AN13718

Using Self-Wake-Up Timer for Counting Pulses in LPC804 and LPC86x

Rev. 1 — 9 May 2023 Application note

Document Information

Information	Content
Keywords	LPC804, LPC86x, Self-Wake-up Timer, WKT, Pulse number count
Abstract	This application note introduces how to use LPC804 and LPC86x Self-Wake-up Timer (WKT) to count pulses when the timer resource is limited to meet the application requirement.

1 Introduction

In many use cases, the function for measuring the number of pulses is required. Usually, the capture function of timer can apply for this function. LPC804 equips one CTimer with capture function, but in many cases, the CTimer is occupied by other functions that need timer.

This application note introduces how to use LPC804 Self-Wake-up Timer (WKT) to count the pulses when the timer resource is limited to meet the application requirement.

Because the WKT work principle in LPC86x is same with LPC804, this count method can also be applied to LPC86x. This application note contains both demo for LPC804 and LPC86x.

2 LPC804 WKT

2.1 Introduction

The WKT is a 32-bit and loadable down counter. Writing any non-zero value to this timer automatically enables the counter and launches a countdown sequence.

When a starting count value is loaded, the WKT automatically turns on, counts from the pre-loaded value down to zero, generates an interrupt and/or a wake-up request, and then turns itself off until relaunched by a subsequent software write.

2.2 WKT clock sources

The WKT can be clocked from two alternative internal clock sources and one external clock:

- A 750 kHz clock derived from the FRO oscillator. This clock is the default one.
- A 1 MHz and low-power clock with a dedicated on-chip oscillator as clock source.
- An external clock on the WKCLKIN pin.

Note: *The low-power oscillator and the external clock are valid clock sources in all power modes including deep power down. The FRO can be used in sleep and active mode only.*

Figure 1 shows the three kinds of clock sources for WKT.

