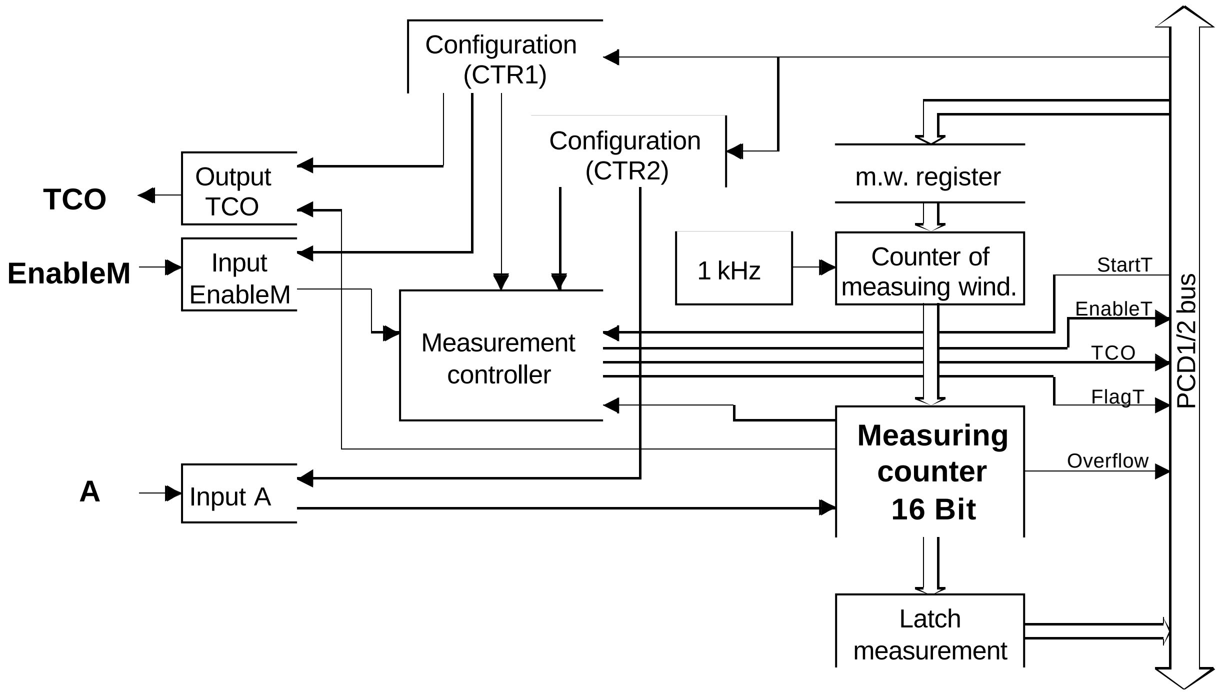
4 PCD2.H110 and measurement

The measurement side of the module H110 can work simultaneously as the counter side of the module. The measurement side cans be use in 3 different modes, which are:

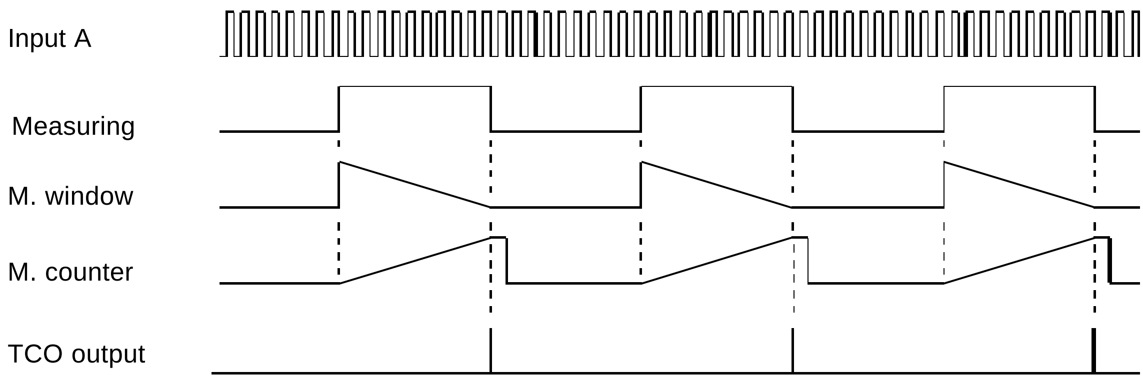
1) Measurement of the frequency on the input “A”
2) Measurement of the period length of signal on the input “A”
3) Measurement of pulse length on the input “A”

