User Manual
Function Block
AGA Report No. 8
Detail Method

Rev. A 12/2013

Doc. Code.: MU***

altus

www.altus.com.br

No part of this document may be copied or reproduced in any form without the prior written consent of Altus Sistemas de Informática S.A. who reserves the right to carry out alterations without advice.

According to current legislation in force in Brazil, the Consumer Defense Code, we provide the following information regarding personal safety and installation by the client.

The industrial automation equipment built by Altus is strong and reliable due to the stringent quality control it is subjected to. However the electronic industrial control equipment (programmable controllers, numerical commands, etc.) can cause damage to the machines or processes through their controllers when there are defective components and programming or installation errors. This can even put human lives at risk.

The user should consider the possible consequences of these defects and should provide additional external installations for security so that, if necessary, the security of the system can be maintained especially during the initial installation and testing.

It is essential to completely read the manuals and/or about the technical characteristics of the product before its installation or use.

The equipments manufactured by Altus don't cause direct environmental hazards and don't produce any kind of pollution during its utilization. However, regarding the equipments discarded, it is important to stress that any electronic components inside these products may cause environmental impacts if discharged incorrectly. Therefore, it's strongly recommended that the product is sent to recycle plants to be discarded with the proper waste treatment.

Altus guarantees that its equipment against genuine production defects for a period of twelve months starting at the shipping date. This guarantee is given in terms of factory maintenance, that is to say, the transportation costs of returning to factory will be borne by the client. The guarantee will be automatically suspended if there are modifications introduced to the equipment by personnel not authorized by Atlus. Altus are exempt from any responsibility with regard to repairs or replacement parts owing to faults created by outside influences, through inappropriate use, as well as the result of accidents or force maneuver.

Altus guarantees that its equipment works in accordance with the clear instructions contained in their manuals and/or the technical features, not guaranteeing the success of any particular type of application of the equipment.

Altus does not acknowledge any other guarantee, directly or implied, mainly when end customers are dealing with third-party suppliers The requests for additional information about the supply, equipment features and/or any other Altus services must be made in written form. Altus's address can be found on the back cover. Altus is not responsible for supplying information about its equipment without formal request.

COPYRIGHTS

Table of Contents

1. Introduction

Function block AGA8Detail computes compressibility factor and other natural gas properties, according Detail Characterization Method of AGA Report No. 8, second edition, published in November 1992.

The function block takes as inputs:

- Temperature
- Absolute pressure
- Temperature of base condition
- Absolute pressure of base condition
- Gas composition (molar percentage of 21 components)

The function block calculates the following outputs:

- Mol weight
- Density at actual condition (actual temperature and actual absolute pressure)
- Density at base condition (base temperature and base absolute pressure)
- Compressibility at actual condition (actual temperature and actual absolute pressure)
- Compressibility at base condition (base temperature and base absolute pressure)
- Super-compressibility
- Uncertainty region
- Total gas percentage (for checking against 100%)
- Warning and error flags

The compressibility factors calculated by AGA8Detail are commonly used to correct gas flow and volume, for instance:

- Simple formulas use the compressibility factor to correct the flow measured by Pitot transmitters.
- If orifice plates are used to measure gas flow, the compressibility factors are used as input for other standards, like AGA Report No. 3.

The function block is delivered within a library (AGA Report No 8 – Detail Method).

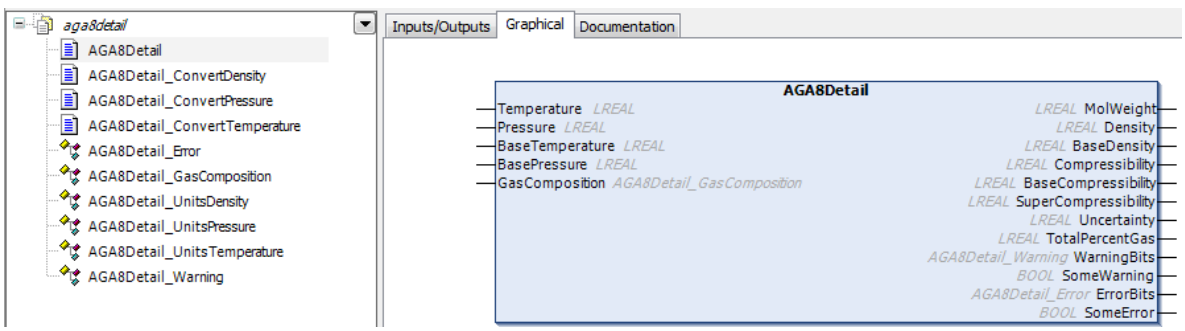

Figure 1-1. Components of library AGA Report No 8 – Detail Method

The main features of the function block and associated library are the following:

- Compatible with Nexto Series CPUs
- 64-bit floating point precision arithmetic
- Low processing time for executing several thousands arithmetic operations (iterative convergent algorithm)
- Low memory consumption
- Besides function block AGA8Detail, the library also contains:
    - Auxiliary data structures used in AGA8Detail function block (gas composition, errors and warnings)
    - Auxiliary functions for converting units of temperature, pressure and density, and auxiliary enumerations defining the allowed units

Documents Related to this Manual

In order to obtain additional information regarding the Nexto Series, other documents (manuals and technical features) besides this one, may be accessed. These documents are available in its last version on the site http://www.altus.com.br.

Each product has a document designed by Technical Features (CE), where the product features are described. Furthermore, the product may have Utilization Manuals (the manuals codes are listed in the CE).

For instance, the NX1001 module has the information for utilization features and purchasing on its CE. On another hand, the NX5001 has, besides the CE, a User Manual (MU).

