MCT 4334

Embedded System Design

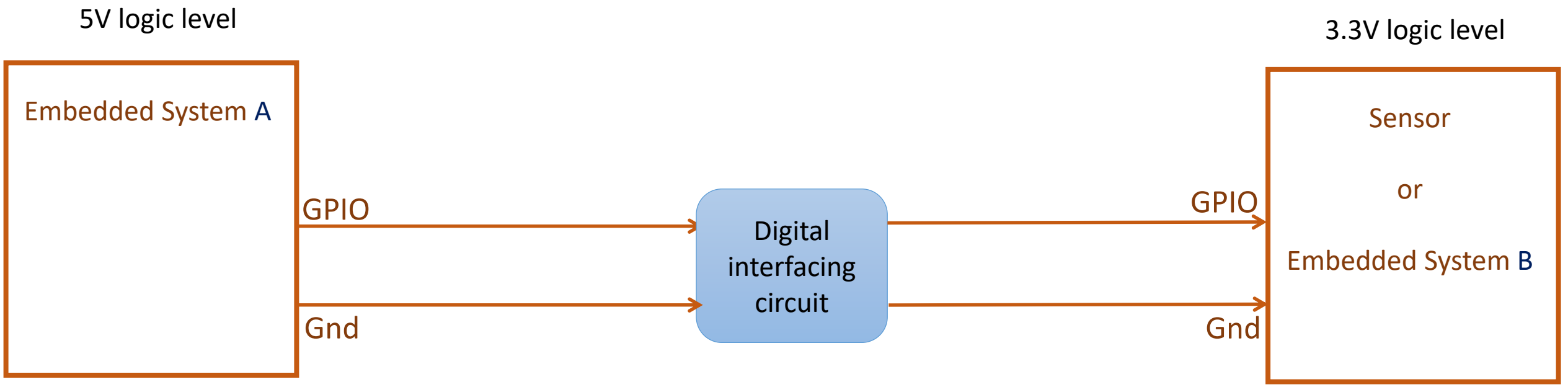
Week 13 Interfacing Circuits

Outline

- Down-shifting logic levels
- Up-shifting logic levels

Digital interfacing circuits

- Different digital systems may operate at different logic levels.
- When two systems with different logic levels want to communicate, digital interfacing circuits must be placed to translate logic levels.
- It is also known as level-shifting.



Down-shifting logic levels

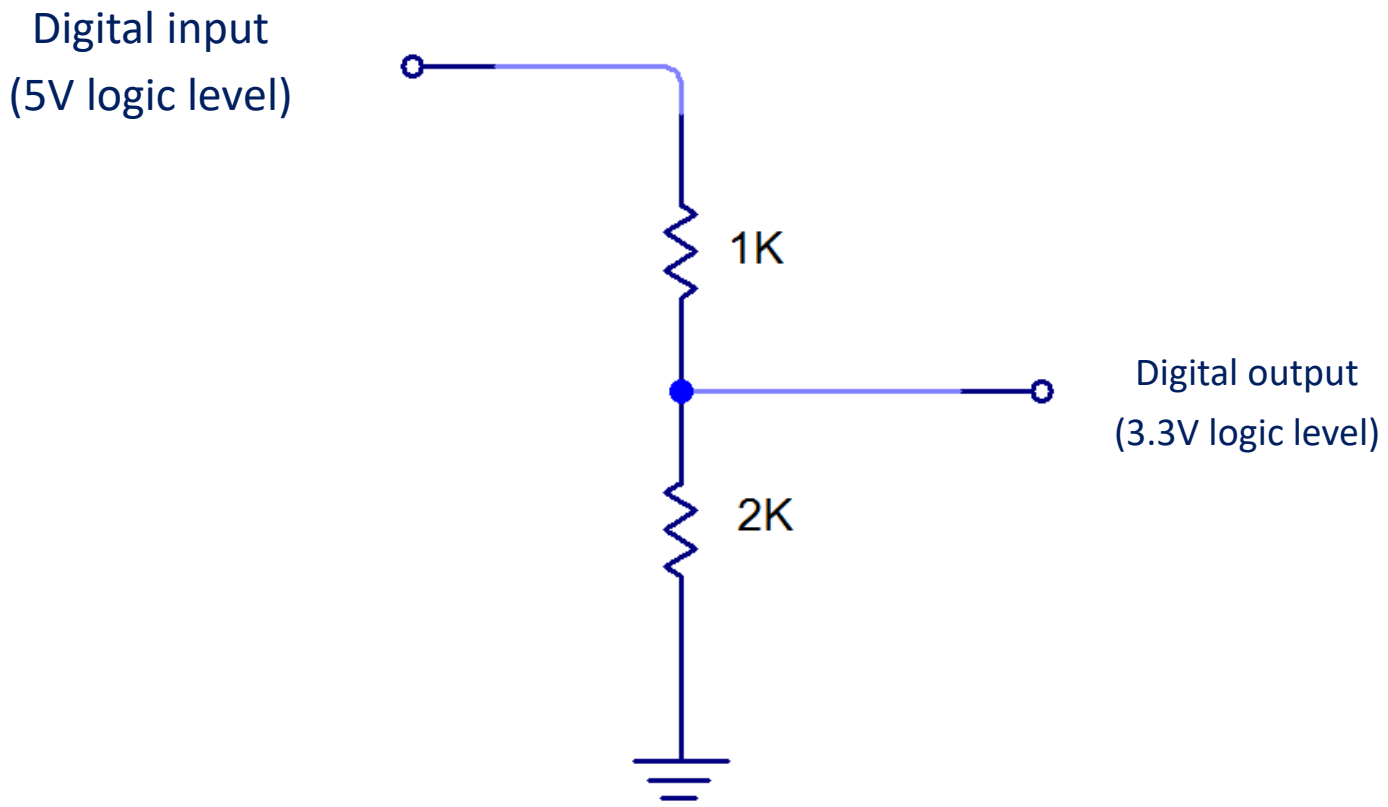
There are many ways to down-shift logic levels.

Examples:

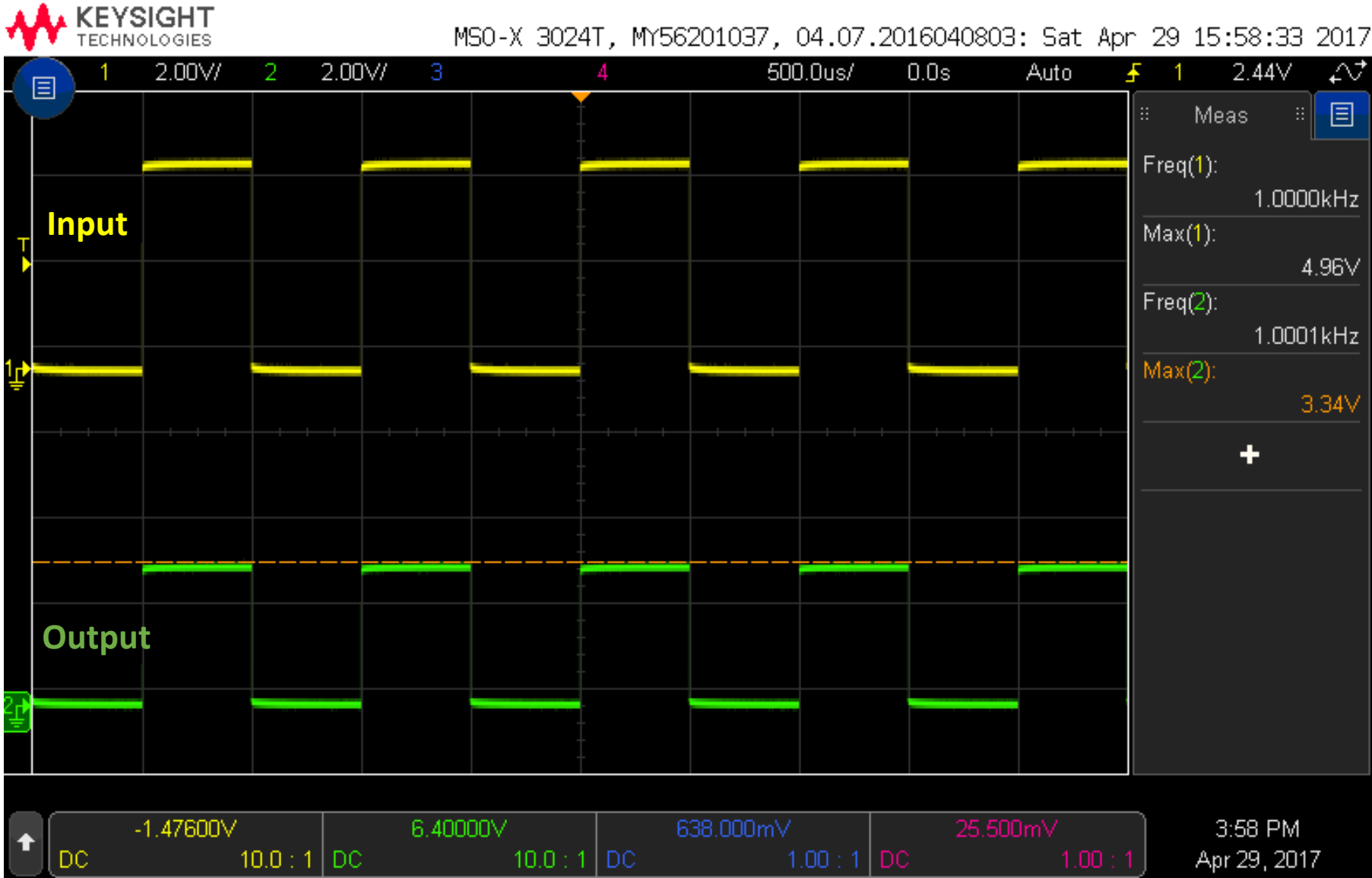
- Voltage divider
- Transistor-based techniques
- Diode-based techniques

Voltage divider

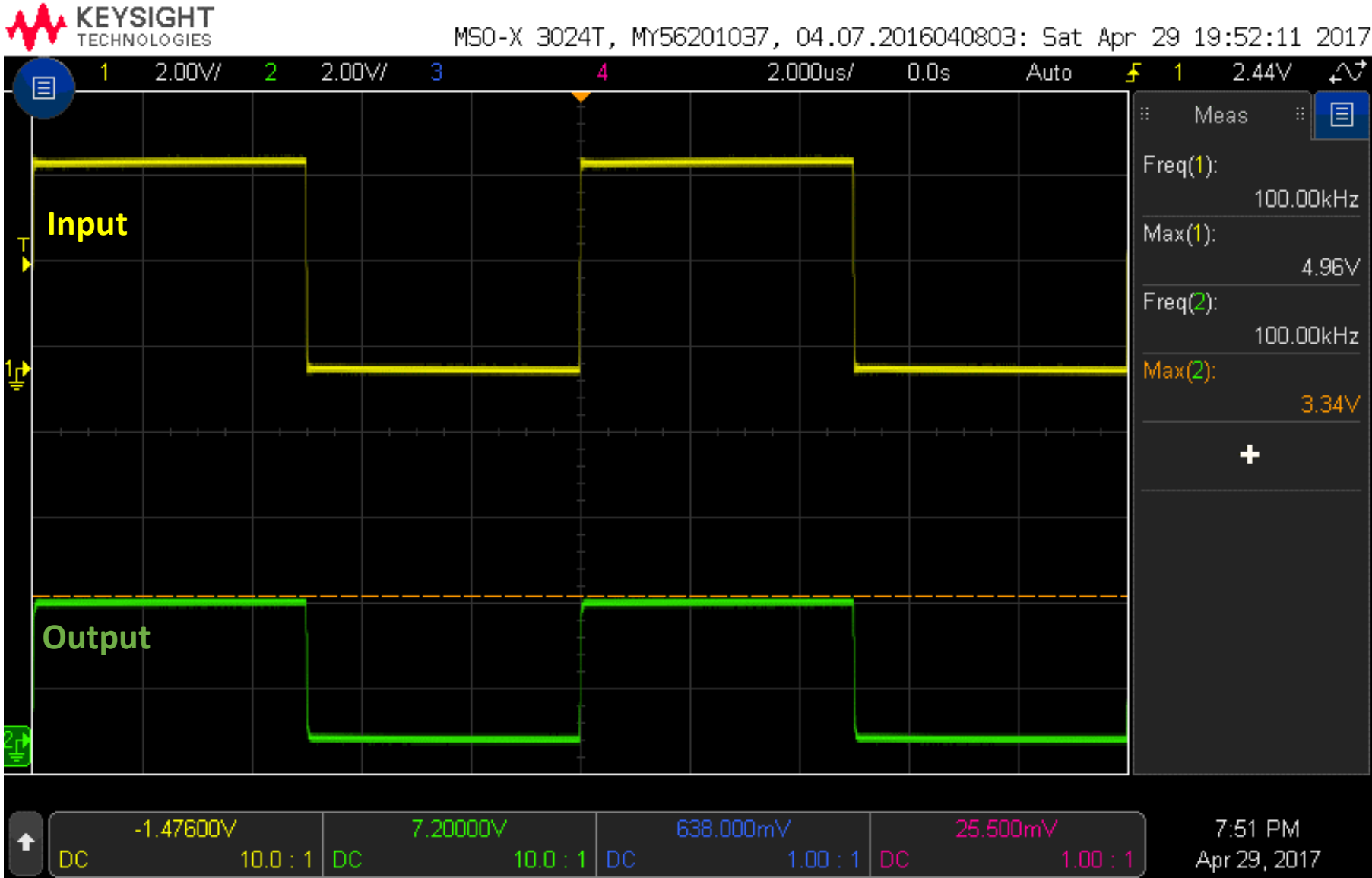
- Simple and effective
- The resistance of the bottom resistor is twice of the top one.