I the following chapters it will be explain how to configure and use those 3 measurement modes.

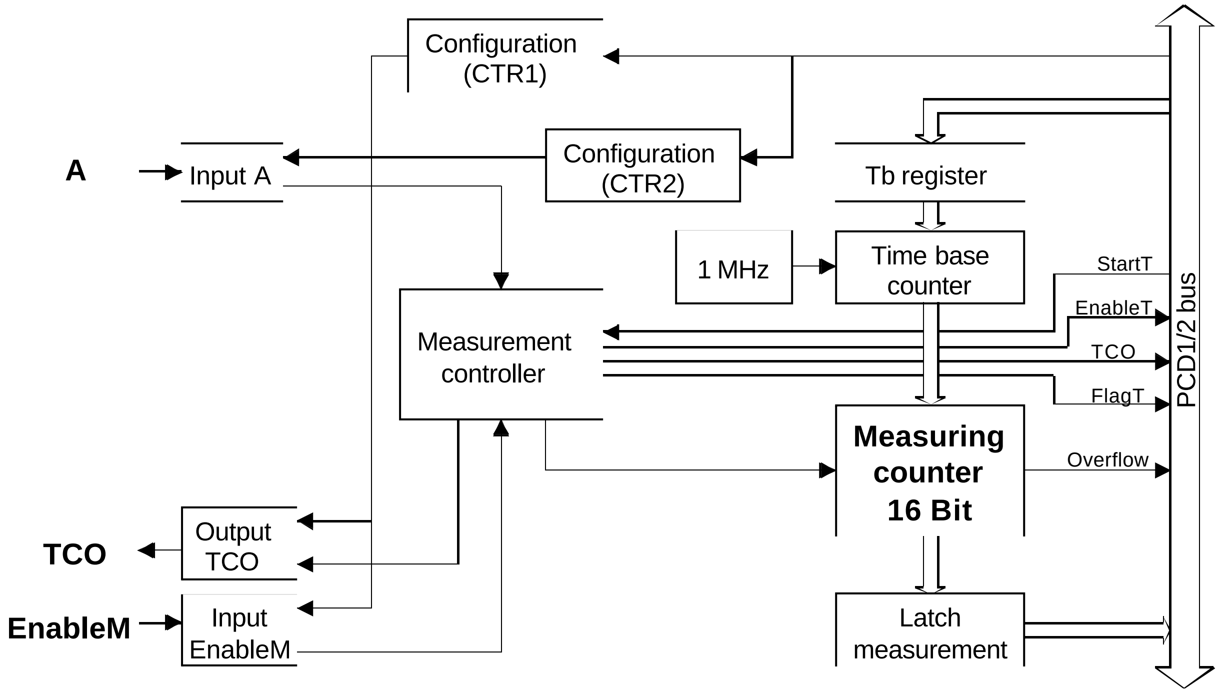
4.1 Block diagram and description for frequency measurement mode



