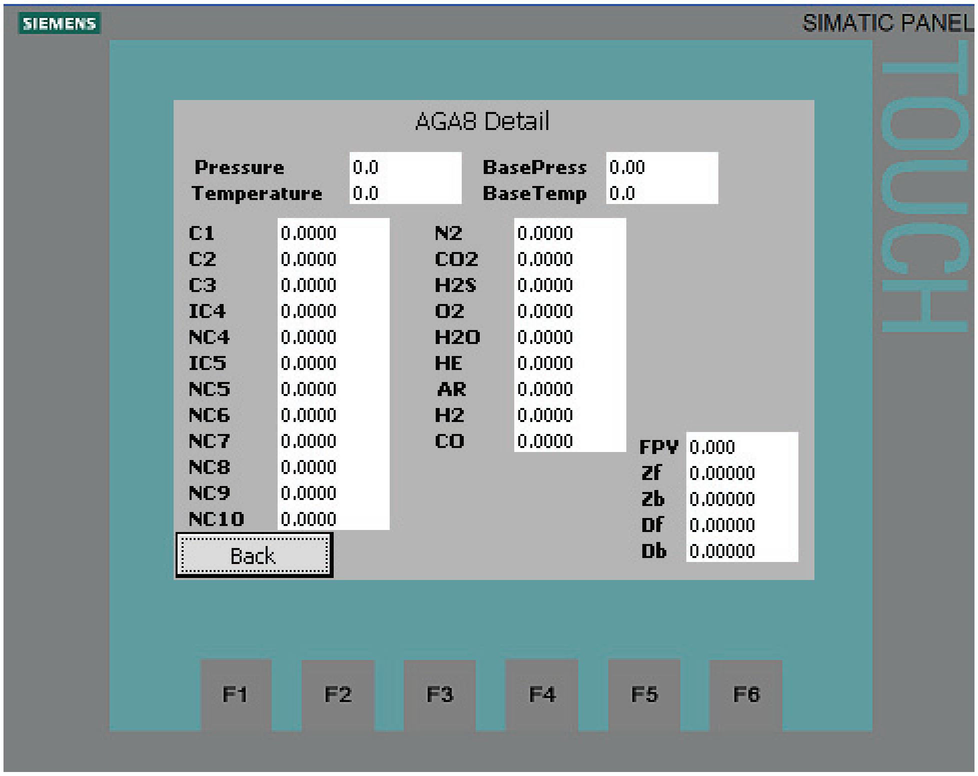
When execution completes, AGA8-Detail produces Zf and Zb outputs that can be used for the gas flow function blocks that require Zf and Zb inputs. AGA8-Detail also provides a supercompressibility output Fpv, that you can use for gas flow functions that require an Fpv input.

AGA8-Detail requires multiple scans to complete. Your user program must wait for Error_Code to equal 0 before using the Zf and Zb outputs.

Example: AGA3-92 with AGA8-Detail



WinCC Flexible Screen



Orifice Metering using FB202 "AGA 3-85"

Description

The AGA3-85 function block is used to calculate the flow rate of gas through an orifice.

The PLC reads an analog input for the differential pressure across the orifice plate, with the engineering units defined in inches of water.

The volume calculation requires additional analog inputs for the flowing gas gauge pressure and temperature in degrees F to the base or contract conditions.

The Patm (Atmospheric Pressure) input parameter is to be entered by the operator or programmer. If this input value is zero, the AGA3 function calculates this value based on the elevation input parameter Helev.

Either the NX19 function or AGA8-Gross function can be used to calculate the supercompressibility value. The programmer must map the Fpv output from the NX19 or AGA8 function to the Fpv input of the AGA3 function.

The resultant calculated flow rate F output is in Thousands of Standard Cubic Feet per Hour (MSCFH).

Parameters

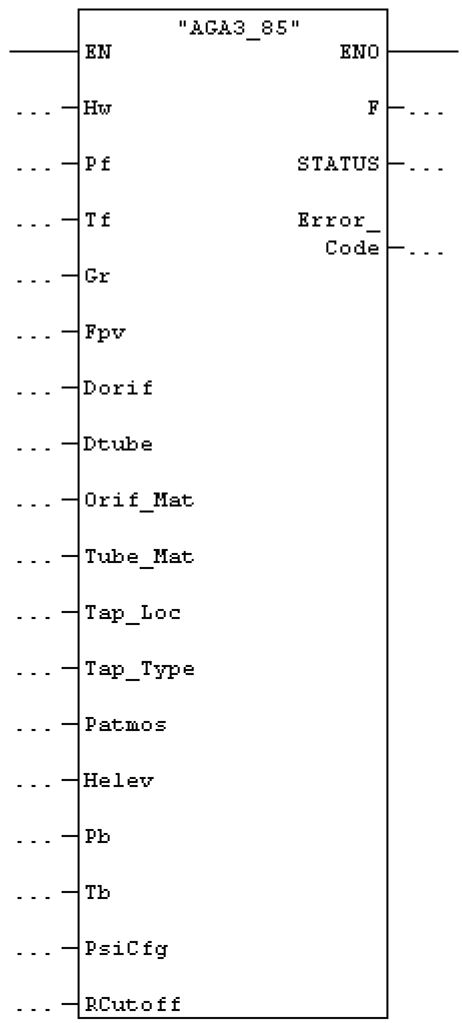
Parameter	Declaration	Data type / Value range	Description
Hw		Real	Scaled and conditioned transmitter input: differential pressure in inches of water
Pf	IN	Real	Scaled and conditioned transmitter input of the flowing gas pressure in PSIG
Tf	IN	Real	Scaled and conditioned transmitter input of the flowing gas in degrees
Gr	IN	Real	Gas Stream Relative Density (Specific Gravity)
Fpv	OUT	Real	Supercompressibility factor of the gas as calculated by FB201 “NX19” or FB206 “AGA8Gross”
Dorif	IN	Real	Orifice size in inches
Dtube	IN	Real	Inside diameter of the pipe in inches
Orif_Mat	IN	Integer 1: 304 or 316 stainless steel 2: Monel	Orifice material: used to calculate orifice constant for thermal expansion factor of the orifice plate for flowing temperature of the gas.
Tube_Mat	IN	Integer 1: 304 or 316 stainless steel 2: Monel 3: Steel	Pipe Material: Used to calculate orifice constant for thermal expansion factor of the pipe for flowing temperature of the gas
Tap_Loc	IN	Boolean 0: Upstream 1: Downstream	Meter construction indicating location of the static pressure tap
Tap_Type	IN	Boolean 0: Pipe 1: Flange	Meter construction indicating whether flange or pipe taps are used
Patmos	IN	Real	Atmospheric pressure in PSIA. If input Patm is not supplied, input Helev is used to calculate the atmospheric pressure.
Helev	IN	Real	The meter location height in feet above sea level; used to calculate the atmospheric pressure
Pb	IN	Real	Base or contract pressure of the gas in PSIA
Tb	IN	Real	Contract base temperature of the flowing gas in degrees F
PsiCfg	IN	Boolean 0: Absolute 1: Gauge (default)	Pf pressure input configuration
RCutoff	IN	Real	Minimum value for Hw input to be

Parameter	Declaration	Data type / Value range	Description
			considered non-zero
F	OUT	Real	Volumetric flow rate at base conditions in thousands of standard cubic feet per hour
STATUS	OUT	Boolean 0: Error 1: No error	Indicator whether error occurred
Error_Code	OUT	Int 0: No error 1: Hw < Rcutoff 2: Invalid orif/tube configuration 3: Invalid specific gravity input	Error value

STEP 7 programming

Follow these steps to use the AGA3-85 flow calculation in your user program:

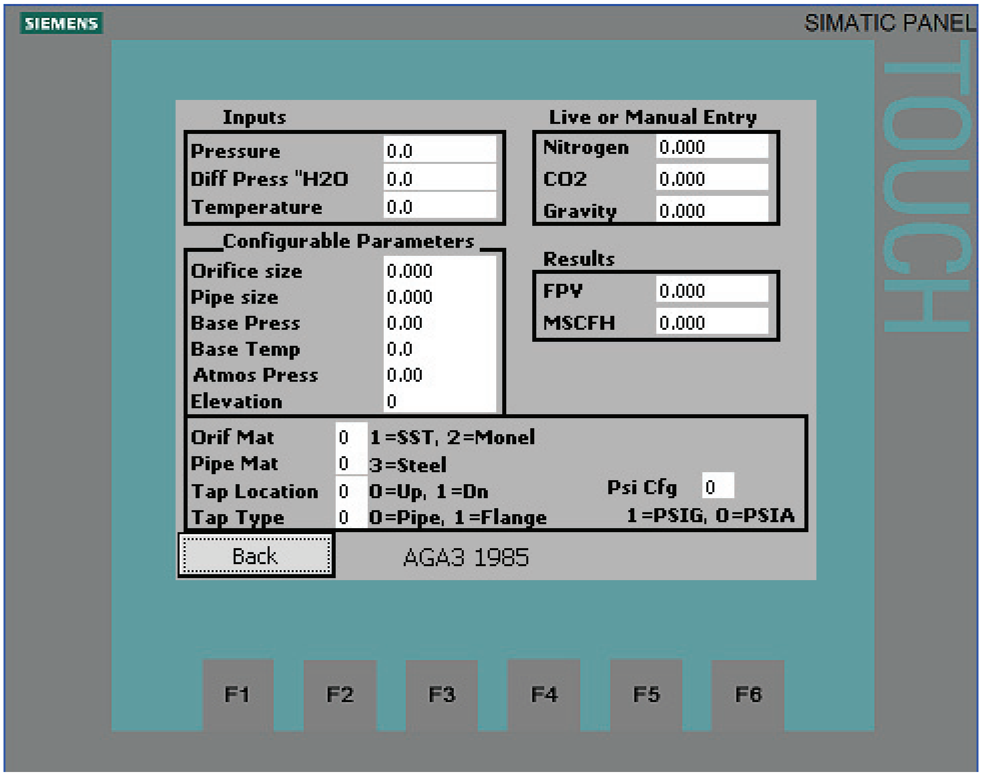
1. From the AGA library, include the AGA3-85 (FB202) function block in your user program and either the NX-19 (FB201) or the AGA8-Gross (FB206) for the compressibility calculation.
2. Open the AGA library in the SIMATIC Manager and copy the Symbols from the AGA folder to your user program..
3. Create a cyclic interrupt OB with a scan time of 1000 ms.
4. In the cyclic OB, program the NX-19 or AGA8-Gross function block to calculate compressibility, and create an appropriately named instance data block for whichever one you use (DB201 or DB206).
5. Call the block AGA3-85, and create an appropriate instance DB for it.
6. Use the Fpv output from the compressibility function for the Fpv parameter of AGA3-85.
7. Program the remaining parameters from I/O locations, or entered values from the user.
8. Add any additional processing that your application requires.



Example: AGA3-85 with NX-19

WinCC Flexible Screen

The AGA library installation CD includes the following WinCC Flexible Screen that you can use for input of parameters for the AGA3-85 function. Note that some of the data fields are user-entered data and some may be I/O values. You can modify the WinCC Flexible Screen as required for your application.



Orifice Metering using FB203 "AGA3-92"

Description

The AGA3-92 function block is used to calculate the flow rate of gas through an orifice plate.

The PLC reads an input for the differential pressure across the orifice plate, with the engineering units defined in inches of water.

The volume calculation requires additional analog inputs for the flowing gas gauge pressure and temperature in degrees F to the base or contract conditions.

The AGA3 function Patm (Atmospheric Pressure) input parameter is to be entered by the operator or programmer. If this input value is zero, the AGA3 function calculates this value based on the elevation input parameter Helev.

The AGA8 function calculates the supercompressibility value. The programmer must map the Zf and Zb outputs from AGA8 function to the corresponding inputs of the AGA3-92 function.

The resultant calculated flow rate F output is in Thousands of Standard Cubic Feet per Hour (MSCFH).

Parameters

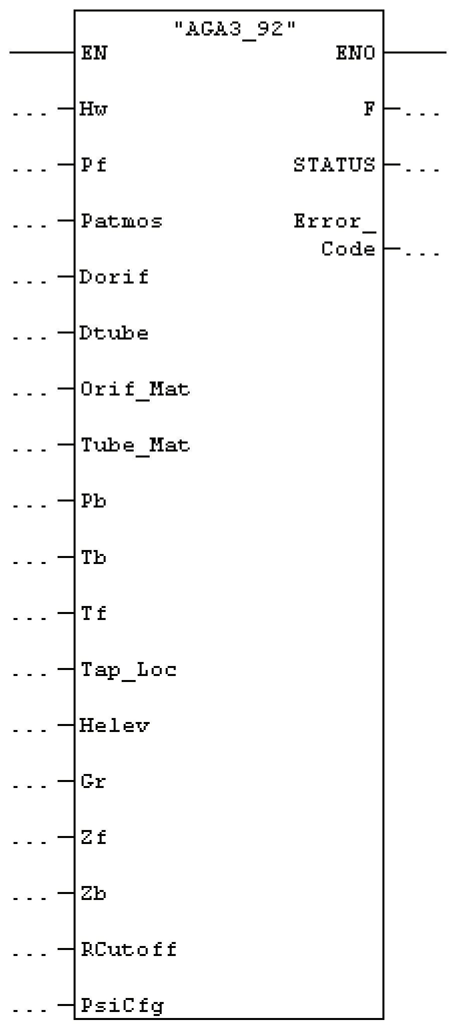
Parameter	Declaration	Data type / Value range	Description
Hw		Real	Scaled and conditioned transmitter input: differential pressure in inches of water
Pf	IN	Real	Scaled and conditioned transmitter input of the flowing gas pressure in PSIG
Patmos	IN	Real	Average barometric pressure in PSIA, which is is added to the Static Pressure to obtain absolute pressure (See Helev)
Dorif	IN	Real	Orifice bore size in inches
Dtube	IN	Real	Inside diameter of the pipe in inches
Orif_Mat	IN	Real 1: 304 or 316 stainless steel 2: Monel	Orifice material: used to calculate orifice constant for thermal expansion factor of the orifice plate for flowing temperature of the gas.
Tube_Mat	IN	Real 1: 304 or 316 stainless steel 2: Monel 3: Steel	Pipe Material: Used to calculate orifice constant for thermal expansion factor of the pipe for flowing temperature of the gas
Pb	IN	Real	Base or contract pressure of the gas in PSIA
Tb	IN	Real	Contract base temperature of the gas in degrees F.
Tf	IN	Real	Scaled and conditions transmitter input of the flowing gas in degrees F.
Tap_Loc	IN	Boolean 0: Upstream 1: Downstream	Pressure tap location
Helev	IN	Real	The meter location height in feet above sea level; used to calculate the atmospheric pressure
Gr	IN	Real	Specific gravity of the flowing gas, and is the ratio of the density of the gas to that of dry air at standard conditions
Zf	IN	Real	Flowing compressibility as calculated by AGA8
Zb	IN	Real	Base compressibility as calculated by AGA8
RCutOff	IN	Real	Minimum value of Hw differential input; indicates a flow of 0 if Hw is less than this value
PsiCfg	IN	Boolean 0: PSIA 1: PSIG	Indicator hether pressure input is gauge or absolute

