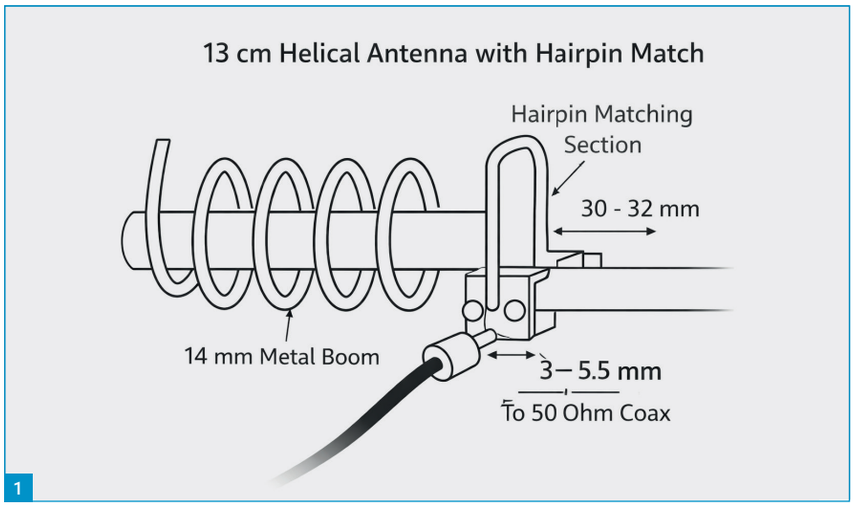
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1

Using AI Assistants such as Chat GPT for Radio Projects (Pt I)

Dr Jonathan Hare G1EXG has the first part of a two-part article looking at using AI to help with radio-related projects.

I have been experimenting with AI to help me develop amateur radio projects. Here I will describe my experiences with two very different projects: i) designing a large air-cored coil for VLF reception (e.g. 60kHz MSF and 77.5kHz DCF) and ii) in part 2 developing projects to use the Icom CI-V control standard for IC-7300 (MK I or MK II) or IC-9700 transceivers such as power control, S-meter and frequency requests, etc.

I will concentrate on using the free version of ChatGPT, but of course there are other 'chat bots' available such as Claude. It is worth signing in to these as they then remember your previous chats, which means you can pick-up on old threads and continue exploring topics later if you want too.

There is a lot of excitement about how AI chat bots such as ChatGPT can help us and transform our digital world [**1**, **2**, **3**]. Understandably, much is written by computer programmers and computer experts. My aim in writing these two articles is as an avid 'maker of things' and a keen radio amateur – I am aiming to explore how ChatGPT can help me in practical ways.

Throughout this article I am going to use a (not too serious) 'running score' after each section or paragraph, as a way of expressing if I thought my overall AI experience was helpful (✓) or unhelpful (✗) e.g.

Cumulative Score:
helpful: ✓✓✓ unhelpful: ✗✗

Someone to chat to

In my career as a scientist and in amateur radio I have been lucky to have friends and colleagues who I can regularly ask questions and receive good advice from. But even my best friends don't have the patience (or spare time) to answer the '100-and-1' questions I always seem to want to ask! So, when AI started to appear I wondered if I might use it to ask questions and explore ideas, but that would never get tired or bored. As we will see, I think AI can do this, but currently you really need to know its limitations.

Sir Harry Kroto – radio molecules in space

My friend and mentor **Sir Harry Kroto** [**4**, **5**] was an expert in microwave spectroscopy. He measured radio wave signals produced by the tumbling and rotation of certain types of molecules both in the lab and within molecular clouds in space. His curiosity about the widespread abundance of the radio signatures of molecule such as HC9N and HC11N in space lead ultimately to the accidental discovery of new forms of carbon – the fullerenes – leading to the 1996 Nobel Prize in Chemistry. Harry died in 2016 and I greatly miss his friendship, expertise and wisdom and his incomparable world view. Harry wrote something I think might actually be very relevant to our use of AI:

"I have always found difficulty in formulating questions because a problem generally manifests itself as a kaleidoscope of confusing impressions. It now seems to me however, that once you have worked out how to ask the question, you also know how to answer it." Sir H W Kroto [5]

Books, Google and ChatGPT

In the past we used to look up things in books, journals and magazines. Then search engines like Google allowed us access to 100s of articles which, if we had the time, we could pore through at our leisure. Then AI came along which can now summarise 100s to 1000s of articles quickly and efficiently for us in seconds. At least that's what it seems to be able to do.

