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Renesas Electronics website: http://www.renesas.com

April 1<sup>st</sup>, 2010 Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

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## Silicon Transistor

# $\mu$ PA833TF

## NPN SILICON EPITAXIAL TRANSISTOR (WITH 2 DIFFERENT ELEMENTS) IN A 6-PIN THIN-TYPE SMALL MINI MOLD PACKAGE

#### **DESCRIPTION**

The  $\mu$ PA833TF has two different built-in transistors (Q1 and Q2) for low noise amplification in the VHF band to UHF band.

#### **FEATURES**

· Low noise

Q1 : NF = 1.7 dB TYP. @ f = 2 GHz,  $V_{CE} = 1$  V,  $I_{C} = 3$  mA Q2 : NF = 1.5 dB TYP. @ f = 2 GHz,  $V_{CE} = 3$  V,  $I_{C} = 3$  mA

· High gain

Q1 :  $|S_{21e}|^2 = 3.5 \text{ dB TYP}$ . @ f = 2 GHz,  $V_{CE} = 1 \text{ V}$ ,  $I_{C} = 3 \text{ mA}$ Q2 :  $|S_{21e}|^2 = 8.5 \text{ dB TYP}$ . @ f = 2 GHz,  $V_{CE} = 3 \text{ V}$ ,  $I_{C} = 10 \text{ mA}$ 

- 6-pin thin-type small mini mold package
- 2 different transistors on-chip (2SC5193, 2SC4959)

#### **ON-CHIP TRANSISTORS**

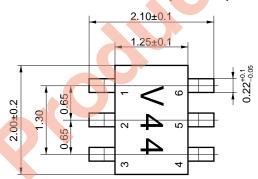
	Q1	Q2
3-pin small mini mold part No.	2SC5193	2SC4959

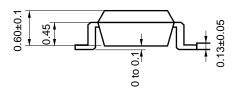
The  $\mu$ PA836TF features the Q1 and Q2 in inverted positions.

#### ORDERING INFORMATION

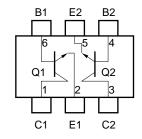
PART NUMBER	QUANTITY	PACKING STYLE
μPA833TF	Loose products (50 pcs)	8-mm wide embossed tape. Pin 6 (Q1 Base), pin 5 (Q2
μPA83 <mark>3TF-T</mark> 1	Taping products (3 kpcs/reel)	Emitter), and pin 4 (Q2 Base) face perforated side of tape.

#### PACKAGE DRAWINGS (Unit:mm)





#### PIN CONFIGURATION (Top View)



#### **PIN CONNECTIONS**

1. Collector (Q1)

4. Base (Q2)

2. Emitter (Q1)

5. Emitter (Q2)

3. Collector (Q2)

6. Base (Q1)

Caution is required concerning excess input, such as from static electricity, because the high-frequency process is used for this device.

The information in this document is subject to change without notice.



#### ABSOLUTE MAXIMUM RATINGS (TA = 25°C)

PARAMETER	SYMBOL	RATING			
PARAMETER	STIVIBOL	Q1	Q2	UNIT	
Collector to base voltage	Vсво	9	9	V	
Collector to emitter voltage	Vceo	6	6	٧	
Emitter to base voltage	VEBO	2	2	V	
Collector current	Ic	100	30	mA	
Total power dissipation	PT	150 in 1 element	150 in 1 element	mW	
		200 in 2 elements <sup>Note</sup>			
Junction temperature	Tj	150	150	°C	
Storage temperature	T <sub>stg</sub>	-65 to	o +150	°C	

Note 110 mW must not be exceeded for 1 element.

(1) Q1

#### **ELECTRICAL CHARACTERISTICS**

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Collector cutoff current	Ісво	Vcb = 5 V, IE = 0			0.1	μΑ
Emitter cutoff current	ІЕВО	V <sub>EB</sub> = 1 V, I <sub>C</sub> = 0			0.1	μΑ
DC current gain	hfe	Vce = 1 V, Ic = 3 mA <sup>Note 1</sup>	100		145	
Gain bandwidth product (1)	f⊤	VcE = 1 V, lc = 3 mA, f = 2 GHz	4.0	4.5		GHz
Gain bandwidth product (2)	fτ	VcE = 3 V, Ic = 20 mA, f = 2 GHz		9.0		GHz
Feedback capacitance	Cre	VCB = 1 V, IE = 0, f = 1 MHz <sup>Note 2</sup>		0.75	0.85	pF
Insertion power gain (1)	S <sub>21e</sub>   <sup>2</sup>	VcE = 1 V, Ic = 3 mA, f = 2 GHz	2.5	3.5		dB
Insertion power gain (2)	S21e  <sup>2</sup>	VcE = 3 V, Ic = 20 mA, f = 2 GHz		6.5		dB
Noise figure (1)	NF	VcE = 1 V, Ic = 3 mA, f = 2 GHz		1.7	2.5	dB
Noise figure (2)	NF	Vce = 3 V, Ic = 7 mA, f = 2 GHz		1.5		dB

**Notes 1.** Pulse measurement: PW  $\leq$  350  $\mu$ s, Duty cycle  $\leq$  2%

2. Collector to base capacitance when measured with capacitance meter (automatic balanced bridge method), with emitter connected to guard pin of capacitance meter.



(2) Q2

#### **ELECTRICAL CHARACTERISTICS**

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Collector cutoff current	Ісво	Vcb = 5 V, IE = 0			0.1	μΑ
Emitter cutoff current	Ієво	V <sub>EB</sub> = 1 V, I <sub>C</sub> = 0			0.1	μΑ
DC current gain	hfe	Vce = 3 V, Ic = 10 mA <sup>Note 1</sup>	75		150	
Gain bandwidth product	f⊤	VcE = 3 V, Ic = 10 mA, f = 2 GHz		12		GHz
Feedback capacitance	Cre	Vcb = 3 V, IE = 0, f = 1 MHz <sup>Note 2</sup>		0.4	0.7	pF
Insertion power gain	S <sub>21e</sub>   <sup>2</sup>	VcE = 3 V, Ic = 10 mA, f = 2 GHz	7	8.5		dB
Noise figure	NF	VcE = 3 V, Ic = 3 mA, f = 2 GHz	•	1.5	2.5	dB

**Notes 1.** Pulse measurement: PW  $\leq$  350  $\mu$ s, Duty cycle  $\leq$  2%

2. Collector to base capacitance when measured with capacitance meter (automatic balanced bridge method), with emitter connected to guard pin of capacitance meter.

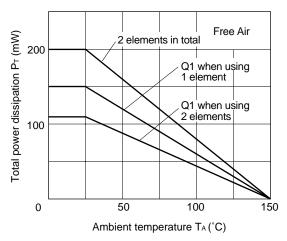
#### **hfe CLASSIFICATION**

Rank	FB
Marking	V44
hre value of Q1	100 to 145
hre value of Q2	75 to 150

#### TYPICAL CHARACTERISTICS (TA = 25°C)

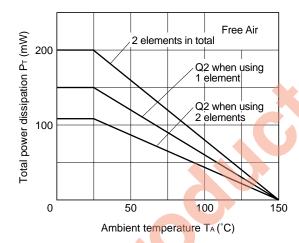
Q1

#### **Total Power Dissipation vs. Ambient Temperature**

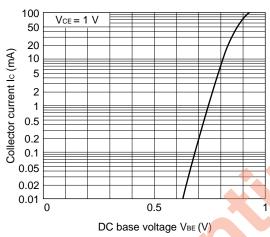


#### Q2

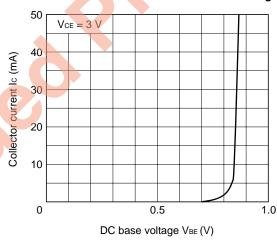
#### **Total Power Dissipation vs. Ambient Temperature**



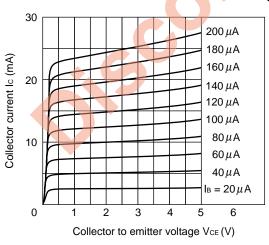
#### Collector Current vs. DC Base Voltage



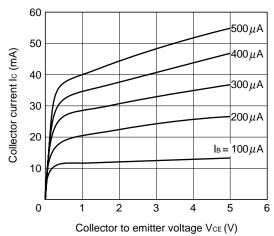
Collector Current vs. DC Base Voltage



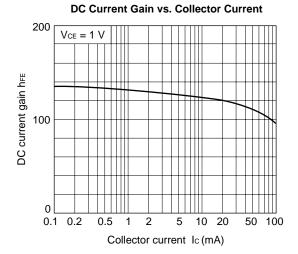
#### Collector Current vs. Collector to Emitter Voltage



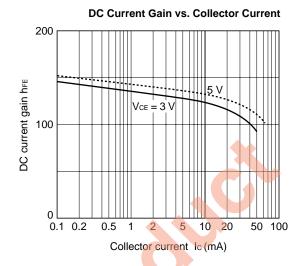
#### Collector Current vs. Collector to Emitter Voltage