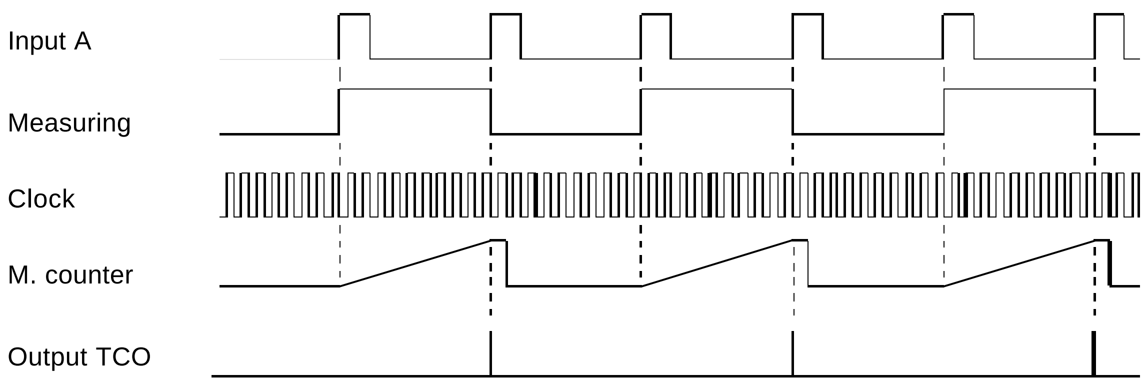
The frequency measurement range is from 500 Hz to 100 kHz. Frequency measurement can be done in parallel with counting. It uses 2 counters of 16 bits each. One counter from this pair, the counter of measuring window, has a fixed clock of 1 kHz. This provides the time base in 1 ms steps for the programmable measuring window. The other counter, the measuring counter, counts the signals arriving at input "A" during the time when the measuring window is open. If the measuring window has been defined as 1s (1000 ms) the result appears in the measuring counter directly in Hz or pulses per second. Frequency measurement runs automatically, i.e. the time defined for the time window is measured, then there is a pause of the same duration for resetting and evaluation, after which the next measurement is done, etc.



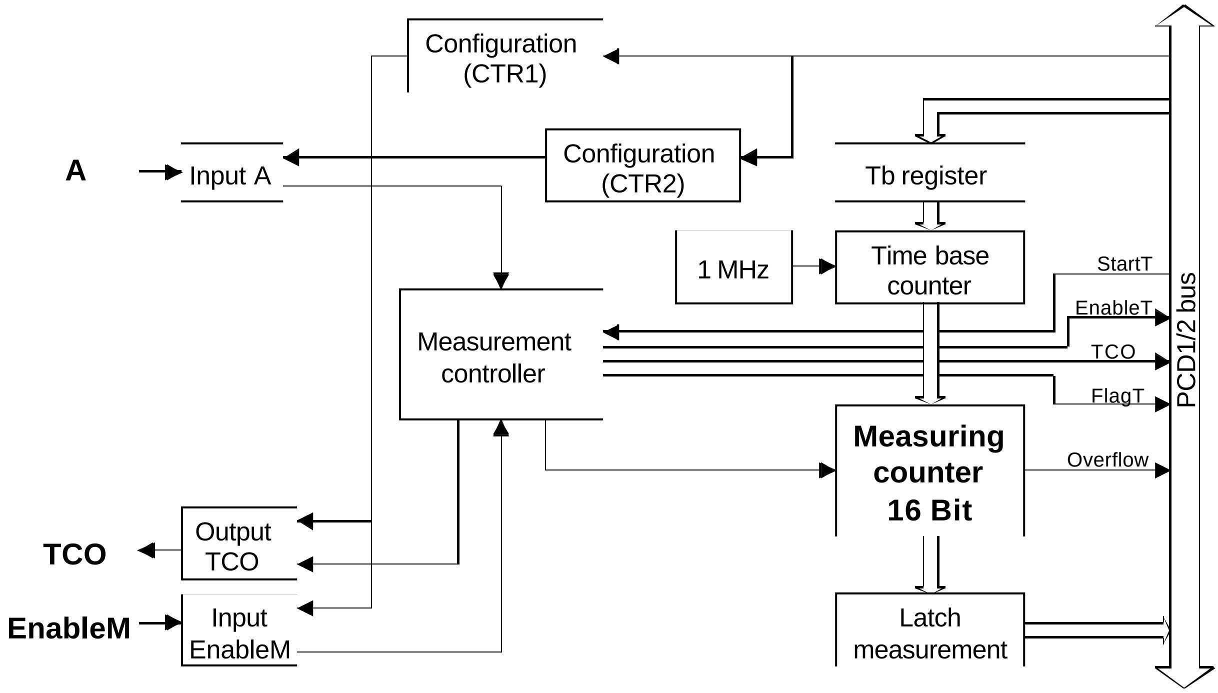
4.2 Block diagram and description for period length measurement mode



