



Circuit Playground: Q is for Quartz

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<https://learn.adafruit.com/circuit-playground-q-is-for-quartz>

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Video

Adabot finds treasure in his rock collection – Quartz! Have a look inside a quartz watch and learn why quartz is so important for electronics.

Transcript



Adabot: Sandstone, obsidian, pyrite ...



Minerva: Hey Adabot - what you up to?

Adabot: Oh - I was just going through my rock collection. I forgot I had so many!

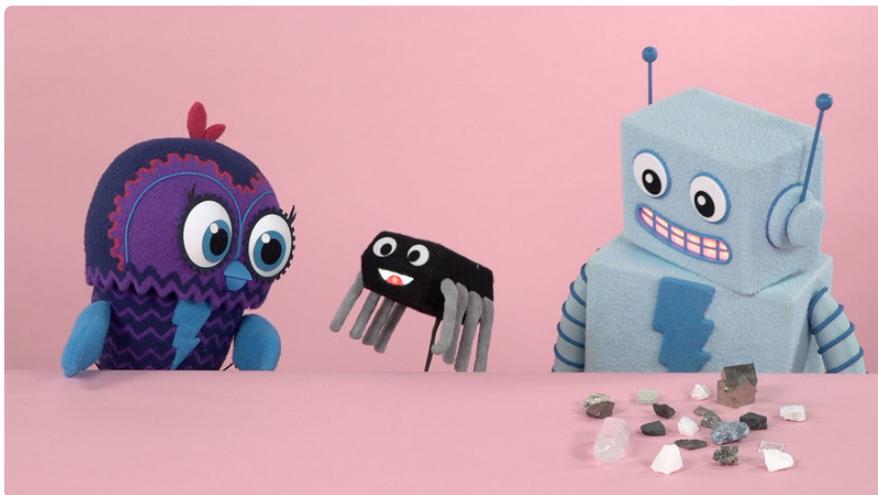
Minerva: Hmm - find anything good?



Adabot: Sure - some precious stones. This one's my favorite - it's quartz!

Minerva: That quartz does look special. Where did you get it?

Adabot: There was a rock show at the museum. I thought there would be more guitar solos, but it turned out to be a bunch of people trading minerals. So, I got this quartz because it looks really neat.



Minerva: It looks neat because it is neat. We use quartz in electronics all the time.

Hans: Did someone say time?!

Minerva: Why, yes! I was just explaining to Adabot how quartz is used in electronics.

Hans: Adabot - do you know why I am the world's greatest integrated circuit?

Adabot: No, Hans - why are you the world's greatest int –



Hans: Timing! It's what I take care of in a circuit. And do you know why my timing is so impeccable?

Adabot: No - why is your timing so imp—

Hans: Quartz! And why does quartz create perfect timing?

Adabot: Umm - are you gonna keep interrupting me?

Minerva: Oh - settle down, Hans. I can explain why quartz is so important for timing.

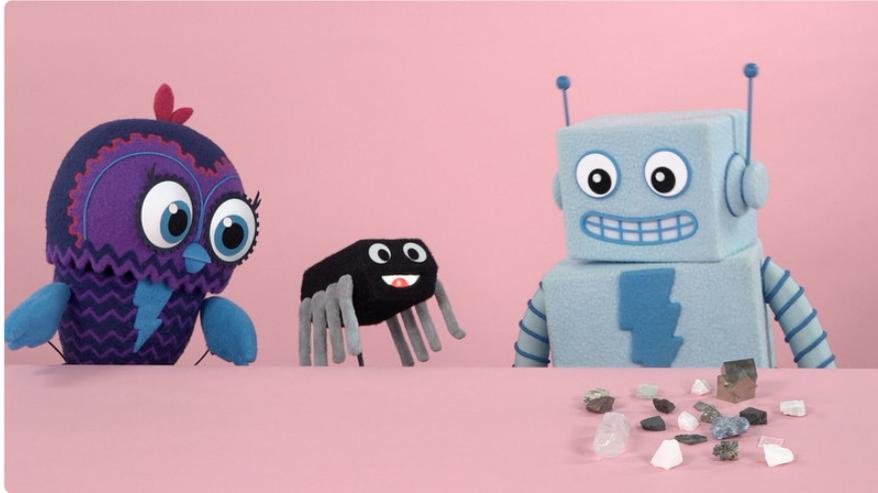
Adabot: Why, thank you.



