



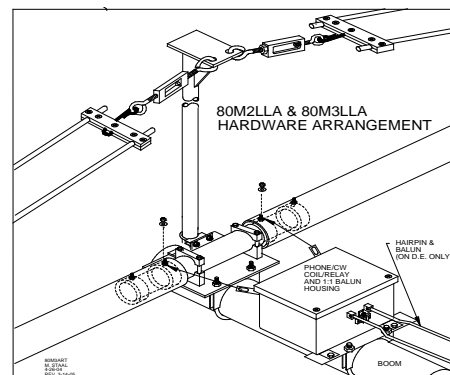
80 METER 3 ELEMENT YAGI, LINEAR LOADED

7-18-97
Rev 1-18-06



SPECIFICATIONS

Model Number	80M3LLC
Frequency Range	3.50-3.565 and 3.750-3.820 MHz Remote Switchable @ 12 VDC
Gain	7.3 dBi free space, 12.3+ dbi over ground, height dependent.
Front to Back	23 dB Typ.
Power Handling	5 KW
Feed Imp. / Conn type	50 Ohms/ SO-239 ('N' opt.)
VSWR / Bandwidth	1.1:1 typ. / 2:1 @ edges
Balun	1:1 Coaxial
Boom Length / Dia.	58 ft / 4-1/2" O.D. center, 4" O.D. ends
Boom support height / type	7 ft. Overhead 3/16" aircraft cable
Element length	105' Refl, 101' D.E.. / Linear Loaded
Element diameter	3", 2, 1-3/4, 1-1/2, 1-1/4, 1, 3/4, & 1/2"
tips	
Recommended height	70 ft Min. 120-180 ft nom.
Turning radius	60' 5"
Mast Size	2 TO 3" nom. or specify
Wind Area / Survival	32 sq. ft. / 100 mph
Weight / Ship wt.	300 lbs / 400 lbs -Truck



The 80M3LLC Yagi is a computer refined and improved performer, both mechanically and electrically. A low loss hairpin match provides perfect 1:1 match capability. Element halves start with 3" o.d. 1/8" wall tubing and taper through 2" sleeved, 1-3/4", 1-1/2", 1-1/4", 1", 3/4", 1/2" & 3/8" tips. The 3" and 2" sections are joined by a custom fiberglass insulator to section each element half for the linear loading (3/8 alum. tube). A solid 2" O.D. Fiberglass rod, sleeved to fit inside the 3" elements, serves as the center insulator for each element. The center boom section is 4-1/2" O.D. x 20' with nearly 1/4" wall thickness. The two outer boom sections are 4" O.D. x 20' x 1/8" wall.

The new, highly efficient 3/8" tube linear loading terminates above the boom and out of the element plane to reduce inductive cancellation, provide element support, and reduce excessive droop. The new, heavy duty 1:1, 5 KW balun, now housed inside the phone / cw switch provides plenty of power handling margin. The standard phone / CW band switching relays and high Q (over 600) coils are housed in a fiberglass housing. The whole assembly is now field serviceable and small frequency adjustments can be made in the CW part of the band. On the air, you'll find little or no competition for the 80M3LLC. Upgrade parts are available for older 80M3's.

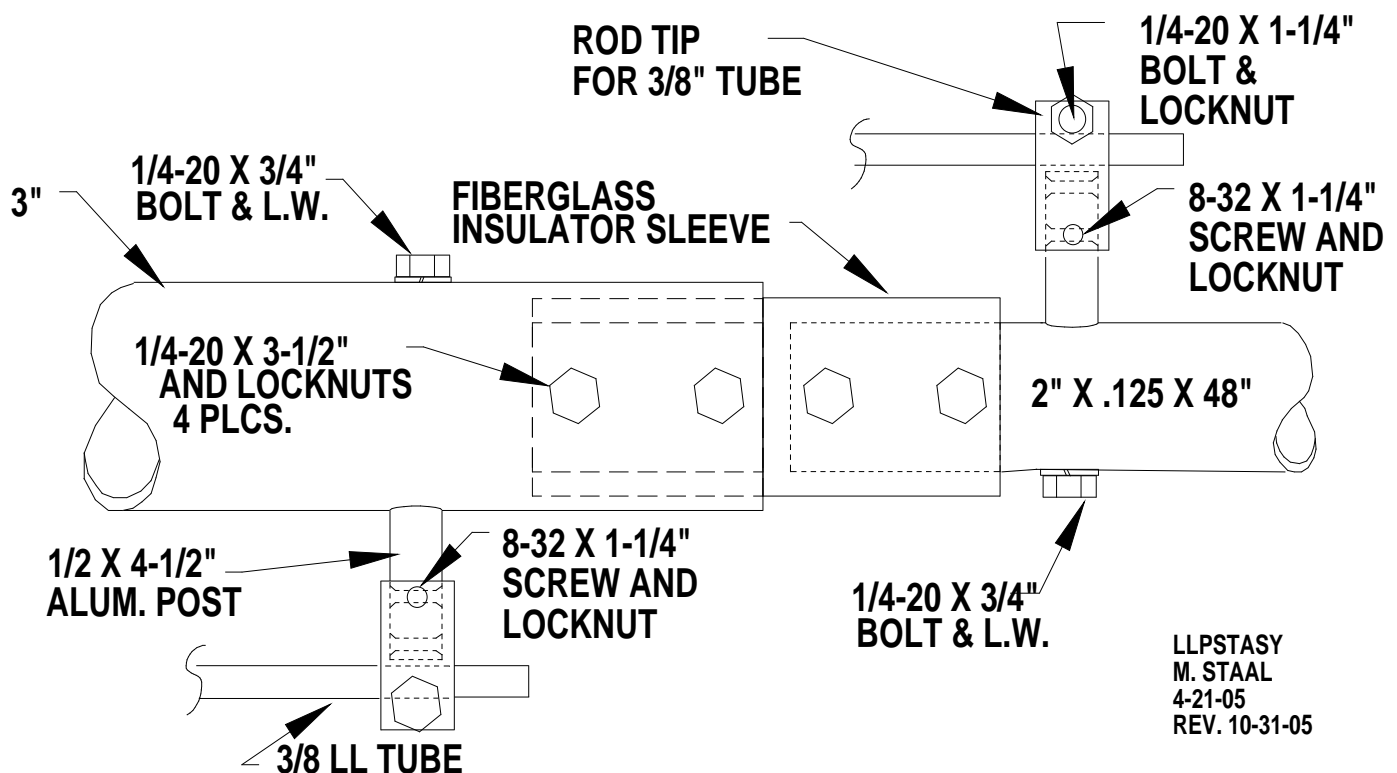
4402 N. Selland Ave, Fresno CA 93722 (559) 432-8873 FAX (559) 432-3059

