Hello all, thank you so much for coming to the Trig 833 radio Masterclass, I'm delighted to have such a good looking crowd for my first Flyer Live!

My name is Lindsey Christie, I'm the Customer support Engineer for Trig Avionics, based up in sunny Edinburgh. As you know, today I am here to talk to you about 8.33kHz radios, and my hope is that by the end of the session you will have a better understanding of 8.33 and how you can prepare.

I see that the Flyer Live program would have you believe that I'm a radio expert, GRIMMACE** Now, if you approach me with 1928 Marconi radio its very unlikely I'll be able to help you fix it! However – I have helped thousands of customers with Trig radio installations – from choosing the right product, to debugging installation problems, and I also repair (the very few) faulty units down to component level.

For those who don't know, Trig is a growing company founded in January 2004 by a very passionate pilot, our CEO Andy Davis. In fact the majority of our company fly, so its true to say we know exactly what our customers want and need – we need the same things! So we make Avionics for GA, built and designed here in the UK – and we're very proud to support British manufacturing. Starting off small, our products gained popularity and we now export to 42 countries around the world. We sponsor a number of charities such as Flying for Freedom, and some of you will have had the pleasure of watching our Aerobatic team performing there +6g displays.

Given that we're here to talk about 8.33 radio's, it would be rude not to introduce our 8.33 products.. Our TY91 remote mount radio is – ideal for aircraft tight on panel space. We also have our slimline TY96 mark width stack radio. Both radios are small, light and compact, and packed with pilot friendly features.

If you'd like to have a closer look, please do stop by our booth at T39 – We'll be happy to give you a demo and answer your questions.

Enough of the shameless sales pitch! Back to business! 8.33kHz radios! Today we'll take a look at the key points of,
why we need 8.33
what is 8.33kHz - how it works.,
Plan your upgrade - who and when?
and then we'll look at the radio installation – and for those permitted to - hopefully give you the confidence that you can do it yourself.

Lets see a show of hands of people that think it's merely a ploy for Trig and friends to make some money?

This is an image offered by NATS to illustrate the sheer volume of traffic in a 24 hour period over Telford – who knew it was such a popular place! Swanick ATC handle over 5500 aircraft on an typical day! And with the radio horizon of 2 commercial airliners being more than 800km, we can see how quickly we begin to run out of radio channels.
This growing congestion and the forecast expansion of airspace, demands action. EASA and Eurocontrol see 8.33 channel spacing as a major benefit to both commercial operations and general aviation. – of course all commercial aircraft have been using 8.33 radios for the last two decades, so this is something of an old story to airline pilots!
So it's time for GA to catch up! Creating new capacity requires all aircraft involved to make the change, and so the mandate is born! As we all know, as of 1st January 2018, if you need a radio, it must be 8.33kHz capable.
I know many of you see this as a distress purchase – and we do sympathise – but it's like any other technology – we've got to move with the times, and adapt to the environment around us. Looking at the positives, this is actually a fantastic opportunity to improve your communications with a modern radio. Our fully certified radio's are tested to survive extreme conditions like temperature's of -20! and other stresses like extreme vibration. They also meet much more stringent design specifications. So you can expect to enjoy better performance - improved range, endurance, with – I think it's safe to say – highly reliable, robust equipment.

How it works?

