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Application Note

TDC-GP30

External circuit for gas meters

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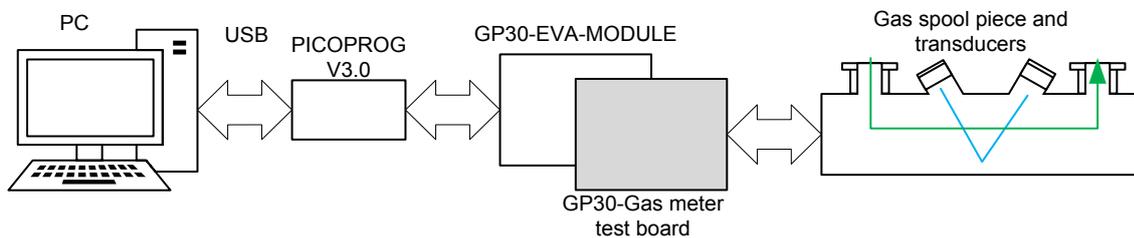
1 Introduction

TDC-GP30Y is an ultrasonic flow converter (UFC) mainly for ultrasonic heat and water meters. However, the TDC-GP30 can cooperate with external analog switches and an amplifier for operation in other ultrasonic applications like clamp-on or gas flow meters. In this so-called gas meter mode the chip uses the available GPIO pins to drive external analog switches with higher voltages. An external amplifier in the receive path can be added, too. In the following we describe such an external circuit in combination with the GP30-EVA-KIT.

1.1 Setup

The figure below shows the general setup of the system.

Figure 1: General Setup



The gray colored unit is the external test board GP30Y – Gasmeter V1.1 which drives the ultrasonic transducers for gas flow measuring applications. PicoProg and GP30-EVA-MODULE are the standard products of ams.

1.2 The Parts of the System

The following table shows the parts required for the system.

Figure 2: Elements of the test setup

A) GP30Y Evaluation Board



B) PicoProg V3.0



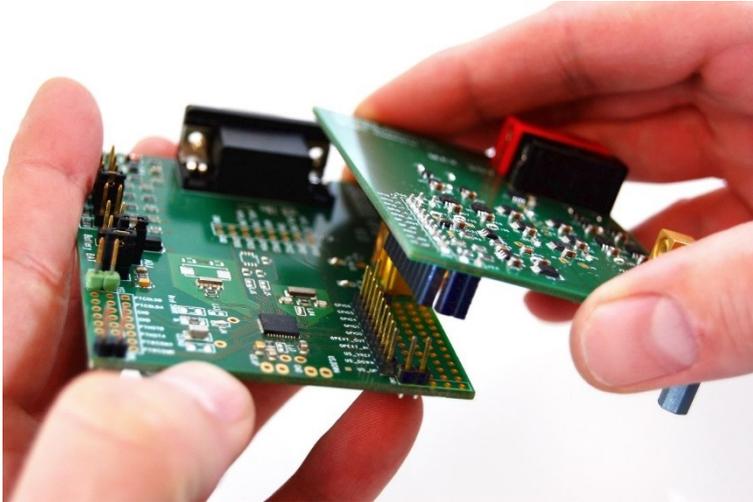
C) GP30Y Gasmeter V1.1



2 Quick Start

- 1 First thing to do should be the installation of the system. Therefore, please first plug the Gasmeter V1.1 on to the GP30-EVA-MODULE as it is shown in the figure below.

Figure 3: Connection of the Gasmeter V1.1 with the EVA-MODULE



- 2 Connect the PicoProg V3.0 (or V2.0, if you have an old one) to the EVA-MODULE. For the moment do not connect the USB cable to the PC.