www.m2inc.com email: sales@m2inc.com

EVEN THOUGH IT IS BIG, THE 80M3LLC IS FAIRLY SIMPLE. LOOK OVER THE DRAWINGS AND GET FAMILIAR WITH THE IDENTIFYING TERMS AND GENERAL CONSTRUCTION. YOU WILL NEED A FAIR AMOUNT OF ROOM FOR EASY ASSEMBLY. YOU ALSO NEED THE FOLLOWING TOOLS: END WRENCHES AND OR SOCKETS FOR 9/16", 1/2" AND 7/16" NUT DRIVERS FOR 7/16 AND 11/32 WILL ALSO BE VERY HELPFUL. A #2 PHILLIPS HEAD SCREW DRIVER AND MISC. SMALL HAND TOOLS MAY BE REQUIRED.

1. Attach a 3" x 4" x 1/4" thick, welded aluminum angle brackets to each 8 x 8 x 1/4" element mounting plates using 1/4-20 x 1" bolts and locknuts. Then loosely install two 1-1/2" U-bolts to each bracket. Locate the (3) 1-1/2 x 36 welded riser tubes. Insert a riser tube into the U-bolts, align the welded top plate to point away from the bracket and tighten the U-bolts.
2. Using four machined 2" saddles, attach the 2" diameter center insulator to 8 x 8 x 1/4" element to boom plate. Use the 3/8-16 x 3-1/2" stainless bolts and locknuts to fasten. Center the insulator and rotate it so the holes are perpendicular to the plate. Tighten the 3/8" hardware. Repeat for all 3 elements.
3. Now begin installing the 3" x 180 inner element section. Each center insulator 2" rod has 4 bushings or coupling rings and each rod may be labeled to match two 3" x 180" inner element sections. Slip on the butt sections and NOTE THE LARGE 1/2" HOLES AT THE OPPOSITE END OF THE SECTIONS ARE FACING THE SAME DIRECTION. Secure each INNER side with a 1/4-20 x 3-3/4" bolt and plain nut, up from the bottom. Use 1/4-20 x 3-1/2" bolts and LOCKNUTS through the outer set of holes. NOTE: The longer inner bolts now form studs where the CW LOADING/SWITCHING assembly is attached later in the assembly. NOTE: The REFLECTOR requires a special 3" X .125 X 180" tube to accept a 3" x 41" "EXTENDER" section.
4. Insert the 1/2" x 4-1/2" aluminum rod posts near the outer end of the 3" sections and butts of the 2" element sections. Attach with 1/4-20 x 3/4" bolts and lock washers BUT DO NOT TIGHTEN YET. Next attach the 3/4" square rod tips and secure each with an 8-32 x 1-1/4" screw and locknut and tighten. Now orient the rod assembly so the 3/8" holes at the ends are parallel with the element and tighten the bolts. Add the 1/4-20 x 1-1/4" bolts and locknuts finger tight at this time. Repeat for all three elements.

LINEAR LOADING POST ASSEMBLY



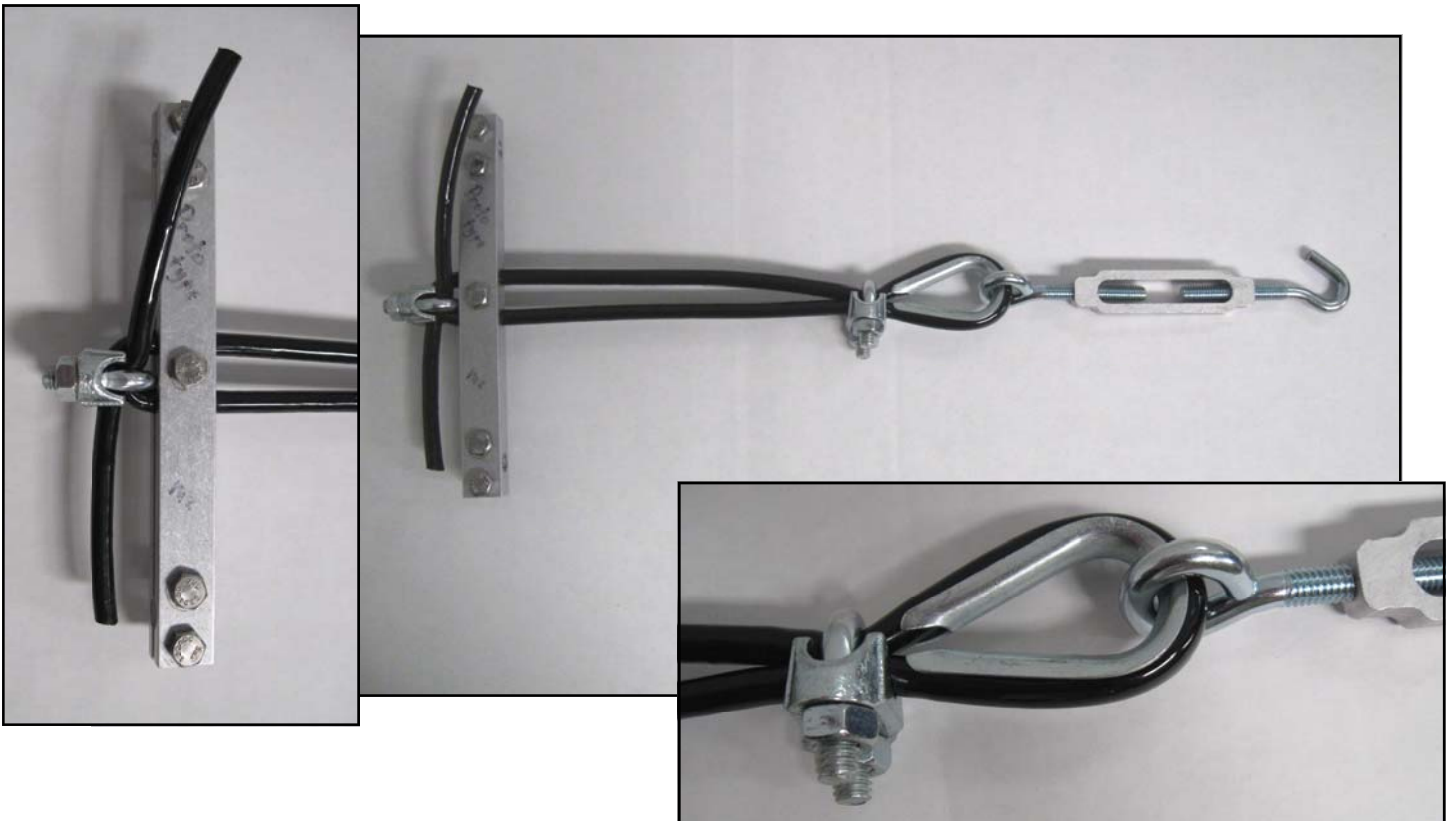
5. Insert each 2-3/4 x 8" fiberglass sleeve insulator into the outer end of the 3" element butts and add the 1/4-20 x 3-1/2" bolts and locknuts finger tight. Now insert the 2" x .125 x 48" section into the insulator and align the holes. Make sure the 1/2" post assembly installed in step #4, points opposite from the post assembly in the 3" element section. Install the 1/4-20 x 3-1/2 bolts and locknuts and NOW TIGHTEN all 4 bolts. Repeat for the other 5 element halves.

