There is some overlap with the summary posting here but extra data and amplification of some points is included in four sections. A number of items here are not complete - sorry but I'm moving on.

SECTION 1: Expansion on some final TT posting points
SECTION 2: Efforts to estimate expected KT34A and KT34A M2 upgrade resonances.
SECTION 3. Summary of KT3** Resonance and Dimension Data
SECTION 4. Some KT34A modeling matters

## SECTION 1: Expansion on some final TT posting points

1. If the KT34A 15 m reflector element (taken alone) has a resonant frequency above, or maybe too near, the lower band edge, 15 m F/B will he compromised, at least low in the band. This may be helped by making the spacing between the 15 m shorting bars (~47," depending on model, which was previously called the "B" dimension) larger. This is consistent with (but not fully spelled out in) an old KLM trouble shooting ("Horse's Mouth") sheet reposted on TT recently by K1KP (also at http://www.hamanuals.com/miscmans.html, KLM section). In the case of the M2 upgrade reflectors for old KT34As with 77" X 3/8" linear loading tubes (which may be all) that form the centers of the capacitors, this spacing cannot be increased without reducing the corresponding spacing for the 10 m section, which may not (but might!) be a good idea. In the opinion of at least 4 upgrade customers, meeting the M2 specified dimensions cannot be quite done as it would require a 77 ¼" tube - M2 does not fully concur in this assessment. M2 recommended to me the purchase of their longer 3/8" tubes (77"-> 80") to accommodate this adjustment. I have not done that, but initially I increased this "B" dimension ¾" by shortening the corresponding one (the old "C" dimension, ~ 28") on the 10 m section by the same amount. The result was the resonance frequency went down over 100 kHz on 15, from 21.03->20.92, and went up about 300 kHz on 10 (okay for me as it appeared low initially, 27.0 -> 27.3, part of the plan). The 15 m F/B went from ~1 to ~6 dB, in the cw band, maybe a bit more higher on 15 but I have no good data there (my local QRPp test range only has 1 xtal/band and a F/B calibration precision of a dB difference at very best). Encouraged, I next extended this same "B" dimension on the reflector of my antenna by another inch (by adding an extension to the 77" tube but keeping the 10 m section unchanged after the first adjustment) resulting in a further lowered resonance value 20.92-> 20.74 and a F/B that improved maybe another dB or so at best to ~ 7 dB at 21.05 (again it might be a little bit better up the band, from on-the-air estimates, but probably not up to spec). The VSWR at the bottom of the band improved modestly with each change and meets expectations now – meaning it looks much like the example in my '84 manual with values no more than about 1.4+ over the band.

While the improved antenna may not be fully up to spec, as a practical matter another 10 dB of F/B may not be a big deal unless there is a bit of gain available, which is certainly not assured. So, I am moving on.

In summary the 15 m F/B problem is improved but the mystery is not fully resolved as to why the original resonance in the 15 m reflector could have been too high, or why the

F/B remains somewhat weak after fixing the resonance – or why a number of other KT3**s might be out of sorts on 15. Just operator assembly error, old bad parts … ? I'm not so sure. Why you ask?

First some background on resonances. All the available individual element resonance data available (as posted on TT) are for the KT34XA, not for the KT34A. Although the unassembled hardware components of the corresponding elements are identical, it turns out (I found out late in the game) that the dimensions for these elements for the two antennas are not the same. Therefore, it is highly likely that the resonances for the two (XA vs A) are also not the same for the corresponding elements, probably by design. I have not seen, or received from M2 or elsewhere, any information indicating the intended values for the KT34A resonances.

The B dimension appears to play an key role in determining the 15 m resonance since it is approximately proportional to the inductance determining this resonance (from the area of the ~ 46" X 3" 15 m loop) . The result is the resonance frequency goes roughly like fo~1/sqrt(B). Using the element resonances example reported by K6MYC of KLM/M2 for the KT34XA, along with the values of B (http://www.hamanuals.com/miscmans.html), this relation can be used as a starting point. It holds pretty well, if you allow for some modest effects of the "C" and "D" (D is the amount of extension on the 72" X 1" tube to the element tip center, 18" to 21") dimensions, and shows a change rate of the resonance frequency with B of a bit over -200 kHz/inch, with everything else held fixed. (Note that this value is pretty close to the derivative of fo~1/sqrt(B), confirming the relevance of that relation.) The appropriate B to use here may be the interior dimension between the shorting straps (or bars for the current M2 units) so you have to correct the drawing values accounting for the measurement points which differ with KLM and M2 versions. Futhermore, it is possible that the old straps and the new bars will give somewhat different inductance results as well even for the same interior dimension.

As discussed in glorious detail in Section 2, the M2-provided resonance frequencies as taken in 1980 (also available from TT postings) on 15 m for all 5 of the XA elements, along with others, provides a basis for estimating the apparent target 34A resonance values, by using the dimension differences (B, C and D). I did a least squares fits to the 5 element resonance value sets (individually for KLM/M2, K1KP, N2IC and W4EF) as a function of 4 variables: an arbitrary reference frequency keyed to the Front Driven element, and the linear change rate of frequency with B, C and D (i.e., $\Delta f/\Delta B$, $\Delta f/\Delta C$ and $\Delta f/\Delta D$). The best fit values for these 4 parameters were then used to determine the 34A resonance estimates using the 34A element dimension differences. The results clearly point to a few past measurements that are suspect but when these are discounted, on the whole, a pretty stable and consistent set of anticipated 34A resonance estimates ('83-'96 era, probably more) result, nearly independent of exactly how it is fit:

REF 20.95 +/- .03
RD 21.0 +/- .05
FD 21.9 +/- .08

DIR 21.9 +/- .07

It is not guaranteed that these are the target values for the M2 upgrade or the KT34M2 with the same (15m) dimensions, but is seems likely. (Sadly, I have apparently exhausted my M2 tech support allocation.)

One striking feature is that the reflector resonance was apparently designed to be just below the band edge. (You might complain that this is not what one expects for a yagi reflector – however, this is not your Grandpa's yagi, especially for 15 m where the elements have very high Q (~ 400 says M2) "tuning stubs, " explicitly not described as traps, that set the resonance.)

B. My initial installation with the current M2 upgrade specified dimensions provided individual element resonance frequencies as:
REF 21.03 kHz
RD 20.9
FD 22.1
DIR 22.0
These values are consistent with values found by one M2 upgrade correspondent of mine, K7HP, aside from the reflector where he got a more soothing 20.91.

In spite of having gone to this fun, I have to point out again that there is no assurance that the old KT34A resonances are actually the target values for the M2 upgrade unit. It seems likely that M2 did some new performance tuning (rather than resonance tuning) when they put together the upgrade and the new KT34M2 dimensions, given the abundant compromises that must have been used. This information is not shared. So it is quite possible that the resonances observed are near the ones that result from new tuned dimensions. (Changing from straps to bars alone may affect the resonances and performance a bit and this may have been compensated for.)

However, my 15 m reflector resonance value at 21.03 is above the lower band edge. M2 says, and it seems right, that this resonance value is expected to hurt the F/B, and also raise the SWR at the lower band edge. This is consistent with my modeling as well which shows a very sharp decline in F/B as the frequency approaches the resonance. (The variation is much sharper than for a pure yagi.)

These data are also pretty consistent with the specified M2 upgrade dimensions indicating that the nominal expected variation with B (freq~ 1/sqrt("B")) is reasonable and indicating that the assembly is okay.