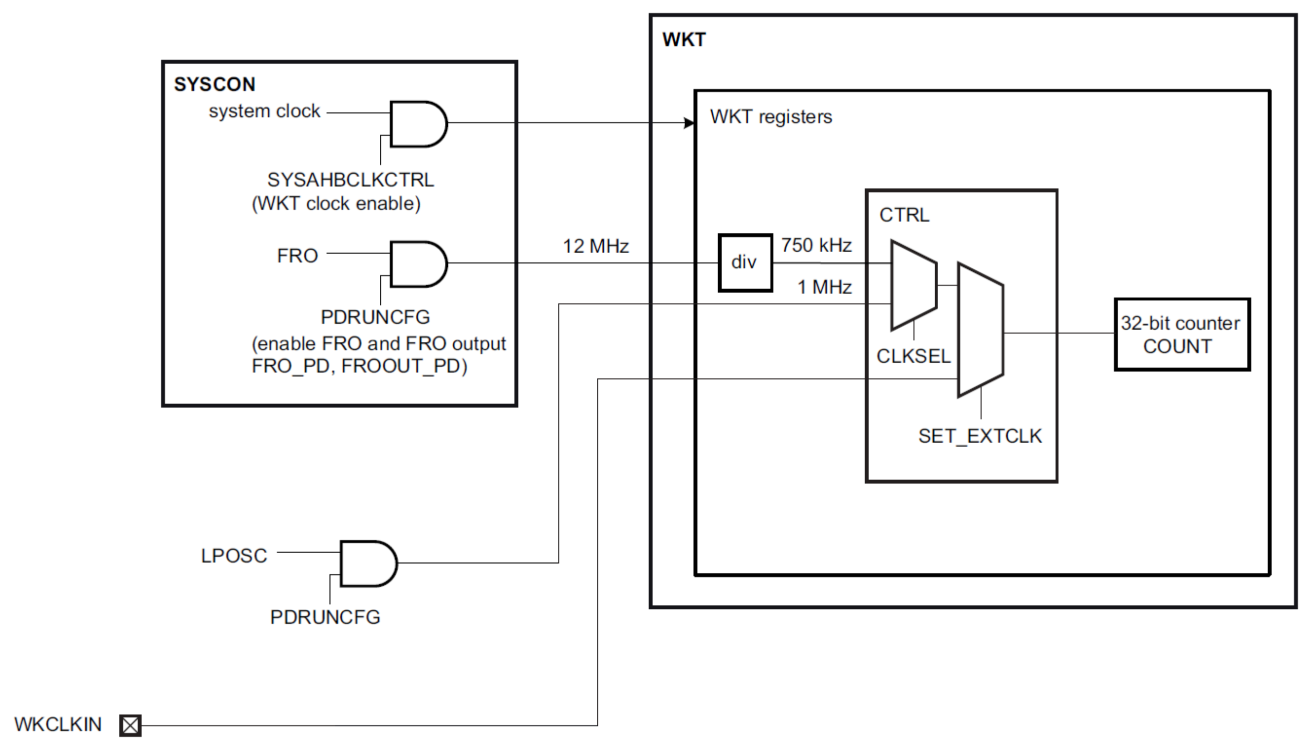

Figure 1. Clock sources for WKT

3 Measurement method introduction

3.1 Measurement principle

3.1.1 For LPC804

In the measurement, use external clock source for the WKT. To enable the clock input for pin `PIO0_11`, set the corresponding bits in switch matrix `PINENABLE0` register to **1**, set the `WKT CTRL` register bit 3 to **1**, and let WKT use the `PIO0_11` as external `WKTCLKIN` pin.

Connect external pulse to `WKCLKIN` pin and let it work as external clock. When a **START COUNT** value is loaded to `COUNT` register, the WKT automatically turns on and launches a countdown sequence. Each falling edge combined with rising edge on `WKCLKIN` pin decreases the **COUNT** value by one. When the external pulses stop, we can read out the **CURRENT COUNT** value. By subtracting the **CURRENT COUNT** from the **START COUNT** value, we can get the number of external pulses.

With this method, we can measure the number of different external pulses, such as, low and high frequency pulses, different duty cycle pulses, even the discontinuous pulses as well.

Figure 2 shows the diagram of measurement principle.

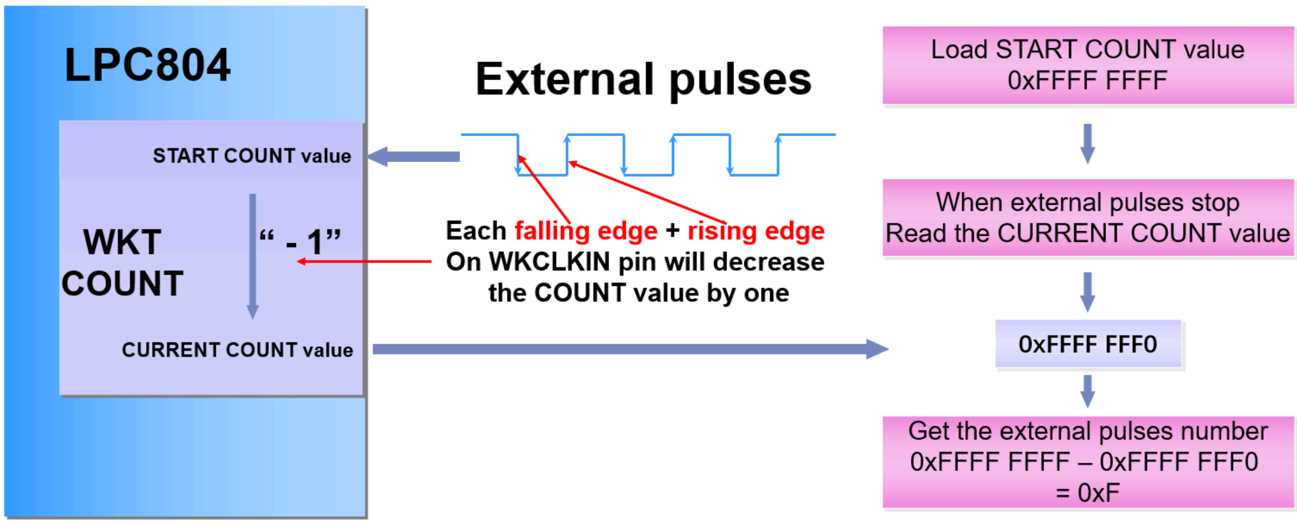

Figure 2. Measurement principle

3.1.2 For LPC86x

The measurement principle for LPC86x is almost same with LPC804. The only difference is the method to set the WKTCLKIN pin. LPC86x does not use switch matrix to configure this pin.

