AE0AM T41 BPF Filter Design Notes

1) All filters were re-simulated in ELSIE using AI6YM kit capacitor values (which differ slightly from K9HZ values, as shown below). Resulting inductances are shown below:

BPF Inductor	From Elsie (C's as built)* Inductance (uH)	BPF Inductor	From Elsie (C's as built)* Inductance (uH)	BPF Inductor	From Elsie (C's as built) Inductance (uH)
L091	2.1700	L201	0.4129	L401	0.1665
L092	12.0000	L202	2.7520	L402	1.2730
L093	1.2200	L203	0.2477	L403	0.0955
L094	12.0000	L204	2.7520	L404	1.2730
L095	2.1700	L205	0.4129	L405	0.1665
L101	1.0000	L291	0.2471	L501	0.1133
L102	6.0000	L292	3.6340	L502	0.7910
L103	0.6000	L293	0.1305	L503	0.0667
L104	6.0000	L294	3.6340	L504	0.7910
L105	1.0000	L295	0.2471	L505	0.1133
L191	0.7350	L301	0.1693	L601	0.0360
L192	4.5200	L302	1.6930	L602	0.6670
L193	0.3525	L303	0.0977	L603	0.0200
L194	4.5200	L304	1.6930	L604	0.6670
L195	0.7350	L305	0.1693	L605	0.0390
	* C92,C96 = 3.2nf (on AI6YM RF Board) (these are 3.1nf on K9HZ RF Board)		* C294 = 1.9nf (on AI6YM RF Board) (this is shown as 1.6nf on K9HZ RF Board)		

2) ARRL and *Toroid.Info* toroid material recommended frequency ranges and tolerances were taken into consideration, as shown below.