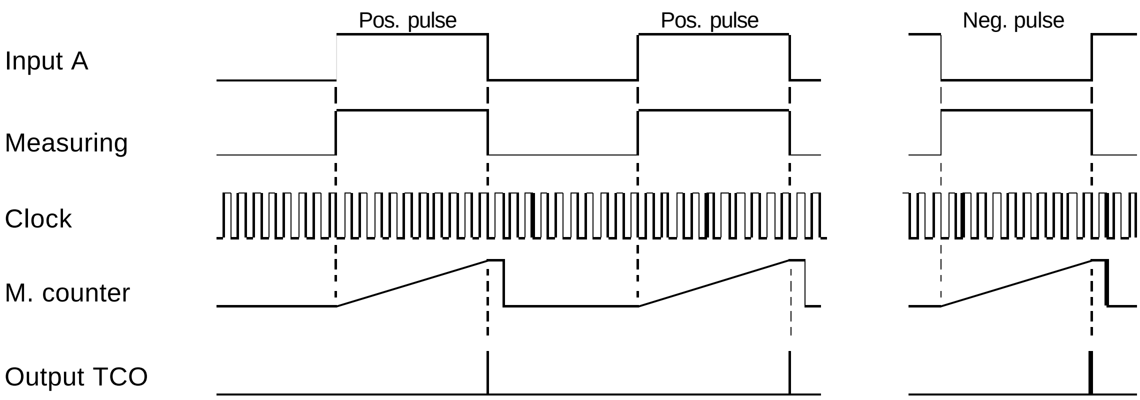
Period length measurement uses 2 counters of 16 bits each. One of these two counters, the time base counter, has a fixed clock of 1 MHz, producing a fundamental time base of 1 µs. The user-defined time base is generated here. The other counter, the measurement counter, counts the time base pulses between two rising edges on input "A". Therefore, when there are consecutive pulses at input "A", measurement is always between pairs of pulses, after which there is a pause to restore readiness for the next measurement (length: < 1 µs), then another measurement, etc.



4.3 Block diagram and description for pulse length measurement mode



Pulse length measurement uses 2 counters of 16 bits each. One of these two counters, the time base counter, has a fixed clock of 1 MHz, producing a fundamental time base of 1 µs. The user-defined time base is generated here. The other counter, the measurement counter, counts the time base pulses while input "A" is H (positive or normal pulse length measurement) or while input "A" is L (negative or inverted pulse length measurement). Negative or inverted pulse length measurement is achieved by setting bit 30 of the "CTR2" register (see demonstration of principle).



4.4 Configure the PCD2.H110 measurement

4.4.1 Hardware configuration

The Module has to be declare in the hardware configuration of the PCD.xx7, this is done on the DB1, DB511 or DB1023.

The module identification is : 81h
Number of input byte needed are : 8
Number of output byte needed are : 14

This module has to be out of the process image area, so the Input and Output address have to be over the address 256 (e.g. CPU 414).

In this example the module PCD2.H110 is on the first slot and its base address are 700 for input and output. These addresses will be also use in further example.