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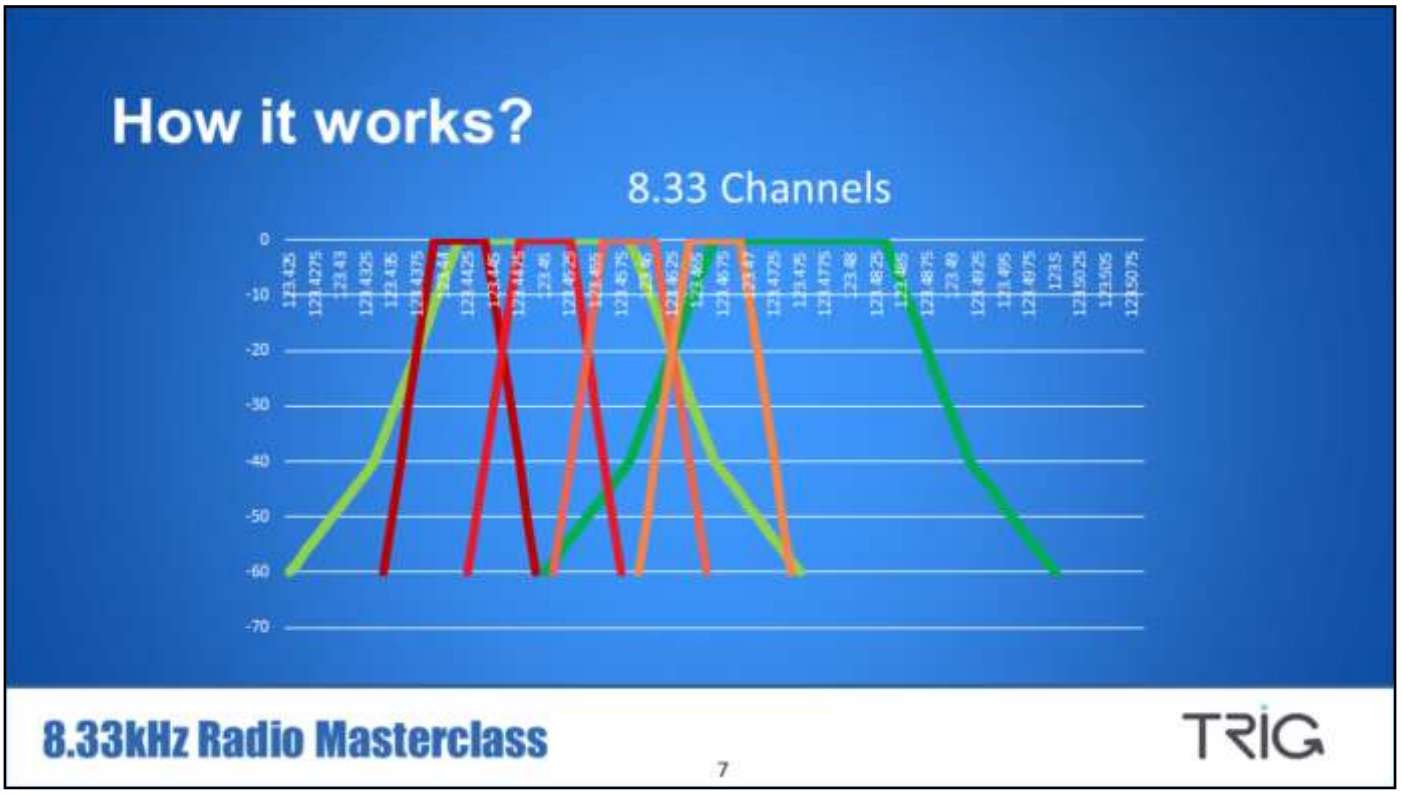
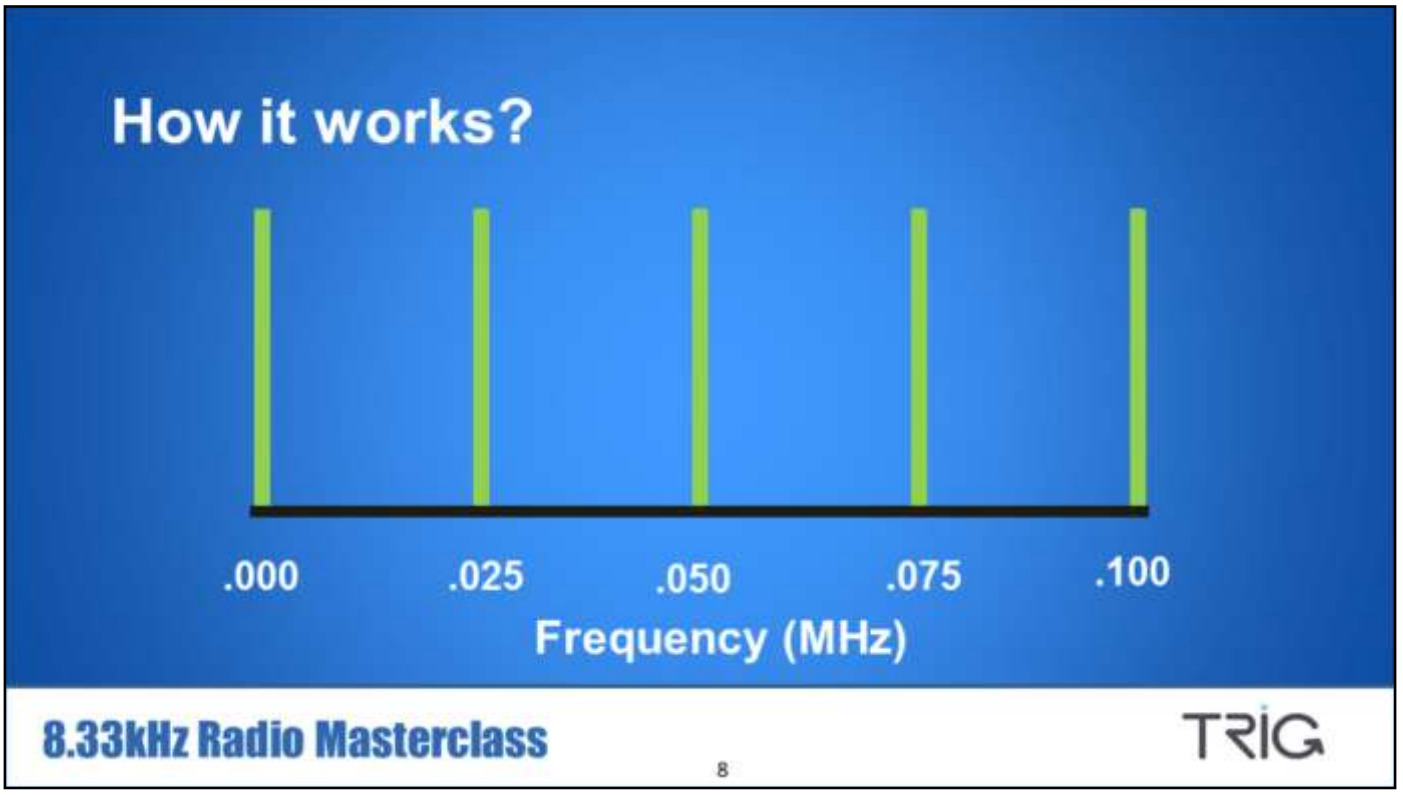


I know that how it really works, is a little messy looking – so for the purpose of explaining we'll start with something easier!



