Wideband Amplifier
1.5 - 47 GHz

CGY2160UH/C1
Rev. V1

Features

- Wide Frequency Range: 1.5 - 47 GHz
- Small Signal Gain: 14.5 dB
- Variable Gain Control
- Output P1dB: 17 dBm @ 10 GHz
- Noise Figure: 2.5 dB @ 10 GHz
- DC Supply Voltage: +5.0 V; -5.2 V
- Power Consumption: 500 mW
- On-Chip Biasing Network
- Chip Size: 1490 x 2580 µm
- 100% RF Tested, Inspected Known Good Die
- Samples Available
- Space & MIL-STD Available
- RoHS* Compliant

Applications

- 43 Gb/s OC-768 Receiver
- 43 Gb/s OC-768 EAM Driver
- Instrumentation
- EW Systems
- General Purpose Wide Band Amplifier

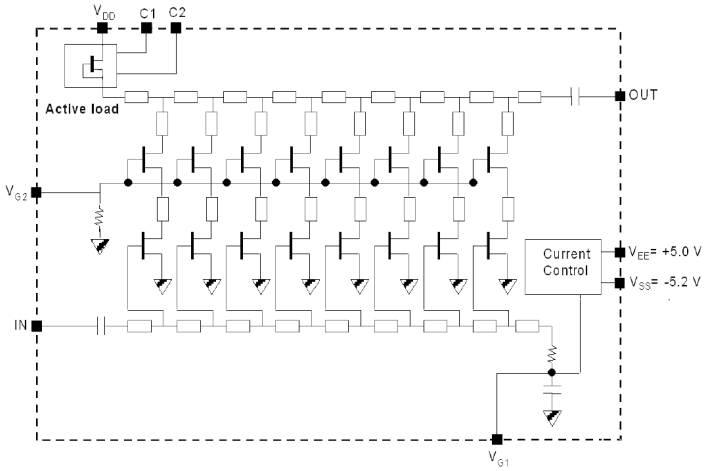
Description

The CGY2160UH/C1 is a distributed wide band amplifier designed to operate from 1.5 to 47 GHz. This device offers low noise performance (2.5 dB noise figure at mid-band) while maintaining good P1dB compression point (17 dBm at 10 GHz).

The on-chip bias network includes a current control function which maintains the device operating close to the nominal biasing point over temperature and component variation.

The MMIC is manufactured using a qualified 0.13 µm pHEMT GaAs D01PH technology. The D01PH process is one of the European Space Agency (ESA) European preferred part list (EPPL) technologies.

Block Diagram



Ordering Information

Part Number	Package
CGY2160UH/C1	Die

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

DC Electrical Specifications:
Freq. = 1.5 - 47 GHz, V_{DD} = 5 V, V_{EE} = 5V V_{SS} = -5.2 V, T_A = +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Drain Supply Current	—	mA	65	80	95
DC Supply Current (I_{EE})	—	mA	9	13	15
DC Supply Current (I_{SS})	—	mA	7	10	12

AC Electrical Specifications: On Wafer,
Freq. = 1.5 - 47 GHz, V_{DD} = 5 V, V_{EE} = 5 V, V_{SS} = -5.2 V, IDD = 80 mA, RL = 50 Ω, T_A = +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Gain	5 GHz	dB	13.5	14.5	16.5
Frequency Cutoff	High (Gain 5 GHz - 3 dB)	GHz	43	47	50
Small Signal Gain Flatness	1.5 - 30 GHz 30 - 40 GHz 40 GHz to F_C	dB	-1.0 — -3.0	—	1.0 2.5 —
Input Return Loss	1.5 - 5 GHz 5 - 35 GHz 35 - 40 GHz 40 - 45 GHz 45 - 65 GHz	dB	—	-10.0 -17.0 -15.0 — —	-8.0 -13.0 -10.0 -3.0 -0.5
Output Return Loss	1.5 - 3 GHz 3 - 30 GHz 30 - 50 GHz 50 - 65 GHz	dB	—	-15 -13 -12 —	-9 -11 -10 -0.5
Noise Figure	2 - 4 GHz 4 - 20 GHz 20 - 29 GHz 29 - 36 GHz	dB	—	3.5 2.5 3.5 4.5	—
Output P1dB	10 GHz 20 GHz	dBm	—	17 16	—
Microwave Stability Factor	-10°C to +85°C, All passive source and load	-	1.4	—	—

Absolute Maximum Ratings[5,6]