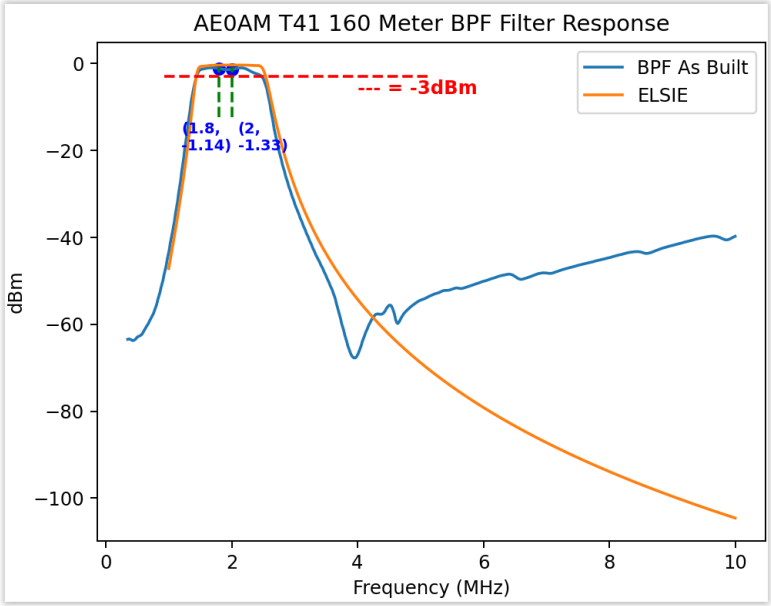
Type	Recommended Freq. Range** Toroids.Info	(2018 ARRL)	Average AL	Tolerance Pct. (+)	Tolerance Pct. (-)	Rec. Freq. Min	Rec. Freq. Max	Color	OD	ID	Height
FT37-61	.2 MHz - 10 MHz	(.2M-10M)	55.300	25%	25%	.2 MHz	10 MHz	Dull Black	0.375	0.187	0.125
FT37-67	.5 MHz - 30 MHz	(15M-25M)	17.600	35%	25%	.5 MHz	30 MHz	Dull Black	0.375	0.187	0.125
T37-0	50 MHz - 300 MHz	(100M - 300M)	0.490	5%	5%	50 MHz	300 MHz	Tan/Tan	0.375	0.205	0.128
T37-1	150 KHz - 3 MHz	(.5M-5M)	8.000	10%	10%	.15 MHz	3 MHz	Blue/Clear	0.375	0.205	0.128
T37-10	15 MHz - 100 MHz	(30M - 100M)	2.500	5%	5%	15 MHz	100 MHz	Black/Clear	0.375	0.205	0.128
T37-17	20 MHz - 200 MHz	(40M - 180M)	1.500	5%	5%	20 MHz	200 MHz	Blue/Yellow	0.375	0.205	0.128
T37-2	250 KHz - 10 MHz	(2M- 30M)	4.000	5%	5%	.25 MHz	10 MHz	Red/Clear	0.375	0.205	0.128
T37-6	3 MHz - 40 MHz	(10M - 50M)	3.000	5%	5%	3 MHz	40 MHz	Yellow/Clear	0.375	0.205	0.128
T37-7	1 MHz - 25 MHz	(7M - 35M)	3.200	5%	5%	1 MHz	25 MHz	White/Clear	0.375	0.205	0.128
T50-0	50 MHz - 300 MHz	(100M - 300M)	0.640	5%	5%	50 MHz	300 MHz	Tan/Tan	0.375	0.205	0.128
T50-1	150 KHz - 3 MHz	(.5M-5M)	10.000	10%	10%	.15 MHz	3 MHz	Blue/Clear	0.375	0.205	0.128
T50-10	15 MHz - 100 MHz	(30M - 100M)	3.100	5%	5%	15 MHz	100 MHz	Black/Clear	0.375	0.205	0.128
T50-17	20 MHz - 200 MHz	(40M - 180M)	1.800	5%	5%	20 MHz	200 MHz	Blue/Yellow	0.375	0.205	0.128
T50-2	250 KHz - 10 MHz	(2M- 30M)	4.900	5%	5%	.25 MHz	10 MHz	Red/Clear	0.375	0.205	0.128
T50-6	3 MHz - 40 MHz	(10M - 50M)	4.000	5%	5%	3 MHz	40 MHz	Yellow/Clear	0.375	0.205	0.128
T50-7	1 MHz - 25 MHz	(7M - 35M)	4.300	5%	5%	1 MHz	25 MHz	White/Clear	0.375	0.205	0.128
T68-1	150 KHz - 3 MHz	(.5M-5M)	11.500	10%	10%	.15 MHz	3 MHz	Blue/Clear	0.69	0.37	0.19
T68-10	15 MHz - 100 MHz	(30M - 100M)	3.200	5%	5%	15 MHz	100 MHz	Black/Clear	0.69	0.37	0.19
T68-17	20 MHz - 200 MHz	(40M - 180M)	2.100	5%	5%	20 MHz	200 MHz	Blue/Yellow	0.69	0.37	0.19
T68-2	250 KHz - 10 MHz	(2M- 30M)	5.700	5%	5%	.25 MHz	10 MHz	Red/Clear	0.69	0.37	0.19
T68-6	3 MHz - 40 MHz	(10M - 50M)	4.700	5%	5%	3 MHz	40 MHz	Yellow/Clear	0.69	0.37	0.19
T68-7	1 MHz - 25 MHz	(7M - 35M)	5.200	5%	5%	1 MHz	25 MHz	White/Clear	0.69	0.37	0.19
	**(FT values are for when toroid used as high-Q inductor)										

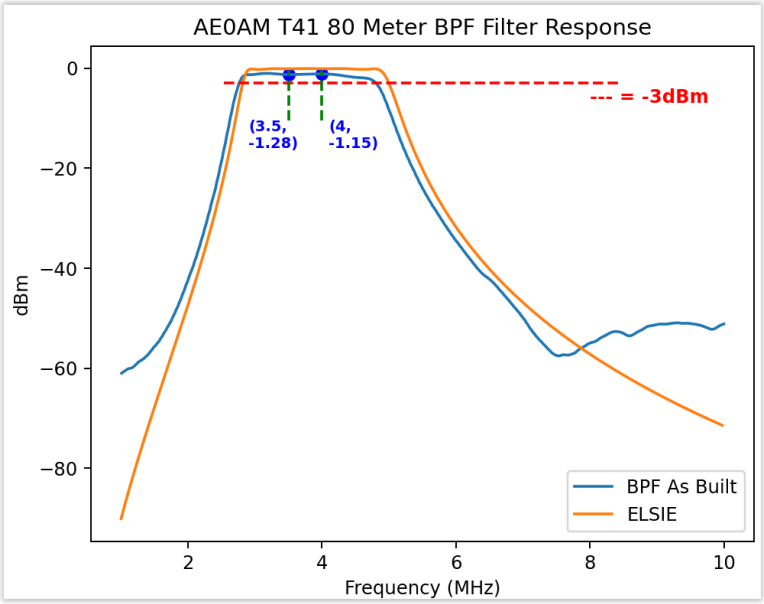
3) No Type 0 (phenolic) material toroids were used.
4) Air core coils were used for all very small values of inductance.
5) All toroids were wound with 28 gauge wire. Heavier gauge (22 or 24) was used for air core inductors.