Parameter	Declaration	Data type / Value range	Description
F	OUT	Real	Volumetric flow rate at base conditions in thousands of standard cubic feet per hour
STATUS	OUT	Boolean 0: Error 1: No error	Indicator whether error occurred
Error_Code	OUT	Int 0: No error 1: Hw < RcutOff 2: Invalid orif/tube configuration 3: Invalid specific gravity input 4: Invalid compressibility inputs	Error value

STEP 7 programming

Follow these steps to use the AGA3-92 flow calculation in your user program:

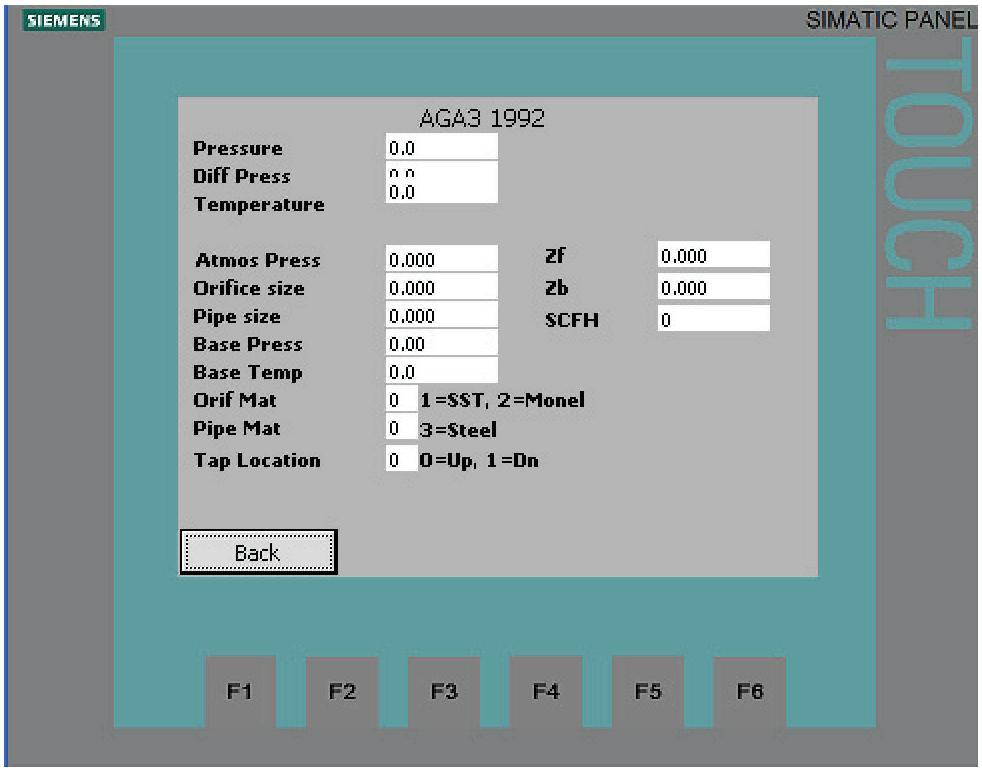
1. From the AGA library, include the AGA3-92 (FB203) function block in your user program and either the AGA8-Gross (FB206) or AGA8-Detail (FB210) for the compressibility calculation.Also include the Symbols from either the AGA or the AGA8_Detail folder.
2. Create a cyclic interrupt OB with a scan time of 1000 ms.
3. In the cyclic OB, program the AGA8-Gross function block to calculate compressibility. (In the case of unusual pressure, temperature, or gas composition conditions, use the AGA8-Detail function instead of AGA8-Gross.)
4. Call the block AGA3-92, and create an appropriate instance DB for it.
5. Use the Zf and Zb outputs from the AGA8-Gross or AGA8-Detail for the Zf and Zb inputs of AGA3-92.
6. Program the remaining parameters from I/O locations, or entered values from the user.
7. Add any additional processing that your application requires.



Examples: AGA3-92 with AGA8-Gross,
AGA3-92 with AGA8-Detail

WinCC Flexible Screen

The AGA library installation CD includes the following WinCC Flexible Screen that you can use for input of parameters for the AGA3-92 function. Note that some of the data fields are user-entered data and some may be I/O values. You can modify the WinCC Flexible Screen as required for your application.



Turbine Metering using FB205 "AGA7"

Description

Turbine meters are considered positive displacement meters and provide indication of volumetric flow to equipment in the form of pulse outputs.

The PLC reads these inputs utilizing a high speed counter module in the form of frequency or Hertz (Hz).

The volume correction to the base or contract conditions requires additional analog inputs for the flowing gas gauge pressure and temperature in degrees F.

The AGA7 function block Patm (Atmospheric Pressure) input parameter is to be entered by the operator or programmer. If this input value is zero, the AGA7 function calculates this value based on the elevation input parameter Helev.

Either the FB201 “NX-19 ” function block or one of the AGA8 function blocks (AGA8-Gross or AGA8-Detail) calculates the supercompressibility. If NX19 is utilized, the programmer must map the Fpv output of NX-19 to the Fpv input of the AGA7 function. If an AGA8 function is utilized the programmer must map the Z output of the AGA8 function to the Zf input of the AGA7 function, and the calculated Zb or Zbase block tag in the instance data block of the

AGA8 function to the Zb input of the AGA7 function. If the Fpv input to AGA7 is zero, AGA7 utilizes the Zf and Zb inputs for the compressibility factors.

The actual cubic feet flow rate per hour is calculated by the AGA7 function based on the frequency input and the configured parameter Pulses_CF and any meter calibration factor parameter Cal_F entered by the operator.

The resultant corrected flow rates are output as Qb in cubic feet per hour, and as MSCF in thousands of Standard Cubic Feet per Hour

Parameters

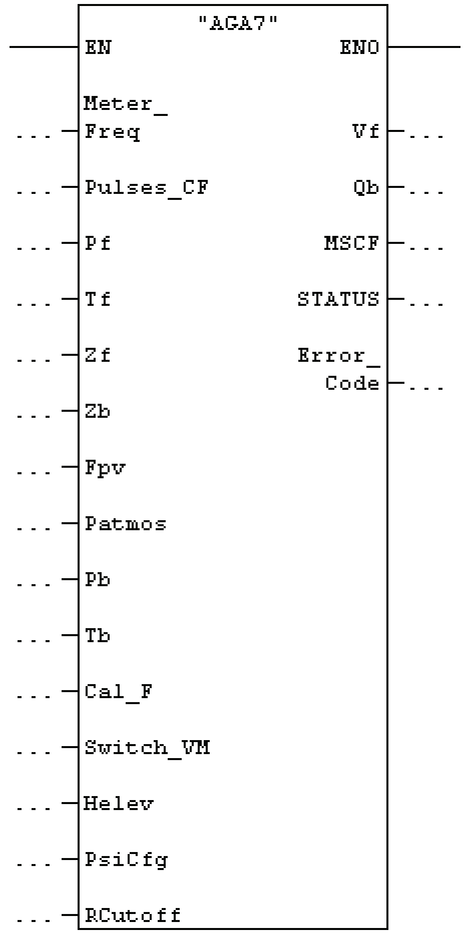
Parameter	Declaration	Data type / Value range	Description
Meter_Freq	IN	Real	High- or low-speed counter value of pulses in Hertz (Hz).
Pulses_CF	IN	Real	Pulses per cubic foot from the meter configuration. Used to calculate the flow rate from the meter frequency input.
Pf	IN	Real	Scaled and conditioned transmitter pressure of the flowing gas in PSIG
Tf	IN	Real	Scaled and conditioned transmitter temperature of the flowing gas in degrees F
Zf	IN	Real	Flowing compressibility from AGA8 function. If Fpv input is non-zero, the Zf input is ignored.
Zb	IN	Real	Base compressibility from AGA8 function. If Fpv input is non-zero, the Zb input is ignored.
Fpv	IN	Real	Compressibility value from NX-19 or AGA8-Gross function. If Fpv is zero, the flow rate is calculated based on Zf and Zb.
Patm	IN	Real	Atmospheric pressure in PSIA. If input Patm is not supplied, input Helev is used to calculate the atmospheric pressure.
Pb	IN	Real	Base pressure in degrees F
Tb	IN	Real	Base temperature in degrees F
Cal_F	IN	Real	Calibration factor for the meter, as provided by the manufacturer. Default value is 1.0.
Switch_VM	IN	Real	Reserved for future use
Helev	IN	Real	Height of meter in feet above sea level. This value is only used if atmospheric pressure, Patm, is not supplied.
RCutoff	IN	Real	Minimum input required to be considered non-zero. (Hz for input Meter_Freq; or analog input

Parameter	Declaration	Data type / Value range	Description
			AI_Rate)
PsiCfg	IN	Boolean 0: Absolute 1: Gauge (default)	Pf pressure input configuration
Vf	OUT	Real	Actual cubic feet flow rate per hour
Qb	OUT	Real	Volumetric cubic feet flow rate per hour at base conditions in cubic feet per hour.
MSCF	OUT	Real	Volumetric cubic feet flow rate per hour at base conditions in thousands of standard cubic feet per hour.
STATUS	OUT	Boolean 0: Error 1: No error	Indicator whether error occurred
Error_Code	OUT	Int 0: No error 1: Invalid compressibility inputs 2: Invalid meter configuration	Error value

STEP 7 programming

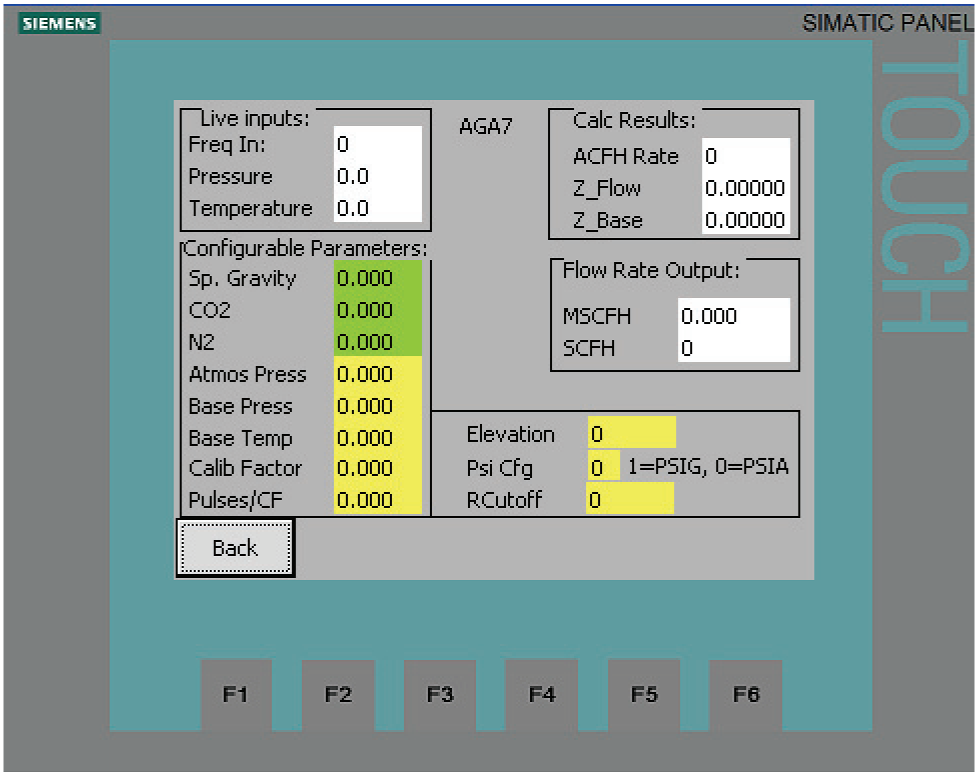
Follow these steps to use the AGA7 flow calculation in your user program:

1. From the AG A library, include the AGA7 (FB200) function block in your user program and either the NX-19 (FB201), AGA8-Gross (FB206), or AGA8-Detail (FB65) function block for the supercompressibility or compressibility calculation.
2. Create a cyclic interrupt OB with a scan time of 1000 ms.
3. In the cyclic OB, program the NX-19 or AGA8-Gross function block to calculate supercompressibility. In the case of unusual pressure, temperature, or gas composition conditions, use the AGA8-Detail function.
4. Call the block AGA7, and create an appropriate instance DB for it.
5. Use the Fpv output of the compressibility function for the Fpv input of AGA7, or use the Z and Zb block tags from the instance data block of the AGA8 function for the Zf and Zb inputs of AGA7.
6. Program the remaining parameters from I/O locations, or entered values from the user.
7. Add any additional processing that your application requires.



Example: AGA7 with AGA8-Gross

WinCC Flexible Screen



Ultrasonic Metering using FB207 "AGA9"

Description

Multipath ultrasonic meters are considered inferential meters and provide indication of volumetric flow to external equipment either in the form of pulse outputs in frequency or as a 4-20ma signal proportional to the span (range) of the meter. They derive the gas flow rate by measuring the transit times of high-frequency sound pulses. The transit times are measured for the number of sound pulses transmitted and received between pairs of transducers positioned on or in the pipe, both upstream against the gas flow and downstream with the gas flow. The difference in these transit times is related to the average gas flow velocity. The ultrasonic meter electronics perform numerical calculations that can be used to compute the gas volume rate at line conditions through the meter.