C. Resonant frequencies for various elements/bands from different people's measurement efforts (provided by N2IC, but with some probable transcription errors) show a substantial amount of variability, especially for the reflector, with standard deviations well over 200 kHz. These data are provided in Section 3. I might have been prepared to dismiss this as due to different people/measurement/construction qualities. However, M2 provided me with second set of resonance values (15 m: 20.525 reflector, 21.1 rear driven) from an unspecified KT3* from other old notes - so even the two KLM reflector resonances differ by 375 kHz. So non-expert kit assemblers perhaps should not be too shocked if they don't always get spot-on resonance/performance. Of course, the recommended dimensions and hardware have varied somewhat over the years so that might be a source of variation as well. However, this does not give me a warm feeling because I would have thought that the target resonance frequencies would be important and pretty stable. Unfortunately none of the data that I have obtained from others have both resonant frequencies and the associated dimensions provided to allow a full analysis. Of course, the measurement of the resonances is also rich in technical danger (including the ever-popular question of minimum SWR vs zero reactance) so over-reliance on data from uncertain sources is a concern – and we aren't called amateurs for nothing.

I conclude that given the M2 upgrade reflector 15m dimensions, it is likely that its resonance cannot be very far from the lower band edge, by design, and so with the variability seen (of uncertain source, stay tuned), some poor devils, such as myself, are going to get a higher resonance frequency that hurts F/B, at least in the cw band.

How strong are the resonance values dependences on the mechanical construction? Thanks in part to K7HP, here are some ways you can change the resonance by 100 kHz by fiddling with the capacitor tube elements or other things, in probable decreasing importance of effect:
1) Change the radius of either the inner (3/8") tube or the (inner) radius of the outer (3/4") tube by 1 mil (yes, that is only 0.001 inch) !! One mil appears to be rather less than the tolerances for dimensions of typical drawn Al tubing. (The coaxial tube capacitance depends on the ratio of the inner radius of the ¾ tube and the outer radius of the 3/8 tube.)
2) Change the insertion depth of the polyethylene caps (for relative dielectric constant ~2) from full, 0.25" to poorly seated, 0.17".
3) Use a polyethylene cap with a 15% different dielectric constant.
4) Displace the 3/8" center tube by ~ 15 mils.
5) Move the shorting bar by ~ ½" (out of the ~46").
6) Insert spiders or high dielectric material (say rain water) in the cap tube?

Implications for others from this collected information, IMHO:

The KT3** antennas appear to be very delicate on 15 m due to the high Q tuned stubs used in all elements. This is combined with a great sensitivity to capacitor construction details.

If your KT3** has always had a poor F/B on 15 m (and likely a high-ish VSWR on the low end of the band), first consider increasing the dimension between the reflector 15 m shorting bars, if possible. Some have inserted additional dielectric into the cap tubes to this end. This is not guaranteed to provide killer F/B but may give improvement and help the VSWR as well.

If you are installing the M2 upgrade to a KT3**, or reassembling an old unit, you might want to verify the individual element resonances before putting it completely together (and up on the tower) - be especially wary of the reflector having resonances very near or above the lower band edge. This is also an excellent check on assembly accuracy. At bare minimum, do the continuity checks.

For an existing installation you have a good shot at diagnosing persistent (not weather related) and sufficiently annoying 15 m problems by measuring the individual element resonances - unfortunately this is a lot of work.

The ambitious could do the resonances for both of the element halves separately, since there is the distinct possibility that one half is good and the other is way off, you might get an incorrect reassurance. (I have not done this – maybe my next project.)

New shiny 15 m capacitor tubes may not fix a poor 15 m F/B problem, check resonances before your leap. Note that the 15 m resonances should be pretty narrow.

Getting reflector longer linear loading tubes (77"-> 80") at $100 may not be able fix a poor 15 m F/B problem and may not be necessary even if your reflector resonance is above the lower band edge. (VE3YF reports on eham reviews of getting revised dimensions from M2, apparently to avoid the 77" limit issue.)

Finally:

I received no responses from my TT questions from anyone saying that their KT34A M2 upgrade is just fine with advertised F/B on 15. This may prove nothing, but I was a bit surprised. M2 indicates that they have sold "many many" upgrade kits and mine is the only case of "no F/B on 15m." However, it is certainly not the only case of poor F/B on 15.

Thanks to N2EA, N7BF, K1KP, N2IC, K5GS, W4EF, K9MUF, K4JRB and K6HJC for responses. Special thanks to K7HP for sharing his data and perspectives. My fun on this year long slow motion project is now over after lowering the antenna 7 times.

# SECTION 2: Efforts to estimate expected KT34A and KT34A M2 upgrade resonances.

## The Last Analysis of the KT34A/XA/M2 Upgrade Individual Element Resonances for 15 and 10 Meters

Resonance data for KT34XA have been collected from N2IC, K6MYC, K1KP and W4EF with some transcription errors fixed. It is not certain that all these antennas are exactly the same, as no dimensions are provided. There also may have been some fiddling and there are certainly differences in measurements methods. I will assume for the following analysis that these all correspond to the 1985 era KT34XA where the dimensions are available. The B, C and D dimensions for the 1985 era KT34A are also available. The A and XA dimensions are NOT identical.

**Conclusions in Advance:**

**15 Meters - 1985 KT34A Estimate**

1) The Reflector resonance for the old KT34A appears to be designed to be just a little below the lower band edge.
2) The design resonances of the other old KT34A elements appear to be fairly close to those quoted by K6MYC and others for the corresponding elements of the XA

**15 Meters - M2 Upgrade Estimates and Measurements**

1) If the M2 Upgrade design resonances are estimated from the XA resonances, assuming old straps and new bars are equivalent if either the interior or strap/bar C/L to C/L dimensions are the same, it is found that the M2 Upgrade estimates are close to the KT34A estimates but maybe a bit lower, probably not significantly. This suggests that the target M2 resonances are either the same or very close to those for the old 34A
2) Two independent sets of measured M2 Upgrade resonances differ significantly from the XA-based KT43A estimates only for the N6MW reflector, agreed by all to be too high. The measured M2 Upgrade resonances for the FD appear to be a bit higher than the KT43A estimates.

**10 Meters - 1985 KT34A Estimate (Less Certainty)**

1) The REF and FD resonances for the old KT34A appear to be quite near those of the XA.
2) The RD old KT34A design resonance appears to be well above the lower band edge.
3) The DIR old KT34A design resonance appears to be well above the DIR or DIR3 of the XA but above the upper band edge as might be expected.

**10 Meters - M2 Upgrade Estimates and Measurements (Less Certainty)**

1) If the M2 Upgrade design resonances are estimated from the XA resonances, assuming old straps and new bars are equivalent if the interior dimensions are the same, it is found

that the M2 Upgrade estimates are close to the KT34A estimates for the REF and RD but well below the 34A estimates for FD and DIR.
2) The measured M2 Upgrade resonances for the REF and RD are lower than either of the other estimates based on the XA data.
3) The measured M2 Upgrade resonances for the FD and DIR are well lower than the estimates for the old KT34A, but comparable with the projections for the M2 using the XA data.
4) The DIR M2 Upgrade measurement is below the top of the band, which is a concern but older KLM KT34XA manuals indicate that the F/B on the high end of 10 is not expected to be very good by design.
5) On the whole, one might think the M2 upgrade could have shorter C dimensions, perhaps closer to those provided for the new KT34M2..
6) Taking the (generally low) W4EF data alone to estimate the M2 resonances agrees remarkably well with the measured M2 resonances. This may be pure coincidence - or not.