It is advised the following documents as additional information source:

Code	Description	Language
CE* **	Function Block AGA Report No. 8 – Detail Method – Technical Characteristics	English
CT* **	Function Block AGA Report No. 8 – Detail Method – Caracteristicas Técnicas	Portuguese
CS* **	Function Block AGA Report No. 8 – Detail Method – Especificaciones y Configuraciones	Spanish
MU* **	Function Block AGA Report No. 8 – Detail Method – User Manual	English
MU* **	Function Block AGA Report No. 8 – Detail Method – Manual de Utilização	Portuguese
MU* **	Function Block AGA Report No. 8 – Detail Method – Manual Del Usuario	Spanish
CE114000	Nexto Series – Technical Characteristics	English
CT114000	Série Nexto – Características Técnicas	Portuguese
CS114000	Serie Nexto – Especificaciones y Configuraciones	Spanish
CE114700	Nexto Series Backplane Racks Technical Characteristics	English
CT114700	Características Técnicas dos Bastidores da Série Nexto	Portuguese
CS114700	Características Técnicas de los Bastidores de la Serie Nexto	Spanish
CE114900	NX4010 Redundancy Link Module Technical Characteristics	English
CT114900	Características Técnicas do Módulo de Redundância NX4010	Portuguese
CS114900	Características Técnicas del Módulo de Redundancia NX4010	Spanish
CE114902	NX5001 PROFIBUS-DP Master Technical Characteristics	English
CT114902	Características Técnicas do Mestre PROFIBUS DP NX5001	Portuguese
CS114902	Especificaciones y Configuraciones Maestro PROFIBUS-DP NX5001	Spanish

CE114903 **CT114903** **CS114903**	Ethernet Module NX5000 Technical Characteristics Características Técnicas do Módulo Ethernet NX5000 Especificaciones y Configuraciones Modulo Ethernet NX5000	English Portuguese Spanish
CT112500	Características Técnicas do Painel de Controle de Redundância PX2612	Portuguese
MU214600 **MU214000** **MU214300**	Nexto Series User Manual Manual de Utilização Série Nexto Manual del Usuario Serie Nexto	English Portuguese Spanish
MU214605 **MU214100** **MU214305**	Nexto Series CPUs User Manual Manual de Utilização UCPs Série Nexto Manual del Usuario UCPs Serie Nexto	English Portuguese Spanish
MU299609 **MU299048** **MU299800**	MasterTool IEC XE User Manual Manual de Utilização MasterTool IEC XE Manual del Usuario MasterTool IEC XE	English Portuguese Spanish
MP399609 **MP399048** **MP399800**	MasterTool IEC XE Programming Manual Manual de Programação MasterTool IEC XE Manual de Programación MasterTool IEC XE	English Portuguese Spanish
MU214601 **MU214001** **MU214301**	NX5001 PROFIBUS DP Master User Manual Manual de Utilização Mestre PROFIBUS DP NX5001 Manual del Usuario Maestro PROFIBUS DP NX5001	English Portuguese Spanish
MU219000 **MU209000**	Ponto Series Utilization Manual Manual de Utilização da Série Ponto	English Portuguese
MU209508	Manual de Utilização Cabeça PROFIBUS PO5063V1 e Cabeça Redundante PROFIBUS PO5063V5	Portuguese
MU219511 **MU209511**	PO5064 PROFIBUS Head and PO5065 Redundant PROFIBUS Head Utilization Manual Manual de Utilização Cabeça PROFIBUS PO5064 e Cabeça Redundante PROFIBUS PO5065	English Portuguese
MU209020	Manual de Utilização Rede HART sobre PROFIBUS	Portuguese

Table 1-1. Related Documents

Visual Inspection

Before resuming the installation process, it is advised to carefully visually inspect the equipments, verifying the existence of transport damage. Verify if all parts requested are in perfect shape. In case of damages, inform the transport company or Altus distributor closest to you.

CAUTION:
Before taking the modules off the case, it is important to discharge any possible static energy accumulated in the body. Touch (with bare hands) any metallic grounded surface before handling the modules. Such procedure guaranties that the module static energy limits are not exceeded.

It's important to register each received equipment serial number, as well as software revisions, in case they exist. This information is necessary, in case the Altus Technical Support is contacted.

Technical Support

For Altus Technical Support contact in São Leopoldo, RS, call +55 51 3589-9500. For further information regarding the Altus Technical Support existent on other places, see http://www.altus.com.br or send an email to altus@altus.com.br.

If the equipment is already installed, you must have the following information at the moment of support requesting:

- The model of the used equipments and the installed system configuration
- The CPU serial number
- The equipment revision and the executive software version, written on the tag fixed on the product side
- CPU operation mode information, acquired through MasterTool IEC XE
- The application software content, acquired through MasterTool IEC XE
- Used program version

Warning Messages Used in this Manual

In this manual, the warning messages will be presented in the following formats and meanings:

DANGER:
Reports potential hazard that, if not detected, may be harmful to people, materials, environment and production.

CAUTION:
Reports configuration, application or installation details that must be taken into consideration to avoid any instance that may cause system failure and consequent impact.

ATTENTION:
Identifies configuration, application and installation details aimed at achieving maximum operational performance of the system.

2. Technical Description

This chapter presents the technical features of Library AGA Report No. 8 – Detail Method.

General Features

Feature	Description
Calculation Method	Detail Characterization Method of AGA Report No. 8, second edition, published in November 1992.
Compatible CPUs	Nexto series: NX3030, NX3020, NX3010
Typical execution time when only pressure and temperature change	Less than 0.5 ms
Typical execution time when gas composition changes	Less than 2.5 ms
Worst case execution time	Less than 15 ms
Common data memory allocated for constant tables (shared by all instances of function block)	16 Kbytes
Data memory allocated for variables of each instance of function block	1.5 Kbytes
Temperature range (ºC) for current temperature and base temperature	-130 to 200 ºC
Pressure range (bar) for current pressure and base pressure	0 to 1400 bar
Units used by function block inputs and outputs	Temperature and base temperature inputs: ºC Pressure and base pressure inputs: bar Density output: kg/m^3
Units supported by temperature conversion function	ºC, ºK, ºF
Units supported by pressure conversion function	Pa, psia, bar
Units supported by density conversion function	mol/dm^3, kg/m^3, lbm/ft^3

Gas composition in normal range	Methane: 45% ... 100% Nitrogen: 0% ... 50% CarbonDioxide: 0% ... 30% Ethane: 0% ... 10% Propane: 0% ... 4% Water: 0% ... 0.05% HydrogenSulphide: 0% ... 0.02% Hydrogen: 0% ... 10% CarbonMonoxide: 0% ... 3% Oxygen: 0% isoButane: 0% ... 1% nButane: 0% ... 1% isoPentane: 0% ... 0.3% nPentane: 0% ... 0.3% nHexane: 0% ... 0.2% nHeptane: 0% ... 0.2% nOctane: 0% ... 0.2% nNonane: 0% ... 0.2% nDecane: 0% ... 0.2% Helium: 0% ... 0.2% Argon: 0%
Gas composition in expanded range	Methane: 0% ... 100% Nitrogen: 0% ... 100% CarbonDioxide: 0% ... 100% Ethane: 0% ... 100% Propane: 0% ... 12% Water: 0% ... dew point HydrogenSulphide: 0% ... 100% Hydrogen: 0% ... 100% CarbonMonoxide: 0% ... 3% Oxygen: 0% ... 21% isoButane: 0% ... 6% nButane: 0% ... 6% isoPentane: 0% ... 4% nPentane: 0% ... 4% nHexane: 0% ... dew point nHeptane: 0% ... dew point nOctane: 0% ... dew point nNonane: 0% ... dew point nDecane: 0% ... dew point Helium: 0% ... 3% Argon: 0% ... 1%