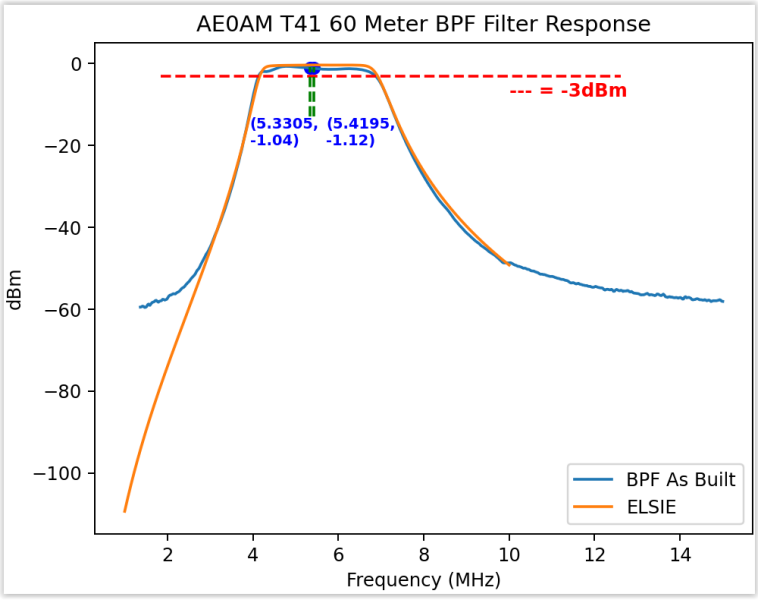
6) All inductor values were checked with LCR meter and “pre-tuned” prior to insertion. In some cases a turn had to be added or removed from the calculated number in order to obtain a better value.
7) Filter as a whole was then tuned until loss was less than at least 3 dBm for entire range.
8) Filter performance was measured with calibrated and normalized DSA832-TG spectrum analyzer, then saved to thumb drive.
9) Filter ELSIE simulated vs. measured performance was displayed using custom Python program.
10) Design details and resulting performance are shown below.

