Comparison of Batteries Yaesu and Batteries America for the VX8, FT1, FT2, FT3, and FT5 series radios

This document is under development. This is Part Three.

Part 1: Initial comparison between Yaesu and Batteries America
Podcast: https://hamoperator.podbean.com/e/mnwis_2023-03-13-ht-batteries-part-1-comparingtwo-vendors-plus-more/

Part 2: Usability and manufacturing

Podcast: https://hamoperator.podbean.com/e/bars_2023-03-20-ht-batteries-and-more/

Part 3: HT features that impact power consumption.

Podcast: Not yet available

Part 4: Love and caring of Li-ion batteries.

Podcast: Not yet available

You may wish to consider a CD-41 alternative for charging the larger Batteries America battery. This appears to be the same charger that BA sells for quite a bit more money. This charger uses a very nice buck converter to charge the battery. That means the charge current stays the same over a wide range of input voltages. In addition, the charge current is higher than the CD-41, about 750 mA vs 500-600 mA.

Other things I like about this charger:

- It does a soft start, limiting potentially damaging inrush current on a very discharged battery.
- It does a soft stop, reducing current as the battery nears full charge.
- It charges to 8.2 V instead of 8.4 V, increasing the number of battery cycles while only reducing the capacity by about 5%.

The battery should be about $24. The amazon link is: https://amzn.to/40DKTzw

See https://HamOperator.com for more details and discussion.

Part 1

Battery Construction

BA uses foil packaging while Yaesu uses metal can. Yaesu: Both batteries are near the heat source whereas with BA one battery is subjected to more heat.

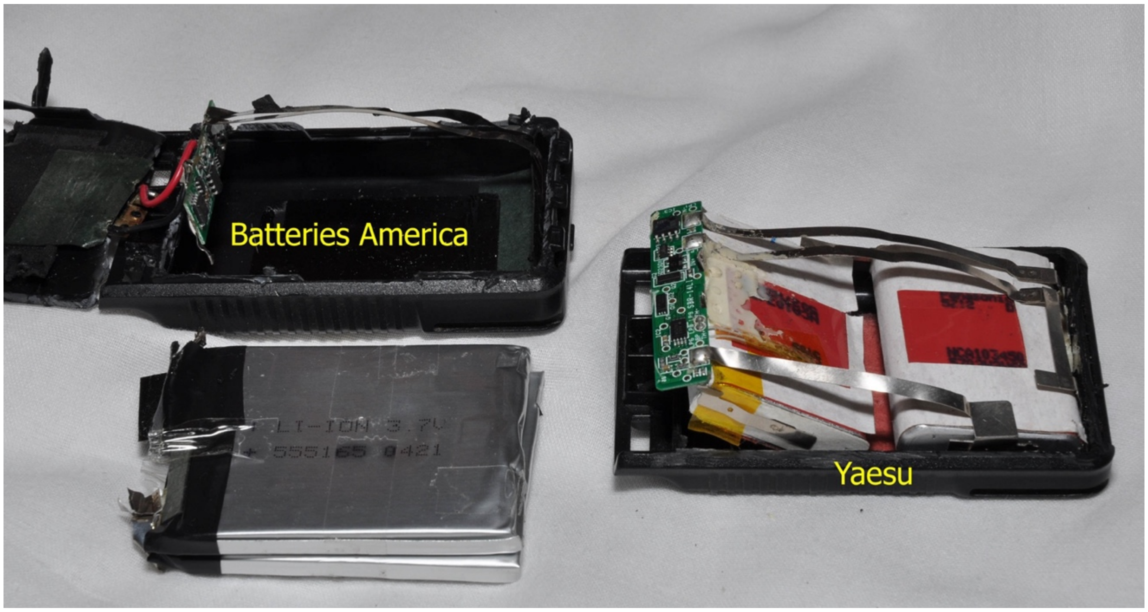

Figure 1 Comparison of internals: BA and Yaesu (China)

Yaesu's thermocouple

Temperature measuring not detected with Batteries America. Note that the thermocouple is between the battery and the radio's (internal) heat sink – very likely the hottest place in the battery pack.