Table 2-1. General Features of Library AGA Report No. 8 – Detail Method

Compatibility with Other Products

Code	Description
MT8500	MasterTool IEC XE version 1.00 or onwards

Note:

Compatibility: There are some limitations related to the MasterTool IEC XE software version acquired, therefore it is recommended the user to see MasterTool IEC XE - MU299609 User Manual to verify specifically the desired applications compatibility with the programmer version.

Performance

The Detail Characterization Method of AGA Report No. 8 is an iterative algorithm. The iterations are repeated until the solution converges to an acceptable precision.

The number of iterations varies according the input data, so the execution time is not fixed.

The execution time also depends on which inputs have changed in the last cycle:

1. The smaller execution time (few microsseconds) is found when all inputs haven't changed.
2. The next smaller execution time is found when only pressure has changed.
3. The next smaller execution time is found when temperature has changed.
4. The next smaller execution time is found when gas composition has changed, but the list of gas components hasn't changed.
5. The higher execution time is found when the list of gas components has changed.

Considering typical gas compositions, where about 10 components have non-zero molar percentage, the execution time keeps normally bellow 0.5 ms when only temperature or pressure changes, and bellow 2.5 ms when composition changes.

The worst case (15 ms) is found when the limit of maximum iterations is attained in some subroutine. In this case, warning bits inform which limit has been attained. If this happens, the precision of calculation may be out of the normal uncertainty range.

Purchase Data

Integrant Items

The product package has the following items:

- Harkey with license (must be connected to an USB port of computer with Mastertool IEC XE).
- Library can be downloaded from ***
- ***???

Product Code

The following code must be used to purchase the product:

Code	Description
***	Function Block AGA Report No. 8 – Detail Method

Table 2-2. Product Code

Related Products

The following products must be purchased separately when necessary:

Code	Description
MT8500	MasterTool IEC XE
NX3010, NX3020 or NX3030	Nexto Series CPU

Table 2-3. Related Products

Notes:

MT8500: MaterTool IEC XE is available in three different versions: LITE, PROFESSIONAL and ADVANCED. For more details, please check MasterTool IEC XE User Manual - MU299609.

3. Programming

This section describes Library AGA Report No 8 – Detail Method, and presents an application example.

This library contains the following components:

- The main function block that calculates compressibility and other gas properties:
  - AGA8Detail
- Auxiliary data structures used by inputs or outputs of function block AGA8Detail:
  - AGA8Detail_GasComposition: composition of gas (percentage of 21 components)
  - AGA8Detail_Warning: warning bits
  - AGA8Detail_Error: error bits
- Unit conversion functions:
  - AGA8Detail_ConvertPressure: convert units of pressure
  - AGA8Detail_ConvertTemperature: convert units of temperature
  - AGA8Detail_ConvertDensity: convert units of density
- Enumerations with the allowed units, used in the unit conversion functions:
  - AGA8Detail_UnitsTemperature: supported units of temperature
  - AGA8Detail_UnitsPressure: supported units of pressure
  - AGA8Detail_UnitsDensity: supported units of density

The following figure shows these components in the Library Manager tab of Masertool IEC XE.

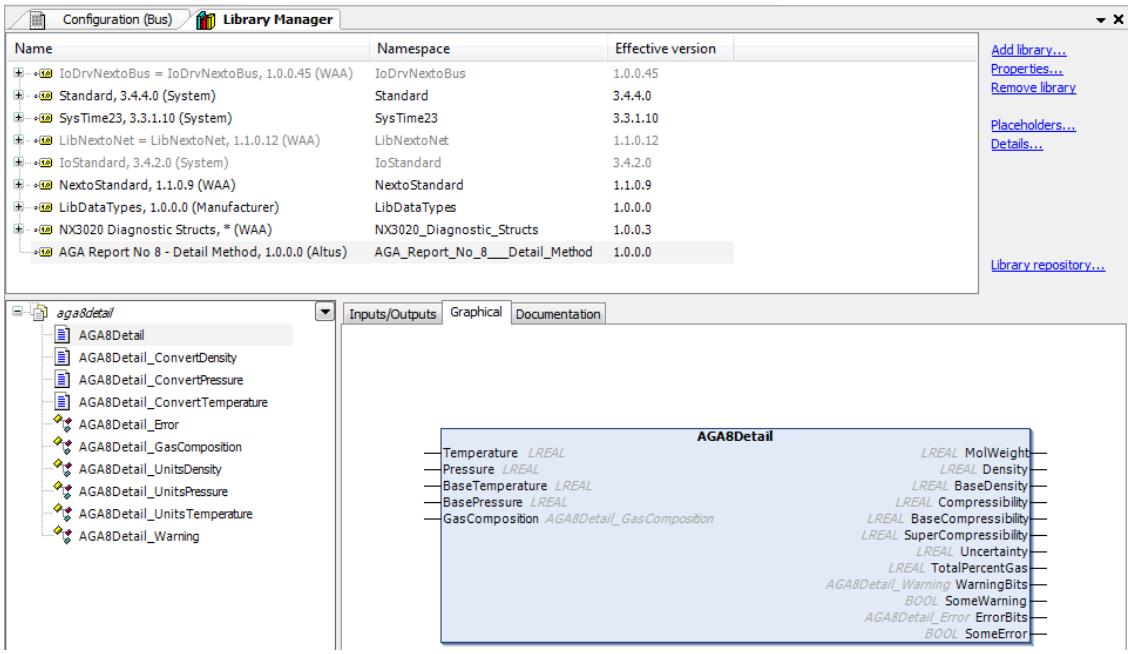

Figure 3-1. Components of Library AGA Report No 8 – Detail Method

NOTE:
Refer *Mastertool IEC XE User Manual* to learn how libraries can be installed in the library repository, and how they can be added in application projects.

AGA8Detail Function Block

This function block is the main component of the library. The following figure shows inputs (left side of the box) and outputs (right side of the box) of this function block.