Minerva: You see - certain materials, such as quartz crystals, are Piezoelectric. Simply put - this means if you apply a small amount of mechanical force to a piece of quartz, it will generate a small electrical voltage.

Adabot: Wow - that sounds pretty unusual! So if i crushed it, it would shock me?

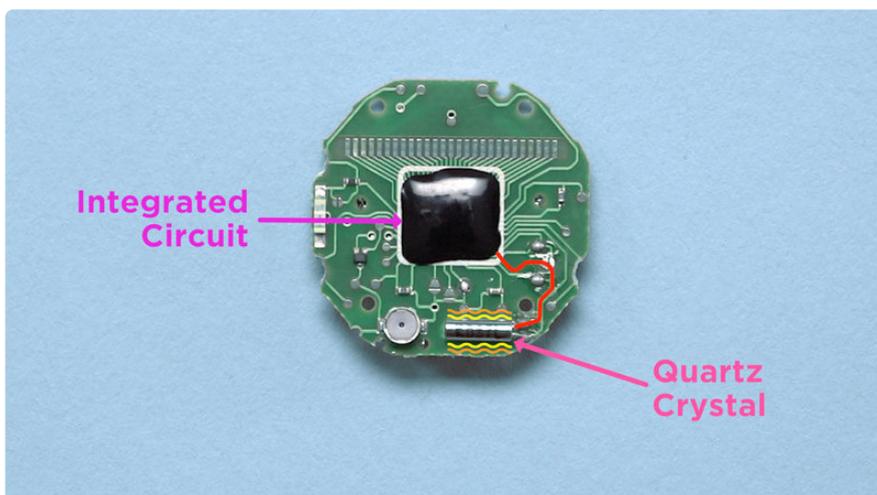
Minerva: Well, you have to squeeze it very lightly, and just right and the electrical voltage is very, very small. But...yes I suppose you're right!



Hans: And the opposite is also true! If you apply voltage to a piece of quartz - it will respond with a precise mechanical vibration.

Adabot: Quartz sounds like magic!

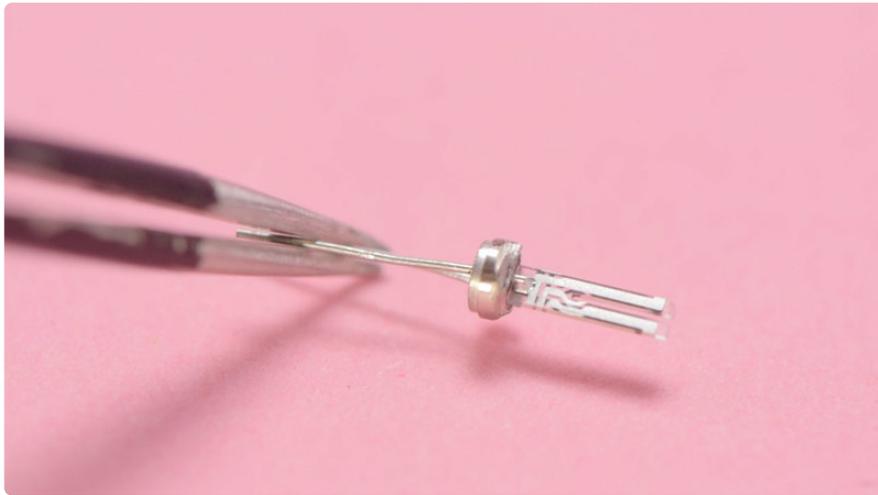
Minerva: It's not magic, Adabot - it's science! Take a look inside this quartz watch for instance.



Hans: this little integrated circuit here passes electrical current to the quartz crystal. Then the quartz vibrates at precisely 32768 times per second.

Minerva: After that, the IC detects the vibrations, counts them one by one, and when it gets all 32,768 it knows one second has passed!