Parameter	Absolute Maximum
CW Input Power[1]	17 dBm
Positive Supply Voltage[2] (V_{DD})	-0.5 V to +8.0 V
Positive Supply Voltage[2] (V_{EE})	-0.5 V to +8.0 V
Negative Supply Voltage[2] (V_{SS})	-6 V to 0 V
Gate Voltage 2[2]	-0.5 to +3.0 V
Supply Current[2]	150 mA
Thermal Resistance	48°C/W
Junction Temperature[2]	+150°C
Storage Temperature	-55°C to +150°C

1. When P_{IN} = 17 dBm is applied at the input of the device for 15 min. no performance degradation is observed after power exposure.
2. Exceeding any one or combination of these limits may cause permanent damage to this device.
3. MACOM does not recommend sustained operation near these survivability limits.

Operating Conditions

Parameter	Value
Positive Supply Voltage (V_{DD})	+4.75 V to +5.25 V
Positive Supply Voltage (V_{EE})	+5.0 V
Negative Supply Voltage (V_{SS})	-5.2 V
Gate Voltage 2	-0.2 to +2.0 V
Supply Current	150 mA
Operating Temperature	-10°C to +85°C

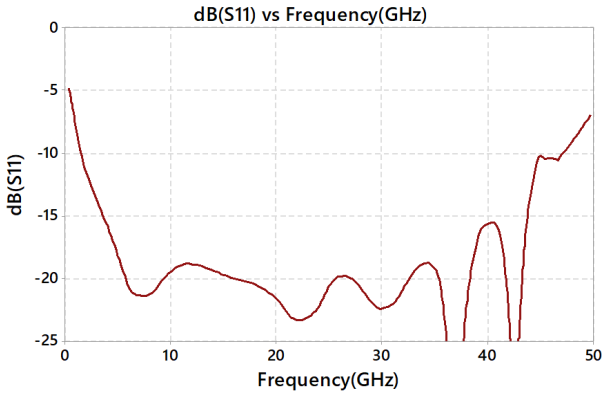
Handling Procedures

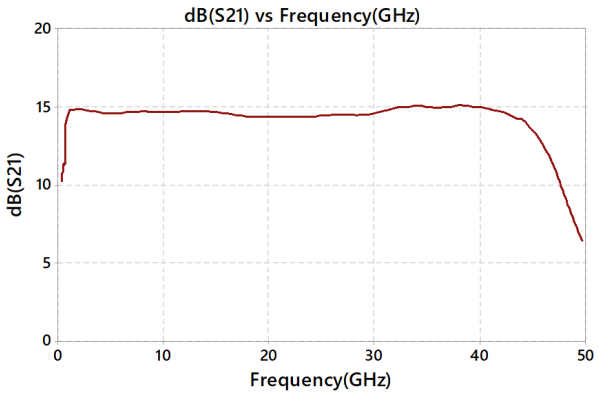
Please observe the following precautions to avoid damage:

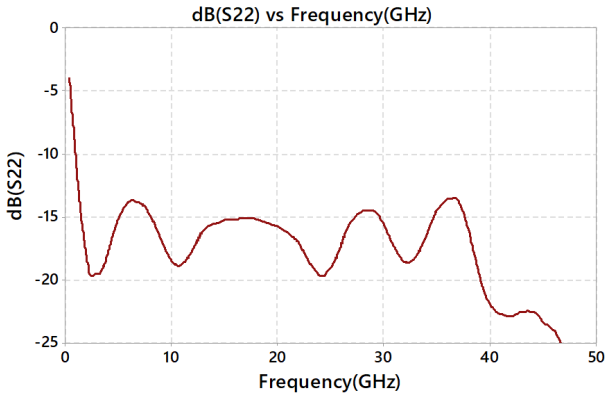
Static Sensitivity

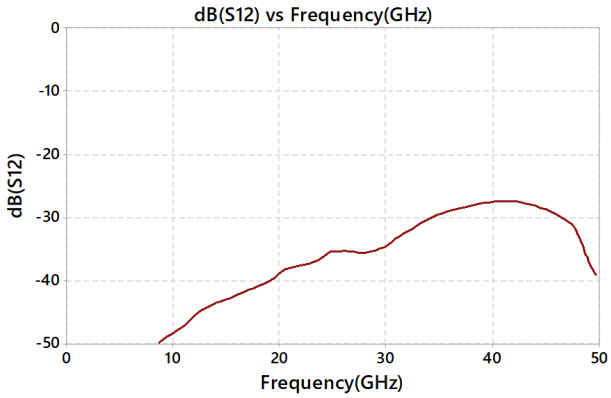
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