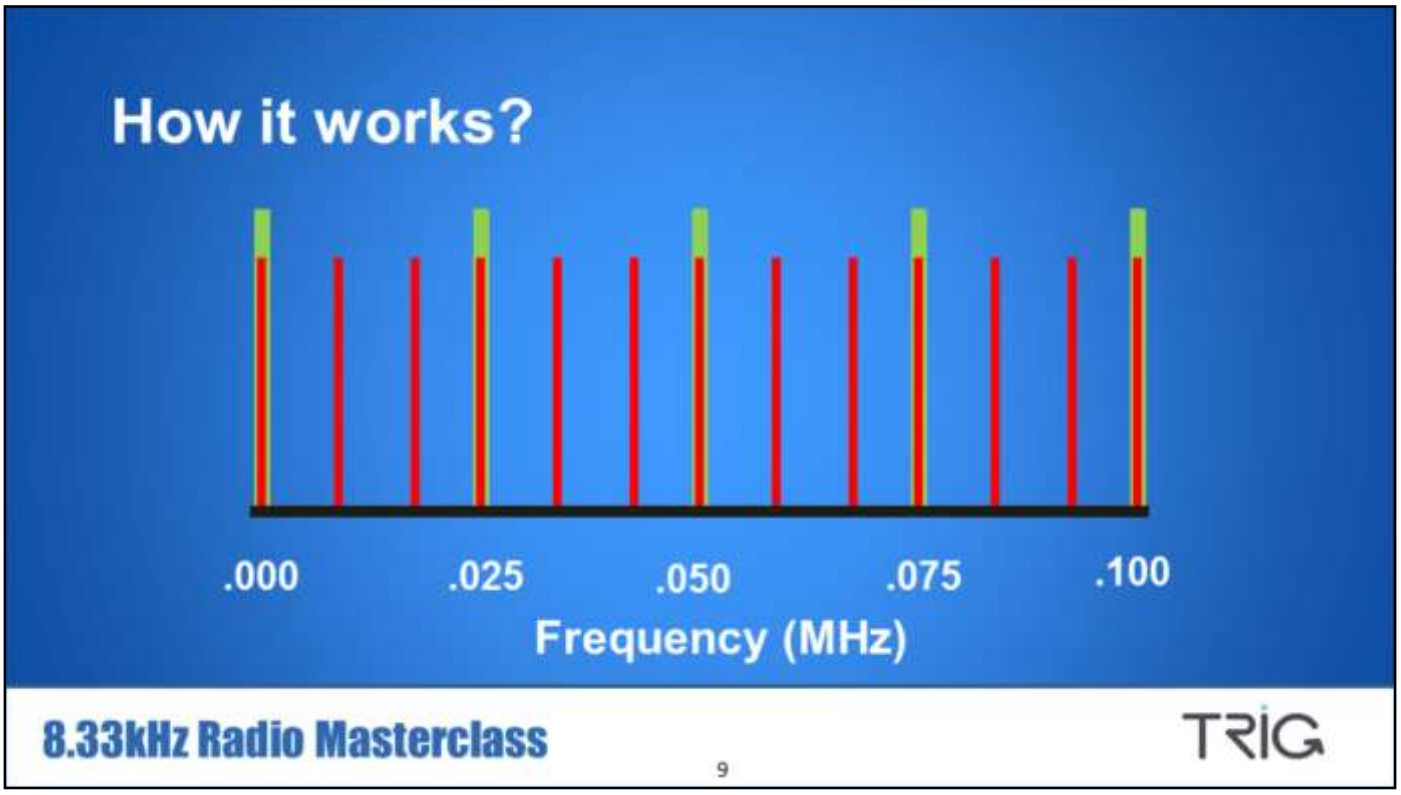
Lets start really basic! A radio comprises of a transmitter, and a receiver – 2 separate missions! Your transmitter tries to transmit as close as possible to the frequency you dial in, as close as possible to the green line in our diagram. Modern radios are quite good at this, due to refined designs and improved components. Older transmitters will often have difficulty targeting the green line, and will transmit a little bit 'offset', somewhere either side of that green line.

Your receiver is listening for incoming transmissions, so casts a net wide enough around that frequency, to catch transmissions, even from wonky old radios.

So we've got our 25K gaps, and if you've got a nice modern radio, when you dial in decimal 05 and press PTT, your radio is probably transmitting somewhere quite close to that green line. Older radio's are less accurate and can be offset to either side of the green line.

We are all comfortable with the old 25 kHz spacing…

Now let's look at the technical aspects of 8.33.



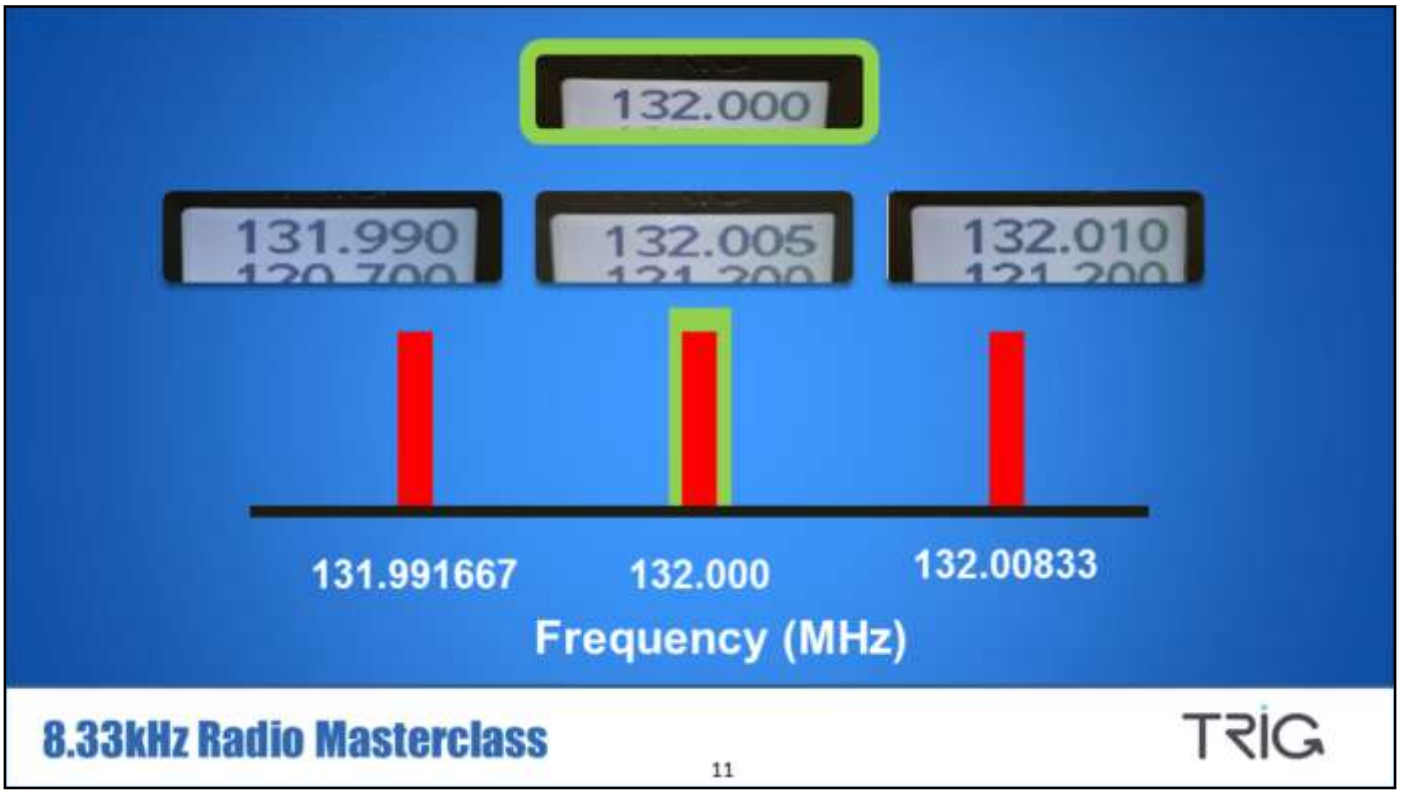
It all works much the same, except we've chopped our old 25K cake into 3 slices. The green lines represent the old 25K frequencies, and the red lines are your new 8.33K frequencies.

