0.1 Part 1

The common-drain amplifier shown in Figure 1 is constructed, using two $10k\ \Omega$ resistors in parallel for the $5k\ \Omega$ resistor. These resistors are measured to have a parallel resistance of $4.924k\Omega$.

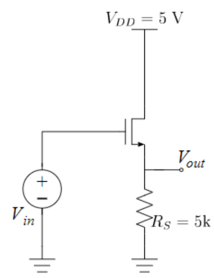

Figure 1: Circuit 1

With V_{DS} constant at 5V, V_{GS} is swept from 0 to 5V to obtain the voltage transfer characteristic shown in Figure (2) and Table (1).

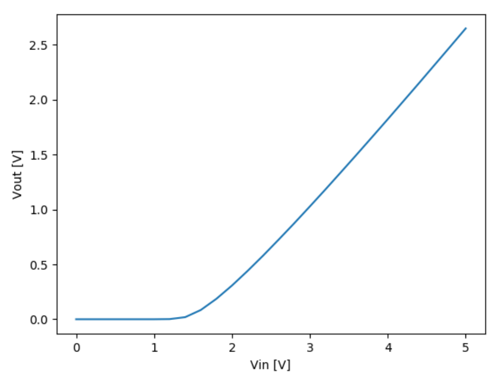

Figure 2: V_{out} vs V_{in} for the Common-Drain Amplifier

Table 1: Figure (2) Data

Vin [V]	Vout [V]
0.0	0.00
0.2	0.00
0.4	0.00
0.6	0.00
0.8	0.00
1.0	0.00
1.2	0.0014
1.4	0.0191
1.6	0.0842
1.8	0.186
2.0	0.307
2.2	0.440
2.4	0.580
2.6	0.726
2.8	0.875
3.0	1.028
3.2	1.183
3.4	1.341
3.6	1.500
3.8	1.661
4.0	1.823
4.2	1.987
4.4	2.151
4.6	2.317
4.8	2.483
5.0	2.650

For this circuit, $V_{out} = I_D R_S$, so $V_{out} = 0$V while the transistor is in cutoff. Afterward, even when Vin = 5V, V_{DS} is more than $V_{in} - V_t$ so that the transistor is in saturation any time it is on. The threshold voltage appears to be around 1.4V. For maximum possible input swing, the circuit is biased at the middle of the saturation region $V_{GS} = 3.3$V.

Next, a 10mV signal is applied to V_{in}, starting off at 1kHz under the assumption that the amplifier performs better when at lower frequencies. The amplifier should have a higher low-frequency gain because of the transistor's parasitics, such as the junction and diffusion capacitances in the BJT. At higher frequencies, these parasitic capacitances dominate, causing the BJT to act like a low-pass filter, thereby decreasing the high-frequency gain. The frequency is subsequently increased to 100kHz and then 1MHz. Oscilloscope screenshots are shown for each frequency in Figures (3), (4), and (5), respectively. The gains at each frequency are tabulated in Table (2).