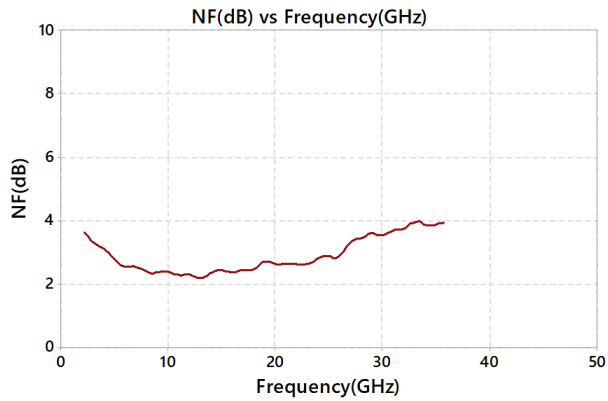
Typical Performance Curves: On Wafer, V_{DD} = 5 V, V_{EE} = 5 V, V_{SS} = -5.2 V, T_A = +25°C

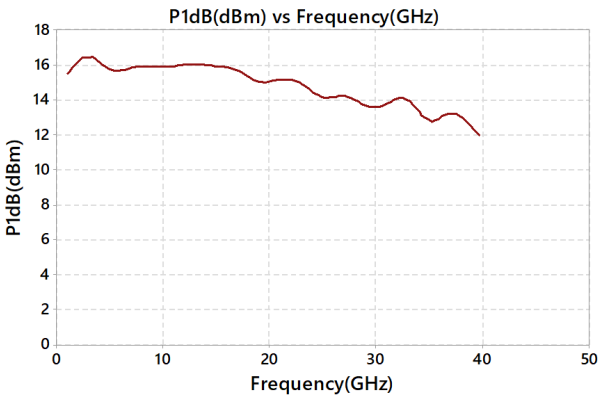


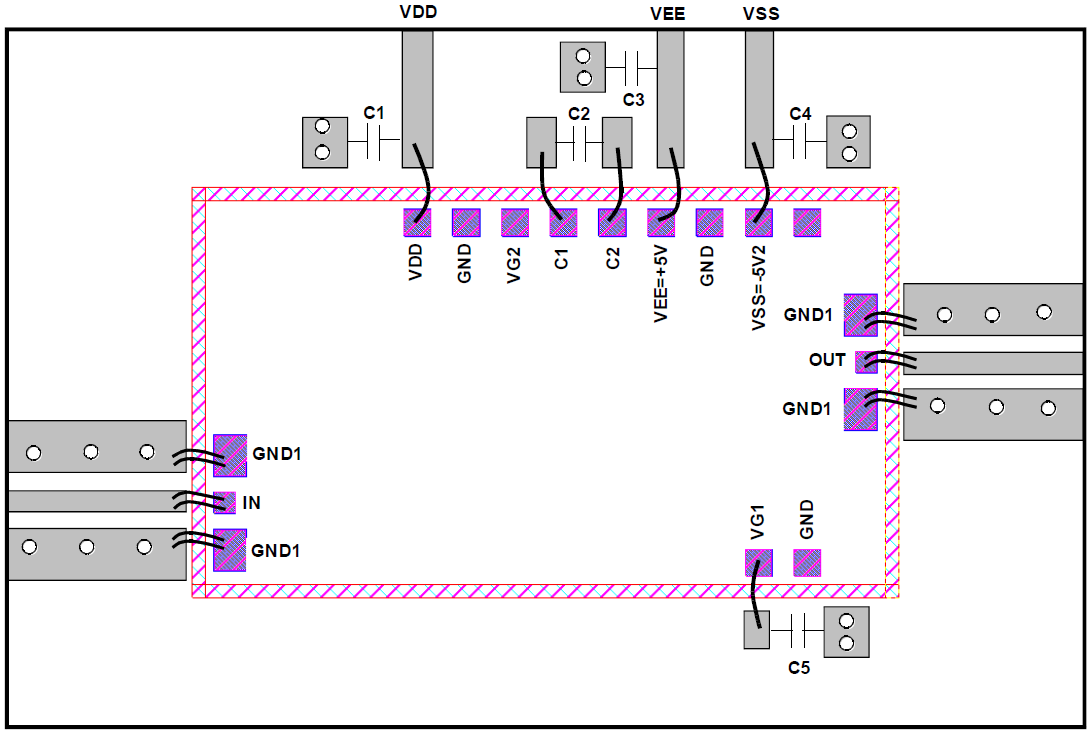












Chip assembly and Bonding diagram : with automatic current control via V_{EE} and V_{SS}.