6. Use the dimension sheet to determine the length and positioning of 3/8" LL Tube. Add a shorter 3/8" LL tube to the inner and the longer LL tube to the outer post by inserting it through the hole about 1", and tighten the 1/4-20 x 1-1/4" bolt and locknut. Continue until you have all 4 tubes for one element attached and secured.

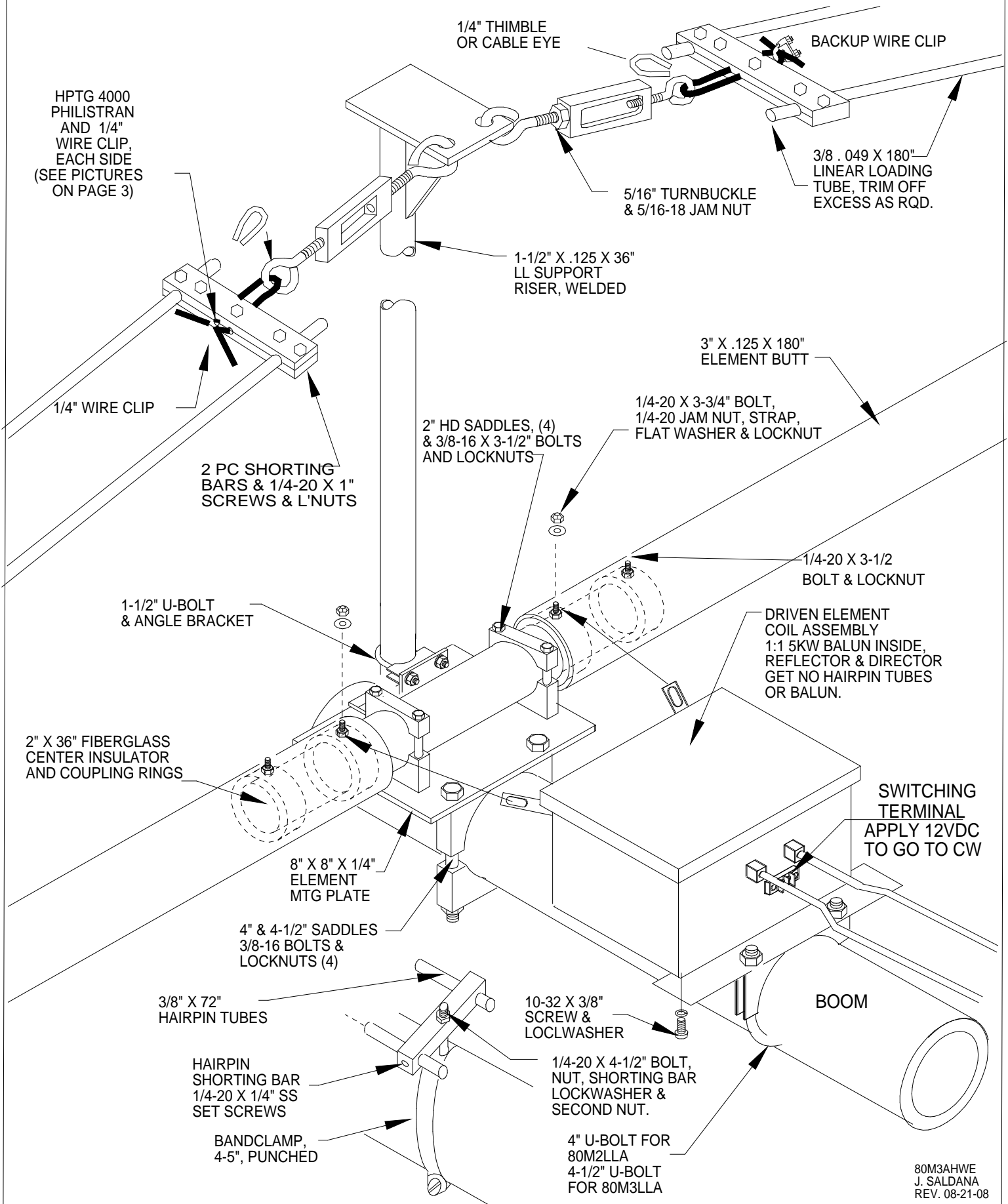
7. Loosely install five (5) 1/4-20 x 1" screws and locknuts in all pairs of "linear loading shorting bars". Refer to the DIMENSION SHEET and pictures for the shorting bar positions for each set of linear loading tubes. Use a permanent marking pen or a ring of masking tape to mark the shorting bar position on the 3/8" tubes. Prepare the 5/16" turnbuckles by removing the "hook" end of each turnbuckle and add a 5/16-18 'JAM' nut on the threads all the way to the hook. Now replace the hook end into the turnbuckle body and adjust the threaded ends EVENLY so just one thread "shows" inside the body of the turnbuckle. Now hook the turnbuckles into the welded plate at the top of the risers.

8. Refer to the TYPICAL HARDWARE ARRANGEMENT drawing and pictures below. Slide one loosely assembled shorting bar pair onto the two tubes to the marks. Tighten one outside screw just enough to hold the shorting bar in position. Loop the 40" section of HPTG-4000 Phillistran cord through the turnbuckle eye and back through the two center grooves in the shorting bar pair. Tighten the center screw in the shorting bar to grip the cord, holding the LINEAR LOADING TUBE AND SHORTING BAR up.

