Cubic Astro 103 Restoration Notes

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February 2016

I restored a Cubic Astro 103 a few years ago and have enjoyed operating it for years. It's a very nice geezer wireless and the last amateur radio product Cubic produced before a transition to Government only products. Like a dummy, I was operating during what I thought was a light thunderstorm. A lightening strike 4 miles away blew the wall wart on my COX alarm system and turned my 103 silent (the transition to Hell Boy 103).

Since the quest to make it better again was extremely challenging and I had to learn more about the design than I ever planned on, I wrote up some notes for those brave enough to tackle one of these.

Figure 1 – Cubic Astro 103 Front View

Theory for Dummies

It's useful to develop a basic understanding of the design before attempting any serious work on this transceiver. The Service Manual has excellent detailed theory sections for each stage and a summary is provided here. You don't need to understand all the details to identify major problems. If needed, you can then focus on the component (s) of interest with a deeper theory/debug dive.

Appendix A and B show the complete block diagrams from the User Manual but for first pass troubleshooting you only need to know the following with focus on RF paths and boards.

Receive

1. Antenna jack or receive antenna jack
2. **Low Pass filter Board** with T/R reed relay, band switching via rotary switches
3. **Preselector Board**, has PIN diodes for selecting T or R paths and each filter is switched with PIN diodes with the band control voltage (10vdc)
4. **Exciter Board** with many functions, in order of the RF path:
    a. Double balanced mixer
    b. Noise blanker gate
    c. 9 Mhz crystal filter
    d. AGC attenuator
    e. 3 pass band tuning stages
    f. IF amplifier
    g. Product detector and carrier oscillators
5. **Audio Board**
    a. AF preamplifier
    b. Notch filter
    c. AF power amplifier

Transmit

1. Microphone
2. **Audio Board**
    d. Microphone amplifier
    e. Speech processor
    f. Modulation amplifier
3. **Exciter Board** with many functions, in order of the RF path:
    g. Balanced modulator
    h. 9 Mhz crystal filter
    i. Mixer
4. **Exciter Board** with many functions in order of the RF path:
    j. Balanced modulator
    k. 9 Mhz crystal filter
    l. Mixer
6. **Preselector Board**, has PIN diodes for selecting T or R paths and each filter is switched with PIN diodes with the band control voltage (10vdc)
7. **PA Power Module**
8. **Low Pass filter Board** with T/R reed relay, band switching via rotary switches

Oscillators

The oscillators are:

- **PTO A** and **PTO B** supply a 5.0 to 5.5Mhz tuning range that mixes with the LO signal for the operating frequency.
- **LO Board** is a complex board with an "unobtanium", old school PROM, programmed with fusible links. Good luck finding one of these geezers and a programmer unit to match. The programming information is actually provided in the manual. A stable local oscillator signal based on band selections is provided.

Band	Mhz
160	10.5 - 11
80	12.5 - 13
40	16 – 16.5
20	23 – 23.5
15	30 – 30.5
10A	37 – 37.5
10B	37.5 - 38
10C	38 – 38.5
10D	38.5 - 39

- Carrier oscillators are located on the **Exciter Board** with trimmer capacitors.

Mode	Mhz
LSB	9.00000
USB	9.00330
CW	9.00250

Trouble Shooting and Warnings

This is a 100% solid state, 100 watt, USB, LSB CW transceiver. PIN diodes are used to switch all signal paths with the exception if the HAMLIN T/R reed relays. These geezer PIN diodes are 100 nano amp devices that easily short out. The boards are high quality but not easy to get at sample points.

Do not attempt to work on this transceiver unless you have lab tech skills and quality test equipment. You will need a calibrated scope, frequency counter, DVM and precision RF generator down to 1 microvolt. The S-METER is calibrated for S9 at 50uv input.

The PC board foil side is up and most component loops are connected to the foil side so resistor loops are mostly useless for scope probes. Also, the ribbon cable DIP connectors can easily be inserted off-by-one and this can blow components just like Mother Nature. I have unfortunate experience here.

