Overcoming Fears of SMD Kit Building

(and getting on the 500KHz band someday)

FRRL Program

January 2013

By AH6EZ

Vision of 500 KHz band operation

- I thought I would buy an old boat anchor like a Heathkit DX100 and gradually convert it
- I was looking around at Dayton
- I stumbled onto a little box for $150
- It was an unbuilt TX500 kit (retail $400)
- I figured I would learn about building with SMDs
- IARU allocated the spectrum
- ARRL is asking the FCC for rules
- I am now ready…

Sharing my experiences

- Looking at the MANY, SMALL parts…
- I knew I was in for a challenge
- I have now learned a lot and feel I could assemble *any* SMD kit
- I think that you could too…

- Good vision (somehow) is a prerequisite

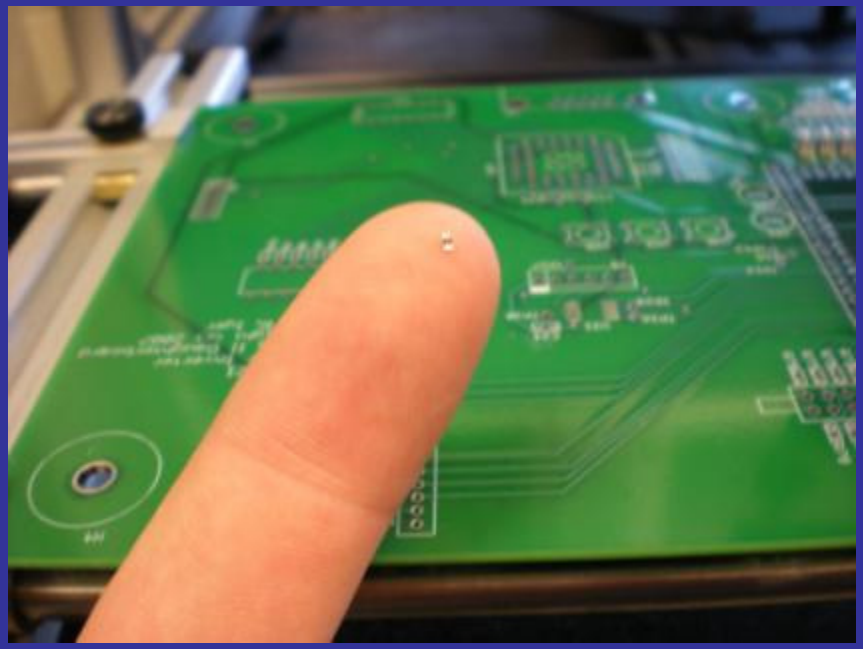
Advantages of SMD Devices

1. Smaller components (could also be seen as a disadvantage)
2. Much higher component density
3. Many more connections per component
4. Lower initial cost and time of setting up for production
5. Fewer holes need to be drilled
6. Simpler and faster automated assembly (automated up to 136K/hr
7. Small errors in component placement are corrected by surface tension of molten solder
8. Components can be placed on both sides of the circuit board
9. Lower resistance and inductance at the connection
    - Fewer unwanted RF signal effects
    - Better and more predictable high-frequency performance
10. Better mechanical performance under shake and vibration conditions
11. Many SMD cost less than equivalent through-hole
12. Better EMC compatibility (radiated emissions)
    - smaller radiation loop area (because of smaller package)
    - smaller lead inductance

Disadvantages of SMD Devices

- Manual prototype assembly or component-level repair is more difficult and requires skilled operators and more expensive tools
- SMDs cannot be used directly with prototype plug-in breadboards
- SMDs' solder connections may be damaged by thermal cycling of potting compounds
- Smaller SMD Solder joint dimensions can lead to solder paste reflow voids
- SMD unsuitable for large, high-power, or high-voltage parts
- SMT unsuitable as sole attachment method for components subject to frequent mechanical stress

Yeah, I know… They Are Small !

