HardFlex – 24 Bit Counter and High Speed Outputs GR900

Product Description

The HardFlex GR900 function is compatible to Grano Series microcontrollers which supports hardware configuration by software application. GR900 function contains one 24 bit high speed counter and two VFO (Variable Frequency Output) outputs, both working up to 20 kHz.

GR350, GR351, GR370 and GR371 microcontrollers contain GR900 function in your standard configuration.

Ordering Information

Packing List

The product packing contains the following parts:

- C-GR900.003 and C-GR900.004 modules
- F-CONTR.004 function module for high speed counter
- F-SAIDR.009 function module for high speed outputs
- I/O configuration file for MasterTool programming software (GR900.skn)
- HardFlex GR900 Technical Specifications
- License agreement

Part Number

The following code must be used when ordering the product:

Part Number	Description
GR900	HardFlex - Contador 24 bits e Saídas Rápidas

Related Products

Part Number	Description
GR350	Microcontrol 14ED 12SD Contador
GR351	Microcontrol 14ED 12SD Contador c/ Expansão
GR370	Microcontrol 14ED 12SD 4EA 2SA Termopar Contador
GR371	Microcontrol 14ED 12SD 4EA 2SA Termopar Contador c/ Expansão

Counter Characteristics

The 24 bit high speed counter can count input pulses up to 20 kHz. Thus, the counter can read linear or rotative encoders signals executing high precision positioning tasks.

Counter main characteristics:

- Programmable "Up/Down" 24 bit counter;
- Reset input;
- Hold input;
- Two configurable comparison outputs and one zero output;
- Diagnosis, operands read and write via F-CONTR.004 module.

Typical applications :

- Positioning control;
- Machine synchronization by using pulse sensors;
- High speed event counting.

	24 bit High Speed Counter
Function type	24 Bit High Speed Counter
Maximum operation frequency	20 kHz
Maximum allocated inputs	4
Maximum allocated outputs	3
Input Type	Sink
Input functions (the code shows the terminal which signal is connected to)	I1- Count A I2- Count B I3- Reset I4- Hold
Output functions (the code shows the terminal which signal is connected to)	T0- Comparator 1 T1- Comparator 2 T2- Zero
Input operation modes	0 – Pulses applied on Count A input-> UP counting; Pulses applied on Count B input-> DOWN counting. 1 – Signal level applied on Count A input gives the counting direction and pulses applied on Count B input counts UP or DOWN 2 – Positioning encoder mode. Quadrature pulses from positioning encoders applied on Count A and Count B inputs. Quadrature decoding generates 4 counts per pulse period 3 – Same as mode 2, but it generates 2 counts per pulse period
Input signal level	24 Vdc
Functions executed by software	Counter value real time reading Counter value writing Comparators writing Reset and Hold the counter value Counter parameterization Real time counter status reading
Function access	Via F-CONTR.004 module, by time interrupt (E018) or by external interrupt (E020)
Diagnosis	Diagnostic bytes can be read via MasterTool software.
Configurable parameters	Count mode Comparison outputs and zero output Inputs and outputs used by the counter

Table notes:

1 – Inputs and outputs used by the counter are allocated from digital input and outputs terminals of the microcontroller. Inputs used by the counter can also be read as normal digital inputs. Outputs used by the counter cannot be used as normal digital outputs.

Counter Installation

Connection of inputs and outputs used by the counter to the Grano microcontroller terminals must be made according to the following diagram.

Diagram shows a connection between the counter and a linear optical position encoder, but many types of encoders can be used. Input signals must be 24 Vdc level.