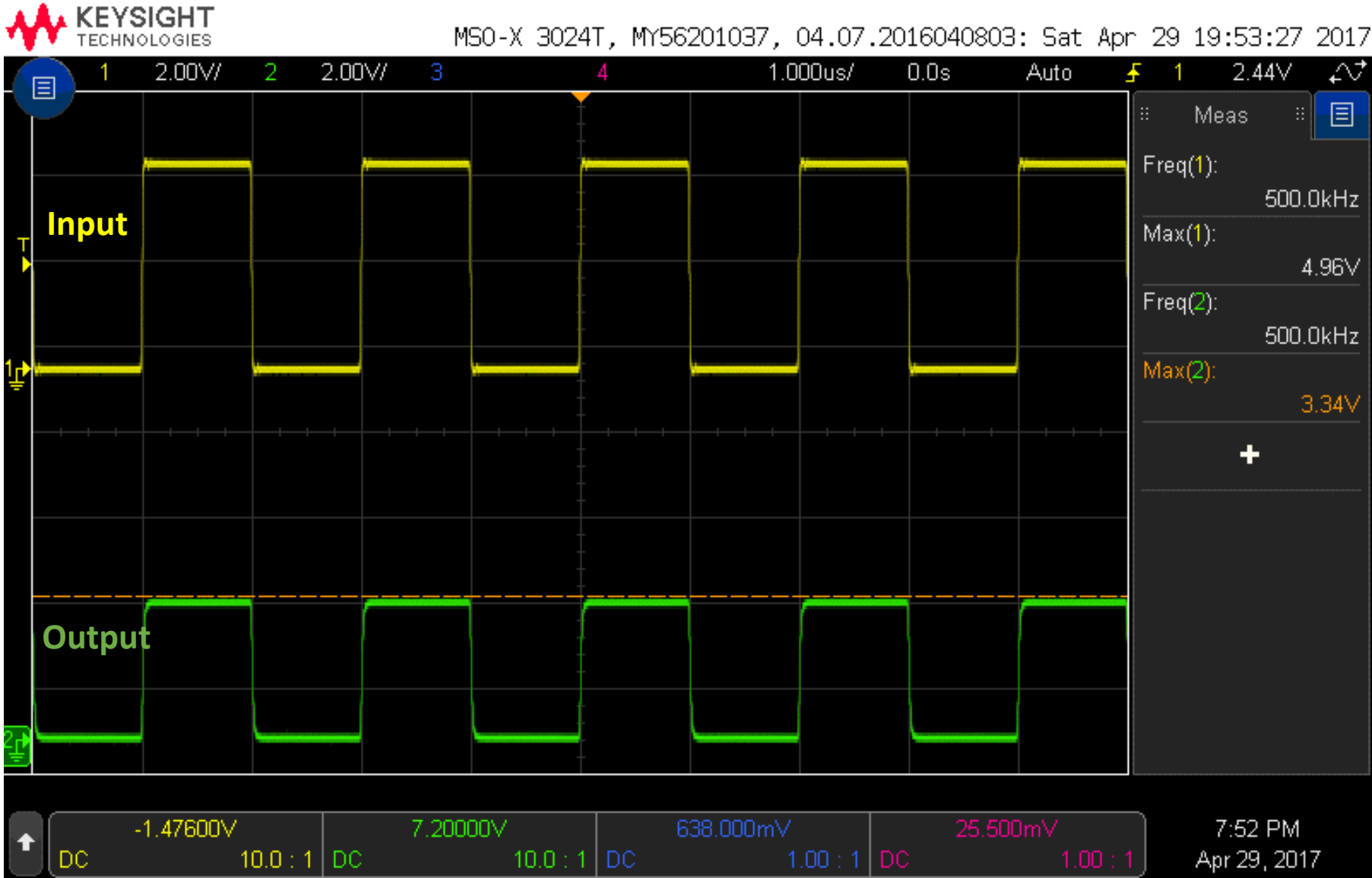
Input is 1kHZ square wave (5V logic level)



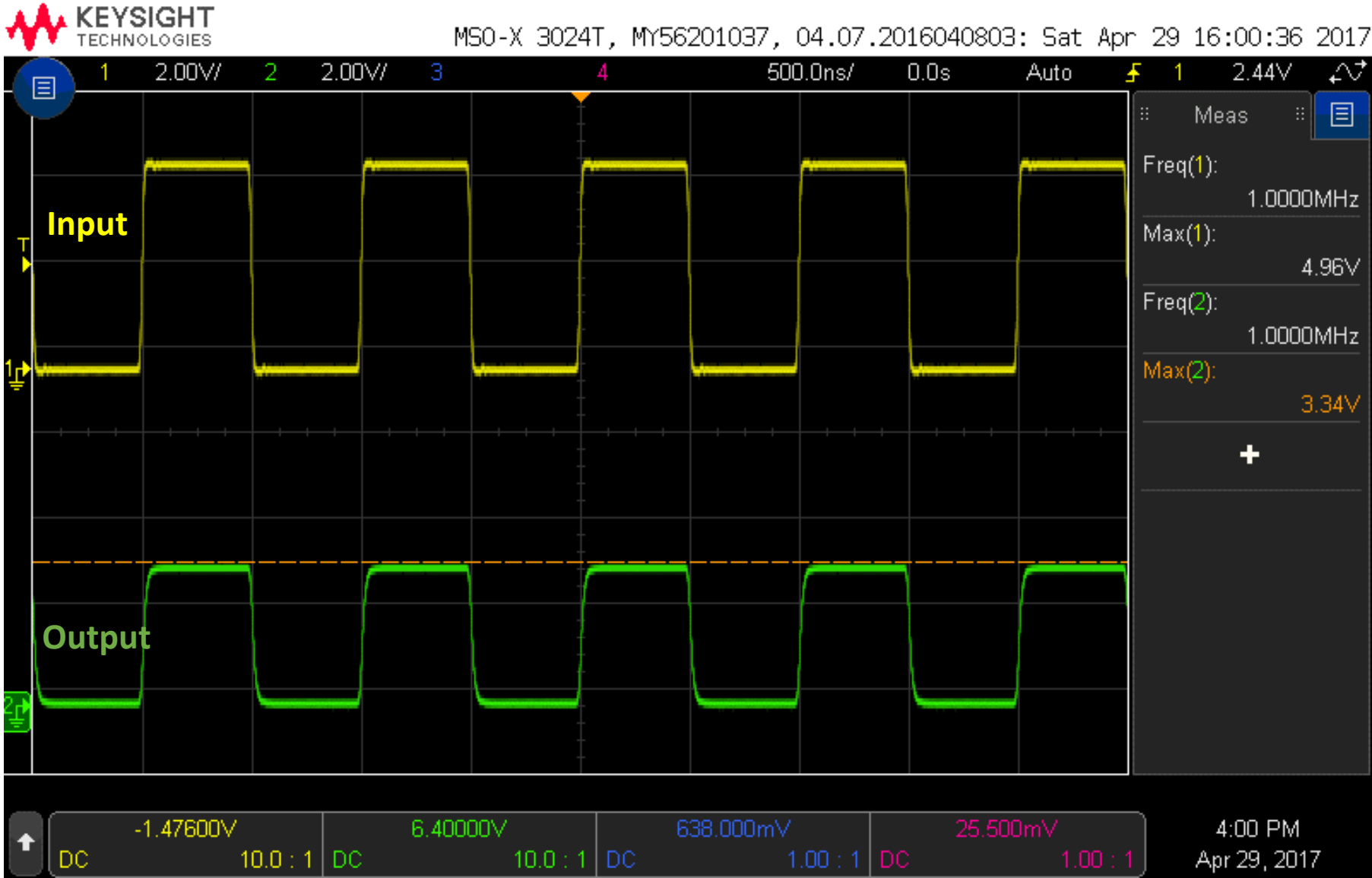
Input is 100kHZ square wave (5V logic level)