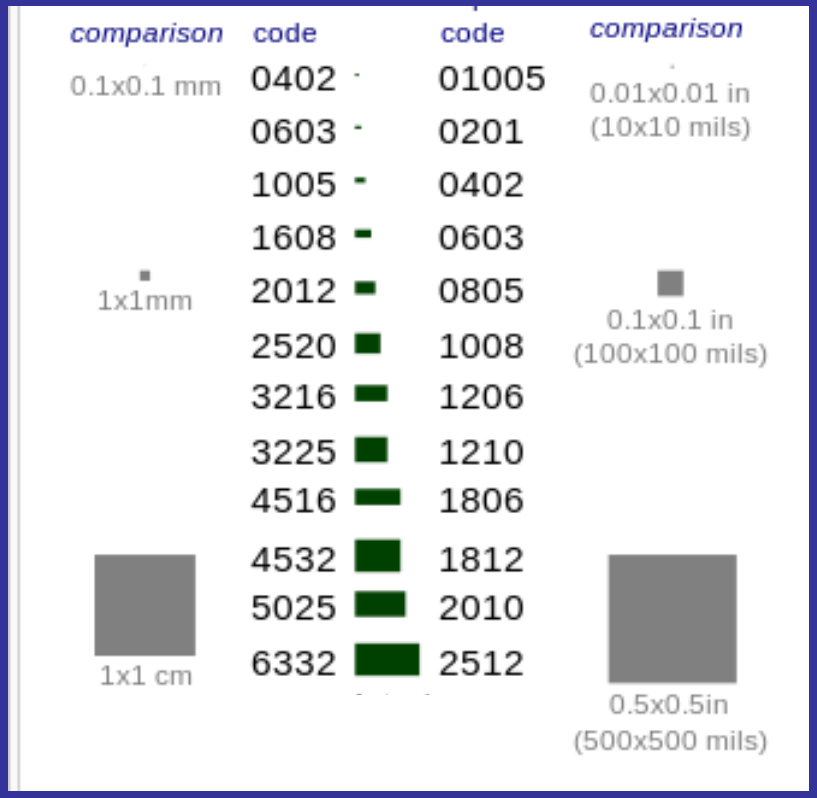


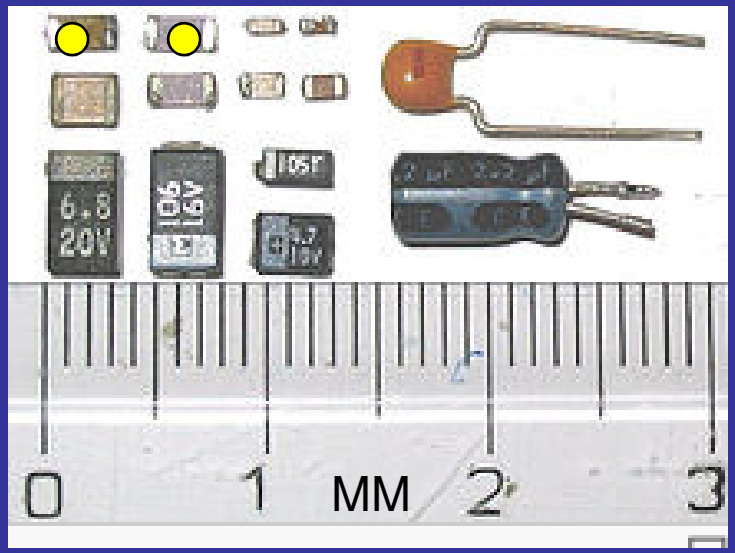
Watch out for kits with parts this small !!!

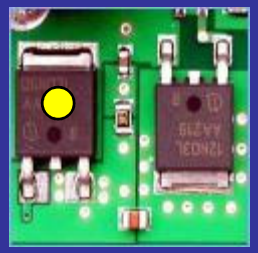
Disadvantages of SMD Devices

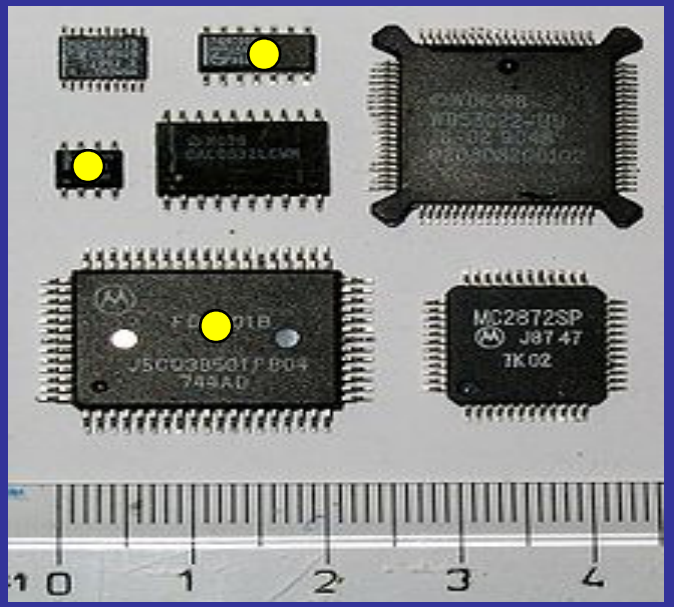
1. Manual assembly or component-level repair is more difficult and requires skilled operators and more expensive tools
2. SMDs can’t be used with prototype plug-in breadboards
   - However PC Board services are now faster and cheaper
3. SMDs' solder connections may be damaged by thermal cycling of potting compounds
4. Smaller SMD Solder joint dimensions can lead to solder paste reflow voids
5. SMD unsuitable for large, high-power, or high-voltage parts
   - Likely combination of SMD and leaded parts

