

# How to Control Turn On/off Thresholds in Voltage Regulators Using a Logic Level UVLO

---

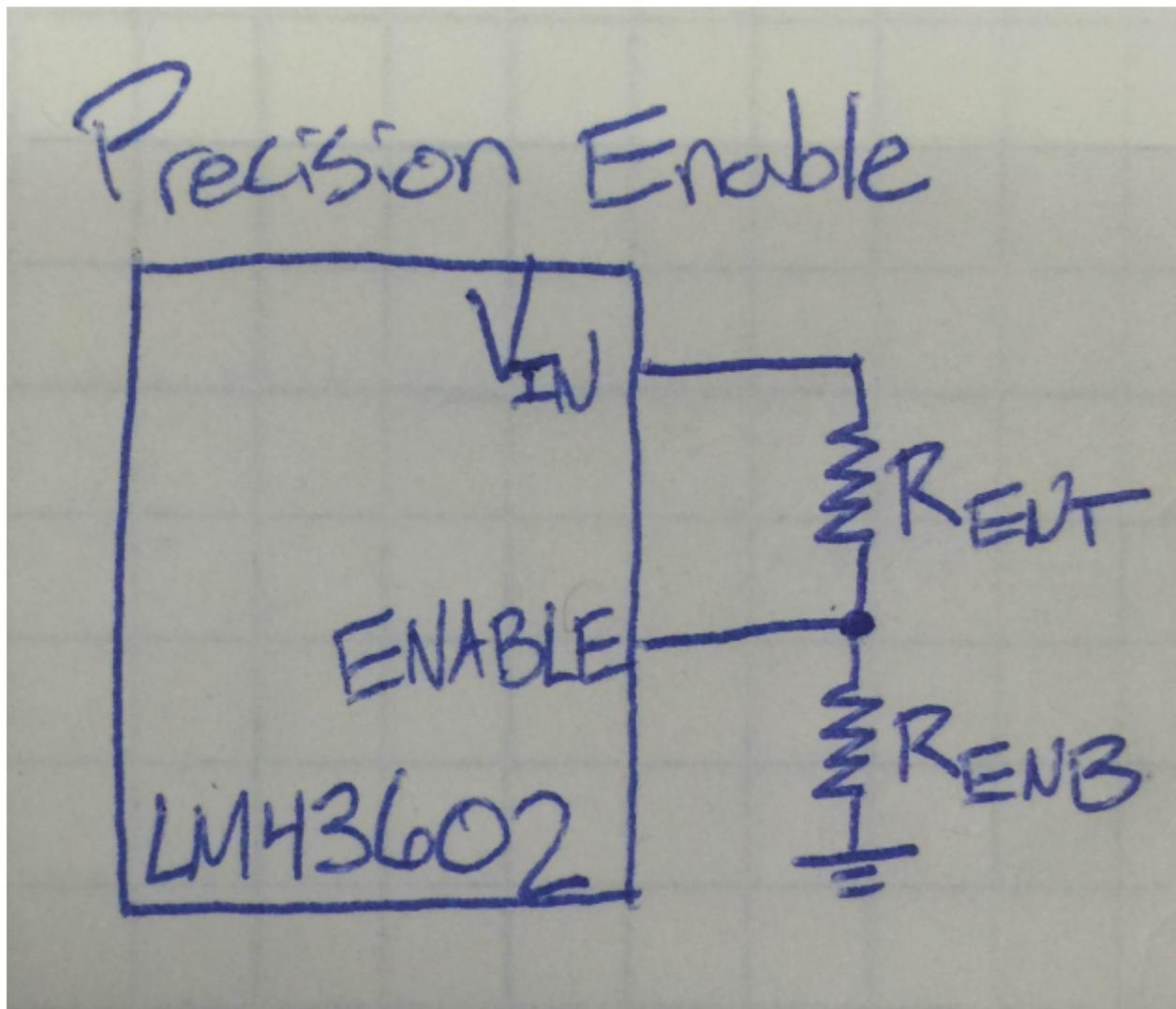


Gregory Cusack

When using a voltage regulator, it often happens that the converter will attempt to regulate the output even before the voltage on its input has reached the acceptable design level. As a result, in this condition, the converter will demand more current from the power supply, potentially current-limiting the power source. Also, the output voltage during this moment of operation may be out of spec, since the duty cycle of the regulator may be at its maximum value. To avoid this, we can use an under-voltage lockout circuit (UVLO) to set a specific input voltage threshold at which the converter turns on and off.