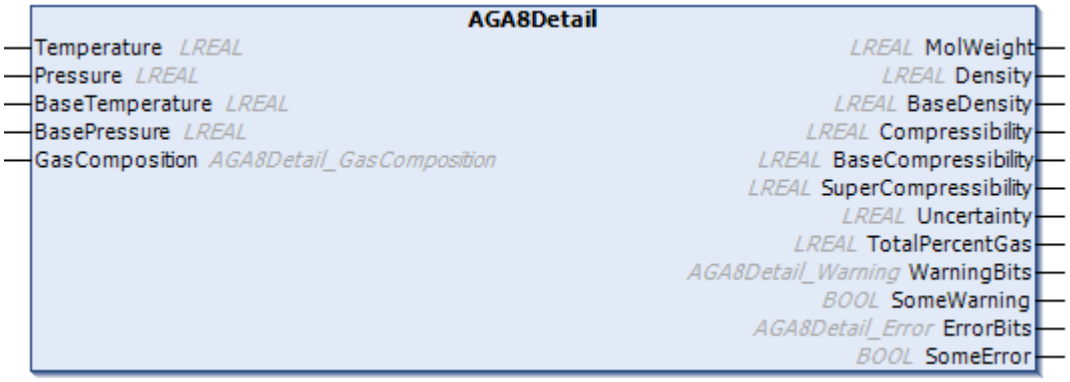

Figure 3-2. Graphical representation of function block AGA8Detail

The types for each input and output are also shown in italic.

Some of these types are standard:

- LREAL: 64-bit floating point
- BOOL: binary logic bit

The other types are defined in data structures (AGA8Detail_GasComposition, AGA8Detail_Warning, AGA8Detail_Error). These data structures will be described in the next sub-section.

The following table describes the inputs with more details.

Input parameters	Type	Description
Temperature	LREAL	Temperature of actual condition in degrees Celsius (ºC).
Pressure	LREAL	Absolute pressure of actual condition in bar (bar)
BaseTemperature	LREAL	Temperature of base condition in degrees Celsius (ºC).
BasePressure	LREAL	Absolute pressure of base condition in bar (bar)
GasComposition	AGA8Detail_GasComposition	Percentage of 21 gas components.

Table 3-1. Input Parameters

Temperature and absolute pressure of base condition may change in different applications (e.g.: customers or countries). For instance, in tests vectors of AGA Report 8 standards, the base temperature is 60 ºF (15.555 ºC) and base pressure is 14.73 psia (1.0156 bar), as usual in United States of America. However, in other countries, different base temperature and base pressure may be used.

The following table describes the outputs with more details.

Output parameters	Type	Description
MolWeight	LREAL	Mol weight of gas in kg/mol.
Density	LREAL	Density of gas at actual condition in kg/m^3.
BaseDensity	LREAL	Density of gas at base condition in kg/m^3.
Compressibility	LREAL	Compressibility factor at actual condition (dimensionless)
BaseCompressibility	LREAL	Compressibility factor at base condition (dimensionless)
SuperCompressibility	LREAL	Supercompressibility factor (dimensionless)
Uncertainty	LREAL	Percentage of uncertainty according figure 1 of AGA Report No. 8
TotalPercentGas	LREAL	Sum of all 21 percentages in GasComposition input parameter (should be 100%).
WarningBits	AGA8Detail_Warning	Set of bits indicating warnings. Warnings don't prevent execution of function block.
SomeWarning	BOOL	Indicates that at least one warning bit is set in output parameter WarningBits. This may indicate some lack of precision in calculations.
ErrorBits	AGA8Detail_Error	Set of bits indicating errors. Errors prevent execution of function block.
SomeError	BOOL	Indicates that at least one error bit is set in output parameter ErrorBits. Therefore, the function block was not executed.

Table 3-2. Output Parameters

The following figure is a copy of figure 1 of AGA Report No. 8, and defines how the output parameter Uncertainty is calculated. Note that it depends on input parameters Temperature and Pressure. The values of Uncertainty are percentages (0.1%, 0.3%, 0.5% or 1%). The special value 100% is returned in case of error, that is, when output SomeError is returned activated.

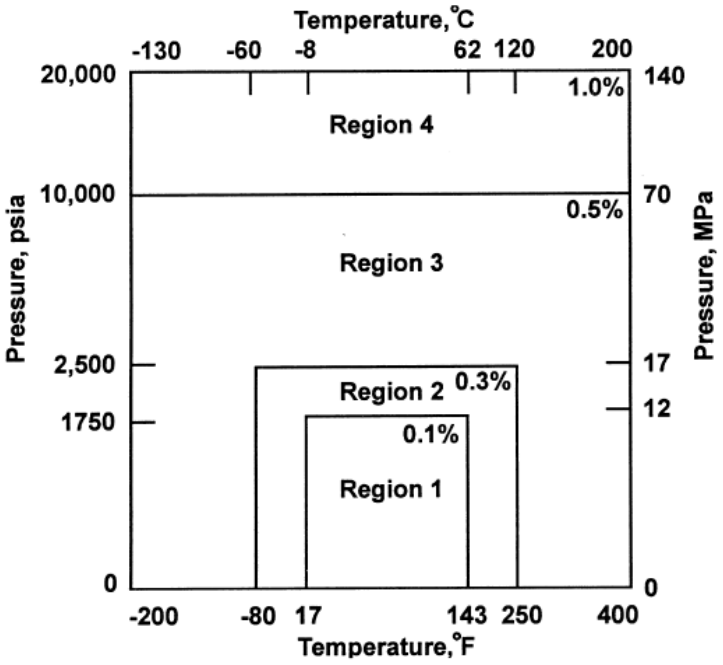

Figure 3-3. Calculation of output parameter Uncertainty

Data Structures Defined for AGA8Detail Function Block

Three data structures (customized types) are defined for usage in function block AGA8Detail.

AGA8Detail_GasComposition

This type is used for input parameter GasComposition. The data structure contains 21 percentages of gas components (each percentage has type LREAL). The following figure details the data structure.