SMD Part Sizes



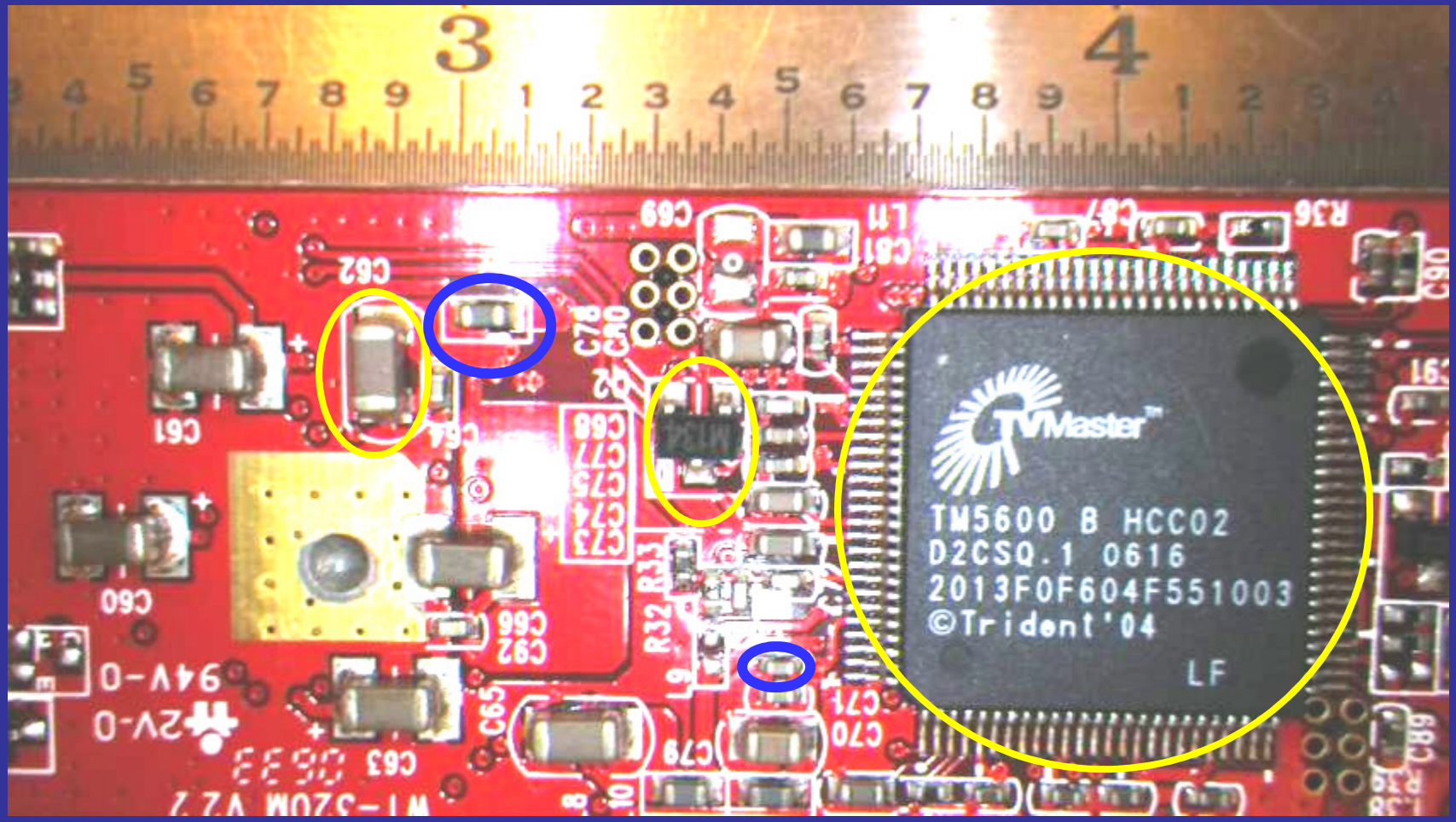






= Parts in the TX500

Small and smaller and tiny SMD



TX500 kit included these larger SMD parts not these

SoftRock SMD Soldering Technique

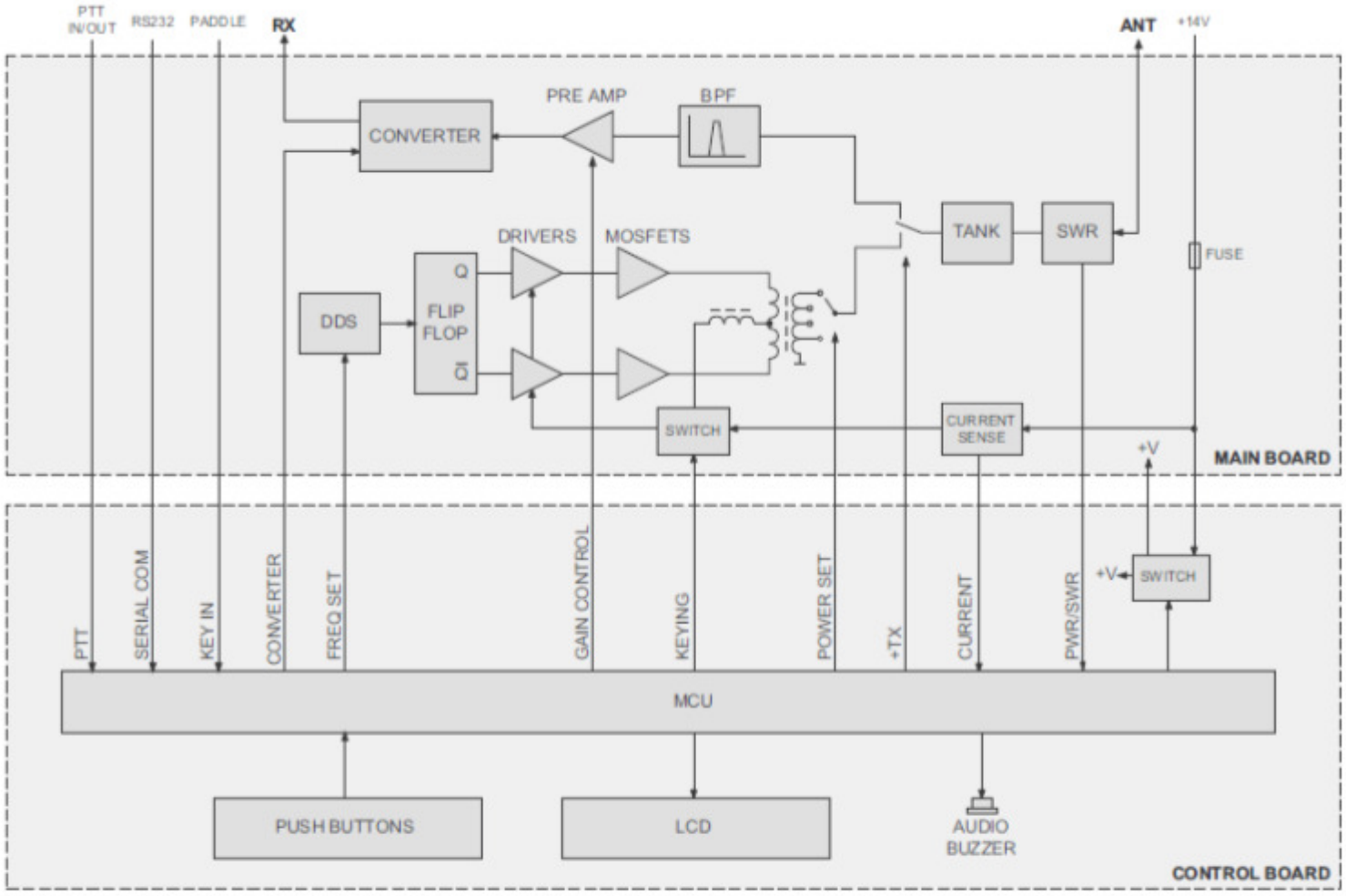
- Did not use solder paste
- Used standard soldering iron
- Used small rosin core solder
- Used a weighted arm to hold each part
- Soldered one end of each part at a time
- Manually kept each part aligned
- Fortunate to have good enough eye sight to not need to use a magnifying glass

Juma TX500 ($396 kit)

General features

- RF output power 60 W key down proof
- Four power levels (MIN 4W, LOW 15W, HI 35 W, MAX 60W)
- Supply voltage nominal 14 VDC (range 12 VDC...15 VDC)
- Typical max current 5 A (with over current protection)
- Frequency range 450 kHz...550 kHz (step 10 Hz)
- Frequency step 1 Hz with Windows control software
- Top quality keyer with speed range of 1 wpm... 50 wpm
- Speed range 0.1 wpm...50 wpm with serial control
- Good clickless CW keying shape
- T/R switch with CW speed adaptive release delay
- RX preamplifier
- RX up-converter from 500 kHz to 3.5 MHz
- Beacon mode
- Windows software for PC control
- Small size, Width 180 mm, Height 60 mm, Depth 124mm