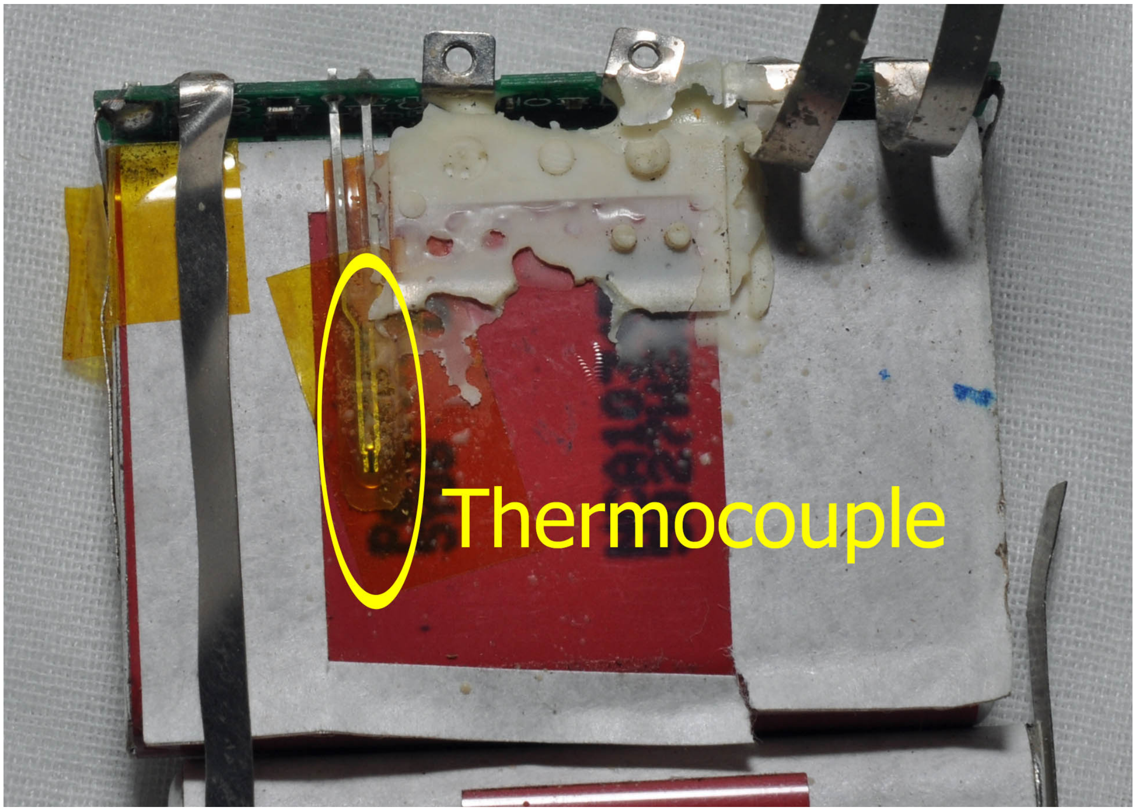

Figure 2 Yaesu thermocouple

Charging a Li-ion battery at high temperatures can significantly reduce battery life.