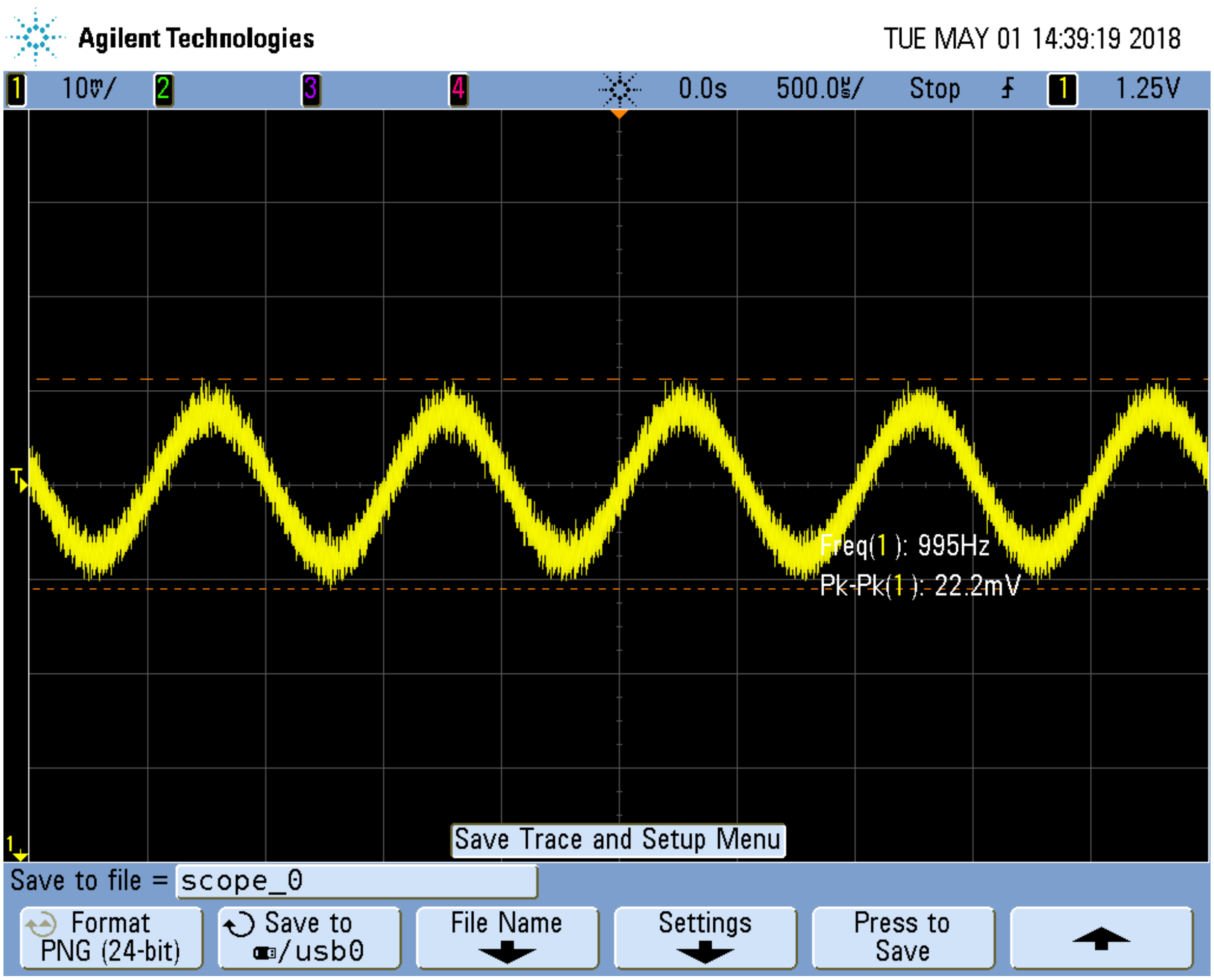

Figure 3: Amplified Waveform of a 1kHz Signal of Peak-to-Peak Amplitude of 20mV