Address	Name	Type	Initial Value	Comment
0.0		STRUCT		
+0.0	Kennbyte1	CHAR	'M'	This identify this DB
+1.0	Kennbyte2	CHAR	'x'	as the hardware configuration DB,
+2.0	Kennbyte3	CHAR	'x'	and the module setting.
+3.0	Kennbyte4	CHAR	'7'	
+4.0	Modul21	STRUCT		
+0.0	kenn	WORD	W#16#81	
+2.0	PANr	INT	0	
+4.0	InCnt	INT	8	
+6.0	OutCnt	INT	14	
+8.0	InBase	INT	700	
+10.0	OutBase	INT	700	
+12.0	mask	BYTE	B#16#0	
+13.0	dummy_b	BYTE	B#16#0	
+14.0	INIT_COUNT	BYTE	B#16#0	
+15.0	INIT_MEASURE	BYTE	B#16#0	
=16.0		END_STRUCT		

You can also see, there are two byte parameters in the structure , which are INIT_COUNT and INIT_MEASURE. The measurement function can be use in combination with the counting function, in this case the two parameters need INIT_COUNT and INIT_MEASURE have to be set.

4.4.2 Parameter INIT_MEASURE

This byte parameter is needed to configure the measurement part of the module. Each bit of this byte has his meaning.
The configuration of INIT_MEASURE can be done in the configuration DB or also during execution time, with a specific instruction, but this will be seen in the chapter 3.5.4.

Bit N°	Description
0	1 = Input EnableM is Dynamic 0 = Input EnableM is Static
1	1 = Input EnableM is Inverted 0 = Input EnableM is not inverted
2	1 = Output TCO is Static 0 = Output TCO is Dynamic
3	Not use
4	1 = Automatically repeat measurement 0 = Manual
5	Irrelevant if bit 6 = 1 1 = Measurement of Period 0 = Measurement of Pulse
6	1 = Frequency measurement 0 = Pulse or Period measurement
7	Relevant only for Pulse measurement 1 = Input A is Inverted 0 = Input A is not Inverted

Let’s see those parameter in details :

4.4.2.1 EnableM input

"static / normal"
While the Enable input is "H", measurement is allowed.
While the Enable input is "L", measurement is stopped.

"static / inverted"
While the Enable input is "L", measurement is allowed.
While the Enable input is "H", measurement is stopped.

"dynamic / normal"
The Enable input is "L". The first positive edge (H) switches Enable on, the next switches it off again, etc.

"dynamic / inverted"
The Enable input is "H". The first negative edge (L) switches Enable on, the next switches it off again, etc.

4.4.2.2 TCO output

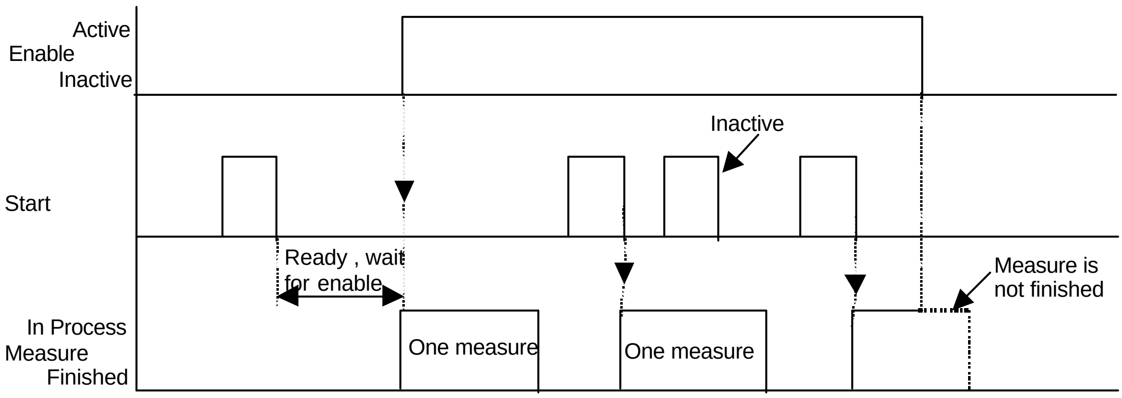
"Static"
The TCO indicate when the measure is finished, in this case the output will be activate (level HIGH) and stay at this HIGH level until a measurement windows is loaded (L.M.W.) or a start measurement (STM) command is given.