Figure 4: Connect PICOPROG



- 3 Now install of the ams GP30 evaluation software. For details see chapter 3. If the software and PicoProg driver is already installed then you can skip this section and continue with item 4.
- 4 Start the software and connect the PicoProg and the PC by means of the USB cable.
- 5 Click on **System Reset** button. The two indicators on the GIU, namely **Pico Prog FW Version** and **Comm. With GP30 OK?** should now turn to green.
- 6 The next step is loading the configuration file and writing it to the GP30. Therefore, go to **File ► Open Config**
Search for the specific configuration file for gas meter applications:

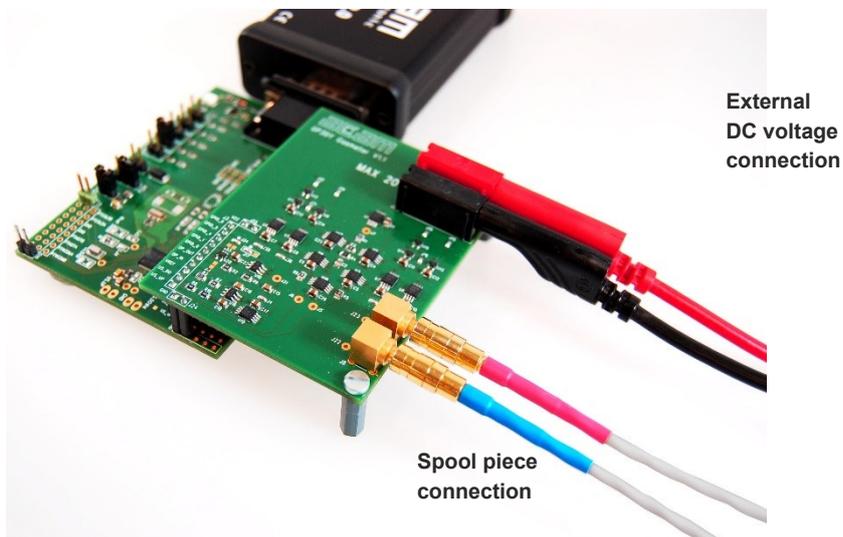
GP30y_config_GasMeter_[Project Name].cfg

⚠ Caution! Never use configuration files other than for gas meters, as long as the gas meter board is plugged and energized by external voltage.

- 7 Click on the **Write Config** button to write the configuration file into the TDC-GP30 chip.
- 8 Connect the external voltage source (9 to 20 V) and the transducers (spool piece) to the Gasmeter V1.1. Please refer to the figure below. You can now energize the Gasmeter V1.1 with an external DC voltage which will define the peak voltage of the ultrasonic fire pulses.

⚠ Caution! The maximum external dc voltage that the board can bear is 20V. However, the maximum ratings of the transducers should also be taken into account.

Figure 5: Connection of the transducers and power supply



The cable connection of the transducers for test purposes is shown, too.

- 9 Click on **Start Measurement** button to start the measurement process. After this step, the chip should start measurement and the results should be seen at the software. For the graphical demonstration of the results please open the graph view by clicking on **Open TOF Graph**.

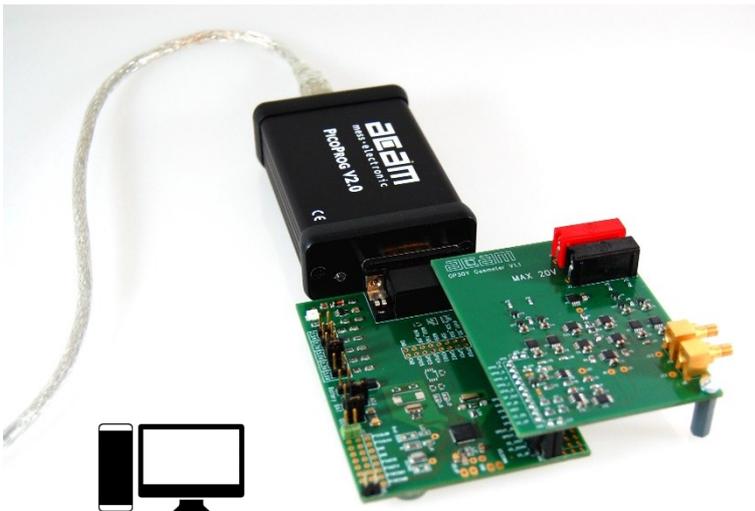
3 Installation of the Software

There is a set of files required for installation of the PicoProg and the GUI (Graphical User Interface) of the development kit. The file structure is shown below and the steps to do the installation follow.