**Basis for Conclusions:**

**Question #1. Given the reported XA resonances and the element-to-element differences in the KLM manual specified dimensions, what resonance values do you expect for the old KT34A elements based on their different dimensions? (Note this question has nothing to do with the M2 Upgrade.)**

The method used here was a least squares fit to the XA resonances, taken from the four data sources one at a time, using four fit parameters: a reference frequency (arbitrarily taken for the FD element) to set the level, and three rate of change values Δf/ΔB, Δf/ΔC and Δf/ΔD. There are then 5 elements and 4 parameters. Four parameters were thus chosen to provide a best fit to, potentially, each of the four data sets (so up to 16 parameters were found). The resulting parameters were then used with the '85 KT34A dimensions to estimate the 34A resonances.

**15 Meters**

Data selection issues for 15 m:
W4EF values are lower than others for every element, sometimes significantly. This set was not used.
N2IC value for REF appears anomalously low. This value was not used but the rest of the set was.

Parameter values:
On theoretical and modeling grounds I expect that the Δf/ΔB parameter will dominate for 15 meters and will be in the general neighborhood of – 225 kHz/inch. This turns out to be true for the fits. Fit values for Δf/ΔC and Δf/ΔD are found to be small and variable over the data sets. (Modeling might suggest Δf/ΔC ~ -30 kHz/inch and Δf/ΔD ~ -10 kHz/inch.)

Results for the estimates of the (averaged & rounded) '85 era KT34A element resonances with generous uncertainties on 15 m as found from the 3- data sets are:

REF 20950 +/- 25
RD 21000 +/- 50
FD 21900 +/- 80
DIR 21900 +/- 70

Note that the variation (standard deviation over the 3 sets, rounded up) is small.

Here is a comparison of the estimates for KT34A ('85) with the individual XA data.
**Keep in mind that these may not be designed to agree.**

| | W4EF XA measured* | K1KP XA measured | K6MYC XA measured | N2IC XA measured | **KT34A Rez Estimate** |
|---|---|---|---|---|---|
| REF | 20520 | 20890 | 20900 | 20530* | **20950** |
| RD | 20530 | 20930 | 20925 | 20930 | **21000** |
| FD | 21850 | 21970 | 21860 | 22000 | **21900** |
| DIR | 21780 | 21950 | 21900 | 21850 | **21900** |
| DIR3 | 21380 | 21840 | 21650 | 21830 | **N/A** |

* not used in forming KT34A estimate

**10 Meters**

There are more concerns in dealing with 10 m since the resonances are not nearly as sharp as for 15, the factors that control the resonance appear to be less clean and the resonance data are more variable. The only good news is, as indicated in the KLM info sheet and modeling, that the 15 meter portion has very little effect on 10. I take the $\Delta f/\Delta B$ parameter to be zero, which is consistent with the modeling.

Data selection issues for 10 m:
Again the data show more variability than for 15
The K6MYC value for the RD of 28750 does not line up well with the other values. Initial suspicion that it should have been 27750 now appears equally questionable. This value will be dropped in the fitting.
The W4EF values generally appear somewhat low compared to the other three (more later) and are not used in averaging.

Parameter values:
For 10 m we take $\Delta f/\Delta B$ to be zero. On theoretical and modeling grounds I expect that the $\Delta f/\Delta C$ parameter will be significant and modeling, while shaky, suggests values of ~ – 300 kHz/inch and $\Delta f/\Delta D$ ~ - 100 kHz/inch. This holds up pretty well in the fits. However note that the 10 m capacitor tubes are NOT all the same length. This absolutely must be taken into account. This was done by defining a corrected Cc dimension parameter that was the true C dimension times the scaled Cap Tube length. This choice

is based on the notion that the resonance LC value will have an L proportional to the "C" dimension and a capacitance C proportional to the capacitor tube length. The altered parameter is then Δf/ΔCc.

Results for the estimates of the rounded averaged '85 era KT34A element resonances with generous uncertainties on 10 m as found are not so stable as for 15 m over the 3 data sets:

REF 27500 +/- 300
RD 28300 +/- 200
FD 29650 +/- 100
DIR 29800 +/- 150

Here is a comparison of the estimates for KT34A ('85) with the individual XA data. **Keep in mind that these may well not be designed to agree.**

| | *W4EF** XA measured | K1KP XA measured | K6MYC XA measured | N2IC XA measured | **KT34A Rez Estimate** |
|---|---|---|---|---|---|
| REF | *27040* | 27380 | 27800 | 27730 | **27500** |
| RD | *27730* | 27990 | *28750** | 28300 | **28300** |
| FD | *29530* | 29660 | 29575 | 29600 | **29650** |
| DIR | *29070* | 29390 | 29350 | 29230 | **29800** |
| DIR3 | *29130* | 29320 | 29150 | 29340 | **N/A** |

* not used in forming KT34A estimate

**Question #2. Given the above fits to the XA resonances and the differences in the manual-specified element dimensions from the M2 Upgrade, what resonance values would you expect for the KT34A with the M2 Upgrade applied? (Note this has nothing to do with the 1985 KT34A resonance estimates from Q1.)**

The method used here is to take the same individual fits to the XA resonances already found values for Δf/ΔB, Δf/ΔC and Δf/ΔD and the fit (FD) reference for the XA resonance value to project the M2 upgrade values from dimension differences. The M2 upgrade element B and C dimensions are corrected to equivalent XA (or old KT34A) values (+.75") to make the interior strap-strap, bar-bar dimensions correspond properly when the differences are taken. Note that if the new shorting bars provide a different inductance than the straps with the some interior dimensions, this may be revealed as a systematic difference. This was not found.

**15 Meters**

Data selection issues for 15 m:

W4EF data are not used due to their systematic lower resonances. Here the "INTERIOR" version corrects the shorting bar "B" dimension by adding 0.75". The "CL-CL" provides a smaller 0.5" correction (with a difference of ~ 50 kHz between the two) which would be appropriate if the proper inductance loop is defined by the center lines of the tubes.. For some KT34A M2 upgrades, it is necessary to replace the old 5" 1/2 to 3/4 swagged tubes with 12" versions for some of the elements. IF the effects of this on the interior dimensions are treated as reducing the effective inductance interior area, it would give a resonance increase of ~ 75 kHz for any element with this 12" tube. For N6MW, this tubing replacements is just the reflector while for K7HP it is all the elements.

| | KT34A Rez Estimate (Q1) from Above | **IC/MYC/KP Fit Estimate for M2 Upgrade Rez's INTERIOR** | **IC/MYC/KP Fit Estimate for M2 Upgrade Rez's CL-CL** | N6MW M2 U Measurements | K7HP M2 U Measurements |
|---|---|---|---|---|---|
| REF | 20950 | **20900** | **20950** | 21030 | 20913 |
| RD | 21000 | **20850** | **20900** | 20900 | 20857 |
| FD | 21900 | **21925** | **21975** | 22100 | 22082 |
| DIR | 21900 | **21875** | **21925** | 22000 | 21908 |

**10 Meters**

Data selection issues for 10 m:
The N2IC, K1KP and K6MYC (less RD) data provide similar results and the estimates are averaged. The W4EF data shows noticeably lower values (but which are similar to the M2 upgrade measurements) and are provided separately as a matter of interest.
The KT34M2 column has the same meaning as the M2 Upgrade column except the KT34M2 dimensions are used (all these "C" 10 meter dimensions are ¾" smaller than the corresponding M2 upgrade ones).