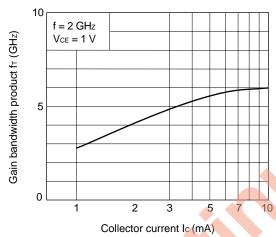
Q1



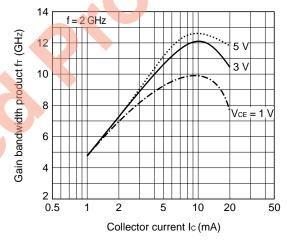
#### Q2



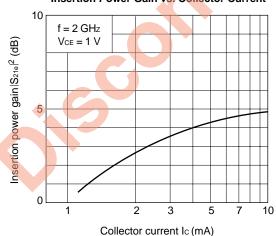
#### Gain Bandwidth Product vs. Collector Current



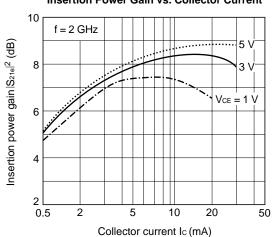
Gain Bandwidth Product vs. Collector Current



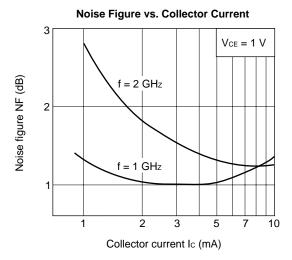
#### Insertion Power Gain vs. Collector Current



Insertion Power Gain vs. Collector Current

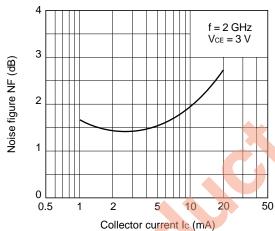


Q1

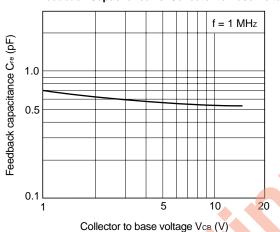


Q2

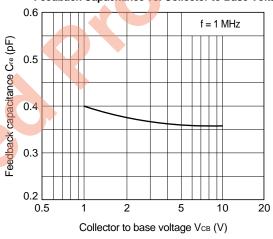
Noise Figure vs. Collector Current



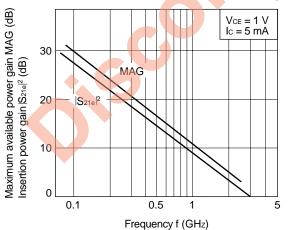
Feedback Capacitance vs. Collector to Base Voltage



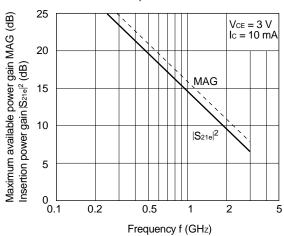
Feedback Capacitance vs. Collector to Base Voltage



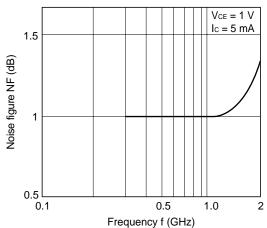
Maximum Available Gain, Insertion Power Gain vs. Frequency



Maximum Available Gain, Insertion Power Gain vs. Frequency



Q1 Noise Figure vs. Frequency





· //	٠							
VcE = 3 V, Ic = 1	$mA, Z_0 =$	$50 \Omega$						
FREQUENCY		S11		S21	S	12		S22
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.97	-14.33	2.43	166.54	.04	80.24	.99	-7.18
.20	.95	-28.67	2.38	154.71	.07	70.60	.97	-13.99
.30	.91	-42.88	2.36	144.04	.10	62.11	.92	-19.89
.40	.87	-56.75	2.27	134.07	.13	54.03	.88	-25.53
.50	.83	-70.72	2.23	125.01	.15	47.25	.83	-29.96
.60	.79	-84.33	2.16	116.71	.16	40.79	.78	-34.25
.70	.75	-97.41	2.08	108.43	.17	35.62	.75	-37.36
.80	.71	-109.76	1.99	101.04	.17	31.08	.70	-40.60
.90	.68	-122.09	1.92	93.80	.18	26.89	.67	-43.12
1.00	.66	-133.22	1.82	87.30	.18	23.81	.64	-45.41
1.10	.64	-144.02	1.74	81.47	.18	21.08	.62	-47.82
1.20	.62	-154.11	1.66	75.63	.18	19.11	.60	-49.75
1.30	.61	-163.41	1.57	70.50	.17	17.32	.58	-51.90
1.40	.61	-172.15	1.50	65.55	.17	16.33	.57	-54.11
1.50	.61	179.69	1.43	60.93	.17	15.48	.56	-56.32
1.60	.61	172.31	1.36	56.58	.16	15.52	.54	-58.59
1.70	.61	165.55	1.29	52.57	.16	15.97	.54	-61.07
1.80	.62	159.12	1.24	48.65	.15	16.87	.53	-63.68
1.90	.63	153.12	1.18	44.96	.15	18.29	.52	-66.32
2.00	.63	147.73	1.12	41.71	.15	20.29	.52	-69.09
2.10	.64	142.54	1.08	38.29	.15	22.73	.51	-71.98
2.20	.65	137.65	1.03	35.21	.15	25.25	.51	-75.26
2.30	.66	133.23	.99	32.01	.15	27.87	.51	-78.60
2.40	.67	129.32	.95	29.64	.15	30.83	.50	-82.11
2.50	.67	125.32	.92	27.04	.15	33.50	.50	-85.80
2.60	.68	121.78	.88	24.60	.16	36.03	.50	-89.61
2.70	.69	118.50	.85	22.41	.17	38.41	.50	-93.50
2.80	.70	115.24	.82	20.14	.17	40.23	.50	-97.66
2.90	.71	112.33	.79	18.25	.18	41.83	.50	-101.66
3.00	.72	109.50	.76	16.28	.19	42.71	.50	-105.83
Vce = 3 V, Ic = 3	mA, Z <sub>0</sub> =	50 Ω						
FREQUENCY		S11		S21	s	12		S22
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.91	-20.87	6.85	160.51	.04	76.06	.95	-14.18
.20	.84	-40.75	6.38	145.81	.06	64.42	.87	-26.10
.30	.77	-60.61	6.07	133.27	.08	55.69	.77	-34.95
.40	.69	-79.21	5.65	122.38	.10	49.28	.68	-41.90
			5.55					

FREQUENCY		S11	;	S21	S	12		S22
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.91	-20.87	6.85	160.51	.04	76.06	.95	-14.18
.20	.84	-40.75	6.38	145.81	.06	64.42	.87	-26.10
.30	.77	-60.61	6.07	133.27	.08	55.69	.77	-34.95
.40	.69	-79.21	5.65	122.38	.10	49.28	.68	-41.90
.50	.62	-96.87	5.20	112.63	.11	45.15	.61	-46.55
.60	.57	-112.43	4.72	104.66	.12	41.99	.54	-50.59
.70	.52	-126.51	4.31	97.30	.12	40.07	.50	-53.40
.80	.49	-139.31	3.94	91.09	.13	38.98	.46	-55.90
.90	.47	-150.57	3.59	85.51	.13	38.14	.42	-58.00
1.00	.46	-160.97	3.31	80.44	.14	38.00	.40	-60.02
1.10	.46	-170.30	3.05	75.95	.14	37.60	.38	-62.10
1.20	.46	-178.72	2.83	71.60	.14	37.86	.36	-63.86
1.30	.46	173.69	2.64	67.73	.15	37.91	.34	-66.00
1.40	.47	166.63	2.47	63.86	.15	38.15	.33	-68.28
1.50	.47	160.24	2.32	60.26	.16	38.28	.32	-70.83
1.60	.48	154.42	2.19	56.86	.16	38.60	.31	-73.24
1.70	.49	149.16	2.07	53.60	.17	38.76	.30	-76.06
1.80	.50	144.23	1.96	50.43	.17	39.12	.29	-78.94
1.90	.51	139.58	1.86	47.34	.18	38.98	.28	-81.98
2.00	.52	135.44	1.77	44.29	.18	39.31	.28	-85.18
2.10	.53	131.39	1.70	41.48	.19	39.23	.27	-88.50
2.20	.54	127.65	1.62	38.94	.20	39.28	.26	-92.55
2.30	.55	124.36	1.55	36.05	.20	39.08	.26	-96.16
2.40	.57	121.18	1.49	33.64	.21	39.04	.26	-100.32
2.50	.58	118.19	1.43	31.34	.22	39.03	.26	-104.63
2.60	.59	115.58	1.38	28.95	.22	38.56	.26	-109.15
2.70	.60	112.99	1.33	26.70	.23	38.53	.26	-113.50
2.80	.61	110.43	1.29	24.45	.24	38.23	.26	-118.22
2.90	.62	108.13	1.24	22.28	.24	37.87	.26	-122.53
3.00	.63	105.91	1.20	20.22	.25	37.38	.26	-126.83



