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STM32 – Encoder

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Incremental encoders

From: T 07 – Slide 61

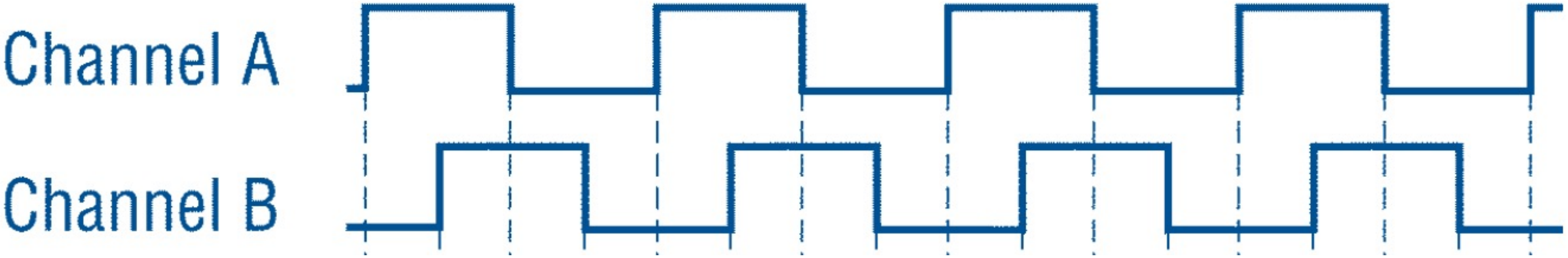
Provide a specific number of pulses per revolution (PPR) in rotary motion, or per inch or millimeter in linear motion.

- **single channel output** → doesn't provide direction of movement
- **quadrature output** → provides direction sensing (two channels 90° out of phase)

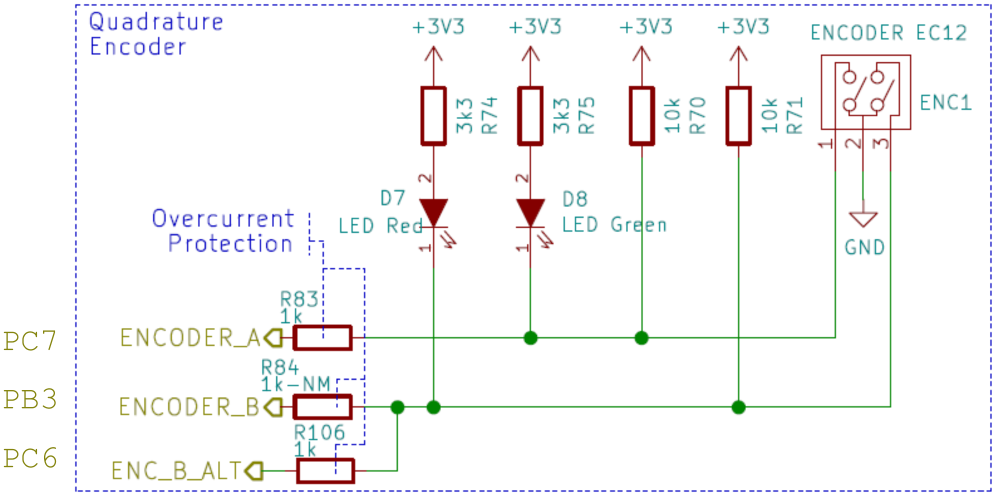
To determine position, its pulses must be accumulated by a counter.

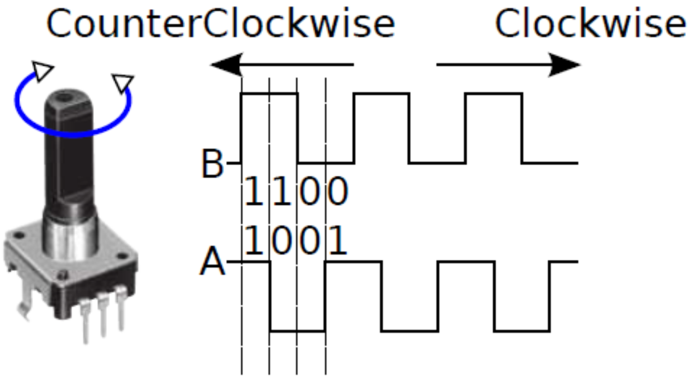
When starting up, the equipment must be driven to a reference or home position to initialize the position counters.

Some incremental encoders also produce another signal, the "marker," produced once per revolution.