A key point which many have misunderstood, is that when you cut your 25K frequencies into 3 you still retain your original 25kHz channel. 8.33kHz radio's can all transmit and receive on old 25 kHz channels. So looking at the diagram - you've got 2 new frequencies in between, then a 'new' frequency on top of the 25K channel. I can see brows furrowing! And quite rightly so! We're thinking BUT THEY'RE THE EXACT SAME FREQUENCY so how do they differ?! (we'll come back to this in a bit!) - first we need to understand the relevance of the terminology – the difference between 'channels' and frequencies'.

In a 25 kHz world frequencies are easy, the 25 x table gives us nice round numbers to work with. 25…50….75….100 But try dividing 25 by 3 .. This gives us 8.33333333

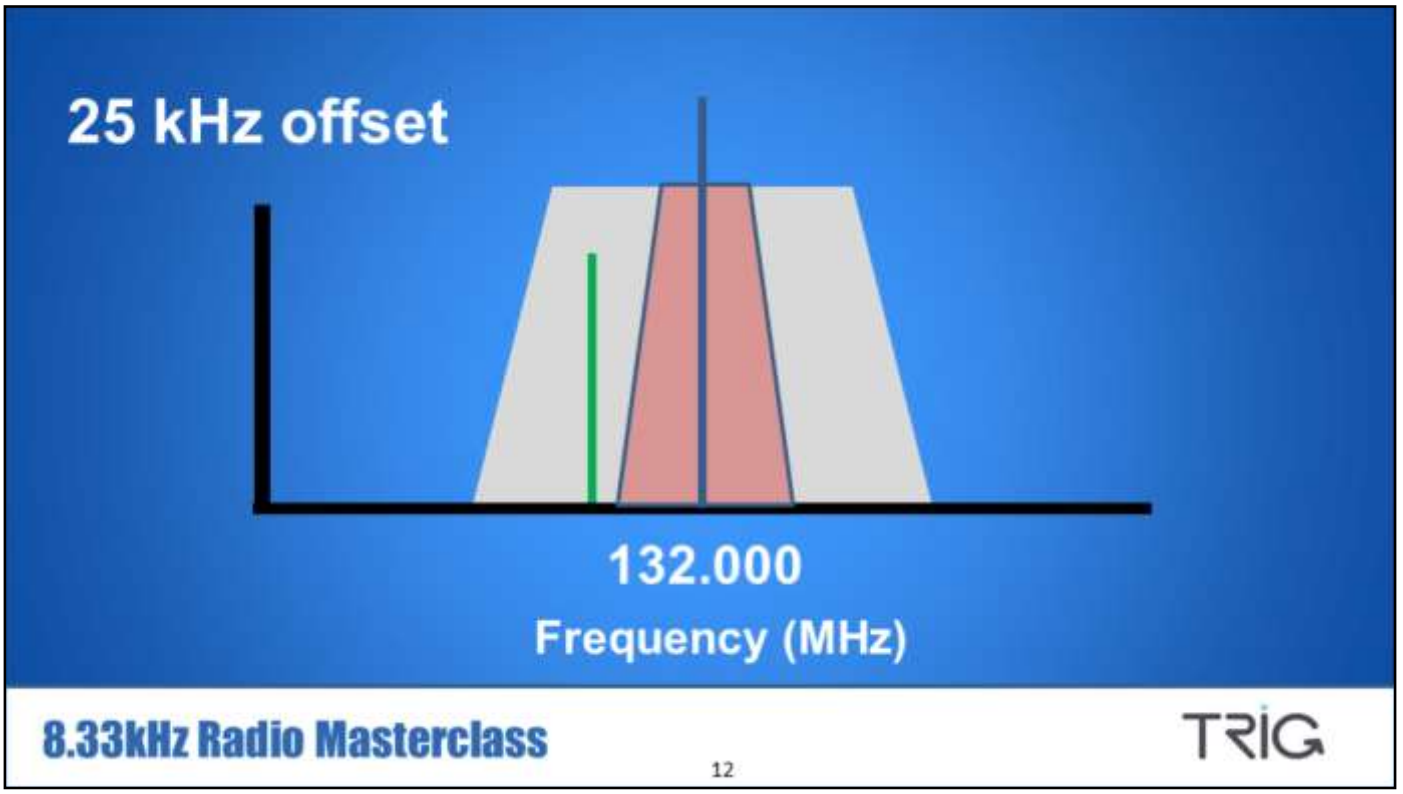
and so your frequencies end up as very long recurring numbers. When ATC call up and ask you to tune to 131.991666666666666... you'll a) most likely get it wrong and b) run our of characters on your screen.

