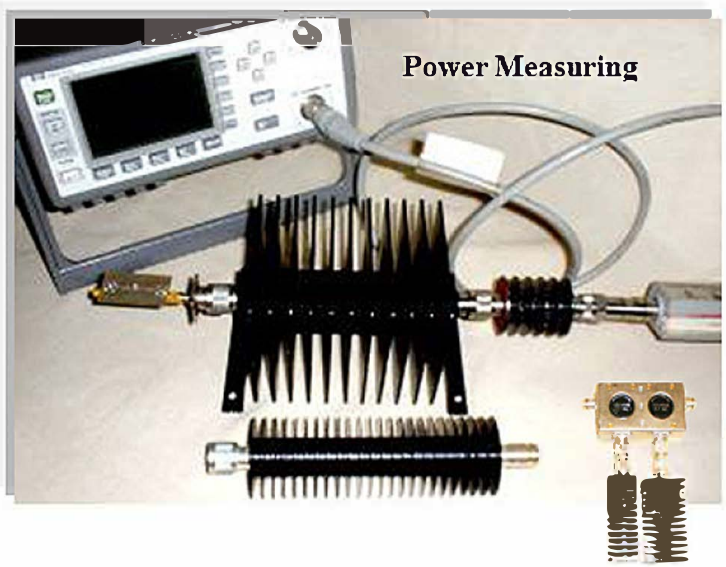
Power vs. Heat
Capacitor Characterizations



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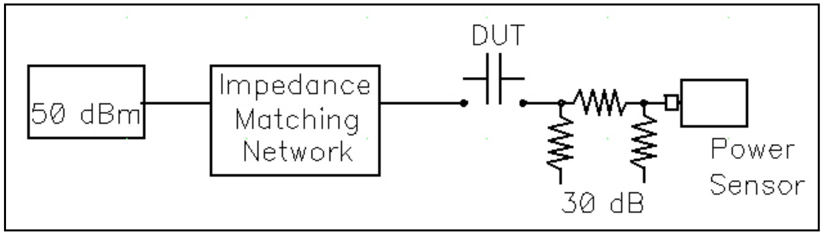
Power vs. Heat Capacitor Characterizations

Part Number

_____/ **0402**

7.5 pf

Series 3 *(qty 12)* 0603, 0805, 1210	**Series 2** *(qty 13)* 2325, 3739	**Series 1** *(qty 12)* 0402, 0603, 0805, 1210



Test Frequency MHz	Calculated Impedance	Input Power	Power Through DUT	Calculated Current	Failure	Temperature Δ° C / Notes
2	10.6 KΩ	+49 dBm	+23 dBm	0.02 amps	survived	temperature rise < 0.2 C
10	2.1 KΩ	+50 dBm	+34 dBm	0.22 amps	survived	temperature rise < 0.2 C
13.56	1.5 KΩ	+50 dBm	+35.5 dBm	0.25 amps	survived	temperature rise < 0.2 C
30	700 Ω	+50 dBm	+39 dBm	0.41 amps	survived	temperature rise < 0.2 C
64	330 Ω	+50 dBm	+42 dBm	0.60 amps	survived	temperature rise 0.6 C
128	165 Ω	+50 dBm	+44 dBm	0.77 amps	survived	temperature rise 1.0 C
250	84 Ω	+50 dBm	+47 dBm	1.05 amps	survived	temperature rise 2.2 C
500	42 Ω	+50 dBm	+48 dBm	1.15 amps	survived	temperature rise 5.5 C
1000	23.5 Ω	+50 dBm	+44 dBm	0.77 amps	survived	temperature rise 20.0 C
2400	8.8 Ω	+46 dBm	+41 dBm	0.52 amps	survived	temperature rise 16.8 C

Testing Notes:
Impedance matching the 10.6K Ohm part into a 50-Ohm system netted significant loss. In this case of the 7.5 pf capacitor, 26 dB, or about 99.75% of the power at the 2 MHz test frequency was lost. Whereby, the 1 pf capacitor has a 2 MHz impedance of 80 KΩ and thus may not be practical to test in this manner. See Nominal Picofarad Parts note at section conclusion.