Batteries America Protection PCB Front and Rear

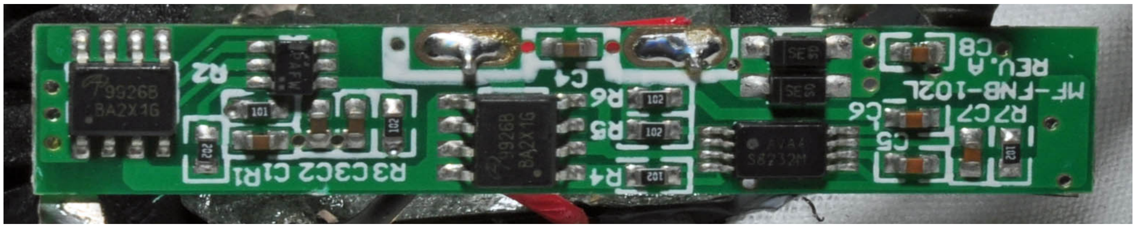

Figure 3 BA Protection PCB Front

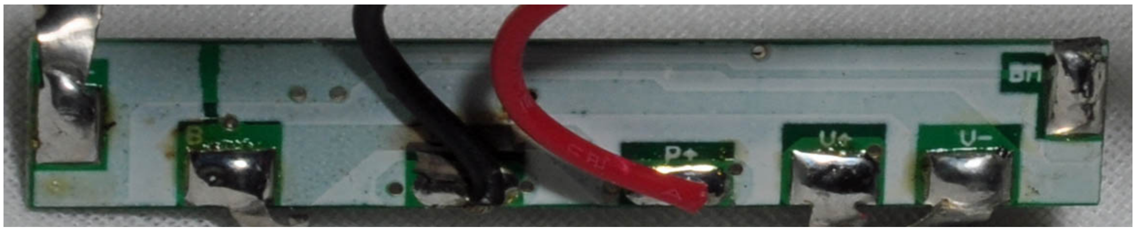

Figure 4 BA Circuit Protection Back

Yaesu front/back – more circuitry

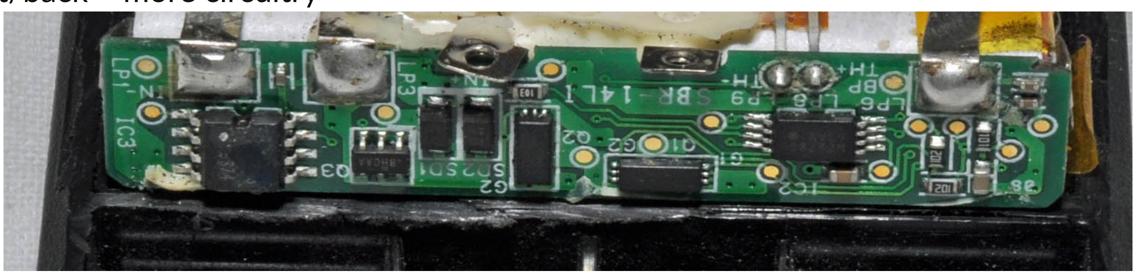

Figure 5 Yaesu Circuit Protection Front

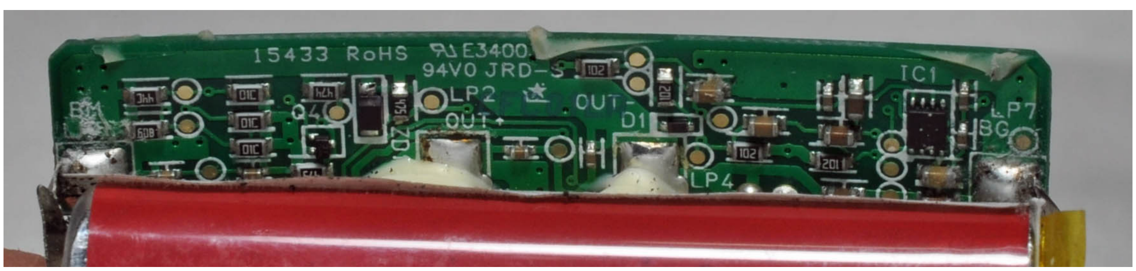

Figure 6 Yaesu Circuit Protection Rear

Results so far

Both are good batteries albeit with different construction techniques. The foil batteries (BA) allow for slightly higher power density and lower cost while the metal cells (Y) are easier to manufacture since a jelly roll can be used vs. a cut and welded design.

The analysis so far is not enough to determine if one is significantly better than the other. Points are awarded to Yaesu for inclusion of temperature sensing and better thermal management.

Part 2

Manufacturing, Size, and Usefulness

Greater capacity means a bigger battery. That may or may not be an issue depending upon how you use the radio.

In these three pictures we see the standard Yaesu (Y) battery (left), the 3.8 Ah Batteries America (BA) center, and the Y battery with the battery clip, all on an FT5 HT. The BA unit extends to the rear, but the contoured shape makes it feel good when holding it in your hand. Clearly the battery clip arrangement first used on the FT5 does not work with any battery that is any larger than the standard battery. Not only does it not work with the 3.8 Ah BA battery, it doesn't work with Yaesu's own 3-"AA" battery pack.

The next three photos show:

- Y1800 - An older Yaesu battery manufactured the 2nd week of 2014 in Japan (1800 mAh).
- Y2200 - A newer Yaesu battery manufactured the 13th week of 2021 in China (2200 mAh).
- BA – 3800 The 3800 mAh Batteries America battery manufactured the 12th week of 2022 in China.

Note that Yaesu appears to have switched from manufacturing batteries in Japan to making them in China around the middle of 2015.

Figure 7 Back (HT side) of all three batteries

Figure 8 Rear of all three batteries.

Figure 9 Side by side battery comparison

Who Makes the Batteries?