STRUCT AGA8Detail_GasComposition

Name	Type	Comment
Methane	LREAL	% Mole of Methane (C1 - CH4)
Nitrogen	LREAL	% Mole of Nitrogen (N2 - N2)
CarbonDioxide	LREAL	% Mole of Carbon Dioxide (CO2 - CO2)
Ethane	LREAL	% Mole of Ethane (C2 - C2H6)
Propane	LREAL	% Mole of Propane (C3 - C3H8)
Water	LREAL	% Mole of Water (H20 - H20)
HydrogenSulphide	LREAL	% Mole of Hydrogen Sulphide (H2S - H2S)
Hydrogen	LREAL	% Mole of Hydrogen (H - H)
CarbonMonoxide	LREAL	% Mole of Carbon Monoxide (CO - CO)
Oxygen	LREAL	% Mole of Oxygen (O2 - O2)
isoButane	LREAL	% Mole of iso-Butane (iC4 - C4H10)
nButane	LREAL	% Mole of n-Butane (nC4 - C4H10)
isoPentane	LREAL	% Mole of iso-Pentane (iC5 - C5H12)
nPentane	LREAL	% Mole of n-Pentane (nC5 - C5H12)
nHexane	LREAL	% Mole of n-Hexane (nC6 - C6H14)
nHeptane	LREAL	% Mole of n-Heptane (nC7 - C7H16)
nOctane	LREAL	% Mole of n-Octane (nC8 - C8H18)
nNonane	LREAL	% Mole of n-Nonane (nC9 - C9H20)
nDecane	LREAL	% Mole of n-Decane (nC10 - C10H22)
Helium	LREAL	% Mole of Helium (He - He)
Argon	LREAL	% Mole of Argon (Ar - Ar)

Figure 3-4. Data Structure AGA8Detail_GasComposition

The sum of these 21 percentages can be checked in output parameter TotalPercentGas.

This sum should be 100%. However, the function block AGA8Detail tolerates a sum different from 100%. This situation could arise, for instance, when these percentages are read from gas chromatographs, or due to some arithmetic conversion imprecision.

When the percentage is different from 100%, the values are internally ponderated by function block AGA8Detail. For instance, consider a gas composition with:

- Methane = 90%
- Ethane = 2.5%
- Propane = 8%
- All other 18 components = 0%

In this case, the sum is 100.5%, and function block makes the following internal ponderation:

- Methane = 90 * (100 / 100.5) = 89,55%
- Ethane = 2.5 * (100 / 100.5) = 2,49%
- Propane = 8 * (100 / 100.5) = 7,96%

After the ponderation, the sum is 100%.

A warning bit (BadComposition) is set when the sum of percentages is out of the range 99.9% ... 100.1% (see type AGA8Detail_Warning).

AGA8Detail_Warning

This type is used for output parameter WarningBits. The data structure contains several warning bits (each warning bit has type BOOL).

Note that warning bits don't prevent the execution of function block. However, when some of them are set, this may indicate lack of precision in calculations. Ideally, all they should be cleared. If any warning bit is set in this data structure, the function block AGA8Detail will also activate the SomeWarning output.

The following figure details the data structure.

STRUCT AGA8Detail_Warning

Name	Type	Comment
Methane	BOOL	% Mole of Methane (C1 - CH4) out of normal range 45% ... 100%
Nitrogen	BOOL	% Mole of Nitrogen (N2 - N2) out of normal range 0% ... 50%
CarbonDioxide	BOOL	% Mole of Carbon Dioxide (CO2 - CO2) out of normal range 0% ... 30%
Ethane	BOOL	% Mole of Ethane (C2 - C2H6) out of normal range 0% ... 10%
Propane	BOOL	% Mole of Propane (C3 - C3H8) out of normal range 0% ... 4%
Water	BOOL	% Mole of Water (H20 - H20) out of normal range 0% ... 0.05%
HydrogenSulphide	BOOL	% Mole of Hydrogen Sulphide (H2S - H2S) out of normal range 0% ... 0.02%
Hydrogen	BOOL	% Mole of Hydrogen (H - H) out of normal range 0% ... 10%
CarbonMonoxide	BOOL	% Mole of Carbon Monoxide (CO - CO) out of normal range 0% ... 3%
Oxygen	BOOL	% Mole of Oxygen (O2 - O2) out of normal range 0% ... 0%
isoButane	BOOL	% Mole of iso-Butane (iC4 - C4H10) out of normal range 0% ... 1%
nButane	BOOL	% Mole of n-Butane (nC4 - C4H10) out of normal range 0% ... 1%
isoPentane	BOOL	% Mole of iso-Pentane (iC5 - C5H12) out of normal range 0% ... 0.3%
nPentane	BOOL	% Mole of n-Pentane (nC5 - C5H12) out of normal range 0% ... 0.3%
nHexane	BOOL	% Mole of n-Hexane (nC6 - C6H14) out of normal range 0% ... 0.2%
nHeptane	BOOL	% Mole of n-Heptane (nC7 - C7H16) out of normal range 0% ... 0.2%
nOctane	BOOL	% Mole of n-Octane (nC8 - C8H18) out of normal range 0% ... 0.2%
nNonane	BOOL	% Mole of n-Nonane (nC9 - C9H20) out of normal range 0% ... 0.2%
nDecane	BOOL	% Mole of n-Decane (nC10 - C10H22) out of normal range 0% ... 0.2%
Helium	BOOL	% Mole of Helium (He - He) out of normal range 0% ... 0.2%
Argon	BOOL	% Mole of Argon (Ar - Ar) out of normal range 0% ... 0%
BadComposition	BOOL	Sum of %Mole out of range 99.9% ... 100.1%
MaxIterBracket	BOOL	Maximum number of iterations exceeded in subroutine Bracket - default density used(CODE = 3)
ExcDensBracket	BOOL	Density exceeds maximum allowable value in subroutine Bracket - default procedure used (CODE = 2)
PressNegDensBracket	BOOL	Pressure has a negative density derivative in subroutine Bracket - system may contain liquid - default density used (CODE = 1)
MaxIterDDetail	BOOL	Maximum number of iterations exceeded in subroutine DDETAIL

Figure 3-5. Data Structure AGA8Detail_Warning

The first 21 warning bits indicate that the corresponding gas component has a percentage out of the normal range. The normal range is indicated in the comment column. If all these bits are cleared, this indicates that calculations have better precision.

BadComposition indicates that the sum of 21 percentages in input parameter GasComposition is out of range 99.9% ... 100.1%.

MaxIterBracket indicates that maximum number of iterations (200) was executed in subroutine BRAKET. This limit is defined in AGA Report No. 8 standard, in the detail method.

ExcDensBraket indicates that maximum allowable density was exceeded in subroutine BRAKET. This warning message is defined in AGA Report No. 8 standard, in the detail method.