Input is 500kHZ square wave (5V logic level)

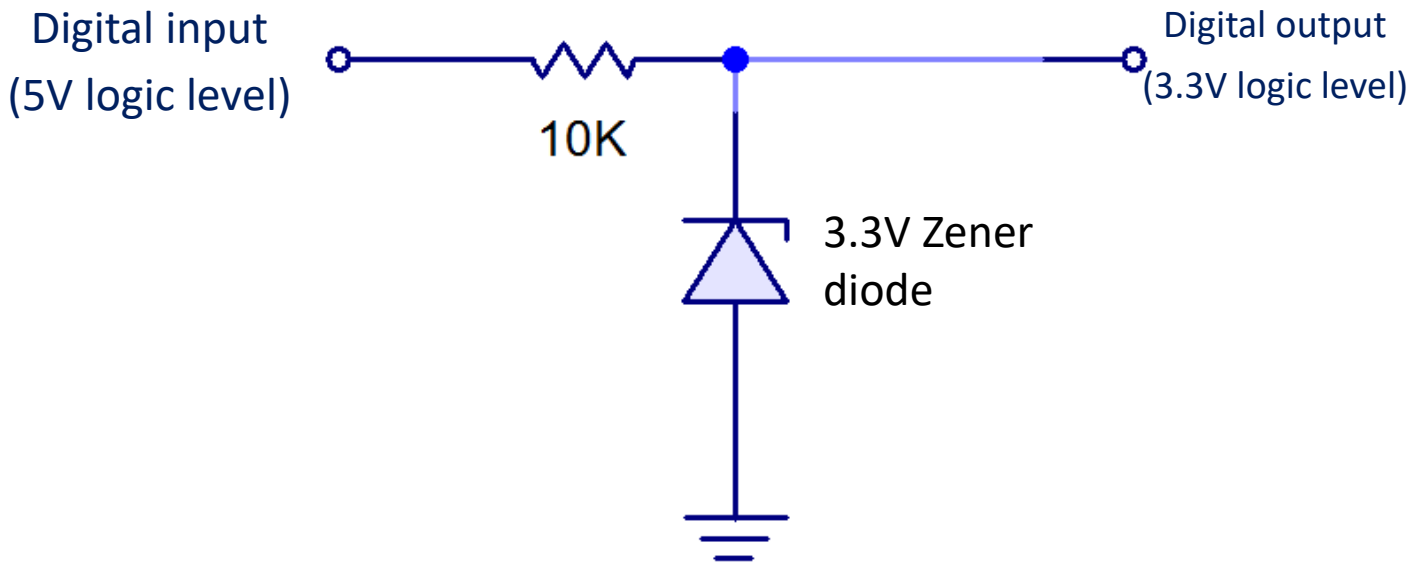


Input is 1MHZ square wave
5V logic level)



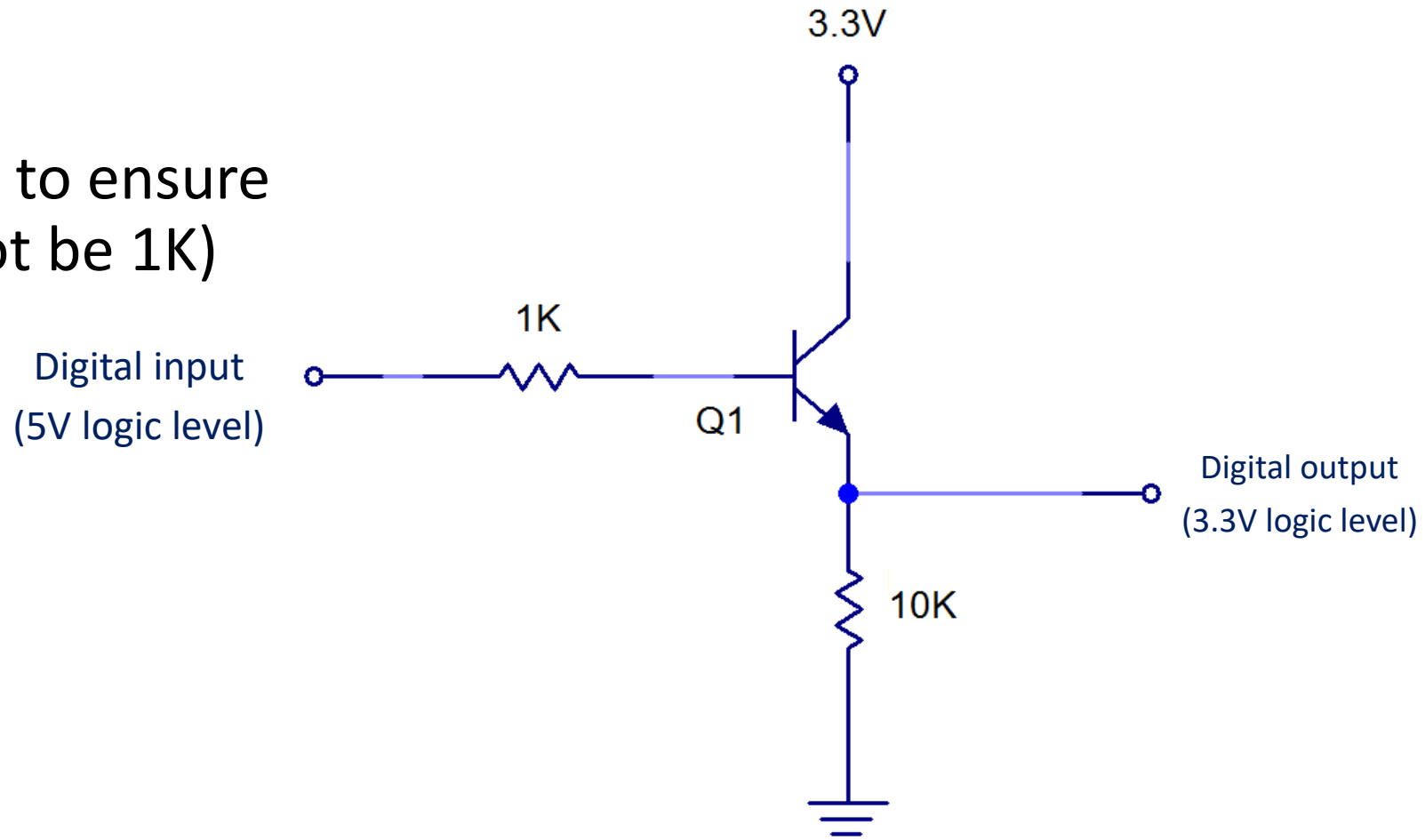
Zener diode

- The voltage drop of the Zener diode is 3.3V



Transistor-based

- High-side switching
- Choose base resistor size to ensure saturation mode (may not be 1K)