"Dynamic"
The TCO will be activated at the end of the measure and will stay on the HIGH level for about 25..100 µs.

4.4.2.3 Measurement mode

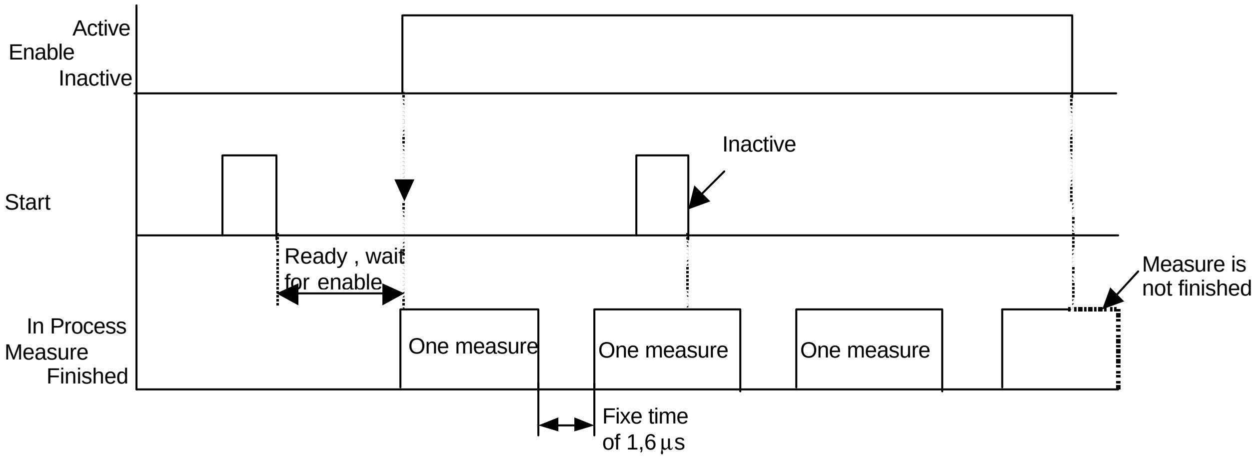
Two modes are available for the frequency measurement. One is the manual mode and the other is the automatic mode.
In the following figure the Enable is the input E3.

Mode **MANUAL** (bit 4 = 0)



In this mode, only one measurement is done, to restart a measurement you need to reload the measurement windows (LMW) and the start command (STM).

Mode **Automatic**



As soon as the start command (STM) is given and the enable is active, the measurement start and when it’s done, it will be repeated automatically after a short delay of 1,6 µs. The measurement is then repeated until the enable is active.

4.4.2.4 Measurement function

The bits 5 and 6 of the configuration byte **INIT_MEASURE**, are us to select the measurement function, which are the Frequency measurement, Period Measurement or the Pulse Measurement.

4.4.2.5 Pulse measurement inversion

Pulse Measurement function does measure how long a signal stay on the HIGH level, starting from the rising edge. If you like to measure the low level of a signal, then you will need to invert the signal input. The bit 7 of the byte INIT_MEASURE has the purpose to invert the input signal.

4.4.3 Configuration example

Let’s say for the example that the application requires the EnableM Dynamic and not inverted, the TCO will be Static. The Frequency measurement will be done in the manual mode.
So for this configuration the byte INIT_MEASURE will look like:

INIT_MEASURE = b#16#44							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	0	0	0	1	0	0

4. 5 Programming in the frequency measurement mode

4.5.1 Instruction set

Reading function

Offset	Use	Operation	Description
+ 0.0	C	L PED	Reserve for counting mode
+ 4.0	M	L PEW	Result of the measurement
+ 6.0	C	L PEB	Reserve for counting mode
+ 7.0	M	L PEB	Measurement Status Byte (**MSTA**) Bit 0 = Status of **EnableM** Bit 1 = Status of the **TCO** Bit 2 = **OverFlow** Bit 3 = **FlagT** ; Measurement valid

