

## Appendix D

### SAMPLE S-PARAMETER MODEL

*RF Micro Devices RF2301 Touchstone Format*

Used with permission of RF Micro Devices

#### D.1. RF MICRO DEVICES RF2301 S PARAMETER: TOUCHSTONE FORMAT

```
! Vcc = 5.0V
!
# HZ      S
! freq      ReS11      ImS11      ReS21      ImS21      ReS12      ImS21      ReS22      ImS22
1.00000E+008 7.12835E-001 -3.63994E+001 1.27654E+001 -1.15192E+002 3.47731E-003 -1.02163E+002 9.41197E-001 -8.77695E+000
1.29000E+008 6.77515E-001 -3.80355E+001 1.26185E+001 -1.24682E+002 2.38669E-003 -1.02781E+002 9.14716E-001 -7.94114E+000
1.58000E+008 6.31758E-001 -4.12172E+001 1.28985E+001 -1.36511E+002 6.96522E-004 -7.01082E+001 8.84407E-001 -6.04719E+000
1.87000E+008 5.60678E-001 -4.31970E+001 1.32742E+001 -1.51161E+002 1.11915E-003 4.16082E+001 8.57612E-001 -4.88894E+000
2.16000E+008 5.12883E-001 -4.38271E+001 1.36711E+001 -1.63049E+002 6.63488E-004 -9.20931E+000 8.67972E-001 -6.55131E+000
2.45000E+008 4.77985E-001 -4.62495E+001 1.42084E+001 -1.72564E+002 8.40523E-004 3.19989E+001 8.69005E-001 -7.31170E+000
2.74000E+008 4.36622E-001 -4.88427E+001 1.47677E+001 1.78372E+002 1.21335E-003 3.34036E+001 8.65312E-001 -7.56113E+000
3.03000E+008 3.92198E-001 -4.81999E+001 1.50242E+001 1.68881E+002 6.17196E-004 7.93960E+001 8.54819E-001 -9.05004E+000
3.32000E+008 3.87824E-001 -5.04470E+001 1.51683E+001 1.62885E+002 9.35218E-004 6.72485E+001 8.55270E-001 -9.57558E+000
3.61000E+008 3.58699E-001 -5.22648E+001 1.55322E+001 1.55736E+002 8.10138E-004 5.07971E+001 8.59098E-001 -1.07814E+001
3.90000E+008 3.30669E-001 -5.29561E+001 1.57420E+001 1.48348E+002 6.00418E-004 6.05938E+001 8.54081E-001 -1.19106E+001
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4.19000E+008	3.09918E-001	-5.05009E+001	1.56201E+001	1.41248E+002	1.46806E-003	8.02478E+001	8.46642E-001	-1.20844E+001
4.48000E+008	3.08834E-001	-5.13806E+001	1.56080E+001	1.35722E+002	1.89654E-003	4.47555E+001	8.60679E-001	-1.26328E+001
4.77000E+008	2.86101E-001	-5.19052E+001	1.58416E+001	1.29334E+002	1.60637E-003	3.95619E+001	8.57418E-001	-1.37731E+001
5.06000E+008	2.67945E-001	-5.16910E+001	1.59471E+001	1.22802E+002	1.62588E-003	3.91558E+001	8.52119E-001	-1.45887E+001
5.35000E+008	2.52861E-001	-4.95264E+001	1.58728E+001	1.16437E+002	2.01566E-003	5.05051E+001	8.46187E-001	-1.49925E+001
5.64000E+008	2.45835E-001	-5.23847E+001	1.60644E+001	1.11394E+002	1.87603E-003	2.41937E+001	8.55043E-001	-1.63283E+001
5.93000E+008	2.26932E-001	-5.27479E+001	1.62435E+001	1.05550E+002	1.52931E-003	2.30966E+001	8.49514E-001	-1.73798E+001