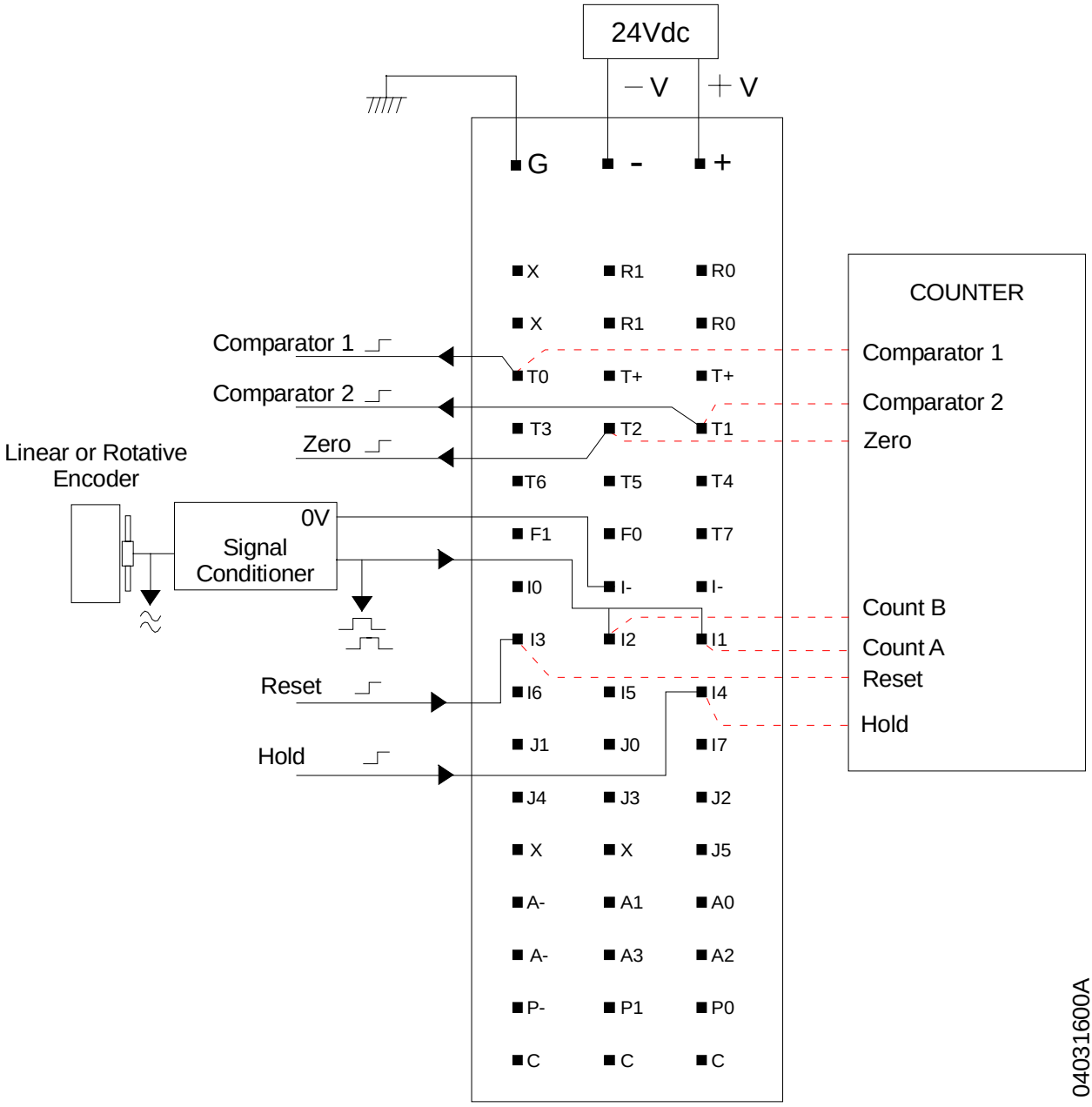


Diagram notes:

1 – Only I1, I2, I3 and I4 inputs can be used as counter inputs;

2 – Inputs (Reset and Hold) not used by the counter can be configured as normal digital inputs;

3 – Only T0, T1 and T2 transistor outputs can be used as counter outputs;

4 – Outputs (T0 - Comparator 1, T1 - Comparator 2 or T2 - Zero) not used by the counter are used as normal transistor outputs;

5 – GR350, GR351, GR370 e GR371 digital inputs are 24 Vdc sink. Encoders and sensor must be compatible to this level, otherwise level adapters need to be used.

Connection Terminals

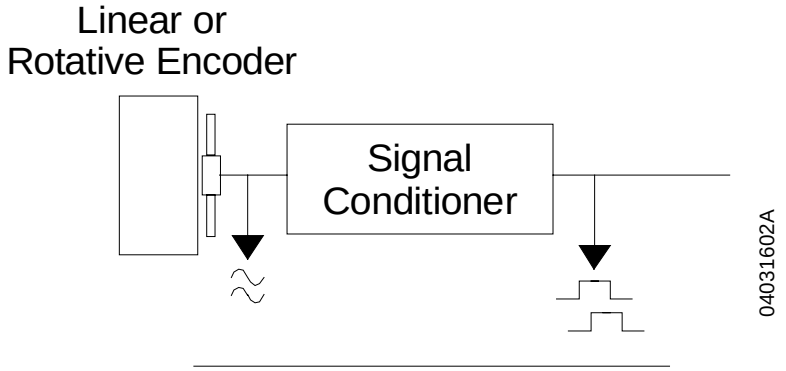
The connection terminals are described for GR371 Grano microcontroller.

+	R0	R0	T+	T1	T4	T7	I-	I1	I4	I7	J2	J5	A0	A2	P0	C
-	R1	R1	T+	T2	T5	F0	I-	I2	I5	J0	J3	X	A1	A3	P1	C
G	X	X	T0	T3	T6	F1	I0	I3	I6	J1	J4	X	A-	A-	P-	C

- Relay output: 2 relay outputs: R0-R0 e R1-R1
- Transistor output: 8 outputs: T0, T1, T2, T3, T4, T5, T6, T7
  Supply: T+, T+
- High speed outputs: 2 outputs: F0, F1
- Digital inputs: 14 inputs: I0, I1, I2, I3, I4, I5, I6, I7, J0, J1, J2, J3, J4, J5
  Common: I-, I-
- Analogic inputs: 4 inputs 0 - 10 Vdc: A0, A1, A2, A3
- 2 thermocoupler inputs: A0, A1
- Common: A-, A-
- Analogic outputs: 2 outputs 0 - 10 Vdc: P0, P1
  Common: P-
- Not used terminals: X
- Common terminals: C
- Power supply: 24 Vdc: + , -
- Ground: G

Position Encoder Connection

The module can interface to optical encoders like the following diagram:



The optical encoder (linear or rotary) generates senoidal signals with difference of 90°. These signals have low current capacity.
The signal conditioner receives these signals, amplifies them and changes them into rectangular signals. These rectangular signals are sent to the counter module.