- 1 Open the directory  acam GP30 Installer v1_5_2 (version 1.5.2 or newer) and the **Volume** directory inside. Run **Setup.exe** (installer). Now select the installation path, recommended is the default setting. Then click to “Next” and confirm the license agreement. After that, a window appears that shows a summary of the software (includes the **PicoProg** driver) to be installed. This part of the installation can take some minutes to complete.
- 2 Restart the computer.
- 3 Set up the hardware connections as previously explained. Then connect the USB cable to the PC (figure 6). So that the USB device (PicoProg v2.0) is installed on a Windows PC. Double check that the `<picoprogram v2.0 unprogrammed>` shows up as a functioning USB device in the Windows Device Manager similar to this,

 picoprogram v2.0 unprogrammed

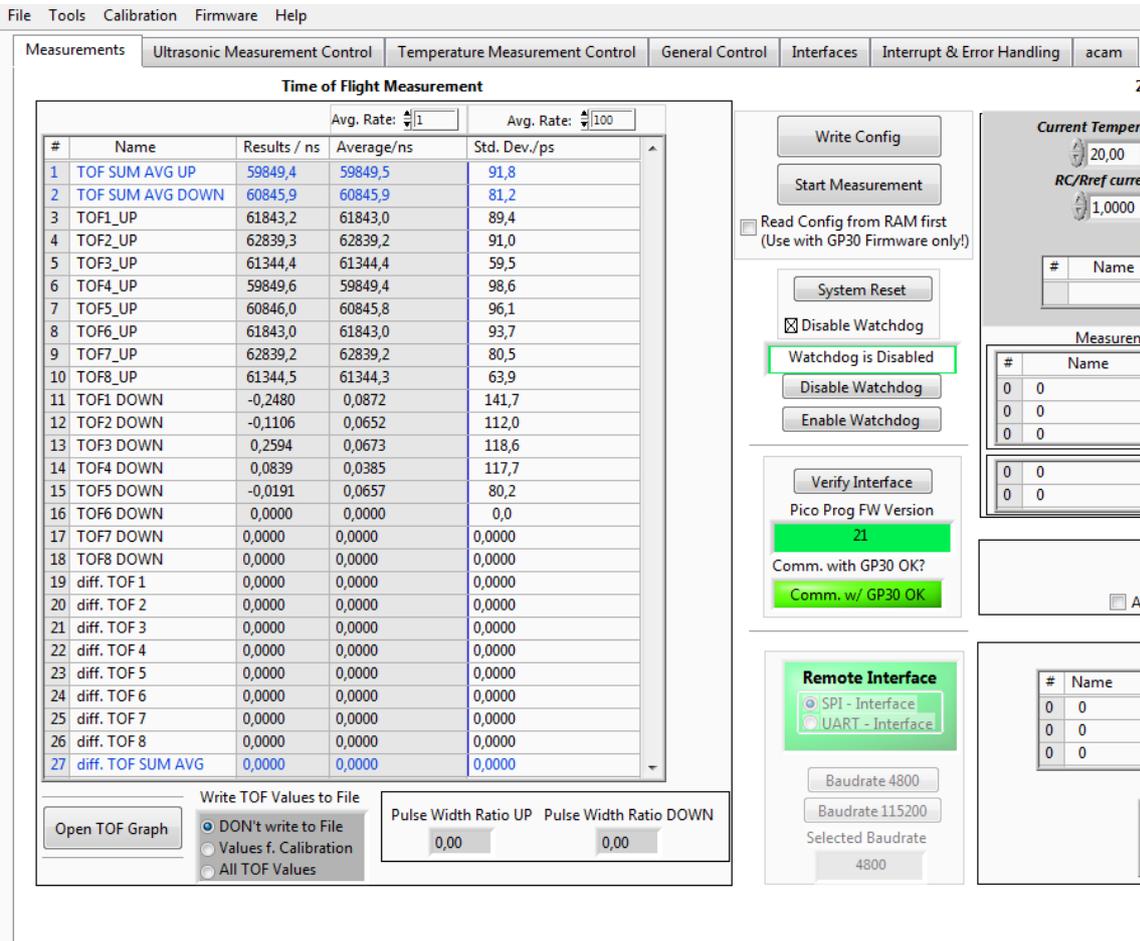
Figure 6: Connect PICOPROG and PC



Only in case it is not showing up or not properly installed, please run the **PicoProg Driver Installer**. To do so, navigate to and run **Setup.exe** (installer). You will need to hit **Next** a few times to complete the installation.

- 4 Run the GUI software by clicking on  GP30_v1_5_2
You may be prompted for a **GP30 Evaluation License Code** to unlock the software. If so, please send an email request to support.stutensee@ams.com to request an unlock code with validity for one year. Enter the code provided into the dialog box and the software will unlock.

Figure 7: Graphical user’s interface (GUI) of the GP30 evaluation software.



5 Click on System Reset button.

The two indicators on the GIU, namely Pico Prog FW Version and **Comm. With GP30 OK?** should now turn to green. First one indicates that there is communication between the computer and the PicoProg. The second indicator verifies if the communication is working to the GP30-EVA-MODULE.