6.22000E+008	2.13969E-001	-5.18740E+001	1.63466E+001	9.96711E+001	1.60521E-003	2.60503E+001	8.44441E-001	-1.82948E+001
6.51000E+008	2.04110E-001	-4.97439E+001	1.63605E+001	9.38675E+001	1.56886E-003	3.35663E+001	8.37751E-001	-1.89154E+001
6.80000E+008	2.04933E-001	-5.18869E+001	1.64261E+001	8.88554E+001	2.20010E-003	1.47696E+001	8.47583E-001	-1.95897E+001
7.09000E+008	1.92109E-001	-5.13135E+001	1.64468E+001	8.28611E+001	2.06457E-003	1.13690E+001	8.41576E-001	-2.07207E+001
7.38000E+008	1.82346E-001	-5.00904E+001	1.64718E+001	7.71856E+001	2.00262E-003	1.32049E+001	8.34510E-001	-2.16508E+001
7.67000E+008	1.76148E-001	-4.80899E+001	1.64403E+001	7.14902E+001	1.83130E-003	2.12608E+001	8.26189E-001	-2.22821E+001
7.96000E+008	1.73742E-001	-5.04682E+001	1.64719E+001	6.62731E+001	2.64516E-003	9.94202E+000	8.36486E-001	-2.30161E+001
8.25000E+008	1.60213E-001	-4.87987E+001	1.64611E+001	6.05387E+001	2.08643E-003	1.26373E+000	8.26902E-001	-2.43479E+001
8.54000E+008	1.53981E-001	-4.58993E+001	1.64010E+001	5.53263E+001	2.00936E-003	3.68043E+000	8.17991E-001	-2.51444E+001
8.83000E+008	1.52874E-001	-4.40729E+001	1.63417E+001	5.01712E+001	2.23439E-003	1.54398E+001	8.12048E-001	-2.54653E+001
9.12000E+008	1.50423E-001	-4.54685E+001	1.63820E+001	4.52306E+001	2.92996E-003	7.02035E+000	8.18777E-001	-2.59920E+001
9.41000E+008	1.41661E-001	-4.28033E+001	1.63441E+001	3.94527E+001	2.32366E-003	3.94782E+000	8.06687E-001	-2.71544E+001
9.70000E+008	1.39474E-001	-4.18381E+001	1.62270E+001	3.42008E+001	2.42691E-003	1.04770E+001	8.00261E-001	-2.76888E+001
9.99000E+008	1.40992E-001	-4.26558E+001	1.62003E+001	2.94330E+001	3.10010E-003	1.64656E+001	8.01764E-001	-2.75931E+001
1.02800E+009	1.33468E-001	-4.22929E+001	1.62729E+001	2.42256E+001	3.18310E-003	1.18884E+000	8.02887E-001	-2.89207E+001
1.05700E+009	1.27366E-001	-3.93545E+001	1.62472E+001	1.85417E+001	2.75855E-003	-3.81836E+000	7.92099E-001	-3.00491E+001
1.08600E+009	1.29765E-001	-3.64683E+001	1.61104E+001	1.32175E+001	2.79507E-003	6.23630E+000	7.83311E-001	-3.04423E+001
1.11500E+009	1.25743E-001	-3.53005E+001	1.60763E+001	8.19655E+000	3.09725E-003	-8.07147E-001	7.86705E-001	-3.12310E+001
1.14400E+009	1.18252E-001	-3.23802E+001	1.60471E+001	2.91273E+000	2.78723E-003	-1.48695E+001	7.81894E-001	-3.27969E+001
1.17300E+009	1.17999E-001	-3.06407E+001	1.59866E+001	-2.21780E+000	2.53881E-003	-9.11822E+000	7.74499E-001	-3.32662E+001
1.20200E+009	1.20035E-001	-3.03429E+001	1.59561E+001	-7.31727E+000	2.62066E-003	2.65936E+000	7.69527E-001	-3.34140E+001