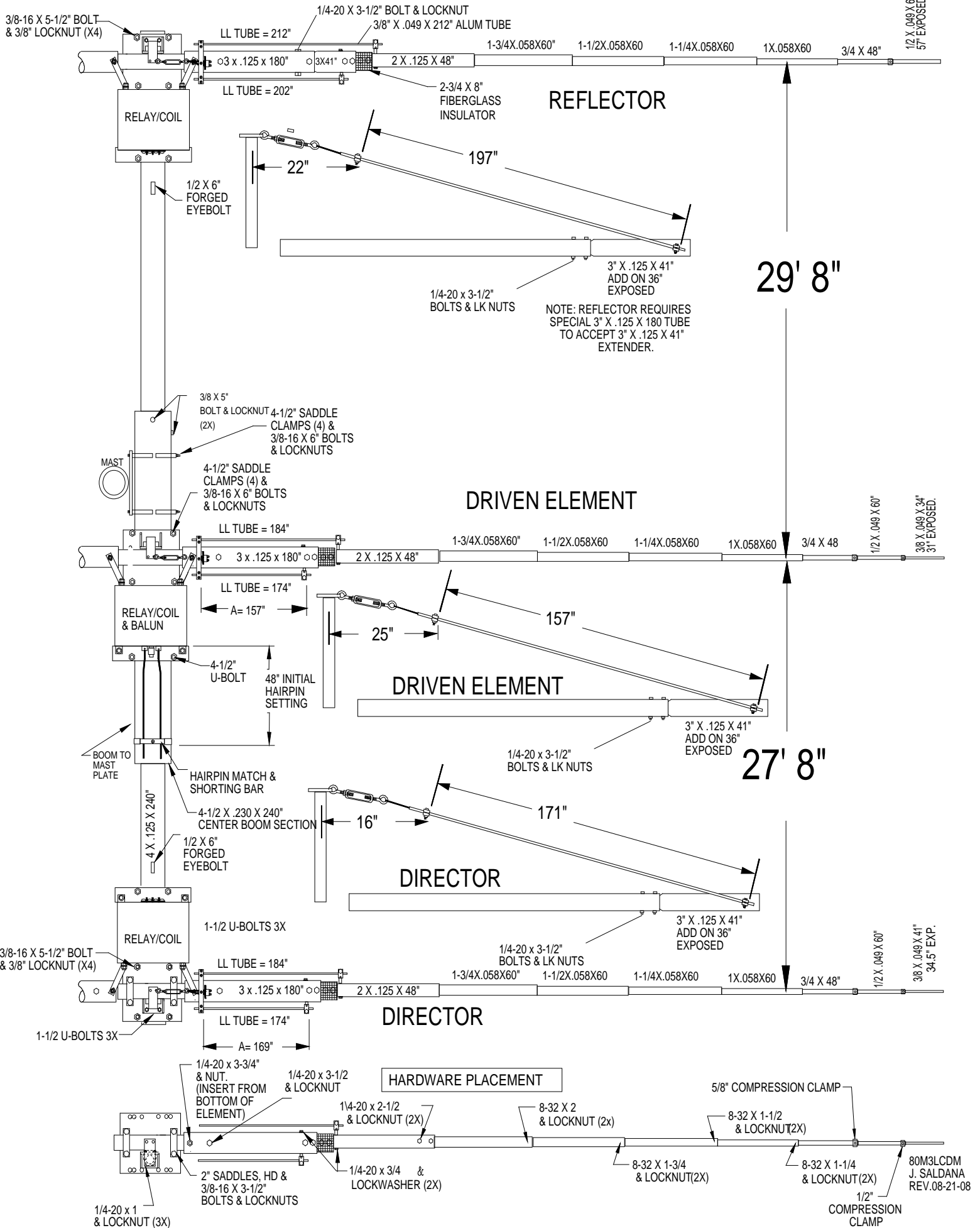
9. Thread the cord ends toward each other through a 1/4" wire clip. Push the clip up tight against the shorting bar and tighten. Trim off all but 2" of the cord. Repeat for the other side. Now tighten the rest of the screws in the shorting bars. BE SURE THE TURNBUCKLE DOES NOT SHORT TO THE SHORTING BAR.



TYPICAL HARDWARE ARRANGEMENT 80M2LLC & 80M3LLC



80M3LLC DIMENSIONS



10. Now, begin tensioning the linear loading tubes using the turnbuckles. Adjust tension until each element is flat and not bowed up. Momentarily loosen the 1/4-20 x 3/4" bolts holding the LL posts so the tube can run straight up to the shorting bars. Tighten the jam nut on the turnbuckle. Final adjustment of the tube tensioning, if necessary, can be done after the element is complete. NOTE: THESE TUBES FORM THE ELEMENT LINEAR LOADING AND ALSO HELP TO SUPPORT THE ELEMENT HALVES AND MINIMIZE DROOP. Repeat STEP 6, 7, 8, and 9 for all three elements.

Once the three center assemblies are complete **MARK THEM** according to the shorting bar position; one as "**REFLECTOR**", one as "**DRIVEN**" and one as "**DIRECTOR**". THIS IS IMPORTANT SINCE THE ELEMENT TIPS ARE ALSO DIFFERENT LENGTHS!!!

BOOM ASSEMBLY

11. Assemble the boom. Note the middle section is heavy wall and is marked at each end for the appropriately marked tip section. Slip in the tip section, align the mark and the holes, add the 3/8" x 5" bolts, lock washers and nuts and tighten. Repeat for the other end.

12. Install the longer (303") guy cable and forged eyebolt assembly at the REFLECTOR end of the boom. Install the shorter (286") guy cable assembly at the DIRECTOR end of the boom. Route the support cables to the center of the boom. Attach the 12" x 12" x 3/8" BOOM TO MAST PLATE about 8" FORWARD of center using the 4-1/2" cradles and 3/8" bolts and locknuts. NOTE: THE TOP OF THE PLATE HAS ONLY ONE SET OF U-BOLT HOLES. DO NOT TIGHTEN THE PLATE IN PLACE YET. Install a temporary 8 foot mast to the plate with two Heavy Duty 2" U-bolts (3/8-16 hdwe). Mount the large turnbuckle plate on the mast using the standard 2" x 5/16" U-bolts. Open the turnbuckles fully and attach them to the plate. Raise the turnbuckle plate until cables are tensioned and boom is straight. Then adjust the BOOM TO MAST plate position so cables are tensioned the same and the mast is perpendicular to the boom. NOW TIGHTEN THE BOOM TO MAST PLATE IN POSITION.