$V_{CE} = 3 \text{ V}, \text{ Ic} = 5 \text{ mA}, Z_0 = 50$	$\Omega$	
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VCE = 3 V, IC = 5	o mA, ∠₀ =	= 50 \Omega\$						
FREQUENCY		S11	Ş	S21	5	S12		S22
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.85	-26.44	10.69	155.98	.03	73.46	.92	-19.86
.20	.05 .75	-26.44 -51.20	9.61	139.24	.03	61.17	.79	-19.66 -34.91
.30	.64	-75.20	8.75	125.25	.07	54.17	.65	-44.33
.40	.56	-96.72	7.76	113.92	.08	50.16	.55	-51.20
.50	.49	-115.03	6.80	104.72	.09	48.17	.48	-55.56
.60	.45	-130.31	5.95	97.69	.10	47.13	.42	-59.25
.70	.42	-143.59	5.26	91.52	.11	46.84	.38	-61.89
.80	.41	-155.39	4.72	86.26	.11	46.85	.35	-64.36
.90	.40	-165.50	4.25	81.56	.12	46.62	.32	-66.67
1.00	.40	-174.72	3.87	77.29	.13	46.83	.30	-68.91
1.10	.40	177.10	3.55	73.37	.13	46.91	.28	-71.34
1.20	.41	169.76	3.28	69.66	.14	46.94	.27	-73.69
1.30	.41	163.14	3.04	66.19	.15	46.69	.25	-76.39
1.40	.42	157.10	2.83	62.87	.16	46.57	.24	-79.41
1.50 1.60	.43 .44	151.58 146.60	2.66 2.50	59.70 56.66	.16 .17	46.31 45.94	.23	-82.66
1.70	.44 .45	142.01	2.36	53.73	.17	45.59	.22	-86.03 -89.61
1.80	.46	137.81	2.23	50.83	.19	45.07	.21	-93.69
1.90	.48	133.84	2.12	48.10	.19	44.55	.21	-97.41
2.00	.49	130.04	2.01	45.17	.20	44.01	.20	-101.67
2.10	.50	126.68	1.93	42.52	.21	43.30	.20	-105.84
2.20	.51	123.26	1.83	40.17	.22	42.61	.20	-111.09
2.30	.52	120.32	1.76	37.50	.22	41.82	.19	-115.75
2.40	.53	117.64	1.69	35.27	.23	41.27	.20	-120.90
2.50	.54	114.93	1.62	32.99	.24	40.36	.20	-125.90
2.60	.56	112.60	1.56	30.62	.25	39.55	.20	-131.14
2.70	.57	110.25	1.50	28.52	.25	38.85	.20	-136.28
2.80	.58	108.05	1.46	26.39	.26	38.08	.21	-141.19
2.90	.59	105.95	1.41	24.29	.27	37.27	.21	-145.61
3.00	.60	103.96	1.36	22.18	.27	36.49	.21	-149.97
Vce = 3 V. lc = 7	′ mA. Zo =	= 50 Ω						
Vce = 3 V, Ic = 7	′ mA, Zo =				,	240		000
FREQUENCY		S11		S21		S12		S22
	′ mA, Z₀ =		MAG	S21 ANG	§ MAG	S12 ANG	MAG	S22 ANG
FREQUENCY GHz .10		S11 ANG -31.67						
FREQUENCY GHz .10 .20	MAG .79 .67	S11 ANG -31.67 -60.82	MAG 14.14 12.28	ANG 152.27 133.87	MAG .03 .05	ANG 71.15 59.89	MAG .88 .72	ANG -24.58 -41.34
FREQUENCY GHz .10 .20 .30	MAG .79 .67 .55	S11 ANG -31.67 -60.82 -87.90	MAG 14.14 12.28 10.67	ANG 152.27 133.87 119.07	MAG .03 .05 .06	ANG 71.15 59.89 54.65	MAG .88 .72 .57	ANG -24.58 -41.34 -50.83
FREQUENCY GHz .10 .20 .30 .40	MAG .79 .67 .55	S11 ANG -31.67 -60.82 -87.90 -110.16	MAG 14.14 12.28 10.67 9.04	ANG 152.27 133.87 119.07 108.13	MAG .03 .05 .06 .07	ANG 71.15 59.89 54.65 52.59	MAG .88 .72 .57 .47	ANG -24.58 -41.34 -50.83 -57.33
FREQUENCY GHz .10 .20 .30 .40 .50	MAG .79 .67 .55 .47	S11 ANG -31.67 -60.82 -87.90 -110.16 -127.95	MAG 14.14 12.28 10.67 9.04 7.66	ANG 152.27 133.87 119.07 108.13 99.95	MAG .03 .05 .06 .07	ANG 71.15 59.89 54.65 52.59 51.97	MAG .88 .72 .57 .47 .40	ANG -24.58 -41.34 -50.83 -57.33 -61.50
FREQUENCY GHz .10 .20 .30 .40 .50 .60	MAG .79 .67 .55 .47 .42	ANG -31.67 -60.82 -87.90 -110.16 -127.95 -142.37	MAG 14.14 12.28 10.67 9.04 7.66 6.59	ANG 152.27 133.87 119.07 108.13 99.95 93.83	MAG .03 .05 .06 .07 .08	ANG 71.15 59.89 54.65 52.59 51.97 51.63	MAG .88 .72 .57 .47 .40	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70	MAG .79 .67 .55 .47 .42 .39	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35	MAG .03 .05 .06 .07 .08 .09	71.15 59.89 54.65 52.59 51.97 51.63 52.13	MAG .88 .72 .57 .47 .40 .35	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80	MAG .79 .67 .55 .47 .42 .39 .38	S11  ANG  -31.67  -60.82  -87.90  -110.16  -127.95  -142.37  -154.76  -165.47	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75	MAG .03 .05 .06 .07 .08 .09 .10	71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11	MAG .88 .72 .57 .47 .40 .35 .32	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90	MAG .79 .67 .55 .47 .42 .39 .38 .37	S11  ANG  -31.67  -60.82  -87.90  -110.16  -127.95  -142.37  -154.76  -165.47  -174.83	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53	MAG .03 .05 .06 .07 .08 .09 .10 .11	71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18	MAG .88 .72 .57 .47 .40 .35 .32 .29	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00	MAG .79 .67 .55 .47 .42 .39 .38 .37	ANG -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27 .25	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .37	ANG -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27 .25	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .37 .38 .38 .39 .40 .41	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .38 .38 .39 .40 .41	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63 141.98	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19 .19	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .37 .48 .39 .40 .41 .42 .44	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63 141.98 137.93	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18 .19	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19 .19 .18	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .37 .48 .40 .41 .42 .44 .45	S11  ANG  -31.67  -60.82  -87.90  -110.16  -127.95  -142.37  -154.76  -165.47  -174.83  176.89  169.63  162.95  156.98  151.53  146.63  141.98  137.93  133.89	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51 2.38	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72 50.97	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .14 .15 .16 .17 .18	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77 48.00	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19 .19 .18 .18	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69 -106.30
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .37 .48 .49 .40 .41 .42 .44 .45 .46	S11  ANG  -31.67  -60.82  -87.90  -110.16  -127.95  -142.37  -154.76  -165.47  -174.83  176.89  169.63  162.95  156.98  151.53  146.63  141.98  137.93  133.89  130.36	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51 2.38 2.26	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72 50.97 48.32	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18 .19 .20 .20	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77 48.00 47.04	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19 .19 .18 .18	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69 -106.30 -110.96
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .38 .38 .39 .40 .41 .42 .44 .45 .46 .47	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63 141.98 137.93 133.89 130.36 126.94	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51 2.38 2.26 2.14	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72 50.97 48.32 45.65	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18 .19 .20 .21	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77 48.00 47.04 46.10	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19 .18 .18 .18	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69 -106.30 -110.96 -116.39
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .38 .38 .39 .40 .41 .42 .44 .45 .46 .47 .48	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63 141.98 137.93 133.89 130.36 126.94 123.80	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51 2.38 2.26 2.14 2.05	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72 50.97 48.32 45.65 43.03	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18 .19 .20 .20 .21 .22	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77 48.00 47.04 46.10 45.20	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19 .18 .18 .18 .17	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69 -106.30 -110.96 -116.39 -120.97
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .38 .38 .39 .40 .41 .42 .44 .45 .46 .47 .48 .49	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63 141.98 137.93 133.89 130.36 126.94 123.80 120.71	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51 2.38 2.26 2.14 2.05 1.95	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72 50.97 48.32 45.65 43.03 40.91	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18 .19 .20 .20 .21 .22 .23	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77 48.00 47.04 46.10 45.20 44.15	MAG  .88     .72     .57     .40     .35     .32     .29     .27     .25     .23     .22     .21     .20     .19     .18     .18     .18     .18     .17     .17	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69 -106.30 -110.96 -116.39 -120.97 -126.84
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .38 .38 .39 .40 .41 .42 .44 .45 .46 .47 .48 .49	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63 141.98 137.93 133.89 130.36 126.94 123.80 120.71 118.00	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51 2.38 2.26 2.14 2.05 1.95 1.87	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72 50.97 48.32 45.65 43.03 40.91 38.45	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18 .19 .20 .20 .21 .22 .23 .24	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77 48.00 47.04 46.10 45.20 44.15 43.05	MAG  .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19 .19 .18 .18 .18 .17 .17 .17	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69 -106.30 -110.96 -116.39 -120.97 -126.84 -132.13
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .38 .38 .39 .40 .41 .42 .44 .45 .46 .47 .48 .49 .50 .52	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63 141.98 137.93 133.89 130.36 126.94 123.80 120.71 118.00 115.48	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51 2.38 2.26 2.14 2.05 1.95 1.87 1.80	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72 50.97 48.32 45.65 43.03 40.91 38.45 36.15	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18 .19 .20 .20 .21 .22 .23 .24 .24	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77 48.00 47.04 46.10 45.20 44.15 43.05 42.04	MAG  .88     .72     .57     .47     .40     .35     .32     .29     .27     .25     .23     .22     .21     .20     .19     .18     .18     .18     .17     .17     .17     .18     .18	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69 -106.30 -110.96 -116.39 -120.97 -126.84 -132.13 -137.40
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .38 .38 .39 .40 .41 .42 .44 .45 .46 .47 .48 .49	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63 141.98 137.93 133.89 130.36 126.94 123.80 120.71 118.00	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51 2.38 2.26 2.14 2.05 1.95 1.87	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72 50.97 48.32 45.65 43.03 40.91 38.45	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18 .19 .20 .20 .21 .22 .23 .24 .24 .25	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77 48.00 47.04 46.10 45.20 44.15 43.05	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19 .19 .18 .18 .18 .17 .17 .17 .18 .18	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69 -106.30 -110.96 -116.39 -120.97 -126.84 -132.13
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50 2.60 2.70	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .38 .39 .40 .41 .42 .44 .45 .46 .47 .48 .49 .50 .52 .53 .54	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63 141.98 137.93 133.89 130.36 126.94 123.80 120.71 118.00 115.48 113.00 110.80 108.67	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51 2.38 2.26 2.14 2.05 1.95 1.87 1.80 1.73 1.66 1.60	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72 50.97 48.32 45.65 43.03 40.91 38.45 36.15 33.97 31.82 29.74	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18 .19 .20 .21 .22 .23 .24 .24 .25 .26 .26	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77 48.00 47.04 46.10 45.20 44.15 43.05 42.04 41.08 39.96 39.23	MAG .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19 .18 .18 .18 .17 .17 .17 .18 .18 .18 .19 .19	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69 -106.30 -110.96 -116.39 -120.97 -126.84 -132.13 -137.40 -142.69 -148.07 -152.96
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50 2.60 2.70 2.80	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .37 .38 .38 .39 .40 .41 .42 .44 .45 .46 .47 .48 .49 .50 .52 .53 .54 .55	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63 141.98 137.93 133.89 130.36 126.94 123.80 120.71 118.00 115.48 113.00 115.48 113.00 110.80 108.67	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51 2.38 2.26 2.14 2.05 1.95 1.87 1.80 1.73 1.66 1.60 1.55	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72 50.97 48.32 45.65 43.03 40.91 38.45 36.15 33.97 31.82 29.74 27.34	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18 .19 .20 .20 .21 .22 .23 .24 .24 .25 .26 .26 .27	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77 48.00 47.04 46.10 45.20 44.15 43.05 42.04 41.08 39.96 39.23 38.14	MAG  .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19 .18 .18 .18 .17 .17 .17 .18 .18 .18 .19 .19 .20	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69 -106.30 -110.96 -116.39 -120.97 -126.84 -132.13 -137.40 -142.69 -148.07 -152.96 -157.19
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50 2.60 2.70 2.80 2.90	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .38 .38 .39 .40 .41 .42 .44 .45 .46 .47 .48 .49 .50 .52 .53 .54 .55 .56 .58	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63 141.98 137.93 133.89 130.36 126.94 123.80 120.71 118.00 115.48 113.00 110.80 108.67 106.60 104.57	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51 2.38 2.26 2.14 2.05 1.95 1.87 1.80 1.73 1.66 1.55 1.50	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72 50.97 48.32 45.65 43.03 40.91 38.45 36.15 33.97 31.82 29.74 27.34 25.66	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18 .19 .20 .20 .21 .22 .23 .24 .24 .25 .26 .26 .27 .28	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77 48.00 47.04 46.10 45.20 44.15 43.05 42.04 41.08 39.96 39.23 38.14 37.25	MAG  .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19 .19 .18 .18 .18 .17 .17 .17 .18 .18 .18 .19 .19 .20 .21	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69 -106.30 -110.96 -116.39 -120.97 -126.84 -132.13 -137.40 -142.69 -148.07 -152.96 -157.19 -161.69
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50 2.60 2.70 2.80	MAG .79 .67 .55 .47 .42 .39 .38 .37 .37 .37 .38 .38 .39 .40 .41 .42 .44 .45 .46 .47 .48 .49 .50 .52 .53 .54	S11  ANG  -31.67 -60.82 -87.90 -110.16 -127.95 -142.37 -154.76 -165.47 -174.83 176.89 169.63 162.95 156.98 151.53 146.63 141.98 137.93 133.89 130.36 126.94 123.80 120.71 118.00 115.48 113.00 115.48 113.00 110.80 108.67	MAG 14.14 12.28 10.67 9.04 7.66 6.59 5.76 5.12 4.59 4.16 3.81 3.50 3.25 3.03 2.83 2.66 2.51 2.38 2.26 2.14 2.05 1.95 1.87 1.80 1.73 1.66 1.60 1.55	ANG 152.27 133.87 119.07 108.13 99.95 93.83 88.35 83.75 79.53 75.64 72.18 68.56 65.42 62.34 59.33 56.50 53.72 50.97 48.32 45.65 43.03 40.91 38.45 36.15 33.97 31.82 29.74 27.34	MAG .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .16 .17 .18 .19 .20 .20 .21 .22 .23 .24 .24 .25 .26 .26 .27	ANG 71.15 59.89 54.65 52.59 51.97 51.63 52.13 52.11 52.18 52.20 51.99 51.72 51.33 50.81 50.15 49.40 48.77 48.00 47.04 46.10 45.20 44.15 43.05 42.04 41.08 39.96 39.23 38.14	MAG  .88 .72 .57 .47 .40 .35 .32 .29 .27 .25 .23 .22 .21 .20 .19 .18 .18 .18 .17 .17 .17 .18 .18 .18 .19 .19 .20	ANG -24.58 -41.34 -50.83 -57.33 -61.50 -65.05 -67.82 -70.62 -73.11 -75.82 -78.72 -81.78 -85.11 -88.95 -92.87 -97.18 -101.69 -106.30 -110.96 -116.39 -120.97 -126.84 -132.13 -137.40 -142.69 -148.07 -152.96 -157.19