To enable the external WKTCLKIN pin, LPC86x sets:

- LPOSC enable register: `LPOSCEN [bit1]-WKT_CLK_EN`
- Deep power down control register: `DPDCTRL [bit5]-WAKECLKPAD_DISABLE`

3.2 Measurement specification for LPC804

3.2.1 External pulses frequency

Table 1 shows the external pulse frequency specification.

Table 1. Dynamic characteristics: WKTCLKIN pin (T_{amb} = -40 °C to +105 °C; 1.8 V ≤ V_{DD} ≤ 3.6 V)

Symbol	Parameter	Conditions		Min.	Max.	Unit
f_{clk}	Clock frequency	Deep power-down mode and power-down mode	[1]	—	1	MHz
		Deep-sleep, sleep, and active mode	[1]	—	10	MHz
t_{CHCX}	Clock HIGH time	—		50	—	ns
t_{CLCX}	Clock LOW time	—		50	—	ns

[1] Assuming a square-wave input clock.

3.2.2 Number of measurable maximum pulses

Because the WKT is a 32-bit and loadable down counter, the START COUNT value, `0xFFFF FFFF`, decides the number of measurable maximum pulses.

4 Demonstration for measurement

Because the demonstration for LPC86x is same with LPC804, this chapter only introduces the measurement demonstration for LPC804. We also provide the demo project for LPC86x together with this Application Note. Users can run LPC86x demonstration according to detailed description in *readme.txt* file.

4.1 Demo platform

4.1.1 Hardware

The measurement demo developed on LPCXpresso804 version B board.

4.1.2 Software

Provided demo code base on SDK_2.11.0_LPCXpresso804.

IDE: MDK5.35

4.2 Demo illustration

This demo develops on LPCXpresso804 board, uses `PIO0_13` to output pulses, `PIO0_11` as WKCLKIN pin, and WKT to count the number of different type of pulses.

4.2.1 Board setup

Connect `PIO0_13` to `PIO0_11` with a wire. Let the external pulses from `PIO0_13` input to `PIO0_11` as WKT clock source.

4.2.2 Measurement for low frequency pulses

Figure 3 shows the measuring of low frequency pulses (3 Hz). Set the value of pulse number to **15**.