Recommended Parts List

Component	Value	Package
C1, C3, C4, C5	100 nF	0402 sub-mount capacitors
C2	47 pF	Chip capacitor from appropriate manufacturer

Operating & Handling Instructions

This amplifier is a very high performance GaAs device and as such, care must be taken at all times to avoid damage due to inappropriate handling, mounting, packaging and biasing conditions.

1- Power Supply Sequence

The following power supply sequence is recommended.

i) Apply VSS and VEE
ii) Apply VDD
iii) Apply the RF input signal

2- Mounting and ESD handling precautions

For high performance Integrated Circuits, such as this device, care must be taken when mounting GaAs MMICs so as to correctly mount, bond and subsequently seal the packages and hence obtain the most reliable long-term operation.

Application Information

Wedge-Wedge or Ribbon bonding is highly recommended to maintain the shortest possible bond wires. Degradation of gain and matching will be seen if the RF input and output inductances are not minimized. All others bond wire connections should also be kept as short as possible.

All RF input and output bonding inductance should be minimized to give the best performance of the module assembly. Two gold wires are recommended with maximum separation between the wires. Overall wire length should be kept less than 0.4 mm to keep the total equivalent inductance to less than 0.2 nH.

This MMIC has via holes connecting the front side to the backside of the chip. A good RF grounding connection should be maintained between the backside of the chip and system ground. The chip should be attached to ground plane using either AuSn solder or conductive epoxy material.

Capacitors C1, C3, C4, C5 are used for power supply rejection. The C2 capacitor is used to improve the low frequency gain flatness. The gain has a typical low frequency cut-off of 500 MHz but the device is specified at 1.5 GHz due to the input return loss being higher than -10 dB at low frequencies.

Biasing Information

The nominal bias conditions is V_{DD} = +5.0 V, V_{EE} = +5.0 V, V_{SS} = -5.2 V. This is a good linear operating point. V_{EE} and V_{SS} are used for current control. Power supply sequence will be as follow: apply V_{SS} first, then V_{EE} and finally V_{DD}.

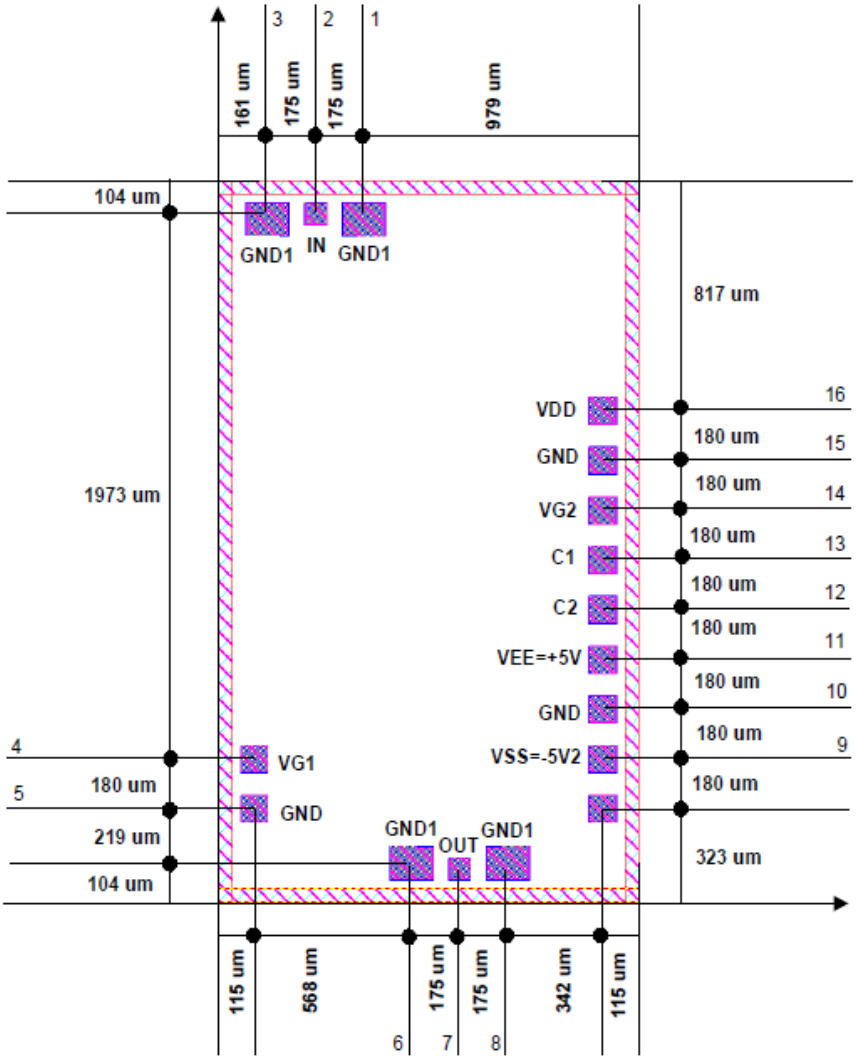
Other biasing points can be used depending on the application:

For application needing lower small signal amplification (gain control),VG2 can be set in the range of values specified in the DC characteristics table. VG2 will be applied after applying V_{DD}. The values of V_{SS} and V_{EE} are maintained at their typical values, -5.2 V and +5.0 V respectively.

DC blocks

The amplifier has on-chip MIM capacitors on the input and output RF lines which provide DC isolation. Therefore, external coupling capacitors are not required into the RF paths.

Mechanical Information



Chip Size = 1490 x 2580 µm (Tolerance ± 15 µm)
V_{DD}, GND, V_{G2}, C1, C2, V_{EE}, V_{SS}, V_{G1} Pads = 100 x 100 µm
IN/OUT Pads = 79 x 79 µm
GND1 Pads = 154 x 120 µm
Chip Thickness = 100 µm
Backside Metal = TiAu

Pad Position[4]

Pad Name	Pad#	Coordinate		Description
		X	Y	
GND1	1	2476	511	Ground
IN	2	2476	336	RF Input
GND1	3	2476	161	Ground
V_{G1}	4	503	115	Must be decoupled to ground using an external capacitor
GND	5	323	115	Ground
GND1	6	104	683	Ground
OUT	7	104	858	RF Output
GND1	8	104	1033	Ground
V_{SS} = -5.2V	9	503	1375	DC supply voltage, used for current control, must be decoupled to ground using external capacitor
GND	10	683	1375	ground
V_{EE} = 5V	11	863	1375	DC supply voltage, used for current control, must be decoupled to ground using external capacitor
C2	12	1043	1375	Used for connecting an external capacitor
C1	13	1223	1375	Used for connecting an external capacitor
V_{G2}	14	1403	1375	Do not bond
GND	15	1583	1375	Ground
V_{DD}	16	1763	1375	Drain supply voltage, must be decoupled to ground using external capacitor

4. X = 0, Y = 0 at bottom left corner.

Tamb = 25°C, VDD = +5.0 V, VEE = 5.0 V, VSS = -5.2 V, IDD = 80 mA, RL = 50 Ω.