For most converters, there is either a precision enable or a logic level enable pin on the chip itself.

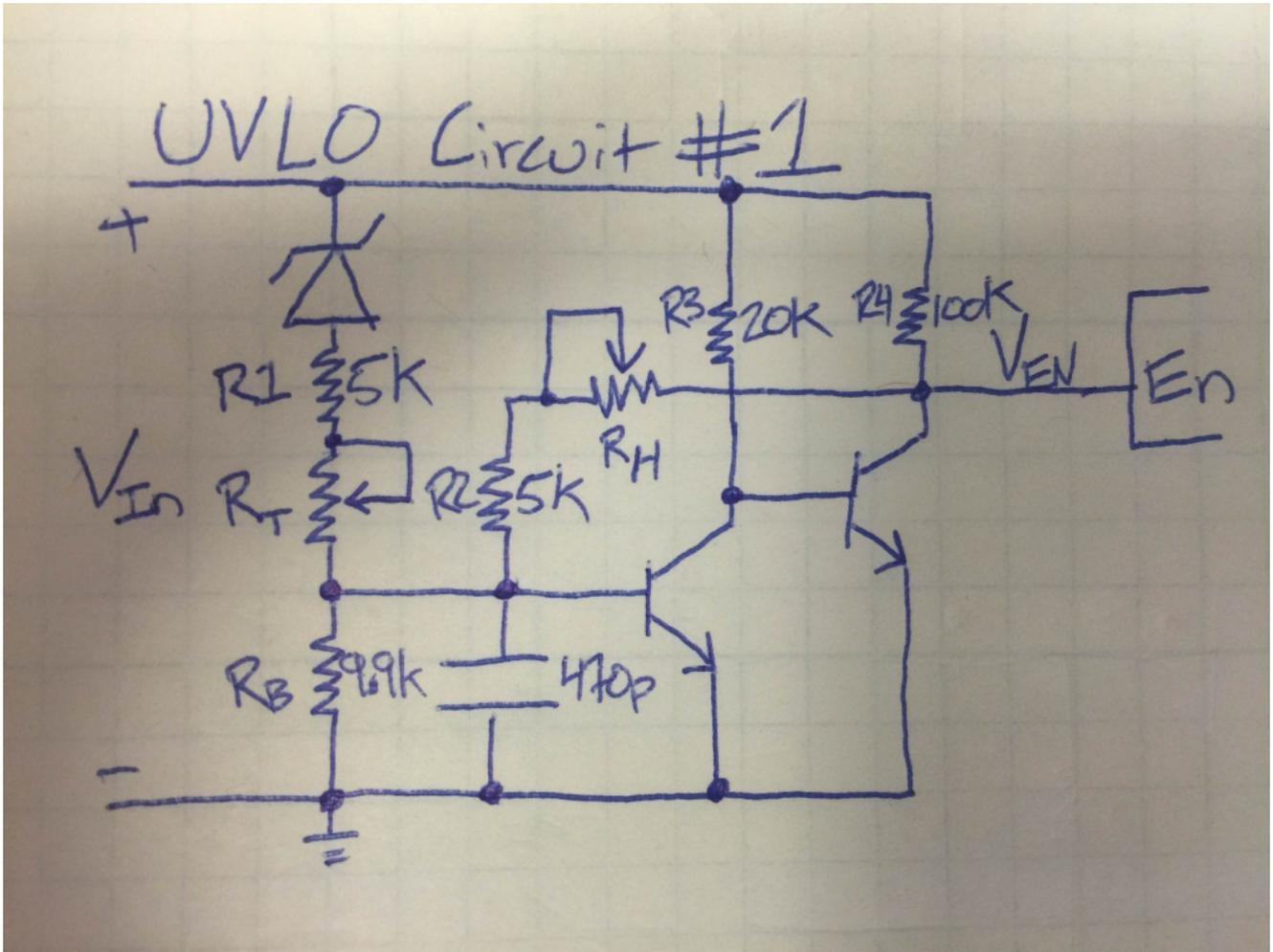
For converters with precision enable, the chip compares the voltage at the enable pin to some set, precise internal voltage reference. Providing an enable voltage above the internal voltage reference turns the converter on, and applying a lower voltage turns the converter off. As shown in [Figure 1](#), you can usually use just a voltage divider from  $V_{IN}$  to the enable pin to set a precise enable threshold based on the input supply voltage.