AI chat bots such as ChatGPT are language models. They are very good at summarising long documents (web pages, PDFs or word documents). You can also use them to write and correct computer code. They have had some limited success at technical and mathematical problems [1, 2, 3]. Presently the free ChatGPT does not seem to be very good at creating diagrams although it can create flow charts and sketches using alphanumeric symbols (see Part 2). AI is aware of these limitations, as most chats end with a statement such as *"ChatGPT can make mistakes. Check important info …"*

The prompt

The way ChatGPT works is to type in a question or request in a box on the website or App. As we will see, for best results, this 'prompt' needs to have as much information as possible to generate something reliable or useful. A scientist colleague recently told me that industry is now using AI to help create very detailed prompts - some 100s to 1000s of words long – to ensure it creates results of value.

According to ChatGPT the most frequent prompts are for:

- Helping with writing, editing, and communication.
- Learning and understanding complex subjects.
- Generating ideas and creative support.
- Practical advice and how-to's for everyday tasks.
- Information and fact-finding, often instead of traditional search engines.

Reliable data or discussions

Looking back over just the last few months using ChatGPT I have used it over 500 times to explore diverse areas such as: 3D printing

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Fig. 1: A helical antenna as drawn by AI.
Fig. 2: A dish with LNB, as drawn by AI.
Fig. 3: VLF coil.

problems, physics, astronomy, coding and radio of course. It has also been very useful for non-technical investigations such as water colour painting or finding out more about Greek history and philosophy as well as providing me with plot and character summaries for **Isaac Azimov's** *Foundation* novel series. I even found its advice helpful recently for fixing my washer-dryer.

I want AI to help me in my research, to check calculations and to offer areas of interest that I might not have thought of or come across. I don't always expect it to be correct, and I would probably try to follow up any important results it provides me.

AI chat bots can also act as 'sounding boards', allowing you to quickly and effectively explore other areas and so helping you not to get stuck. This allows you to move on much more rapidly, even if some of the data presented to you by the AI may not be correct.

For example, you may ask a question which generates a response, and sometimes AI offers suggestions which lead you to ask a series of other questions. This inevitably forces you to pose your question more carefully and precisely. This certainly focuses your mind and attention, and you learn a lot - you can often explore a topic as if you were chatting to an expert in that area.

I have found that it can 'kick-start' projects, getting me to a starting point much more quickly. As a result, I am finding that fewer projects are now sitting on the shelf waiting to be developed.