The PLC reads these inputs either utilizing either a high speed counter module in the form of frequency or (Hz) Hertz, or an isolated 4-20ma analog input module.

Additional analog inputs for the flowing gas gauge pressure and temperature in degrees F are required for volume correction to the base or contract conditions.

The Patm (Atmospheric Pressure) input parameter is to be entered by the operator or programmer. If this input value is zero, AGA9 calculates atmospheric pressure based on the elevation input parameter Helev.

Supercompressibility is to be calculated using the AGA8 function. When using the AGA8 function, the programmer must map the Zf and Zb outputs from the AGA8 function to the appropriate inputs of the AGA9 function.

AGA9 calculates the actual cubic feet flow rate per hour based on the frequency input and the configured parameter Pulses_CF and any meter calibration factor parameter Cal_F. The programmer can use a constant value for the calibration factor or an operator-entered value.

AGA9 outputs the resultant corrected flow rate at the Qb output in cubic feet per hour and at the MSCF output in thousands of standard cubic feet per hour.

Parameters

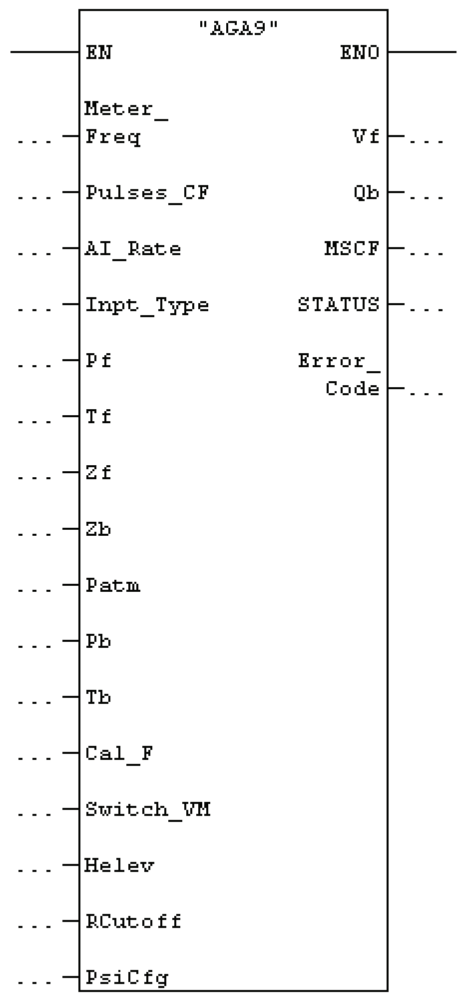
Parameter	**Declaration**	**Data type / Value range**	**Description**
Meter_Freq	IN	Real	High Speed Counter input in Hz
Pulses_CF	IN	Real	Pulses per cubic foot from meter configuration, used to determine the rate from the meter frequency input
AI_Rate	IN	Real	Analog input rate proportional to meter configuration.
Inpt_Type	IN	Boolean 0: Frequency input (default) 1:Analog input for rate	Type of input
Pf	IN	Real	Scaled and conditioned pressure of the flowing gas in PSIG
Tf	IN	Real	Scaled and conditioned temperature of the flowing gas in degrees F
Zf	IN	Real	Flowing compressibility from AGA8
Zb	IN	Real	Base compressibility from AGA8
Patm	IN	Real	Atmospheric pressure; If input value is 0, then Helev is used to calculate Patm
Pb	IN	Real	Base pressure in PSIA
Tb	IN	Real	Base temperature in degrees F
Cal_F	IN	Real	Calibration factor for the meter, as provided by the manufacturer. Default value is 1.0.
Switch_VM	IN	Boolean 0: Volumetric flow (default) 1: Mass flow	Indicator of whether calculations or volumetric or mass flow calculations
Helev	IN	Real	The meter location height in feet above sea level; used to calculate the atmospheric pressure if Patm input is zero
RcutOff	IN	Real	Minimum input required to be considered non-zero. (Hz for input Meter_Freq; or analog input AI_Rate)
PsiCfg	IN	Boolean 0: Absolute 1: Gauge (default)	Pf pressure input configuration
Vf	OUT	Real	Flow rate per hour in actual cubic feet
Qb	OUT	Real	Volumetric flow rate per hour at base conditions in cubic feet per hour

Parameter	Declaration	Data type / Value range	Description
MSCF	OUT	Real	Volumetric flow rate at base conditions in thousands of standard cubic feet per hour
STATUS	OUT	Boolean 0: Error 1: No error	Indicator whether error occurred
Error_Code	OUT	Int 0: No error 1: Invalid compressibility inputs 2: Invalid meter configuration	Error value

STEP 7 programming

Follow these steps to use the AGA9 flow calculation in your user program:

1. From the AGA library, include the AGA9 (FB205) function block and either the AGA8-Gross (FB206), or AGA8-Detail (FB65) function block for the supercompressibility or compressibility calculation. Also include the Symbols from the AGA folder.
2. Create a cyclic interrupt OB with a scan time of 1000 ms.
3. In the cyclic OB, program AGA8-Gross function block to calculate supercompressibility. In the case of unusual pressure, temperature, or gas composition conditions, use the AGA8-Detail function.
4. Call the block AGA9, and create an appropriate instance DB for it.
5. Use the Z output and the Zb output from the AGA8-Gross function for the Zf and Zb inputs to AGA9. (If using AGA8-Detail, use the Z output and Zbase block tag as the Zf and Zb inputs).
6. Program the remaining parameters from I/O locations, or entered values from the user.
7. Add any additional processing that your application requires.



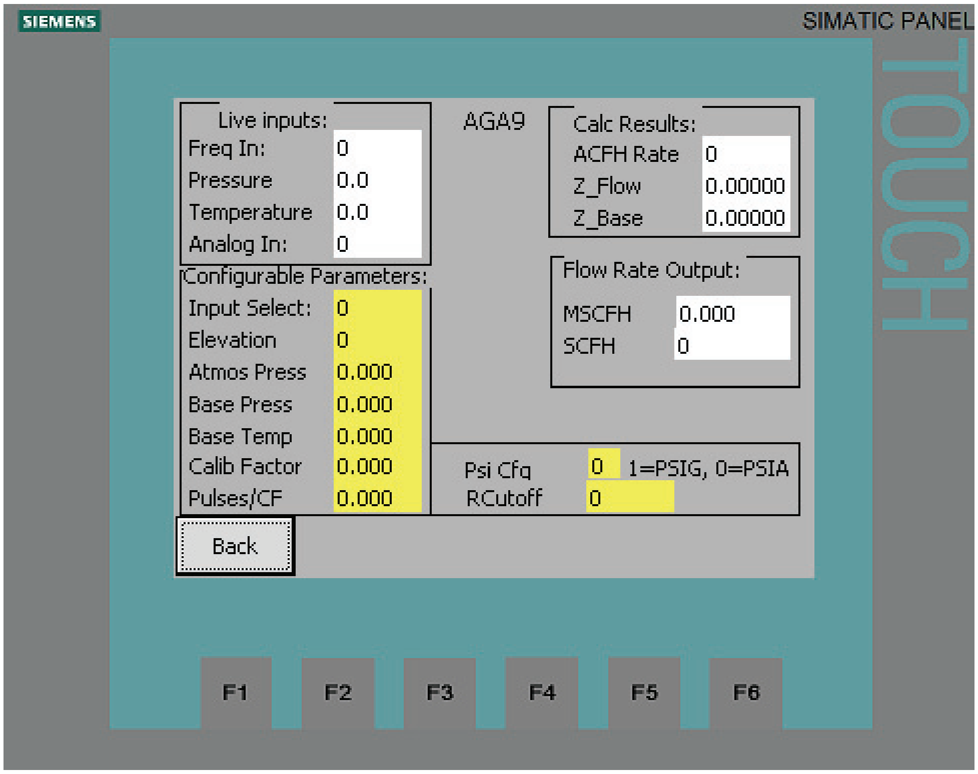
Example: AGA9 with AGA8-Gross

Bidirectional metering considerations

Some manufacturers of multi-path ultrasonic meters allow for bidirectional flow measurement. In those instances, the meter provides an indication of flow direction, usually as a contact closure. The programmer must account for properly mapping the resultant calculations to the proper accumulators and HMI tags, if used.

In other installations, the gas flow is always in a single direction through the meter, and the actual flow direction is based on valving configurations external to the meter run.

WinCC Flexible Screen



Coriolis Metering using FB209 "AGA11"

Description

Coriolis meters are considered inferential meters and provide indication of volumetric flow to external equipment either in the form of pulse outputs in frequency or as a 4-20ma signal proportional to the span (range) of the meter. They operate on the principle of the apparent bending force known as the Coriolis force. When a fluid particle inside a rotating body moves in a direction toward or away from a center of rotation, that particle generates an inertial force (known as the Coriolis force) that acts on the body. In the case of a Coriolis meter, the body is a tube through with the fluid flows.

The Coriolis meter outputs the flow rates at line conditions to external equipment using either frequency output in Hz, or an analog output proportional to the meter span.

The PLC reads these inputs utilizing either a high speed counter module in the form of frequency (Hz) or an isolated 4-20ma analog input module.

AGA11 requires additional analog inputs for the flowing gas gauge pressure in PSIG and temperature in degrees F for volume correction to the base or contract conditions.

The Patm (Atmospheric Pressure) input parameter should be entered by the operator or programmer. If this input value is zero, the AGA11 function calculates the atmospheric pressure value based on the elevation input parameter Helev.

Supercompressibility is to be calculated using the AGA8 function. When using the AGA8 function, the programmer must map the Zf and Zb outputs from AGA8 to the Zf and ZB inputs of AGA11.

The AGA11 function calculates the actual cubic feet flow rate per hour based on the frequency input Meter_Freq together with the configured parameter Pulses_CF and any meter calibration factor parameter Cal_F entered by the operator, or alternatively using the analog input AI_Rate.

AGA11 outputs the resultant corrected flow rates on the Qb output in cubic feet per hour,and at the MSCF output in thousands of standard cubic feet per hour.

Parameters

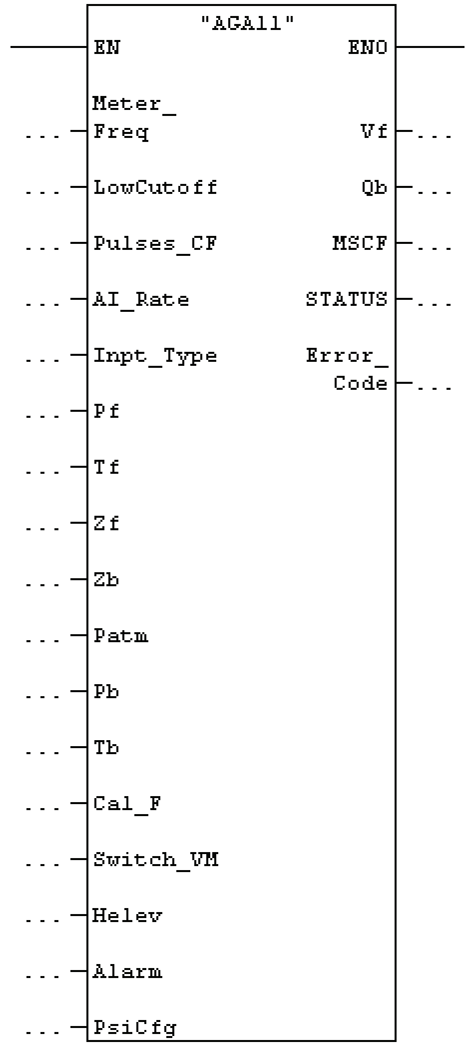
Parameter	Declaration	Data type / Value range	Description
Meter_Freq	IN	Real	High speed counter value of pulses in Hertz (Hz).
LowCutoff	IN	Real	Low Flow Cutoff : minimum required frequency or minimum required AI_Rate value to allow flow calculations
Pulses_CF	IN	Real	Pulses per cubic foot from the meter configuration. Used to calculate the flow rate from the meter frequency input.
AI_Rate	IN	Real	Analog input proportional to meter configuration.
Inpt_Type	IN	Boolean 0: Frequency input (default) 1:Analog input for rate	Type of input
Pf	IN	Real	Scaled and conditioned pressure of the flowing gas in PSIG
Tf	IN	Real	Scaled and conditioned temperature of the flowing gas in degrees F
Zf	IN	Real	Flowing compressibility from AGA8 function. If Fpv input is non-zero, the Zf input is ignored.
Zb	IN	Real	Base compressibility from AGA8 function. If Fpv input is non-zero, the Zb input is ignored.
Patm	IN	Real	Atmospheric pressure in PSIA. If input Patm is not supplied, input Helev is used to calculate the atmospheric pressure.
Pb	IN	Real	Base pressure in PSIA
Tb	IN	Real	Base temperature in degrees F

Parameter	Declaration	Data type / Value range	Description
Cal_F	IN	Real	Calibration factor for the meter, as provided by the manufacturer. Default value is 1.0.
Switch_VM	IN	Boolean	Indicator of whether calculations or volumetric or mass flow: TRUE: Mass flow calculations FALSE: Volumetric flow calculations (default)
Helev	IN	Real	Height of meter in feet above sea level. This value is only used if atmospheric pressure, Patm, is not supplied.
Alarm	IN	Boolean 0: No failure (default) 1: Meter fail; force output to zero	Meter Fault Alarm input
PsiCfg	IN	Boolean 0: PSIA 1: PSIG (default)	Pressure input configuration
Vf	OUT	Real	Actual cubic feet flow rate per hour
Qb	OUT	Real	Volumetric cubic feet flow rate per hour at base conditions in cubic feet per hour.
MSCF	OUT	Real	Volumetric cubic feet flow rate per hour at base conditions in thousands of standard cubic feet per hour.
STATUS	OUT	Boolean 0: Error 1: No error	Indication whether error occurred
Error_Code	OUT	Int 0: No error 1: Invalid compressibility inputs 2: Invalid meter configuration 3: External meter alarm input	Error value

STEP 7 programming

Follow these steps to use the AGA11 flow calculation in your user program:

1. From the AGA library, include the AGA11 (FB206) function block and either the AGA8-Gross (FB206), or AGA8-Detail (FB65) function block for the supercompressibility or compressibility calculation. Also include the Symbols from the AGA folder.
2. Create a cyclic interrupt OB with a scan time of 1000 ms.
3. In the cyclic OB, program AGA8-Gross function block to calculate supercompressibility. In the case of unusual pressure, temperature, or gas composition conditions, use the AGA8-Detail function.
4. Call the block AGA11, and create an appropriate instance DB for it.
5. Use the Z output and the Zb output from the AGA8-Gross function for the Zf and Zb inputs to AGA11. (If using AGA8-Detail, use the Z output and the Zbase tag of the AGA8-Detail instance data block as the Zf and Zb inputs).
6. Program the remaining parameters from I/O locations, or entered values from the user.
7. Add any additional processing that your application requires.