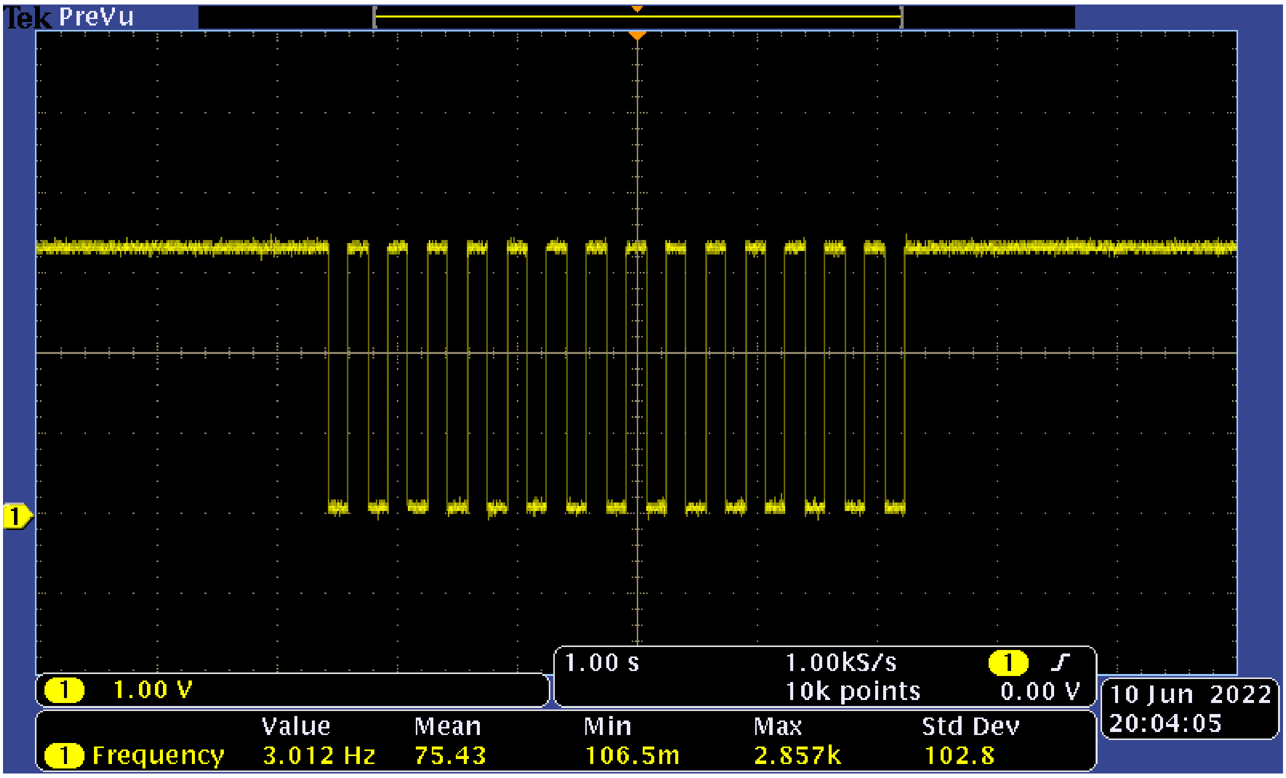

Figure 3. Low frequency pulses

Figure 4 shows the measurement result for low frequency pulses.

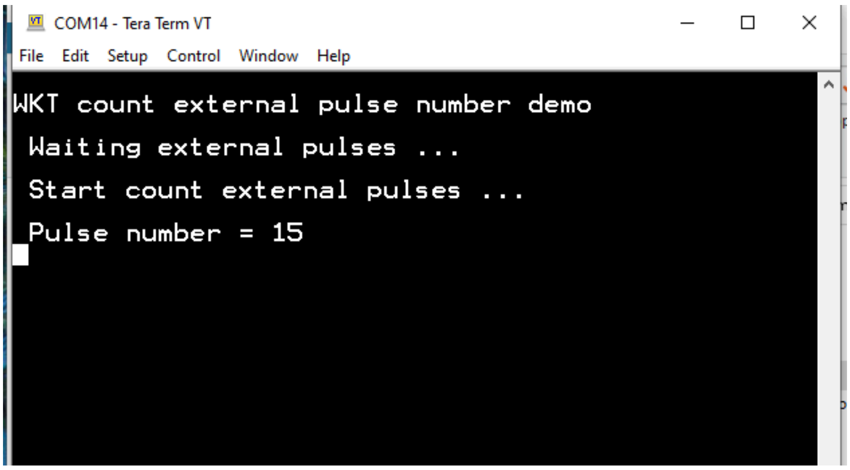

Figure 4. Low frequency pulses measurement result

4.2.3 Measurement for high frequency pulses

Figure 5 shows the measuring of high frequency pulses (188 kHz). Set the value of pulse number to **8**.