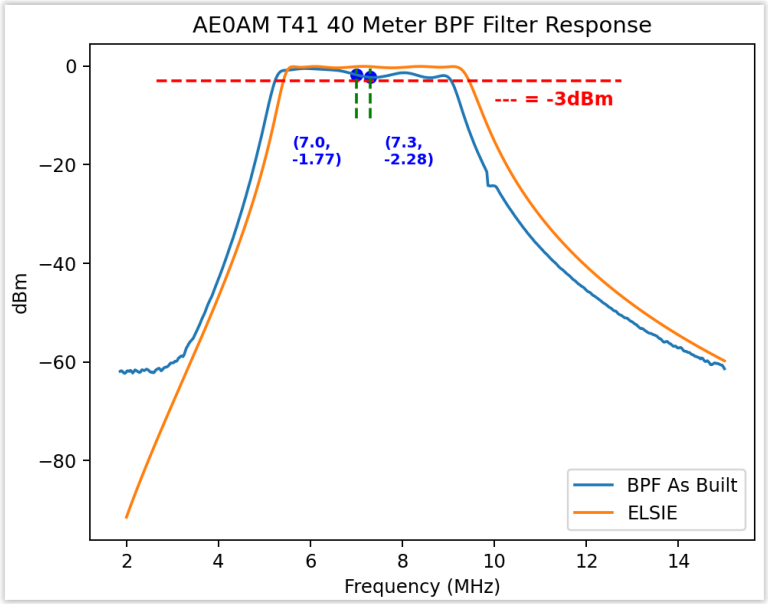
AE0AM T41 V12.6 BPF Inductors

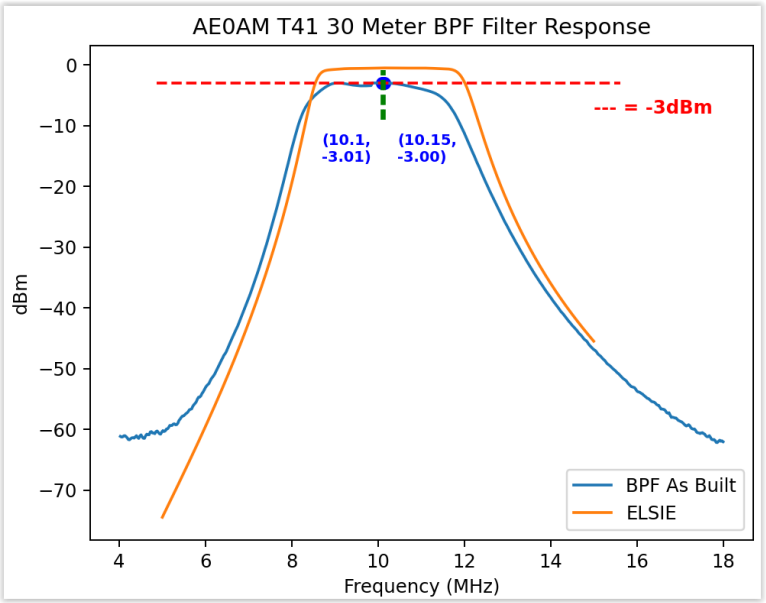
Band	BPF Inductor	From Elsie (C's as built) Inductance (uH)	Center Mhz	Toroid	Toroid Material Color	As Built & Measured (& corrected) Turns	Approx Wire Length (in.)	Enamel Wire Gauge
160	L091	2.1700	1.9	T37-7	White/Clear	26	14	28
	L092	12.0000		FT37-67	Dull Black	26	17	28
	L093	1.2200		T37-1	Blue/Clear	12	8	28
	L094	12.0000		FT37-67	Dull Black	26	17	28
	L095	2.1700		T37-7	White/Clear	26	16	28
80	L101	1.0000	3.75	T37-2	Red/Clear	16	10	28
	L102	6.0000		FT37-67	Dull Black	19	12	28
	L103	0.6000		T37-6	Yellow/Clear	14	9	28
	L104	6.0000		FT37-67	Dull Black	19	12	28
	L105	1.0000		T37-2	Red/Clear	16	10	28
60	L191	0.7350	5.3585	T37-7	White/Clear	14	9	28
	L192	4.5200		FT37-67	Dull Black	16	11	28
	L193	0.3525		T37-6	Yellow/Clear	11	7	28
	L194	4.5200		FT37-67	Dull Black	16	11	28
	L195	0.7350		T37-7	White/Clear	14	9	28
40	L201	0.4129	7.15	T37-2	Red/Clear	10	6	28
	L202	2.7520		T37-2	Red/Clear	26	16	28
	L203	0.2477		T37-6	Yellow/Clear	9	6	28
	L204	2.7520		T37-2	Red/Clear	26	16	28
	L205	0.4129		T37-2	Red/Clear	10	6	28
30	L291	0.2471	10.125	T37-6	Yellow/Clear	9	6	28
	L292	3.6340		T37-7	White/Clear	34	21	28
	L293	0.1305		Air Core Coil	5 turns; .25" form; ~1/4" long	5	5	22
	L294	3.6340		T37-7	White/Clear	34	21	28
	L295	0.2471		T37-6	Yellow/Clear	9	6	28
20	L301	0.1693	14.175	Air Core Coil	6 turns; .25" form; ~1/4+" long	6	6	22
	L302	1.6930		T37-7	White/Clear	23	14	28
	L303	0.0977		Air Core Coil	6 turns; 3/16" form; ~1/2" long	6	5	24
	L304	1.6930		T37-7	White/Clear	23	14	28
	L305	0.1693		Air Core Coil	6 turns; .25" form; ~1/4+" long	6	6	22
17/15	L401	0.1665	19.759	Air Core Coil	6 turns; .25" form; ~1/4+" long	6	6	22
	L402	1.2730		T37-7	White/Clear	20	12	28
	L403	0.0955		Air Core Coil	6 turns; 3/16" form; ~3/16+" long	6	5	24
	L404	1.2730		T37-7	White/Clear	20	12	28
	L405	0.1665		Air Core Coil	6 turns; .25" form; ~1/4+" long	6	6	22
12/10	L501	0.1133	27.295	Air Core Coil	5 turns; .25" form; ~1/2" long	5	5	22
	L502	0.7910		T37-17	Blue/Yellow	22	14	28
	L503	0.0667		Air Core Coil	4 turns; 3/16" form; ~3/8" long	5	4	22
	L504	0.7910		T37-17	Blue/Yellow	22	14	28
	L505	0.1133		Air Core Coil	5 turns; .25" form; ~1/2" long	5	5	22
6	L601	0.0360	52	Air Core Coil	3 turns; .25" form; spread coil	3	4	24
	L602	0.6670		T37-17	Blue/Yellow	20	13	28
	L603	0.0200		Air Core Coil	3 turns; 3/16" form; spread coil	3	3	24
	L604	0.6670		T37-17	Blue/Yellow	20	13	28
	L605	0.0390		Air Core Coil	3 turns; .25" form; spread coil	3	4	24