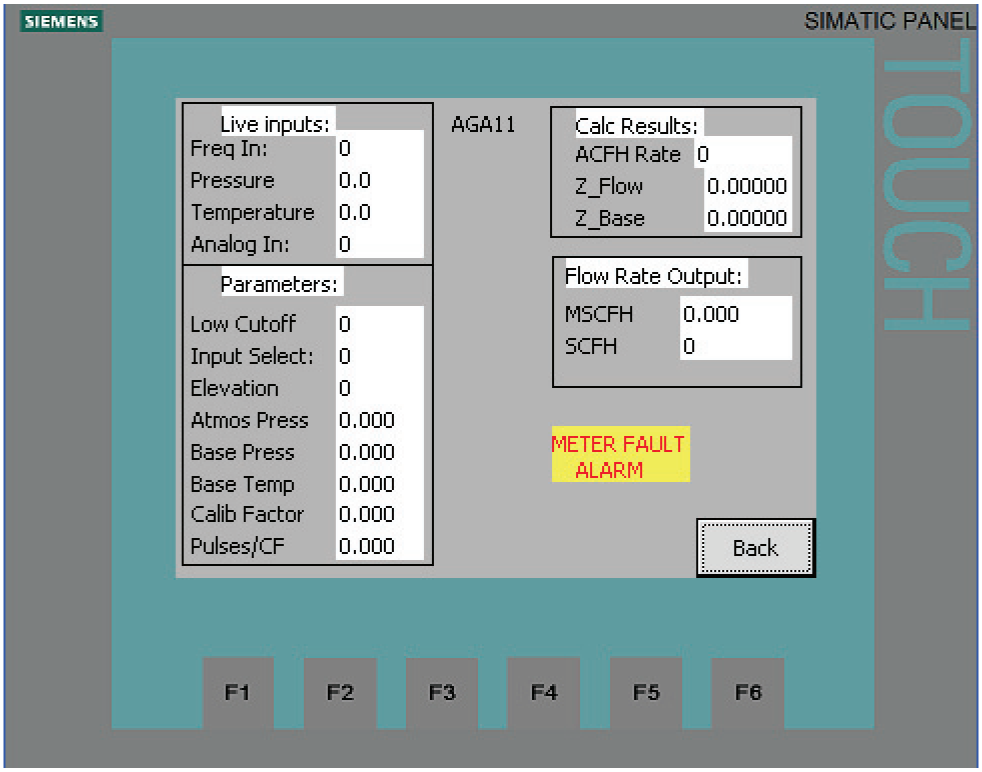
Example: AGA11 with AGA8-Gross

Bidirectional metering considerations

Coriolis meters allow for bidirectional flow measurement. Some manufacturers provide an indication of flow direction, usually as a contact closure. The programmer must account for properly mapping the resultant calculations to the proper accumulators and HMI tags, if used.

In other installations, the gas flow is always in a single direction through the meter, and the actual flow direction is based on valving configurations external to the meter run.

WinCC Flexible Screen



Energy Calculation using FB204 "AGA5"

Description

The AGA5 function block performs calculations for conversion of gas percentages to energy equivalents as described in the American Gas Association Report No. 5, reference Catalog No. XQ0776.

Use this function only when a calorimeter signal or chromatograph data is not available.

The AGA5 function block outputs the resultant calculated energy equivalents at the DKTH_G and DKTH_N outputs in Dekatherms, based on the Energy Conversion factor. When dekatherm energy units are required, this energy conversion factor equals one. (One dekatherm = 1 million BTUs = 1 MMBTU.) The calculation uses base conditions of pressure at 14.73 psia and temperature of 60 deg F.

Parameters

Parameter	Declaration	Data type / Value range	Description
Volume	IN	Real	Metered volume of gas in MSCF or flow rate in MSCFH
Vol_Convers	IN	Real	Volume conversion factor: Default = 1000, for MSCF (/ H); if SCF use 1.0
Energy_Conv	IN	Real	Energy conversion factor: Default = 0.000001 dekatherm (1 Dekatherm = 1 MMBTU)

Parameter	Declaration	Data type / Value range	Description
C_1	IN	Real Range: 45.0 to 100.0	Mole Percentage Methane
C_2	IN	Real Range: 0 to 10.0	Mole Percentage Ethane
C_3	IN	Real Range: 0 to 4.0	Mole Percentage Propane
I_C4	IN	Real Range: 0 to 1.0	Mole Percentage I-Butane
N_C4	IN	Real Range: 0 to 0.3	Mole Percentage N-Butane
I_C5	IN	Real Range: 0 to 0.3	Mole Percentage I-Pentane
N_C5	IN	Real Range: 0 to 0.3	Mole Percentage N-Pentane
N_C6	IN	Real Range: 0 to 0.2	Mole Percentage N-Hexane
N2	IN	Real Range: 0 to 50.0	Mole Percentage Nitrogen
CO2	IN	Real Range: 0 to 30.0	Mole Percentage Carbon Dioxide
H2S	IN	Real Range: 0 to 0.02	Mole Percentage Hydrogen Sulfide
O2	IN	Real Range: 0 to 21.0	Mole Percentage Oxygen
H2O	IN	Real Range: 0 to 0.05	Mole Percentage Water
He	IN	Real Range: 0 to 0.2	Mole Percentage Helium
Ar	IN	Real Range: 0 to 1.0	Mole Percentage Argon
H2	IN	Real Range: 0 to 10.0	Mole Percentage Hydrogen
CO	IN	Real Range: 0 to 3.0	Mole Percentage of Carbon Monoxide
HV_Gross	OUT	Real	Gross Heating Value (BTU / ft^3)
HV_Net	OUT	Real	Net Heating Value (BTU / ft^3)
DKTH_G	OUT	Real	Energy rate at HV_Gross in Dekatherms
DKTH_N	OUT	Real	Energy rate at HV_Net in Dekatherms
Status	OUT	Boolean 0: Error 1: No error	Indicator whether error occurred

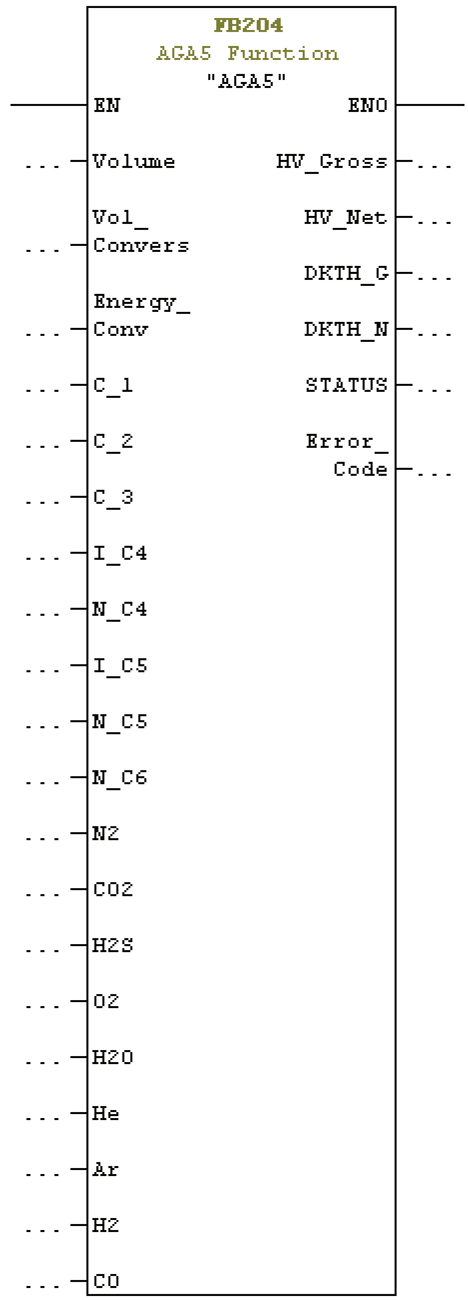
Parameter	Declaration	Data type / Value range	Description
Error_Code	OUT	Int 0: No error 1: Error – mole percents are not within 0.1% of 100%	Error code

STEP 7 programming

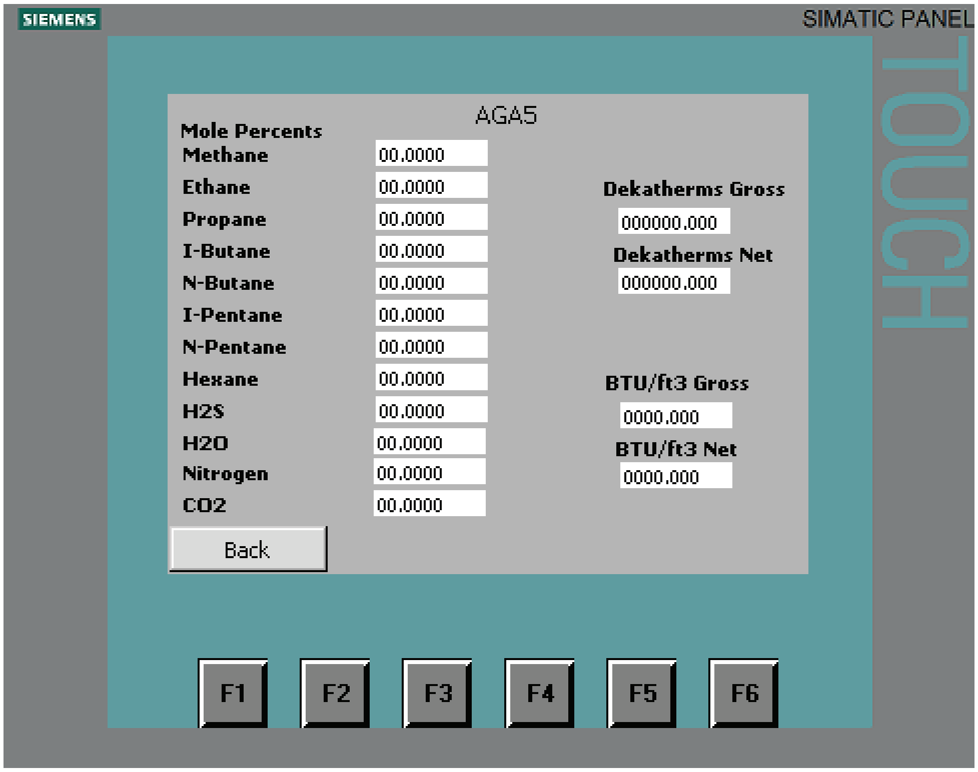
Follow these steps to use the AGA5 flow calculation in your user program:

1. From the AGA library, include the AGA5 (FB210) function block and either the AGA8-Gross (FB206), or AGA8-Detail (FB65) function block for the supercompressibility or compressibility calculation. Also include the Symbols from the AGA folder.
2. Create a cyclic interrupt OB with a scan time of 1000 ms.
3. Call the block AGA5, and create an appropriate instance DB for it.
4. Program the input parameters from I/O or from operator-entered data values.
5. Add any additional processing that your application requires.

Example: AGA5



WinCC Flexible Screen



Accumulation using FB208 "ACCUM"

Description

The ACCUM function block calculates total flow volume per hour, shift, day and month based on the flow rate calculated from one of the flow rate function blocks. Volume totals are calculated in thousands or millions of standard cubic feet or BTUs, depending on the selected units.

