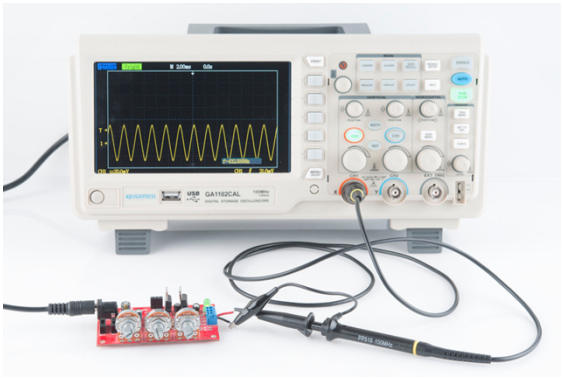
Build Your Own Data Logger
Module 3: Proof of Concept
Submodule 4 – Real Time Clock

Terminology Starter Guide

Video	Intro
Real Time Clock (RTC)	A real-time clock (RTC) is a computer clock, usually in the form of an integrated circuit, that is solely built for keeping time. It's found in any device that needs to keep accurate time (such as a data logger).
Clock Drift (or just drift)	Clock drift refers to when a clock does not run at exactly the same rate as a reference clock. That is, after some time the clock "drifts apart" or gradually desynchronizes from the other clock. Even when initially set accurately, clocks will start to drift from one another after some amount of time because they count at slightly different rates.
Digital Clock	A digital clock uses either the oscillations on the power line or the oscillations of a quartz crystal as the resonator, and then counts these using a digital counter.
Resonator Resonation	All clocks track the passage of time by counting the "ticks" of a "resonator." In a pendulum clock, the resonator is a pendulum and the gears in the clock keep track of time by counting the resonations (the swingings back and forth) of the pendulum.

	The pendulum usually resonates at a frequency of one swing per second. The accuracy of the clock is determined by the accuracy of the resonator at the specified frequency.
Oscillation	Oscillation refers to the repeated back and forth movement of something between two positions or states. An oscillating movement occurs around an equilibrium point or mean value. For example, the side-to-side swing of a pendulum, or the up-and-down motion of a spring with a weight. A single oscillation is a complete movement, whether up and down or side to side, over a period of time.
Periodic Oscillation	Periodic oscillation is an oscillation that repeats itself at regular time intervals. For periodic motion, frequency is the number of oscillations per unit time.
Electronic Oscillator	An oscillator is a circuit which produces a continuous, repeated, alternating waveform without any input. Oscillators basically convert direct current (DC) into an alternating current (AC) with a waveform of the desired frequency. The exact waveform generated depends on the type of circuit used to create the oscillator.
Electrical Polarity	There are two types of poles in an electrical circuit: positive / high (+) and negative / low (−).

	This represents the electrical potential at the ends of a circuit. Eg. A battery has a positive terminal (+ pole) and a negative terminal (− pole).
Direct Current (DC)	When the electric current flows in one direction, and does not change. Ie. The high / positive terminal of the circuit is always positive, and the negative terminal is always negative. Direct current sources provide a constant voltage over time. Some examples of DC current sources include: • Solar Cells • Batteries • Power Supplies
Alternating Current (AC)	When the electric current that reverses direction periodically. Since the direction of the current reverses periodically, the polarity also reverses i.e. the high / positive potential (+) and low / negative potential (-) swap. The waveform of AC has an amplitude and a wave cycle. The amplitude corresponds with the peak voltage. The frequency of the wave is the number of wave cycles that occur per second, and the period of the wave is the time it takes to complete one cycle. The number of times electric current changes its direction in one second is called its frequency (Hz). Alternating current is commonly used in homes.

Oscilloscope 	An oscilloscope allows you to view how voltage changes over time. An oscilloscope displays the measured signals of the voltage using a graph. The voltage is represented on the vertical axis and time on the horizontal axis. Oscilloscopes are used to determine if the behaviour of a circuit is working as expected. It helps locate any problems in the circuit, like unwanted signals called noise. There are two types of oscilloscope; analog and digital.
Quartz Crystal (xtal)	An quartz crystal (xtal) is a resonator that vibrates at a specific frequency.
Quartz Crystal Oscillator (QCO) 	A type of timekeeping device used in an electronic device (like a data logger). A quartz crystal oscillator is the complete circuit that takes the crystal, adds circuitry, and produces a square wave output at that specific frequency. In a QCO, when an electric field is applied to the crystal, it will mechanically distort in response, producing a piezoelectric effect (and vice-versa). The crystal will vibrate at a consistent rate when returning to its original shape, and can be used as a reference for time-keeping. Many factors can impact the QCO's stability: the cut of the crystal, the quality and purity of it, the temperature, humidity, even radiation. Shock can also change the frequency permanently.

	Over time, the frequency of crystals will also drift due to aging.
Nominal Frequency	A stated frequency that's used as a reference or measurement
Parts per million (PPM) (in the context of when using quartz crystals for timekeeping)	Measurement used to express the accuracy of a quartz crystal oscillator. Indicates how much the QCO's frequency may deviate from the nominal (or stated) value.
Atomic Clock	An atomic clock is a clock that uses the resonance frequencies of atoms as its "resonator". Atomic clocks are the most accurate.
Piezoelectricity	Piezoelectricity is the electric charge that accumulates in certain solid materials in response to applied mechanical stress. The word piezoelectricity means electricity resulting from pressure and latent heat.
Rubidium Atomic Clock	A type of atomic clock that is made from the element Rubidium. Rubidium clocks are used in GPS satellites.
Cesium Atomic Clock	A type of atomic clock made from the element Cesium. The most accurate atomic clock.

Libraries

PCF8563 Real Time Clock Library (courtesy of elpaso)	https://github.com/elpaso/Rtc_Pcf8563

RTC Library Parameters References

RTCC_DATE_CZ *Nb. This is the default setting*	dd.mm.yyyy
RTCC_DATE_ASIA	yyyy-mm-dd
RTCC_DATE_WORLD	dd-mm-yyyy
Week Day	Sunday = 0 Monday = 1 Tuesday = 2 Wednesday = 3 Thursday = 4 Friday = 5 Saturday = 6
Day of the month	*As per calendar day (1 – 31)* *Eg.* 1st of the month = 1 2nd of the month = 2 3rd of the month = 3
Month of the year	*As per calendar month (1-12)* *eg.* January = 1 February = 2 March = 3
Century	*0 or 1* 2000 = 0 1900 = 1

Year	*Last two digits of calendar year (0-99)* *eg.* 2021 = 21 2020 = 20
Time	*Hours (00), minutes(00), seconds(00)* *eg. 12:34:21* *24 hours* 12am = 00 1am = 01 2am = 02 3 am = 03 etc 12 noon = 12 1pm = 13 2pm = 14 3pm = 15 etc

Useful Links

Circuit Basics – What is Direct Current?	https://www.circuitbasics.com/what-is-current/
Circuit Basics – What is Alternating Current?	https://www.circuitbasics.com/what-is-alternating-current
Leap Seconds	https://leapsecond.com/ http://www.leapsecond.com/time-nuts.htm
All About Circuits – Crystal and Atomic Oscillators	https://www.allaboutcircuits.com/news/precise-time-keeping-crystal-oscillator-atomic-clock-quantum-clock/
How Stuff Works - What is an Atomic Clock and How Does It Work?	https://science.howstuffworks.com/question40.htm