NOTE: The temporary mast may be left in position as a support and stabilizing member during lifting the completed antenna into position on the tower. Another option which may help during installing the antenna is to leave the DRIVEN element off until the antenna is up and in position. This reduces the weight of the antenna considerably as well as keeping the center area clear of interference to guy wires etc. The DRIVEN element is mounted just off center, so it can be installed after the antenna is in its final location.

13. Consult the DIMENSION SHEET, note the position of elements with respect to the boom to mast plate: The DRIVEN ELEMENT AND REFLECTOR are on one side (with longer guy cable) and the DIRECTOR is on the other. Position the REFLECTOR and DIRECTOR so the outer 4" saddle clamp set is at least 1/2" from the end of the boom. Adjust elements so they are at a right angle to the forged eyebolts and the boom to mast plate, and are aligned with each other. Tighten the saddle clamps securely.

14. Mount the DRIVEN element now, at least temporarily, using the 4-1/2" cradles and align with other elements.

AGAIN, REVIEW THE "HARDWARE ARRANGEMENT" DRAWING FOR THE FOLLOWING STEPS.

15. Locate the two relay / coil housings with no RF connector. These units are for the REFLECTOR and the DIRECTOR. Open the unit and inspect it for loose connections to the relay or any other possible shipping damage. We suggest you apply 12 volts DC to the two small terminals and watch the relay close and open. Also note there is a small 1/8" dia. Hole in the left hand front corner of the housing. This is a pressure equalization or vent hole and of course should water some how get into the box, it can drain out. This visual inspection will also educate you as to the function of the assembly. Now close the housing and install the right angle aluminum jumpers on the 1/4" studs using 1/4-20 locknuts. The units mount just inside the reflector and director elements using 4" U-bolts lock washers and nuts. Slip the jumpers over the inner 1/4 x 3-3/4" studs nearest the butts of the 3" element sections and secure with 1/4" locknuts and flat washers.

16. Install the DRIVEN ELEMENT RELAY / COIL / BALUN assembly in the same way but use a 4-1/2" U-bolt. Install the two right angle aluminum jumpers and secure with 1/4-20 locknuts. Slip the jumpers over the studs at the element butts and again secure with 1/4-20 locknuts and flat washers. Now add two 1/4-20 set screws in each HAIRPIN CONNECTORS .

17. Insert the 3/8 x 72" HAIRPIN tubes into the HEX connectors, align the tubes to 4-1/8" APART and tighten the set screws with an 1/8" Allen wrench. Install two more 1/4-20 set screws into the HAIRPIN SHORTING BAR

and slide the bar onto the ends of the tubes. Set the bar to the recommended dimension and tighten the set screws. Place a 1/4-20 x 4-1/2" bolt through the stainless BAND CLAMP and attach the clamp assembly around the boom under the Shorting Bar. Run a 1/4-20 nut onto the bolt and slide the shorting bar over the stud. Align the assembly and tighten the band clamp. Add a locknut to the stud and tighten the shorting bar in position. THIS DC GROUNDS THE DRIVEN ELEMENT ASSEMBLY. Final adjustment of the hairpin match and driven element linear loading jumper positions may be done (if required) after final installation is complete.

18. Wire up the RELAY/COIL assemblies using #20 AWG or larger twisted pair, shielded wire, OR RG-58AU. Each relay is simply in parallel with the others and CW is activated when 12 VDC is applied to the leads. There is no polarity requirements on the relay hookup but the three shields should be tied together at the DRIVEN element. The shield of the main lead should be grounded at the SHACK end. The shield should eliminate RF from getting into the shack. DO NOT SWITCH FROM PHONE TO CW WHILE TRANSMITTING AS RELAY DAMAGE MAY OCCUR.

19. Assemble and install all the outer element sections to the inner element assemblies already installed on the boom. See Dimension Sheet for section size, length, and hardware. NOTE: THE REFLECTOR IS SLIGHTLY DIFFERENT FROM THE DRIVEN AND DIRECTOR ELEMENT. The reflector has no 3/8" element tips.

20. Equalize linear loading / element support by final adjusting the 5/16" turnbuckles. Use the jam nuts to lock the turnbuckles in the final position. All elements should droop equally. Do not attempt to "gull wing" elements. They are more stable in the wind if 3" inner sections STAY LEVEL or are allowed to droop 1 to 2". Outer section tips will tend to droop about 3'-4'; which is normal.

NOTE: This balun will handle 5000 watts of continuous RF energy. However there may be situations where higher power handling is advantageous. **CONTACT M² FOR RECOMMENDATIONS AND AVAILABILITY OF OPTIONAL HIGHER POWER VERSIONS.**

CAREFULLY DESIGNED AND MANUFACTURED BY:

M² ANTENNA SYSTEMS INC.

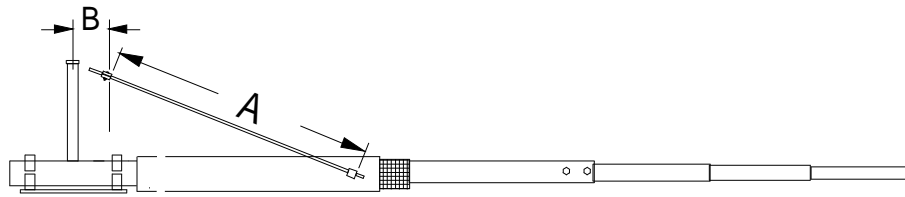
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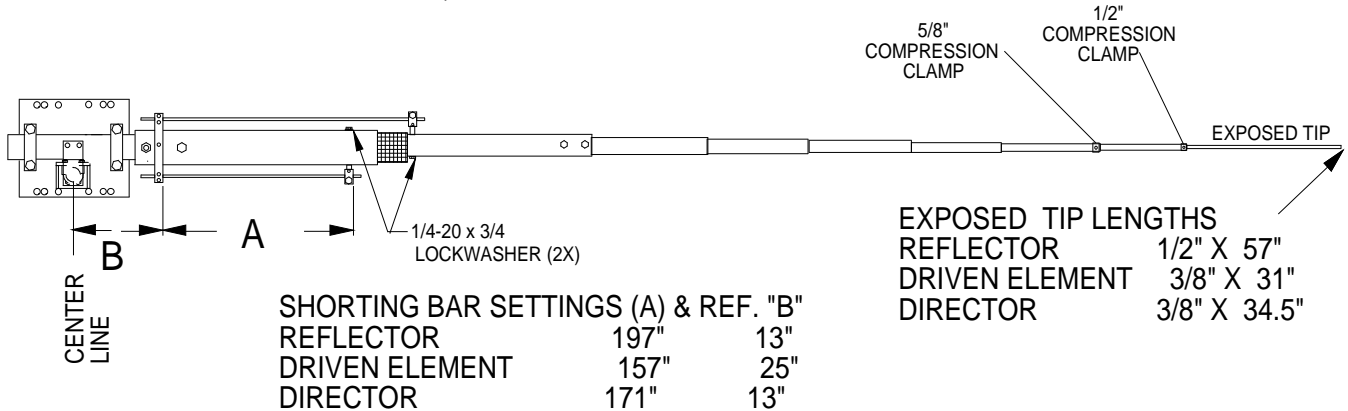
559-432-8873 FAX 559-432-3059