Suggested Step by Step to Avoid Disasters

The beauty of this design is that one can quickly learn a lot about a problem with just a DC volt meter and some knowledge of the design. All of the key voltages are easily probed on the **Distribution Board** ribbon cable connectors – See Figure 2. **DO NOT TRANSMIT** until all the control voltages have been confirmed. If the **T** and **R** control lines are messed up along with T/R relay/protection transistor Q101, the delicate PIN diodes on the **Preselector Board** and **Exciter Board** are easily damaged.

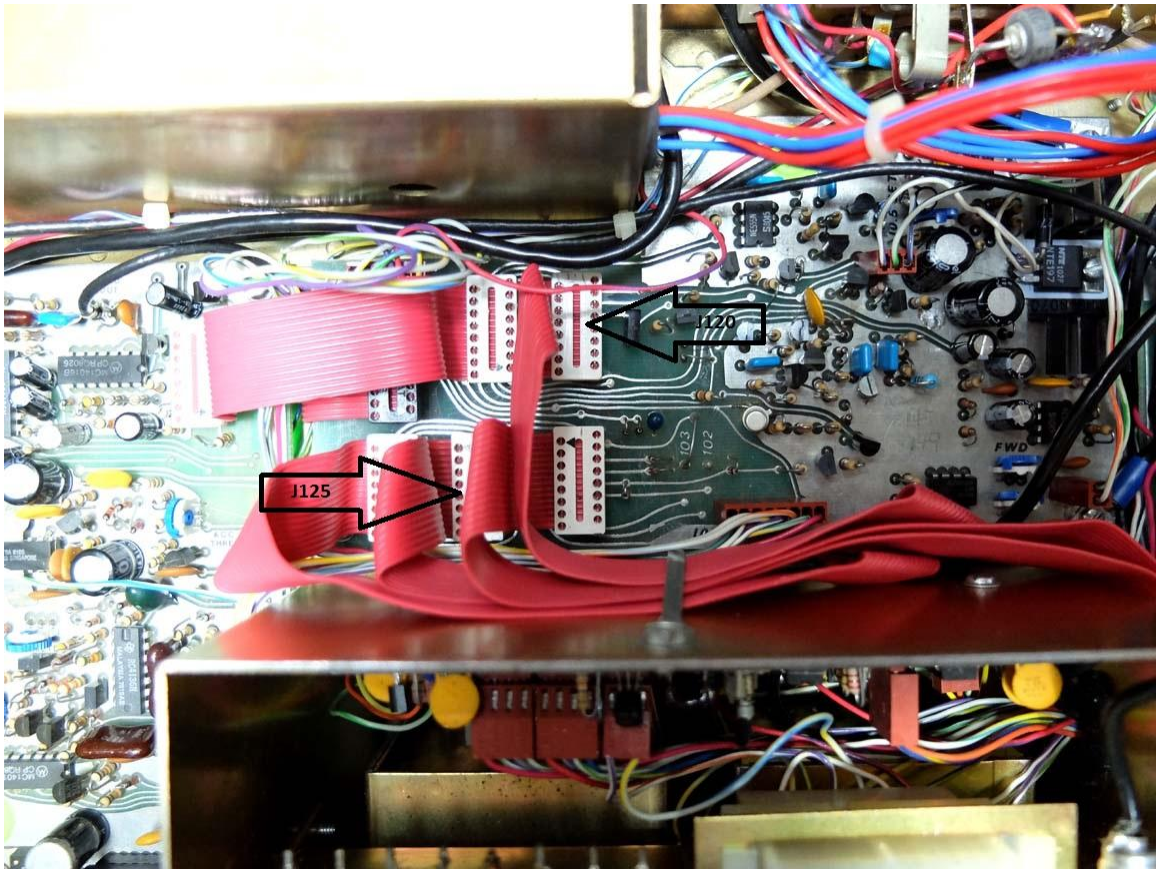


Figure 2 – Distribution Board

1. Buy the Service Manual and User Guide. The MANUALMAN does nice work. The service manual is excellent with one glaring omission. No important signal levels and many important DC voltages are not included. This was my prime motivation for this document effort

2. Turn the MIC Level control full CCW and set mode to USB.

3. Power ON and rotate the band switch through all bands and note that the display indicates the correct frequency. If it does not or it's all the same like 10.000 then major problems are afoot.