Testing Notes: 0402 Components

In testing the 7.5, 10 and 12 pf components, a temperature rise of about 5° C per amp of RF current was measured.   This testing is limited due to the low currents below 500 MHz, and the DUT temperature rise being highly dependent on test fixturing.

The 0402 chip capacitors were replaced with a 16-Ohm 0402 resistor, and temperature rise versus DC watts were recorded. COMPET. literature notes that an "Infinite Heat Sink Test Fixture" was used in their measurements.   While not "Infinite," it is notable that the test fixture used was able to dissipate 2-watts from the 0402 resistor.

The infrared thermometer used for the below reads in 0.2° C increments.

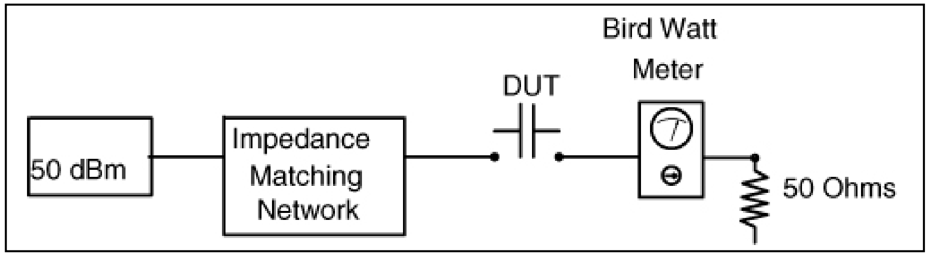
Test Fixture temperature rise vs. DC Watts

Temperature Rise ° C	Watts
4.0	0.075
8.0	0.14
10.4	0.225
14.0	0.34
20	0.46
30	0.60
40	0.77
52	1.00
72	1.31
85	1.50
100	1.75
110	2.00
145	2.15 failed open

In general, the electronics industry thermally designs to keep all components below 60° C. For the 12 pf component, a temperature rise of 30° C would require approximately 6 amps of current. Even at 500 MHz, this would necessitate nearly 150-volts across a component with a typical 25-volt rating. It is safe to say that with virtually all applications below 500 MHz, and with capacitance below 100 pf, the primary failure mode will be voltage break down, not RF current.

Part Number

4.7 pf / case 2325

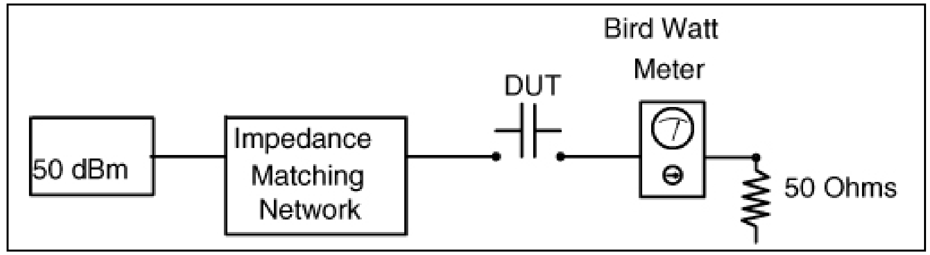


Test Frequency MHz	Calculated Impedance	Input Power	Power Through DUT	Calculated Current	Failure	Temperature ∆° C / Notes
2	16.9 KΩ	+50 dBm	+20 dBm	0.01amps	survived	temperature rise < 0.2 C
10	3.4 KΩ	+50 dBm	+33 dBm	0.20 amps	survived	temperature rise < 0.2 C
13.56	2.5 KΩ	+50 dBm	+34 dBm	0.22 amps	survived	temperature rise < 0.2 C
30	1.1 KΩ	+50 dBm	+35.5 dBm	0.25 amps	survived	temperature rise < 0.2 C
64	530 Ω	+52 dBm	+41 dBm	0.52 amps	survived	temperature rise < 0.2 C
128	260 Ω	+50 dBm	+42 dBm	0.60 amps	survived	temperature rise < 0.2 C
250	135 Ω	+50 dBm	+ 43 dBm	0.68 amps	survived	temperature rise < 0.2 C
500	68 Ω	+50 dBm	+ 46 dBm	0.92 amps	survived	temperature rise < 0.2 C

Testing Notes:
30 dB Attenuator and Power Sensor replaced with Bird Watt Meter and 1000-watt load.
Due to the high reactance of this component, input power had to be restricted.