Freq(GHz)	MagS11	AngS11	MagS21	AngS21	MagS12	AngS12	Mag(S22)	AngS22
0.3	-3.02	-37.62	9.881	-96.44	-69.88	162.4	-3.027	-43.4
0.7	-6.831	-51.42	14.07	-150.8	-58.89	95.14	-8.427	-62.07
1.1	-8.986	-58.36	14.7	-175.6	-55.65	57.09	-12.45	-66.13
1.5	-10.46	-64.38	14.84	167.8	-54.44	34.04	-15.74	-64.38
2	-11.83	-71.36	14.92	151.7	-55.02	10.24	-19.1	-51.44
2.5	-12.83	-79.33	14.9	137.4	-55.73	-2.742	-20.84	-35.51
3	-13.7	-88.62	14.8	124.2	-55.98	-2.572	-21.72	-17.66
3.5	-14.79	-98.76	14.66	112.3	-54.92	-27.61	-20.91	4.993
4	-15.66	-110.3	14.52	101.3	-58.48	-28.95	-17.97	16.09
5	-18.05	-139.1	14.49	80.2	-59.6	3.552	-13.6	5.871
7	-23.5	122	14.72	36.64	-51.36	-31.11	-12.09	-34.66
9	-20.16	17.31	14.67	-7.392	-49.3	-56.77	-17.01	-66.34
11	-18.02	-49.36	14.66	-50.48	-47.32	-93.41	-21.66	-11.5
13	-18.57	-115.1	14.76	-93.8	-43.91	-125	-14.22	-20.29
15	-20.45	164.3	14.69	-138.2	-43.14	-163.5	-14.47	-46.83
17	-19.98	78.7	14.46	177.8	-41.53	162.3	-16.34	-48.42
19	-20.21	3.304	14.35	134.6	-40.2	133.5	-14.73	-49.99
21	-22.53	-79.11	14.37	91.81	-37.52	78.04	-13.5	-76.9
23	-25.8	158.8	14.37	46.9	-37.74	49.05	-19.97	-107.4
25	-19.46	69.79	14.43	2.235	-34.89	12.39	-21.86	-3.818
27	-18.78	-2.447	14.59	-43.89	-35.65	-38.81	-12.78	-43.9
29	-22.51	-70.28	14.39	-89.32	-35.69	-74.05	-13.06	-80.61
31	-23.73	165.4	14.74	-134.6	-33.23	-110.3	-17.89	-110.1
33	-18.11	80.23	15.29	173.7	-31.16	-160.6	-20.95	-28.43
35	-18.51	21.23	15.01	121.7	-29.59	149.9	-12.93	-56.66
35.5	-20.22	6.44	14.91	109.5	-29.12	136.6	-12.26	-67.76
36	-23.38	-9.562	15	97.54	-28.82	123.4	-11.95	-78.84
36.5	-29.86	-16.57	14.97	84.03	-28.6	109.9	-12.18	-91.32
37	-44.12	84.02	14.88	71.74	-28.75	96.81	-13.06	-102.6
37.5	-26.56	119.8	15.04	59.57	-28.57	86.44	-14.01	-111.5
38	-21.45	108.3	15.1	46.28	-28.16	75.53	-15.46	-119.7
38.5	-18.52	95.53	15.31	32.73	-27.87	62.95	-17.13	-125
39	-16.43	83.37	15.24	17.98	-27.73	49.17	-19.53	-130.5
39.5	-15.2	69.39	15.3	3.601	-27.69	36.91	-22.5	-122.7
40	-14.79	56.67	15.2	-11.16	-27.67	23.78	-23.82	-111.5
40.5	-14.7	42.87	14.98	-25.59	-27.65	11.86	-24.4	-94.63
41	-15.62	28.84	14.88	-39.45	-27.43	-0.9687	-23.46	-86.63
41.5	-17.73	14.29	14.73	-53	-27.49	-15.47	-22.71	-85.02
42	-22.7	6.105	14.72	-67	-27.65	-28.05	-23.27	-89.08
42.5	-32.85	30.98	14.81	-82.09	-27.49	-41.89	-23.93	-76.89
43	-23.03	129.1	14.6	-97.9	-27.86	-56.87	-23.15	-69.45
43.5	-16.47	120.8	14.52	-113.5	-27.77	-71	-22.11	-66.25
44	-12.73	107.4	14.3	-129.3	-28.18	-86.86	-20.48	-66.37
45	-9.244	77.42	13.69	-161.9	-28.85	-116.2	-19.8	-90.23
46	-9.312	51.15	12.72	166.1	-29.67	-144.3	-22.81	-102.2
47	-12.29	44.47	11.46	133.9	-30.08	-178.9	-25.43	-99.08
48	-11.21	70.94	9.539	104.2	-32.64	143	-30.22	-91.09
49	-7.33	64.73	7.635	79.35	-37.62	117.3	-31.3	-35.28
50	-5.894	55.11	6.036	60.29	-39.17	123.3	-24.35	-26.23
51	-4.385	47.77	5.797	42.49	-37.66	120.6	-21.37	-53.51
53	-2.464	25.52	6.207	-9.246	-32.72	83.6	-21.94	179.8
55	-1.974	7.453	5.82	-72.83	-30.28	31	-13.69	59.33
57	-1.705	-6.393	5.087	-138.4	-28.33	-39.33	-15.01	-4.052
58	-1.729	-12.98	4.586	-172.3	-27.65	-65.17	-22.14	16.58
59	-1.884	-18.35	3.668	153.1	-27.57	-97.43	-13.74	54.9
60	-1.942	-22.32	3.37	117.1	-27.34	-135.5	-9.119	26.9
61	-1.958	-25.48	2.964	76.03	-27.96	179.7	-8.565	-13.97
62	-1.684	-32.33	3.8	24.65	-26.48	128.4	-13.44	-122.8
63	-2.258	-37.93	-0.3021	-45.56	-27.99	49.22	-3.593	88.19
64	-2.491	-37.36	-6.14	-93.87	-34.85	-5.534	-1.471	37.22
65	-2.488	-39.02	-13.94	-129.3	-41.16	-24.08	-1.207	12.06