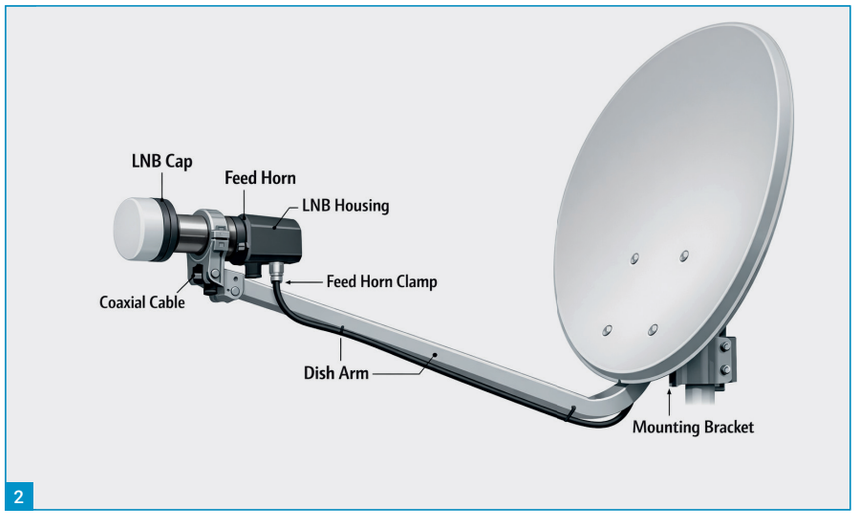
AI generated videos

YouTube is starting to show AI generated videos. Sometime these are a script someone has written but AI is used to get a famous person to present it. For example, **Richard Feynman** (Nobel Prize winning physicist) based videos are starting to appear. I really value the excellent 'Feynman lecture notes' that he helped edit, so I do value real Feynman videos. The AI versions are basically using Feynman to say other people's ideas – these AI generated videos worry me greatly.

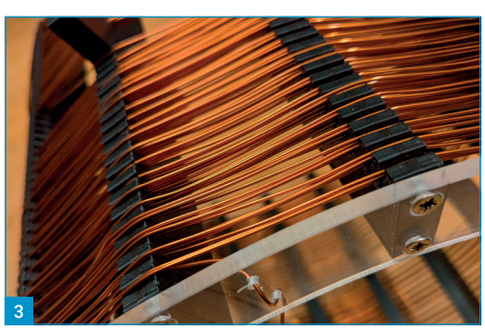
Hallucinations and mistakes: Early days 2022

One oddity is that AI can provide a very convincing well written answer to something, implying that it has everything properly and accurately calculated, even when it has not done this at all!

In Sept. 2023 a colleague [5] asked ChatGPT *"is 3743 a prime number?"* and it confidently replied:







"Yes, 3743 is a prime number" which is incorrect [**6**].
Cumulative Score:
helpful: 0 unhelpful: ✗

I asked the same question in early 2026 and got *"No — 3743 is not a prime number. It can be factored as: 3743=19×197"*. So that is progress … in a short time.

Some AI chat bots allow you to 'Bolt on' other programs and I am sure if I had used Maths programs such as Wolfram Maths, the chat bot would never have made this mistake. That's fine of course if you can afford it and if you know in advance what you might need.
Cumulative Score:
helpful: ✓ unhelpful: ✗

Diagrams

At the end of a chat thread ChatGPT will often suggest further areas to explore and sometimes asks if you would like a diagram or graph. When ChatGPT is creating diagrams, it seems to me it is a bit like what you might get if you asked a blind person to try to draw a picture from a description.

In **Fig. 1** you can see the slightly crazy picture it created when I asked it how it would match the approx. 140Ω impedance of a helix antenna to 50Ω. It suggested a hairpin match, however, a 75-80Ω Q-section is usually used. You can see the diagram it drew is not clear at all. The boom that supports the helix has become disjointed and the diagram does not show a reflector (although to be fair I didn't specifically ask for one). The helix is a series of circles, and the feedpoint is very unclear. AI seems to do slightly better when it draws diagrams less artistically such as using ASCII characters (see Part 2). I guess the developers know that AI struggles with creating diagrams, so they are constantly trying to exercise it by responding to feedback from us, which they hope will teach it to do better.

Another example of just how odd AI diagrams can be, I asked ChatGPT to draw a *"clear diagram of an LNB and dish arm"*. As you can see, **Fig. 2**, it drew a lovely picture and got the parts right, but not the assembly – the LNB is pointing away from the dish!
Cumulative Score:
helpful: ✓ unhelpful: ✗✗✗