We don't know but there are some interesting features. First off, the Y1800 Yaesu battery has the Yaesu logo on it. The others don't. The 2nd feature is a notch that is midway down the left-side of the HT power connector label. The Y1800 Yaesu battery does not have the notch, but both the Y2200 and BA3800 do. Also compare other features of the plastic mold. Everything indicates that the same mold was used to manufacture that part of the battery which interfaces with the radio. (The BA3800 by necessity has a different mold for the rear to accommodate the larger size.) You'll also notice the Y2200 and BA3800 have the same "-" and "+" symbols. Also note the similarity between the labeling on the batteries. Because of regulatory issues, this labeling is critical and a company is not likely to want to mess with it unless they really have to.

The conclusion is that the BA3800 and the Y2200 were likely made by the same company!

If you look closely at the photos, you'll see other hints that the batteries were made by the same company. Side note: You can use this same technique to see if other products are made by the same company. For example: AA batteries, cans of soup, RF connectors, etc.

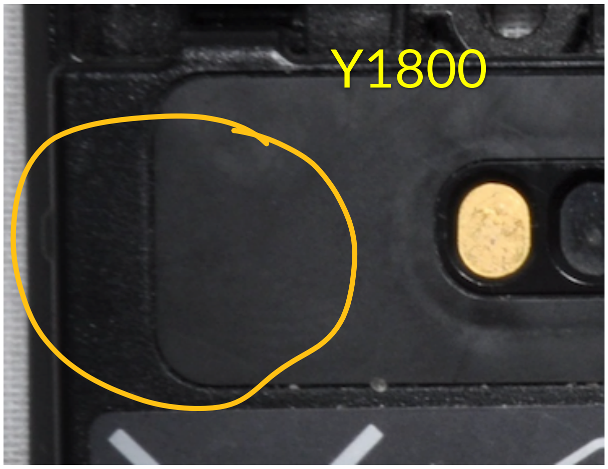

Figure 10 Blow-up of Y1800

Figure 11 Blow-up of Y2200

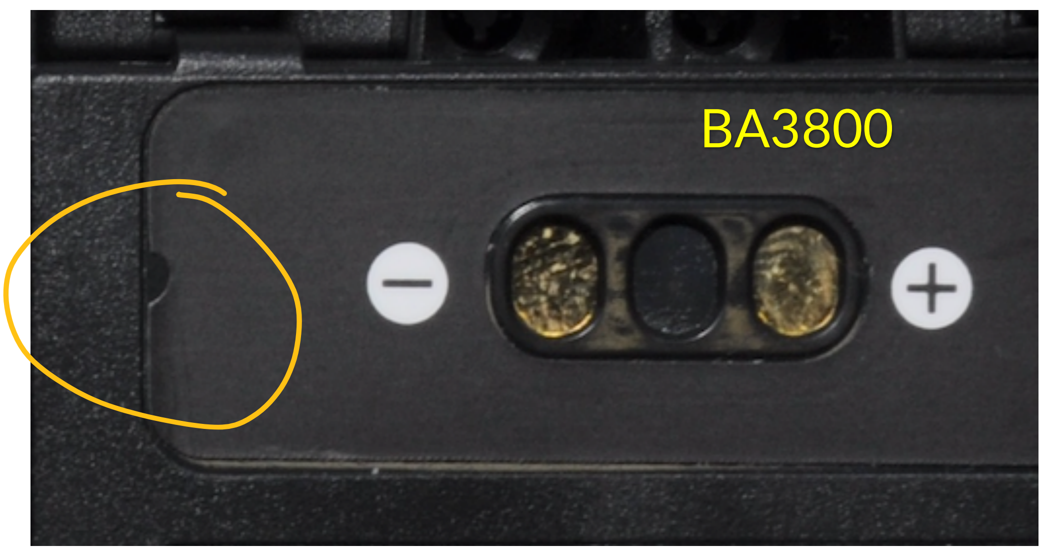

Figure 12 Blow-up of BA3800

Usability

I found that the larger BA3800 battery isn’t that bad. It makes the HT a bit heavier but it’s nice knowing I have a solid day of operation without a recharge. I don’t think I’d recommend using it with the optional (supplied) battery clip. That’s a lot of weight and bulk to be hanging on your belt.

The Yaesu-supplied clip that mates with the radio is a good solution that takes the strain off of the battery/radio retaining clips.

Table 1 Component Weights

Y1800	104g
Y2200	107g
BA3800	126g
FT5 (no battery or antenna)	164g
Yaesu antenna	27g

Thus, an FT5 with antenna and the Y2200 battery weighs 298g. Using the BA3800 increases the weight to 317g, a gain of about 6%. Not bad for a 75% increase in capacity (16 vs 25.1 Wh from the label). You’ll also find that the cost per watt-hour is less than the BA2270 and certainly less than the Y2200.