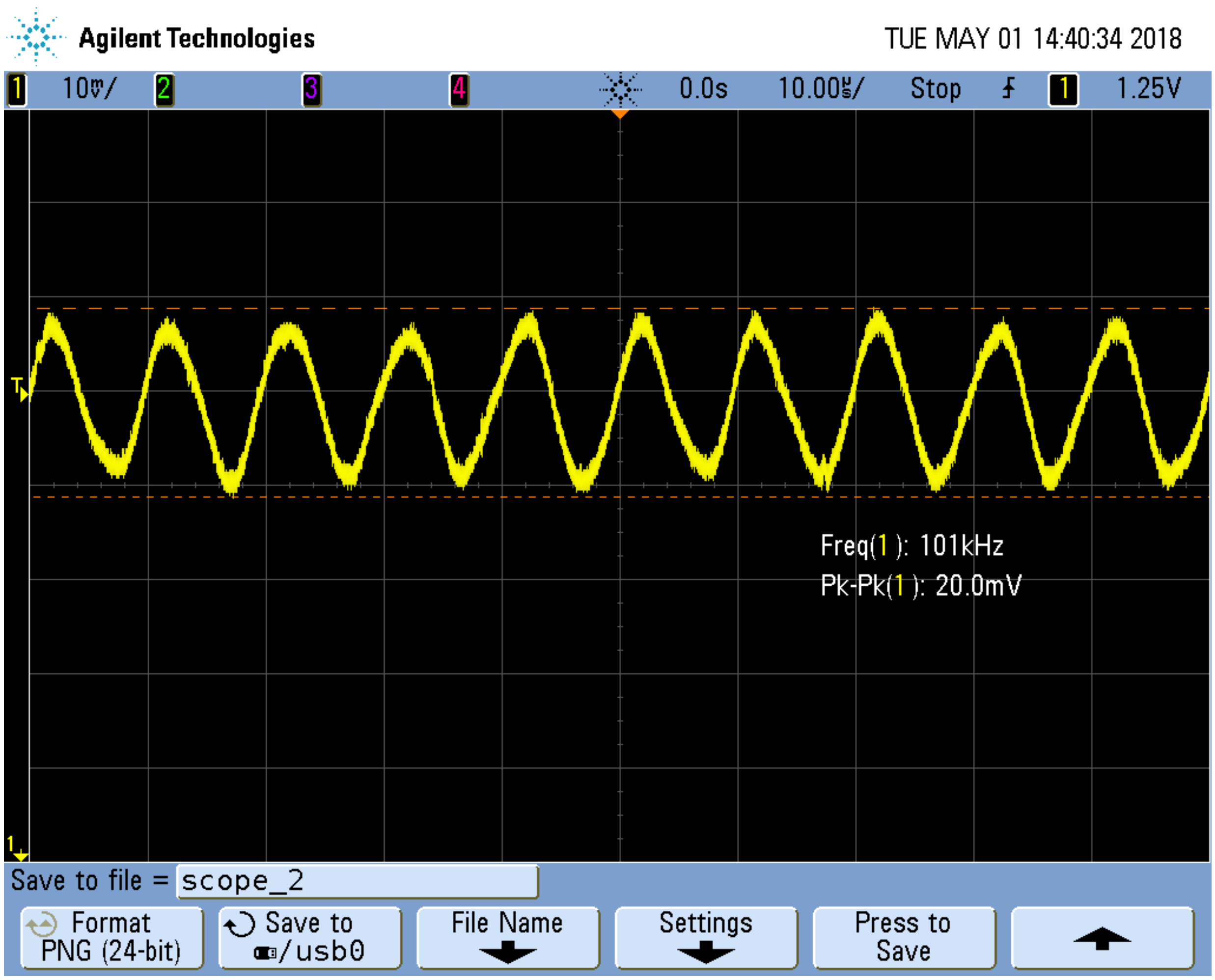

Figure 4: Amplified Waveform of a 100kHz Signal of Peak-to-Peak Amplitude of 20mV

