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Cleverscope Test Ruler Brief

Summary

The Cleverscope Test Ruler can be used as a metric/imperial ruler (length 250mm) and also as a tool to explore many Cleverscope capabilities. The Cleverscope Test Ruler Manual describes each capability, and refers to a supporting video.

In addition, versatility is increased by providing the source code to the on board STM8L151G3U6 microprocessor, which can be modified as desired. ST provides free tools for doing this.

Power

The Test Ruler can be powered any one of these three ways:

1. From a PC - powered by the USB 5V output via a Micro USB socket and cable.
2. From a CS448 or CS328A - by plugging into the Link Port.
3. From an external 7-28V power supply such as the Cleverscope CS1050 or bench supply.

Capabilities

The Test Ruler is used to exercise all the capabilities of the Cleverscope CS328A and CS448. The Test Ruler Manual details each capability with step by step instructions and the name of the .apc file that setups for that capability, and the video that shows it being exercised. These resources are a work in progress!

Most of the interfaces work in parallel, and the user can simply probe each one as needed. The larger holes are Banana plug compatible.

Indicators

There are 4 LEDs for indication.

Controls

Two user controls are provided:

- FUNC - a pushbutton that selects between output functions. The 4 LED's indicate the function.
- OPT - a pushbutton that selects the next option for a given function.

Currently we have defined these functions:

- Toggle In1 - pressing OPT causes the output sent to IN1 to toggle between 0 and 1.
- Toggle In2 - pressing OPT causes the output sent to IN2 to toggle between 0 and 1

- Phase Angle - pressing OPT causes the IN1/IN2 outputs to generate pulses with phase angle stepping 0, 30, 60, 90 .. degrees. At the same time the PWM 1 and 2 outputs will drive the FLT1 and FLT 2 with approximately 1kHz sine ways with stepping phase angle.
- Pulse train. Pressing OPT starts various pulse trains out of IN1 - IN4. IN1 outputs 30 pulses as a pulse group. IN2 Outputs 1000 pulses with IN3 outputting a synchronous pulse every 100 pulses. IN4 generates a pulse train where the duty cycle increases from 10% to 90%. Each output can be used to explore triggering and counting.
- DAC DC level - pressing OPT steps the SPI DAC from 0 to 3.3V in 0.1V steps.
- DAC Signal - pressing OPT cycles the SPI DAC through various signals that can be used to explore the display system, triggering and Maths. In addition the PWM outputs drive the FLT1 and FLT2 outputs to simulate a varying voltage and current that can be used to explore Maths.

Outputs

These are the outputs that can be probed:

- IN1-IN4 digital outputs to drive the Cleverscope IN1-4 or IN5-8 digital inputs. The digital inputs can be toggled between values, output an incrementing number sequence, generate a pulse train, and output pulses of various phase.
- PWM1 and PWM2 pulse width modulated digital outputs. These are used to drive
- FLT1 and FLT2 filtered outputs for DC and low frequency (0 - 1500 Hz) signals.
- RUNT - this digital output outputs continuous pulse trains containing various kinds of pulse defects such as runt, slow slew rate, non monotonic rise, long pulse, missing pulse and glitch. These can be used to explore the triggering system.
- R-2R DAC - this 4 bit resistor ladder DAC is driven by the IN1-4 outputs. The Toggle, Phase Angle and Pulse train outputs can be used to toggle between voltage levels, generate stepped analog waveforms with varying phase, and generate interesting analog pulse streams.
- Pulse - a separate digital pulse output generates continuous pulse trains of varying characteristics to explore display, spectra, triggering and maths. For future applications the Pulse pin can also be used as a 12 bit 1 MSPS ADC input.
- SPI DAC - this 8 bit DAC is used to generate various signals for signal exploration, triggering and maths. The SPI signal driving the DAC is exposed for digital probing and protocol decoding.
- SPI - a full SPI interface is presented, which can be used to control external SPI devices, or to do SPI protocol decoding. The SPI is also used to drive the SPI DAC.
- UART - a full logic level UART is presented. It is used to output a Cleverscope message with incrementing count at 115 200 baud for display and protocol decoding.
- I2C - a full I2C interface is presented. It is used to output a Cleverscope message with incrementing count at 400 kbit/sec for display and protocol decoding. I2C interface is also wired through to the Link Port, and will in the future allow the CS448 to control the Ruler.
- Microphone - a 100 - 8K Hz microphone is an interesting signal source for waveform and spectral exploration.
- Load - The load circuit block can be used independently or wired to the PWM1 output by placing a resistor. The Load block consists of a 40 mOhm 60V 5.5A I_{max} FET with a 10 Ohm 2.5W series load resistor that connects to 0V if turned on. A current sense resistor is included. If wired to the IN1 or IN2 outputs it can be toggled using the OPT button.

FRA Facilities

The Test Ruler includes a number of circuit blocks to explore the FRA capabilities.

Passive components

- Capacitors - 10p, 1nF, 100nF, 10uF ceramic and 470uF electrolytic to measure C, ESR and DF vs frequency.
- Inductors - 1uH and 10uH to measure L, Series Resistance and Q vs frequency.
- Open and Short calibration positions allow you to calibrate the probes. Reference resistors are included.
- A transformer with connections to measure transfer response, primary inductance, leakage inductance, and inter-winding capacitance, all vs frequency.

Active Circuit blocks

- A 7-28V in, +/-5V out at up to 2A, which you can use for your own projects. It is based on the TI TPS54233 300 kHz step down converter. Tap points are provided to measure the Gain/Phase response, and the Output Impedance. The Load Switch can be used to measure transient response. Responses can be compared with the data published in the data sheet.
- A linear regulator (TPS71701 LDO) outputting 3.3V, which you can use in your own projects. Tap points are provided to test PSRR, and compare this with the published response.
- A 2 MHz GBW single supply op-amp, with input and output accessible for your own projects or to buffer the microphone. Tap points are provided to measure PSRR and Gain-Phase vs frequency.

Resources

- Cleverscope Test Ruler design material including source code - www.cleverscope.com/ruler
- STM8L151G3U6 - the ST processor we use. See http://www.st.com/web/catalog/mmc/FM141/SC1244/SS1336/LN1570/PF251470
- The STM8S-Discovery Kit includes an ST-LINK programmer which can be used to directly program the SWIM port on the Test Ruler. It is available from RS Electronics as part 705-6031, at a cost of about USD9.
- The STVD visual development environment includes ST-Link programming and editing tools. It is available here at no charge: http://www.st.com/web/en/catalog/tools/PF210567
- The Cosmic compiler is required by the STVD environment. A free, one year licences with an 32K program limit is available here: http://www.cosmicsoftware.com/download_stm8_32k.php