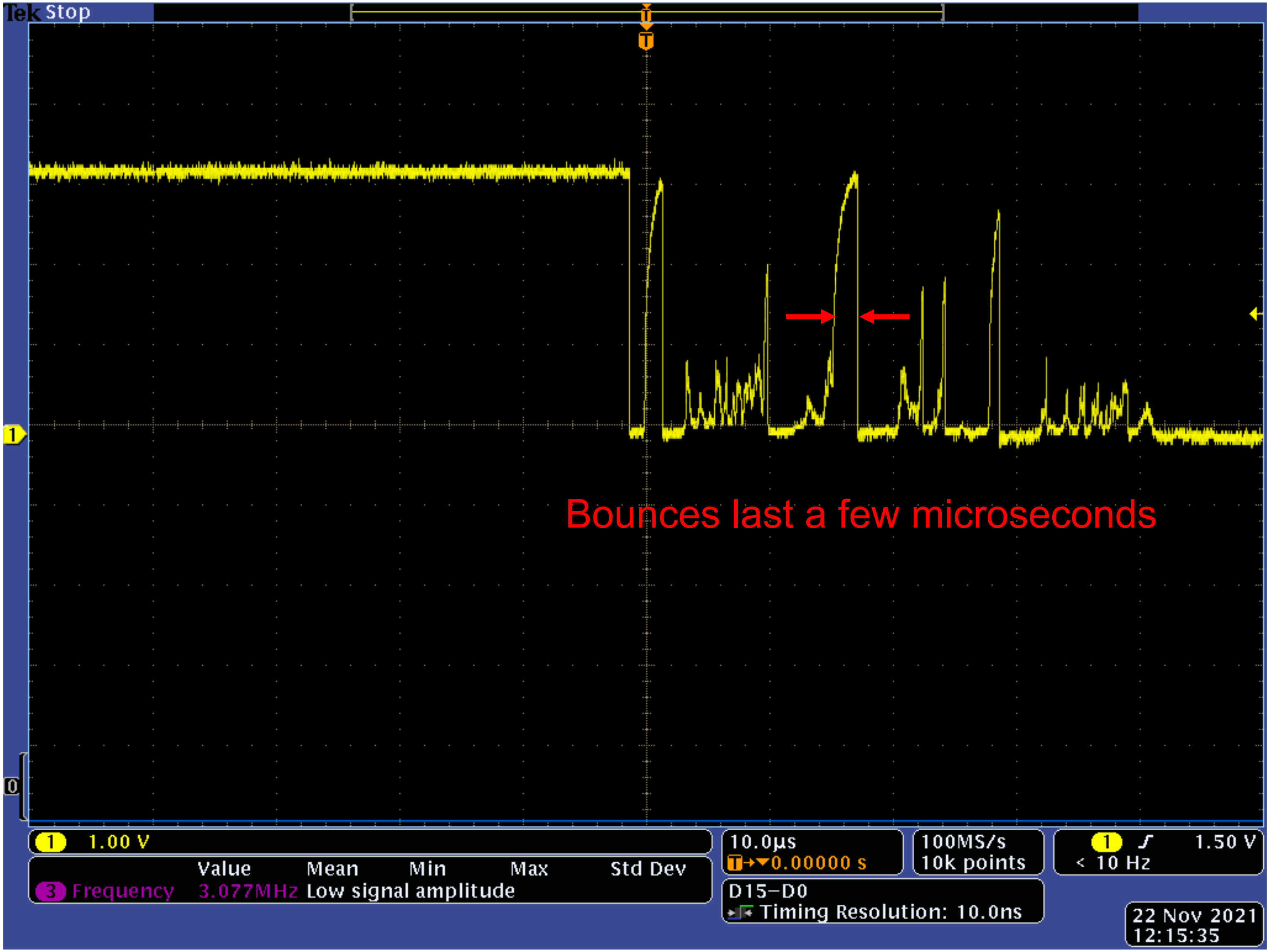
PMDB16: encode





- The encoder is connected to pins PC6 / PC7 of the STM32
- No hardware debouncing: we will use **digital filtering**
- STM32 Timer peripherals feature dedicated encoder mode. Let’s setup the hardware