**Figure 1. Simple Switcher<sup>®</sup> LM43602 Enable**

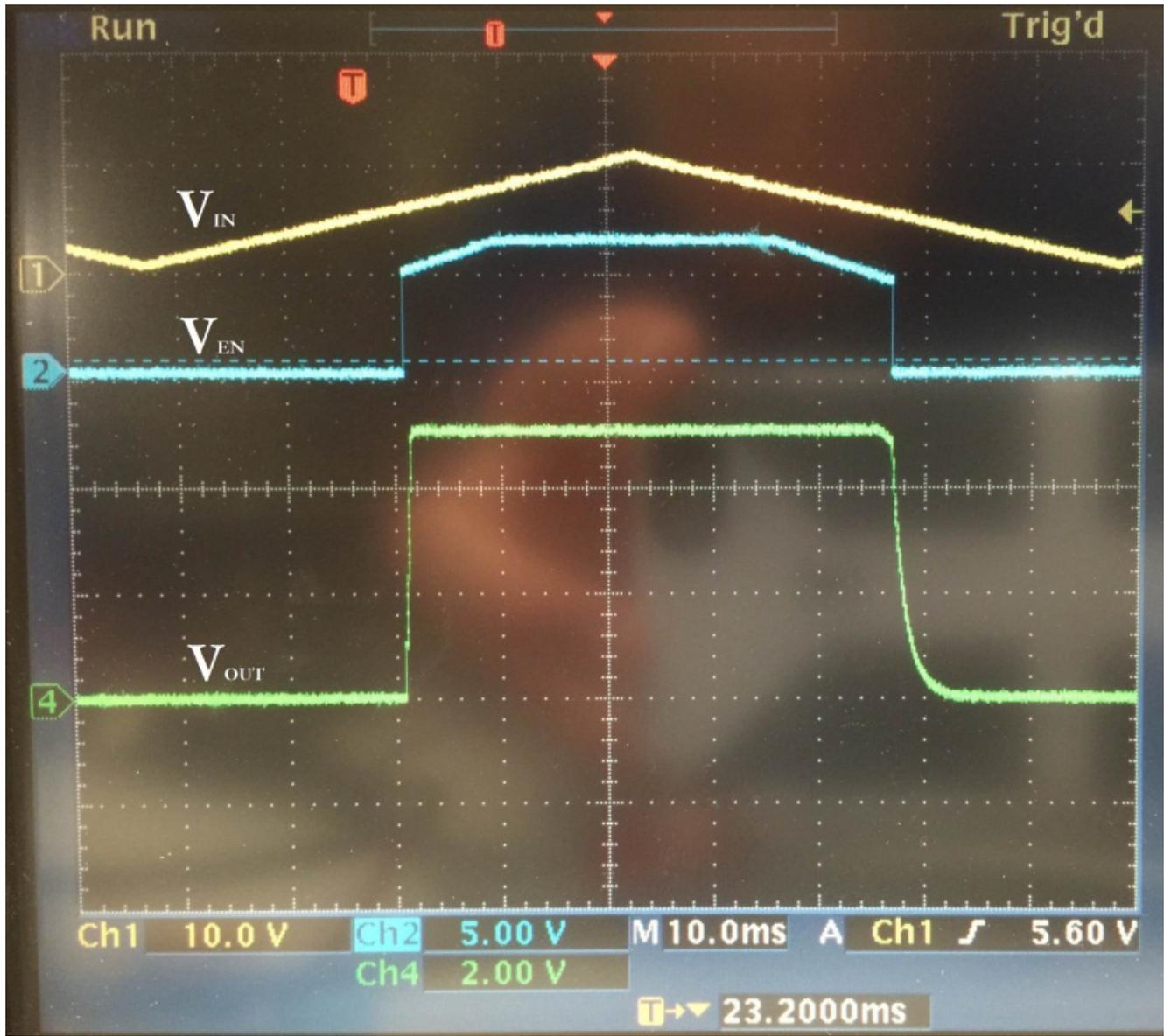
However, not all regulators have a precision enable function. For converters with logic level EN input, a simple external UVLO circuit can be used to generate the EN signal based on the required  $V_{IN}$  range of the converter. The external UVLO circuit provides a logic low signal that keeps the converter disabled until the proper input voltage is reached.