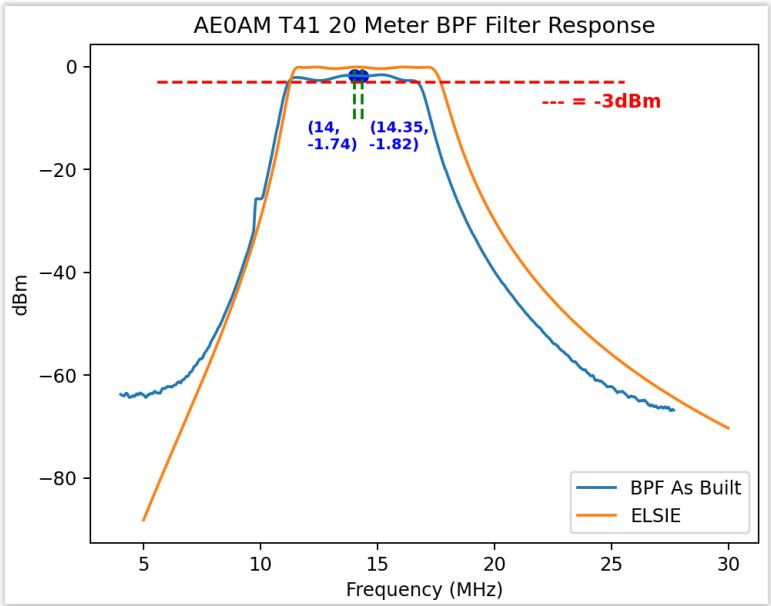

AE0AM T41 160 Meter BPF Filter Response
BPF As Built
ELSIE
--- = -3dBm
(1.8, -1.14)
(2, -1.33)
dBm
Frequency (MHz)

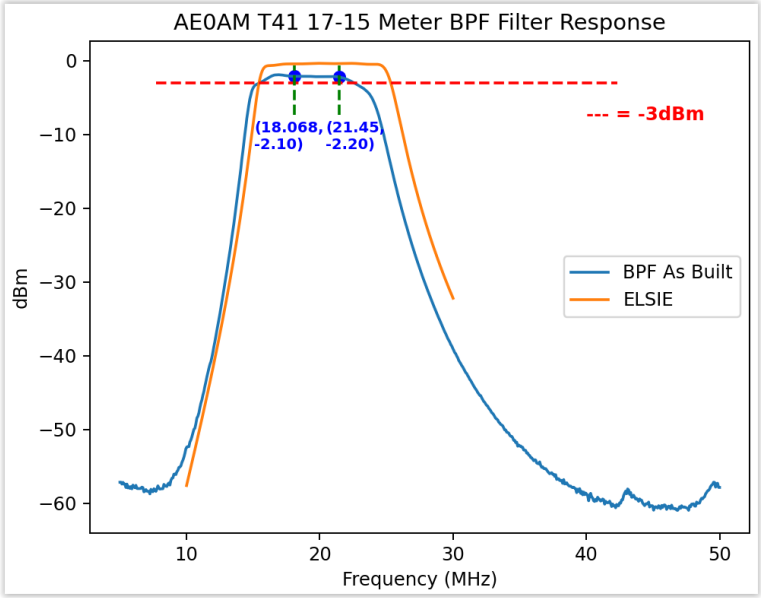

AE0AM T41 80 Meter BPF Filter Response
--- = -3dBm
(3.5, -1.28)
(4, -1.15)
BPF As Built
ELSIE
dBm
Frequency (MHz)