Vce = 3 V, Ic = 10 mA, Z	$0 = 50 \Omega$
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FREQUENCY		S11	9	S21	S	12	5	S22
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.71	-39.03	18.58	147.71	.03	68.69	.83	-30.16
.20	.57	-73.63	15.31	127.39	.05	59.38	.63	-48.07
.30	.45	-102.58	12.43	112.73	.06	56.68	.49	-57.41
.40	.39	-124.33	10.08	102.91	.07	56.27	.40	-63.51
.50	.36	-141.02	8.36	95.89	.08	56.57	.34	-67.57
.60	.35	-154.37	7.10	90.47	.09	56.86	.29	-71.19
.70	.34	-165.44	6.16	85.73	.10	57.18	.26	-74.31
.80	.34	-175.03	5.44	81.62	.11	57.18	.24	-77.41
.90	.34	176.63	4.87	77.75	.12	57.09	.22	-80.56
1.00	.35	169.25	4.40	74.22	.13	56.69	.21	-83.81
1.10	.36	162.75	4.02	71.00	.14	56.34	.20	-87.55
1.20	.37	156.83	3.70	67.77	.15	55.55	.19	-91.34
1.30	.38	151.50	3.42	64.82	.16	54.83	.18	-95.70
1.40	.39	146.60	3.19	61.79	.17	53.99	.17	-100.40
1.50	.40	142.12	2.98	59.04	.17	53.03	.17	-104.99
1.60	.41	138.03	2.80	56.45	.18	52.03	.16	-110.36
1.70	.42	134.21	2.63	53.75	.19	51.04	.16	-115.48
1.80	.43	130.67	2.50	51.05	.20	49.91	.16	-120.86
1.90	.45	127.37	2.37	48.74	.21	48.75	.16	-126.15
2.00	.46	124.22	2.25	46.04	.22	47.77	.16	-131.74
2.10	.47	121.31	2.15	43.60	.23	46.48	.16	-136.39
2.20	.48	118.37	2.05	41.36	.24	45.20	.17	-142.70
2.30	.49	115.87	1.96	38.90	.25	43.97	.17	-147.46
2.40	.50	113.55	1.89	36.95	.25	42.65	.18	-152.75
2.50	.52	111.30	1.81	34.71	.26	41.70	.19	-157.66
2.60	.53	109.28	1.74	32.62	.27	40.45	.19	-162.35
2.70	.54	107.16	1.67	30.43	.28	39.28	.20	-166.91
2.80	.55	105.27	1.62	28.76	.28	38.16	.21	-170.83
2.90	.57	103.43	1.57	26.44	.29	37.04	.22	-174.49
3.00	.58	101.61	1.51	24.93	.30	36.10	.23	-177.86