Juma TX500 Block Diagram

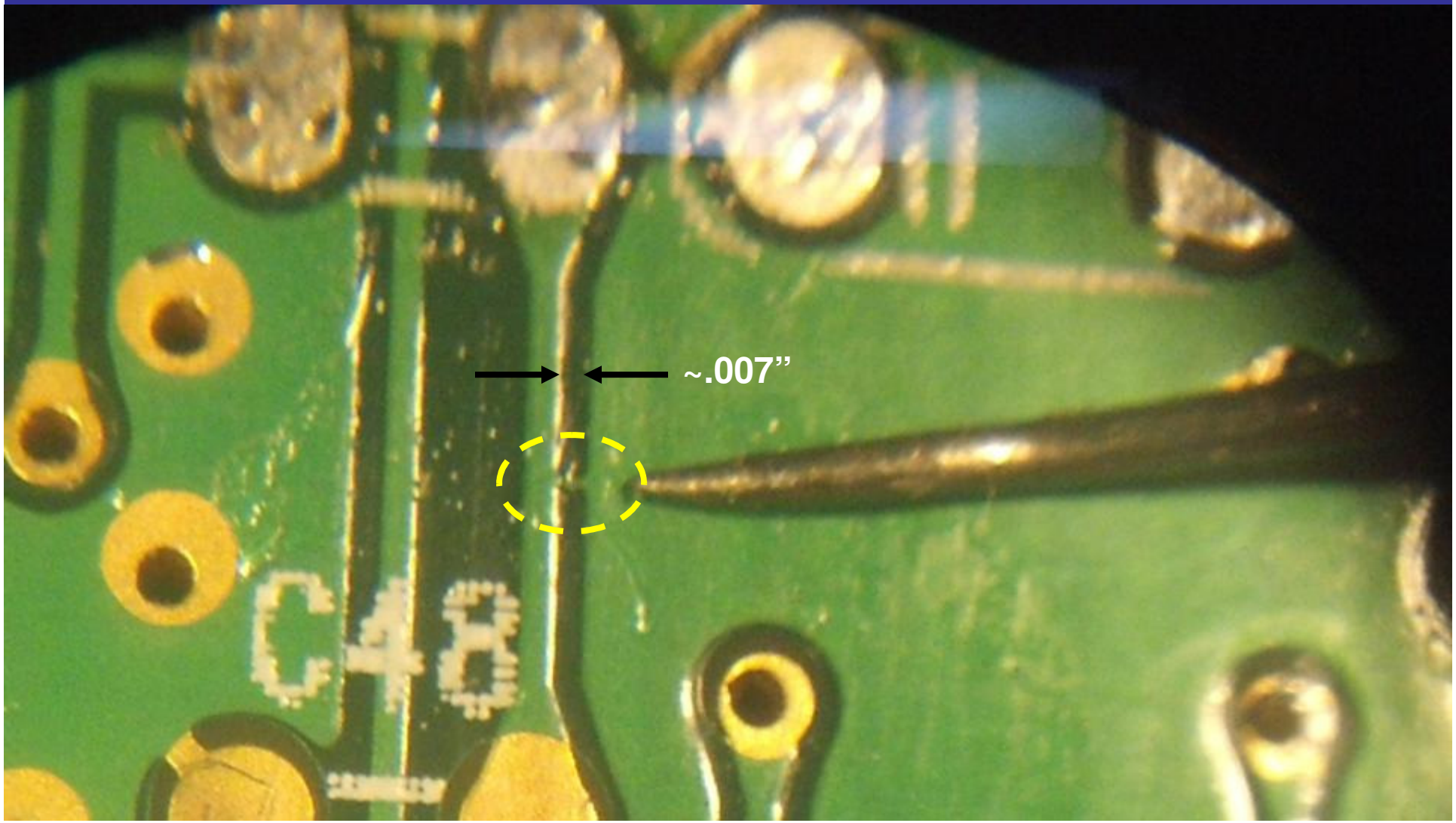


JUMA TX500 & TX136 block diagram
2009-09-10 OH2NLT & OH7SV

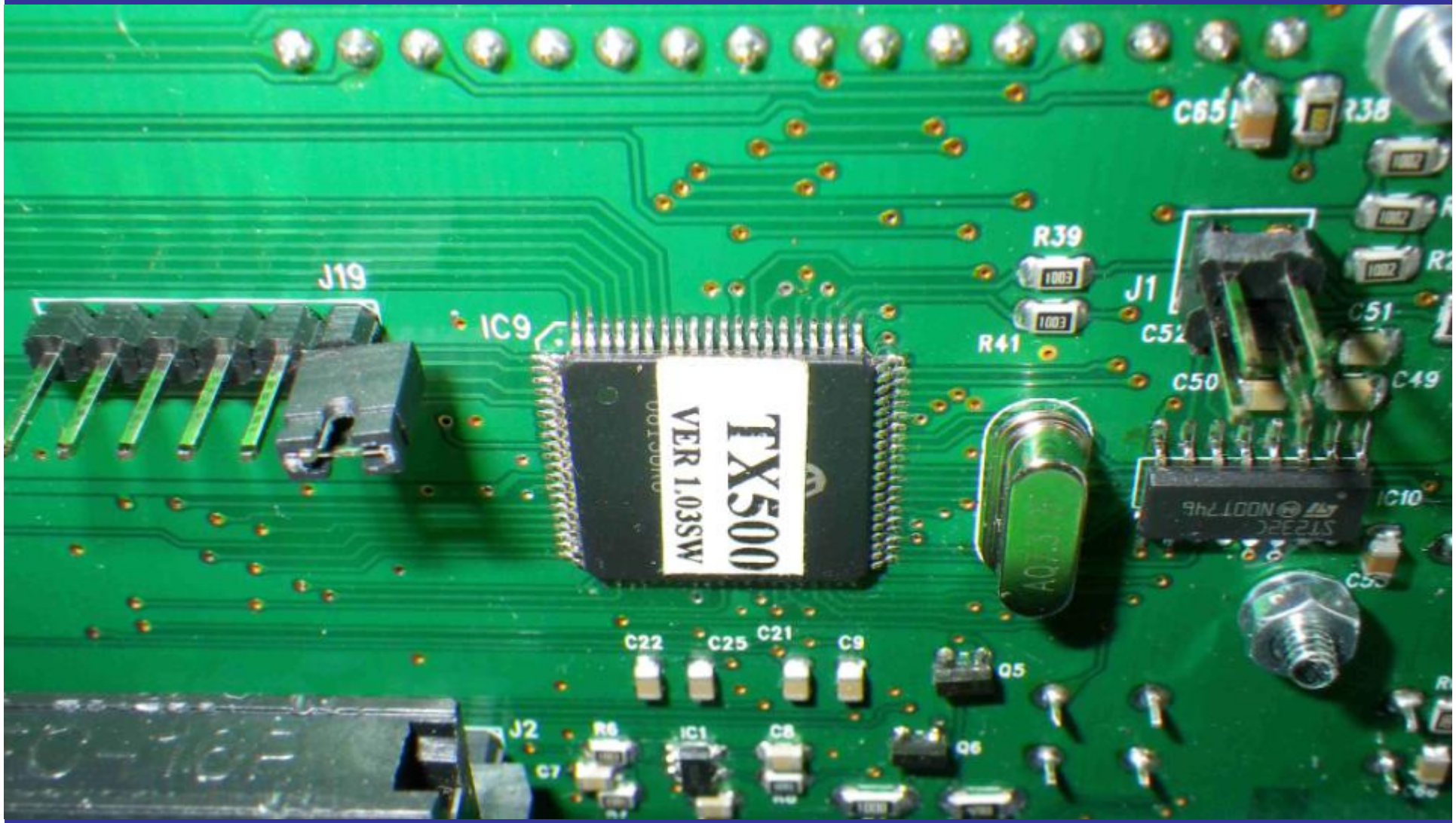
Juma Kit Experience

- Schematics and parts lists supplied (EU values, nf = pf, etc)
- No recommended build procedure (Not a Heathkit)
- Parts lists didn't have part numbers (C21, R15, etc)
  - Cross referencing from schematic took a lot of time
- Capacitors had no markings!
  - Fortunately separate labeled bags allowed identification by quantity
- Very limited operation guides
- Only two 42 turn toroids to wind
- Nothing to tune or adjust
- Class D transmitter is VERY efficient, small heat sink
- 80m RX converter much more sensitive than noise floor
- Took about 20 hours to build