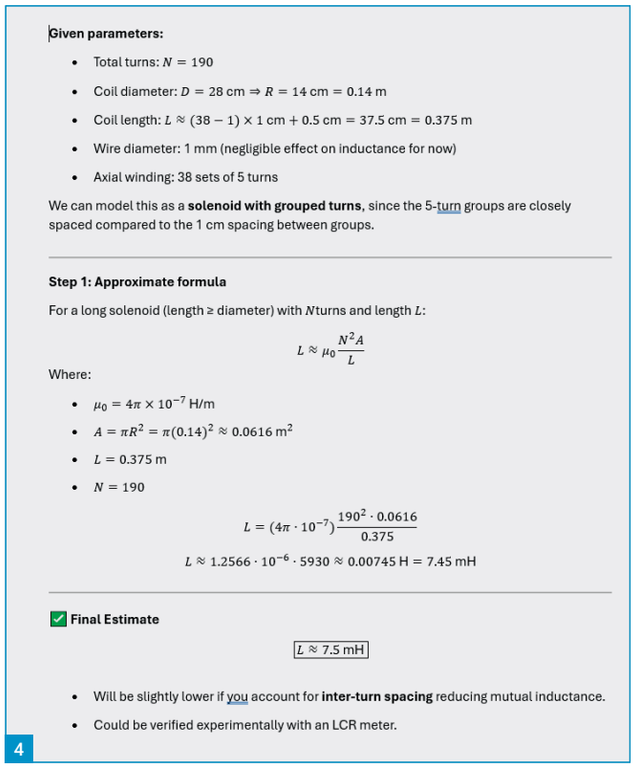
Using AI as a check

In 2025 I did some consultancy work for a UK energy company and made some heat storage calculations for them. For the first time I decided to use ChatGPT to check my calculations and see if it might inform me if I had overlooked anything.

My calculations agreed with the AI calculations which was reassuring, but there were a few oddities. Firstly, AI didn't say anything about

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Given parameters:

- Total turns: $N = 190$
- Coil diameter: $D = 28\text{ cm} \Rightarrow R = 14\text{ cm} = 0.14\text{ m}$
- Coil length: $L \approx (38 - 1) \times 1\text{ cm} + 0.5\text{ cm} = 37.5\text{ cm} = 0.375\text{ m}$
- Wire diameter: 1 mm (negligible effect on inductance for now)
- Axial winding: 38 sets of 5 turns

We can model this as a **solenoid with grouped turns**, since the 5-turn groups are closely spaced compared to the 1 cm spacing between groups.

Step 1: Approximate formula

For a long solenoid (length ≥ diameter) with N turns and length L:

$$L \approx \mu_0 \frac{N^2 A}{L}$$

Where:

- $\mu_0 = 4\pi \times 10^{-7}$ H/m
- $A = \pi R^2 = \pi(0.14)^2 \approx 0.0616\text{ m}^2$
- $L = 0.375$ m
- $N = 190$

$$L = (4\pi \cdot 10^{-7}) \frac{190^2 \cdot 0.0616}{0.375}$$

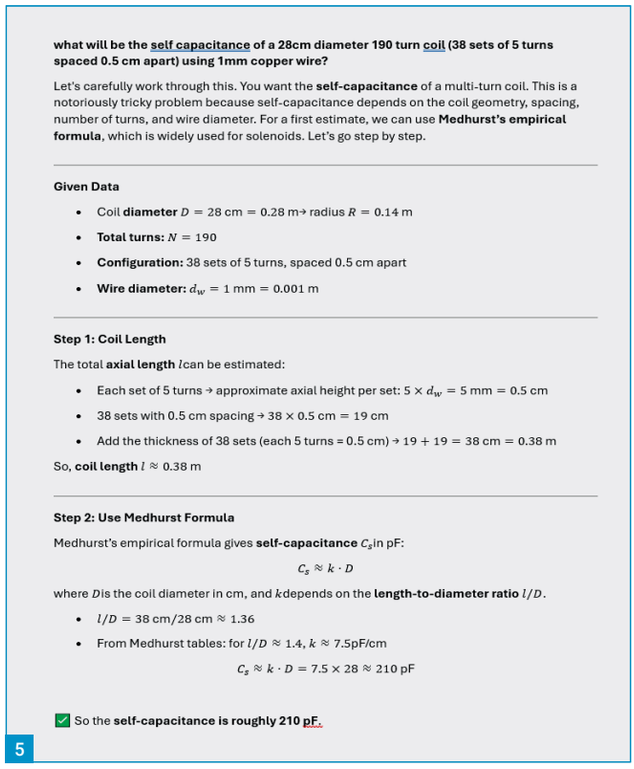
$$L \approx 1.2566 \cdot 10^{-6} \cdot 5930 \approx 0.00745\text{ H} = 7.45\text{ mH}$$