The following signals from the signal conditioner must be connected to the high-speed counter module:

- The two output channels must be connected to Counting A and Counting B inputs;
- The ground signal (GND) to the GND input;
- Optionaly the reference signal or zero mark can be connected to the reset input. Changing the connections between A and B the counting direction is inverted.

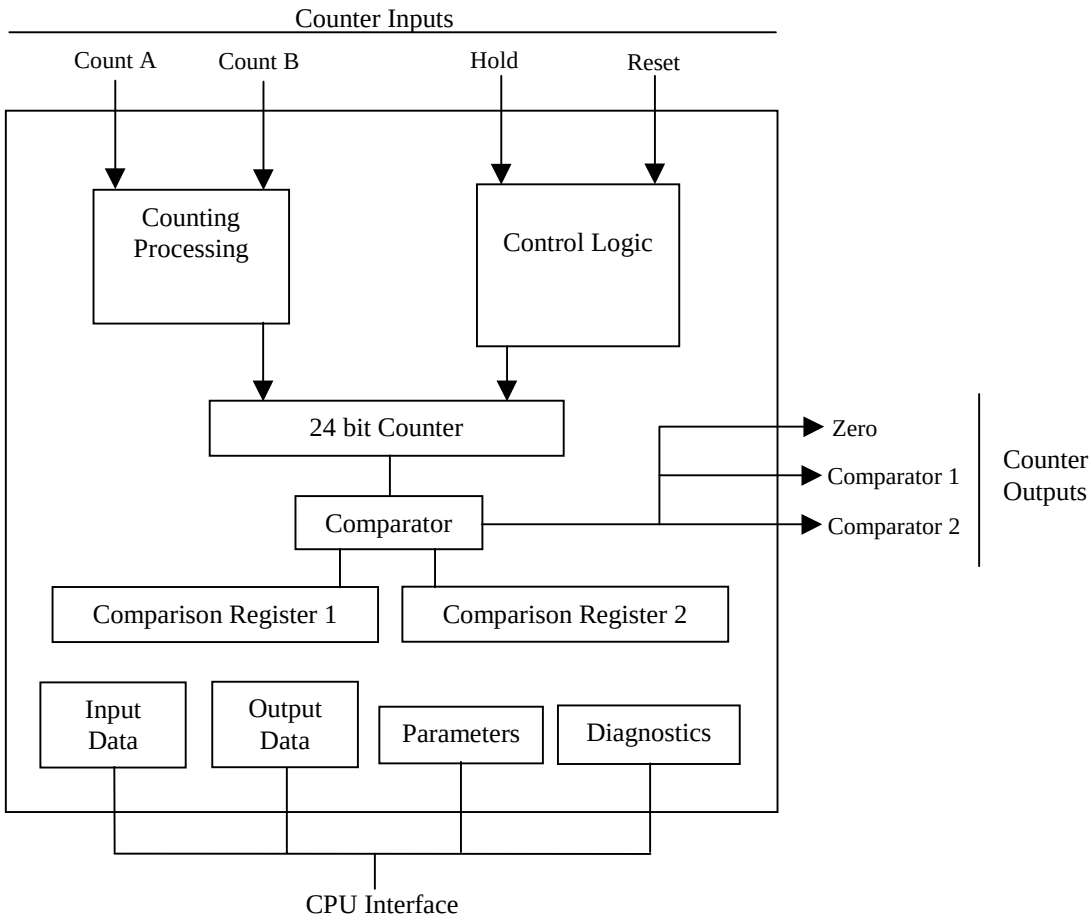
Counter Utilisation

Functional Description

The counter has inputs, outputs, internal registers and control logic according to the diagram below.

Counter value and diagnostics can be found in operands defined when the application software is configured in MasterTool software. Thus, the application software can control the entire counter behaviour.

The application software configures the HardFlex counter using F-CONTR.004 function module. Values read or written to the counter are on %F (float) operands. Commands and status are read and written via %A (auxiliary) operands or %M (memory) operands.



Counter Components

- Counter

  The function has a 24 bit binary counter, covering the integer range between –8.388.608 e +8.388.607.

  When the counter overflows or underflows the counting is reseted and the counter restarts counting in the same direction it was counting before.

- Counting Inputs

  The counting occurs when electrical signals are applied to Count A and Count B inputs. These signals are processed by the control logic, which determines the pulse quantity and the direction of counting.

- Reset Input

  The counter value also can be reset externally by applying high level on the reset input. The activation of this input depends on the counter parameterization.

- Hold Input

  The counting procces remains stopped while high level is applied on the hold input. The activation of this input also depends on the counter parameterization.