4. Next, verify that all the important control voltages are correct with a DMV before doing anything else. The following table shows the required values and the **Distribution Board** ribbon cable pins to measure them on with easy access. I did not include the WARC bands but you can find them on the daughter boards if needed.

The important control voltages fall into 4 categories and can easily be accessed on the **Preselector Board** and **Exciter Board** J125 and J120 connectors. If these voltages are not perfect, the unit will not play properly and whatever you do, **DO NOT TRANSMIT** until all is perfect.

- Band Control - exclusive 10vdc for each SW position
- Transmit and Receive mode control - exclusive 10vdc
- USB, LSB, CW and CWN mode control - exclusive 10vdc
- PA Bias control

10vdc = 9.0-10.7vdc

Test Setup	Results	Signal Name	Connector & Pin
Power ON, any band	10.55vdc, adjust POT if not spot on	10.55v	J125 Pin 3
Power ON, any band	-5vdc	-5v	J125 pin 8
USB, Receive 160 Band Select	10vdc, exclusive	160	J125 pin 16
USB, Receive 80 Band Select	10vdc, exclusive	80	J125 pin 15
USB, Receive 40 Band Select	10vdc, exclusive	40	J125 pin 14
USB, Receive 20 Band Select	10vdc, exclusive	20	J125 pin 13
USB, Receive 15 Band Select	10vdc, exclusive	15	J125 pin1 12
USB, Receive 10A Band Select	10vdc, exclusive	10A	J125 pin 11
USB, Receive 10B Band Select	10vdc, exclusive	10B	J125 pin 10
USB, Receive 10C Band Select	10vdc, exclusive	10C	J125 pin 9
USB, Receive 20 Band Select	10vdc on R, 0vdc on T	R & T	J125 pin 2 (R) J125 pin 1(T)
USB, PTT closed 20 Band Select	10vdc on T, 0vdc on R	R & T	J125 pin 1 (T) J125 pin 2(R)
USB/CW Receive 20 Band Select	10vdc	USB & CW	J120 pin 7
LSB Receive 20 Band Select	10vdc	LSB	J120 pin 6

LSB Receive 20 Band Select	13vdc (developed on Exciter Board)	PA Bias	J120 pin 15
LSB PTT Closed 20 Band Select	0vdc	PA Bias	J120 pin 15
CW PTT Closed 20 Band Select	10vdc	CWX	J120 pin 5

A Few Failure Scenarios

- Display fails to indicate correct frequency based on band switch position - check band select voltages on the **Preselector Board.** There must be 0vdc on all positions not selected and 10vdc on the selected band position. If you have 3-6vdc on one, check PIN diodes on the **Preselector Board** because one is shorted.

  The LO Board is another possibility. Check the logic on the input to U105 on pins 14-10. 0=0vdc, 1=3vdc.

Band	Mhz
160	00000
80	00001
40	00010
20	00011
15	00100
10A	00101
10B	00110
10C	01000
10D	10000

- No power output - check T, R and Bias control voltages. The T voltage is switched by discrete transistors on the **Distribution Board** and the 13vdc Bias is sunk to ground by other discrete transistors on this board. If Bias is not 0vdc, there will be zero RF output.

- No CW output or side tone - check CW control signal. This is also switched by discrete transistors on the **Distribution Board.**

- No ALC indicated on meter in transmit - recalibrate ALC: ZERO, FWD and REV on the **Preselector Board** per the manual. If not correctly done, no ALC will be indicated on the meter with output present.