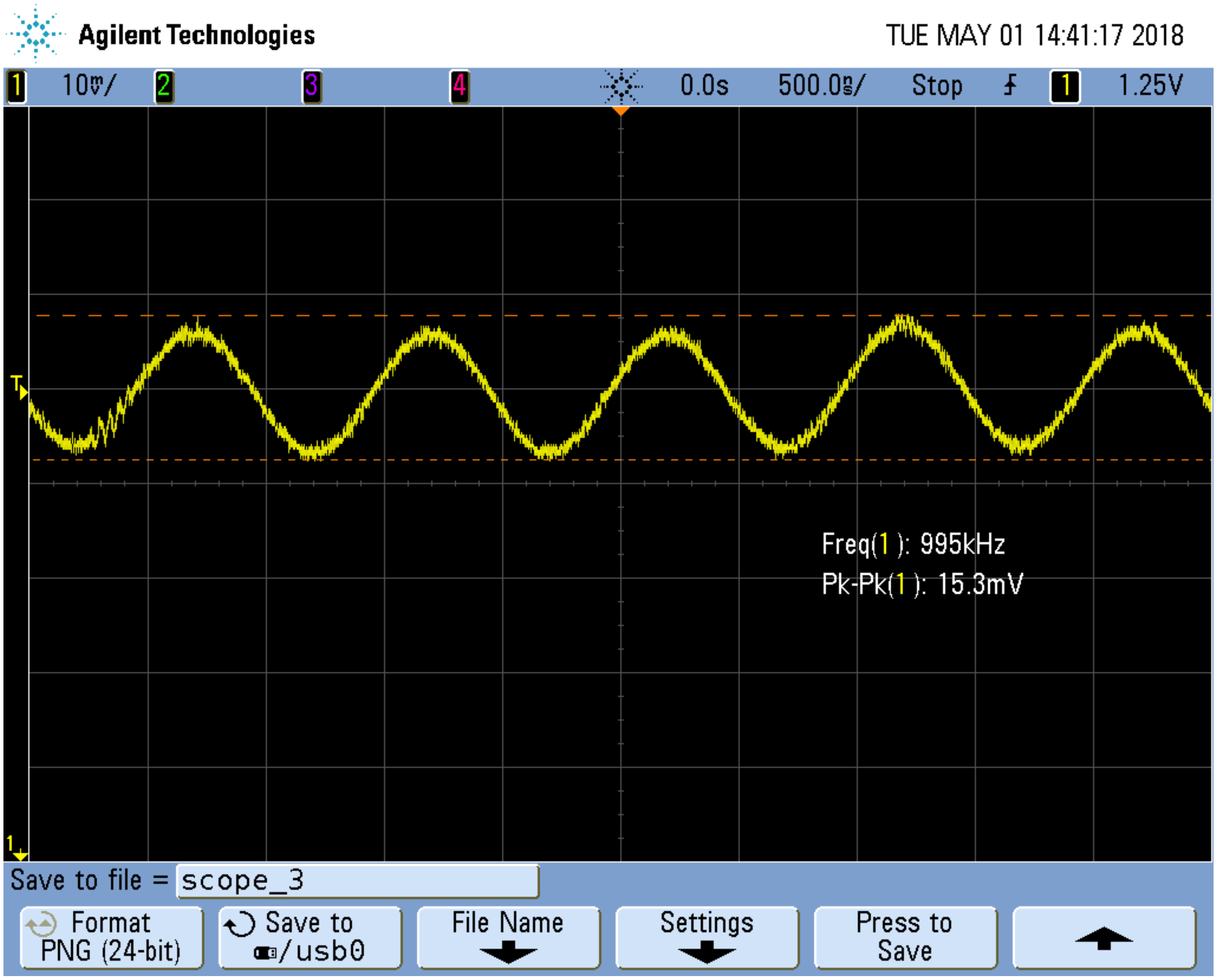

Figure 5: Amplified Waveform of a 1MHz Signal of Peak-to-Peak Amplitude of 20mV

Table 2: Figure (5) Data

Frequency [kHz]	Gain [V/V]
1	1.11
100	1.00
1000	0.77

The varying gains as a function of frequency shows that the amplifier is not as effective at higher frequencies. In order for this circuit to function as a voltage follower or buffer as it is intended, the signal frequency should stay near

100kHz.

This procedure is repeated when biasing the transistor 10mV higher. Results are shown in Figures (6), (7), and (8), respectively, and gains are tabulated in Table (3).