✅ **Final Estimate**

$$\boxed{L \approx 7.5\text{ mH}}$$

- Will be slightly lower if you account for **inter-turn spacing** reducing mutual inductance.
- Could be verified experimentally with an LCR meter.

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what will be the self capacitance of a 28cm diameter 190 turn coil (38 sets of 5 turns spaced 0.5 cm apart) using 1mm copper wire?

Let's carefully work through this. You want the **self-capacitance** of a multi-turn coil. This is a notoriously tricky problem because self-capacitance depends on the coil geometry, spacing, number of turns, and wire diameter. For a first estimate, we can use **Medhurst's empirical formula**, which is widely used for solenoids. Let's go step by step.

Given Data

- Coil **diameter** $D = 28\text{ cm} = 0.28\text{ m} \rightarrow$ radius $R = 0.14\text{ m}$
- **Total turns:** $N = 190$
- **Configuration:** 38 sets of 5 turns, spaced 0.5 cm apart
- **Wire diameter:** $d_w = 1\text{ mm} = 0.001\text{ m}$

Step 1: Coil Length

The total **axial length** l can be estimated:

- Each set of 5 turns → approximate axial height per set: $5 \times d_w = 5\text{ mm} = 0.5\text{ cm}$
- 38 sets with 0.5 cm spacing → $38 \times 0.5\text{ cm} = 19\text{ cm}$
- Add the thickness of 38 sets (each 5 turns = 0.5 cm) → $19 + 19 = 38\text{ cm} = 0.38\text{ m}$

So, **coil length** $l \approx 0.38$ m

Step 2: Use Medhurst Formula

Medhurst's empirical formula gives **self-capacitance** C_s in pF:

$$C_s \approx k \cdot D$$

where D is the coil diameter in cm, and k depends on the **length-to-diameter ratio** l/D.

- $l/D = 38\text{ cm}/28\text{ cm} \approx 1.36$
- From Medhurst tables: for $l/D \approx 1.4$, $k \approx 7.5$pF/cm

$$C_s \approx k \cdot D = 7.5 \times 28 \approx 210\text{ pF}$$

✅ So the **self-capacitance is roughly 210 pF.**

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Fig. 4: ChatGPT inductance calculation.
Fig. 5: ChatGPT self-capacitance calculation.
Fig. 6: ChatGPT explanation of negative capacitance.

the fact that the calculations were based on theoretical maximum and that real-life values would be considerably less. I was already aware of this, so I was not relying on AI to point it out. However, what was very strange was that the AI showed all the steps of the calculation yet in the top summary box I found it had used a completely different value for this very same energy. This value seemed to have nothing to do with the nicely laid out and well explained calculation! With AI you have to keep your eye out for these kinds of strange anomalies. As AI is used all over the internet, this type of thing can happen anywhere.

Cumulative Score:
helpful: ✓ unhelpful: ✗✗✗✗

Made up links and references

One of the students I mentor uses ChatGPT to help him research and write essays at university. Being a good student, he does go off and check any key pieces of information that AI offers. However, he has told me that AI often suggest references that simply don't exist. This is very disturbing, as we then don't know if the information was bogus (i.e. made up by AI a so called 'hallucination') or just that the web link or reference source AI used was lost for some reason.

Cumulative Score:
helpful: ✓ unhelpful: ✗✗✗✗✗

Calculations: VLF coils: inductance and self-capacitance

As a relatively simple test project I decided to use ChatGPT to help me design a large air cored tuned circuit for very low frequency (VLF) work. It's something a radio amateur might have made 100 years ago but I wanted to see how AI might help.