| | KT34A Rez Estimate (Q1) from Above | **IC/MYC/KP Fit Estimate for M2 Upgrade INTERIOR** | **IC/MYC/KP Fit Estimate for current KT34M2 INTERIOR** | N6MW M2 Upgrade | K7HP M2 Upgrade | *W4EF Fit Estimate for M2* Upgrade |
|---|---|---|---|---|---|---|
| REF | 27500 | **27350** | **27553** | 27000 | 26745 | *26667* |
| RD | 28300 | **28100** | **28294** | 27700 | 27595 | *27602* |
| FD | 29650 | **29325** | **29492** | 29100 | 29340 | *29188* |
| DIR | 29800 | **29475** | **29645** | 29500 | 29480 | *29360* |

## SECTION 3. Summary of KT3** Resonance and Dimension Data

Here are tables of resonance data as expanded and updated from N2IC with independent contributions for W4EF, K1KP, K6MYC and K7HP.

| N2IC Measurements | K6MYC Notebook | W4EF Measurements | K1KP Measurements | | KT34A M2 Upgrade Measurements | N6MW | K7HP |
|---|---|---|---|---|---|---|---|
| X=0 at 15' ht | SWR min at 28' ht with 1:1 balun | SWR min off a short tower ~ 10' from bldg with 1:1 balun | SWR min at 60" ht | | | SWR min at 30' ht with 1:1 balun | X=0 at 88" ht |
| | | | | | Note: | | |
| 27730 | 27800 | 27040 | 27380 | | 34A dimensions are not generally | 27000 | 26745 |
| 20530 | 20900 | 20520 | 20890 | | the same as the corresponding | 21030 | 20913 |
| 13660 | 13800 | 13630 | 13690 | | 34XA values so resonances | 13900 | 13531 |
| | | | | | not expected to be the same | | |
| 28300 | 28750 | 27730 | 27990 | | Also the old 34A dimensions and | 27700 | 27595 |
| 20930 | 20925 | 20530 | 20930 | | hardware differ from both the M2 Upgrade | 20900 | 20857 |
| 14020 | 14030 | 13960 | 13990 | | and the KT34M2. | 14100 | 13800 |
| | | | | | | | |
| 29600 | 29400 | 29530 | 29660 | | | 29100 | 29340 |
| 22000 | 21860 | 21850 | 21970 | | | 22100 | 22082 |
| 15000 | 15075 | 14870 | 15160 | | | 15100 | 14852 |
| | | | | | | | |
| 29230 | 29350 | 29070 | 29390 | | | 29500 | 29480 |
| 21850 | 21900 | 21780 | 21950 | | | 22000 | 21908 |
| 14340 | 14400 | 14340 | 14510 | | | 14800 | 14449 |
| | | | | | | | |
| 29340 | 29150 | 29130 | 29320 | | | | |
| 21830 | 21650 | 21380 | 21840 | | | 21030 is | |
| 14490 | 14600 | 14330 | 14520 | | | above lower | |
| | | | | | | band edge | |
| | | | | | | and affects | |
| | 28750 may really be | | | | | the F/B - | |
| | 27750 (indirect-Staal) | ?? | | | | later corrected | |
| | | | | | | with B adjustment | |
| | old 14340 should be | | | | | | |
| | 14400 | | | | | | |
| | | | | | | | |
| | old 21830 should be | old 21830 should be | | | | | |
| | 21650 | 21380 | | | | | |
| Yellow highlighted values appear to differ significantly from expected value based on the "B" dimension | | | | | | | |
| taken from the KLM KT34XA FROM AFER 1980 | | | | | | | |

and a collection of dimensions

| KT34** Dimensions (inches) | | 1/2" straps, L on 10, outer-outer | | | KLM | | | M2 | 1/4" bars outer-inner | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Element | KT34A '80(01275) | KT34A '83(01759) | KT34A '84(01888) | KT34A '85&'96(VE3YF posting) | 85 KT34XA | 80?update KT34XA | 01Upgrade(withdrawn) | 02Upgrade (current) | 04KT34M2 (current) |
| | | | | all same | | &97upgrade | modern cap tubes | | | |
| "B" | Ref | 47.5 | 47.25 | 47.25 | 47.25 | 47.5 | 47.5 | 47.5 | 46.75 | 46.75 |
| 15 m | RD | 47.75 | 47 | 47 | 47 | 47.25 | 47.75 | 47.75 | 47 | 47 |
| | FD | 43 | 43 | 43 | 43 | 42.75 | 43 | 43 | 42.25 | 42.25 |
| | Dir | 43.25 | 43 | 43 | 43 | 42.75 | 43.5 | 43.25 | 42.5 | 42.5 |
| | D3 | | | | | 44 | 44 | | | |
| "C" | Ref | 28 | 28 | 28 | 28 | 27.75 | 27.75 | 28 | 28 | 27.25 |
| 10 m | RD | 27 | 27 | 27 | 27 | 27.25 | 27.25 | 27 | 27 | 26.25 |
| | FD | 26 | 25.25 | 25.25 | 25.25 | 25.25 | 26.75 | 26 | 26 | 25.25 |
| | Dir | 24.5 | 23.75 | 23.75 | 23.75 | 26.25 | 27 | 24.5 | 24.5 | 23.75 |
| | D3 | | | | | 26.25 | 26 | | | |
| "A" | Ref | 60.5 | 59.25 | 59.25 | 59.25 | 61.5 | 61.5 | 60.5 | 60.5 | 60.125 |
| 20 m | RD | 55 | 56.5 | 56.5 | 56.5 | 54 | 53 | 55 | 55 | 54.625 |
| | FD | 45 | 45.5 | 45.5 | 45.5 | 43.75 | 43.75 | 45 | 45 | 44.625 |
| | Dir | 51 | 51 | 51 | 51 | 53.5 | 53.5 | 51 | 51 | 50.625 |
| | D3 | | | | | 53 | 53 | | | |
| "D" | Ref | 18 | 18 | 18 | not given | 18 | 18 | 18 | 18 | 18 |
| | RD | 21 | 21 | 21 | not given | 21 | 21 | 21 | 21 | 21 |
| | FD | 18 | 18 | 18 | not given | 18 | 18 | 18 | 18 | 18 |
| | Dir | 20 | 20 | 20 | not given | 20 | 20 | 20 | 20 | 20 |
| | D3 | | | | | 20 | 20 | | | |

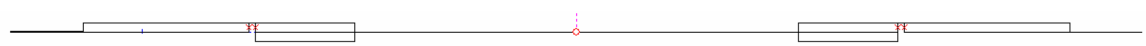
An excel document with these data is on this website "kt36xaUpdate2sheet.xls".

# SECTION 4. Some KT34A modeling matters

One desirable aspect of the current MMANA code, a work in progress, is that it is free via a download. I have no reason to think that this antenna modeling tool is particularly suitable for the KT34A. Standard wisdom is that most, perhaps all, antenna modeling software available to amateurs, does not handle close parallel wires or sharp bends well. Probably no such codes will allow first principles modeling of the KT3* coaxial capacitor tubes – they must be put in a lumped elements with values specified. All this being said, one probably should not trust KT3* modeling very far. Probably the only real hope is to gain some general understanding of key features and perhaps to see how small variations in dimensions/parameters produce small changes in performance for tuning.