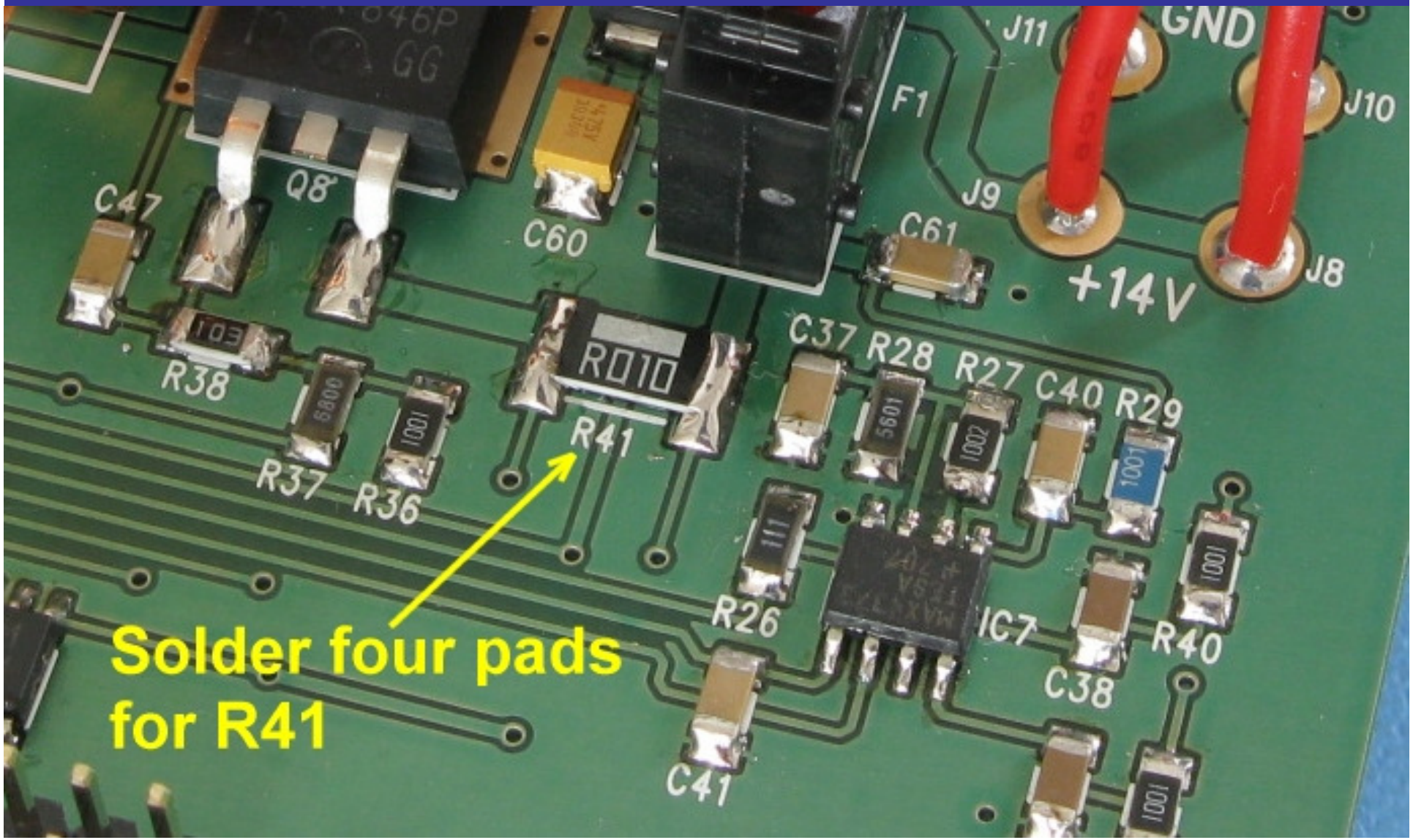
Short on TX500 5v buss found by W9XA



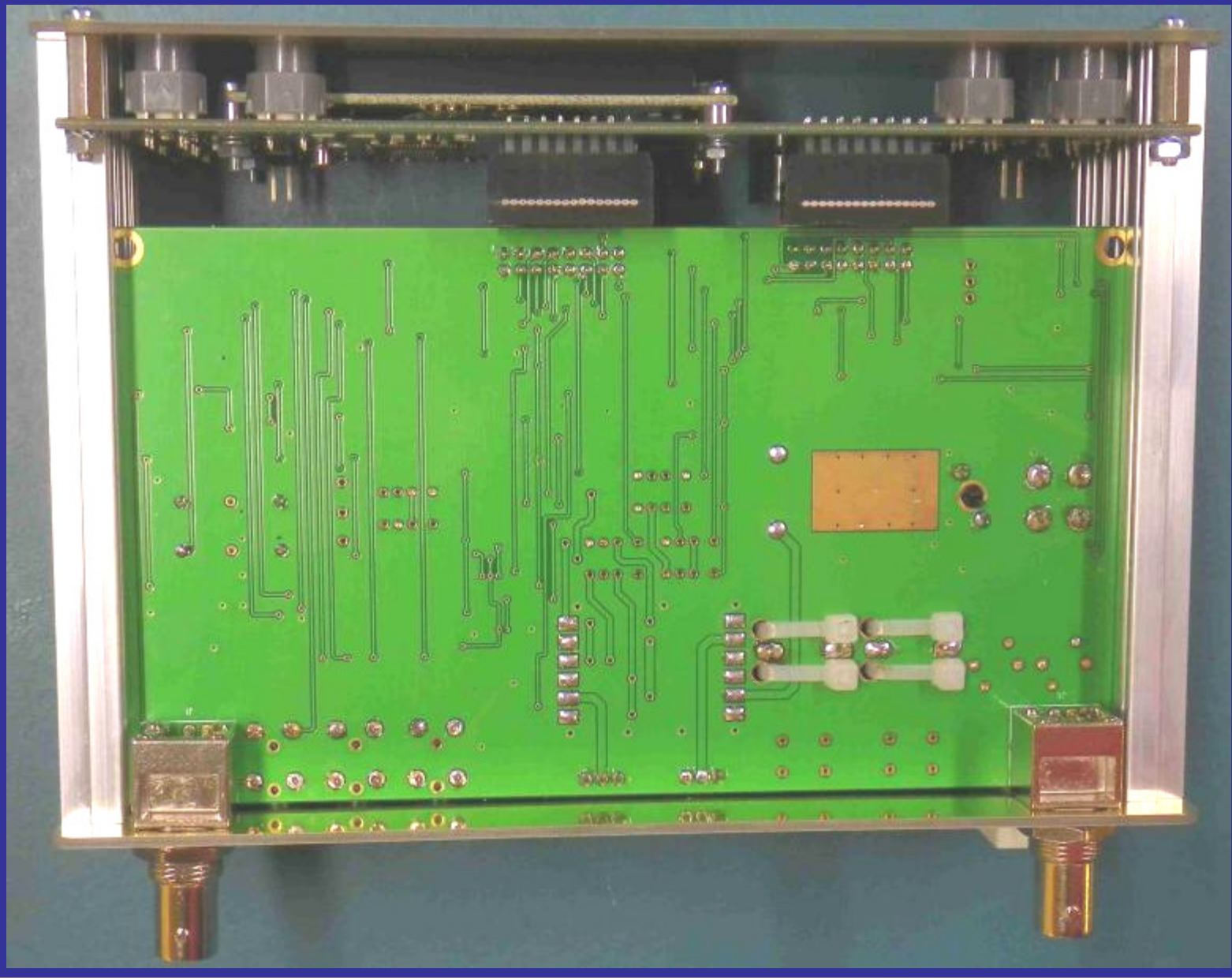
TX500 Pic Controller (80 pin quad pack)