4 Circuit Design in Detail

The circuit design and the layout of the **Gasmeter V1.1** can be seen in section 5.

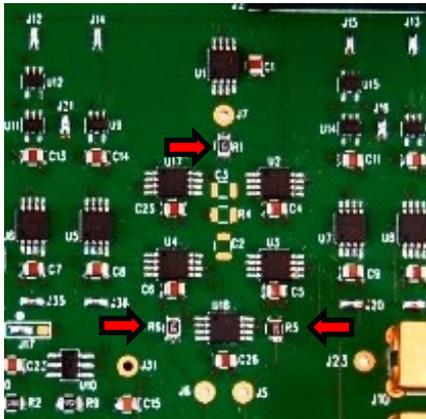
Basically, the **Gasmeter V1.1** is designed to send ultrasonic fire pulses that have relatively high peak values and amplify the received signal to a value which is meaningful for the GP30. The circuit was designed for development and test purposes, therefore there are many things added to increase the flexibility, observability and immunity against other disturbances.

Maybe the number of devices used is also not quite as less as it could be. For instance the quantity of some analog switches, e.g. **U2** and **U17**, could be decreased to one, or instead of separate housing 2 switches at one device could be used... However to decrease crosstalks and increase the robustness such savings haven't been done.

In the circuit the jumpers can be seen almost everywhere (**J19**, **J20**, **J21**, etc.). This was done for the sake of flexibility. Because it makes it quite easy to separate certain parts from the whole circuit and see its advantages/disadvantages to the system.

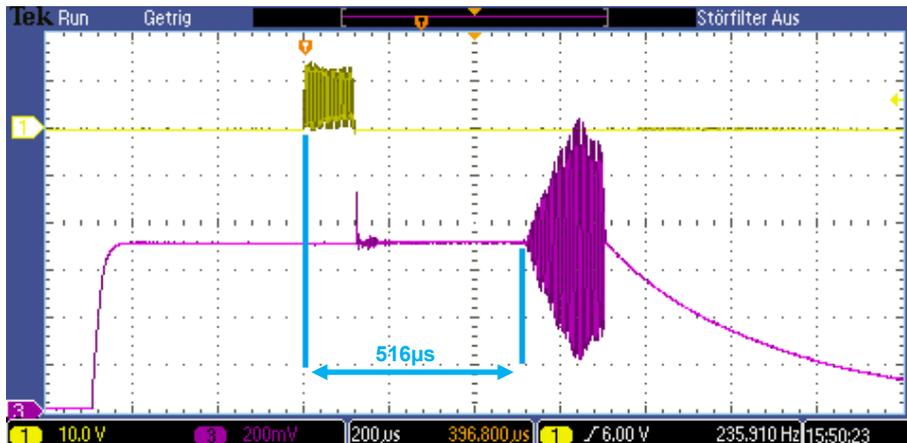
Moreover, the circuit has been equipped with some test points. So that it is easily observed what is actually going on in that certain point of the circuit. On **J5** and **J6** the sent signal or the received signal before the amplification can be seen. The amplified received signal can also be seen on **J31**. The circuit is coming with a default assembly of 560 Ohm resistors in the driver/Receiver patch. For transducers with different impedance resistors **R1**, **R5** and **R6** need to be matched to the transducer.