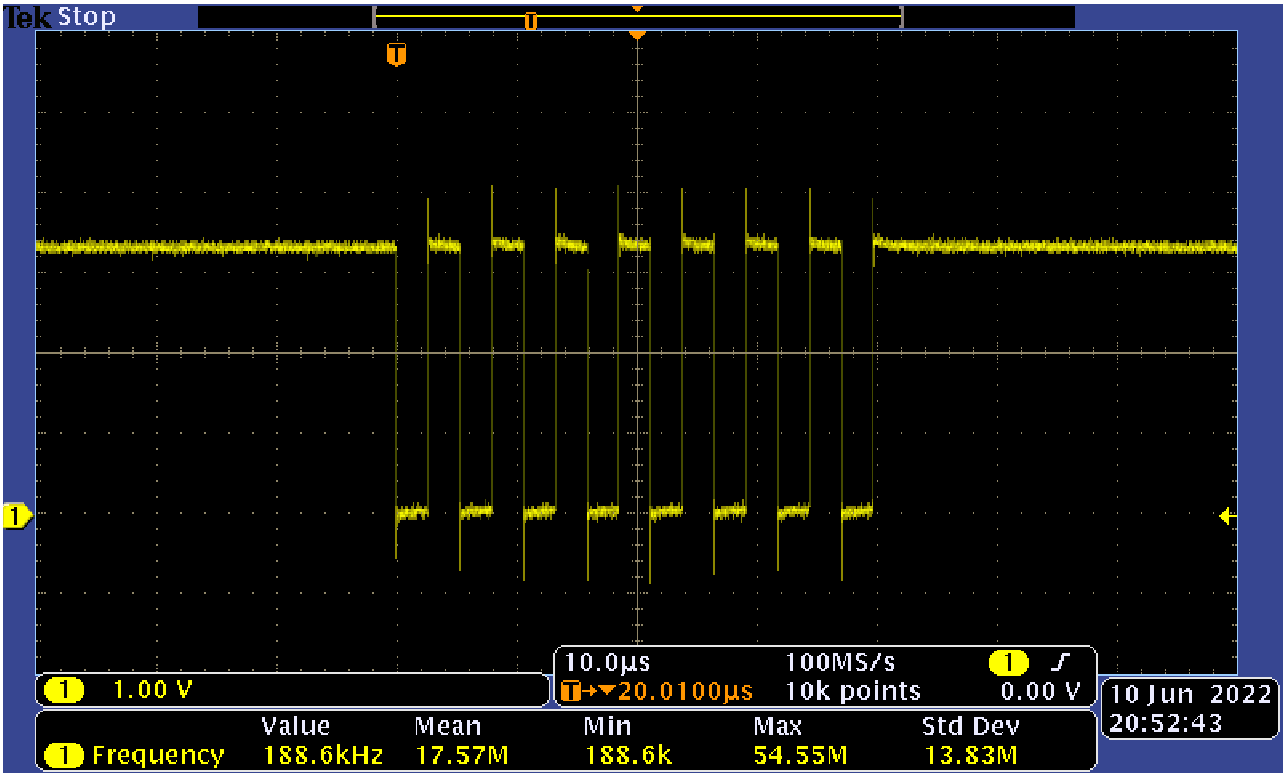

Figure 5. High frequency pulses

Figure 6 shows the measurement result for high frequency pulses.

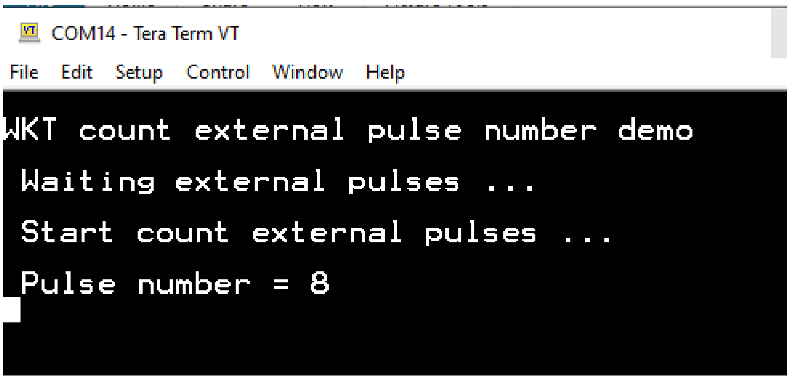

Figure 6. High frequency pulse measurement result

4.2.4 Measurement for different duty cycle pulses

Figure 7 shows the measuring of 90 % duty cycle pulses. Set the value of pulse number to **5**.