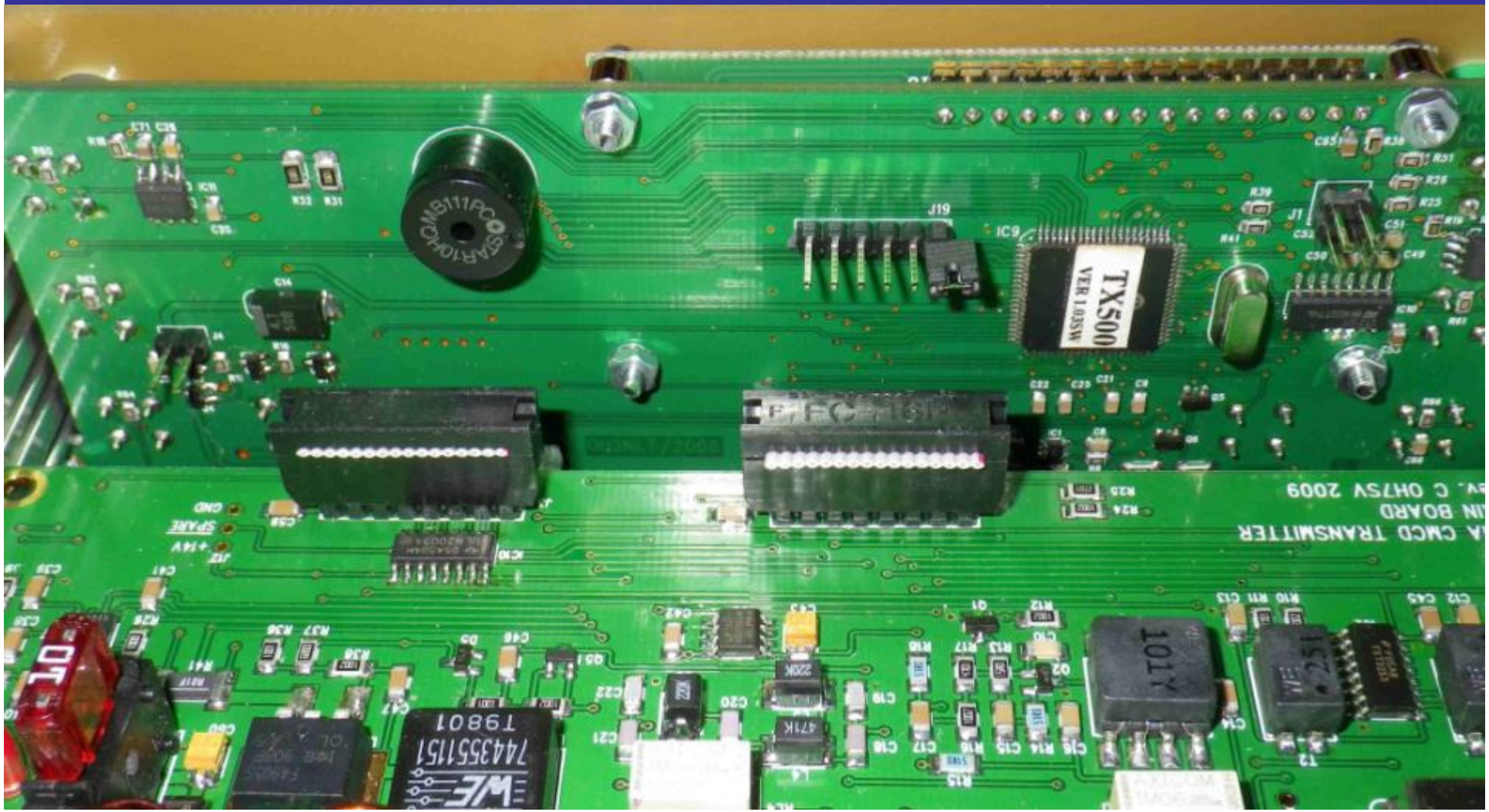
Dual pad hi power resistor in TX500



Bottom of TX500 (no parts)



Rear of TX500 Control Board



TX500 Front and Rear Panels

TX500 Current and Voltage Display

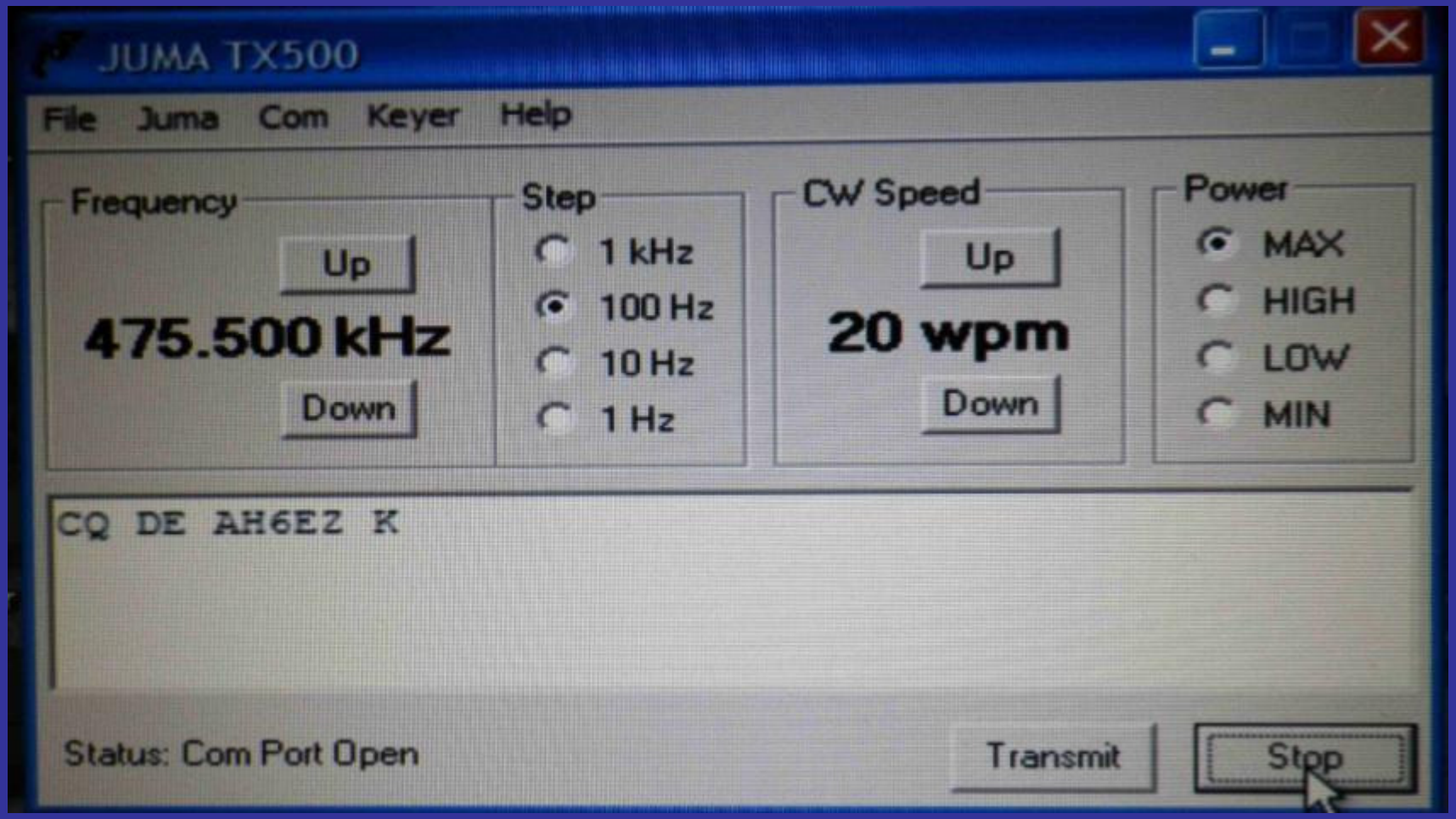
Power Input = 4.9 x 14.11 = 69.1 Watts

RF Power Output Measured = 57.5 Watts

Class D Efficiency = 83.2%

TX500 RF Power and SWR Display

Windows Control Software



Connects using RS232
Allows QRSS down to .1 WPM

My TX500 SMD Soldering Approach

- Got a hot air rework station
- Practiced on a broken computer board
- Concerned about the 80 pin IC, mounted it first
- Started using too much solder paste
  - Cured by using smaller nozzle tube from Kermit
- Watched some YouTube tutorial videos
- Developed a technique