Part 3 Power Consumption

Power consumption tests are done by connecting the radio to a variable power supply via an DVM used as a current meter. The power is connected to the EXT DC input on the radio, when available. Radio “off” current is measured directly at the battery terminals using the same setup.

A constant basis current is established by selecting a minimum set of features that results in no variation in current. Each feature is enabled, and the new current is measured. The difference between the basis and the feature enabled current is then calculated and presented.

For each test, except where noted, the power supply is adjusted such that the voltage displayed on the radio is 8.0V. This is done to compensate for IR drop in the test cables.

Transmitter tests measure output as measured by a Bird wattmeter terminated by a 50-ohm, 1 GHz dummy load. Connection to the Bird is done via approximately 16” of RG-174 coax which has some loss. The values presented are those read by the Bird without compensation for the connecting cable. RG-174 has a loss of about 19 dB / 100’ at 450 MHz. Therefore, 16” will have a loss of about 0.25 dB or about 6 %.

The transmitter measurements include an analysis of output versus voltage to determine the impact of battery voltage on transmitter output.

Readings displayed as mA were measured by a Fluke 77 meter using the 300 mA inputs (higher resistance). Readings displayed as A were measured by the same meter using the 10 A inputs.

Test frequencies are VHF: 146.52, UHF: 446.500.

Table 2 looks at receiver current. The FT70D's Rx Save feature allows the receiver to periodically check the channel for activity, leaving the receiver off for a variable amount of time. If 1:1 is selected, the receiver is off for 50% of the time. For example, if 1:2 is selected, the Rx is on for 200 ms and off for 400 ms. Thus, the average UHF standby current over 600 ms would be (71.1 *2) + (128 * 1) / 3 = 90.5 mA.

Note that the 200 ms Rx Save interval implies that the FT70D scans at 5 channels/sec. This is typical for prior radios.

Table 2 FT70 Rx Current

Test	Current (mA)	Notes
VHF Rx Save	72.6	
UHF Rx Save	71.7	Value used as basis
VHF Rx Save Off	120.0	
UHF Rx Save Off	128.0	
UHF Rx Receiving FM	141.8	No audio
UHF Rx Receiving DN	149.9	

When the radio receives an FM signal on UHF, the current increases to 141.8 mA. Thus, it takes about 13.8 mA to turn on the audio amplifier. DN mode requires use of the DSP. Thus, it takes about 8.1 mA to run the DSP when digital is being used. This is amazingly low considering what the DSP is doing.

Similarly, the "flashlight" feature requires 190.8 mA or an additional

Table 3 shows the current required by certain features. The Off current is the amount of current consumed from the battery when the HT is switched off. For example, the HT will require 94 mAh from the battery if it is left off for a week.

Table 3 FT70D Feature Currents

Feature	Current	Notes
LED "Flashlight"	63 mA	
Off Current	0.56 mA	Measured at battery terminals
LCD Backlight	35 mA	
DN Mode	8.1 mA	Use of DSP for digital

Table 4 provides current and data on the transmitter function. The radio was remarkably good at maintaining full power output with low battery voltage. Prior radios (FT1, FT2, etc.) were not this good. The Tx current would increase as the voltage dropped implying that there was some active compensation for dropping input voltage.

The Tx function is not very efficient. For example, on UHF high power, the radio consumes 14.2 watts to produce 3.4 watts output. An overall efficiency of 23% on UHF and 39% on VHF.

Clearly this radio did not meet the 5W specification on UHF. It should be noted that there is a potential defect with this radio where at higher powers it produces spurious outputs exceeding FCC regulations.

Table 4 FT70D Transmitter Current

Test @ 8.0 V	**Current VHF / Power Output**	**Current UHF / Power Output**
Tx Low	0.47 A / 0.3 W	0.62 A / 0.4 W
Tx Mid	0.82 A / 1.9 W	1.14 A / 1.6 W
Tx High	1.41 A / 4.65 W	1.78 A / 3.4W
Tx High @ 7.0 V	4.4 W	3.2 W

FT5D

Table 5Table 2 looks at receiver current. The FT5D's Rx Save feature allows the receiver to periodically check the channel for activity, leaving the receiver off for a variable amount of time. If 1:1 is selected, the receiver is off for 50% of the time. For example, if 1:4 is selected, the Rx is on for 50 ms and off for 200 ms. Thus, the average UHF standby current would be (77.6 *4) + (131 * 1) / 5 = 88.3 mA. Note that a 1:2 setting will guarantee that a DN mode key-up will decode the callsign information. Longer intervals reduce that likelihood.