Up-shifting logic levels

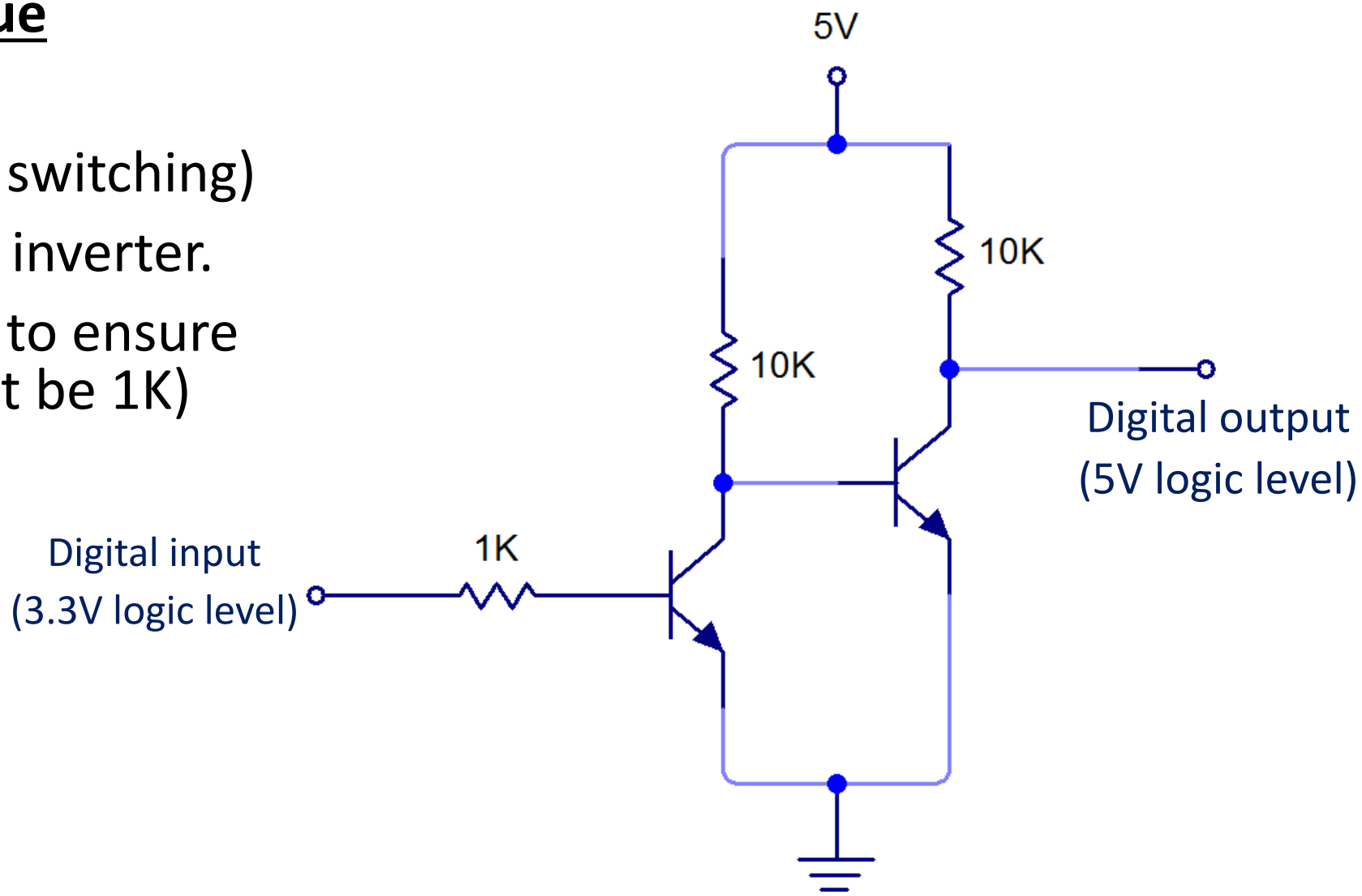
There are many ways to up-shift logic levels.

Examples:

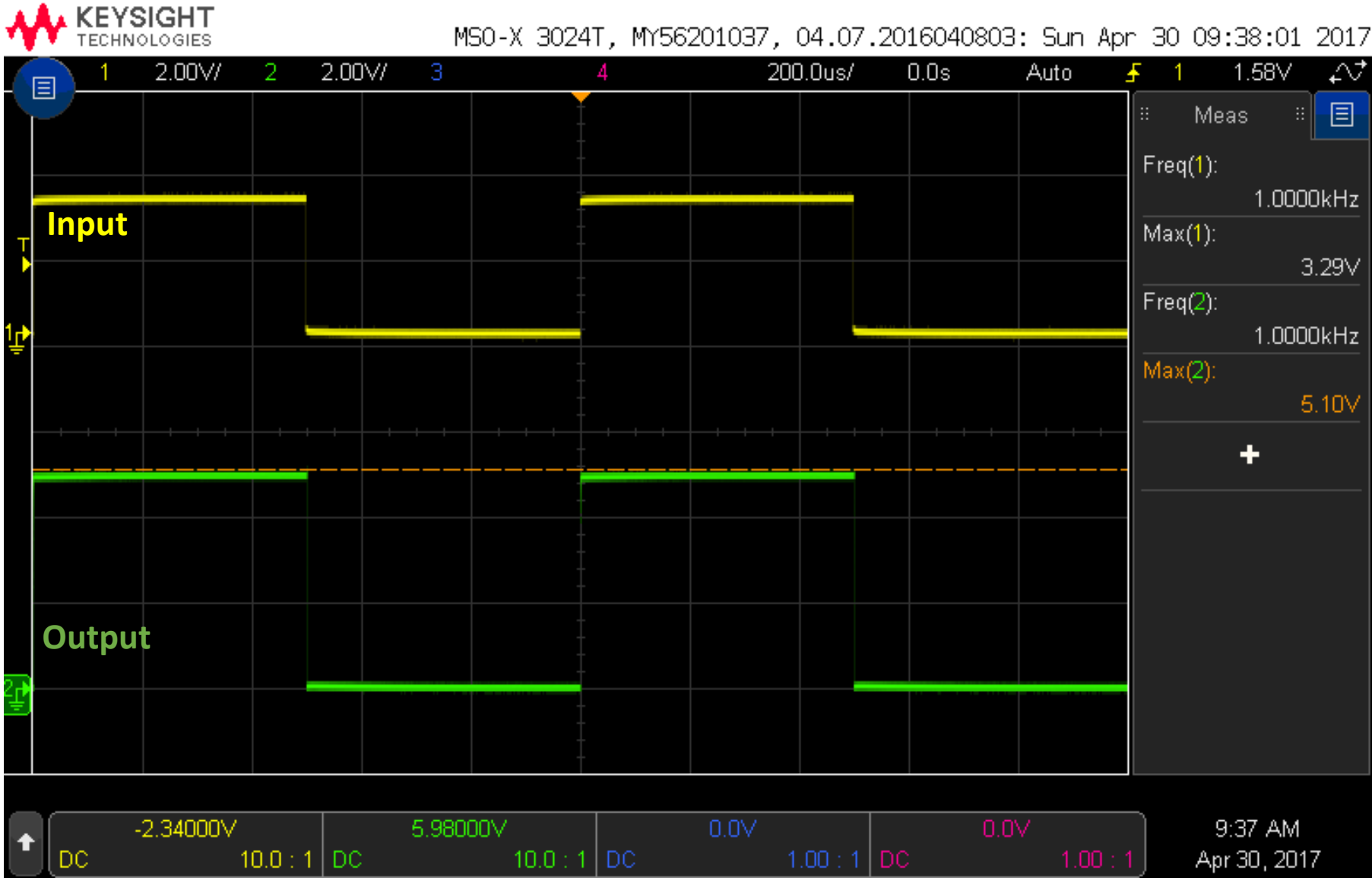
- Double-transistor techniques
- Single transistor techniques
- Diode-based techniques