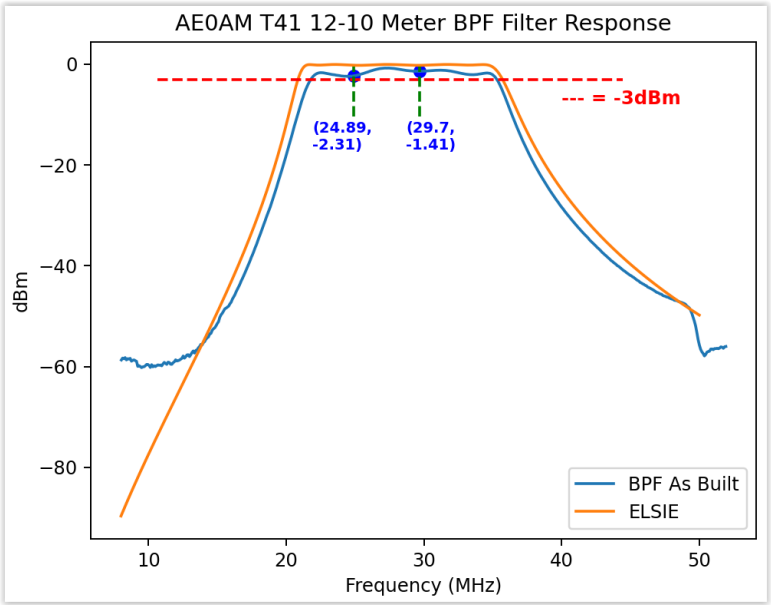

AE0AM T41 60 Meter BPF Filter Response
--- = -3dBm
(5.3305, -1.04)
(5.4195, -1.12)
BPF As Built
ELSIE
dBm
Frequency (MHz)

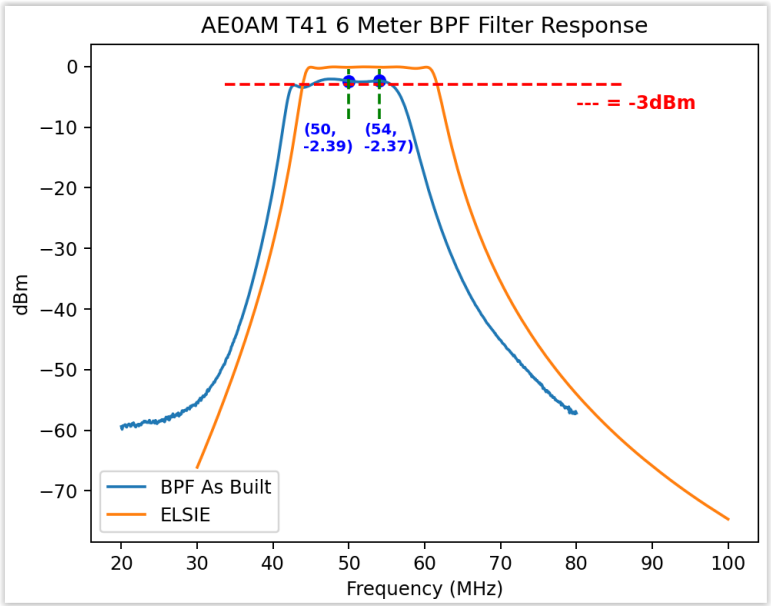

AE0AM T41 40 Meter BPF Filter Response
--- = -3dBm
(7.0, -1.77)
(7.3, -2.28)
BPF As Built
ELSIE
dBm
Frequency (MHz)


AE0AM T41 30 Meter BPF Filter Response
--- = -3dBm
(10.1, -3.01)
(10.15, -3.00)
BPF As Built
ELSIE
dBm
Frequency (MHz)


AE0AM T41 20 Meter BPF Filter Response
--- = -3dBm
(14, -1.74)
(14.35, -1.82)
BPF As Built
ELSIE
dBm
Frequency (MHz)


AE0AM T41 17-15 Meter BPF Filter Response
--- = -3dBm
(18.068, -2.10)
(21.45, -2.20)
BPF As Built
ELSIE
dBm
Frequency (MHz)


AE0AM T41 12-10 Meter BPF Filter Response
--- = -3dBm
(24.89, -2.31)
(29.7, -1.41)
BPF As Built
ELSIE
dBm
Frequency (MHz)


AE0AM T41 6 Meter BPF Filter Response
--- = -3dBm
(50, -2.39)
(54, -2.37)
BPF As Built
ELSIE
dBm
Frequency (MHz)