Note that the minimum Rx Save interval implies that the FT5D can scan at a rate of 20 channels/sec. This is much faster than any prior radio implying that a significant design change was made in the FT5D's receiver. One consequence of this is that a much higher Rx Save ratio can be used thus reducing battery drain.

Table 5 FT5D Rx Current

Test	**Current (mA)**	**Notes**
VHF Rx Save	79	Estimated
UHF Rx Save	77.6	
VHF Rx Save Off	126	
UHF Rx Save Off	131	
UHF Rx Receiving FM	129	Sq Open, no audio
Dual UHF Rx	156.8	
UHF Rx Receiving DN	134.5	No audio
Band B Rx	+2 mA	More than band A

It appears that the FT5D uses a different audio amplifier since a squelch open condition does not increase current. DN mode requires use of the DSP. Thus, it takes about 3.5 mA to run the DSP when digital is being used. This is amazingly low considering what the DSP is doing and appears to be lower than all previous radios. The implication is that Yaesu has switched to a more power efficient DSP for the vocoder.

Table 6 shows the current required by certain features. The Off current is the amount of current consumed from the battery when the HT is switched off. For example, the HT will require 77 mAh from the battery if it is left off for a week.

Table 6 FT5D Feature Currents

Feature	**Current**	**Notes**
GPS	17 mA	
GPS on w/display		Display updates consume more power – not measured
Bluetooth on	2.5 mA	
Bluetooth searching	9 mA	
Bluetooth connected	7 mA	
Display Brightness = 1	3 mA	
Display Brightness = 2	10 mA	
Display Brightness = 3	18 mA	
Display Brightness = 4	25 mA	
Display Brightness = 5	32 mA	
Display Brightness = 6	43 mA	
EQ Audio	0 mA	
DN mode	7.5 mA	Use of the DSP
Radio off	0.46 mA	

Table 7 summarizes power used to produce audio output. A DTMF '6' is transmitted by another Yaesu radio using FM to produce a reference level. (Note that Yaesu radios are calibrated to produce the same levels for DTMF.) Volume settings are approximate.

Table 7 FT5 Audio Output Power

Volume Level	**Current (A)**	**Notes**
0 %	0.14	
25 %	0.18	
50 %	0.24	
75 %	0.32	
100 %	0.41	

Table 8 provides current and data on the transmitter function. The radio was remarkably good at maintaining full power output with low battery voltage. Prior radios (FT1, FT2, etc.) were not this good.

The Tx function is not very efficient. For example, on UHF high power, the radio consumes 14.4 watts to produce 4.5 watts output. An overall efficiency of 31% on UHF and 38% on VHF.

Table 8 FT5D Transmitter Current

Test @ 8.0 V	**Current VHF / Power Output**	**Current UHF / Power Output**
Low 1	0.44 A / 0.3 W	0.52 A / 0.3 W
Low 2	0.62 A / 0.8 W	0.71 A /
Low 3	0.99 A / 2.4 W	1.17 A / 2.2 W
High	1.47 A / 4.5 W	1.80 A / 4.5 W
High, diff voltage	4.05 W @ 7.4 V	2.8 W @ 7.0 V

Charging

Surprisingly the radio DOES charge the battery when connected to external power with the radio on.

Table 9 shows current with a battery charged to 7.2 V attached. The increase in power with voltage implies that a series, resistor rather than a buck converter, is being used to limit current. The radio's CPU is likely using some of the current, so the actual battery charging current will be less.

Yaesu's manual says that it takes about 9 hours to charge the battery when connected to the SAD-25 charger (12 V). Charing a 2200 mAh battery takes about 15 % extra current because of inefficiencies during charging. From 2530 mAh is required over 9 hours, we can calculate that the radio is intended to charge the battery at about 281 mA. This agrees well with the measurement. The CD-41 desk charger is estimated at 5 hours, producing an estimate of about 500 mA.

Table 9 FT5D Charging Current / Power

Voltage	**Current (A)**	**Power (W)**
9.2	0.17	1.5
10.5	0.27	2.8
12.0	0.31	3.7
14.2	0.33	4.6