Parameters

Parameter	Declaration	Data type / Value range	Description
SampleTime	IN	Real	Execution interval time in seconds of the OB that contains the ACCUM function block. (OB35, for example, is a cyclic interrupt that executes every 0.1 second.)
MCFRate	IN	Real	Input flow rate in MSCF per hour, required to obtain output in MSCF or MMSCF
BTURate	IN	Real	Input flow rate in MBTU per hour, required to obtain output in MBTU or MMBTU
EOD_Hr	IN	Int Range: 0 to 23	Hour to end day accumulations, 0 = midnight

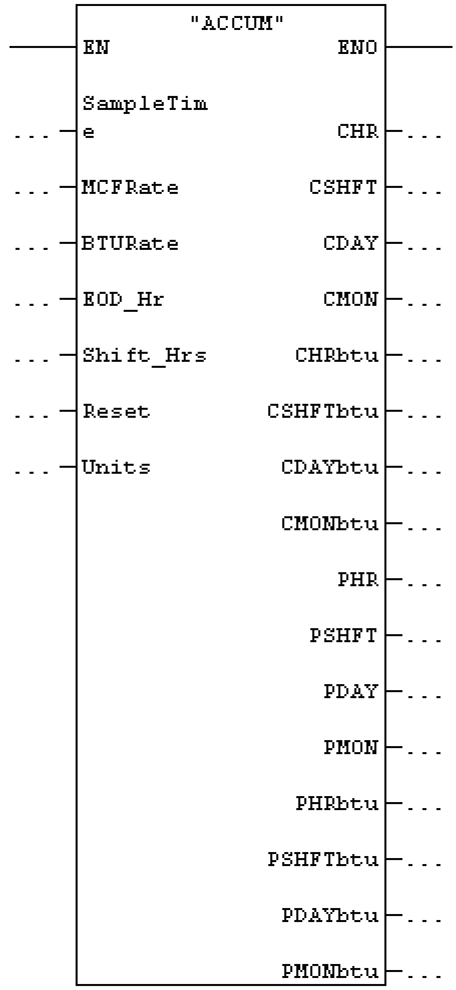
Parameter	Declaration	Data type / Value range	Description
Shift_Hrs	IN	Int Default: 12	Number of hours in shift; first shift starts at EOD_Hr.
Reset	IN	Bool 0: do not reset (default) 1: reset all accumlations	Reset: clear all accumulations
Units	IN	Bool 0: MSCF/MBTU 1: MMSCF/MMBTU	Output units (thousands of cubic feet / BTU or millions of cubic feet / BTU). The Units parameter
CHR	OUT	Real	Current hour accumulation
CSHFT	OUT	Real	Current shift accumulation
CDAY	OUT	Real	Current day accumulation
CMON	OUT	Real	Current month accumulation
CHRbtu	OUT	Real	Current hour accumulation in BTU
CSHFTbtu	OUT	Real	Current shift accumulation in BTU
CDAYbtu	OUT	Real	Current day accumulation in BTU
CMONbtu	OUT	Real	Current month accumulation in BTU
PHR	OUT	Real	Previous hour accumulation
PSHFT	OUT	Real	Previous shift accumulation
PDAY	OUT	Real	Previous day accumulation
PMON	OUT	Real	Previous month accumulation
PHRbtu	OUT	Real	Previous hour accumulation in BTU
PSHFTbtu	OUT	Real	Previous shift accumulation in BTU
PDAYbtu	OUT	Real	Previous day accumulation in BTU
PMONbtu	OUT	Real	Previous month accumulation in BTU

STEP 7 programming

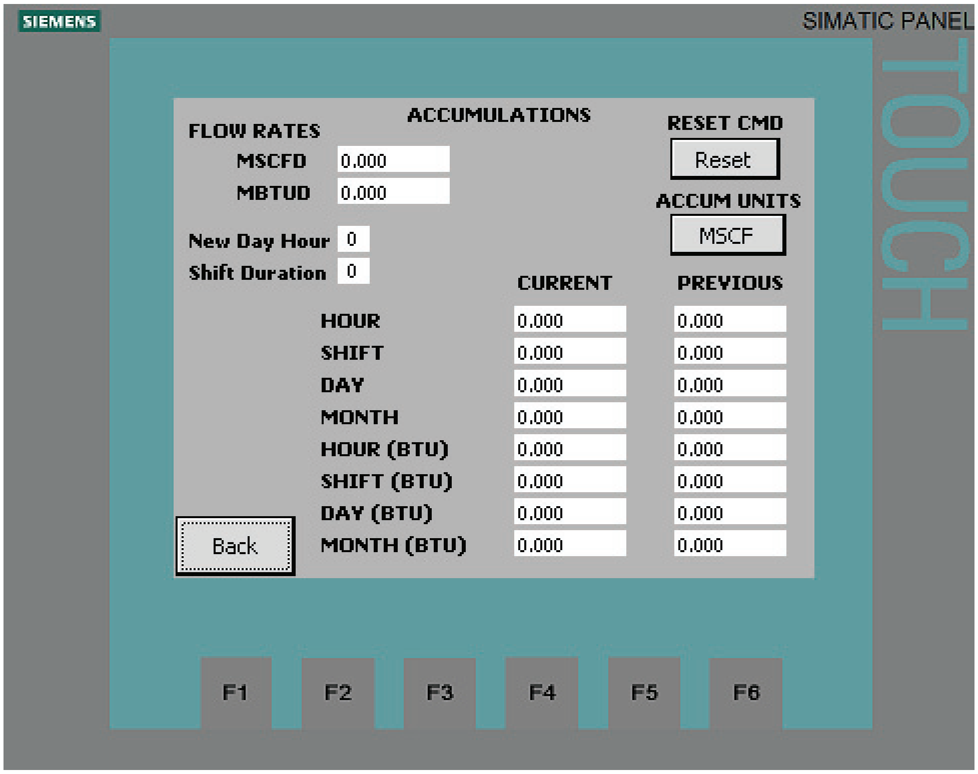
Follow these steps to use the ACCUM flow calculation in your user program:

1. From the AGA library, include the ACCUM (FB208) function block in your user program, SFC1, and SFC64.
2. Create a cyclic interrupt OB with a scan time of 1000 ms.
3. In the cyclic OB, call the ACCUM function block, and create an appropriate instance DB for it.
4. Configure the inputs to ACCUM function block.
5. Add any additional processing that your application requires.

Example: ACCUM



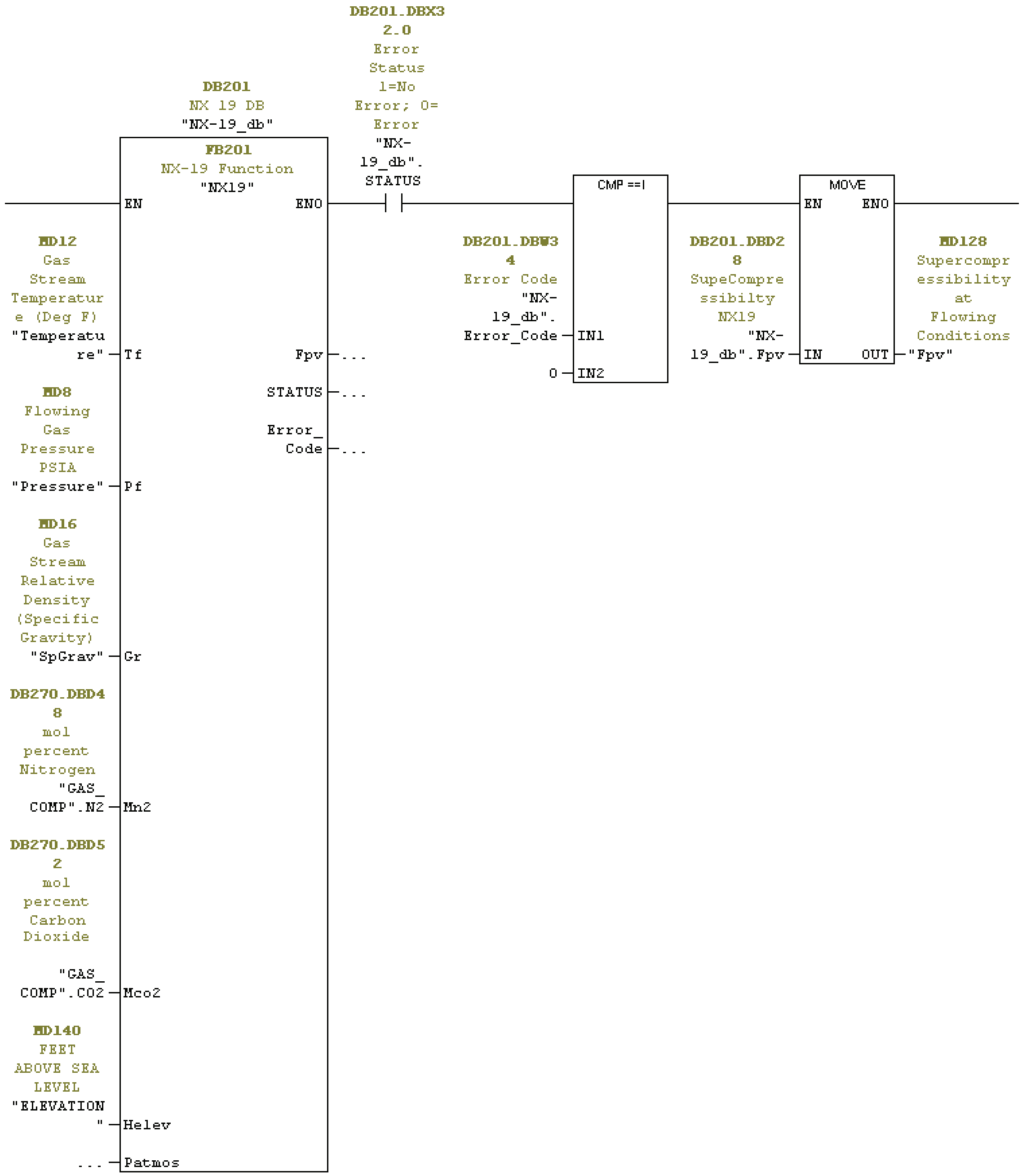
WinCC Flexible Screen

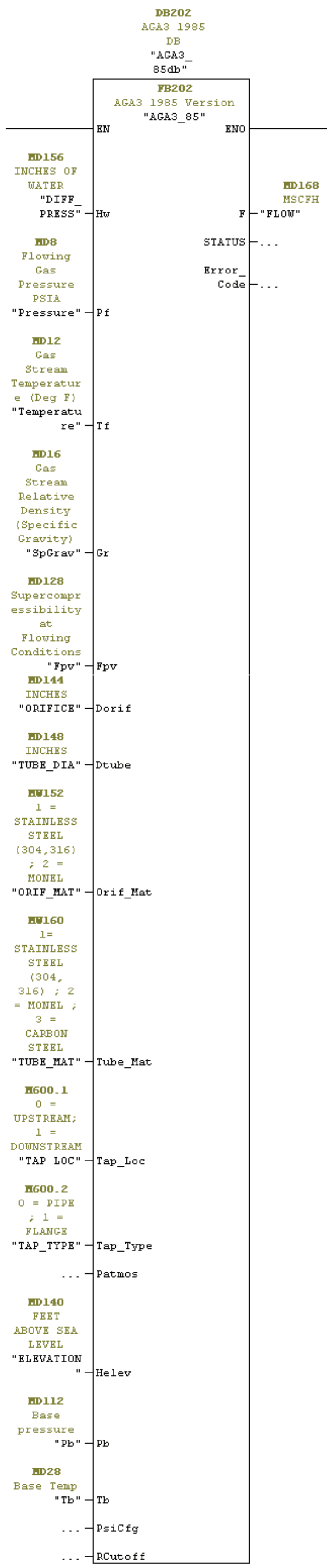


Examples

Example: AGA3-85 with NX-19

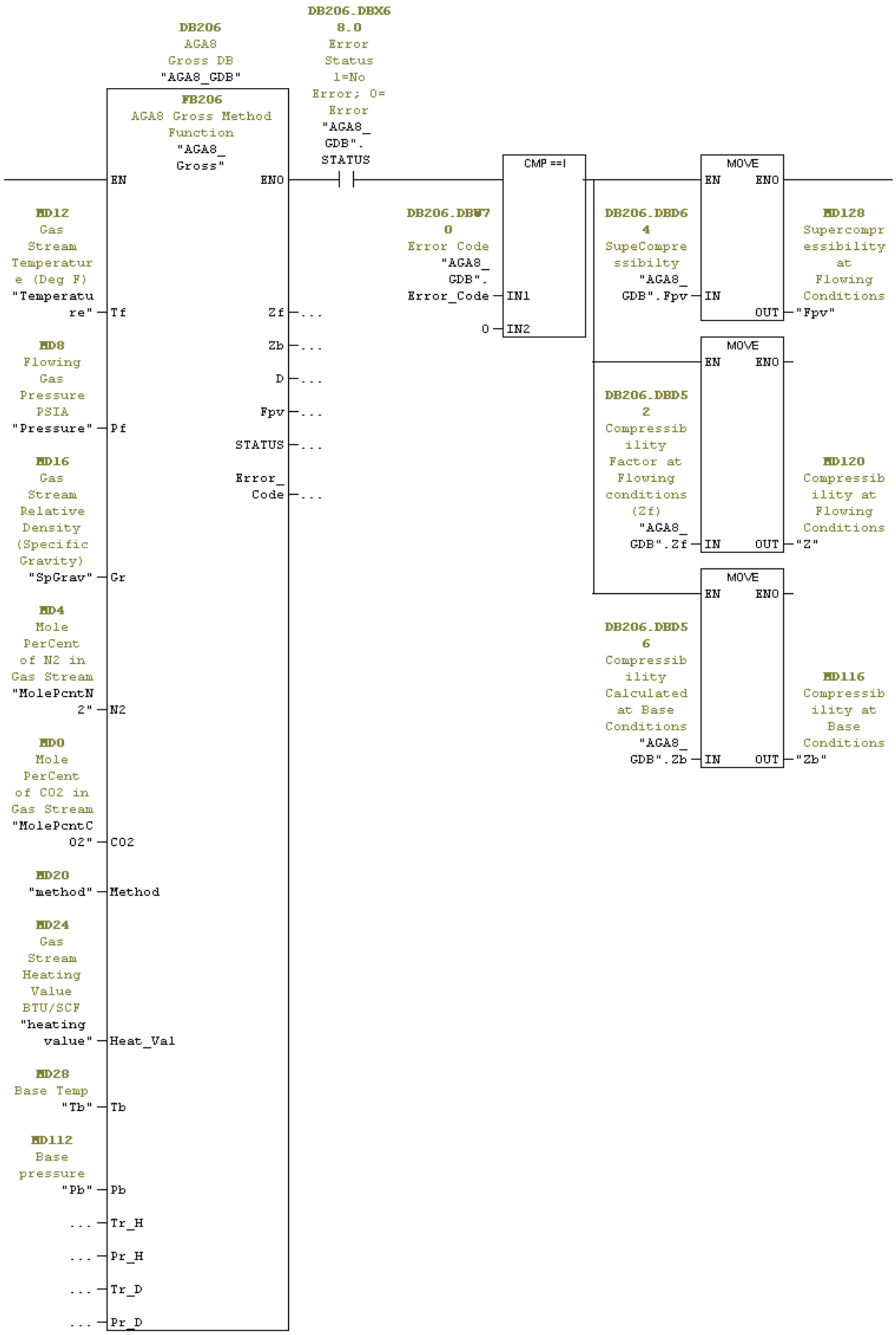
The following example illustrates an AGA3-85 flow calculation using NX-19 to provide supercompressibility. When the Error_Code output indicates that the calculation is finished, the Fpv output from NX-19 is moved to the Fpv input to AGA3-85.