Figure 8: Resistors to adopt to transducer's impedance



The figure below was taken from the oscilloscope while the GP30 was performing zero flow measurement. The oscilloscope was triggered by the signal on **J5** and the amplified received signal was seen on **J31**. The fire pulses (yellow signal) have 13Vpp values while the received signal on the transducer is only around 20mVpp. Without amplification this value is just senseless and impossible to be detected by GP30. Therefore an external amplification unit has been used on the circuit which also is controlled by the GP30. After opamp, the received packet reaches to 500mVpp.

Figure 9: Send and receive signals

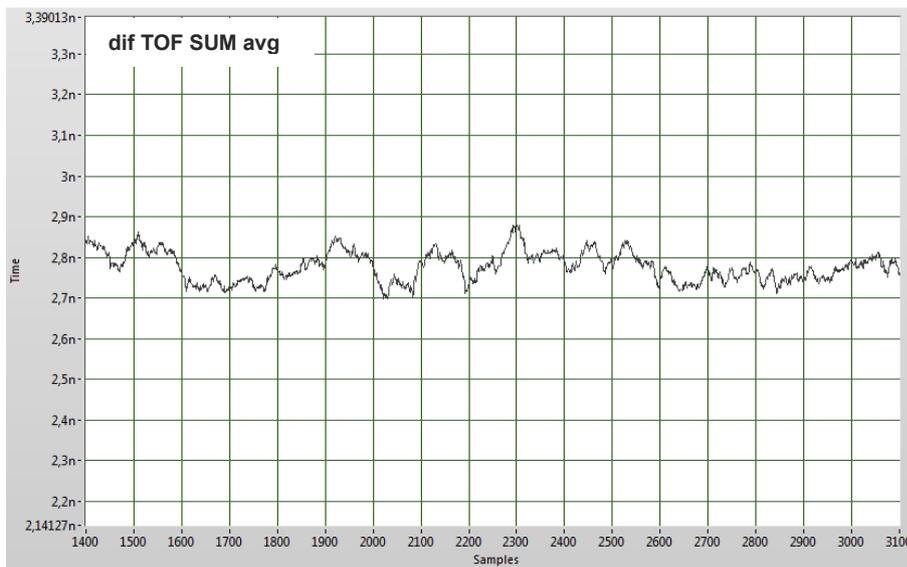


Note: Oscilloscope view of the signals. Yellow: Sent signal (fire pulses), 13Vpp. Purple: Received signal, amplified, ~500mVpp(max). The time of flight between transducers is 516µs for air at room temperature.

The figure shows the received signal after the amplification (purple signal). It can be seen that the distance between the first hit of the fire pulses and the moment that the receiving transducer starts to oscillate is around 516µs.

At the same time the measurement results can be seen on the graphical window of the GP30 Evaluation Software. The following figure shows this view.

Figure 10: Zero Flow Measurement results



Note: The standard deviation is ~10ps. (averaging factor 100).

In zero flow measurements the standard deviation is around ~10ps, which is already a promising and it shows quite stable measurement performance.

4.1 GPIO Signals

TDC-GP30 gas meter mode is turned on by setting TI_ERA_EN and TI_GM_MODE.