1.23100E+009	1.16071E-001	-2.91799E+001	1.59543E+001	-1.24425E+001	2.93711E-003	-1.37616E+001	7.75217E-001	-3.44151E+001
1.26000E+009	1.16633E-001	-2.65056E+001	1.57975E+001	-1.76229E+001	2.75465E-003	-1.36291E+001	7.64004E-001	-3.52283E+001
1.28900E+009	1.18208E-001	-2.45238E+001	1.57483E+001	-2.25856E+001	2.47829E-003	-1.28597E+001	7.55299E-001	-3.56674E+001
1.31800E+009	1.18986E-001	-2.51823E+001	1.57102E+001	-2.76618E+001	2.76444E-003	-4.44684E+000	7.50370E-001	-3.57942E+001
1.34700E+009	1.15001E-001	-2.37676E+001	1.57078E+001	-3.29664E+001	3.18512E-003	-1.94047E+001	7.55975E-001	-3.68755E+001
1.37600E+009	1.16050E-001	-2.24960E+001	1.55648E+001	-3.80793E+001	2.88782E-003	-2.24554E+001	7.46548E-001	-3.75028E+001
1.40500E+009	1.16327E-001	-2.21695E+001	1.54891E+001	-4.27286E+001	2.80027E-003	-2.05612E+001	7.40382E-001	-3.79417E+001
1.43400E+009	1.18070E-001	-2.29946E+001	1.54656E+001	-4.74861E+001	2.83846E-003	-1.33429E+001	7.35726E-001	-3.80678E+001

1.46300E+009	1.14578E-001	-2.04822E+001	1.54818E+001	-5.26588E+001	3.34643E-003	-2.87727E+001	7.44391E-001	-3.92134E+001
1.49200E+009	1.18006E-001	-1.94682E+001	1.53791E+001	-5.78444E+001	2.75749E-003	-2.80208E+001	7.31978E-001	-3.99328E+001
1.52100E+009	1.20704E-001	-1.93689E+001	1.52317E+001	-6.28123E+001	2.42271E-003	-2.36728E+001	7.24648E-001	-4.01572E+001
1.55000E+009	1.23125E-001	-1.91574E+001	1.51931E+001	-6.77079E+001	2.57289E-003	-1.12943E+001	7.20684E-001	-3.99789E+001
1.57900E+009	1.16581E-001	-1.59536E+001	1.52778E+001	-7.28391E+001	4.20948E-003	-2.00668E+001	7.37518E-001	-4.02721E+001
1.60800E+009	1.19492E-001	-1.40283E+001	1.52896E+001	-7.80362E+001	4.31364E-003	-2.37300E+001	7.29168E-001	-4.11990E+001
1.63700E+009	1.20157E-001	-1.29112E+001	1.52237E+001	-8.33603E+001	4.47006E-003	-2.12163E+001	7.24973E-001	-4.16059E+001
1.66600E+009	1.16508E-001	-1.02334E+001	1.52317E+001	-8.83724E+001	5.68082E-003	-1.93148E+001	7.33666E-001	-4.15449E+001
1.69500E+009	1.18053E-001	-6.16231E+000	1.51427E+001	-9.33866E+001	6.18503E-003	-3.27424E+001	7.42218E-001	-4.34206E+001
1.72400E+009	1.25489E-001	-4.85824E+000	1.50523E+001	-9.85554E+001	5.18499E-003	-4.35039E+001	7.23996E-001	-4.53655E+001
1.75300E+009	1.28495E-001	-5.11651E+000	1.49469E+001	-1.03702E+002	4.69936E-003	-4.39208E+001	7.13979E-001	-4.58295E+001
1.78200E+009	1.31252E-001	-3.57260E+000	1.48313E+001	-1.08882E+002	4.87354E-003	-4.53657E+001	7.11224E-001	-4.62465E+001