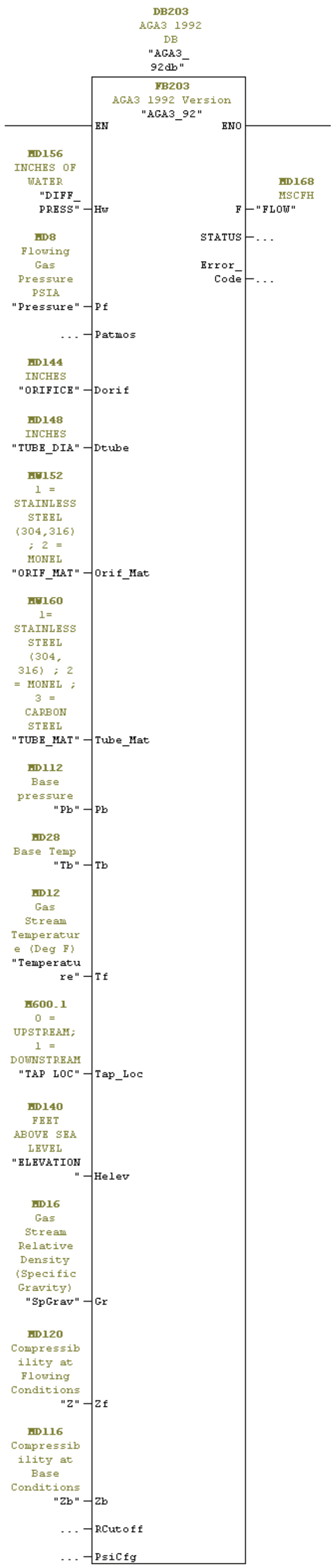



DB202
AGA3 1985
DB
"AGA3_
85db"
FB202
AGA3 1985 Version
"AGA3_85"
EN
ENO
MD156
INCHES OF
WATER
"DIFF_
PRESS"
Hw
MD168
MSCFH
F
"FLOW"
STATUS
...
Error_
Code
...
MD8
Flowing
Gas
Pressure
PSIA
"Pressure"
Pf
MD12
Gas
Stream
Temperatur
e (Deg F)
"Temperatu
re"
Tf
MD16
Gas
Stream
Relative
Density
(Specific
Gravity)
"SpGrav"
Gr
MD128
Supercompr
essibility
at
Flowing
Conditions
"Fpv"
Fpv
MD144
INCHES
"ORIFICE"
Dorif
MD148
INCHES
"TUBE_DIA"
Dtube
MW152
1 =
STAINLESS
STEEL
(304,316)
; 2 =
MONEL
"ORIF_MAT"
Orif_Mat
MW160
1=
STAINLESS
STEEL
(304,
316) ; 2
= MONEL ;
3 =
CARBON
STEEL
"TUBE_MAT"
Tube_Mat
M600.1
0 =
UPSTREAM;
1 =
DOWNSTREAM
"TAP_LOC"
Tap_Loc
M600.2
0 = PIPE
; 1 =
FLANGE
"TAP_TYPE"
Tap_Type
...
Patmos
MD140
FEET
ABOVE SEA
LEVEL
"ELEVATION
"
Helev
MD112
Base
pressure
"Pb"
Pb
MD28
Base Temp
"Tb"
Tb
...
PsiCfg
...
RCutoff

Example: AGA3-92 with AGA8-Gross

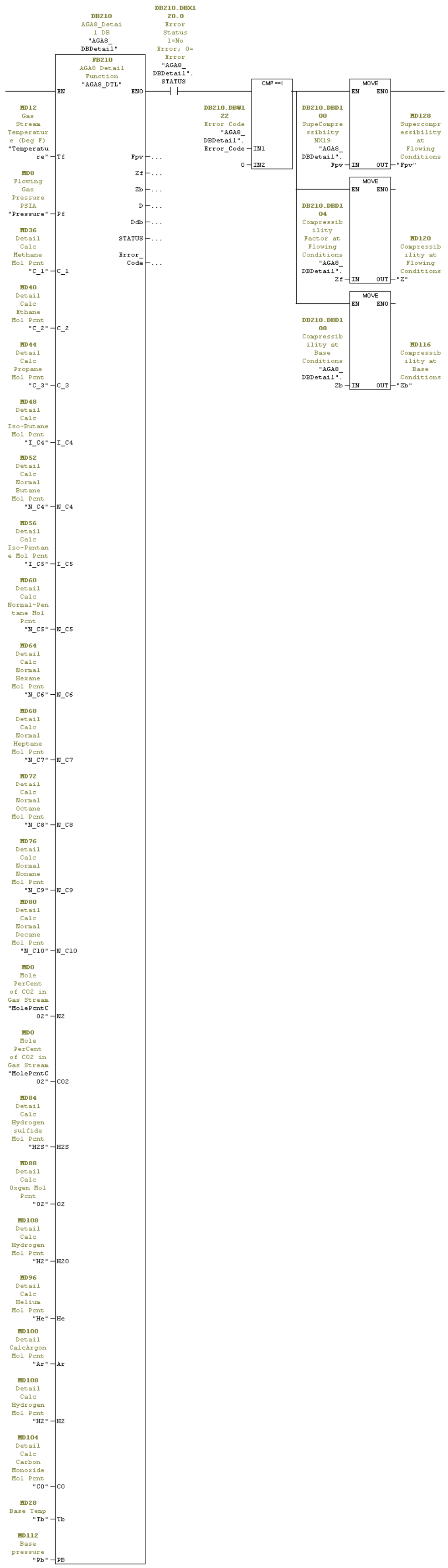
The following example illustrates an AGA3-92 flow calculation using AGA8-Gross to provide compressibility. When the Error_Code value of AGA8-Grossl is zero, the compressibility calculation is finished. AGA3-92 can then use the Zf and Zb outputs from AGA8-Gross as the Zf and Zb inputs.

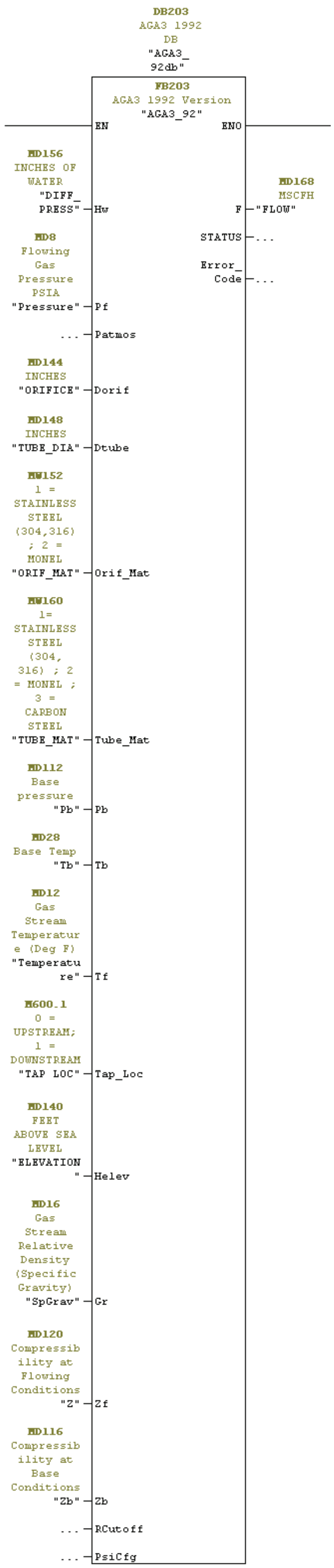



DB203
AGA3 1992
DB
"AGA3_
92db"
FB203
AGA3 1992 Version
"AGA3_92"
EN
ENO
MD156
INCHES OF
WATER
"DIFF_
PRESS"
Hw
MD168
MSCFH
F
"FLOW"
STATUS
...
Error_
Code
...
MD8
Flowing
Gas
Pressure
PSIA
"Pressure"
Pf
...
Patmos
MD144
INCHES
"ORIFICE"
Dorif
MD148
INCHES
"TUBE_DIA"
Dtube
MW152
1 =
STAINLESS
STEEL
(304,316)
; 2 =
MONEL
"ORIF_MAT"
Orif_Mat
MW160
1=
STAINLESS
STEEL
(304,
316) ; 2
= MONEL ;
3 =
CARBON
STEEL
"TUBE_MAT"
Tube_Mat
MD112
Base
pressure
"Pb"
Pb
MD28
Base Temp
"Tb"
Tb
MD12
Gas
Stream
Temperatur
e (Deg F)
"Temperatu
re"
Tf
M600.1
0 =
UPSTREAM;
1 =
DOWNSTREAM
"TAP LOC"
Tap_Loc
MD140
FEET
ABOVE SEA
LEVEL
"ELEVATION
"
Helev
MD16
Gas
Stream
Relative
Density
(Specific
Gravity)
"SpGrav"
Gr
MD120
Compressib
ility at
Flowing
Conditions
"Z"
Zf
MD116
Compressib
ility at
Base
Conditions
"Zb"
Zb
...
RCutoff
...
PsiCfg

Example: AGA3-92 with AGA8-Detail

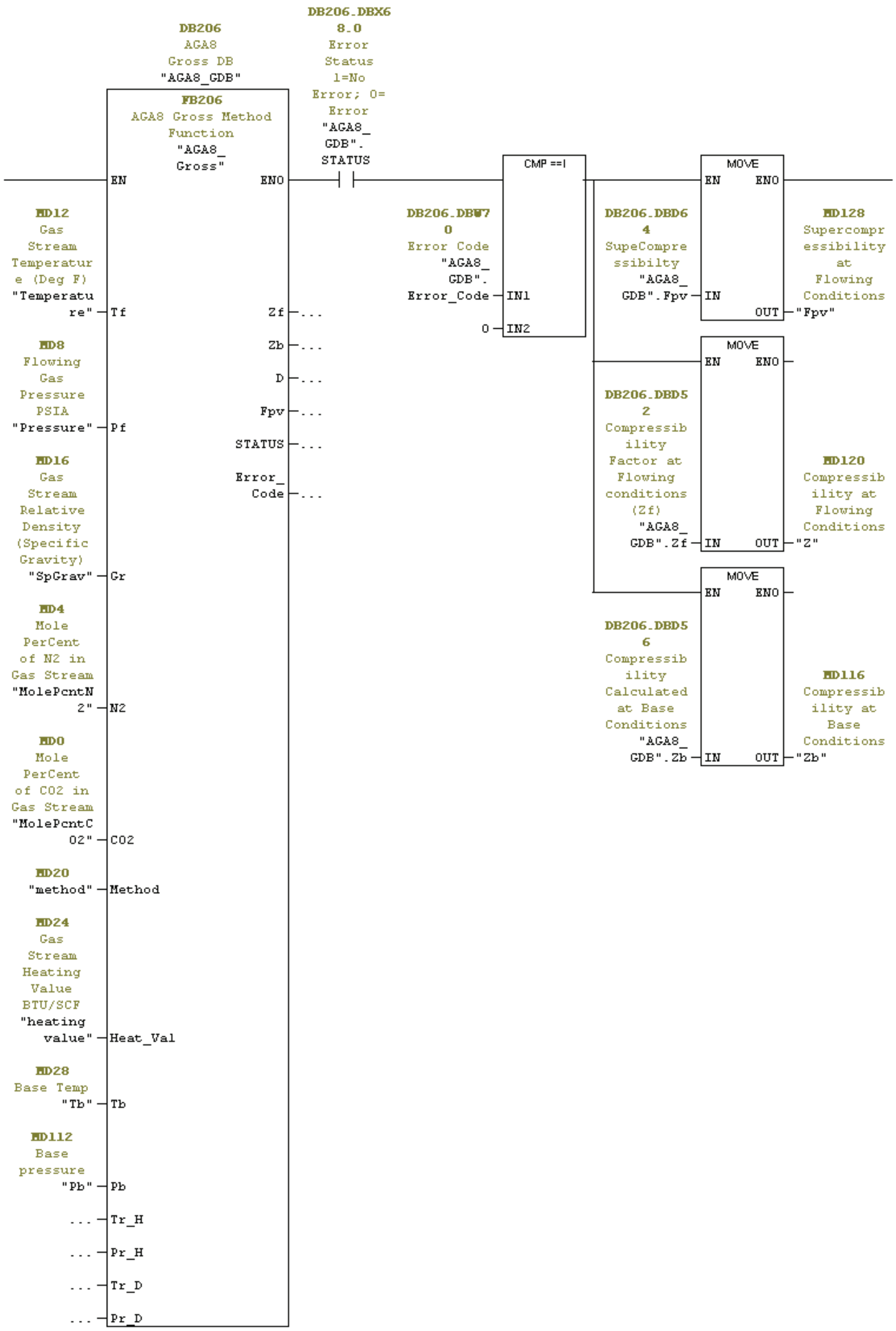
The following example illustrates an AGA3-92 flow calculation using AGA8-Detail to provide compressibility. When the Error_Code value of AGA8-Detail is zero, the compressibility calculation is finished. AGA3-92 can then use the Zf and Zb outputs from AGA8-Detail as the Zf and Zb inputs.