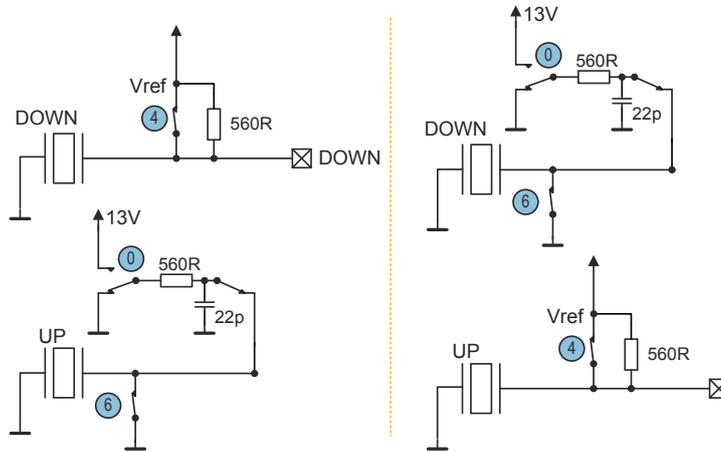
Figure 11: Setting gas meter mode in GUI



With this setting, general purpose IOs GPIO0, GPIO1, GPIO4 and GPIO6 provide the signals to control external analog switches.

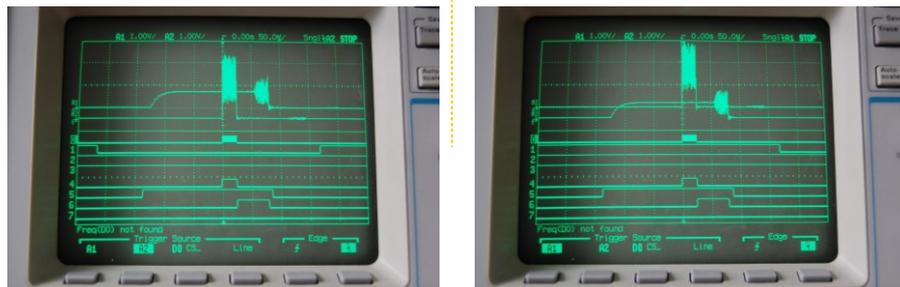
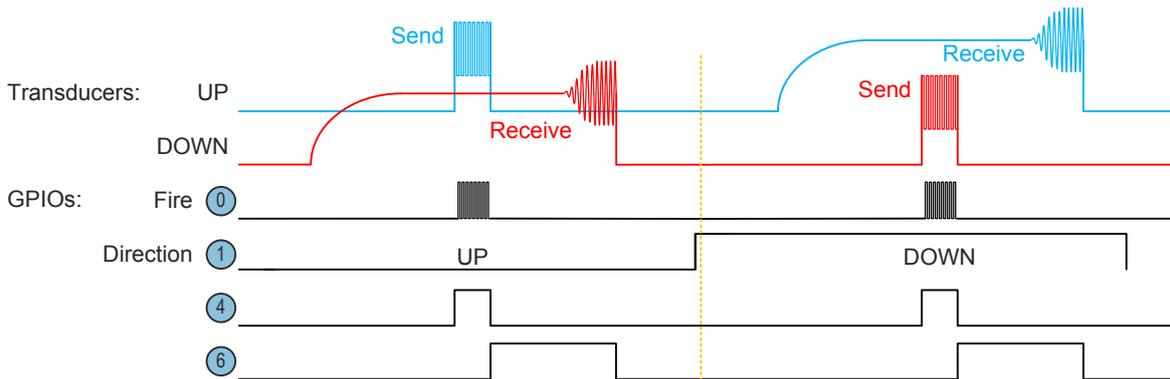
The following figure sketches the principal function of the circuit.