Vce = 3 V, Ic = 20 mA, Zo = 50  $\Omega$ 

02 - 0 1, 10 - 2	• ···· ·, <u>—</u>	- 00 11						
FREQUENCY		S11	;	S21	S	12		S22
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.52	-60.10	28.62	137.10	.02	67.35	.71	-41.30
.20	.39	-103.44	19.94	115.16	.04	63.08	.48	-59.79
.30	.33	-130.53	14.51	103.51	.05	63.34	.35	-68.39
.40	.31	-148.95	11.26	96.02	.06	64.33	.28	-74.25
.50	.30	-162.62	9.15	90.56	.07	65.01	.24	-78.55
.60	.30	-172.99	7.69	86.27	.08	65.06	.21	-82.95
.70	.31	178.35	6.63	82.36	.09	64.97	.19	-87.11
.80	.31	170.80	5.84	78.82	.11	64.40	.18	-91.38
.90	.32	164.26	5.21	75.55	.12	63.46	.16	-96.07
1.00	.33	158.34	4.70	72.35	.13	62.64	.16	-100.35
1.10	.34	153.02	4.28	69.45	.14	61.47	.15	-105.51
1.20	.35	148.21	3.94	66.66	.15	60.45	.15	-110.63
1.30	.36	143.86	3.63	63.96	.16	59.09	.15	-116.00
1.40	.37	139.65	3.38	61.26	.17	58.05	.15	-121.72
1.50	.38	135.96	3.16	58.61	.18	56.50	.15	-127.25
1.60	.40	132.38	2.97	56.19	.19	55.17	.15	-133.07
1.70	.41	129.06	2.79	53.72	.20	53.77	.15	-138.41
1.80	.42	126.14	2.64	51.32	.21	52.54	.16	-143.83
1.90	.43	123.11	2.50	48.96	.22	51.02	.16	-148.58
2.00	.44	120.40	2.38	46.54	.23	49.64	.17	-153.87
2.10	.46	117.80	2.27	44.17	.24	48.25	.18	-157.74
2.20	.47	115.23	2.16	42.21	.25	46.65	.18	-162.91
2.30	.48	112.96	2.07	39.64	.26	45.13	.19	-167.09
2.40	.49	110.86	1.99	37.96	.27	43.59	.20	-171.04
2.50	.50	108.77	1.90	35.67	.27	42.37	.21	-174.96
2.60	.51	106.98	1.84	33.82	.28	40.93	.22	-178.81
2.70	.53	105.14	1.77	31.79	.29	39.70	.23	177.40
2.80	.54	103.40	1.72	29.93	.30	38.37	.24	174.62
2.90	.55	101.60	1.65	28.01	.30	37.05	.25	171.56
3.00	.56	100.10	1.61	26.09	.31	35.76	.26	168.73

S22



#### S-PARAMETERS Q2

FREQUENCY

$V_{CE} = 3 \text{ V, Ic}$	= 1 mA. Zo	$= 50 \Omega$
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S11