- Comparison Registers

  The counter has two 24 bit comparison registers whose values are written by application software. The comparison outputs are activated when the counter reaches the comparison values.

- Outputs

  The counter can be configurated and generates up to three output signals:

  - Comparator 1: activated when the counter reaches the value of comparison register 1;
  - Comparator 2: activated when the counter reaches the value of comparison register 2;
  - Zero: activated when the counter reaches the value zero.

  Obs.: These outputs generate rectangular pulses with minimum duration of 50 ms.

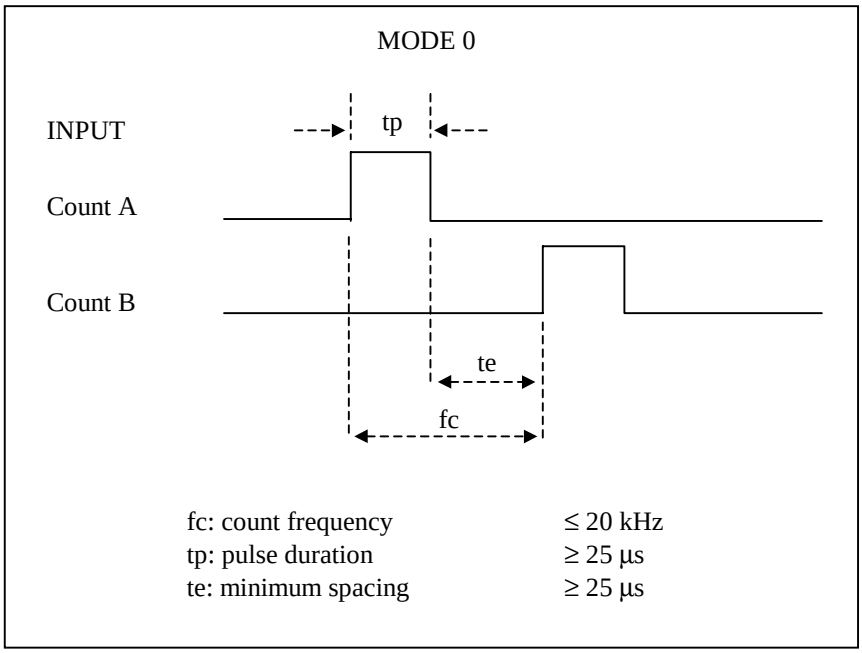
Counter Modes

The Counting Process Unit can operate in four different modes. The configuration is made by parameterization via MasterTool Programming Software.

- Mode 0

  In this mode a pulse applied on channel A counts UP and a pulse applied on channel B counts DOWN.

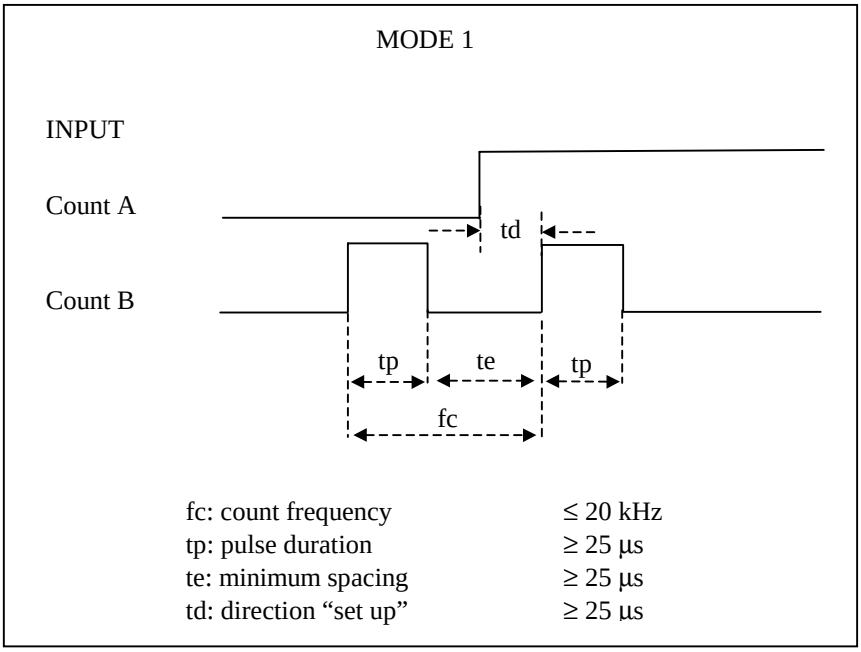
  The signals applied on the count inputs must be within the following limits:



- Mode 1

  In mode 1 the level applied on channel A gives the counting direction and pulses applied on channel B count. High level on channel A indicates UP counting and low level indicates DOWN counting.