Email: sales@m2inc.com

80M3LLC PHONE/CW SWITCHING DIAGRAM AND DIMENSIONS



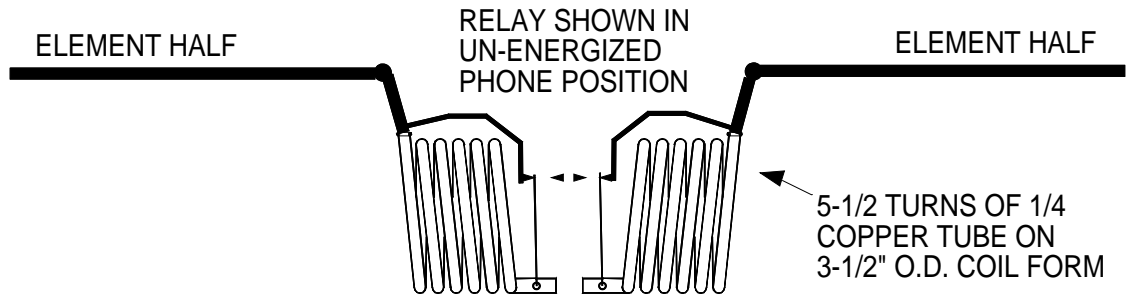
'A' IS YOUR PRIMARY DIMENSION.
'B' IS A CROSS CHECK DIMENSION.
'B' SHOULD NOT BE OFF BY MORE THAN 1/2".



EXPOSED TIP LENGTHS

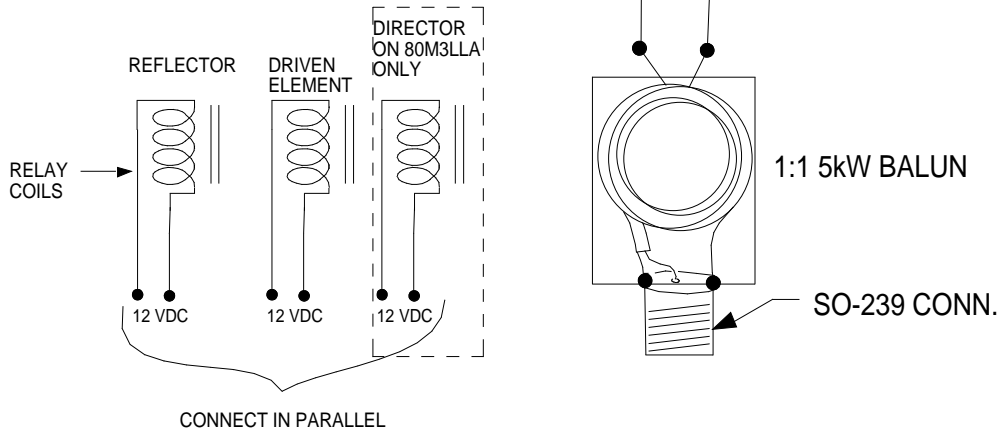
REFLECTOR	1/2" X 57"
DRIVEN ELEMENT	3/8" X 31"
DIRECTOR	3/8" X 34.5"

REFLECTOR



REFL. AND DIRECTOR GET THE JUMPER

BALUN CONNECTED ON DRIVEN ELEMENT.



WE RECENTLY RE-DESIGNED THE PHONE –CW RELAY AND COIL HOUSING AND GENERAL ASSEMBLY. This was done to make manufacture easier and to allow customer modification and maintenance. We now use a fiberglass enclosure that can be opened for inspection, repair or modification.

Looking inside the housing you will see that we have provided two holes in the coil leg that attaches to the relay. Generally the easiest way to move the frequency of the element when the coil is engaged, is to change the inductance of the coil by spreading it. Quite a wide range of inductance can be achieved by lengthening or shortening the coils. They are set to be just under 2.5 uHy from the factory. By shifting to the other holes in the coil legs, the inductance can be dropped to about 2.3 uHy. This will shift operation up the band about 50 kHz. You may also have to physically open the coil since it is springy and make sure all the turns are evenly spaced. Larger movement in frequency can be achieved by removing turns, however you should do some calculations first or contact the factory to avoid seriously degrading the bandwidth, or performance of the antenna. The antenna has been modeled in Brian Beezley's AO "PRO" ,version 6.5. Linear loading will not necessarily model correctly in NEC based programs. AO is Mininec based and does much better at modeling parallel wires than NEC.

What about coils in the place of the linear loading? Several hams have had another group modify our Yagi to eliminate the linear loading and convert to coils. The boom is also lengthened by about UP TO 18 feet. This results in a gain improvement of .8-.9 dB and this is not due to the coils, but to the added boom length AND NARROW BANDING.. We have modeled both coils and linear loading and when all other parameters are equal, the performance is virtually the same. One big But remains however. The "Q" of the coils used must be over 600. This is very difficult and expensive to do. For those of you who have structural or local weather concerns, you should know we are planning on producing a coil version of the 80M3. We are doing this carefully and slowly. We are also planning on offering a longer boom version of the 80M3. As always, we like to make changes in such a way that past owners can upgrade. We will continue to review customers desires and at some point, if some want or need coils or a longer boom, or both, we will make what our customers request.

We have recently returned to the modeling program and found a few things that we could improve. The original linear loading was done with #10 copperweld and while this material is good in a dipole and good in many other applications, when it is used in a very narrow bandwidth Yagi structure, IR losses start to magnify. We recently have converted from copperweld to 3/8" diameter tubing. This has raised the efficiency of the antenna and reduced the losses by an amazing 0.7 db. Now while this is not earth shattering gain improvement, we also tweaked a few other parameters and now have an antenna with one full dB more gain.