PressNegDensBracket indicates that pressure has a negative density derivative in subroutine BRAKET. This warning message is defined in AGA Report No. 8 standard, in the detail method.

MaxIterDDetail indicates that maximum number of iterations (150) was executed in subroutine DDETAIL. This limit is defined in AGA Report No. 8 standard, in the detail method.

AGA8Detail_Error

This type is used for output parameter ErrorBits. The data structure contains several error bits (each error bit has type BOOL).

Note that error bits cancel the execution of function block. If any error bit is set in this data structure, the function block AGA8Detail will also activate the SomeError output.

The following figure details the data structure.

STRUCT AGA8Detail_Error

Name	Type	Comment
Temperature	BOOL	Temperature out of expanded range -130 ... 200 oC (degrees Celsius)
Pressure	BOOL	Pressure out of expanded range 0 ... 140 MPa
Methane	BOOL	% Mole of Methane (C1 - CH4) out of expanded range 0% ... 100%
Nitrogen	BOOL	% Mole of Nitrogen (N2 - N2) out of expanded range 0% ... 100%
CarbonDioxide	BOOL	% Mole of Carbon Dioxide (CO2 - CO2) out of expanded range 0% ... 100%
Ethane	BOOL	% Mole of Ethane (C2 - C2H6) out of expanded range 0% ... 100%
Propane	BOOL	% Mole of Propane (C3 - C3H8) out of expanded range 0% ... 12%
Water	BOOL	% Mole of Water (H20 - H20) out of expanded range 0% ... 100% (dew point)
HydrogenSulphide	BOOL	% Mole of Hydrogen Sulphide (H2S - H2S) out of expanded range 0% ... 100%
Hydrogen	BOOL	% Mole of Hydrogen (H - H) out of expanded range 0% ... 100%
CarbonMonoxide	BOOL	% Mole of Carbon Monoxide (CO - CO) out of expanded range 0% ... 3%
Oxygen	BOOL	% Mole of Oxygen (O2 - O2) out of expanded range 0% ... 21%
isoButane	BOOL	% Mole of iso-Butane (iC4 - C4H10) out of expanded range 0% ... 6%
nButane	BOOL	% Mole of n-Butane (nC4 - C4H10) out of expanded range 0% ... 6%
isoPentane	BOOL	% Mole of iso-Pentane (iC5 - C5H12) out of expanded range 0% ... 4%
nPentane	BOOL	% Mole of n-Pentane (nC5 - C5H12) out of expanded range 0% ... 4%
nHexane	BOOL	% Mole of n-Hexane (nC6 - C6H14) out of expanded range 0% ... 100% (dew point)
nHeptane	BOOL	% Mole of n-Heptane (nC7 - C7H16) out of expanded range 0% ... 100% (dew point)
nOctane	BOOL	% Mole of n-Octane (nC8 - C8H18) out of expanded range 0% ... 100% (dew point)
nNonane	BOOL	% Mole of n-Nonane (nC9 - C9H20) out of expanded range 0% ... 100% (dew point)
nDecane	BOOL	% Mole of n-Decane (nC10 - C10H22) out of expanded range 0% ... 100% (dew point)
Helium	BOOL	% Mole of Helium (He - He) out of expanded range 0% ... 3%
Argon	BOOL	% Mole of Argon (Ar - Ar) out of expanded range 0% ... 1%

Figure 3-6. Data Structure AGA8Detail_Error

Temperature indicates that input parameter Temperature is out of the allowed range, described in the comment column.

Pressure indicates that input parameter Pressure is out of the allowed range, described in the comment column.

The next 21 error bits indicate that the corresponding gas component has a percentage out of the expanded range. The expanded range is indicated in the comment column.

Converting Units of Temperature

The library contains a function to convert temperature (AGA8Detail_ConvertTemperature) and an enumeration that lists the supported units (AGA8Detail_UnitsTemperature).

The following figure shows enumeration AGA8Detail_UnitsTemperature.

ENUM AGA8Detail_UnitsTemperature

Name	Type	Inherited from	Address	Initial	Comment
AGA8Detail_TEMPERATURE_KELVIN	INT			0	Temperature in Kelvin (SI)
AGA8Detail_TEMPERATURE_CELSIUS	INT			1	Temperature in Celsius (metric)
AGA8Detail_TEMPERATURE_FARENHEIT	INT			2	

Figure 3-7. Enumeration AGA8Detail_UnitsTemperature

The following figure shows the graphic representation of function AGA8Detail_ConvertTemperature.

Figure 3-8. Graphical representation of function AGA8Detail_ConvertTemperature

The input parameter Temperature (type LREAL) contains the temperature to be converted.

The input parameter InputUnit (type AGA8Detail_UnitsTemperature) defines the unit of temperature to be converted.

The input parameter OutputUnit (type AGA8Detail_UnitsTemperature) defines the unit of converted temperature.

The output parameter AGA8Detail_ConvertTemperature (type LREAL) returns the converted temperature.

Converting Units of Pressure

The library contains a function to convert pressure (AGA8Detail_ConvertPressure) and an enumeration that lists the supported units (AGA8Detail_UnitsPressure).

The following figure shows enumeration AGA8Detail_UnitsPressure.

ENUM AGA8Detail_UnitsPressure

Name	Type	Inherited from	Address	Initial	Comment
AGA8Detail_PRESSURE_PA	INT			0	Pressure in Pascal (SI)
AGA8Detail_PRESSURE_PSIA	INT			1	Pressure in psia (US, IP)
AGA8Detail_PRESSURE_BAR	INT			2	

Figure 3-9. Enumeration AGA8Detail_UnitsPressure

The following figure shows the graphic representation of function AGA8Detail_ConvertPressure.

Figure 3-10. Graphical representation of function AGA8Detail_ConvertPressure

The input parameter Pressure (type LREAL) contains the pressure to be converted.

The input parameter InputUnit (type AGA8Detail_UnitsPressure) defines the unit of pressure to be converted.

The input parameter OutputUnit (type AGA8Detail_UnitsPressure) defines the unit of converted pressure.

The output parameter AGA8Detail_ConvertPressure (type LREAL) returns the converted pressure.

Converting Units of Density

The library contains a function to convert density (AGA8Detail_ConvertDensity) and an enumeration that lists the supported units (AGA8Detail_UnitsDensity).

The following figure shows enumeration AGA8Detail_UnitsDensity.