- PIN diodes keep blowing on the **Preselector Board** when transmitting - **c**heck the T and R voltages and protection transistor Q101 on the Low Pass Filter Board and the reed contact in K101 T/R relay. Also verify that the Ext Relay RCA jack for a linear is properly bypassed with a 0.01uf 500v capacitor. Some fool had removed this in my unit. I suspect this caused me many extra unwanted challenges.

  NTE555A PIN diodes are direct replacements and work well.

- Frequency display problems with some segments – this is the display itself or one of driver ICs on the frequency counter card. I had one IC fail.

- No transmit or receive even with all good control voltages - **Exciter Board** mixer Z-101PIN diodes could be shorted. Replace the RCA CA3039 can. This is a HUGE task but can be done without de-soldering the 16 pin carrier. The Service Manual has the pin-out detail. eBAY had the RCA CA3039 cans and you could also just solder 4 matched PIN diodes across the carrier. Be very careful with the microscopic toroid wires.

Assorted Board Images

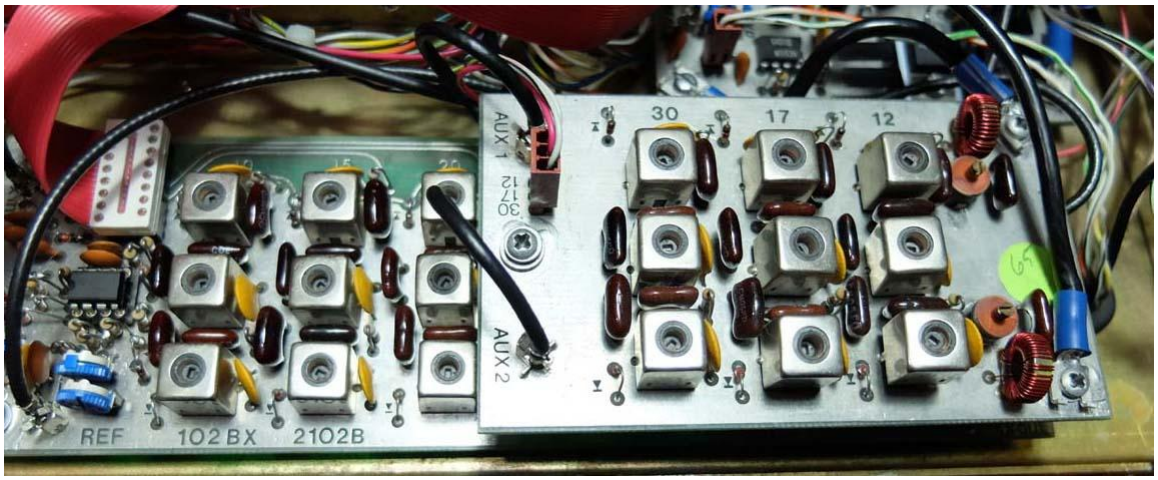


Figure 3 – Preselector Board with WARC Daughter

Figure 4 – LO Board with WARC Daughter and No Cover