FREQUENCT		311	•	321		312		322
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.98	-5.93	2.43	171.79	.02	85.64	.99	-3.75
.20	.97	-11.82	2.41	164.40	.04	80.86	.99	-7.53
.30	.95	-17.85	2.42	157.59	.05	76.45	.97	-11.10
.40	.93	-23.59	2.39	151.04	.07	72.26	.95	-14.56
.50	.90	-29.61	2.38	144.91	.09	68.73	.93	-17.91
.60	.87	-35.62	2.37	139.49	.10	64.78	.90	-21.19
.70	.84	-41.49	2.34	133.87	.11	61.52	.87	-23.71
.80	.81	-47.40	2.32	128.66	.12	58.06	.85	-26.91
.90	.77	-53.49	2.32	123.12	.13	55.30	.82	-29.05
1.00	.73	-59.00	2.26	118.06	.14	52.86	.78	-31.52
1.00			2.20					
1.10	.69	-65.20	2.25	113.30	.15	50.42	.76	-33.73
1.20	.65	-71.05	2.21	108.31	.16	48.61	.73	-35.51
1.30	.62	-77.22	2.17	103.81	.16	46.62	.70	-37.59
1.40	.58	-83.22	2.15	99.18	.17	45.21	.68	-39.34
1.50	.54	-89.53	2.13	94.49	.17	43.82	.66	-41.12
1.60	.51	-95.27	2.07	90.14	.18	42.57	.63	-42.89
1.00								
1.70	.47	-101.29	2.02	86.01	.18	41.68	.61	-44.56
1.80	.45	-107.59	1.99	82.00	.18	40.66	.59	-46.38
1.90	.42	-114.02	1.95	78.38	.19	40.08	.57	-47.99
2.00	.40	-120.45	1.90	74.87	.19	39.57	.55	-49.87
2.10	.38	-127.04	1.87	70.82	.19	39.19	.53	-51.49
2.20	.36	-133.41	1.83	67.34	.20	38.84	.51	-53.44
2.20						30.04		
2.30	.35	-139.83	1.78	63.84	.20	38.49	.50	-55.39
2.40	.34	-146.46	1.74	60.75	.20	38.49	.48	-57.67
2.50	.33	-153.17	1.71	57.60	.21	38.43	.46	-59.91
2.60	.32	-159.96	1.68	54.38	.21	38.28	.45	-62.31
2.70	.32	-166.01	1.64	51.35	.22	38.20	.43	-64.97
2.80	.32	-172.06	1.61	48.28	.22	38.44	.41	-67.87
2.90	.32	-177.98	1.58	45.54	.23	38.28	.40	-70.94
3.00	.33	177.01	1.54	42.57	.23	38.11	.38	-74.21
$V_{CE} = 3 \text{ V, Ic} = 3$	s mA, Z <sub>0</sub> =			204		C12		<b>C</b> 22
FREQUENCY	mA, Z <sub>0</sub> =	S11		S21		S12		S22
FREQUENCY		S11			MAG			
FREQUENCY GHz	MAG	S11 ANG	MAG	ANG	MAG	ANG	MAG	ANG
FREQUENCY GHz .10	MAG .93	S11 ANG -9.39	MAG 6.76	ANG 166.53	.02	ANG 82.60	MAG .98	ANG -7.24
FREQUENCY GHz .10 .20	MAG .93 .90	S11 ANG -9.39 -18.39	MAG 6.76 6.46	ANG 166.53 155.80	.02 .03	ANG 82.60 76.86	MAG .98 .94	ANG -7.24 -13.64
FREQUENCY GHz .10 .20 .30	MAG .93 .90 .84	ANG -9.39 -18.39 -27.39	MAG 6.76 6.46 6.32	ANG 166.53 155.80 146.52	.02 .03 .05	ANG 82.60 76.86 71.65	MAG .98 .94 .89	ANG -7.24 -13.64 -18.91
FREQUENCY GHz .10 .20	MAG .93 .90	S11 ANG -9.39 -18.39	MAG 6.76 6.46	ANG 166.53 155.80	.02 .03	ANG 82.60 76.86	MAG .98 .94	ANG -7.24 -13.64
FREQUENCY GHz .10 .20 .30 .40	MAG .93 .90 .84 .79	ANG -9.39 -18.39 -27.39 -35.83	MAG 6.76 6.46 6.32 6.06	ANG 166.53 155.80 146.52 138.21	.02 .03 .05 .06	ANG 82.60 76.86 71.65 67.47	MAG .98 .94 .89 .83	ANG -7.24 -13.64 -18.91 -23.49
FREQUENCY GHz .10 .20 .30 .40 .50	MAG .93 .90 .84 .79	ANG -9.39 -18.39 -27.39 -35.83 -44.06	MAG 6.76 6.46 6.32 6.06 5.82	ANG 166.53 155.80 146.52 138.21 130.60	.02 .03 .05 .06 .07	ANG 82.60 76.86 71.65 67.47 64.58	MAG .98 .94 .89 .83 .77	ANG -7.24 -13.64 -18.91 -23.49 -26.46
FREQUENCY GHz .10 .20 .30 .40 .50 .60	MAG .93 .90 .84 .79 .72	ANG -9.39 -18.39 -27.39 -35.83 -44.06 -51.67	MAG 6.76 6.46 6.32 6.06 5.82 5.54	ANG 166.53 155.80 146.52 138.21 130.60 123.94	.02 .03 .05 .06 .07	ANG 82.60 76.86 71.65 67.47 64.58 61.95	MAG .98 .94 .89 .83 .77	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70	MAG .93 .90 .84 .79 .72 .66	ANG -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07	.02 .03 .05 .06 .07 .08	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46	MAG .98 .94 .89 .83 .77 .72	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80	MAG .93 .90 .84 .79 .72 .66 .59	ANG -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07	.02 .03 .05 .06 .07 .08 .09	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12	MAG .98 .94 .89 .83 .77 .72 .68	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90	MAG .93 .90 .84 .79 .72 .66 .59 .53	ANG -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46	.02 .03 .05 .06 .07 .08 .09 .10	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98	MAG .98 .94 .89 .83 .77 .72 .68 .64	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48	ANG -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46	.02 .03 .05 .06 .07 .08 .09 .10	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39	MAG .98 .94 .89 .83 .77 .72 .68 .64 .60 .57	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43	ANG -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46	.02 .03 .05 .06 .07 .08 .09 .10	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96	MAG .98 .94 .89 .83 .77 .72 .68 .64	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43	ANG -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95	.02 .03 .05 .06 .07 .08 .09 .10 .10	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96	MAG .98 .94 .89 .83 .77 .72 .68 .64 .60 .57	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .38	ANG -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74	.02 .03 .05 .06 .07 .08 .09 .10 .10 .11	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54	MAG .98 .94 .89 .83 .77 .72 .68 .64 .60 .57 .55	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .38 .34	ANG -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96	.02 .03 .05 .06 .07 .08 .09 .10 .10 .11 .12 .13	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14	MAG .98 .94 .89 .83 .77 .72 .68 .64 .60 .57 .55 .52	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .38 .34 .31 .28	ANG -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35	.02 .03 .05 .06 .07 .08 .09 .10 .10 .11 .12 .13 .13	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14	MAG .98 .94 .89 .83 .77 .72 .68 .64 .60 .57 .55 .52 .50 .48	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .38 .34 .31 .28	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72	MAG .98 .94 .89 .83 .77 .72 .68 .64 .60 .57 .55 .52 .50 .48 .46	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .38 .34 .31 .28 .26 .24	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21	MAG .98 .94 .89 .83 .77 .72 .68 .64 .60 .57 .55 .52 .50 .48 .46 .44	-7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .34 .31 .28 .26 .24	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21 54.91 54.46	MAG .98 .94 .89 .83 .77 .72 .68 .64 .60 .57 .55 .52 .50 .48 .46 .44 .43	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .38 .34 .31 .28 .26 .24	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21	MAG .98 .94 .89 .83 .77 .72 .68 .64 .60 .57 .55 .52 .50 .48 .46 .44	-7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .34 .31 .28 .26 .24	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21 54.91 54.46	MAG .98 .94 .89 .83 .77 .72 .68 .64 .60 .57 .55 .52 .50 .48 .46 .44 .43	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .38 .34 .31 .28 .26 .24 .22 .21 .20	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .15	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21 54.91 54.46 53.91	MAG  .98  .94  .89  .83  .77  .72  .68  .64  .60  .57  .55  .52  .50  .48  .46  .44  .43  .41  .39	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65 -42.70 -43.76
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .31 .28 .26 .24 .22 .21 .20 .19	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46 -130.51 -137.84	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81 2.71	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84 66.02	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .15 .16	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21 54.91 54.46 53.91 53.57 53.01	MAG  .98  .94  .89  .83  .77  .72  .68  .64  .60  .57  .55  .52  .50  .48  .46  .44  .43  .41  .39  .38	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65 -42.70 -43.76 -44.95
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .38 .34 .31 .28 .26 .24 .22 .21 .20 .19 .18	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46 -130.51 -137.84 -145.47	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81 2.71 2.61	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84 66.02 63.33	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .15 .16 .17 .18	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21 54.91 54.46 53.91 53.57 53.01 52.38	MAG .98 .94 .89 .83 .77 .72 .68 .64 .60 .57 .55 .52 .50 .48 .46 .44 .43 .41 .39 .38	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65 -42.70 -43.76 -44.95 -46.23
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .38 .34 .28 .26 .24 .22 .21 .20 .19 .18 .18	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46 -130.51 -137.84 -145.47 -152.73	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81 2.71 2.61 2.52	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84 66.02 63.33 60.80	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .15 .16 .17 .18	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21 54.91 54.46 53.91 53.57 53.01 52.38 51.91	MAG  .98  .94  .89  .83  .77  .72  .68  .64  .60  .57  .55  .52  .50  .48  .46  .44  .43  .41  .39  .38  .36  .35	ANG -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65 -42.70 -43.76 -44.95 -46.23 -47.64
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .38 .34 .31 .28 .26 .24 .22 .21 .20 .19 .18 .18	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46 -130.51 -137.84 -145.47 -152.73 -160.13	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81 2.71 2.61 2.52 2.44	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84 66.02 63.33 60.80 58.00	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .14 .15 .15 .16 .17 .18 .18	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 55.72 55.21 54.91 53.91 53.57 53.01 52.38 51.91 51.17	MAG  .98  .94  .89  .83  .77  .72  .68  .64  .60  .57  .55  .52  .50  .48  .46  .44  .43  .41  .39  .38  .36  .35  .33	ANG  -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65 -42.70 -43.76 -44.95 -46.23 -47.64 -49.19
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .38 .34 .21 .28 .26 .24 .22 .21 .20 .19 .18 .18	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46 -130.51 -137.84 -145.47 -152.73 -160.13 -167.47	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81 2.71 2.61 2.52 2.44 2.36	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84 66.02 63.33 60.80 58.00 55.57	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .14 .15 .15 .16 .17 .18 .18	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 55.72 55.21 54.91 53.91 53.57 53.01 52.38 51.91 51.17 50.80	MAG  .98  .94  .89  .83  .77  .72  .68  .64  .60  .57  .55  .52  .50  .48  .46  .44  .43  .41  .39  .38  .36  .35  .33  .32	ANG  -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65 -42.70 -43.76 -44.95 -46.23 -47.64 -49.19 -50.82
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .31 .28 .26 .24 .22 .21 .20 .19 .18 .18 .18	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46 -130.51 -137.84 -145.47 -152.73 -160.13 -167.47 -174.18	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81 2.71 2.61 2.52 2.44 2.36 2.29	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84 66.02 63.33 60.80 58.00 55.57 53.07	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .14 .15 .15 .16 .17 .18 .19 .20 .21	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21 54.91 53.57 53.01 52.38 51.91 51.17 50.80 49.89	MAG  .98  .94  .89  .83  .77  .72  .68  .64  .60  .57  .55  .52  .50  .48  .46  .44  .43  .41  .39  .38  .36  .35  .32  .30	ANG  -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65 -42.70 -43.76 -44.95 -46.23 -47.64 -49.19 -50.82 -52.82
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .38 .34 .21 .28 .26 .24 .22 .21 .20 .19 .18 .18	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46 -130.51 -137.84 -145.47 -152.73 -160.13 -167.47	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81 2.71 2.61 2.52 2.44 2.36	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84 66.02 63.33 60.80 58.00 55.57	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .14 .15 .15 .16 .17 .18 .18	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 55.72 55.21 54.91 53.91 53.57 53.01 52.38 51.91 51.17 50.80	MAG  .98  .94  .89  .83  .77  .72  .68  .64  .60  .57  .55  .52  .50  .48  .46  .44  .43  .41  .39  .38  .36  .35  .33  .32	ANG  -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65 -42.70 -43.76 -44.95 -46.23 -47.64 -49.19 -50.82
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .31 .28 .26 .24 .22 .21 .20 .19 .18 .18 .18	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46 -130.51 -137.84 -145.47 -152.73 -160.13 -167.47 -174.18	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81 2.71 2.61 2.52 2.44 2.36 2.29	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84 66.02 63.33 60.80 58.00 55.57 53.07	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .14 .15 .15 .16 .17 .18 .19 .20 .21	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21 54.91 53.57 53.01 52.38 51.91 51.17 50.80 49.89	MAG  .98  .94  .89  .83  .77  .72  .68  .64  .60  .57  .55  .52  .50  .48  .46  .44  .43  .41  .39  .38  .36  .35  .32  .30	ANG  -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -36.47 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65 -42.70 -43.76 -44.95 -46.23 -47.64 -49.19 -50.82 -52.82
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50 2.60 2.70	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .31 .28 .26 .24 .22 .21 .20 .19 .18 .18 .18 .18 .18 .19 .20 .20	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46 -130.51 -137.84 -145.47 -152.73 -160.13 -167.47 -174.18 179.79 173.96	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81 2.71 2.61 2.52 2.44 2.36 2.29 2.23 2.16	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84 66.02 63.33 60.80 58.00 55.57 53.07 50.72 48.10	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .15 .16 .17 .18 .19 .20 .21 .22 .22 .22	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21 54.91 54.46 53.91 53.57 53.01 52.38 51.91 51.17 50.80 49.89 49.17 48.35	MAG  .98  .94  .89  .83  .77  .72  .68  .64  .60  .57  .55  .52  .50  .48  .46  .44  .43  .41  .39  .38  .36  .35  .33  .32  .30  .28  .27	ANG  -7.24  -13.64  -18.91  -23.49  -26.46  -29.65  -31.43  -33.17  -34.36  -35.31  -36.47  -37.08  -37.96  -38.83  -39.70  -40.63  -41.65  -42.70  -43.76  -44.95  -46.23  -47.64  -49.19  -50.82  -52.82  -54.67  -56.94
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50 2.60 2.70 2.80	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .31 .28 .26 .24 .22 .21 .20 .19 .18 .18 .18 .18 .19 .20 .20 .21	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46 -130.51 -137.84 -145.47 -152.73 -160.13 -167.47 -174.18 179.79 173.96 168.73	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81 2.71 2.61 2.52 2.44 2.36 2.29 2.23 2.16 2.10	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84 66.02 63.33 60.80 58.00 55.57 53.07 50.72 48.10 45.81	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .15 .16 .17 .18 .19 .20 .21 .22 .22 .23 .24	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21 54.91 54.46 53.91 53.57 53.01 52.38 51.91 51.17 50.80 49.89 49.17 48.35 47.49	MAG  .98  .94  .89  .83  .77  .72  .68  .64  .60  .57  .55  .52  .50  .48  .46  .44  .43  .41  .39  .38  .36  .35  .33  .32  .30  .28  .27  .25	ANG  -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65 -42.70 -43.76 -44.95 -46.23 -47.64 -49.19 -50.82 -52.82 -54.67 -56.94 -59.46
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50 2.60 2.70 2.80 2.90	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .31 .28 .26 .24 .22 .21 .20 .19 .18 .18 .18 .19 .20 .20 .21 .20 .21 .20 .21 .20 .21 .20 .21 .20 .21 .20 .21 .20 .21 .20 .21 .20 .20 .21 .20 .21 .20 .21 .20 .21 .20 .21 .20 .20 .21 .22	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46 -130.51 -137.84 -145.47 -152.73 -160.13 -167.47 -174.18 179.79 173.96 168.73 163.65	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81 2.71 2.61 2.52 2.44 2.36 2.29 2.23 2.16 2.10 2.05	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84 66.02 63.33 60.80 58.00 55.57 53.07 50.72 48.10 45.81 43.41	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .15 .16 .17 .18 .19 .20 .21 .22 .22 .22 .23 .24	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21 54.91 53.91 53.57 53.01 52.38 51.91 51.17 50.80 49.89 49.17 48.35 47.49 46.43	MAG  .98  .94  .89  .83  .77  .72  .68  .64  .60  .57  .55  .52  .50  .48  .46  .44  .43  .41  .39  .38  .36  .35  .33  .32  .30  .28  .27  .25  .24	ANG  -7.24  -13.64  -18.91  -23.49  -26.46  -29.65  -31.43  -33.17  -34.36  -35.31  -36.47  -37.08  -37.96  -38.83  -39.70  -40.63  -41.65  -42.70  -43.76  -44.95  -46.23  -47.64  -49.19  -50.82  -52.82  -54.67  -56.94  -59.46  -62.59
FREQUENCY GHz .10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50 2.60 2.70 2.80	MAG .93 .90 .84 .79 .72 .66 .59 .53 .48 .43 .31 .28 .26 .24 .22 .21 .20 .19 .18 .18 .18 .18 .19 .20 .20 .21	S11  ANG  -9.39 -18.39 -27.39 -35.83 -44.06 -51.67 -58.86 -65.57 -71.57 -77.20 -82.70 -82.70 -87.82 -93.49 -98.65 -104.50 -110.31 -116.75 -123.46 -130.51 -137.84 -145.47 -152.73 -160.13 -167.47 -174.18 179.79 173.96 168.73	MAG 6.76 6.46 6.32 6.06 5.82 5.54 5.28 5.01 4.72 4.45 4.20 3.95 3.74 3.55 3.37 3.21 3.06 2.94 2.81 2.71 2.61 2.52 2.44 2.36 2.29 2.23 2.16 2.10	ANG 166.53 155.80 146.52 138.21 130.60 123.94 117.07 111.07 105.46 100.46 95.95 91.74 87.96 84.35 80.85 77.72 74.57 71.63 68.84 66.02 63.33 60.80 58.00 55.57 53.07 50.72 48.10 45.81	.02 .03 .05 .06 .07 .08 .09 .10 .11 .12 .13 .13 .14 .15 .15 .16 .17 .18 .19 .20 .21 .22 .22 .23 .24	ANG 82.60 76.86 71.65 67.47 64.58 61.95 60.46 59.12 57.98 57.39 56.96 56.54 56.14 55.72 55.21 54.91 54.46 53.91 53.57 53.01 52.38 51.91 51.17 50.80 49.89 49.17 48.35 47.49	MAG  .98  .94  .89  .83  .77  .72  .68  .64  .60  .57  .55  .52  .50  .48  .46  .44  .43  .41  .39  .38  .36  .35  .33  .32  .30  .28  .27  .25	ANG  -7.24 -13.64 -18.91 -23.49 -26.46 -29.65 -31.43 -33.17 -34.36 -35.31 -37.08 -37.96 -38.83 -39.70 -40.63 -41.65 -42.70 -43.76 -44.95 -46.23 -47.64 -49.19 -50.82 -52.82 -54.67 -56.94 -59.46