## 1. Single Element Results

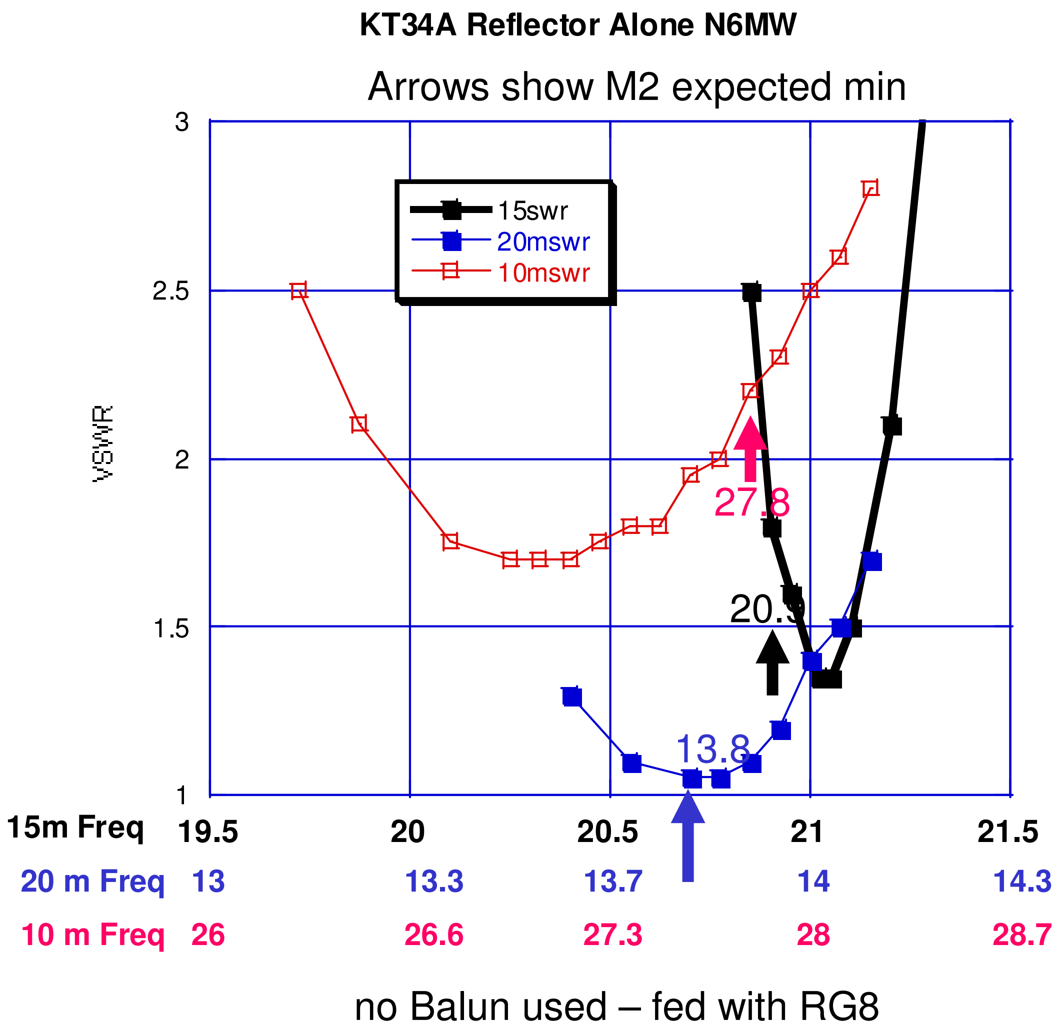
My scheme was to construct each of the 4 elements with wires (really tubes) of roughly the right radius incorporating both the 10 m trap and 15 m tuned stub with their individual lumped capacitor loads. All dimensions were taken from the M2 upgrade values. This provides elements that look like



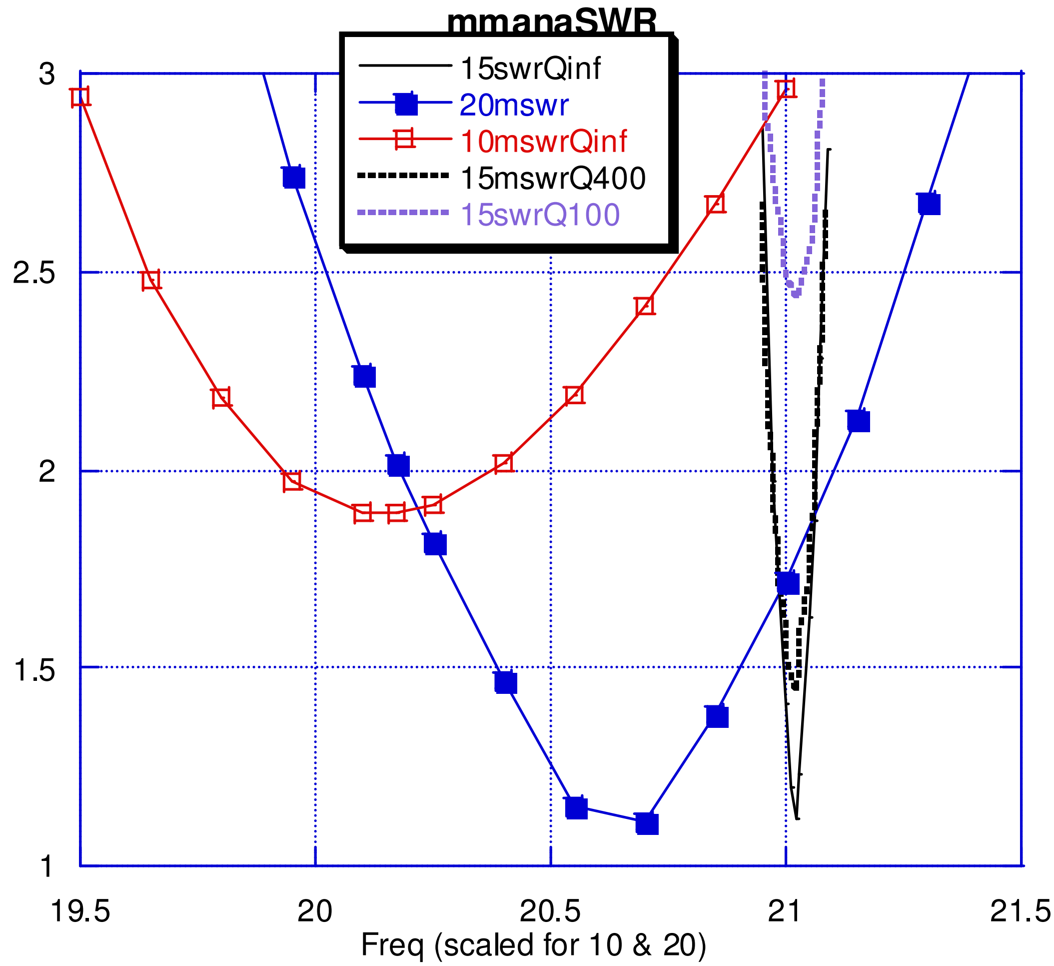
where the red X's are the 4 load capacitors. Note that MMANA allows wires to cross without being electrically connected. In fact to be connected, they must each have an end at the connection point. One worries how crossing wires work in the actual calculation.

Maintaining symmetry, the load capacitors for the four individual elements were then adjusted until the observed or target resonances (jX=0) for 10 and 15 was reached at ten meters height over "real" ground. Finally, the very tips of the elements were adjusted in length a bit to fit the resonance on 20. (So the "A" dimensions of the model are not quite the same as for the actual antenna.) It turns out that the required capacitances are ~ 30 pfd for 10 m and ~ 40 pfd for the 15 m portions – remarkably close the calculated values for coaxial caps of these dimensions.