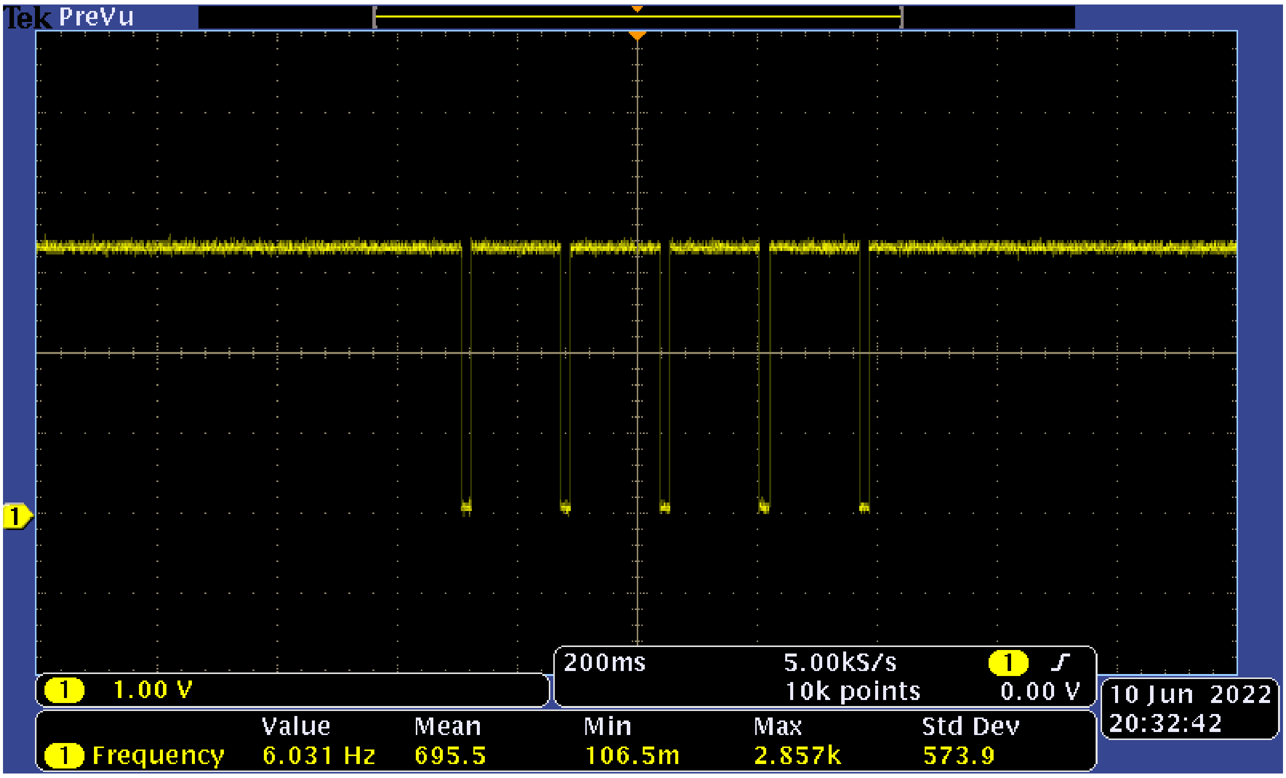

Figure 7. 90 % duty cycle pulses

Figure 8 shows the measurement result for 90 % duty cycle pulses.

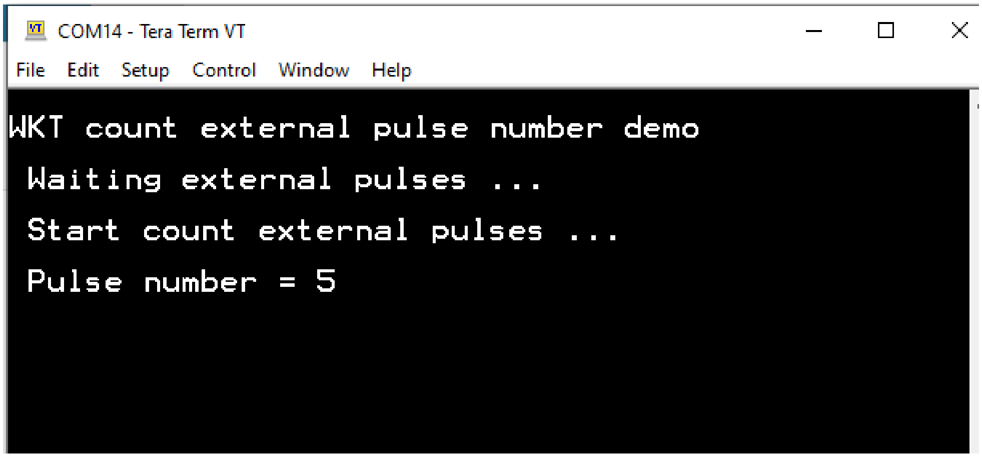

Figure 8. 90 % duty cycle pulses measurement result

Figure 9 shows the measuring of 10 % duty cycle pulses. Set the number of pulses to **5**.