Part Number

10 pf / case 3739



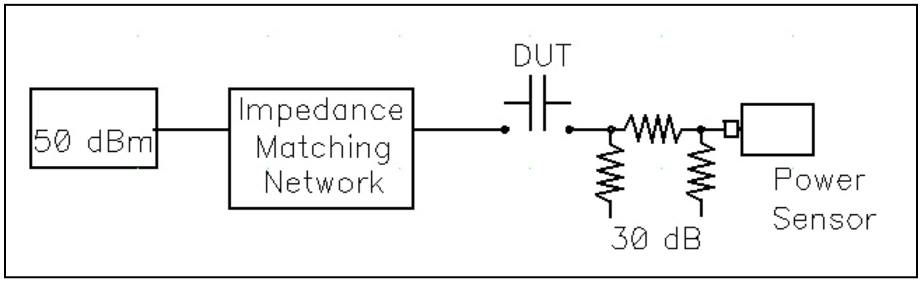
Test Frequency MHz	Calculated Impedance	Input Power	Power Through DUT	Calculated Current	Failure	Temperature Δ° C / Notes
2	8.0 KT	+49 dBm	+22 dBm	0.015 amps	survived	temperature rise < 0.2 C
10	1.6 KT	+55 dBm	+38 dBm	0.35 amps	survived	temperature rise < 0.2 C
13.56	1.2 KT	+55 dBm	+39 dBm	0.41 amps	survived	temperature rise < 0.2 C
30	530 T	+56 dBm	+44 dBm	0.77 amps	survived	temperature rise < 0.2 C
64	250 T	+53 dBm	+45 dBm	0.85 amps	survived	temperature rise < 0.2 C
128	125 T	+54 dBm	+49 dBm	1.50 amps	survived	temperature rise < 0.2 C
250	63 T	+50 dBm	+46 dBm	0.92 amps	survived	temperature rise < 0.2 C
500	32 T	+50 dBm	+48 dBm	1.15 amps	survived	temperature rise < 0.2 C

Testing Notes:

- 30 dB Attenuator and Power Sensor replaced with Bird Watt Meter and 1000-watt load.
- At one point, a significant temperature rise was detected at 10 MHz. This erroneous reading was due to infrared reflections of the lab's florescent lighting bouncing off of the aluminum test fixture.
- An additional higher power attempt was made at 128 MHz. While trying to raise power up to +60 dBm, the SMA connectors used in the test fixture failed at +55-56 dBm.

Comparison Testing

To eliminate variations in the Impedance Matching Network during comparison testing, whenever the amplifier had enough spare gain the Power through the DUT was adjusted for 50 dB.



Part Numbers
SERIES 3-A 100 pf & COMPET.-______

Manuf.	Test Frequency MHz	Calculated Impedance	Input Power	Power Through DUT	Calculated Current	Temperature Δ° C / Notes Rise
CLIENT	**13.56**	**117 T**	**+50 dBm**	**+46 dBm**	**0.92 amps**	**> 0.2 C**
COMPET.	13.56	117 T	+50 dBm	+46 dBm	0.92 amps	> 0.2 C
CLIENT	**30**	**53 T**	**+50 dBm**	**+47 dBm**	**1.05 amps**	**0.4 C**
COMPET.	30	53 T	+50 dBm	+47 dBm	1.05 amps	0.2 C
CLIENT	**64**	**25 T**	**+50 dBm**	**+48 dBm**	**1.15 amps**	**0.6 C**
COMPET.	64	25 T	+50 dBm	+48 dBm	1.15 amps	0.6 C
CLIENT	**128**	**12 T**	**+50 dBm**	**+49 dBm**	**1.4 amps**	**1.0 C**
COMPET.	128	12 T	+50 dBm	+50 dBm	1.5 amps	1.2 C
CLIENT	**250**	**6.3 T**	**+50 dBm**	**+50 dBm**	**1.55 amps**	**2.8 C**
COMPET.	250	6.3 T	+50 dBm	+50 dBm	1.5 amps	2.6 C
CLIENT	**500**	**3.1 T**	**+50 dBm**	**+49 dBm**	**1.55 amps**	**7.2 C**
COMPET.	500	3.1 T	+50 dBm	+49 dBm	1.5 amps	7.2 C
CLIENT	**1000**	**1.6 T**	**+50 dBm**	**+44 dBm**	**0.77 amps**	**16.0 C**
COMPET.	1000	1.6 T	+50 dBm	+44 dBm	0.77 amps	15.2 C
CLIENT	**2400**	**0.66 T**	**+46 dBm**	**+41 dBm**	**0.52 amps**	**14.8 C**
COMPET.	2400	0.66 T	+46 dBm	+41 dBm	0.52 amps	13.6 C