Next there are two figures showing the measured SWR for the physical reflector element and the model SWR for the reflector. These have a common frequency axis that is scaled for comparison. For the model 15 m portion, runs with Q at infinity, 400 and 100 provided the three curves – not what I would have guessed.




Measured data from the reflector.




Modeled results for the reflector (same scales).

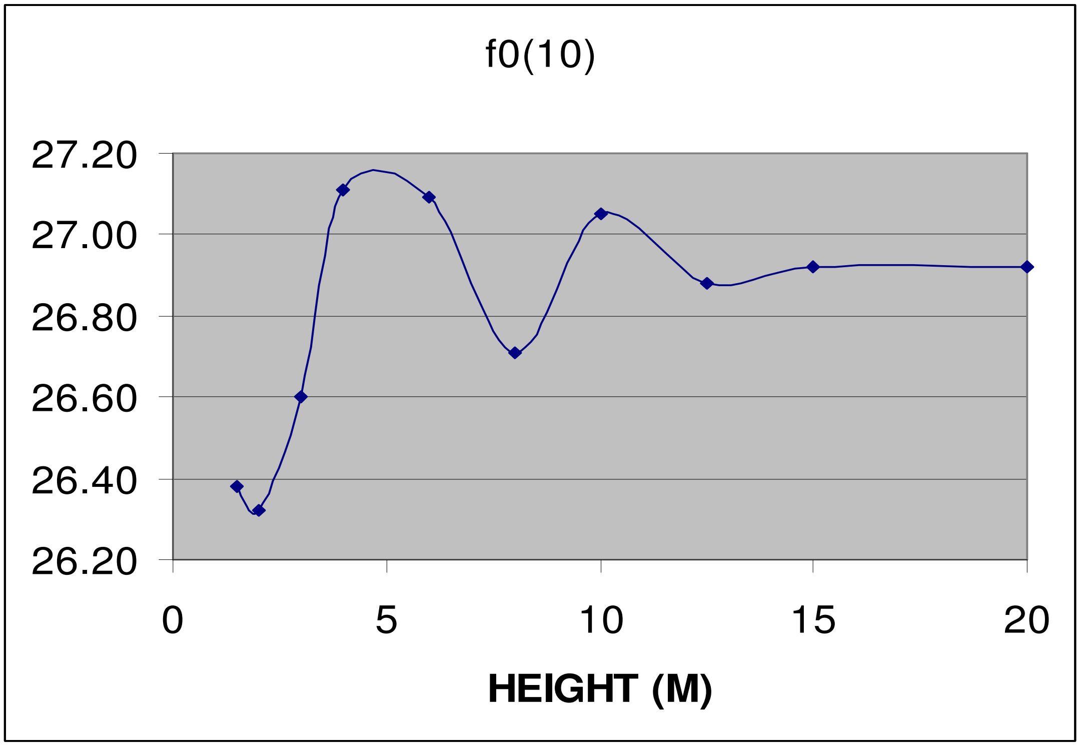
Note that the 15 m resonance is quite sharp and the model appears to require a high Q. The data shown for the actual element was not taken with the use of a 1:1 balun. This was redone later with a balun giving no significant difference.

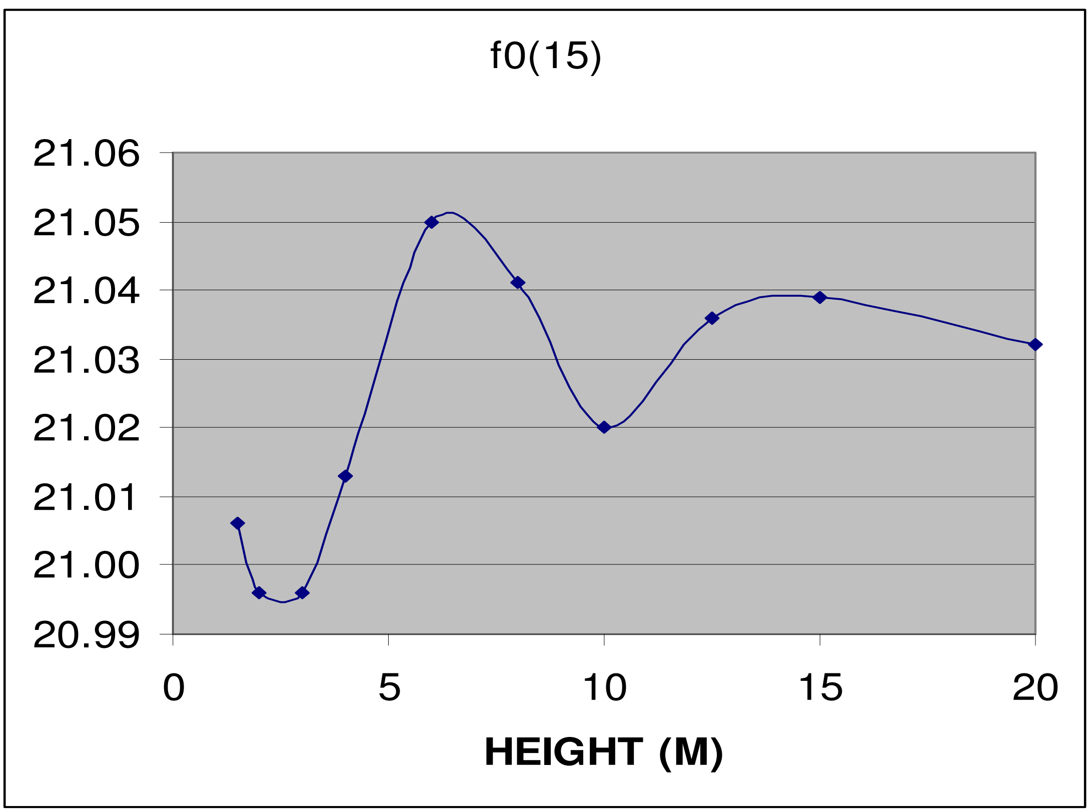
The model and measured results are remarkably similar aside from the very narrow width of the model resonance. The variation with Q is not understood by me.