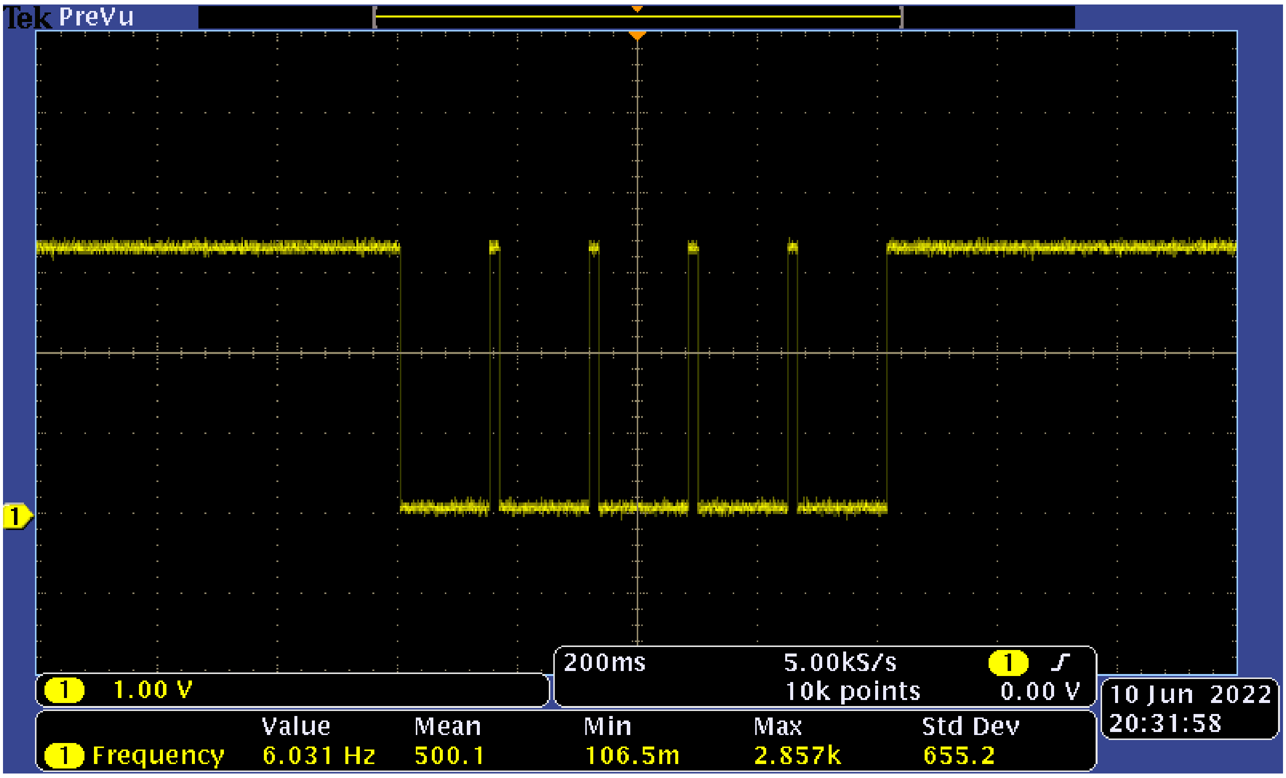

Figure 9. 10 % duty cycle pulses

Figure 10 shows the measurement result for 10 % duty cycle pulses.

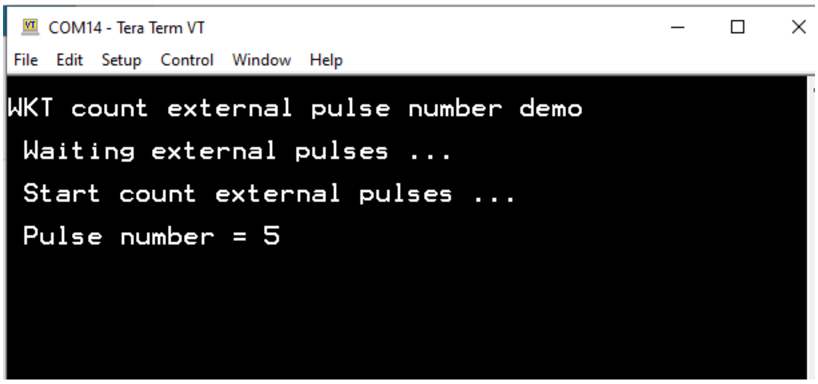

Figure 10. 10 % duty cycle pulses measurement result

4.2.5 Measurement for discontinuous pulses

Figure 11 shows the measuring of discontinuous pulses. Set the number of the first period pulses to **5**, of the second period pulses to **7**, and of the total pulses to **12**.