Double-transistor technique

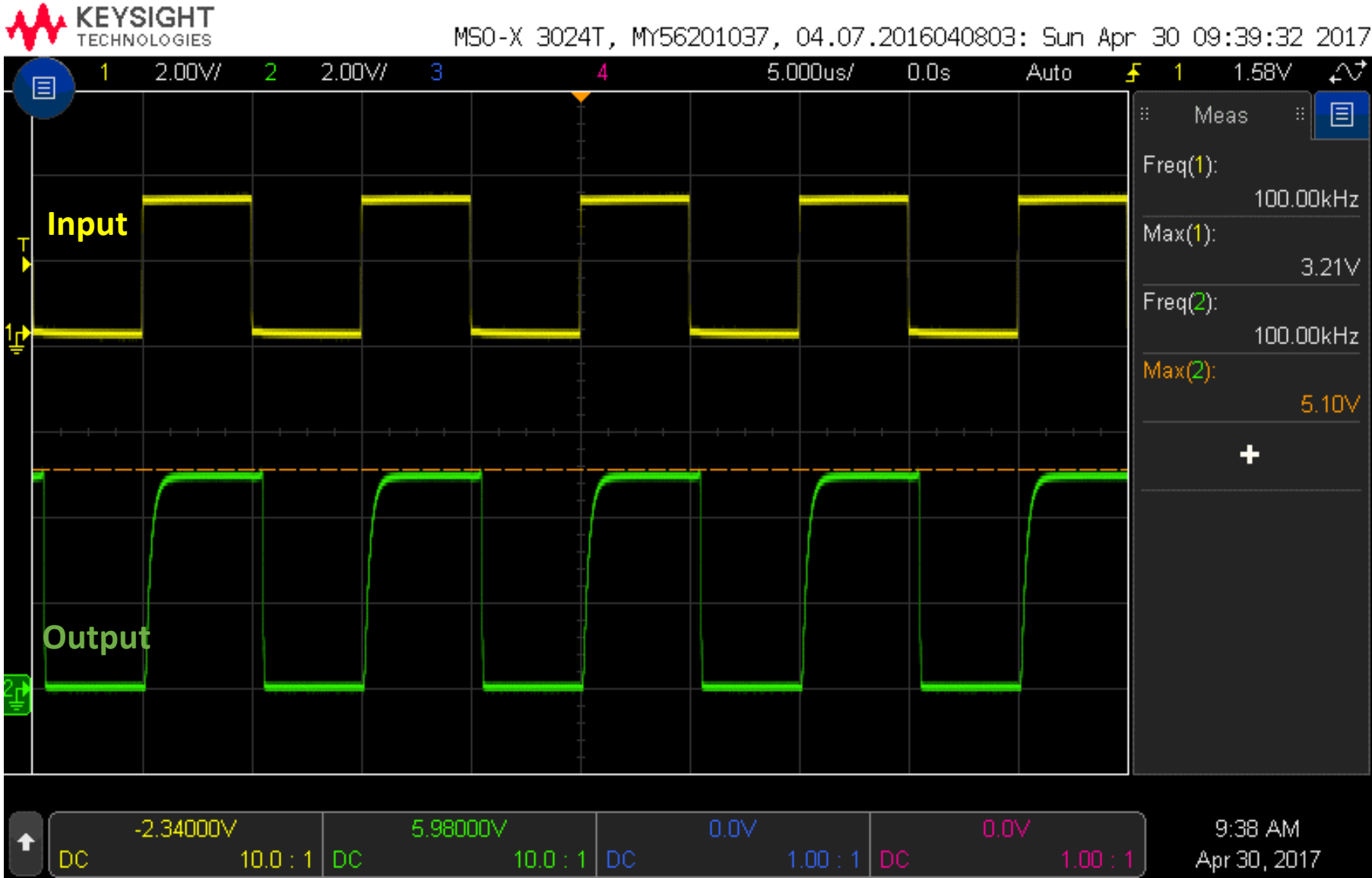
- Two transistors (low-side switching)
- Each transistor acts as an inverter.
- Choose base resistor size to ensure saturation mode (may not be 1K)



Input is 1kHz square wave
(3.3V logic level)