  The signals applied on the inputs must be within the following limits:

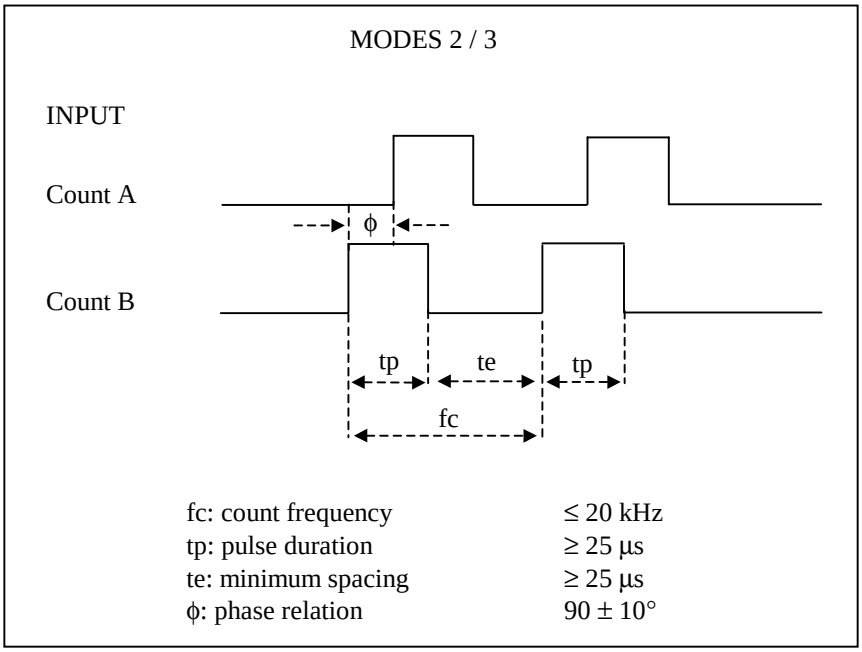


- Modes 2 and 3

  In this mode the counting processing unit decodes the input quadrature signals to give teh counting direction and counting pulses. If signal on channel A is in advance the couting direction is UP, otherwise the direction is DOWN.

  Mode 2 generates 4 counting pulses per period (4x) and mode 3 generates 2 counting pulses per period (2x).

The signals applied on the inputs must be within the following limits:

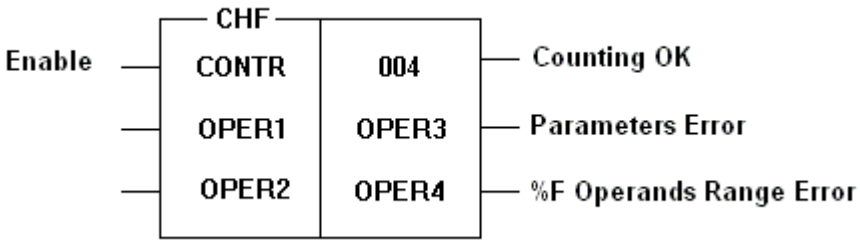


The basic application of these two modes is interfacing to optical position encoders.

Programming

Programming – F-CONTR.004

The F-CONTR.004 function module links the application software and the 24 bit high speed counter in the Grano Series microcontrollers.



Parameterization

The counter is parameterized by one byte using the following table:

Parameterization byte								Description
7	6	5	4	3	2	1	0	
						0	**0**	Mode 0 – A: UP and B: DOWN
						0	**1**	Mode 1 – A: direction and B counts
						1	**0**	Mode 2 – Quadrature, 4 counts per period
						1	**1**	Mode 3 – Quadrature, 2 counts per period
					0			Disable comparator 1 output (output T0)
					1			Enable comparator 1 output (output T0)
				0				Disable comparator 2 output (output T1)
				1				Enable comparator 2 output (output T1)
			0					Disable zero comparator output (output T2)
			1					Enable zero comparator output (output T2)
		0						Disable reset input (input I3)
		1						Enable reset input (input I3)
	0							Disable hold input (input I4)
	1							Enable hold input (input I4)
0								Reset counter after overflow or underflow
1								Reset counter when it reaches comparison register 2 value

Counting Mode

Operands

The instructions cells used in the function call are programmed as follows:

- **OPER1** – Specifies the number of parameters, which are sent to the function in OPER3. This operand must be a memory constant with value 6 (%KM+00006).

- **OPER2** – Must be a memory constant with value 0 (%KM+00000). Determines the number of parameters which can be programmed in the edition window of OPER4.

- **OPER3** – Contains the parameters which are sent to the function. The number of editable parameters is specified in OPER1, constant 5 for this module:

%KMXXXX – Module position in Grano bus. For internal counters this operand is constant %KM0000.

%KMXXXX – HardFlex model.

%KM0001 – GR900
%KM0002 – GR901
%KM0003 – GR902
%KM0004 – GR903

%KMXXXX – Number of the counter which is being accessed. GR900 function has only one counter and this operand is constant %KM0001.

%FXXXX ou %TFXXXX – First operand for reading and writing to the counter. There are four operands in the following sequence:

Value read from the counter.

Value to be written to the counter.

Value to be written to Comparator 1.

Value to be written to Comparator 2.

%AXXXX ou %MXXXX – Status operand of the counter.