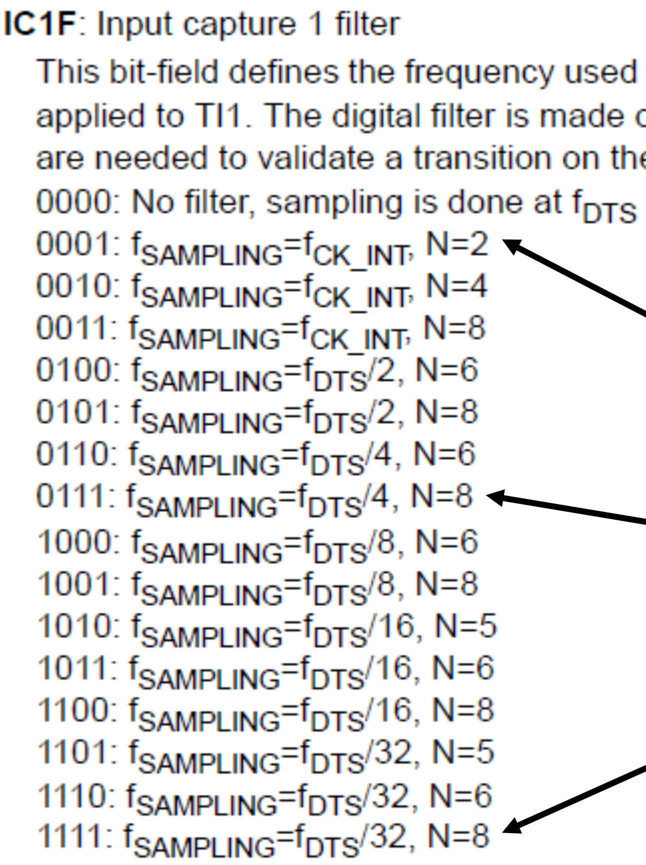
PMDB16: encoder debouncing



Bounces last a few microseconds

```
1  1.00 V
        Value      Mean    Min    Max    Std Dev
3 Frequency  3.077MHz Low signal amplitude
10.0µs
T→▼0.00000 s
100MS/s
10k points
1  ƒ  1.50 V
< 10 Hz
D15−D0
Timing Resolution: 10.0ns
22 Nov 2021
12:15:35
```

STM32 Timer input digital filter



IC1F: Input capture 1 filter

This bit-field defines the frequency used to sample TI1 input and the length of the digital filter applied to TI1. The digital filter is made of an event counter in which N consecutive events are needed to validate a transition on the output:

0000: No filter, sampling is done at f_{DTS}
0001: $f_{SAMPLING}=f_{CK\_INT}$, N=2
0010: $f_{SAMPLING}=f_{CK\_INT}$, N=4
0011: $f_{SAMPLING}=f_{CK\_INT}$, N=8
0100: $f_{SAMPLING}=f_{DTS}/2$, N=6
0101: $f_{SAMPLING}=f_{DTS}/2$, N=8
0110: $f_{SAMPLING}=f_{DTS}/4$, N=6
0111: $f_{SAMPLING}=f_{DTS}/4$, N=8
1000: $f_{SAMPLING}=f_{DTS}/8$, N=6
1001: $f_{SAMPLING}=f_{DTS}/8$, N=8
1010: $f_{SAMPLING}=f_{DTS}/16$, N=5
1011: $f_{SAMPLING}=f_{DTS}/16$, N=6
1100: $f_{SAMPLING}=f_{DTS}/16$, N=8
1101: $f_{SAMPLING}=f_{DTS}/32$, N=5
1110: $f_{SAMPLING}=f_{DTS}/32$, N=6
1111: $f_{SAMPLING}=f_{DTS}/32$, N=8

Minimum pulse duration
@ f_{CK_INT} = 84 MHz, CKD = 1 (CKD = 4)