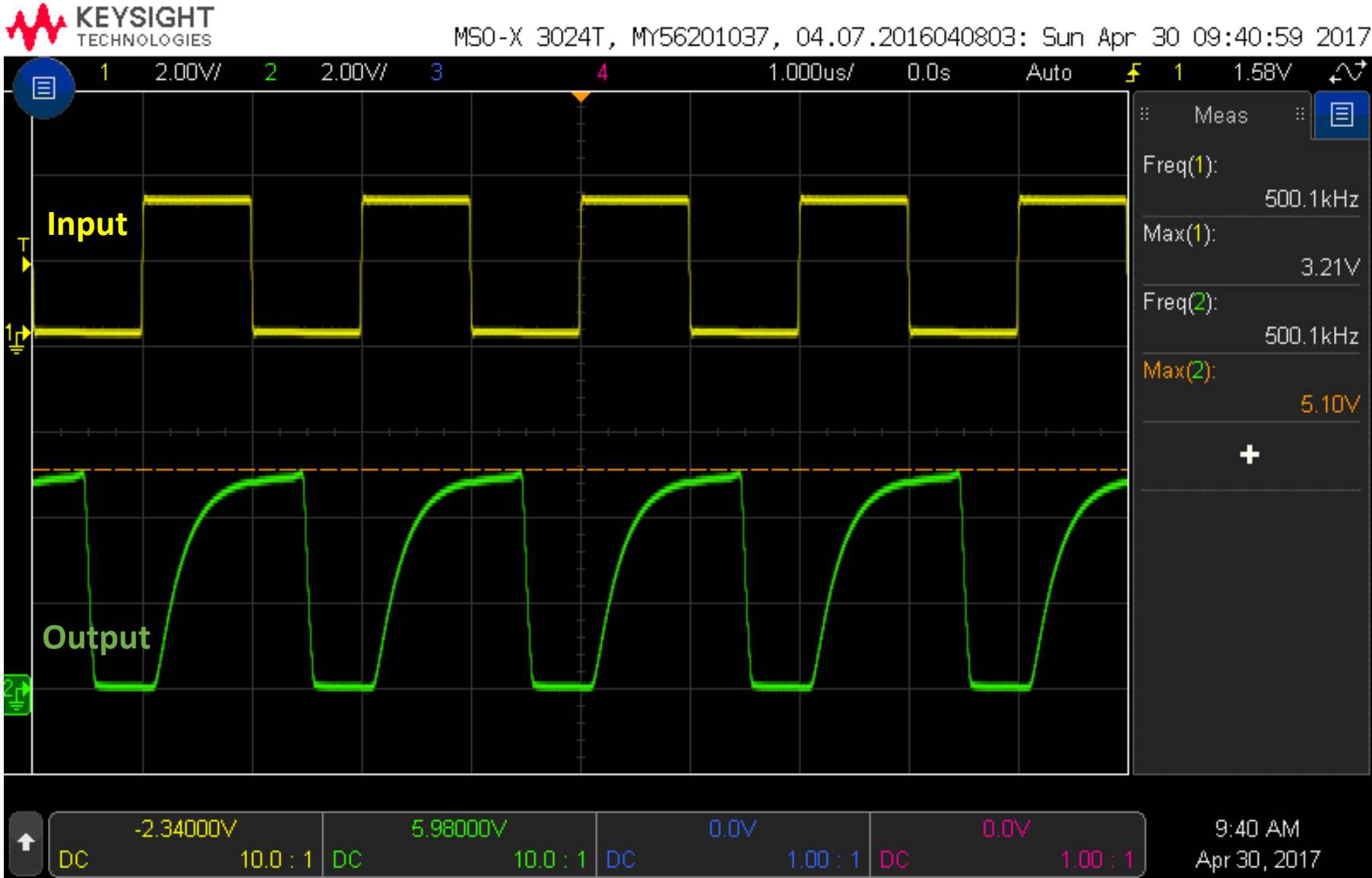


Input is 100kHz square wave (3.3V logic level)



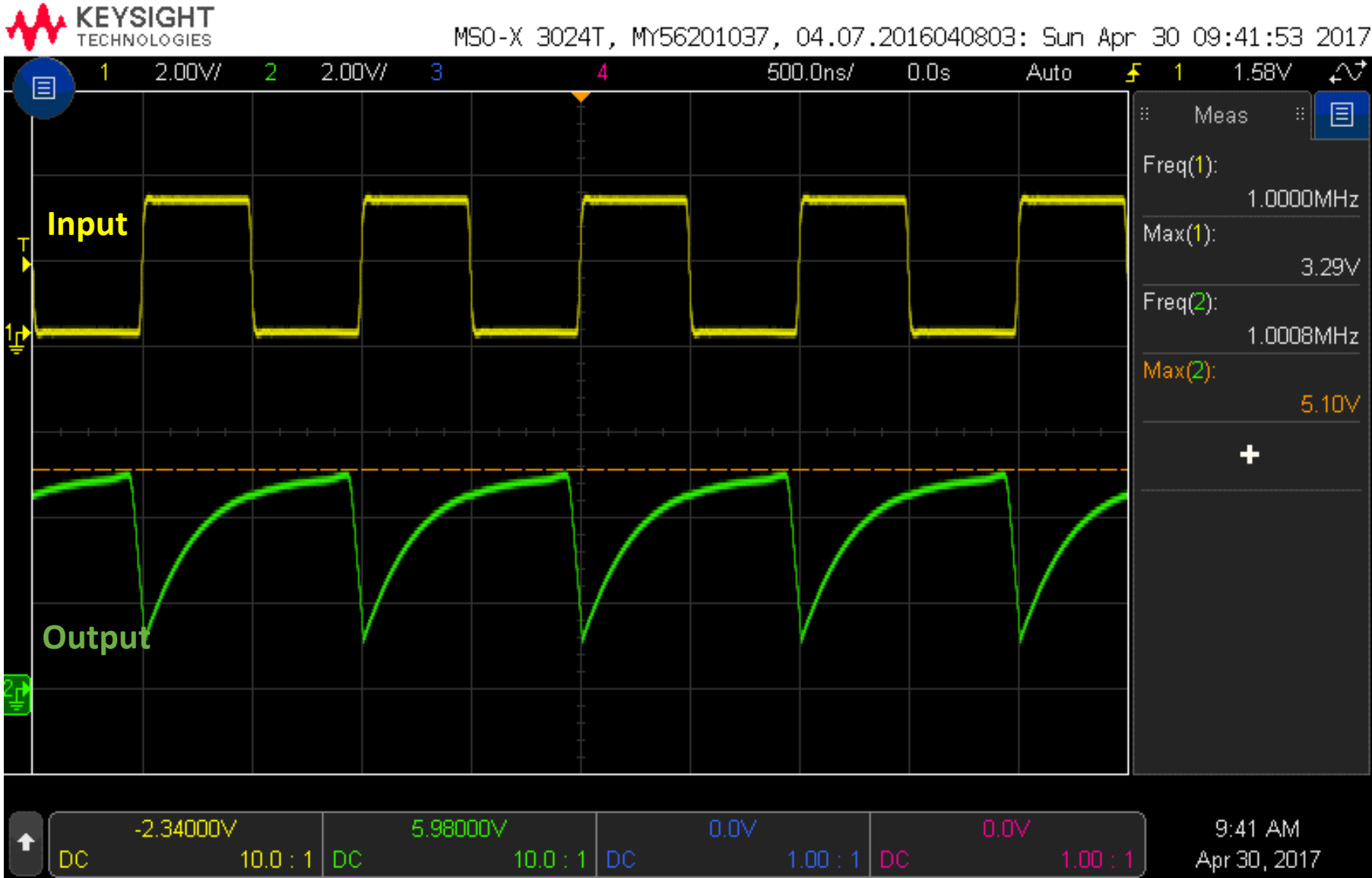
Input is 500kHz square wave (3.3V logic level)