Status byte (%A ou %M)								Descrição
7	6	5	4	3	2	1	0	
							0	Normal counting
							1	Overflow
						0		Normal counting
						1		Underflow
					0			Counting direction DOWN
					1			Counting direction UP
				0				Counter different from comparator 1
				1				Counter equal to comparator 1
			0					Counter different from comparator 2
			1					Counter equal to comparator 2
		0						Counter different from zero
		1						Counter equal to zero
0	**0**							Not used

%AXXXX ou %MXXXX – Command which contains two bytes.

Command byte 1 (%A or %M)								Description
7	6	5	4	3	2	1	0	
							0	Normal counting
							1	Write to the counter
						0		Normal counting
						1		Write to comparator 1
					0			Normal counting
					1			Write to comparator 2
0	**0**	**0**	**0**	**0**				Not used

Command byte 2 (%A ou %M)								Description
7	6	5	4	3	2	1	0	
							0	Normal counting
							1	Hold counter value
						0		Normal counting
						1		Reset counter value
					0			Normal counting
					1			Reset overflow/underflow status bit
0	**0**	**0**	**0**	**0**				Not used

Inputs and Outputs

Inputs description:

- Enable – the function is called when this input is ON. If the parameters are wrong the error output is turned ON. If they are right the commands are executed.

Outputs description:

- Counting ok – is turned ON when the desired operation succeeds. If this output is OFF then some error occurred in the process.
- Parameters Error – is turned ON when the parameters are wrong.
- %F Operands Range Error – is turned ON when some %F (float) operand is out of the allowed range (between +8.388.607 and –8.388.608).
- All outputs OFF – indicates error in the communication with selected module.

High Speed Outputs Characteristics

GR900 HardFlex Function also has two independent high speed VFO (Variable Frequency Output) outputs. These outputs can generate frequencies up to 20 kHz.

High speed outputs main characteristics:

- Programmable frequency up to 20 kHz (1 Hz step);
- Programmable Duty Cycle for each output from 0 to 100% (1% step);
- Two special outputs allocated specially for this purpose (VFO generation);
- Operand writing via F-SAIDR.009 function module.

High speed outputs are used mainly for frequency to voltage conversion. Thus, the microcontroller can implement two aditional analog outputs.

	High speed VFO outputs
Function type	High speed VFO outputs
Maximum frequency generated	20 kHz
Maximum allocated outputs	2 high speed outputs (terminals F0 and F1)
Output functions **(the code shows the terminal which signal is connected to)**	F0- VFO output 0 (frequency output) F1- VFO output 1 (frequency output)
Functions executed by software	Frequency writing in Hz (0 - 20000) Duty Cycle writing in % (0 - 100) Operation start/stop
Function access	Via F-SAIDR.009 module, by time interrupt (E018) or by external interrupt (E020)

High Speed Outputs Installation

Connection of signals used by the high speed outputs to the Grano microcontroller terminals must be made according to the following diagram.

Diagram shows a connection between a high speed output and a frequency to voltage converter.