Thankfully the standards bodies, like the RTCA, realised this was a problem and came to the rescue. They allocated a made up number that we all now call a 'Channel' to best represent the actual 8.33 frequency in use.

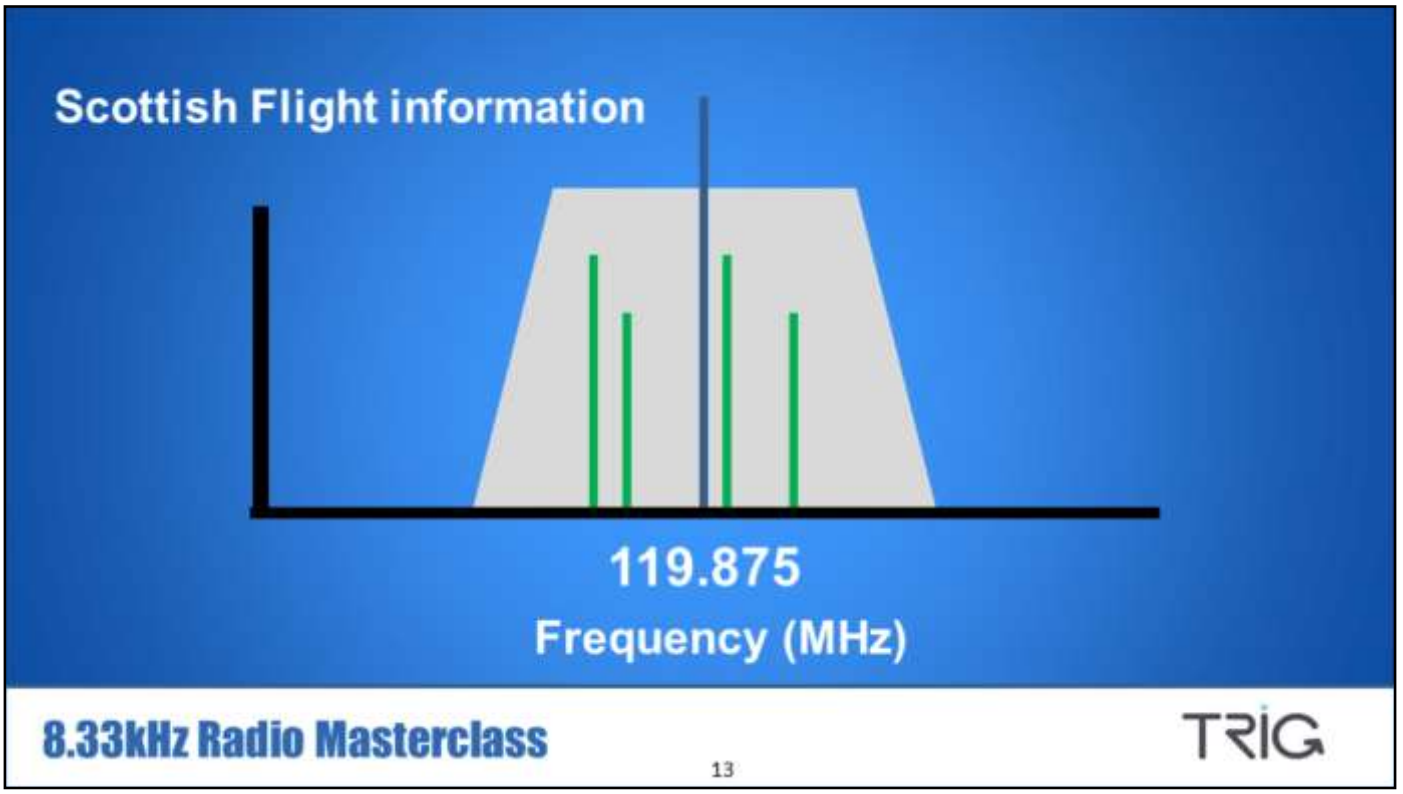


Lets look at how this works in practice. At the base of each red frequency line you can see the actual frequency the radio is transmitting on. So we've got frequency 131.991667 – the **Channel** you dial in is **131 decimal 99)**

Now we can go back to the question of how can we have both our old 25KHz channel AND a new 8.33K Channel on the same frequency?! What does it mean? Looking at the middle line, we see that the 8.33 channel for frequency 132.000, is 132.005. This tells the radio that it is now in 8.33 mode - the transmitter knows it needs to be closer to that green line, and the receiver needs to cast a smaller net, to avoid interference from other near by channels.
Conversely, dialling in the **old 25K channel 132.000**, the radio knows it needs to perform in 25K mode! the receiver knows it needs to cast a wider net, to allow for offset transmissions.