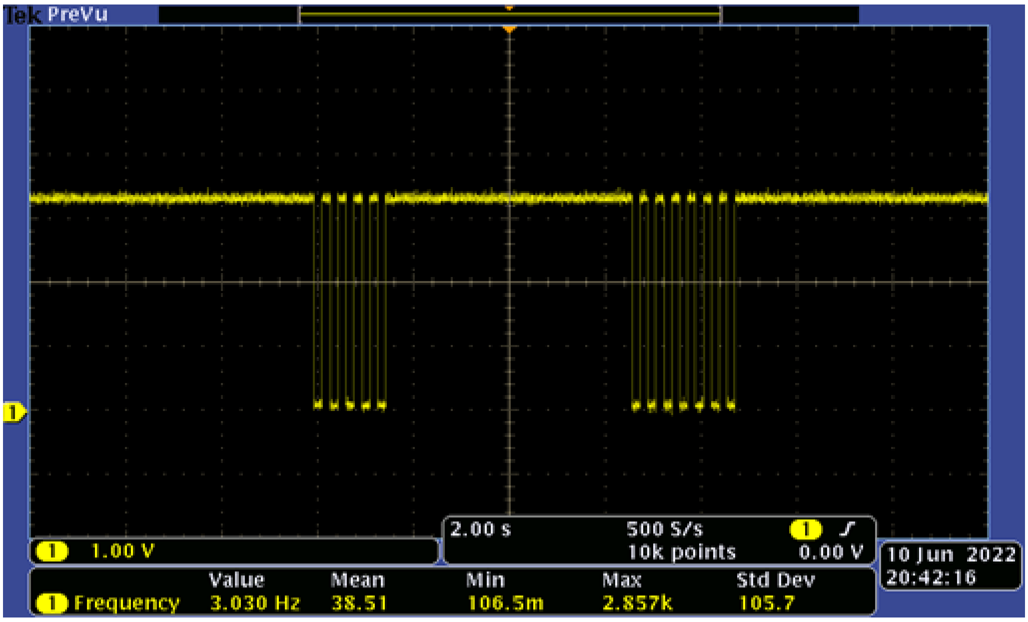

Figure 11. Discontinuous pulses

Figure 12 shows the measurement result for high frequency pulses.

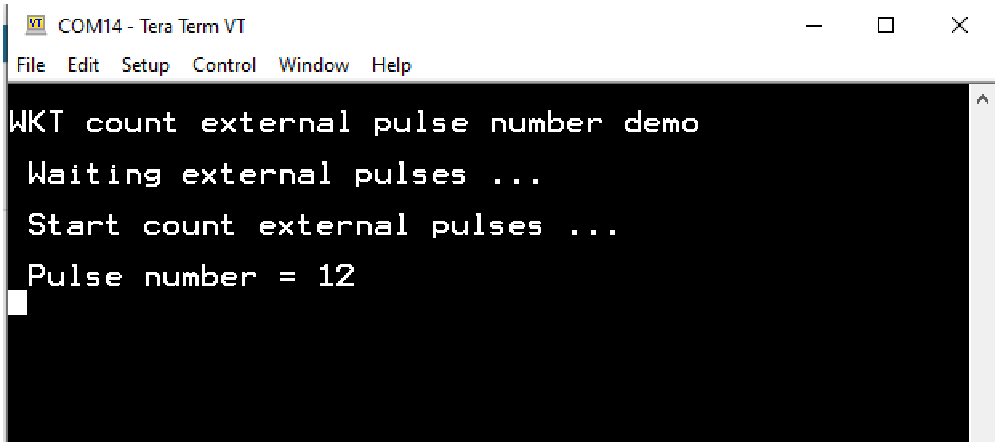

Figure 12. Discontinuous pulses measurement result

5 References

1. *LPC804 User manual* (document UM11065)
2. *LPC804 Data Sheet* (document LPC804_DS)
3. *LPC86x User manual* (document UM11607)
4. *LPC86x Data Sheet* (document LPC86x)

6 Revision history

Table 2 summarizes the revisions to this document.

Table 2. Revision history

Revision number	Date	Substantive changes
1	09 May 2023	Added the description for LPC86x
0	18 August 2022	Initial release

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