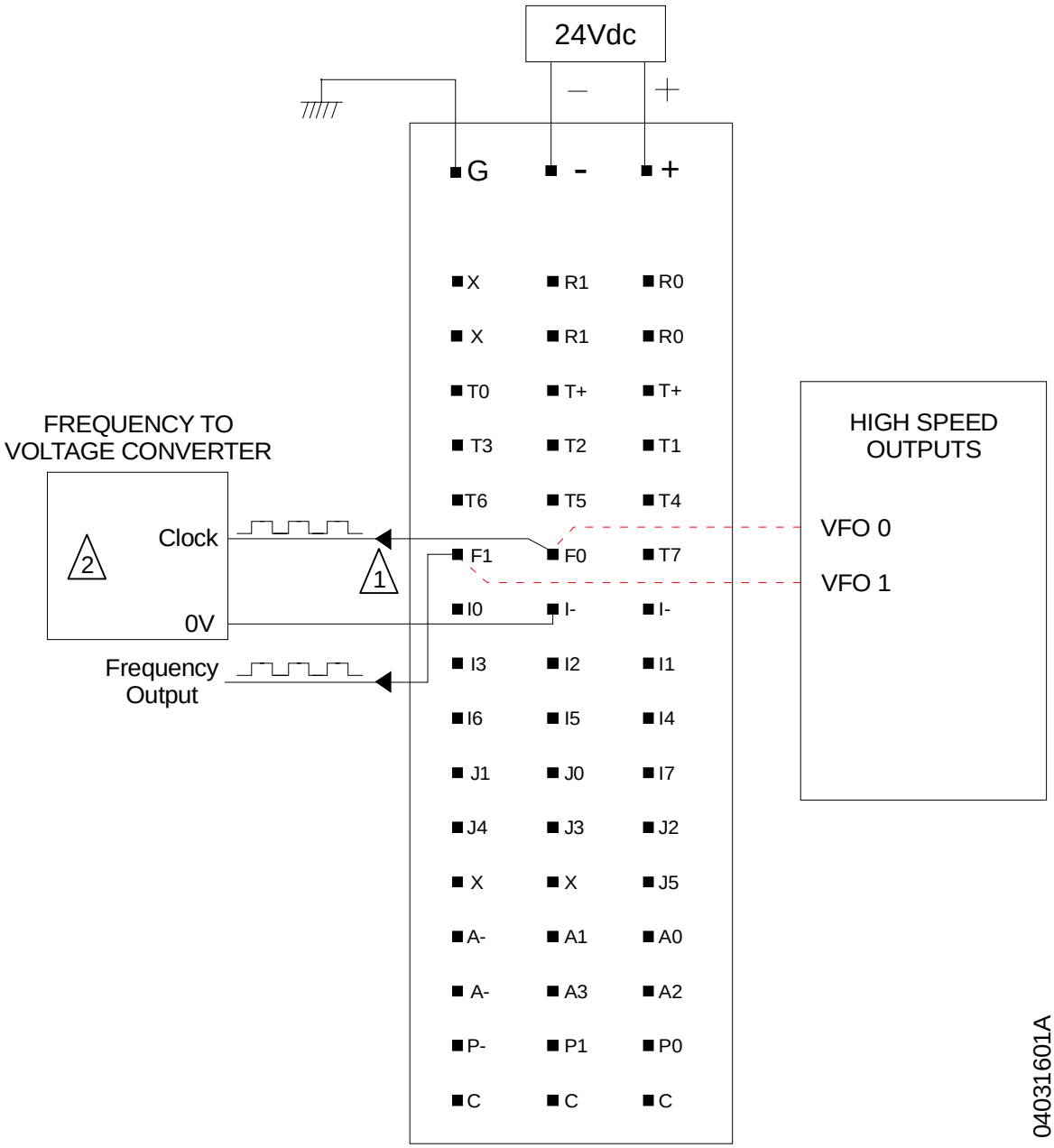


Diagram notes:

1 – Only outputs F0 and F1 can be configured as HardFlex high speed outputs. F0 for VFO 0 output and F1 for VFO 1 output;

2 – Altus recommends Conexel DK6 family converters for frequency to voltage conversion. (for more information, visit Conexel web page at www.conexel.com.br).

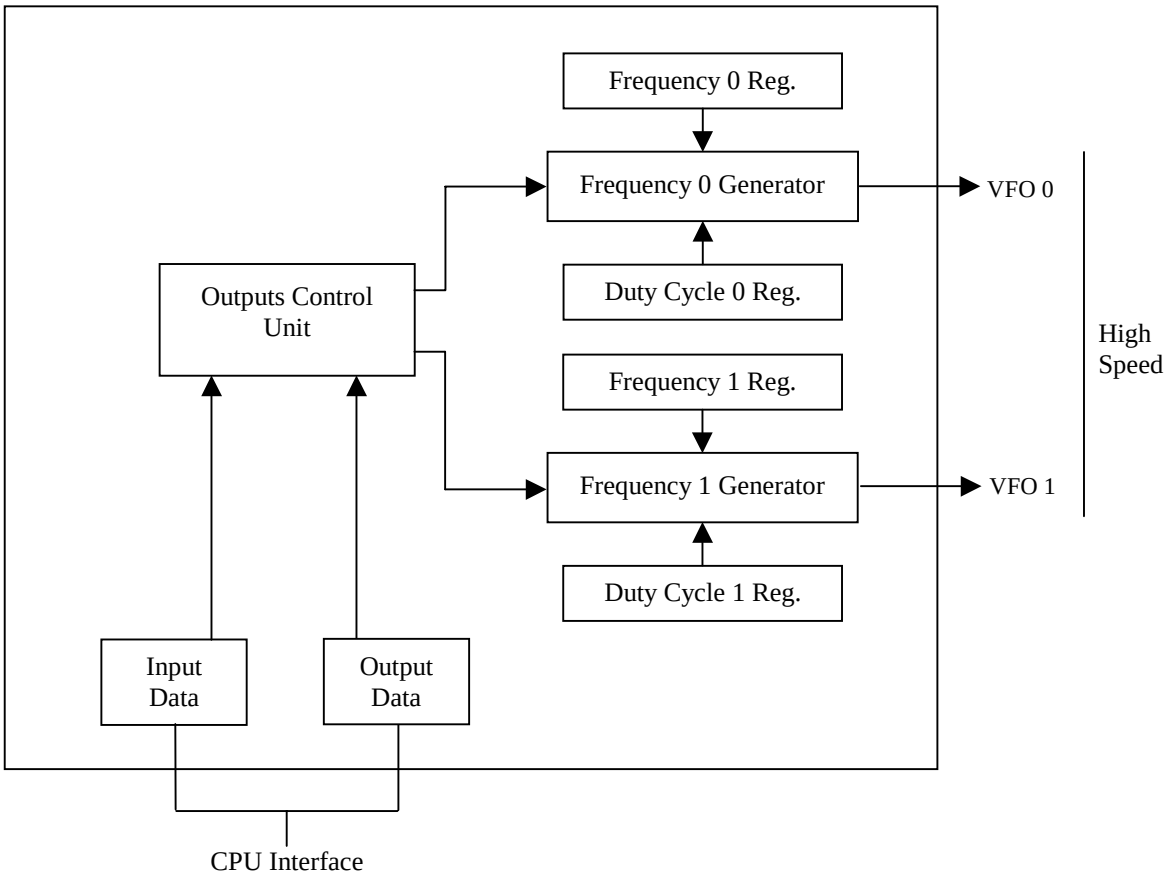
High Speed Outputs Utilisation

Functional Description

The HardFlex high speed outputs have control logic, internal registers and outputs according to the diagram below.