Figure 12: Basic diagram of switch functionality



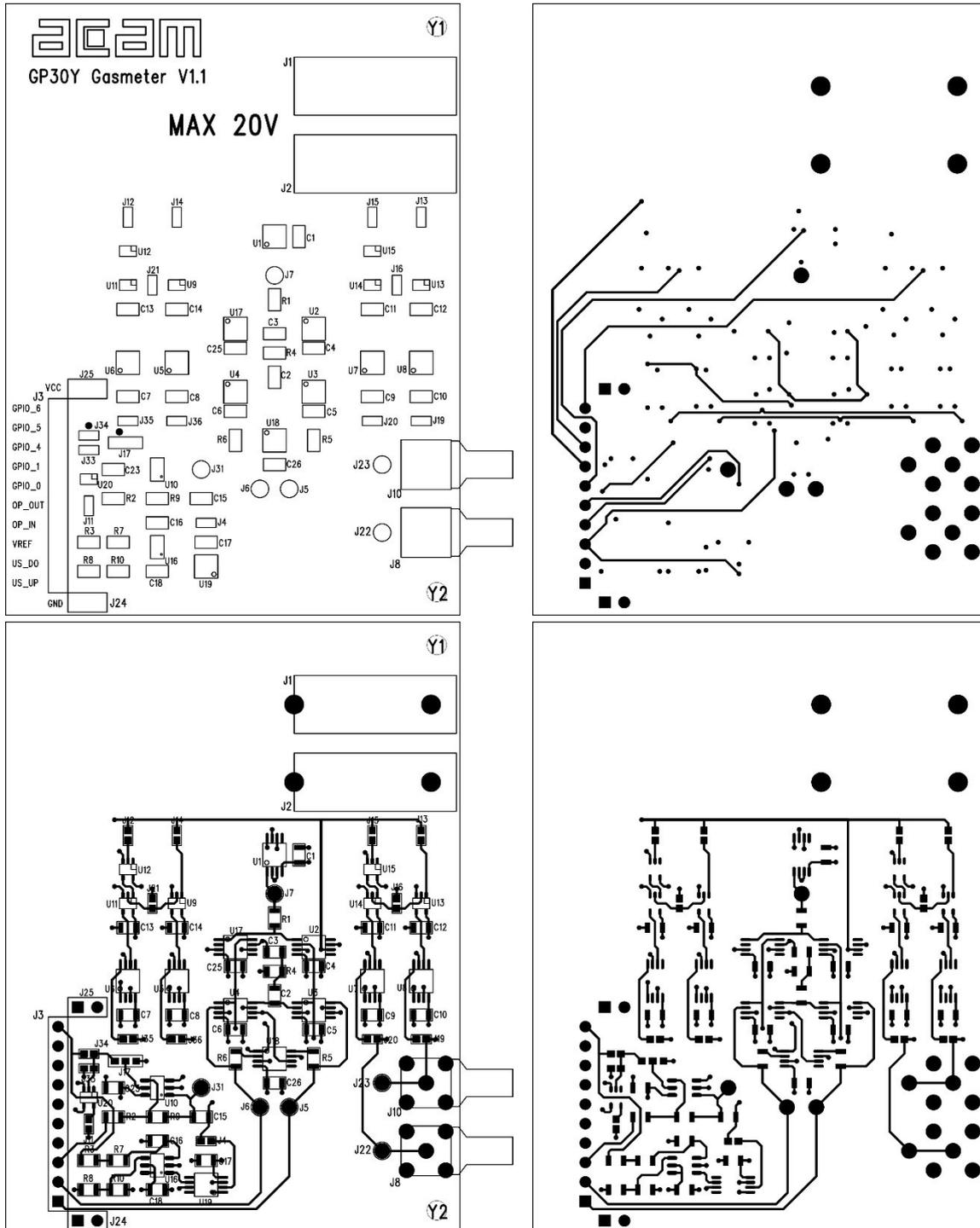
The next figure shows the individual signals.