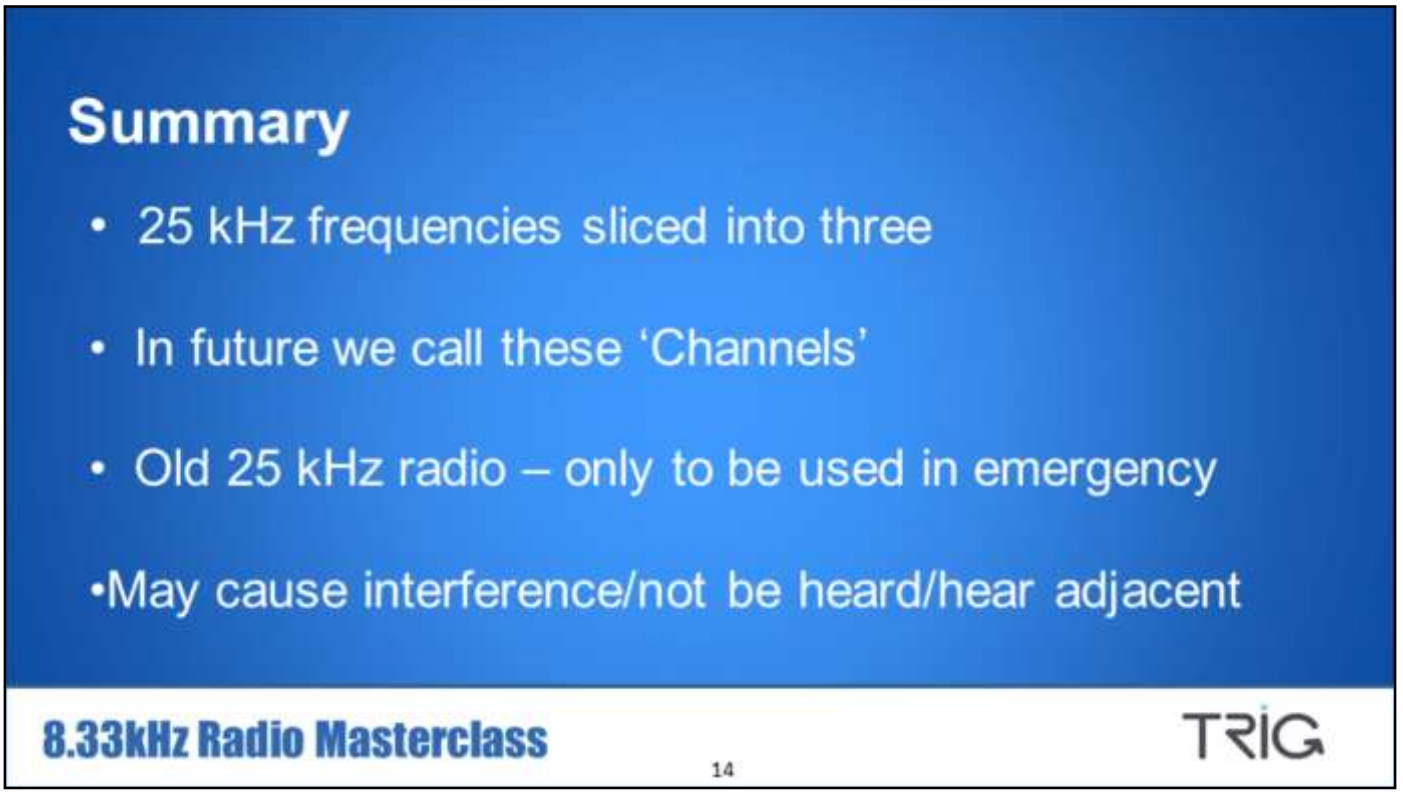


Here we're looking at the receiver behaviour of the 25K mode, versus 8.33 mode. The pink column is the 8.33 receiver bandwidth, and the wider grey column is the 25K receiver bandwidth. The green line shows an old radio trying to transmit on 132 decimal 0, and what I'm trying to demonstrate here, is that the 8.33 receiver would not see this green line. The other risk here is that if you transmit with an old 25K radio, you might be received by an adjacent 8.33 channel without even realising. Causing interference on 131.99 or 131.01. Similarly, If you're listening on 132.000 and you've got 8.33 airfields near by, you may also hear interference from the 8.33 channels on either side of 132.000.



Certain channels will remain 25K spacing – for example emergency freq 121.5. This is sensible given there will be a transition period, and potential for interference from aircraft not yet equipt with 8.33. You can in fact keep a second 'emergency only radio, 25K radio, so long as its labelled as such.

We also need this 25K capability to receive transmissions from **multi-carrier services**, like Scottish or London Flight Information. Services like these transmit across a network of radio masts but use tiny variations within a single 25 kHz frequency (known as frequency offset) to avoid interference between adjacent transmitters.



I just want to do a quick summary at this point, because that's a lot of information to absorb! Key points to remember;

We're cutting our 25K channels into 8,33 slices to create more channels., but we still have our old 25K capabilities.

It's helpful to use the terminology of 8,33 – channels rather frequencies.

Finally, why can't you keep your old 25kHz?
From a practical point of view you may not be heard, you may cause interference for others without even knowing, and finally you might pick up the 8,33 channels on either side of your 25K channel. I think I saw some spotters perk up there! :)