ENUM AGA8Detail_UnitsDensity

Name	Type	Inherited from	Address	Initial	Comment
AGA8Detail_DENSITY_MOL_DM3	INT			0	Density in mol/dm^3 (calculated by standards like AGA8)
AGA8Detail_DENSITY_KG_M3	INT			1	Density in kg/m^3 (metric, SI)
AGA8Detail_DENSITY_LBM_FT3	INT			2	

Figure 3-11. Enumeration AGA8Detail_UnitsDensity

The following figure shows the graphic representation of function AGA8Detail_ConvertDensity.

Figure 3-12. Graphical representation of function AGA8Detail_ConvertDensity

The input parameter Density (type LREAL) contains the density to be converted.

The input parameter MolWeight (type LREAL) contains the mol weight calculated by function block AGA8Detail. This parameter is only used if the input type or the output type is DENSITY_MOL_DM3.

The input parameter InputUnit (type AGA8Detail_UnitsDensity) defines the unit of density to be converted.

The input parameter OutputUnit (type AGA8Detail_UnitsDensity) defines the unit of converted density.

The output parameter AGA8Detail_ConvertDensity (type LREAL) returns the converted density.

Application Example

The following example, developed in ST language, contains a single instance of function block AGA8Detail. It also calls functions for converting units of temperature, pressure and density.

> NOTE:
> Several instances of function block AGA8Detail can exist in the same application. However, the user must consider the execution time and allocated memory (see sections **General Features** and **Performance**, in chapter **Technical Description**).

The next figure shows the variables declared in the application.

Configuration (Bus) / MainPrg

```
1  PROGRAM MainPrg
2  VAR
3      AGA8_Detail_Test : AGA8Detail;  // Instance of function block
4      FirstCycle : BOOL := TRUE;      // Flag for indicating the first cycle of application example
5
6      // Inputs in other units
7      Temp_F : LREAL;             // Temperature of actual condition in Farenheit
8      Press_psia : LREAL;         // Pressure of actual condition in psia
9      BaseTemp_F : LREAL;         // Temperature of base condition in Farenheit
10     BasePress_psia : LREAL;     // Pressure of base condition in psia
11
12     // Inputs for function block instance
13     Temperature_C : LREAL;                    // Temperature of actual condition in Celsius
14     Pressure_bar : LREAL;                     // Absolute pressure of actual condition in bar
15     BaseTemperature_C : LREAL;                // Temperature of base condition in Celsius
16     BasePressure_bar : LREAL;                 // Absolute pressure of base condition in bar
17     GasComposition : AGA8Detail_GasComposition; // Mole % of gas components
18
19     //Outputs for function block instance
20     MolWeight_kgmol : LREAL;            // Mol Weight (kg / mol)
21     Density_kgm3 : LREAL;               // Density at actual condition (kg / m3)
22     BaseDensity_kgm3 : LREAL;           // Density at base condition (kg / m3)
23     Compressibility : LREAL;            // Compressibility factor at actual condition (dimensionless)
24     BaseCompressibility : LREAL;        // Compressibility factor at base condition (dimensionless)
25     SuperCompressibility : LREAL;       // Supercompressibility factor (dimensionless)
26     Uncertainty : LREAL;                // Percentage of uncertainty according figure 1 of AGA Report No. 8
27     TotalPercentGas : LREAL;            // Total percentage of gas composition (should be 100%)
28     WarningBits : AGA8Detail_Warning;   // Input parameters out of normal ranges and other real time warnings
29     SomeWarning : BOOL;                 // At least one warning bit is set in structure WarningBits
30     ErrorBits : AGA8Detail_Error;       // Input parameters out of expanded ranges
31     SomeError : BOOL;                   // At least one error bit is set in structure ErrorBits, FB not being executed
32
33     // Outputs in other units
34     Dens_lbm_ft3 : LREAL;       // Density at actual condition in lbm/ft3
35     BaseDens_lbm_ft3 : LREAL;   // Density at base condition in lbm/ft3
36 END_VAR
```

Figure 3-13. Application Example - Variables

In line 3, an instance of AGA8Detail function block is declared.

In line 4, boolean flag FirstCycle is declared to control some initializations.

In line 7, the actual temperature in Farenheit (Temp_F) is declared.

In line 8, the actual pressure in psia (Press_psia) is declared.

In line 9, the base temperature in Farenheit (BaseTemp_F) is declared.

In line 10, the base pressure in psia (BasePress_psia) is declared.

In lines 13 to 16, actual temperature and absolute pressure, as well base temperature and absolute pressure, are declared with units suitable for the function block (°C for temperatures and bar for pressures).

In line 17, the GasComposition input is declared.

Between lines 20 and 31, the output variables of function block are declared.

In line 34, actual density in lbm/ft^3 (Dens_lbm_ft3) is declared.

In line 35, base density in lbm/ft^3 (BaseDens_lbm_ft3) is declared.