1.81100E+009	1.38703E-001	-2.32966E+000	1.46450E+001	-1.14112E+002	4.64966E-003	-5.51145E+001	7.04487E-001	-4.79621E+001
1.84000E+009	1.40776E-001	-2.36681E+000	1.45721E+001	-1.19043E+002	4.27891E-003	-5.32785E+001	6.92328E-001	-4.85382E+001
1.86900E+009	1.41858E-001	-3.06445E+000	1.45358E+001	-1.24110E+002	4.07220E-003	-5.36588E+001	6.85718E-001	-4.88525E+001
1.89800E+009	1.44869E-001	-2.71368E+000	1.44563E+001	-1.29540E+002	4.10728E-003	-5.42520E+001	6.81448E-001	-4.92532E+001
1.92700E+009	1.48217E-001	-1.43939E+000	1.43217E+001	-1.34956E+002	4.27031E-003	-5.50344E+001	6.81082E-001	-4.99347E+001
1.95600E+009	1.53036E-001	-2.03705E+000	1.41599E+001	-1.39957E+002	4.42108E-003	-5.43278E+001	6.76306E-001	-5.04304E+001
1.98500E+009	1.58133E-001	-1.85242E+000	1.40400E+001	-1.44758E+002	4.13399E-003	-5.41621E+001	6.70988E-001	-5.07273E+001
2.01400E+009	1.63048E-001	-1.47203E+000	1.39813E+001	-1.49886E+002	4.00876E-003	-5.17649E+001	6.66806E-001	-5.08770E+001
2.04300E+009	1.68185E-001	9.95526E-001	1.39206E+001	-1.55391E+002	4.28736E-003	-4.25570E+001	6.71566E-001	-5.05521E+001
2.07200E+009	1.79239E-001	5.85342E-001	1.36921E+001	-1.60765E+002	4.89121E-003	-4.58137E+001	6.81398E-001	-5.15903E+001
2.10100E+009	1.87898E-001	-1.90768E-001	1.35014E+001	-1.65573E+002	5.05406E-003	-5.22533E+001	6.82325E-001	-5.28800E+001
2.13000E+009	1.91649E-001	-6.79726E-001	1.34082E+001	-1.70570E+002	5.52826E-003	-5.47602E+001	6.84155E-001	-5.38963E+001
2.15900E+009	2.00697E-001	-4.18194E-001	1.32621E+001	-1.76228E+002	6.25205E-003	-5.27407E+001	6.91350E-001	-5.49286E+001
2.18800E+009	2.07866E-001	-2.66539E+000	1.29716E+001	1.78365E+002	6.82802E-003	-6.05124E+001	6.92034E-001	-5.75931E+001
2.21700E+009	2.07894E-001	-3.96038E+000	1.27319E+001	1.73652E+002	6.58380E-003	-6.74272E+001	6.77105E-001	-5.93919E+001
2.24600E+009	2.06393E-001	-3.73025E+000	1.25907E+001	1.68679E+002	6.08549E-003	-7.09120E+001	6.65081E-001	-6.04201E+001
2.27500E+009	2.09002E-001	-3.14723E+000	1.25275E+001	1.63588E+002	5.96831E-003	-7.11547E+001	6.57299E-001	-6.12431E+001
2.30400E+009	2.12537E-001	-4.16650E+000	1.23730E+001	1.58471E+002	6.07011E-003	-7.92612E+001	6.50749E-001	-6.28666E+001
2.33300E+009	2.13971E-001	-4.26349E+000	1.22250E+001	1.53432E+002	5.86817E-003	-8.53531E+001	6.37774E-001	-6.37353E+001
2.36200E+009	2.17792E-001	-3.66748E+000	1.20470E+001	1.48285E+002	5.62886E-003	-8.97986E+001	6.26600E-001	-6.42723E+001
2.39100E+009	2.22186E-001	-3.05487E+000	1.18819E+001	1.43199E+002	5.42555E-003	-8.78241E+001	6.18221E-001	-6.46354E+001