I worked at the National Physical laboratory for a year in the 1980's. I had a wonderful time as a 'Time Lord' helping to keep the atomic clocks working and building receivers for the MSF 60kHz time signal. I have kept up my interest in MSF and VLF since. Long Wave ferrite rod antennas (often using Litz wires) can be made to work well at 60kHz by adding extra parallel capacitance. When I was at the NPL we used to log the signal strength of the Rugby signals at Teddington. We saw interesting variations in the signal strength at dawn and dusk. I wondered if the Earth-ionosphere distance was acting as a wave guide at these very long wavelengths, and 'cutting off' at various times of the day leading to phase changes and signal variations when some distance away from the transmitter.

I had made some long-term signal strength measurements using a ferrite rod antenna set up at my home in Brighton, but the permittivity of the ferrite used in the rod antennas often changes with temperature and they can also be de-tuned by magnetic fields. So, to make sure what I was logging was 'real', rather than a temperature change artifact, I decided to investigate using air cored coils. Even though they are much larger than ferrite rod antennas, they would be more stable in these respects. Like a ferrite rod antenna (and unlike a long wire) such a coil can be rotated to null noise.

I had some nice 30cm diameter Perspex rings that were left over from another job and used them with 3D printed parts to create my large coils. My first prototype was just 22 turns as I also wanted to use it up to 3.8MHz for topband and 80m receiver experiments along with an interesting transconductance preamplifier stage described in *Tech Topics* [**7**].

Further experiments with a similar size coil led me to a 190-turn coil made up of 38 sets of 5 turns close together (see photo, **Fig. 3**). The aim was to get a high inductance but reduce the self-capacitance of such a lot of wire close together.

Such a coil tuned with a suitable capacitance, should work well for picking up the relatively strong 60kHz MSF signal and might also be used to receive the vintage SAQ 1920's mechanical CW transmitter in 17.2kHz that still transmits twice a year (Christmas and summer messages).

Formulas to estimate the inductance of such a coil are available in classic RSGB sources, such as data handbooks or the RSGB *RadCom Handbook* [**8**, **9**]. Although an approximate value of the inductance is fairly straightforward to do, I was interested to see how well AI might do these calculations. I also wanted to see how well it might tackle estimating the self-

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ChatGPT said:

That's a very good question — and the short answer is: **the model "L is constant and only capacitance changes" is slightly wrong in a real LC circuit**. A few very common effects can *exactly* produce an apparent **negative self-capacitance** even when the frequency measurements are accurate.

Nothing is "wrong" with your measurements. What's wrong is the assumption that:

- L is constant
- Coil self-capacitance is a fixed lumped element

In reality:

- L decreases slightly with frequency
- Distributed capacitance changes with current distribution

Both effects naturally produce an **apparent negative self-capacitance**.

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capacitance of such a large coil, something which is not so easy to do 'by hand'.

I used ChatGPT to calculate the inductance and the self-capacitance of the muti-turn coil (ChatGPT used the Medhurst calculation for self-capacitance, see screen grabs, **Figs 4** and **5**) - see both the ChatGPT and real-life measurement data in the table.

Cumulative Score:
helpful: ✓✓ unhelpful: XXXXX

190 turn (38 set of 5) turn coil, 1mm enamelled copper wire, 23cm diameter coil, ca 1cm 5-turn spacings

ChatGPT gave an inductance = 7.5mH with a self-cap of 210pF

ChatGPT estimated C = 940pF for resonance at 60kHz (11nF for 17.2kHz)

Real life Peak meter measurement gave 9.0mH (DC resistance 5Ω)

Which would give a resonance at 60kHz using C = 780pF (9.5nF for 17.2kHz)

I found I needed 1050pF (Peak meter measurement [**10**])

Cumulative Score:
helpful: ✓✓✓ unhelpful: ✗✗✗✗✗

What would I expect the self-capacitance of such a large coil to be? Well, a guestimate might be somewhere between 10pF and 100s of pF. So, ChatGPT's value of 210pF seems reasonable.