We can also offer ,due to more accurate modeling, some interesting trade-offs in gain versus front to back. The new 80M3LLC can be easily setup for 7.3 dBi gain and 20+ db front to back or 6.9 dBi gain and 25 dB front to back. Depending on your location this can be very useful. On the West coast we don't usually have a front to back problem going to short path or long path Europe but in the mid West or on the East coast, the West coast stations can be a real pain when you are working short path to Europe or Africa.

We don't want you to be misled by a few random, uncontrolled on the air tests that show one antenna to be better than the other. So many parameters are at play that it is easy to come to the wrong conclusion. Height above ground, local terrain, location in the world or in the United States, feedline loss and of course, the RF power delivered to the antenna all can have massive effects on test comparisons.

Enjoy your 80M3LLC and call me if you have questions or concerns.



The 80M3LLA at K6MYC, North of Fresno CA. Tower is a US TOWER, 589 HDX with special 3" mast provision. Rotator is the OR2800 with 400 feet of control line. Note the 72' boom ready for the later expansion to 71' between the elements.

UPDATE 4-22-05

I (K6MYC) am very active on 75 and 80 meters, and been testing and comparing between a full wave loop and our 3 element (80M3LLA) in the air at 90 feet, pictured above. The loop is 90 feet at the top, fed horizontally polarized and sitting on the top of a ridge that drops off rapidly to the East and West for several hundred feet. The bottom of the loop is 500 feet West and above the top of the 80M3LLA by a few feet. 80M3LLA sits on a similar hillside with a similar drop off to the North through East. The results of many on air checks show the Yagi to be no less than about 5 dB better than the quad loop on DX and local stations. There are times the Yagi is 10-20 dB better! This condition seems to occur as one end of the path or the other is approaching the daylight limit. The 80M3LLA consistently out heard and outperformed any and all 4 squares on the West coast and held its own with all stateside competitors, except when the European blockage occurred for us on the West coast from the auroral curtain. It is U.S. dominant to Africa where the curtain is not a factor.

In November, 2004, I began modeling on a slightly longer (71') boom length model, the **80M3LLX**. I also modeled ways to improve antenna efficiency. I found a noticeable (0.4 dB) improvement by increasing the diameter of the LL wires in the driven element from #10 AWG copperweld to 3/8" aluminum tubing. An additional 0.4 db improvement was noted with 3/8" LL tubes in the Reflector and Director. This loss occurs only in the narrow band Yagi configuration due to the high Q Yagi structure. These two changes resulted in a gain improvement of over 1.4 dB.

In December, 2004, I shifted the Director and Reflector out to the 71' boom length. I also converted the DRIVEN ELEMENT to 3/8" tube linear loading. I immediately noted a narrower (E plane), azimuth beam width. (Similar H plane beam width reduction occurred in the model). This confirmed the prototype design has more gain than the standard unit, which is to be expected. Comparison with the best West coast stations (running our Yagi's with coils and extended booms), show virtually identical performance. So much for COIL superiority over LINEAR LOADING.

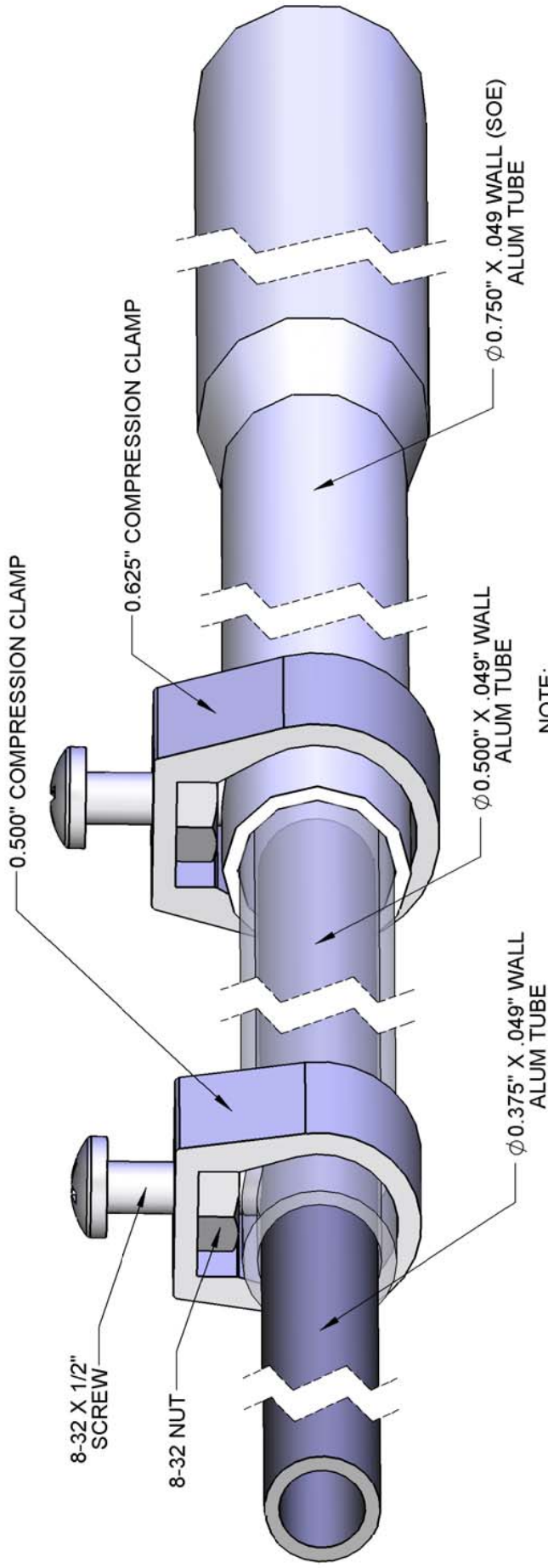
The 80M3LLX Yagi sits at about 10 feet below a ridge when it is pointed at the long path to Europe (215 degrees). The quad loop sits on top of the ridge with a 900 foot drop off to long path. I had no hope for any Yagi performance on the long path. Much to my surprise it is still 3 to 5 dB ahead of the loop and many times can hear and work stations that are not workable on the loop! I am better than 4 squares but cannot keep up with the two big Yagis on 160 and 180 foot towers. This Yagi works!

We may offer the longer 80M3LLX once I have evaluated it mechanical viability over this winter. Customer interest will be the determining factor. I think we have dispelled the mystery of coils versus Linear Loading.