Hot Air Rework Station
Circuit Specialists BK-6000 $236

BK6000 Rework Station Lessons

- Thought the mounting arm would be good
  - Turned out to restrict distance to the board
- Desoldering tool was ok, did not use much
  - SolderWick was better
- Included solder iron on, did not use much
  - Attached smoke “sucker” got in the way
- Small vacuum part picker ineffective
  - Reverse tweezers worked very well

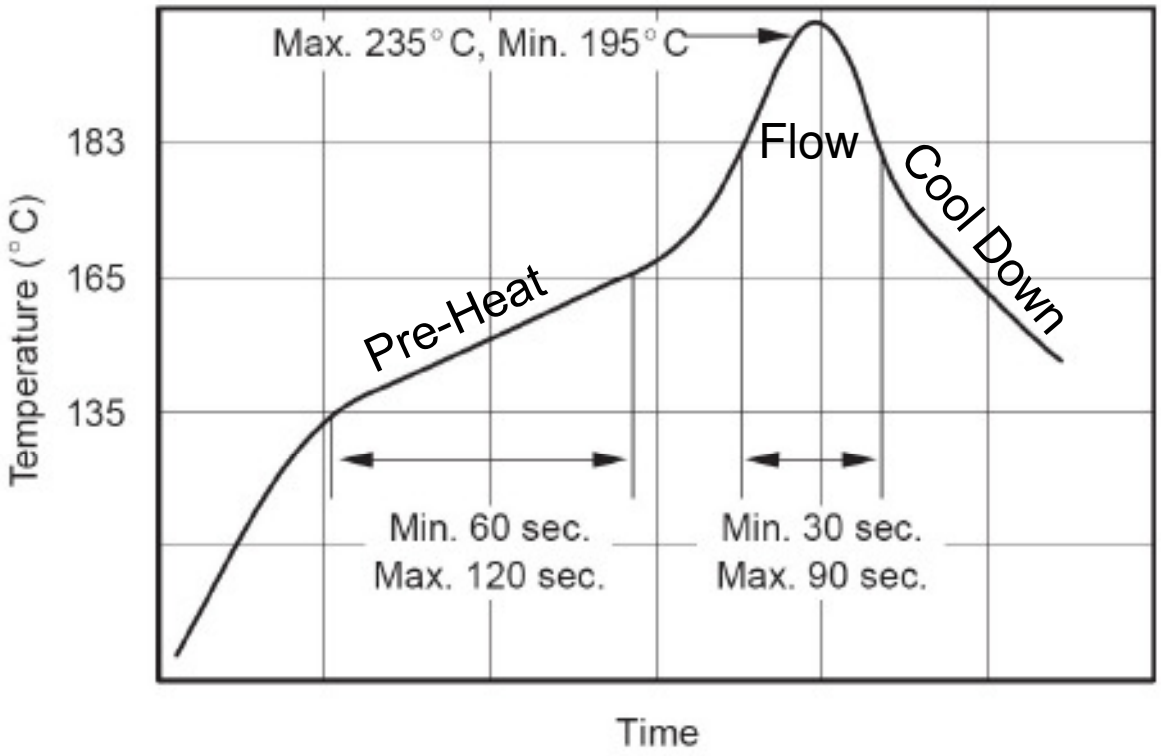
TX500 SMD Soldering Technique

- Used Hot Air Rework Station with smallest air nozzle
  - Lowest temperature – 2 degree C above 188C solder paste melting point
  - Most SMD can withstand 220-260C
  - Selected lowest air flow to avoid blowing parts around on the board
  - Higher temperatures with low air flow caused protective cool down cycle
- Used Tin-Lead (lowest melting temperature) Solder Paste
- Eventually used very small syringe nozzle (difficult with copper pipe as a plunger)
- Applied small amount of solder paste to pads (too much can lead to problems)
- Applied solder paste to far ends of multi-lead ICs to minimize getting underneath
- Grabbed part with spring loaded tweezers (squeeze to release the part)
- Using 2 braced hands, placed the part onto solder paste
- Nudged the part into alignment with toothpick if needed
- Approached part with hot air gradually from a couple of inches
- Flux would melt and flow first
- Solder paste would then turn dull and firm (essentially gluing the part in place)
- Move in closer (.25-.5”) to one end and flow the paste to solder
- Flowed the other end of the part
- Some ground plane connections did not fully heat up, touched up with solder iron
- Inspected for alignment and improper solder joint or bridges, ohm meter if needed
- Used fine solder wick to remove excess solder or to realign a part if needed
- Cleaned excess flux

Other Techniques

- Whole board solder paste using stencils
  - Perhaps more useful for higher volume
- Toaster oven with thermocouple and timer
  - Follow pre-heat and cool down cycles
  - Minimized thermal degradation
- Infrared heating
  - No air flow
  - Less of a hobby technique

Recommended SMD heat cycle



Process Step	Eutectic Solder
Ramp Rate	3℃/sec Maximum
Pre-Heat	165℃, 60 to 120 seconds
Time above Liquidus, 183℃	30 to 90 seconds
Peak Temperature	235℃
Time within 5℃ of Peak Temperature	10 to 20 seconds
Ramp Down Rate	6℃/sec Maximum

Sn/Pb
63/37

Hot Air Tool
Circuit Specialists CSIHOTGUN-2 $89

Both Temperature and Air Flow Controllable

Anybody need solder paste?
(I have 4.5 tubes left that expire in August)

Manncorp
SMTSOLDERPASTE.COM
The SMT Solder Paste Authority

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No-Clean Tin-Lead Solder Paste
MODEL: SH6309-RMA

DOWNLOAD

Tech Info | MSDS

--Specification--

Item	Specification	Standard
Appearance	Gray paste w/o visible foreign matter and clusters	
Alloy composition	Sn63/P37	JIS-Z-3282
Melting Point	183 °C	
Particle Size	(Type 3) +45μm < 1%, −20μm < 10% (Type 4) +38μm < 1%, −20μm < 10%	IPC-TM-650,2.2.14
Powder Shape	Spherical	

Several Instructional Videos

From YouTube