Writing function

Offset	Use	Operation	Description
+ 0.0	C	T PAD	Reserve for counting mode
+ 4.0	C	T PAD	Reserve for counting mode
+ 8.0	M	T PAW	Measurement windows (**LMW**) or measurement duration.
+ 10.0	C	T PAB	Reserve for counting mode
+ 11.0	M	T PAB	Start-Stop the measurement (**STM**) Transfer 1 will Start measurement Transfer 0 will Stop it.
+ 12.0	M	T PAB	Configure the Measurement function (**CFM**)

Function for the Counter part of the module, see chapter ??????

4.5.2 Measurement windows or time duration

Before starting any measurement, you need to set the measurement windows, here is a good way to define it.
The measuring range is between 0 and 65 535 (16 bit).
To obtain a resolution of 1‰ at least 1000 signals must be captured per measurement. The measurement window's open time depends on the frequency to be measured.

To measure 100 kHz a minimum measurement time of 10 ms should be provided; to measure 500 Hz a measurement time of at least 2s is required.

If the frequency to be measured is even smaller, measurement time increases in length, which is not acceptable for every application. For frequencies below approx. 100 Hz, sufficient accuracy within an acceptable measurement time may call for period length measurement.

When the value is define, you will use the instruction (LMW) Load Measurement Windows to set the value inside the H110 module.
As follow :

```
L      1000       //1000 ms
T      PAW  708   //Load Measurement Windows
(LMW)
```

4.5.3 Measurement status byte

This byte contains all the information about the measurement part of the module. It tell you the status of the TCO output and the EnableM input.

There is also a flag (OverFlow) to notify if an error happened during the measurement. The error is that the counting register (16bits) was full, so you should reduce the measurement windows to get less pulses.
This flag will be reset after a new start (STM).

The flagT indicate that a measurement cycle has finished and that a new measure is available to be read. This flag is reset when reading the measurement Status Byte.

4.5.4 Configure the Measurement function (CFM)

As saw in the chapter 3.4.2, the measurement mode is selected in the hardware configuration DB (1,511,1023) through the parameter INIT_MEASURE, but it's also possible to configure the measurement mode during execution time. So any time it's possible to switch from Frequency measurement to Period or Pulse and vice versa. This just by transferring a byte formatted like the INIT_MEASURE parameter to the module with the instruction T PAB (module offset) + 12.0

4.5.5 Programming examples

Here are few programming steps for example. You can find this example in the S7 project annexed to this documentation (DOC_H110.arj), the FC3 show programming for the Frequency measurement, but first you need to configure the OB100.

4.5.5.1 Load windows and start measurement

```
L      1000        //1000 ms
T      PAW  708    //Load Measurement Windows
(LMW)

L      1
T      PAB  711    // STart Measurement (STM)
```

4.5.5.2 Check for a valid measured value

This is the right procedure to read a new measure value.
In first you need to read the Measure Status Byte (MSTA) and then test if no error happened during measurement. Then you test if a new measured value is available (FlagT).

```
L     PEB  707 // LOAD the Measurement Status Byte
SRW   3        // Test the OverFlow flag
SPP   erro     // Jump to error procedure

SRW   1        // Test the new valid measure flag
SPZ   nodr     // If no new data jump over

L     PEW  704 // LOAD the new measure
T     MW   860 // Transfer the measure in a Flag
word
BEA

erro:  …      // Error procedure


nodr: …       // End of reading procedure
```


4. 6 Programming in Period measurement mode

4.6.1 Instruction set

Reading function

Offset	Use	Operation	Description
+ 0.0	C	L PED	Reserve for counting mode
+ 4.0	M	L PEW	Result of the measurement [0..65535]
+ 6.0	C	L PEB	Reserve for counting mode
+ 7.0	M	L PEB	Measurement Status Byte (**MSTA**) Bit 0 = Status of **EnableM** Bit 1 = Status of the **TCO** Bit 2 = **OverFlow** Bit 3 = **FlagT** ; Measurement valid More details see chapter 3.5.3