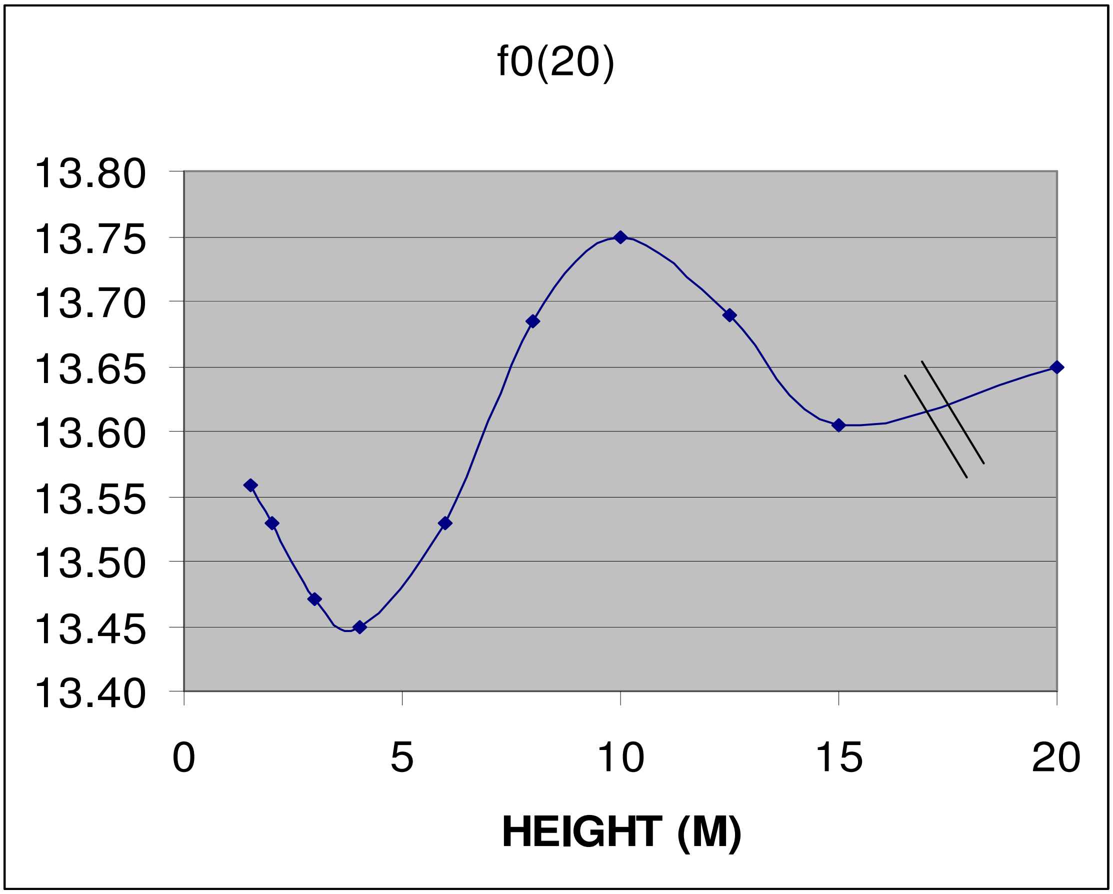
**Variation of reflector model resonance results with height.**

If you vary the height above ground the resonant frequency changes. Here are results (without enough points to fully define the curves, sorry again) where the last point at “twenty meter” height is really the value in free space so it is the limiting value.

Here is the X=0 resonance variation for MMAMA model of KT43A REF element (N6MW's parameters used to force resonance value at 10 m height).






Note that the variation is least for 15 m, perhaps because the resonance is largely defined by the confined tuning stub LC combination. Qualitatively, on 10 m , 400 kHz changes are easy, on 15 m, 30 kHz and on 20 m, perhaps 200 kHz. We assume that the other surroundings, say a house or tree, may have effects as well. Zo also varies substantially with height.

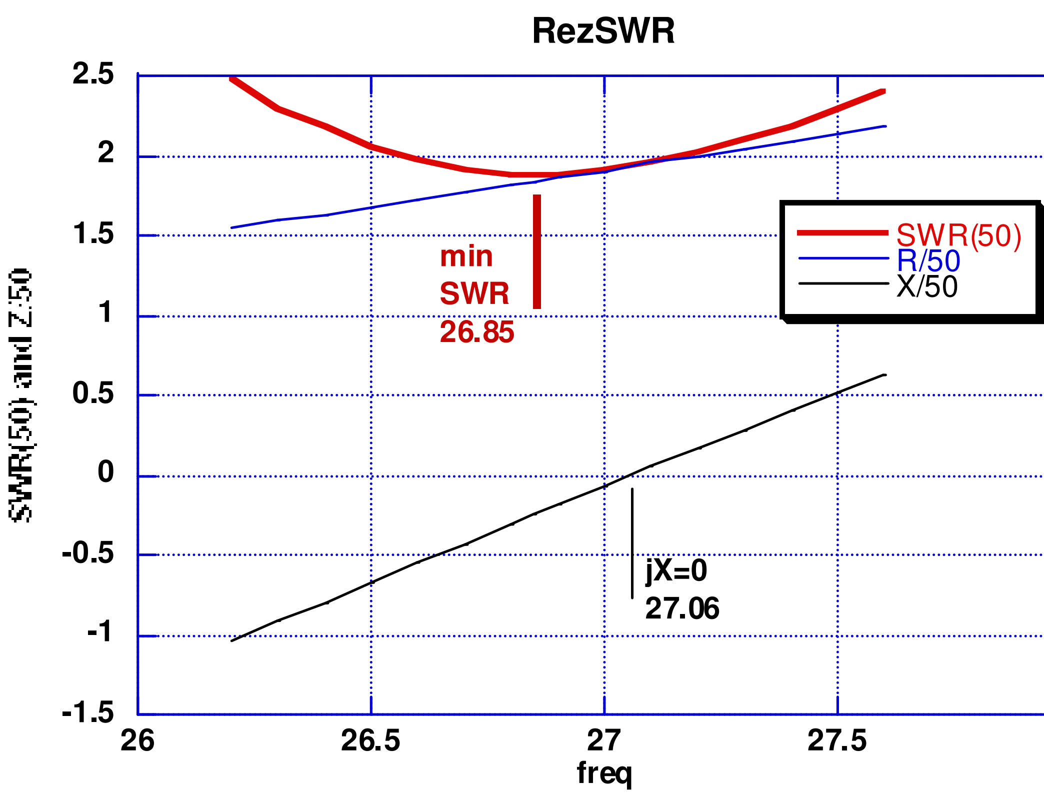
Bottom line is resonance measurements need to be interpreted cautiously. But wait, it gets worse.

**Variation of reflector model resonance results with measurement method.**

The measurements that different people have carried out have used different instruments and methods. Some have used an RF source plus a SWR bridge attached by cable to the remote antenna looking for the minimum SWR. Other have used antenna analyzers of various degrees of complexity. Of these some have measured the resonant point as that for jX=0 and others use minimum SWR, or sometimes both. The antenna analyzers may or may not be connected by a cable run to the antenna. If the analyzer is directly mounted to the center of the antenna, this may limit the height if access is required.

It is easy to show, in general, that the frequency where jX=0 is NOT the same as that which provides a minimum SWR (on a 50 ohm line, say). However they can be quite close if the resistive component of the impedance is nearly constant with frequency and the reactive component passes comparatively quickly, with frequency, through zero. This is not assured to happen.

Take for example the behavior for the KT34A REF element model near its 10 m "resonance" when at a height of ten meters. The minimum SWR and jX=0 point differ by 210 kHz. The difference at 20 m is less than 10 kHz and the difference at 15 m is less than 20 kHz, but both are hard to measure with this software.

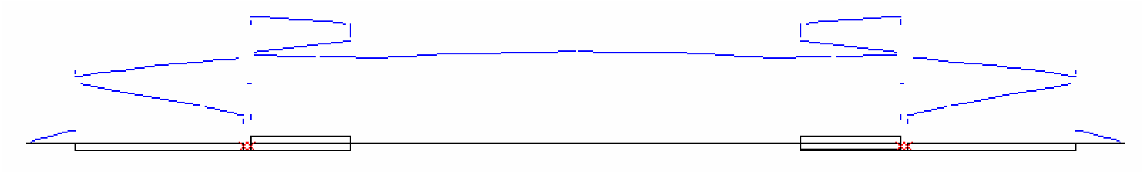



Measurements of jX=0 when using any cable requires a calibration to remove the effects of the cable length. Measurements of SWR with a cable not having a characteristic impedance of 50 ohms requires a correction.