Figure 13: Signal sequences

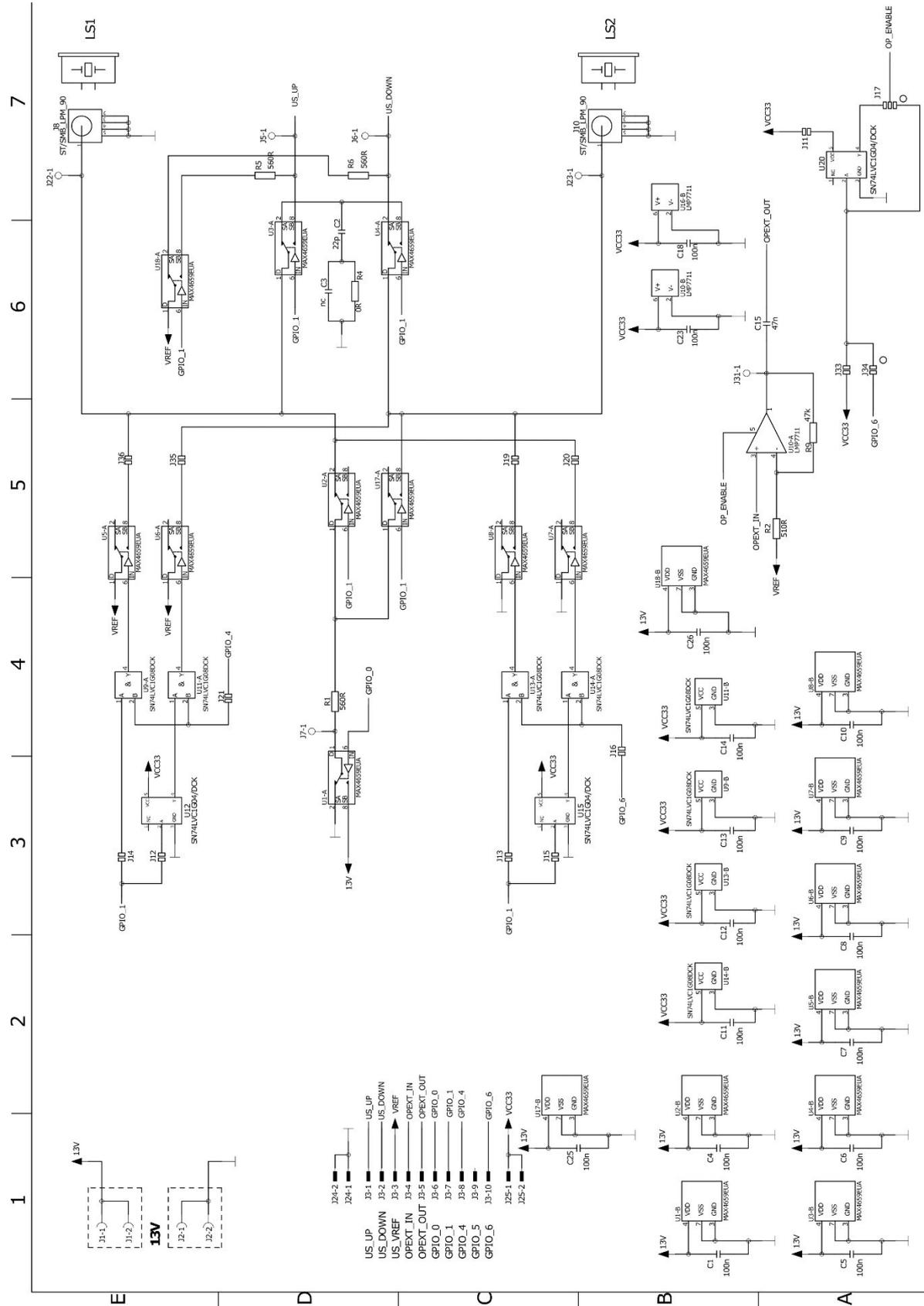


5 Hardware

5.1 Layout



5.2 Schematics



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8 Revision Information

Changes from previous version 0.1 to current revision 1-01 (2017-Jan-31)	Page
Transfer to corporate design	All
New section 4.1	9, 10

Note: Page numbers for the previous version may differ from page numbers in the current revision.

Correction of typographical errors is not explicitly mentioned.