2.42000E+009	2.30241E-001	-3.90652E+000	1.16920E+001	1.38101E+002	5.80811E-003	-8.76215E+001	6.16526E-001	-6.52934E+001
2.44900E+009	2.32758E-001	-4.17674E+000	1.15992E+001	1.32931E+002	5.94115E-003	-8.94896E+001	6.08699E-001	-6.62881E+001
2.47800E+009	2.38490E-001	-3.58937E+000	1.13945E+001	1.27386E+002	5.69950E-003	-9.13279E+001	6.01230E-001	-6.67781E+001

2.50700E+009	2.49305E-001	-3.50021E+000	1.11017E+001	1.22168E+002	6.03928E-003	-8.63785E+001	6.03887E-001	-6.69177E+001
2.53600E+009	2.56532E-001	-4.72204E+000	1.08668E+001	1.17665E+002	6.93770E-003	-8.93601E+001	6.08891E-001	-6.87297E+001
2.56500E+009	2.59613E-001	-5.23711E+000	1.07782E+001	1.12752E+002	7.05405E-003	-9.44663E+001	6.02196E-001	-7.08075E+001
2.59400E+009	2.62237E-001	-5.09754E+000	1.05943E+001	1.07482E+002	6.99113E-003	-9.98118E+001	5.93142E-001	-7.21552E+001
2.62300E+009	2.64957E-001	-5.36979E+000	1.03279E+001	1.02578E+002	7.24497E-003	-1.02931E+002	5.88220E-001	-7.35940E+001
2.65200E+009	2.64694E-001	-5.43485E+000	1.01783E+001	9.83552E+001	7.69655E-003	-1.10221E+002	5.78518E-001	-7.58289E+001
2.68100E+009	2.65917E-001	-4.95422E+000	1.01283E+001	9.35517E+001	7.17747E-003	-1.13674E+002	5.63435E-001	-7.69114E+001
2.71000E+009	2.69304E-001	-4.72886E+000	1.00402E+001	8.81774E+001	6.94801E-003	-1.17081E+002	5.52918E-001	-7.78025E+001
2.73900E+009	2.75841E-001	-4.68968E+000	9.89124E+000	8.24147E+001	6.71728E-003	-1.19242E+002	5.43725E-001	-7.86283E+001
2.76800E+009	2.81373E-001	-4.99639E+000	9.68541E+000	7.71247E+001	6.52915E-003	-1.21314E+002	5.35179E-001	-7.95525E+001
2.79700E+009	2.83545E-001	-5.09421E+000	9.46931E+000	7.19715E+001	6.16719E-003	-1.23971E+002	5.25517E-001	-8.04802E+001
2.82600E+009	2.85346E-001	-4.79443E+000	9.31943E+000	6.68550E+001	5.99775E-003	-1.27267E+002	5.16116E-001	-8.14238E+001
2.85500E+009	2.91490E-001	-4.62092E+000	9.14865E+000	6.12326E+001	5.65443E-003	-1.30071E+002	5.06424E-001	-8.23294E+001
2.88400E+009	2.97602E-001	-4.62897E+000	8.90182E+000	5.58562E+001	5.17133E-003	-1.33867E+002	4.97859E-001	-8.33171E+001
2.91300E+009	3.02936E-001	-4.78473E+000	8.63178E+000	5.08186E+001	4.77386E-003	-1.34346E+002	4.89198E-001	-8.41135E+001
2.94200E+009	3.08256E-001	-4.62798E+000	8.46387E+000	4.59665E+001	4.29673E-003	-1.32281E+002	4.81388E-001	-8.48115E+001
2.97100E+009	3.14804E-001	-4.58444E+000	8.32749E+000	4.15391E+001	3.91961E-003	-1.28397E+002	4.76475E-001	-8.51833E+001
3.00000E+009	3.17469E-001	-4.48234E+000	8.14422E+000	3.82255E+001	3.73790E-003	-1.23905E+002	4.74066E-001	-8.54623E+001