Unusable at this frequency



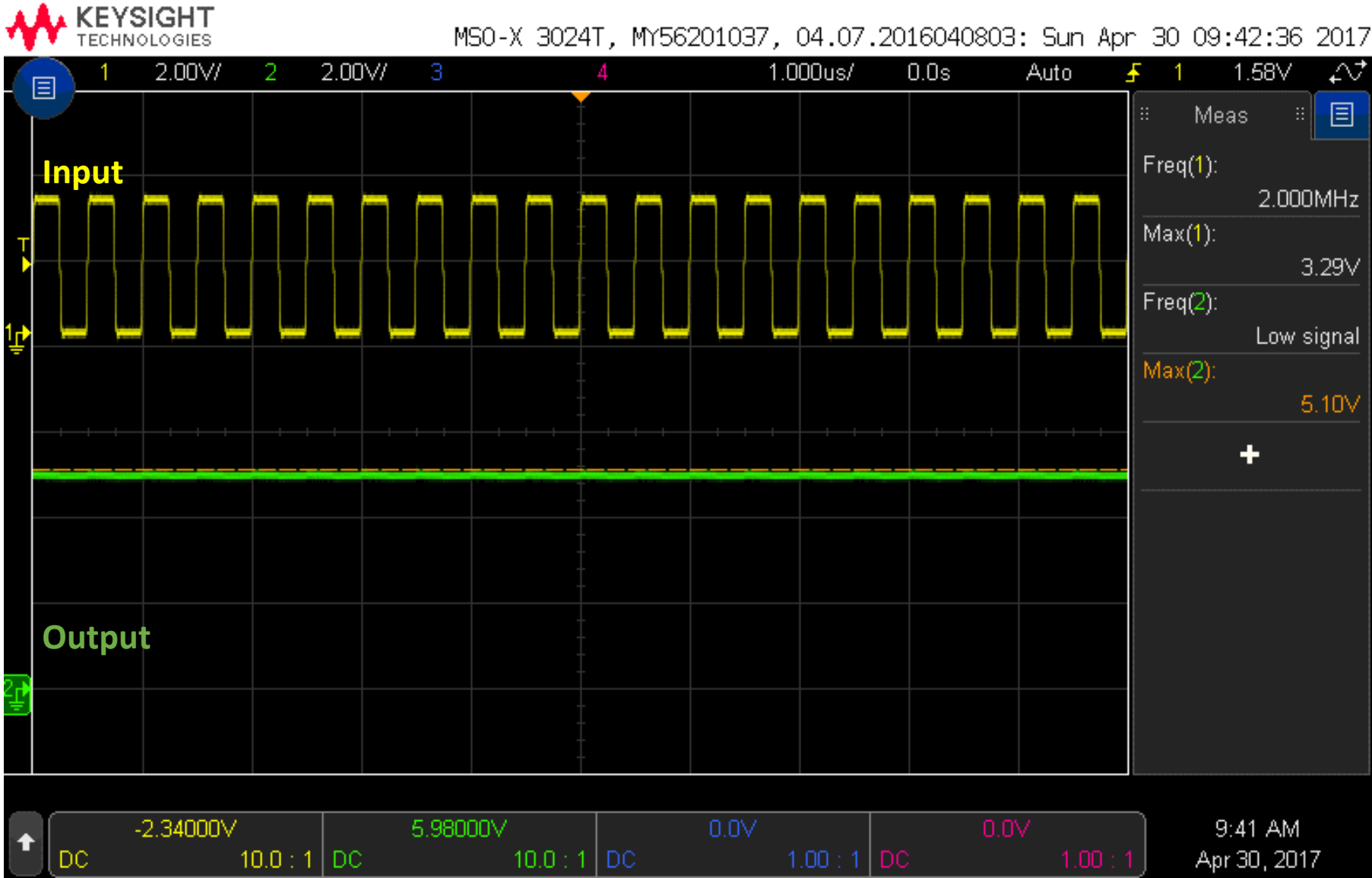
Input is 1MHz square wave (3.3V logic level)

Unusable at this frequency

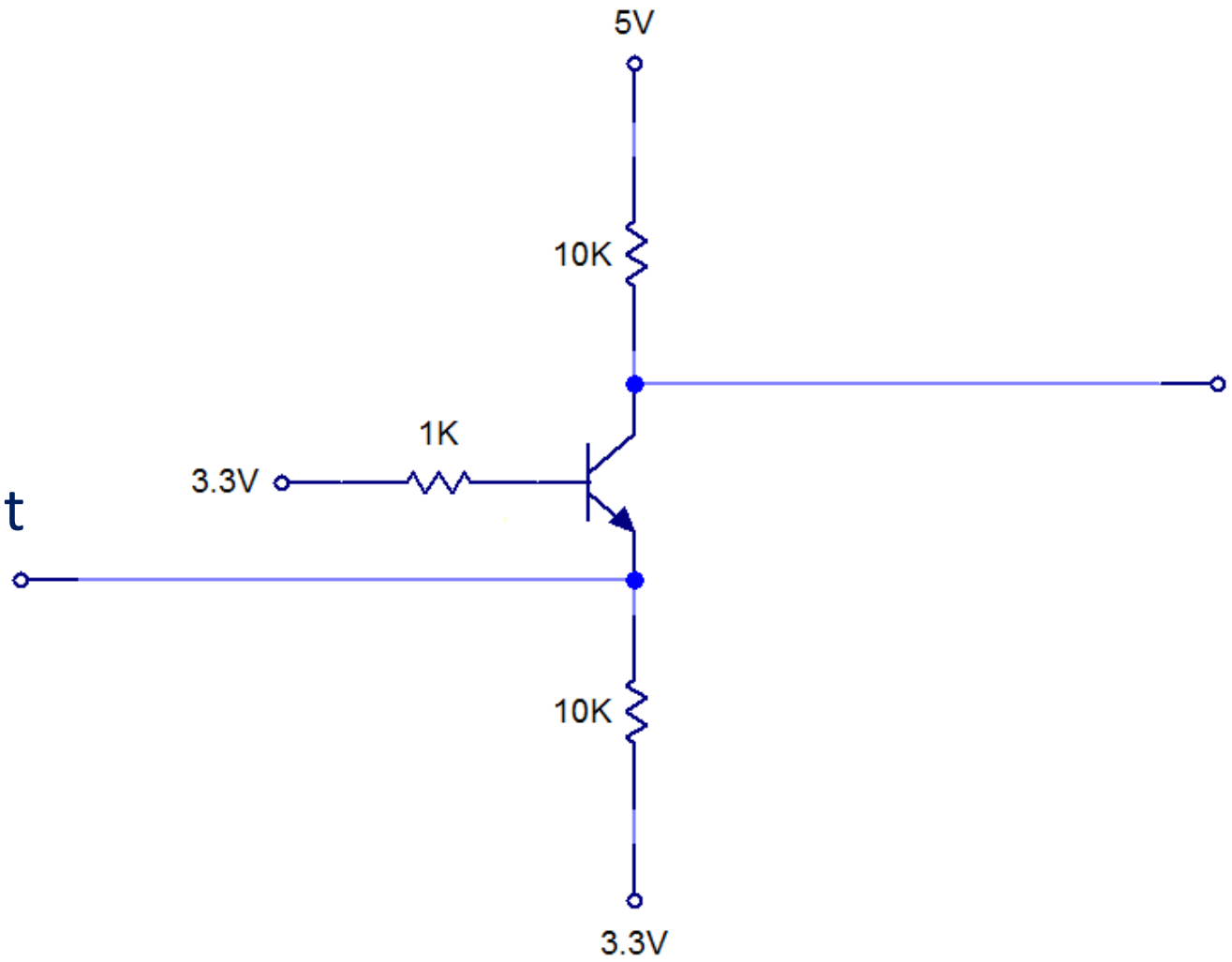


Input is 2MHz square wave (3.3V logic level)

Unusable at this frequency



Single-transistor (bidirectional shifting)



Digital input/output
(5V logic level)

Digital input/output
(3.3V logic level)