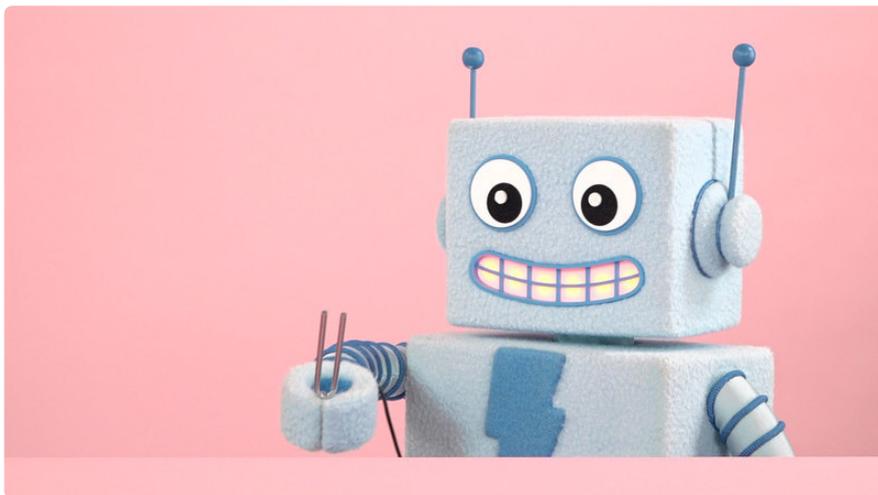
Adabot: So there's a quartz crystal inside of that little metal container?



Hans: Yes - and it looks something like this ...

Adabot: That looks like a tuning fork!

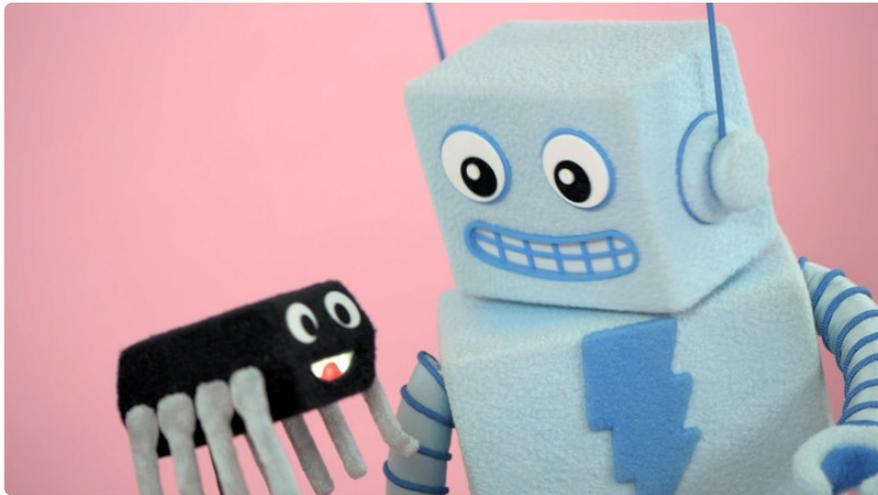
Minerva: That's true - it does look like a tuning fork!



Adabot: Musicians use the vibrations of a tuning fork to tune their instrument - and circuits use quartz to tune their timing!

Hans: You're right!

Minerva: Very true, Adabot. Quartz is an important reference for the timing of so many circuits - microcontrollers, computers, and more.



Adabot: I always wondered what was inside those little metal cans - now I finally know!

Minerva: Well - it's about time!

Hans: ... Adabot, I believe Minerva just made a *time* joke



Adabot: Is that what that was?

Hans: Haaayyooo!

Minerva: Thank you, thank you ...

Learn More

To understand why **quartz** is so useful for **electronics**, we need to understand **piezoelectricity**. Wikipedia defines **piezoelectricity** as such:

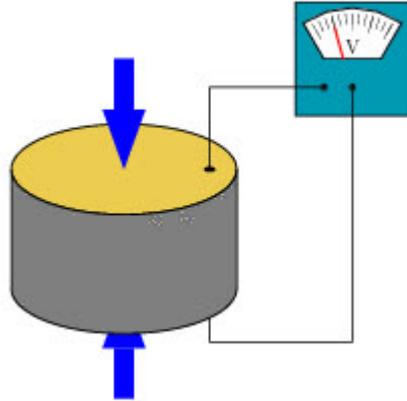


image: [CC BY-SA Tizeff \(https://adafru.it/Ejy\)](https://adafru.it/Ejy)