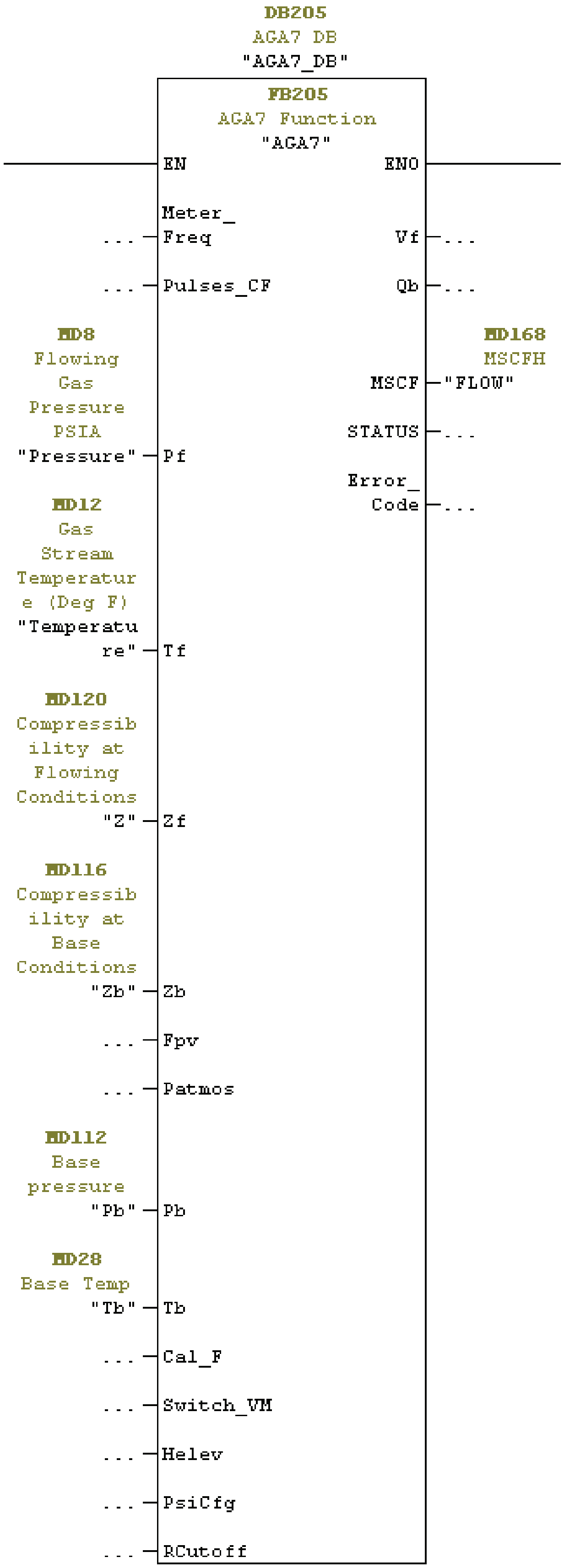

DB210 AGA8_Detail DB "AGA8_DBDetail"
FB210 AGA8 Detail Function "AGA8_DTL"
EN
ENO
DB210.DBX120.0 Error Status 1=No Error; 0=Error "AGA8_DBDetail".STATUS
CMP ==I
DB210.DBW122 Error Code "AGA8_DBDetail".Error_Code
IN1
0
IN2
MOVE
DB210.DBD100 SupeCompressibilty NX19 "AGA8_DBDetail".Fpv
IN
OUT
MD128 Supercompressibility at Flowing Conditions "Fpv"
DB210.DBD104 Compressibility Factor at Flowing Conditions "AGA8_DBDetail".Zf
MD120 Compressibility at Flowing Conditions "Z"
DB210.DBD108 Compressibility at Base Conditions "AGA8_DBDetail".Zb
MD116 Compressibility at Base Conditions "Zb"
Fpv ...
Zf ...
Zb ...
D ...
Ddb ...
STATUS ...
Error_Code ...
MD12 Gas Stream Temperature (Deg F) "Temperature" Tf
MD8 Flowing Gas Pressure PSIA "Pressure" Pf
MD36 Detail Calc Methane Mol Pcnt "C_1" C_1
MD40 Detail Calc Ethane Mol Pcnt "C_2" C_2
MD44 Detail Calc Propane Mol Pcnt "C_3" C_3
MD48 Detail Calc Iso-Butane Mol Pcnt "I_C4" I_C4
MD52 Detail Calc Normal Butane Mol Pcnt "N_C4" N_C4
MD56 Detail Calc Iso-Pentane Mol Pcnt "I_C5" I_C5
MD60 Detail Calc Normal-Pentane Mol Pcnt "N_C5" N_C5
MD64 Detail Calc Normal Hexane Mol Pcnt "N_C6" N_C6
MD68 Detail Calc Normal Heptane Mol Pcnt "N_C7" N_C7
MD72 Detail Calc Normal Octane Mol Pcnt "N_C8" N_C8
MD76 Detail Calc Normal Nonane Mol Pcnt "N_C9" N_C9
MD80 Detail Calc Normal Decane Mol Pcnt "N_C10" N_C10
MD0 Mole PerCent of CO2 in Gas Stream "MolePcntCO2" N2
MD0 Mole PerCent of CO2 in Gas Stream "MolePcntCO2" CO2
MD84 Detail Calc Hydrogen sulfide Mol Pcnt "H2S" H2S
MD88 Detail Calc Oxgen Mol Pcnt "O2" O2
MD108 Detail Calc Hydrogen Mol Pcnt "H2" H2O
MD96 Detail Calc Helium Mol Pcnt "He" He
MD100 Detail CalcArgon Mol Pcnt "Ar" Ar
MD108 Detail Calc Hydrogen Mol Pcnt "H2" H2
MD104 Detail Calc Carbon Monoxide Mol Pcnt "CO" CO
MD28 Base Temp "Tb" Tb
MD112 Base pressure "Pb" PB


DB203
AGA3 1992
DB
"AGA3_
92db"
FB203
AGA3 1992 Version
"AGA3_92"
EN
ENO
MD156
INCHES OF
WATER
"DIFF_
PRESS"
Hw
MD168
MSCFH
F
"FLOW"
STATUS
...
Error_
Code
...
MD8
Flowing
Gas
Pressure
PSIA
"Pressure"
Pf
...
Patmos
MD144
INCHES
"ORIFICE"
Dorif
MD148
INCHES
"TUBE_DIA"
Dtube
MW152
1 =
STAINLESS
STEEL
(304,316)
; 2 =
MONEL
"ORIF_MAT"
Orif_Mat
MW160
1=
STAINLESS
STEEL
(304,
316) ; 2
= MONEL ;
3 =
CARBON
STEEL
"TUBE_MAT"
Tube_Mat
MD112
Base
pressure
"Pb"
Pb
MD28
Base Temp
"Tb"
Tb
MD12
Gas
Stream
Temperatur
e (Deg F)
"Temperatu
re"
Tf
M600.1
0 =
UPSTREAM;
1 =
DOWNSTREAM
"TAP LOC"
Tap_Loc
MD140
FEET
ABOVE SEA
LEVEL
"ELEVATION
"
Helev
MD16
Gas
Stream
Relative
Density
(Specific
Gravity)
"SpGrav"
Gr
MD120
Compressib
ility at
Flowing
Conditions
"Z"
Zf
MD116
Compressib
ility at
Base
Conditions
"Zb"
Zb
...
RCutoff
...
PsiCfg

Example: AGA7 with AGA8-Gross

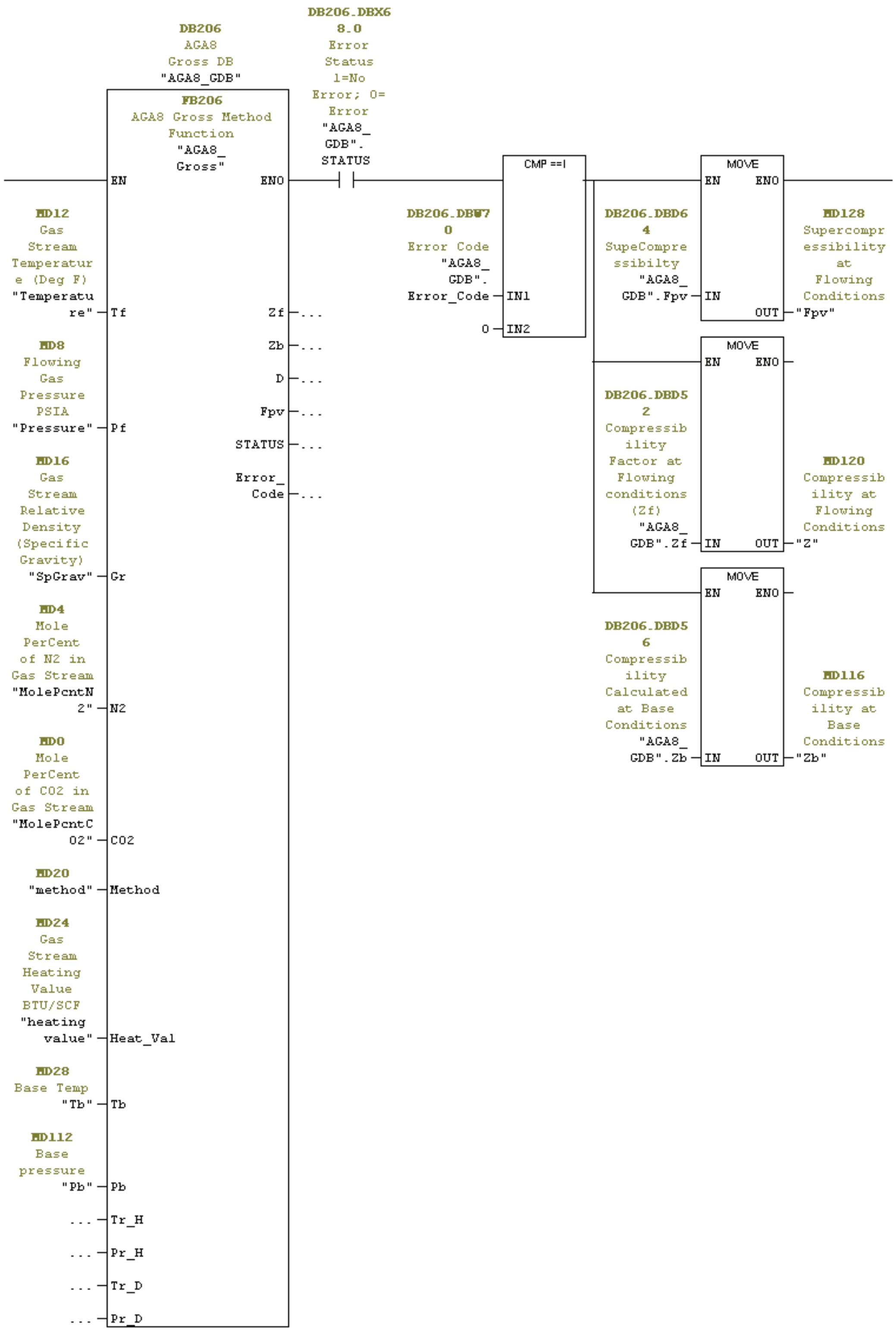
The following example illustrates an AGA7 flow calculation for turbine metering using AGA8-Gross to provide compressibility factors. In this example, AGA7 uses the Zf and Zb inputs for compressibility and not Fpv. When the Error_code from AGA8-Gross indicates that the compressibility calculation is finished, the Zf and Zb outputs of AGA8-Gross are moved to the Zf and Zb input variables for AGA7. The Fpv output is also moved, but in this example it is not used by the AGA7 call.

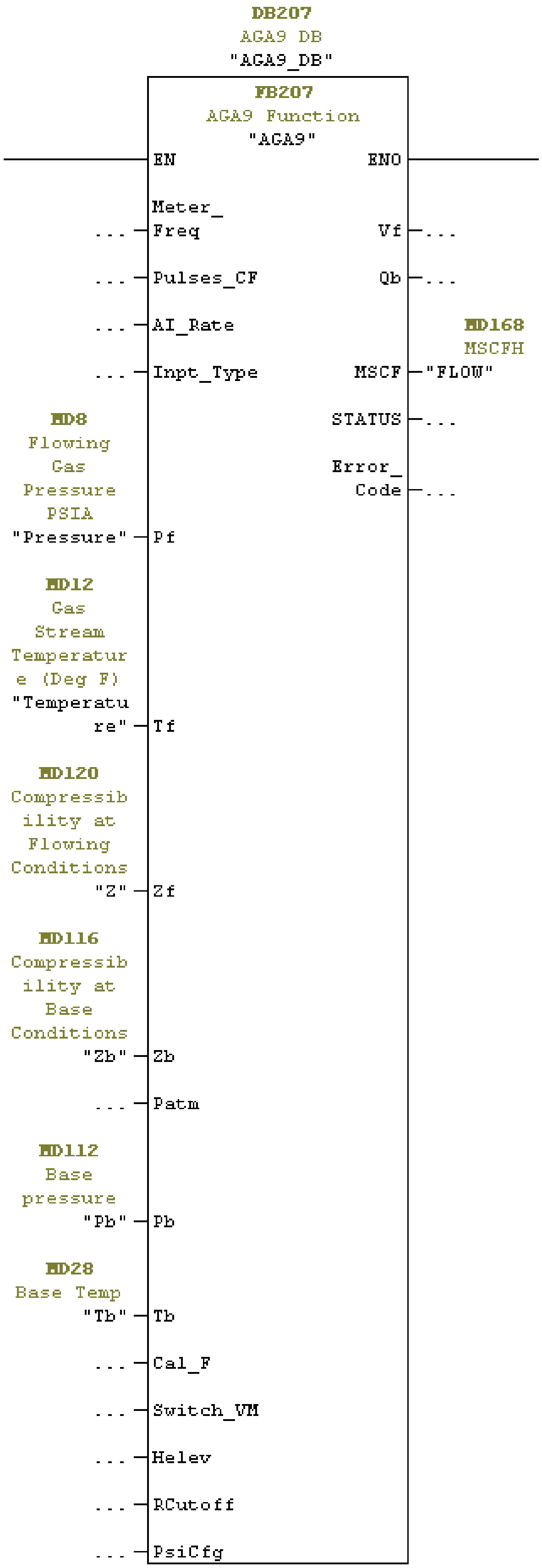



DB205
AGA7 DB
"AGA7_DB"
FB205
AGA7 Function
"AGA7"
EN
ENO
Meter_
Freq
Vf
Pulses_CF
Qb
MD8
Flowing
Gas
Pressure
PSIA
"Pressure"
Pf
MD168
MSCFH
MSCF
"FLOW"
STATUS
Error_
Code
MD12
Gas
Stream
Temperatur
e (Deg F)
"Temperatu
re"
Tf
MD120
Compressib
ility at
Flowing
Conditions
"Z"
Zf
MD116
Compressib
ility at
Base
Conditions
"Zb"
Zb
Fpv
Patmos
MD112
Base
pressure
"Pb"
Pb
MD28
Base Temp
"Tb"
Tb
Cal_F
Switch_VM
Helev
PsiCfg
RCutoff