Writing function

Offset	Use	Operation	Description
+ 0.0	C	T PAD	Reserve for counting mode
+ 4.0	C	T PAD	Reserve for counting mode
+ 8.0	M	T PAW	Time Base [1..65’535]
+ 10.0	C	T PAB	Reserve for counting mode
+ 11.0	M	T PAB	Start-Stop the measurement (**STM**) Transfer 1 will Start measurement Transfer 0 will Stop it.
+ 12.0	M	T PAB	Configure the Measurement function, or also **INIT_MEASUREMENT** (see chapter 3.4.2)

Function for the Counter part of the module, see chapter ??????

4.6.2 Measuring range and time base

The measuring range is between 0 and 65 535 (16 bit).

The formula shown below, can be used to calculate what value to enter for the Time Base (TB):

$$TB = \frac{T * 10^6}{clk} - 1$$

where: T = period length in seconds
clk = number of clock signals , higher is this parameter, higher will be the accuracy of the measure.
TB = value for the Time Base

Example: Let period length equal 10s and the number of clock signals equal 10 000

$$TB = \frac{10 * 10^6}{10\ 000} - 1 = 999$$

So, setting the value of the Time Base (TB)= 1ms = 999, if the period length is 10 seconds, then you will read for the measure 10'000 .

Other example, if the TB = 1999 and the period last 10 seconds, then you will read for the measure 5'000.

4.6.3 Programming examples

Here are few programming steps for example. You can find this example in the S7 project annexed to this documentation (DOC_H110.arj), the FC4 show programming for the Period measurement, but first you need to configure the OB100.

4.6.3.1 Load Time Base and start measurement

```
L      9          // Time base = 10 us
T      PAW  708      // Load TIME BASE (LMW)

L      1
T      PAB  711      // STart Measurement (STM)
```

4.6.3.2 Check for a valid measured value

This is the right procedure to read a new measure value.
In first you need to read the Measure Status Byte (MSTA) and then test if no error happened during measurement. Then you test if a new measured value is available (FlagT).

```
L     PEB  707 // LOAD the Measurement Status Byte
SRW   3        // Test the OverFlow flag
SPP   erro     // Jump to error procedure

SRW   1        // Test the new valid measure flag
SPZ   nodr     // If no new data jump over

L     PEW  704 // LOAD the new measure
T     MW   860 // Transfer the measure in a Flag
word
BEA

erro:  …      // Error procedure


nodr: …       // End of reading procedure
```


4. 7 Programming in Pulse measurement mode

4.7.1 Instruction set

There are no main differences between the Period and Pulse measurement instruction set (see chapter 3.6.1).
The only difference between these two mode is an additional parameter for the pulse measurement. In fact the configuration parameter INIT_MEASURE has one bit which concern only the pulse mode, it's to specify if you are measuring positive or negative pulse. See chapter 4.4.2.5

4.7.2 Measurement range and time base

The measuring range is between 0 and 65 535 (16 bit).

The formula shown below, can be used to calculate what value to enter for the Time Base (TB):

$$TB = \frac{T * 10^6}{clk} - 1$$

where: T = period length in seconds
clk = number of clock signals , higher is this parameter, higher will be the accuracy of the measure.
TB = value for the Time Base

Example: Let period length equal 10s and the number of clock signals equal 10 000

$$TB = \frac{10 * 10^6}{10\ 000} - 1 = 999$$

So, setting the value of the Time Base (TB) = 999, if the period length is 10 seconds, then you will read for the measure 10'000 .

Other example, if the TB = 1999 and the period last 10 seconds, then you will read for the measure 5'000.

4.7.3 Programming examples

Handling of the measurement in the Pulse mode is done exactly like in the period mode. For example see chapter 4.6.3