Piezoelectricity is the [electric charge \(https://adafru.it/Ejz\)](https://adafru.it/Ejz) that accumulates in certain solid materials (such as [crystals \(https://adafru.it/EjA\)](https://adafru.it/EjA), certain [ceramics \(https://adafru.it/EjB\)](https://adafru.it/EjB), and biological matter such as bone, [DNA \(https://adafru.it/rRA\)](https://adafru.it/rRA) and various [proteins \(https://adafru.it/EjC\)](https://adafru.it/EjC)) in response to applied [mechanical stress \(https://adafru.it/EjD\)](https://adafru.it/EjD). The word piezoelectricity means electricity resulting from pressure and latent heat. It is derived from the [Greek \(https://adafru.it/EjE\)](https://adafru.it/EjE) word piezein, which means to squeeze or press, and ēlektron, which means [amber \(https://adafru.it/EjF\)](https://adafru.it/EjF), an ancient source of electric charge. French physicists [Jacques \(https://adafru.it/EjG\)](https://adafru.it/EjG) and [Pierre Curie \(https://adafru.it/EjH\)](https://adafru.it/EjH) discovered piezoelectricity in 1880.

The piezoelectric effect results from the linear electromechanical interaction between the mechanical and electrical states in crystalline materials with no [inversion symmetry \(https://adafru.it/EjI\)](https://adafru.it/EjI). The piezoelectric effect is a [reversible process \(https://adafru.it/EjJ\)](https://adafru.it/EjJ): materials exhibiting the piezoelectric effect (the internal generation of electrical charge resulting from an applied mechanical [force \(https://adafru.it/EjK\)](https://adafru.it/EjK)) also exhibit the reverse piezoelectric effect, the internal generation of a mechanical strain resulting from an applied electrical field.

Crystal Oscillator



In electronics, the piezoelectric properties of quartz are used in the form of a **crystal oscillator** to provide a stable and reliable timing reference. Quartz's **reference frequency** is used like a **drumbeat** for **digital processors** to follow along with. It keeps software instructions moving along at a **consistent rhythm!**

A **crystal oscillator** is an [electronic oscillator \(https://adafru.it/EjL\)](https://adafru.it/EjL) circuit that uses the mechanical [resonance \(https://adafru.it/EjM\)](https://adafru.it/EjM) of a vibrating [crystal \(https://adafru.it/EjA\)](https://adafru.it/EjA) of [piezoelectric material \(https://adafru.it/Ejy\)](https://adafru.it/Ejy) to create an electrical signal with a precise [frequency \(https://adafru.it/EjN\)](https://adafru.it/EjN). This frequency is often used to keep track of time, as in [quartz wristwatches \(https://adafru.it/EjO\)](https://adafru.it/EjO), to provide a stable [clock signal \(https://adafru.it/EjP\)](https://adafru.it/EjP) for [digital \(https://adafru.it/EjQ\) integrated circuits \(https://adafru.it/EjR\)](https://adafru.it/EjQ), and to stabilize frequencies for [radio transmitters \(https://adafru.it/EjS\)](https://adafru.it/EjS) and [receivers \(https://adafru.it/EjT\)](https://adafru.it/EjT). The most common type of piezoelectric resonator used is the [quartz \(https://adafru.it/EjU\)](https://adafru.it/EjU) crystal, so oscillator circuits incorporating them became known as crystal oscillators, but other piezoelectric materials including polycrystalline ceramics are used in similar circuits.

Read more on [Wikipedia \(https://adafru.it/EjV\)](https://adafru.it/EjV)

Links

- [ExplainThatStuff - Quartz Clocks & Watches \(https://adafru.it/EjW\)](https://adafru.it/EjW)

- [EngineerGuy - How a quartz watch works \(https://adafru.it/EjX\)](https://adafru.it/EjX)
- [Autodesk - How Piezoelectricity works \(https://adafru.it/EjY\)](https://adafru.it/EjY)
- [Piezoelectric Effect Explained \(https://adafru.it/EjZ\)](https://adafru.it/EjZ)
- [Science with Kids - Facts about Quartz \(https://adafru.it/Ej-\)](https://adafru.it/Ej-)