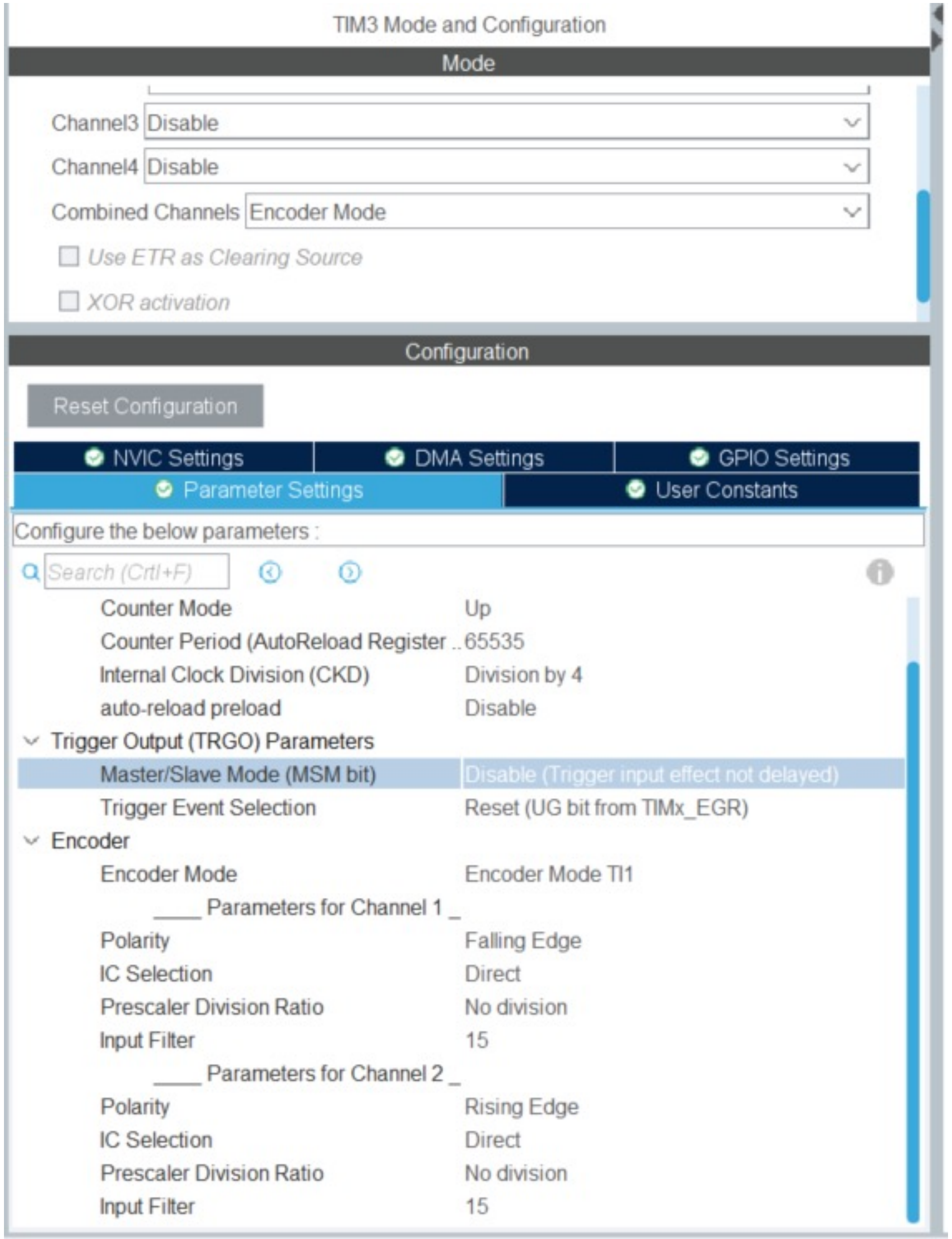
Unfiltered: 11.9 ns (47.7 ns)

381 ns (1.52 µs)

3.05 µs (**12.2 µs**)

$f_{DTS} = f_{CK\_INT}$ / CKD (Internal clock division)

STM32CubeIDE: setup



TIM3 Mode and Configuration

Mode

Channel3 Disable

Channel4 Disable

Combined Channels Encoder Mode

□ *Use ETR as Clearing Source*

□ *XOR activation*

Configuration

Configure the below parameters :

Counter Mode	Up
Counter Period (AutoReload Register ..	65535
Internal Clock Division (CKD)	Division by 4
auto-reload preload	Disable
Trigger Output (TRGO) Parameters	
Master/Slave Mode (MSM bit)	Disable (Trigger input effect not delayed)
Trigger Event Selection	Reset (UG bit from TIMx_EGR)
Encoder	
Encoder Mode	Encoder Mode TI1
____ Parameters for Channel 1 _	
Polarity	Falling Edge
IC Selection	Direct
Prescaler Division Ratio	No division
Input Filter	15
____ Parameters for Channel 2 _	
Polarity	Rising Edge
IC Selection	Direct
Prescaler Division Ratio	No division
Input Filter	15

Project 1a – Encoder readout

Objective

Read the encoder position
and send to the PC the
rotation speed in rpm

Aim of the project

Objective of the project is to readout a quadrature encoder, using the specific modality of STM32 timers, in order to provide the rotation frequency (expressed in rpm / rotations per minute) and direction (“+” for clockwise and “-” for counterclockwise).

The result must be displayed using the remote terminal.

Project hints

- Identify the encoder pins, and enable then in TIMx_CHy mode

- Setup the timer to operate in encoder mode, with the correct input filter applied. Start the timer in encoder mode.

- Within the while(1) loop, poll the counter value every second and compute the delta from the previous read, then convert it to rpms. How many counts does a full rotation of the encoder provide?

- Beware of overflow and underflow of the timer. How to solve this issue?

- Compile and debug the code.

Project 1b – Encoder readout

Objective

Read the encoder position
and send to the PC the
rotation speed in rpm

Use a timer as a timebase and DMA to transfer the UART data