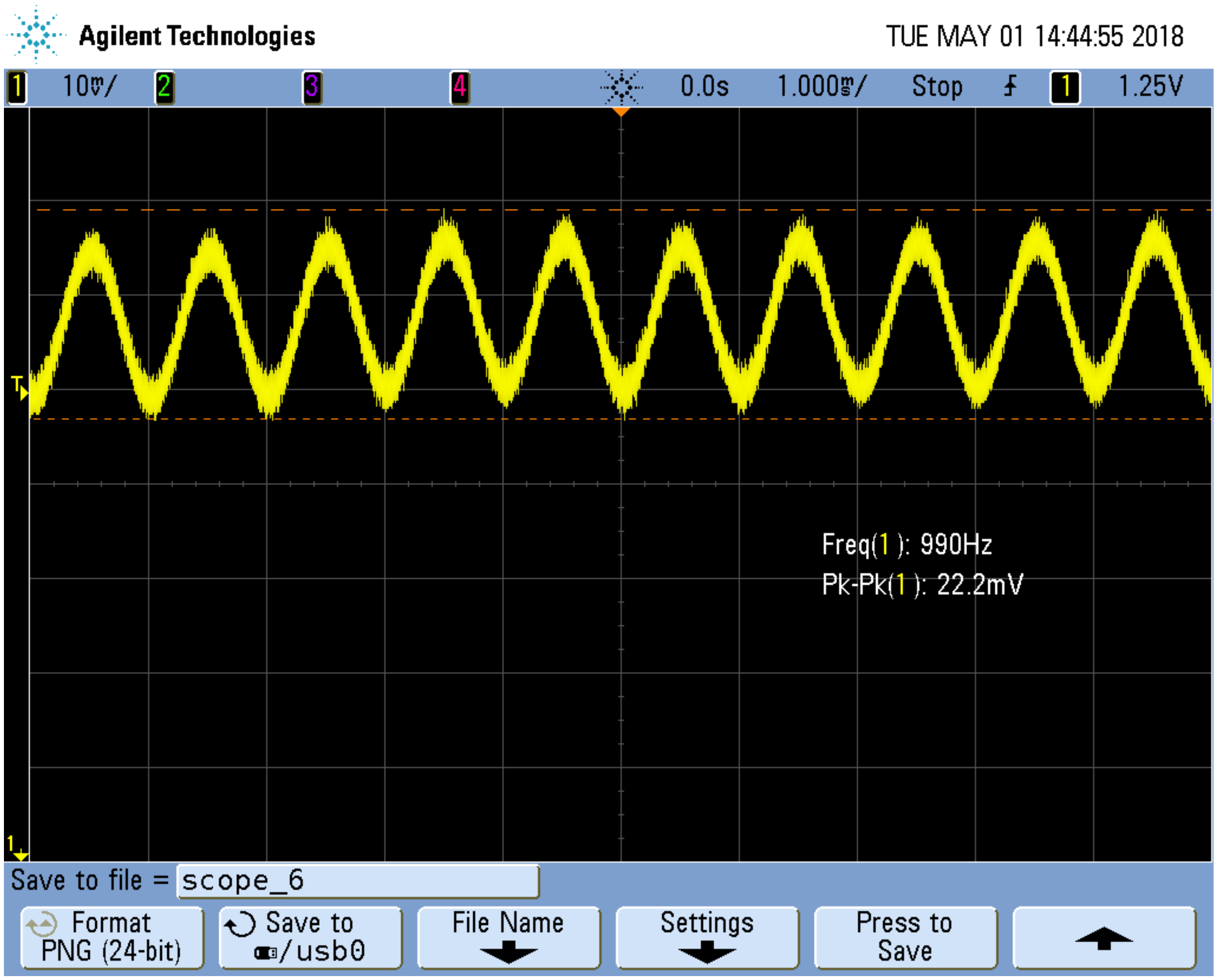

Figure 6: Amplified Waveform of a 1kHz Signal of Peak-to-Peak Amplitude of 20mV