Two simple UVLO schematics can be seen in [Figure 2](#) and [Figure 5](#). The UVLOs were hooked up to the [LM22672 step-down converter](#) which was set to produce an output voltage of 5V. The first schematic uses two NPN transistors. [Figure 2](#) shows two potentiometers,  $R_T$  and  $R_H$ , used to adjust the UVLO turn-on voltage as well as the hysteresis respectively.



**Figure 2. Simple UVLO Circuit #1**

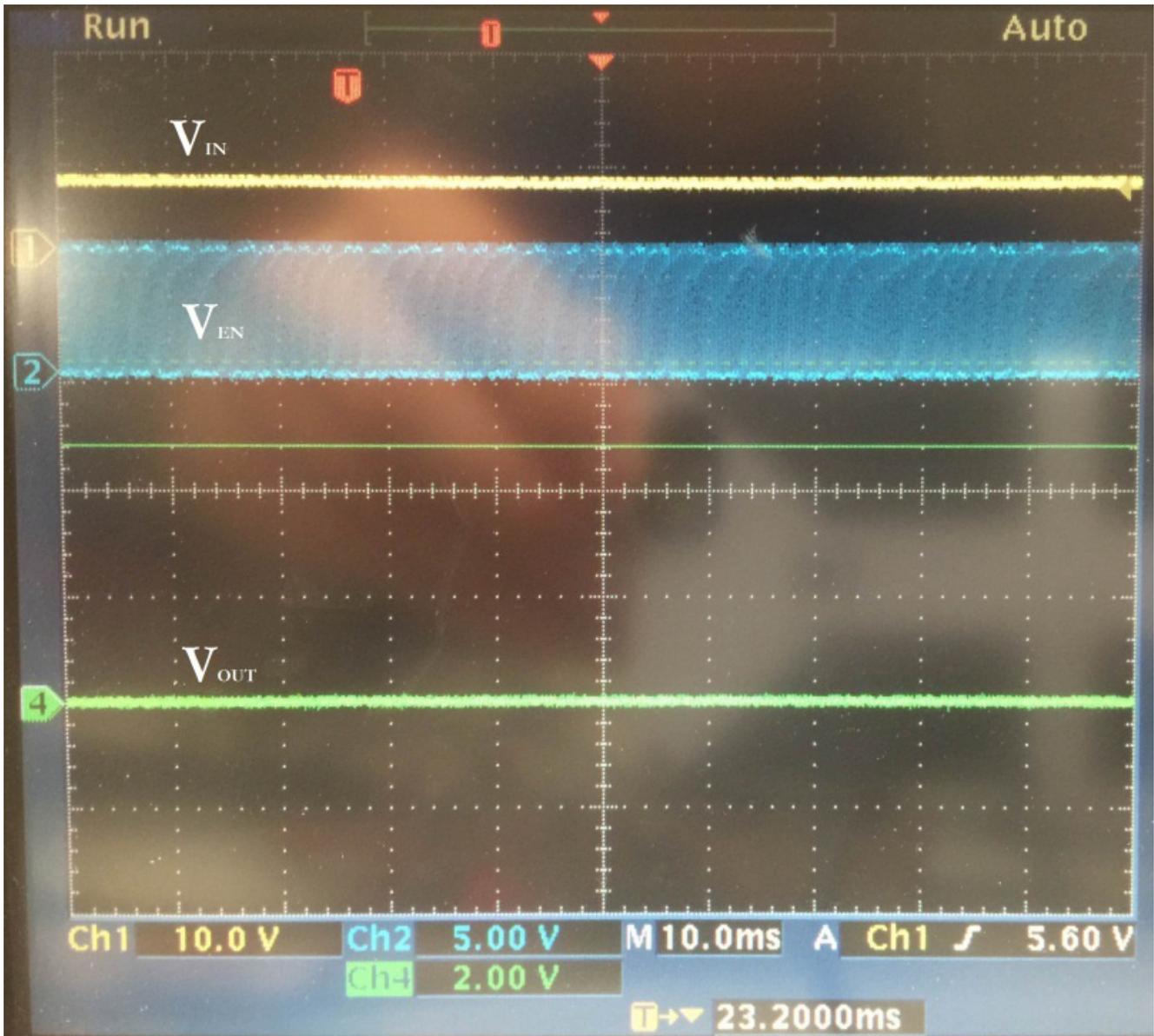
Figure 3 shows the  $V_{IN}$ ,  $V_{EN}$ , and  $V_{OUT}$  waveforms of the UVLO and converter from Figure 2.



**Figure 3. UVLO Controlled Waveforms**

The EN voltage comes up when  $V_{IN}$  has reached the operating range of the design. The output of the converter is able to produce a consistent 5V when the enable pin is logic high.

It is always a good idea to have some hysteresis on the turn-on threshold. The hysteresis in this case is set by RH. Figure 4 shows what happens when there is no hysteresis on the UVLO threshold. As the input voltage is hovering around the threshold, the  $V_{EN}$  pin can be seen chattering on and off at a high frequency. The enable pin is turning on and off too fast for the converter to start up at all.



**Figure 4. UVLO without Hysteresis**

The second external UVLO circuit uses an NPN and a PNP transistor. In [Figure 5](#), potentiometer RB allows the user to set the  $V_{IN}$  UVLO threshold while potentiometer RH sets the hysteresis value.