S21

S12



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FREQUENCY		S11	;	S21	S	12	S	322
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.89	-12.31	10.46	162.72	.02	81.62	.96	-9.77
.20	.83	-23.63	9.75	149.86	.03	74.55	.90	-17.75
.30	.75	-34.70	9.25	138.82	.04	69.69	.81	-23.24
.40	.66	-44.55	8.62	129.30	.06	66.77	.74	-27.15
.50	.57	-53.23	7.96	120.72	.06	64.98	.68	-29.45
.60	.50	-60.42	7.27	113.73	.07	63.78	.62	-31.18
.70	.43	-66.51	6.64	107.23	.08	63.28	.58	-32.03
.80	.37	-71.94	6.08	101.84	.09	62.73	.55	-32.89
.90	.33	-76.60	5.57	97.19	.10	62.37	.52	-33.36
1.00	.29	-81.19	5.15	92.96	.10	62.23	.49	-33.76
1.10	.26	-85.79	4.77	89.24	.11	61.85	.47	-34.33
1.20	.23	-90.41	4.45	85.71	.12	61.60	.45	-34.67
1.30	.21	-95.79	4.17	82.52	.13	61.06	.43	-35.08
1.40	.19	-100.84	3.91	79.44	.14	60.78	.42	-35.79
1.50	.17	-106.89	3.70	76.63	.14	60.08	.40	-36.32
1.60	.16	-113.52	3.50	73.79	.15	59.69	.39	<i>−</i> 37.17
1.70	.15	-120.69	3.33	71.22	.16	58.93	.37	-38.02
1.80	.14	-128.54	3.18	68.57	.17	58.47	.36	-38.84
1.90	.13	-136.73	3.04	66.08	.18	57.63	.34	-40.00
2.00	.13	-145.48	2.92	63.46	.19	57.05	.33	-40.74
2.10	.13	-153.95	2.81	61.14	.20	56.13	.32	-42.01
2.20	.13	-161.96	2.71	58.79	.20	55.20	.30	-43.19
2.30	.14	-169.65	2.61	56.38	.21	54.17	.29	-44.77
2.40	.15	-177.12	2.53	53.98	.22	53.43	.27	-46.33
2.50	.15	176.33	2.45	51.77	.23	52.54	.26	-48.08
2.60	.17	170.73	2.37	49.49	.24	51.49	.24	-49.77
2.70	.18	165.64	2.31	47.17	.25	50.53	.22	-51.64
2.80	.19	160.85	2.24	45.04	.26	49.38	.21	-54.34
2.90	.20	156.69	2.18	42.82	.27	48.22	.19	-56.82
3.00	.22	153.43	2.12	40.65	.27	47.15	.17	-59.19
	<b>.</b>							
VCE = 3 V, IC = 10	$0 \text{ mA}, Z_0$	$= 50 \Omega$						