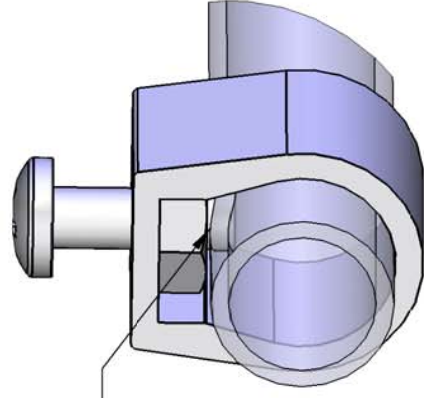


COMPRESSION CLAMP & TIP ASSEMBLY DETAIL

10/26/07



NOTE:
TUBES SHOWN TRANSPARENT
TO SHOW MORE DETAIL



NOTE:
8-32 X 1/2" SCREW
PRESSES ON INNER TUBE

NOTE: INSIDE TUBE NOT SHOWN FOR CLARITY

80M3LLC PART LIST

REV 08-21-08

DESCRIPTION	QTY
Boom, center, 4-1/2 X .230 X 240" ALUM. TUBE.....	1
Boom, end, 4 X .125 X 240" ALUM. TUBE.....	2
Element butt, 3 X .125 X 180" ALUM TUBE (SEC#1)	4
Element butt, 3 X .125 X 180" ALUM TUBE (REF SEC #1)	2
Element extension, 3 x .125 x 41" SOE.....	2
Element section, 2 X .125 X 48" ALUM. TUBE (SEC#2).....	6
Element section, 1-3/4 X .058 X 60" SOE (SEC#3)	6
Element section, 1-1/2 x .058 x 60" SOE (SEC#4).....	6
Element section, 1-1/4 x .058 x 60" SOE (SEC#5).....	6
Element section, 1 x .058 x 60" SOE (SEC#6).....	6
Element section, 3/4 x .049 x 48" SOE.....	6
Element section, 1/2 x .049 x 60"	6
Element section tip, 3/8 x .049 x see DIMENSION sheet.....	4
Linear loading tube, 3/8 x 212"	2
Linear loading tube, 3/8 x 202"	2
Linear loading tube, 3/8 x 184"	4
Linear loading tube, 3/8 x 174"	4
Tubes, hairpin, 3/8 x 72" formed.....	2
Vertical support tube, 1-1/2 x .125 x 36".....	3
Center support insulator, 2" x 36" fiberglass, w/ coupling rings,	3
Relay/coil assembly DE version has SO-239 conn.	1
Relay/coil assembly REFL.-DIR. has 2 terminals only.	2
HF shorting bar, 1/2 x 1/2 x 5 alum.....	1
Band clamp, #72, modified 5", stainless	1
Boom support steel cable, eyebolt, turnbuckle assy, 303" x 3/16"	1
Boom support steel cable, eyebolt, turnbuckle ass'y, 286" x 3/16"	1
Boom to mast plate, 12 x 12 x .375 alum.	1
Main turnbuckle plate, 4 x 6 x .25 alum	1
Element mounting plate, 8 x 8 x .25 alum.....	3
Vertical riser bracket, 3 x 4 x 1/4 angle, aluminum, welded.	3
Linear loading insulator, 2-3/4" x 8.0" Fiberglass	6
Turnbuckle, 5/16 hook and eye	6
Thimbles, (cable eyes) 1/4"	6
Cable clips, 1/4"	12
Cable, HPTG-4000 x 40"	6
Linear loading, shorting bar, 1/4 x 3/4" x 7-1/4"	12
Linear loading connecting rod, 1/2 x 4-1/2" alum.	12
Square rod tip, 3/4 x 3/4" x 1.813 mach. Alum.	12
Compression Clamp, 5/8"	6
Compression Clamp, 1/2"	4
 HARDWARE BOX:	
Saddle clamp, 4-1/2"	8
Saddle clamp, 4"	8
Cradle 2" HD	12
 HARDWARE BAGS	
U-bolt, 2" heavy duty, 3/8"	4
U-bolt, 2" standard (standard 5/16")	2
U-bolt, 1-1/2"	6

HARDWARE BAGS

Bolt, 3/8-16 x 6" hex head stainless	8
Bolt, 3/8-16 x 5-1/2" hex head stainless	8
Bolt, 3/8-16 x 5" hex head stainless	4
Bolt, 3/8-16 x 3-1/2 hex head stainless	12
Nut, 3/8-16 stainless	8
Lock washer, 3/8 split ring stainless	8
Nut, locking, 3/8-16 stainless	32
Nut, 5/16-18 stainless	22
Lock washer, 5/16 split ring stainless	16
Bolt, 1/4-20 x 4-1/2" hex head stainless	1
Bolt, 1/4-20 x 3-3/4" hex head stainless	6
Bolt, 1/4-20 x 3-1/2" hex head stainless	34
Bolt, 1/4-20 x 2-1/2" hex head stainless	12
Bolt, 1/4-20 x 1-1/4" hex head stainless	12
Bolt, 1/4-20 x 1" hex head stainless	39
Bolt, 1/4-20 x 3/4" hex head stainless	12
Set screw, 1/4-20 x 1/4" stainless.....	6
Nut, 1/4-20 locknut stainless	104
Nut, 1/4-20 stainless	8
Lock washer, 1/4" split ring stainless	13
Flat washer, 1/4" stainless.....	6
Screw, 8-32 x 2" pan head stainless	12
Screw, 8-32 x 1-3/4" pan head stainless	12
Screw, 8-32 x 1-1/2" pan head stainless	12
Screw, 8-32 x 1-1/4" pan head stainless	24
Screw, 8-32 x 1/2" pan head stainless	10
Nut, 8-32 locknut stainless	60
Nut, 8-32 stainless	10
Allen wrench, 1/8".....	1
Zinc paste (Penetrox) cup	2

THE FOLLOWING IS LIST OF PART THAT CAN BE OMMITED BY THE CUSTOMER WHEN THEY CHOOSE NOT TO GET THE PHONE-CW RELAYS. BAG SEPARATELY.

PARTS FOR RELAY AND COIL HOUSING INSTALLATION

U-bolt and saddle, 4-1/2" (for driven element)	1
U-bolt and saddle, 4" (for refl and dir.).....	2
Mounting plate, 2 x .125 x 10" alum.	3
Jumper straps, (LEFT), 3/4" wide, angle aluminum.....	3
Jumper straps, (RIGHT) 3/4" wide, angle aluminum	3
Nut, 3/8-16, ss	6
Lock washer, 3/8", split ring, ss	6
Screw, 10-32 x 3/8" ss Phillips	6
Lockwasher, #10 split ring, ss	6