Commands can be written in operands defined when the application software is configured in MasterTool software. Thus, the application software can control the entire high speed outputs behaviour.

The application software configures the HardFlex high speed outputs using F-SAIDR.009 function module. Frequency and Duty Cycle Values are accessible via %M (memory) or %TM (memory table) operands. Commands are written via %A (auxiliary) operands.



High Speed Outputs Components

- Frequency Generators

  The frequency generators can output clock signals with frequency and duty cycle read from frequency adn duty cycle registers.

- Frequency Registers

  Each high speed output has one frequency register whose value is written by application software. This value determines the frequency to be generated and must be between 0 and 20000 (0 to 20 kHz).

- Duty Cycle Registers

  Each output also has one Duty Cycle register whose value is written by application software. This value determines the duty cycle of the clock to be generated. It is written in % and must be between 0 and 100 (0 to 100%).

- Outputs Control Unit
  The control unit analises the data from application software to determine mode of operation, enable and disable of the outputs.

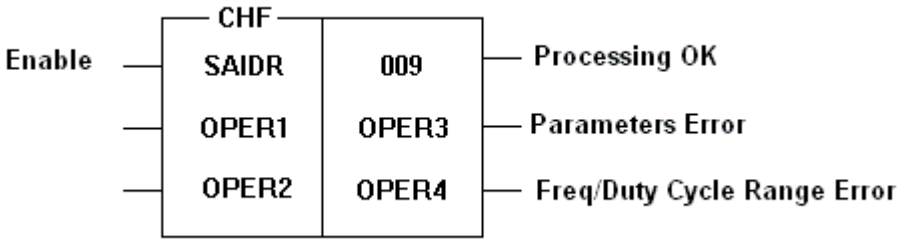
- Outputs
  - VFO 0 output: first frequency high speed output, connected to F0 terminal.
  - VFO 1 output: second frequency high speed output, connected to F1 terminal.

Programming

Programming – F-SAIDR.009

The F-SAIDR.009 function module links the application software and the high speed outputs in the Grano Series microcontrollers.

VFO Outputs



Operands

The instructions cells used in the function call are programmed as follows:

- **OPER1** - Specifies the number of parameters, which are sent to the function in OPER3. This operand must be a memory constant with value 5 (%KM+00005).

- **OPER2** - Must be a memory constant with value 0 (%KM+00000). Determines the number of parameters which can be programmed in the edition window of OPER4.

- **OPER3** - Contains the parameters which are sent to the function. The number of editable parameters is specified in OPER1, constant 5 for this module:

%KMXXXX – Module position in Grano bus. For internal high speed outputs block this operand is constant %KM0000.

%KMXXXX – HardFlex model.

%KM0001 – GR900
%KM0002 – GR901
%KM0003 – GR902
%KM0004 – GR903

%KMXXXX – Number of the high speed outputs block which is being accessed. GR900 function has only one block and this operand is constant %KM0001.

%MXXXX ou %TMXXXX – First operand written to the block. There are four operands in the following sequence:
VFO 0 frequency.
VFO 0 Duty Cycle.
VFO 1 frequency.
VFO 1 Duty Cycle.

%AXXXX ou %MXXXX – Command which contains two bytes.

Command Byte 1(%A or %M)								Description
7	6	5	4	3	2	1	0	
							0	Normal operation
							1	Write VFO 0 frequency and duty cycle
						0		Normal operation
						1		Write VFO 1 frequency and duty cycle
0	**0**	**0**	**0**	**0**	**0**			Not used

Command Byte 2(%A or %M)								Description
7	6	5	4	3	2	1	0	
							0	Disable VFO 0 output (output stopped)
							1	Enable VFO 0 output (output running)
						0		Disable VFO 1 output (output stopped)
						1		Enable VFO 1 output (output running)
0	**0**	**0**	**0**	**0**	**0**			Sempre zeros

Inputs and Outputs

Inputs Description:

- Enable - the function is called when this input is ON. If the parameters are wrong the error output is turned ON. If they are right the commands are executed.

Outputs Description:

- Processing ok – is turned ON when the desired operation succeeds. If this output is OFF then some error occurred in the process.
- Parameters Error - is turned ON when the parameters are wrong.
- Freq/Duty Cycle Range Error - is turned ON when frequency or duty cycle is out of the allowed range (1-20 kHz for frequency and 0-100% for duty cycle).
- All outputs OFF - indicates error in the communication with selected module.

Manuals

For more detailed informations, configuration, installation and programming of HardFlex functions and Grano Series microcontrollers see the following documentation:

Document Code	Description
CT109130	Características Técnicas da Série GRANO
MU210000	Manual de Utilização da Série GRANO
MU203600	Manual de Utilização MasterTool