So we must move to 8.33 spacing…

Plan your upgrade

8.33kHz Radio Masterclass

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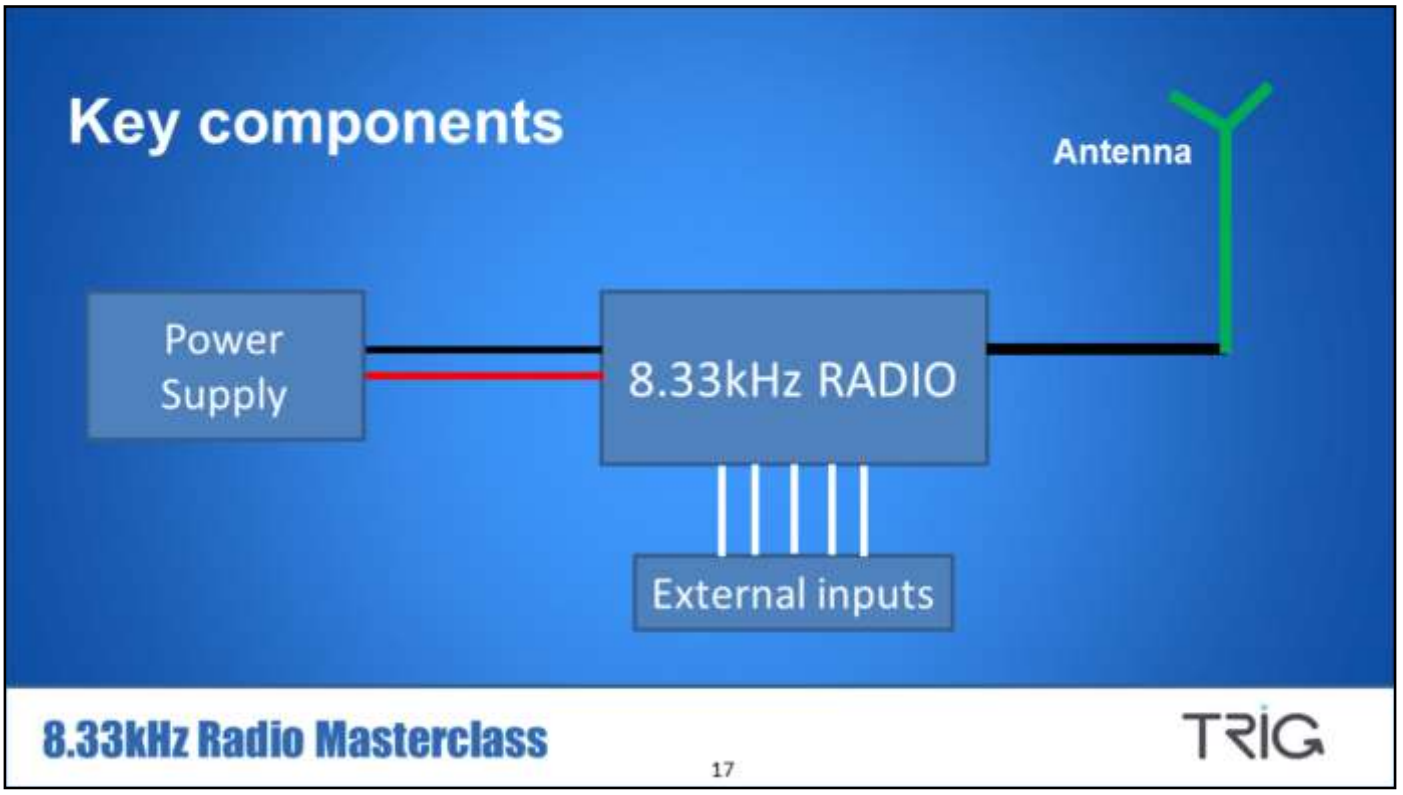
So we must move to 8.33, so lets look at planning your upgrade.

If you fly an EASA type then you must use a B2 licensed engineer who will carry out an installation using the new EASA standard change document, CS-STAN. There's a network of Approved Trig Dealers who will be happy to help you arrange such an installation.

Of course the great thing about this show is that many of you own and maintain your aircraft. If you have a non-EASA aircraft, permit to fly, microlight or glider then you can consider installing a Trig radio DIY. AND you'll be pleased to learn that lots of other people have done just that with great success!

On the paperwork front for the LAA, BMAA and BGA all have standard minor change paperwork to cover off an 8.33 installation via an inspector sign off. All the information you need is found on the respective websites.



That's the paperwork out of the way! Now lets plan the installation. Key components – you need a 8.33 radio. A Power Supply. An antenna. External inputs such as mics/phones/PTT switches etc. Its widely known that the quality of your installation is critical to the performance of your radio, so it pays to be careful in your planning and purchasing stage.

Maximum aircraft Flight Level (FL)	Minimum output power
up to 100	4 Watts
100 to 150	6 Watts
150 to 200	8 Watts
200 to 250	10 Watts
250 to 300	12 Watts
300 to 400	16 Watts

Picking your radio –Firstly, consider form factor. Do we want a remote mount, or stack? The TY91 controller fits into a classic 57mm round hole, and the back box can be mounted anywhere within reason, so this is of course the most popular choice for aircraft tight on space, and has proven very popular in the field.
Secondly – What Class of radio do you need, There's a helpful guide in the EASA CS-STAN document, which you can view online. Our TY91 is 6W, so you can see performs best up to 15,000ft for example. Where as the TY92 has 16W output, so is good up to 40,000ft.

You might also consider interoperability – if you wish to interface with existing equipment, is this radio compatible? All Trig radios support standard aviation headsets/intercoms and audio panels. We're also compatible with a wide variety of GPS, allowing you to push frequencies from you GPS database to the radio.

Power supply considerations: For those of you upgrading from an existing system, you will likely already have a suitable power supply. Though it is worth pointing out that the higher power TY92 and TY97 require a 28V supply. The max current draw of our radio's is around 2A (during transmit), and a tiny 200mA when idle or receiving, so we recommend a 5A circuit breaker in line. For battery powered systems, you must ensure you have enough oomph to supply your COM for the duration of your flight. The total current draw on the battery from your Com and anything else connected, must be considered, such that the Ampere hour rating of your battery is sufficient. If you haven't heard of this before – don't be put off – its actually a very simple calculation.

When connecting your power supply, the main thing you must be careful about – for all avionics involved – is to ensure you connect it the correct way around. Assuming you've got correctly colour coded wire – the red being live and black being ground, you of course want red to red, and black to black. If we get this wrong, it can damage your avionics, so if in any doubt, buzz it out. A quick word about general battery safety - You should connect the +ve (red) first, then the ground. When removing, take the red off first, and then the black. An easy way to remember this – always touch the red first!

Of course safety is most important, so if in doubt always ask someone in the know!

Your antenna! You may wish to reuse your existing antenna and coax – and given that they are in good condition this can work. Either way, your antenna should be:

free from dents/damage.

Clean – as grease on an antenna can degrade performance.

The antenna tech requirements as described in our Install Manuals are 50 Ohm load, vertically polarised.

There are a wide variety of antenna to choose from, either dipole or ½ wavelength antenna), or the shorter more popular ¼ wavelength 'monopole', which needs a ground plane. For those of you scratching your heads – a ground plane is sort of like an electrical mirror, and basically gives the small 1/4wavelength monopole its other half, making it look like a dipole of sorts. For metal skinned aircraft, a ground plane is easy – all you have to do is mount the antenna somewhere such that the 1m2 ground plane is uninterrupted. The antenna does of course need to be mounted outside of the aircraft.

For fabric/compostite aircraft using a monopole, you will need to fabricate a ground plane as shown above. This can be a bit of copper tape in a cross, or even a disposable baking tray!