Example: AGA9 with AGA8-Gross

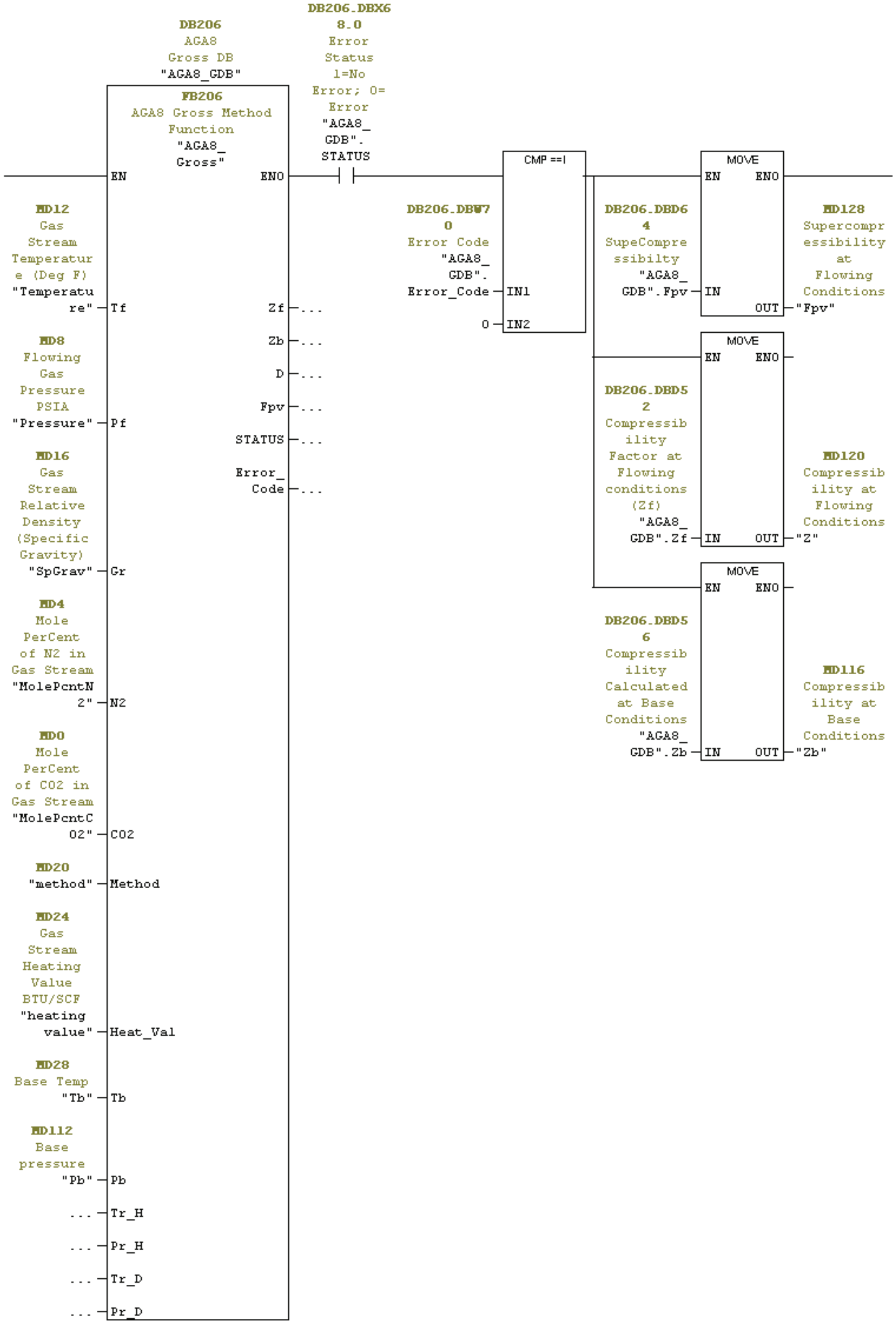
The following example illustrates an AGA9 flow calculation for ultrasonic metering using AGA8-Gross to provide compressibility factors. When the Error_code from AGA8-Gross indicates that the compressibility calculation is finished, the Zf and Zb outputs are moved to the Zf and Zb input variables for AGA9.

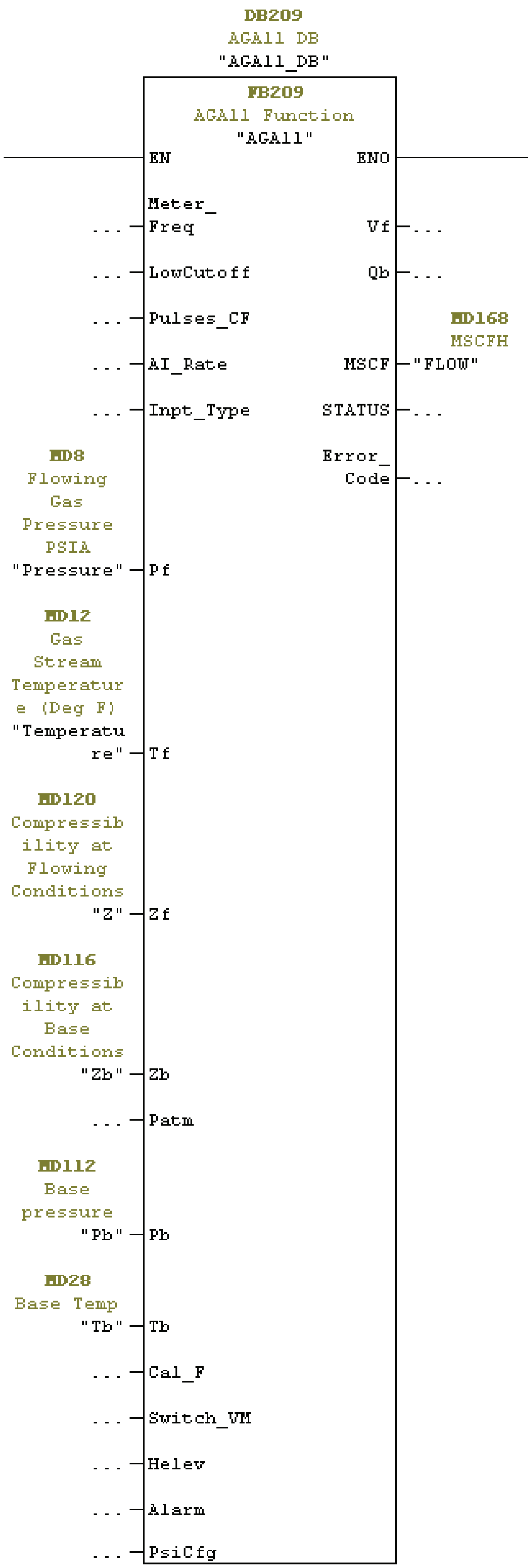



DB207
AGA9 DB
"AGA9_DB"
FB207
AGA9 Function
"AGA9"
EN
ENO
Meter_
Freq
Vf
...
Pulses_CF
Qb
AI_Rate
MD168
MSCFH
Inpt_Type
MSCF
"FLOW"
STATUS
Error_
Code
MD8
Flowing
Gas
Pressure
PSIA
"Pressure"
Pf
MD12
Gas
Stream
Temperatur
e (Deg F)
"Temperatu
re"
Tf
MD120
Compressib
ility at
Flowing
Conditions
"Z"
Zf
MD116
Compressib
ility at
Base
Conditions
"Zb"
Zb
Patm
MD112
Base
pressure
"Pb"
Pb
MD28
Base Temp
"Tb"
Tb
Cal_F
Switch_VM
Helev
RCutoff
PsiCfg

Example: AGA11 with AGA8-Gross

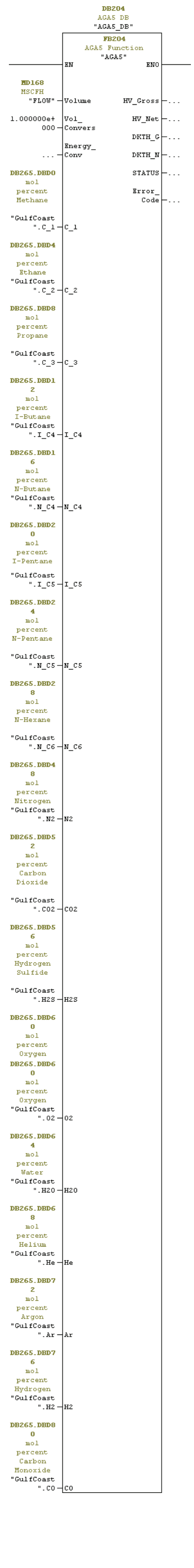
The following example illustrates an AGA11 flow calculation for coriolis metering using AGA8-Gross to provide compressibility factors. When the Error_code from AGA8-Gross indicates that the compressibility calculation is finished, the Zf and Zb outputs are moved to the Zf and Zb input variables for AGA11.




DB209
AGA11 DB
"AGA11_DB"
FB209
AGA11 Function
"AGA11"
EN
ENO
...
Meter_ Freq
Vf
...
...
LowCutoff
Qb
...
...
Pulses_CF
MD168
MSCFH
...
AI_Rate
MSCF
"FLOW"
...
Inpt_Type
STATUS
...
Error_ Code
...
MD8
Flowing Gas Pressure PSIA
"Pressure"
Pf
MD12
Gas Stream Temperature (Deg F)
"Temperature"
Tf
MD120
Compressibility at Flowing Conditions
"Z"
Zf
MD116
Compressibility at Base Conditions
"Zb"
Zb
...
Patm
MD112
Base pressure
"Pb"
Pb
MD28
Base Temp
"Tb"
Tb
...
Cal_F
...
Switch_VM
...
Helev
...
Alarm
...
PsiCfg

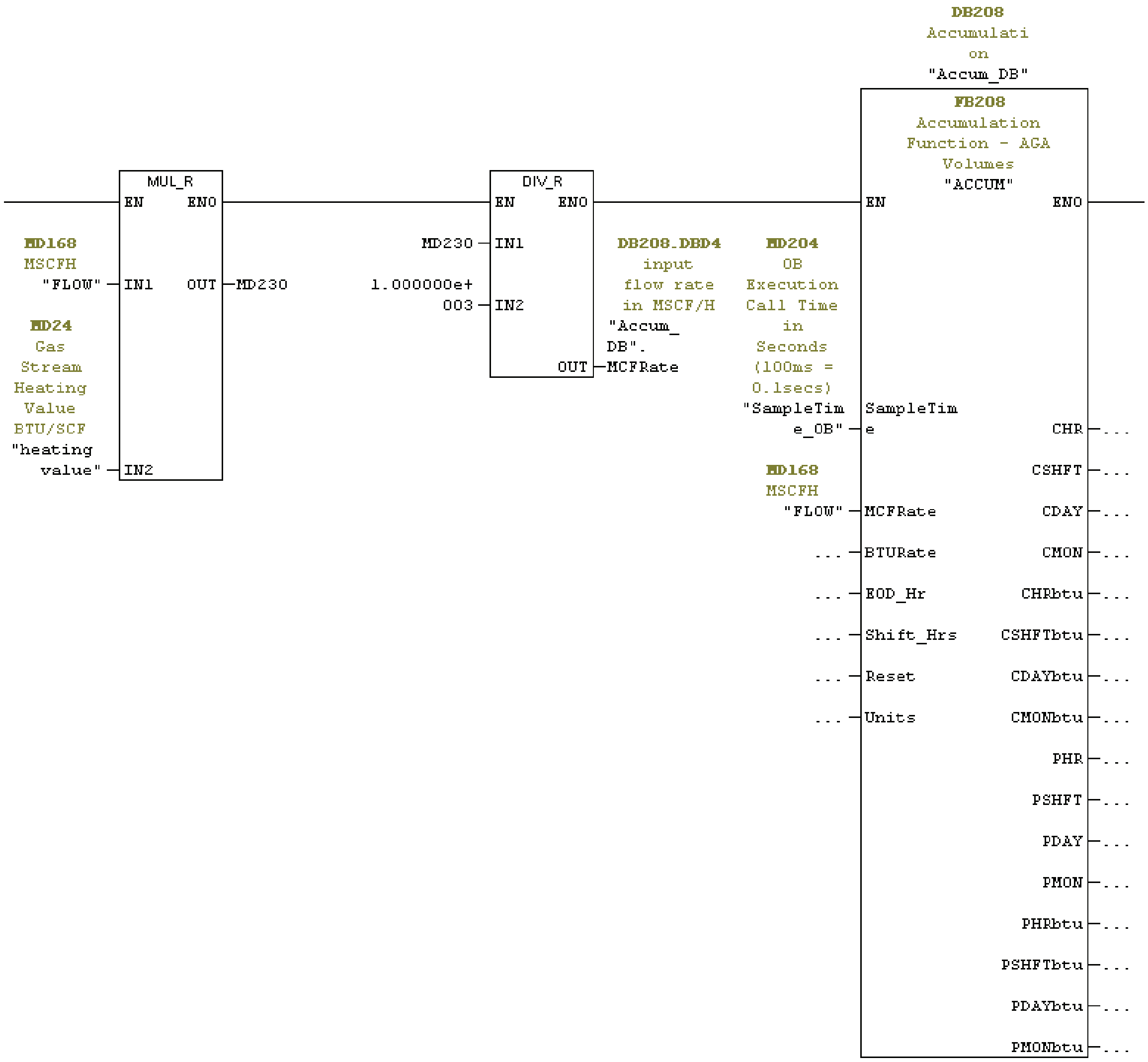
Example: AGA5

The following example illustrates an energy calculation with AGA5.



Example: ACCUM

The following example shows volumetric flow calculations per hour, shift, day and month using the ACCUM function block. This example calculates the BTURate from the MSCFH flow rate and stores it in the BTUrate parameter of the instance data block, and provides the flow rate input at MCFRate. The ACCUM function block produces the output volumes in the default units of MSCF (thousands of standard cubic feet) and thousands of BTU.



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