The next figure shows the code for this application.

```
1  // Initialize inputs in first cycle of application
2  IF FirstCycle THEN
3      FirstCycle := FALSE;
4      Temp_F := 65;
5      Press_psia := 750;
6      BaseTemp_F := 60;
7      BasePress_psia := 14.73;
8      GasComposition.Methane := 96.5222;
9      GasComposition.Nitrogen := 0.2595;
10     GasComposition.CarbonDioxide := 0.5956;
11     GasComposition.Ethane := 1.8186;
12     GasComposition.Propane := 0.4596;
13     GasComposition.Water := 0;
14     GasComposition.HydrogenSulphide := 0;
15     GasComposition.Hydrogen := 0;
16     GasComposition.CarbonMonoxide := 0;
17     GasComposition.Oxygen := 0;
18     GasComposition.isoButane := 0.0977;
19     GasComposition.nButane := 0.1007;
20     GasComposition.isoPentane := 0.0473;
21     GasComposition.nPentane := 0.0324;
22     GasComposition.nHexane := 0.0664;
23     GasComposition.nHeptane := 0;
24     GasComposition.nOctane := 0;
25     GasComposition.nNonane := 0;
26     GasComposition.nDecane := 0;
27     GasComposition.Helium := 0;
28     GasComposition.Argon := 0;
29 END_IF
30
31 // Convert units of inputs
32 Temperature_C := AGA8Detail_ConvertTemperature(Temp_F, AGA8Detail_TEMPERATURE_FARENHEIT, AGA8Detail_TEMPERATURE_CELSIUS);
33 Pressure_bar := AGA8Detail_ConvertPressure(Press_psia, AGA8Detail_PRESSURE_PSIA, AGA8Detail_PRESSURE_BAR);
34 BaseTemperature_C := AGA8Detail_ConvertTemperature(BaseTemp_F, AGA8Detail_TEMPERATURE_FARENHEIT, AGA8Detail_TEMPERATURE_CELSIUS);
35 BasePressure_bar := AGA8Detail_ConvertPressure(BasePress_psia, AGA8Detail_PRESSURE_PSIA, AGA8Detail_PRESSURE_BAR);
36

37 // Call instance of function block
38 AGA8_Detail_Test(
39     Temperature:= Temperature_C,
40     Pressure:= Pressure_bar,
41     BaseTemperature:= BaseTemperature_C,
42     BasePressure:= BasePressure_bar,
43     GasComposition:= GasComposition,
44     MolWeight=> MolWeight_kgmol,
45     Density=> Density_kgm3,
46     BaseDensity=> BaseDensity_kgm3,
47     Compressibility=> Compressibility,
48     BaseCompressibility=> BaseCompressibility,
49     SuperCompressibility=> SuperCompressibility,
50     Uncertainty=> Uncertainty,
51     TotalPercentGas=> TotalPercentGas,
52     WarningBits=> WarningBits,
53     SomeWarning=> SomeWarning,
54     ErrorBits=> ErrorBits,
55     SomeError=> SomeError
56 );
57
58 // Convert units of outputs
59 Dens_lbm_ft3 := AGA8Detail_ConvertDensity(Density_kgm3, MolWeight_kgmol, AGA8Detail_DENSITY_KG_M3, AGA8Detail_DENSITY_LBM_FT3);
60 BaseDens_lbm_ft3 := AGA8Detail_ConvertDensity(BaseDensity_kgm3, MolWeight_kgmol, AGA8Detail_DENSITY_KG_M3, AGA8Detail_DENSITY_LBM_FT3);
```

Figure 3-14. Application Example - Code

Between lines 1 and 29, in the first cycle of application, the input variables are initialized. In real applications, the input variables should be read from instruments (temperature transmitters, pressure transmitters and gas chromatographs).

In line 32, temperature in Farenheit (Temp_F) is converted to Celsius (Temperature_C).

In line 33, pressure in psia (Press_psia) is converted to bar (Pressure_bar).

In line 34, base temperature in Farenheit (BaseTemp_F) is converted to Celsius (BaseTemperature_C).

In line 35, base pressure in psia (BasePress_psia) is converted to bar (BasePressure_bar).

Between lines 37 and 56, the instance of function block AGA8Detail is called.

In line 59, actual density in kg/m^3 (Density_kgm3) is converted to lbm/ft^3 (Dens_lbm_ft3).

In line 60, base density in kg/m^3 (BaseDensity_kgm3) is converted to lbm/ft^3 (BaseDens_lbm_ft3).

4. Glossary

General Glossary

Algorithm	Finite sequence of well defined instructions, for problem solution.
Bit	Basic information unit which can assume state 0 or 1.
Byte	Information unit composed by 8 bits.
Programmable controller	Also called PLC. Equipment which executes a control under the applicative program command. It's composed by a CPU, a power supply and a I/O structure.
CP	See Programmable controller.
Database	Data base.
Default	Pre defined value for a variable, used in case there's no definition.
Diagnostic	Procedure used to detect and isolate failures. It's also the data group used for such determination, which serves for problem analysis and correction.
Download	Program or configuration load in the PLC.
I/O	See Input/output
Input/output	Also called I/O. Data I/O devices of a system. In case of PLCs, typically correspond to digital or analog inputs or outputs modules which monitor or activate the controlled device.
Hardkey	Connector normally connected to the parallel interface of a PC in order to avoid the execution of software illegal copies.
Hardware	Physical equipments used in data processing where the programs (software) are executed.
IEC 61131	Generic standard for operation and utilization of PLCs. Old IEC 1131.
Interface	Device which adapts electrically and/or logically the signal transference between two pieces of equipment.
Interruption	High priority attending event which temporarily stops the program execution and detour for a specific attending routine.
kbytes	Memory quantity unit. Means 1024 bytes (if 1kbyte).
Programming language	A group of rules and conventions used for a program creation.
Logic	Graphic matrix where are inserted the language instructions of a relay diagram which compose a applicative program. A group of logics organized in sequence form a program module.
MasterTool	Identifies the Altus software for PC, executable only in Windows®, which allows the development of applicative for the Ponto Series CPUs, AL-2000, AL-3000 e Quark. Throughout this manual, this software is referenced by its acronym or as MasterTool programming.
Menu	Set of options available and displayed by a program on video and that can be selected by the user to activate or perform a certain task.
Module (referencing hardware)	Basic element of a complete system that has well defined functions. Normally the system is connected by connectors and can be easily replaced.
Module (referencing software)	Part of an application program capable of performing a specific function. It can be run independently or in conjunction with other modules, exchanging information via parameter passing.
I/O Modules	Module belonging to the inputs and outputs subsystem.
PLC	Acronym for programmable logic controller.
Start up	Procedure for final clearance of the control system when the programs of all stations and remote CPUs are run together, having been developed and verified individually.
Applicative Program	It's the program loaded into a PLC, which determines the operation of a machine or process.
Executive Program	Operating system from a programmable controller. Controls the basic functions of the controller and the execution of applicative programs.
RAM	Acronym for random access memory. It's where all the memory addresses can be accessed directly at random and at the same speed. It is volatile, thus, its contents are lost when the device is powered down, unless you have a battery for retaining values.
Software	Computer programs, procedures and rules related to the operation of a data processing system.
I/O Subsystem	Set of analog or digital I/O modules and interfaces of a programmable controller.
Tag	Name associated with a variable or a logic that allows a brief identification of its contents.
CPU	Abbreviation for central processing unit. Controls the information flow, interprets and executes program instructions and monitors the devices in the system.
Upload	PLC configuration or program reading.

Revisões deste Manual

Esta página não fará parte da versão enviada ao usuário (arquivo .PDF). Ela serve somente para o uso da Altus. Preencha o formulário a seguir para manter o histórico das alterações correspondentes a cada revisão do manual.

Revisão: A	Data: 16/12/2013
Aprovação: Fernando Trein	
Autor: Osmar Brune	

Observações:

- *Versão Inicial*
- *Revisor Gerencial Sr.Fernando Trein*
- *Revisor Técnico Sr. Daniel Salazar/ Matheus Webler*