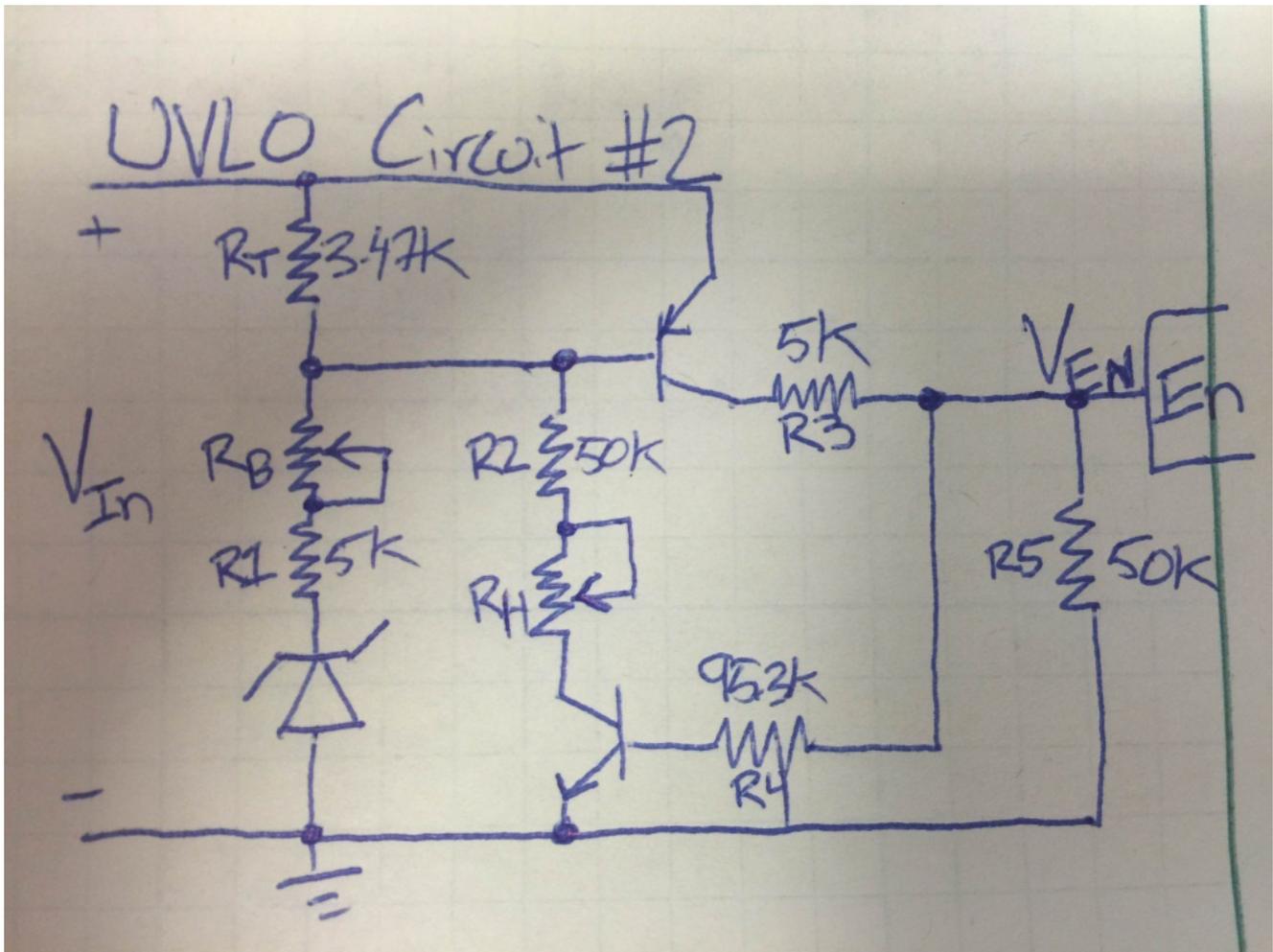
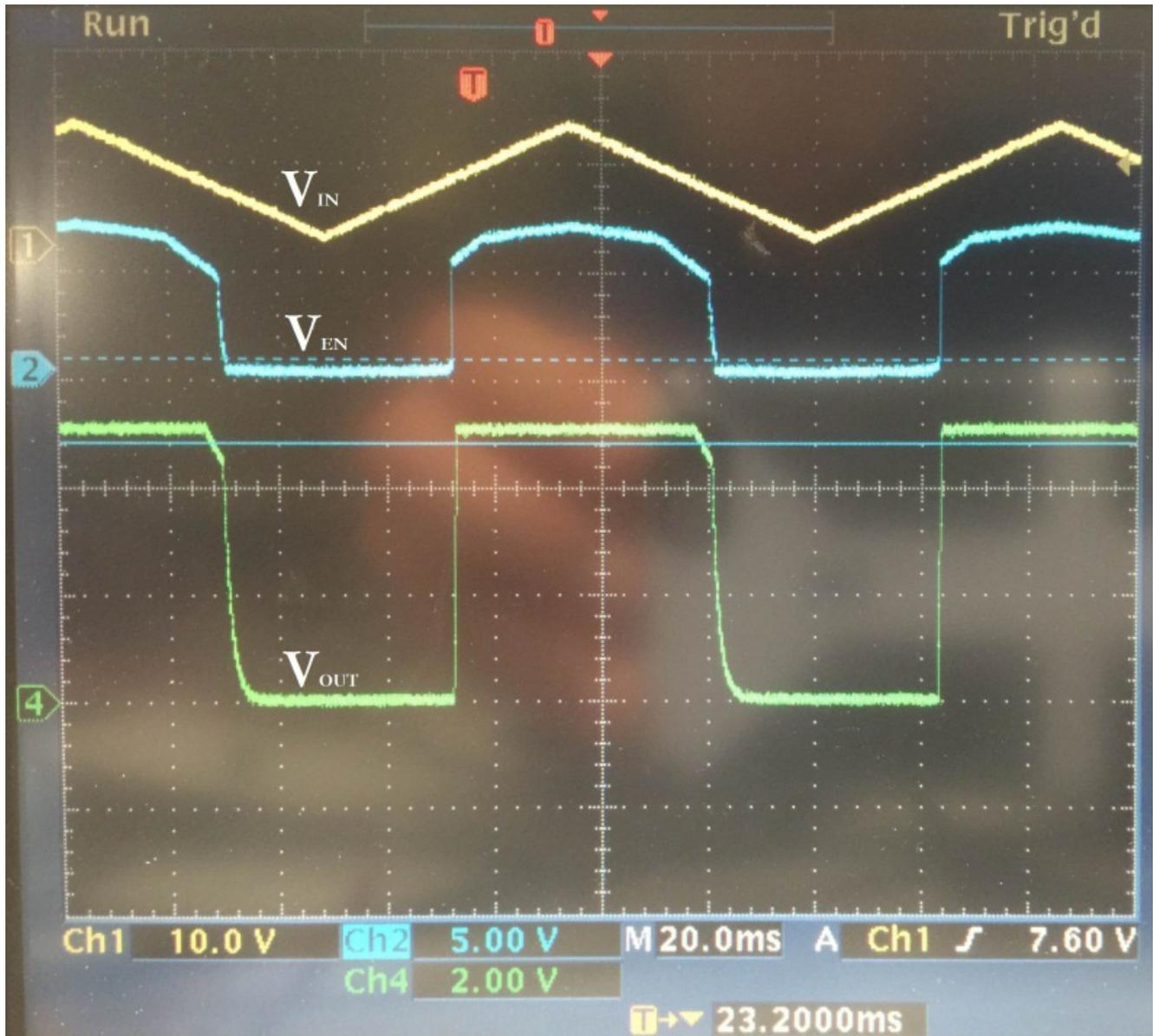


Figure 5. Simple UVLO Circuit #2

Figure 6 shows the UVLO successfully enabling and disabling the step-down converter at the set  $V_{IN}$  thresholds.



**Figure 6. UVLO Controlled Waveforms**

So, if you find yourself with a converter requiring a logic level enable input and you need a more precise UVLO, take one of the circuits above and adjust the two resistors to set the enable threshold and hysteresis as desired. Simply hook the output of the UVLO circuit up to your IC's enable pin and you're good to go!

What's your favorite UVLO circuit? Please feel free to comment below.

#### Additional Resources

- Consider TI's SIMPLE SWITCHER [LM43602](#) and [LM22672](#) step-down voltage converters for your next design.
- Get more information on all of [TI's SIMPLE SWITCHER products](#).
- Start a design now with TI's [WEBENCH Power Designer](#).

## IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2023, Texas Instruments Incorporated