,							
	S11	;	S21	S	312	5	S22
MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.79	-18.18	17.81	156.05	.02	79.00	.92	-14.07
.67	-33.75	15.65	139.27	.03	72.98	.80	-22.91
.55	-46.32	13.67	125.80	.04	69.74	.69	-27.06
.44	-55.16	11.71	115.64	.05	69.07	.61	-28.96
.37	-61.11	10.03	108.02	.06	68.93	.56	-29.47
.31	-65.90	8.70	102.30	.07	68.67	.52	-29.62
.26	-69.64	7.66	97.45	.07	68.49	.49	-29.55
.23	-73.22	6.84	93.31	.08	68.26	.46	-29.57
.20	-76.64	6.18	89.63	.09	68.18	.44	-29.61
.18	-80.09	5.63	86.38	.10	67.74	.43	-29.60
	-84.01	5.17	83.43	.11	67.32	.41	-29.87
.14	-88.42	4.80	80.51	.12	66.68	.40	-29.99
.12		4.47	77.83	.13	65.96	.38	-30.36
		4.18		.14	65.40	.37	-30.99
		3.94			64.56	.36	-31.58
		-				.34	-32.25
							-33.11
						-	-33.82
							-34.82
							-35.72
							-36.80
						-	-37.90
							-39.12
							-40.48
							-42.08
							-43.45
					-	-	-44.76
		-					-46.97
			-				-49.05
.20	146.66	2.21	40.11	.28	48.32	.14	-51.14
	.79 .67 .55 .44 .37 .31 .26 .23 .20 .18	MAG ANG  .79 -18.18 .67 -33.75 .55 -46.32 .44 -55.16 .37 -61.11 .31 -65.90 .26 -69.64 .23 -73.22 .20 -76.64 .18 -80.09 .15 -84.01 .14 -88.42 .12 -94.33 .11 -100.18 .10 -107.91 .09 -116.38 .08 -126.27 .08 -137.48 .08 -148.12 .09 -158.61 .09 -168.26 .10 -176.89 .11 176.30 .12 170.07 .13 164.55 .14 160.22 .16 156.24 .17 152.57 .19 149.35	MAG ANG MAG  .79	MAG         ANG         MAG         ANG           .79         -18.18         17.81         156.05           .67         -33.75         15.65         139.27           .55         -46.32         13.67         125.80           .44         -55.16         11.71         115.64           .37         -61.11         10.03         108.02           .31         -65.90         8.70         102.30           .26         -69.64         7.66         97.45           .23         -73.22         6.84         93.31           .20         -76.64         6.18         89.63           .18         -80.09         5.63         86.38           .15         -84.01         5.17         83.43           .14         -88.42         4.80         80.51           .12         -94.33         4.47         77.83           .11         -100.18         4.18         75.30           .10         -107.91         3.94         72.79           .09         -116.38         3.72         70.38           .08         -126.27         3.53         68.12           .08         -137.48         3.36 </td <td>MAG         ANG         MAG         ANG         MAG           .79         -18.18         17.81         156.05         .02           .67         -33.75         15.65         139.27         .03           .55         -46.32         13.67         125.80         .04           .44         -55.16         11.71         115.64         .05           .37         -61.11         10.03         108.02         .06           .31         -65.90         8.70         102.30         .07           .26         -69.64         7.66         97.45         .07           .23         -73.22         6.84         93.31         .08           .20         -76.64         6.18         89.63         .09           .18         -80.09         5.63         86.38         .10           .15         -84.01         5.17         83.43         .11           .14         -88.42         4.80         80.51         .12           .12         -94.33         4.47         77.83         .13           .11         -100.18         4.18         75.30         .14           .10         -107.91         3.94         <td< td=""><td>MAG         ANG         MAG         ANG         ANG           .79         -18.18         17.81         156.05         .02         79.00           .67         -33.75         15.65         139.27         .03         72.98           .55         -46.32         13.67         125.80         .04         69.74           .44         -55.16         11.71         115.64         .05         69.07           .37         -61.11         10.03         108.02         .06         68.93           .31         -65.90         8.70         102.30         .07         68.67           .26         -69.64         7.66         97.45         .07         68.49           .23         -73.22         6.84         93.31         .08         68.26           .20         -76.64         6.18         89.63         .09         68.18           .18         -80.09         5.63         86.38         .10         67.74           .15         -84.01         5.17         83.43         .11         67.32           .14         -88.42         4.80         80.51         .12         66.68           .12         -94.33         4.47<td>MAG         ANG         MAG         ANG         MAG           .79         -18.18         17.81         156.05         .02         79.00         .92           .67         -33.75         15.65         139.27         .03         72.98         .80           .55         -46.32         13.67         125.80         .04         69.74         .69           .44         -55.16         11.71         115.64         .05         69.07         .61           .37         -61.11         10.03         108.02         .06         68.93         .56           .31         -65.90         8.70         102.30         .07         68.67         .52           .26         -69.64         7.66         97.45         .07         68.49         .49           .23         -73.22         6.84         93.31         .08         68.26         .46           .20         -76.64         6.18         89.63         .09         68.18         .44           .18         -80.09         5.63         86.38         .10         67.74         .43           .15         -84.01         5.17         83.43         .11         67.32         .41     &lt;</td></td></td<></td>	MAG         ANG         MAG         ANG         MAG           .79         -18.18         17.81         156.05         .02           .67         -33.75         15.65         139.27         .03           .55         -46.32         13.67         125.80         .04           .44         -55.16         11.71         115.64         .05           .37         -61.11         10.03         108.02         .06           .31         -65.90         8.70         102.30         .07           .26         -69.64         7.66         97.45         .07           .23         -73.22         6.84         93.31         .08           .20         -76.64         6.18         89.63         .09           .18         -80.09         5.63         86.38         .10           .15         -84.01         5.17         83.43         .11           .14         -88.42         4.80         80.51         .12           .12         -94.33         4.47         77.83         .13           .11         -100.18         4.18         75.30         .14           .10         -107.91         3.94 <td< td=""><td>MAG         ANG         MAG         ANG         ANG           .79         -18.18         17.81         156.05         .02         79.00           .67         -33.75         15.65         139.27         .03         72.98           .55         -46.32         13.67         125.80         .04         69.74           .44         -55.16         11.71         115.64         .05         69.07           .37         -61.11         10.03         108.02         .06         68.93           .31         -65.90         8.70         102.30         .07         68.67           .26         -69.64         7.66         97.45         .07         68.49           .23         -73.22         6.84         93.31         .08         68.26           .20         -76.64         6.18         89.63         .09         68.18           .18         -80.09         5.63         86.38         .10         67.74           .15         -84.01         5.17         83.43         .11         67.32           .14         -88.42         4.80         80.51         .12         66.68           .12         -94.33         4.47<td>MAG         ANG         MAG         ANG         MAG           .79         -18.18         17.81         156.05         .02         79.00         .92           .67         -33.75         15.65         139.27         .03         72.98         .80           .55         -46.32         13.67         125.80         .04         69.74         .69           .44         -55.16         11.71         115.64         .05         69.07         .61           .37         -61.11         10.03         108.02         .06         68.93         .56           .31         -65.90         8.70         102.30         .07         68.67         .52           .26         -69.64         7.66         97.45         .07         68.49         .49           .23         -73.22         6.84         93.31         .08         68.26         .46           .20         -76.64         6.18         89.63         .09         68.18         .44           .18         -80.09         5.63         86.38         .10         67.74         .43           .15         -84.01         5.17         83.43         .11         67.32         .41     &lt;</td></td></td<>	MAG         ANG         MAG         ANG         ANG           .79         -18.18         17.81         156.05         .02         79.00           .67         -33.75         15.65         139.27         .03         72.98           .55         -46.32         13.67         125.80         .04         69.74           .44         -55.16         11.71         115.64         .05         69.07           .37         -61.11         10.03         108.02         .06         68.93           .31         -65.90         8.70         102.30         .07         68.67           .26         -69.64         7.66         97.45         .07         68.49           .23         -73.22         6.84         93.31         .08         68.26           .20         -76.64         6.18         89.63         .09         68.18           .18         -80.09         5.63         86.38         .10         67.74           .15         -84.01         5.17         83.43         .11         67.32           .14         -88.42         4.80         80.51         .12         66.68           .12         -94.33         4.47 <td>MAG         ANG         MAG         ANG         MAG           .79         -18.18         17.81         156.05         .02         79.00         .92           .67         -33.75         15.65         139.27         .03         72.98         .80           .55         -46.32         13.67         125.80         .04         69.74         .69           .44         -55.16         11.71         115.64         .05         69.07         .61           .37         -61.11         10.03         108.02         .06         68.93         .56           .31         -65.90         8.70         102.30         .07         68.67         .52           .26         -69.64         7.66         97.45         .07         68.49         .49           .23         -73.22         6.84         93.31         .08         68.26         .46           .20         -76.64         6.18         89.63         .09         68.18         .44           .18         -80.09         5.63         86.38         .10         67.74         .43           .15         -84.01         5.17         83.43         .11         67.32         .41     &lt;</td>	MAG         ANG         MAG         ANG         MAG           .79         -18.18         17.81         156.05         .02         79.00         .92           .67         -33.75         15.65         139.27         .03         72.98         .80           .55         -46.32         13.67         125.80         .04         69.74         .69           .44         -55.16         11.71         115.64         .05         69.07         .61           .37         -61.11         10.03         108.02         .06         68.93         .56           .31         -65.90         8.70         102.30         .07         68.67         .52           .26         -69.64         7.66         97.45         .07         68.49         .49           .23         -73.22         6.84         93.31         .08         68.26         .46           .20         -76.64         6.18         89.63         .09         68.18         .44           .18         -80.09         5.63         86.38         .10         67.74         .43           .15         -84.01         5.17         83.43         .11         67.32         .41     <

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