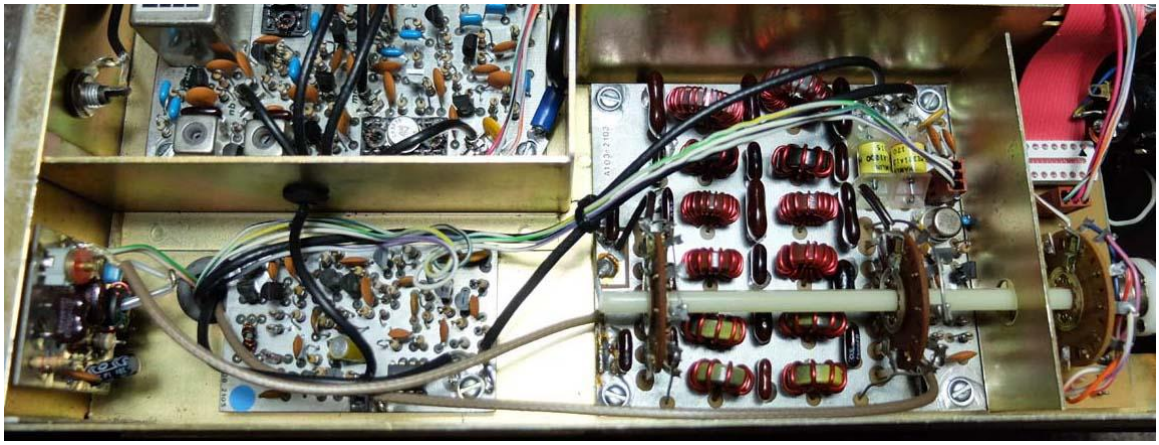


Figure 5 – Low Pass Filter Boards with no Cover

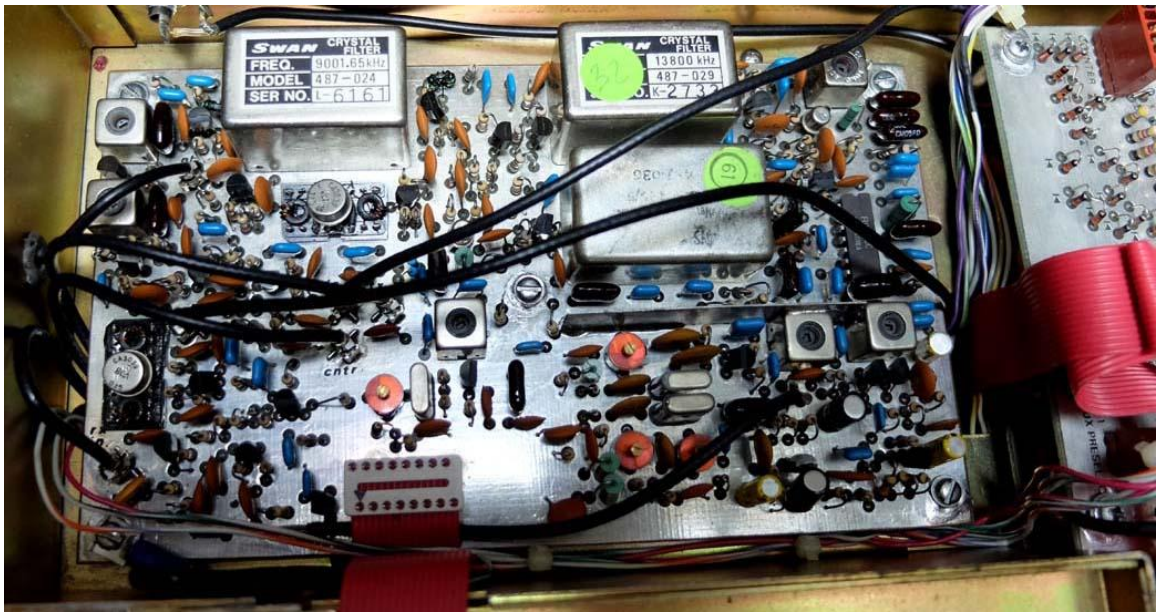


Figure 6 – Exciter Board

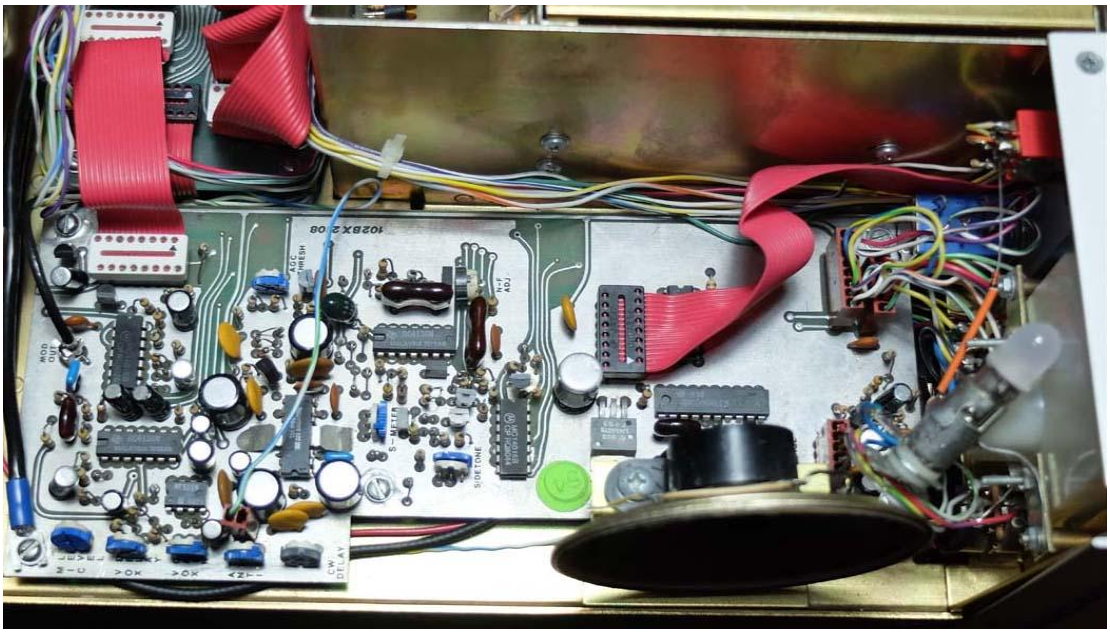


Figure 7 – Audio Board

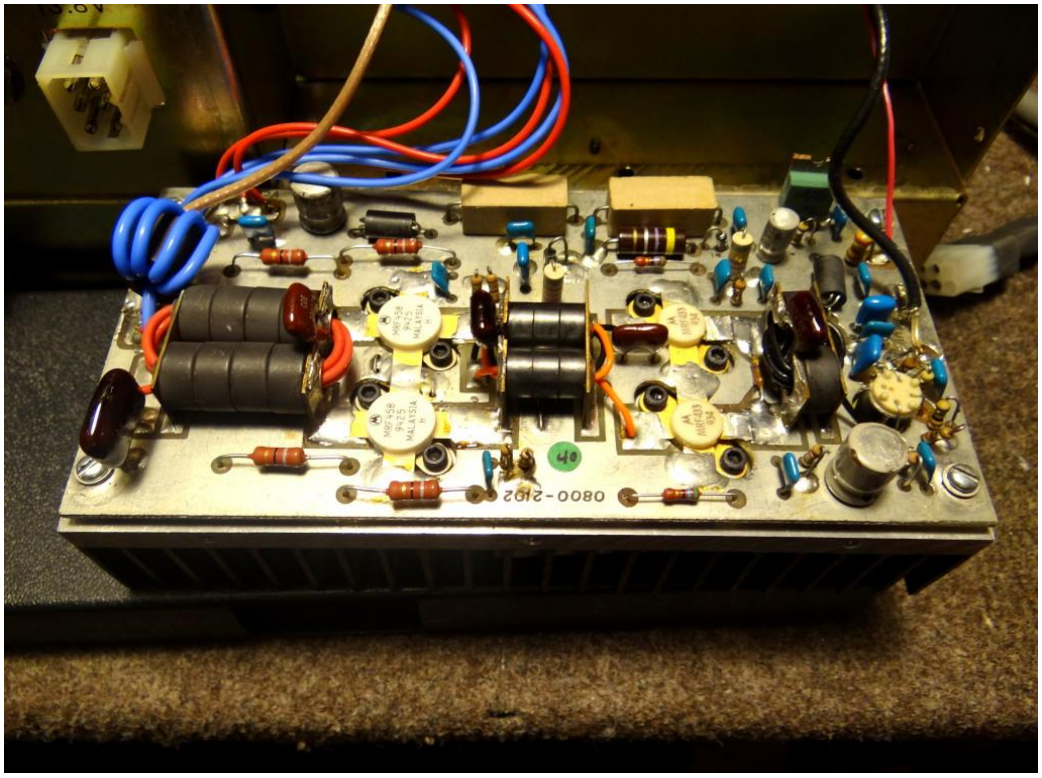
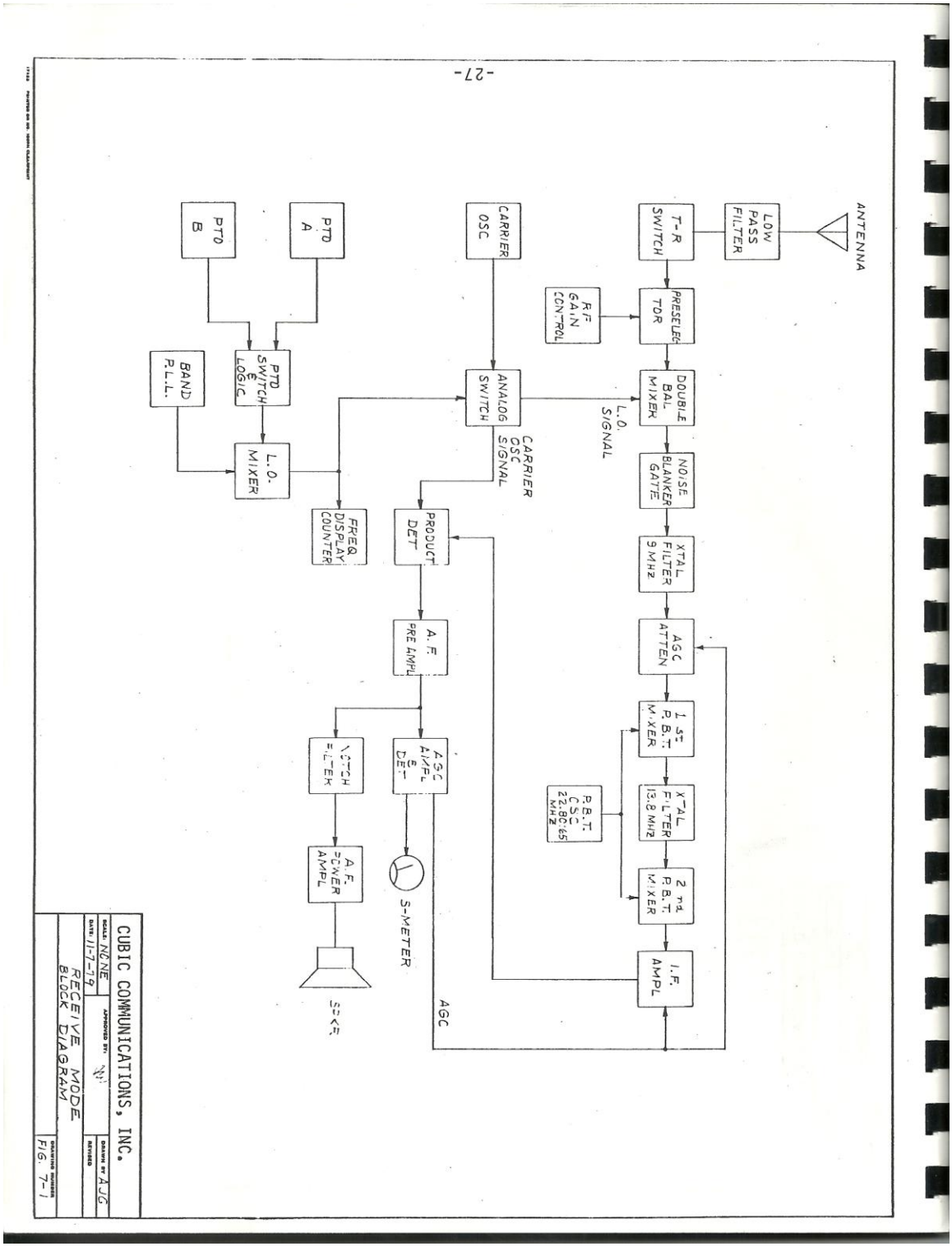


Figure 8 – Robust PA Unit

Appendix A – Receive Block Diagram



Appendix B – Transmit Block Diagram