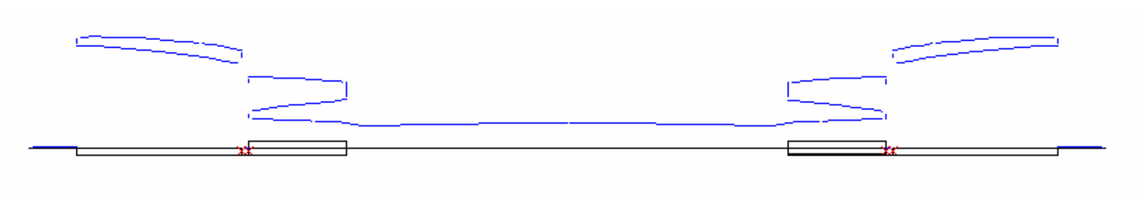
**Variation of KT34A elements resonances with measurement method.**

For four actual KT34A M2 upgrade elements K7HP has made measurements both with minimum SWR and jX=0 and found differences averaging -229 kHz for 10 meters, -84 kHz for 15 meters, for +12 kHz for 20 meters. Here – means SWR is lower than jX=0 measurement.

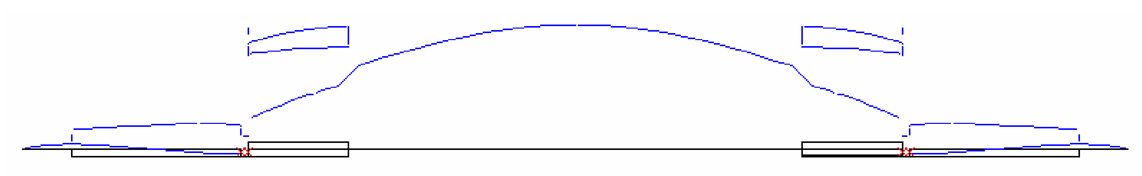
**Current Patterns for the Reflector model alone driven as a dipole.**



REF 14.2MHz  -  Blue is current magnitude in each wire



REF 21.25 MHz  -  Blue is current magnitude



REF 28.5MHz  -  Blue is current magnitude

The 3 current scales are different and arbitrary chosen only to make a useful display.

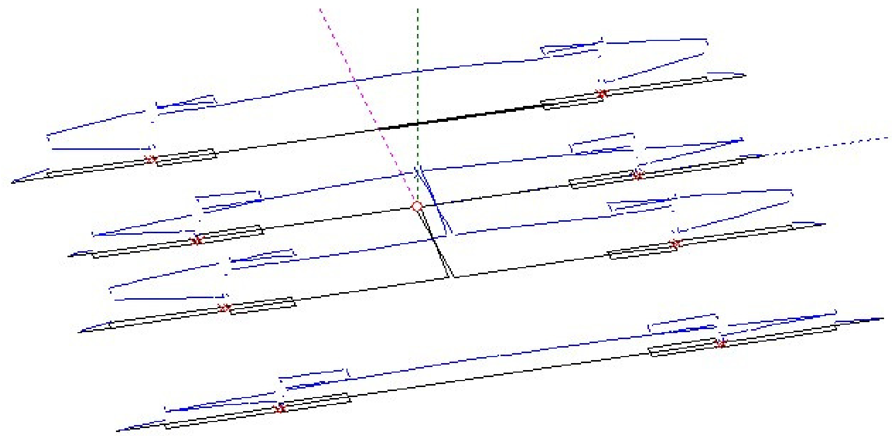
Note that for 21 and 28 MHz, the decoupling stub or trap has high currents. Since this just shows magnitude, the fact that the large currents are in opposite directions for the inductive loops is not evident. In all cases, the radiation pattern looks much like a dipole.

## 2. Full Antenna Results

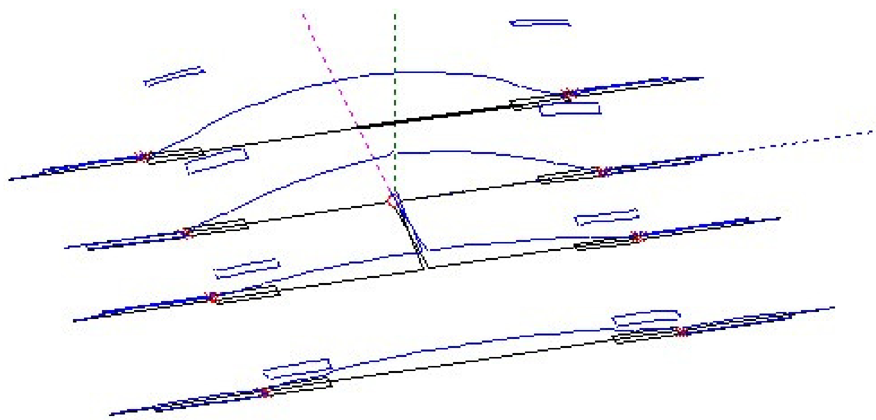
After assembling and tuning the four elements, they were put together with the proper spacing and connected with the X dual driven element feed. The T match was left off since it had no effect on patterns and currents and did not appear to provide any sensible impedance matching. This is an area where the model seems weak at best. The assembled impedances don't seem right for any band.

Using the version of the model with the KLM resonances supplied by M2, here are some results at a height of 10 meters over "real" ground. The gain given by the software is obviously calculated in some funny way and will not be quoted.

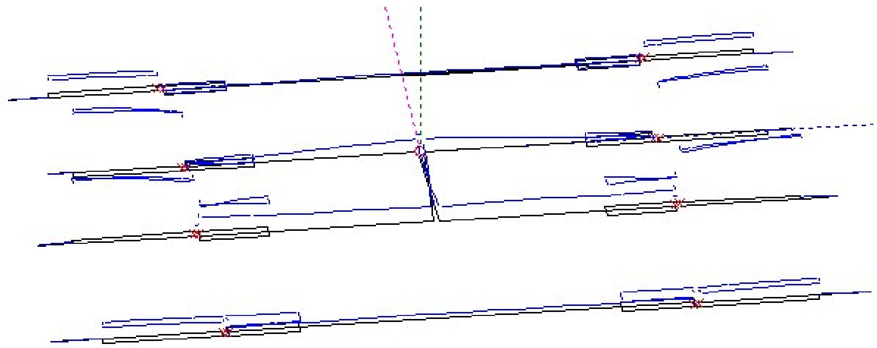
14.0 MHz  F/B 13 dB /  14.2 MHz  F/B 10.2 dB / 14.35 MHz  F/B 6.3 dB



Current pattern at 14.2 MHz.
----------------------------------------
28.0 MHz  F/B 19 dB/  28.5 MHz  F/B 10.6 dB/ 29.00 MHz  F/B 4.1 dB



Current pattern at 28.5 MHz.
--------------------------------------
21.0 MHz  F/B 6.2 dB/  21.25 MHz  F/B 4.9 dB/21.45 MHz  F/B 6.2 dB
The F/B goes rapidly to zero at 20.85 (and negative below) with the resonance for the reflector set at 20.835 for this model.  The F/B at 20.90 is over 8 dB.  This appears to be a standard feature of the KT34 on 15 meters – the F/B falls rapidly as the operating frequency gets near reflector resonance frequency.



Current pattern at 21.25 MHz.  Note that the director current is very low.  This is true for all the band.  FWIW, a 15 m model was constructed essentially the same as the KT34 except instead of traps, each element was a simple 15 m dipole with appropriate resonance.  This "Analog" model does not show low director current and it has a much better F/B.

The data for the model used here for the MMANA code is posted on this website as "kt34a_FullXM2.maa".  Use at your own risk.

To repeat, this modeling is largely for entertainment and results should be treated with all the respect they deserve, which is not much.