Conclusion: Up to 2400 MHz, parts are functionally identical. Loss/Temperature rise difference well within measurement uncertainties.

Part Numbers
SERIES 3-B 470 pf & COMPET.-______

Manuf.	Test Frequency MHz	Calculated Impedance	Input Power	Power Through DUT	Calculated Current	Temperature Rise △° C / Notes
CLIENT	**13.56**	**25 T**	**+50 dBm**	**+48 dBm**	**1.15 amps**	**< 0.2 C**
COMPET.	13.56	25 T	+50 dBm	+48 dBm	1.15 amps	< 0.2 C
CLIENT	**30**	**11 T**	**+50 dBm**	**+50 dBm**	**1.55 amps**	**< 0.2 C**
COMPET.	30	11 T	+50 dBm	+50 dBm	1.55 amps	< 0.2 C
CLIENT	**64**	**5.3 T**	**+50 dBm**	**+50 dBm**	**1.55 amps**	**< 0.2 C**
COMPET.	64	5.3 T	+50 dBm	+50 dBm	1.55 amps	0.2 C
CLIENT	**128**	**2.6 T**	**+50 dBm**	**+50 dBm**	**1.55 amps**	**0.8 C**
COMPET.	128	2.6 T	+50 dBm	+50 dBm	1.55 amps	1.2 C
CLIENT	**250**	**1.4 T**	**+50 dBm**	**+50 dBm**	**1.55 amps**	**2.2 C**
COMPET.	250	1.4 T	+50 dBm	+50 dBm	1.55 amps	2.2 C
CLIENT	**500**	**0.7 T**	**+50 dBm**	**+48.5 dBm**	**1.4 amps ***	**8.6 C**
COMPET.	500	0.7 T	+50 dBm	+48.5 dBm	1.4 amps *****	9.4 C
CLIENT	**1000**	**0.34 T**	**+50 dBm**	**+44 dBm**	**0.77 amps**	**17.6 C**
COMPET.	1000	0.34 T	+50 dBm	+44 dBm	0.77 amps	17.0 C
CLIENT	**2400**	**0.14 T**	**+46 dBm**	**+41 dBm**	**0.52 amps**	**15.8 C**
COMPET.	2400	0.14 T	+46 dBm	+41 dBm	0.52 amps	15.6 C

* There was evidence of self-resonance in the test fixture with these components. Thus, the actual current could well be higher than the calculated 1.4 amps. Temperature rise difference could easily be the result of minor variations of capacitance and the components position on the resonance curve. Q of the resonance was not determined.

Conclusion: Up to 2400 MHz, parts are functionally identical. Loss/Temperature rise difference well within measurement uncertainties.

RECEIVED PARTS INVENTORY

Series 3 *(qty 12)* 0603, **(0605) 0805**, 1210	**Series 2** *(qty 13)* 2325, 3739	**Series 1** *(qty 11)* 0402, 0603, 0805, 1210
13.56, 30, 64, 128, 250, 500, 1000 & 2400 MHz	2,10, 13.56, 30, 64, 128, 250, 500 MHz	13.56, 30, 64, 128, 250, 500, 1000 & 2400 MHz

5th Character	6th Temp Coefficient	7-9 Capacitance	10th Tolerance	11th	12th Termination Code	Remaining
1=100 volts 3=25 5=50 Y=16 Z=10	J= High-perf. K=Norm-perf.	1R0=1.0 7R5=7.5 100=10 102=1000	18 Types	A=Accu-F B=Series 1	Solder contents	TR=Tape & Reel Otherwise loose

Following 5-page part itemization omitted...