Ignoring the damping effect of the resistance on such a large inductance, the capacitance required for resonance can easily be calculated from the standard LC formula [7, 8]. I made up the coils and experimented with the real-life capacitance (variable capacitor) needed to resonate the coils as shown in the table. I coupled into the coil / antenna using two turns around the middle of the coil, the two ends of which simply went to a piece of 50Ω coax and on to the VLF receiver. Tuning the receiver to 60kHz MSF I found the coil required 1050pF for resonance, while at 77.5kHz DCF it resonated with ca. 656pF [**10**]. The beauty of using the time signals of course is that we are sure of the frequency.

For measurement 1: $f_1 = 1 / 2\pi\sqrt{L(C_1 + C_{self})}$
Which is equivalent to:
$(2\pi f_1)^2 L(C_1 + C_{self}) = 1$

For measurement 2: $f_2 = 1 / 2\pi\sqrt{L(C_2 + C_{self})}$
Which is equivalent to:
$(2\pi f_2)^2 L(C_2 + C_{self}) = 1$

If you assume the inductance (L) is the same at each frequency, you can solve the equations for the self-capacitance (Cs).

$(F_2/F_1)^2 = (C_1 + C_s) / (C_2 + C_s)$

I did this by hand and got ca. 70pF. As a check I then asked ChatGPT to see if it could also solve the equations, I asked:

"An LC circuit with inductance L and capacitance (C + self-capacitance) is resonant at 60kHz with C = 1050pF and 77.5kHz with C = 656pF. What is the self-capacitance?"

And ChatGPT gave minus 67pF, yes -67pF!

When I went back to my original calculations I found I had made a very basic error, and ChatGPT was indeed correct!

Cumulative Score:
helpful: ✓✓✓✓ unhelpful: ✗✗✗✗✗

What does a minus capacitance mean!? It appears that at these frequencies the interaction between the sets of five turns and the change of skin depth affects the way the coil behaves as you change the frequency. The result is the inductance is not constant between these two frequencies. If you assume L is constant, the maths will generate a negative capacitance.

When directly asked about this negative capacitance ChatGPT outlined that this could indeed be the case (see screen grabs).

Cumulative Score
helpful: ✓✓✓✓✓ unhelpful: ✗✗✗✗✗

References and links

[1] New Scientist, AI solves historical maths problems, 16 Jan 2026.
[2] PC Pro, March 2026.
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[5] Microwave Rotational spectroscopy, H W Kroto, Dover Publications, 2003, ISBN 9780486495408.
[6] Andrew Pratt, personal communication.
[7] Technical Topics, November 1996 and June 2003.
[8] Radio Data reference book, G R Jessop, 5th Edition.
[9] Radio Communications handbook.
[10] Peak LCR measurement meter.

Summary so far

It was very interesting to see how straightforward it was to ask AI to do inductance and self-capacitance calculations. I was impressed by how easy it was to do the dual frequency calculation and realised that ChatGPT provides a very useful check for my own calculations. I was impressed with how it responded to explaining the 'negative' capacitance brought about by assuming the inductance was constant with frequency. Presently it seems to struggle with creating diagrams. So far, I have given ChatGPT equal / helpful good (✓✓✓✓✓) and unhelpful scores (✗✗✗✗✗).

Next time we will look at using ChatGPT to create code to design projects to communicate with modern Icom transceivers.

The cost of AI prompts

I asked ChatGPT how much a typical prompt cost. Programmers pay per 'token' which is around 750 words. A text only type prompt e.g. *"Explain how photosynthesis works in about 300 words"* will be about $0.01 / £0.01. An ASCII type diagram turns out to usually cost a little less, as they are relatively small and so cost about the same price as a text-based answer. A more carefully drawn diagram - like the one of the LNB and dish - are more expensive depending on the detail but typically cost about $0.04 / £0.03 per image. **PW**

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