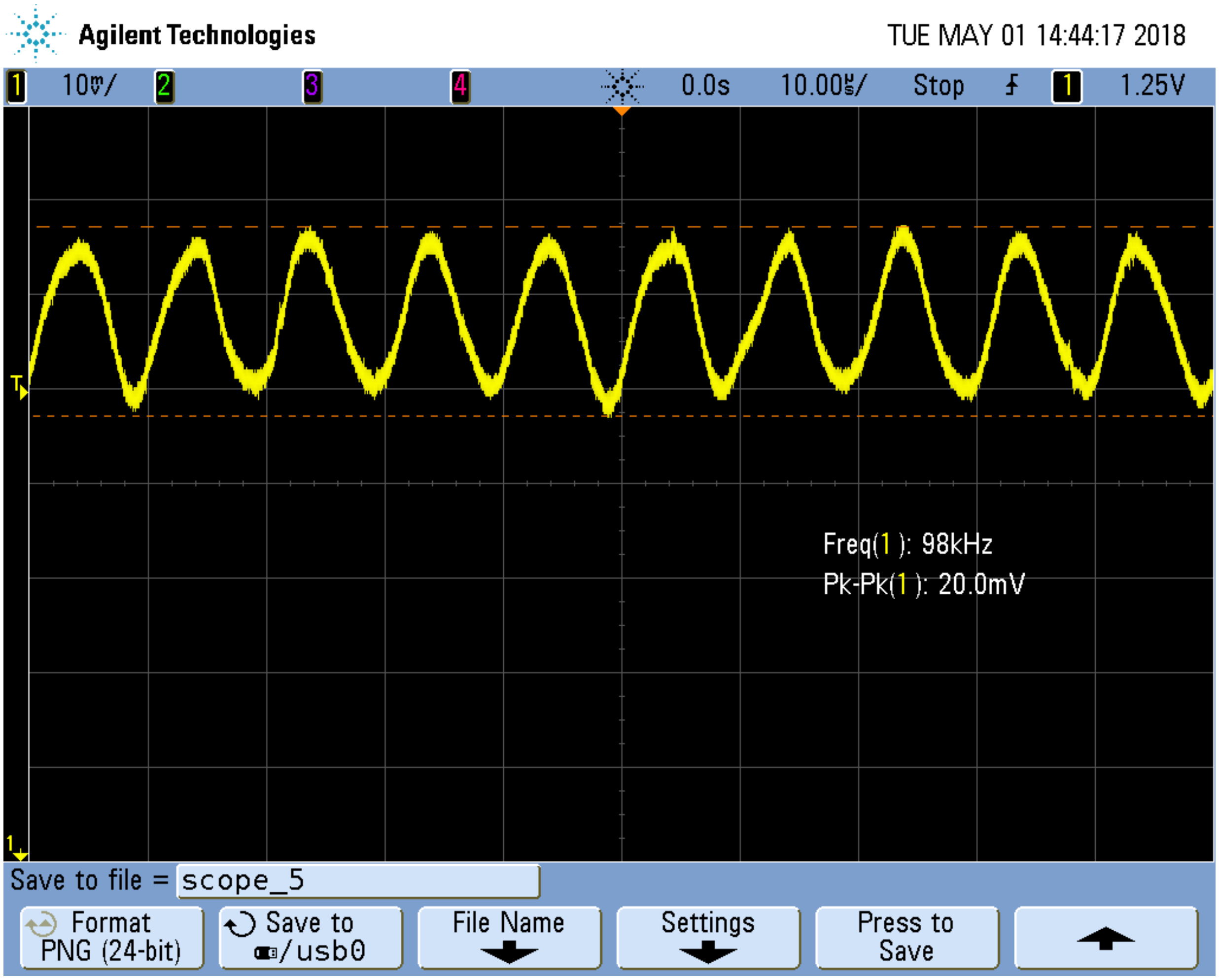

Figure 7: Amplified Waveform of a 100kHz Signal of Peak-to-Peak Amplitude of 20mV