Typically COM antenna are mounted on top of the aircraft, well removed from any projections or moving parts, and keeping as much distance as possible away from other antenna. Above you can see the Trig trainer aircraft up in Fife – with a sun photo shopped into the back ground! Here we see the 2 COM antennas mounted over the wings, about 2 foot apart. For smaller aircraft with lots of other antenna, this might be tricky! If you're having trouble finding space, just ask and we'll do our best to assist you.

Moving on, your antenna is no use until connected to your radio – we call this cable coax! If you're planning to reuse existing coax, its worth considering that the RF shielding on coax does degrade over time, (that's the metal braid you can see in the top image), The shield is there to drag any RF headed for your signal line, down to ground. But after years of use humidity can cause oxidation (rust) and this results in breaks in the conductivity, hindering the shields purpose in life. In practice, this may cause you to hear RF interference such as clicking from the transponder, or whine which changes in pitch with engine revs.

Generally, I would advise that for old installations, it's best to upgrade your coax while you've got your panel apart.

Coax considerations: You want 50Ohm impedance aircraft grade cable. Depending on your installation, you may also need to consider cable loss – and by cable loss we mean the power lost per foot of coax length.

For an electrically noisy aircraft where you've got a slightly longer cable run to your antenna - we recommend RG400 as its low loss and double shielded.

For shorter runs RG223 is sufficent and still double shielded).

I know that RG58 is quite popular, but for modern radios I would recommend that you avoid RG58 (as its only single shielded, and is therefore more vulnerable to RF interference). General rules of routing the coax are

Keep the run as short as possible

Route away from heat sources and avoid sharp bends/kinking the coax. Its also best to route away from your transponder coax/stobe lights. Again – full detail of this in our Installation manuals.

For you guys buying a new antenna – there are plentiful options on the market. And as with anything in life - you get what you pay for. It comes down to durability and aesthetics. Comant C121 £200 looks slick with the powder coated finish, better protected from the elements, and better supported against bumps and scrapes.

Or you can choose a basic metal whip type – seen on the right. At just quarter of the price its Function over fashion – does the trick but just doesn't look as attractive. Looking at the bottom 2 images, Microlites often favour the king post dipole antenna, since they've got the real estate to fit the longer length. Something like the Microavionics MM052 King Post Antenna

Moving on, your external inputs, you may wish to reuse your existing mic sockets/phones and even the wiring. It may be that you use an external intercom. For all of the above, so long as the wiring is in good safe condition, then this is fine. All you need to do is re-terminate to the new connector following the Radio Installation Manual. All Trig radios come with an installation kit which include excellent quality connectors and pins – everything you need except wires and tools, and we even provide additional wiring diagrams to help you integrate with other popular avionics.

At this stage, its worth mentioning that if soldering and crimping doesn't sound like fun to you, then you can opt for a premade harness, The one in the image is made by Mendelssohns Pilot Supplies up in Edinbrugh, and several Trig dealers have been known to give these away free or at a reduced price when buying as a bundle. In this case all you have to do is specify your measurements, then plumb it in.

If however, you enjoy a bit of tinkering, then you can create the harness yourself. It's actually relatively simple, and requires only a few non standard tools. (other than your wire snips/phillips screwdriver/Stanley blade. You'll need a soldering iron. You'll need wire snips, and wire strippers. And finally, if terminating the coax, you'll need a hex crimp tool. These can be pricey, but I know installers that use the £15 unbranded one from Farnell – and it works great.

The most important advice I can give you, is to take time to read the radio installation manual before attempting any work, and particularly observe the key notes on the wiring diagram. If there's anything you're unsure of, we'll be happy to advise.

Shielding tips

- Mic lines are most sensitive to RF
- Terminate shield to ground at radio end only
- Avoid ground loops

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The wiring diagrams are laid out clearly, so generally people find them easy to follow, and although the wiring up can be a little fiddly, there's really nothing difficult about it. The wire you choose should be aircraft quality – which means it doesn't go on fire as easily as cheap stuff – and won't give off poisonous fumes in any such unsavoury event, and its important that you avoid having sections of bare wire – adding heat shrink is a great way to avoid shorts. The power supply wires should be 18 or 20AWG, and the rest of the wiring can be 18 to 24AWG, usually 22AWG. AWG just mean American wire gauge – your avionics shop can help you source the right stuff.
The only thing that DIY guys often get caught out by is audio shielding. The mic inputs are always best served shielded from RF, as they are sensitive to small signals, so pick up RF more readily than phones or data lines. If you've got an electrically noisy engine, then I would shield data lines and phones too. Shielding might sound mysterious – but its very simple – buy some shielded wire, strip it as you see above, then connect the metal sheath to radio ground, to drag stray RF to ground – keeping it away from the signal line.
Stripping and crimping wires is easy as can be. I could spend all day describing this in detail, but its much more useful to see it done! So for practical demo's of crimping/stripping and terminating coax to TNC, please pop by our stand! T39.

Results – case study

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So as I said, easy as pie, anyone can do it. It might take you 10, 20 even 30 hours, If you don't believe me – theres a fantastic case study on our website – a happy chap that did all himself with no previous electronics experience.

If you get stuck at all, our support team will be happy to advise, just email us at support@trig-avionics.com.

This brings me to end of the presentation, does anyone have any questions?

Can I use a handheld 8.33 radio?

Yes for EASA Balloons/blimps and gliders, registered in the UK, NON Commercial use! Not in Class A,B or C airspace and only accepted in the UK.

Yes the CAA rebate applies to handhelds.

Why would I bother with a panel mount when handheld is a fraction of the price.

Class A; below FL195, in airways. Near airports and flight routes. UK doesn't have Class B airspace.

Class C; above FL195

Class G airspace, you can fly without a radio or transponder.

Is the CAA rebate confirmed? Yes, CAA have assured us they will honour a 20% rebate on any 8.33 purchases after Feb 2016. They estimate that they've got 8000 aircraft still needing upgraded, and 4.3million euros budget for the rebate scheme.