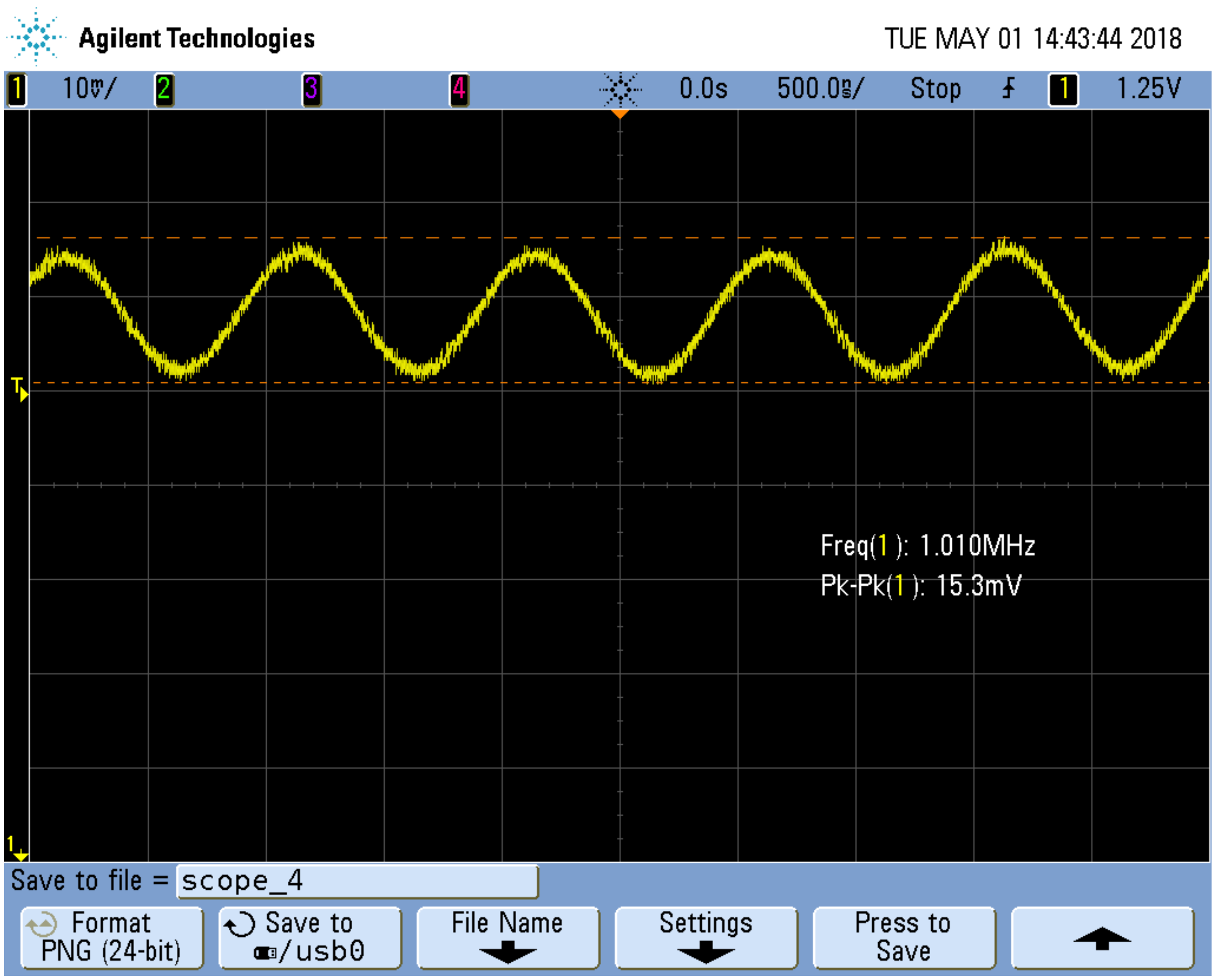

Figure 8: Amplified Waveform of a 1MHz Signal of Peak-to-Peak Amplitude of 20mV

Table 3: Figure (8) Data

Frequency [kHz]	Gain [V/V]
1	1.11
100	1.00
1000	0.765

Due to the nearly uniform slope of the VTC in the saturation region, the gain as a function of the bias voltage is nearly constant. Thus, these waveforms and gains are practically identical to what is observed earlier.