Medium Gain Broadband Amplifier
DC - 54 GHz

CGY2144UH/C2
Rev. V1

Features

- Suitable for 43 Gb/s Optical Fiber Links
- Wide Frequency Range: DC - 54 GHz
- Small Signal Gain: 13 dB
- Noise Figure: 2.5 dB @ 20 GHz
- Fast Rise/Fall Time: <10 ps
- Transimpedance Gain: 280 Ω, (49 dBΩ)
- Input current density: 10 pA/Hz @ 30 GHz
- Overload: >3.5 mApp
- Low Group Delay Variation: ±7 ps @ 25 GHz
- Single Positive Supply Voltage: 5 V
- Chip Size: 1490 x 2170 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

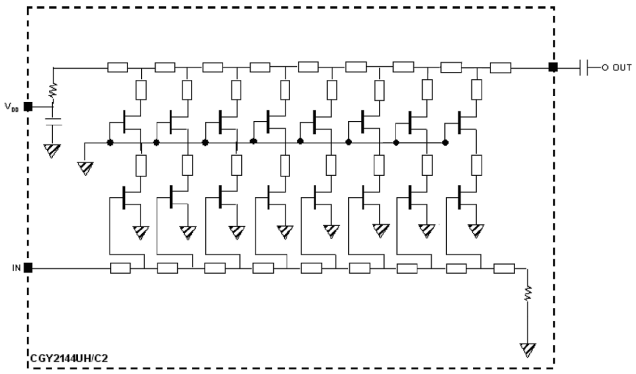
Description

The CGY2144UH/C2 is a broadband distributed amplifier designed especially for OC-768 (43 Gb/s) based fiber optic networks. The amplifier can be used as a Transimpedance Amplifier (TIA) or either as a driver amplifier for Electro-Absorption Modulator (EAM). This amplifier can also be used as a flexible multi-purpose gain block.

This device features single ended RF input and output and operates with a power consumption of typically 500 mW. It requires only a single 5 V supply via on-chip bias network and a minimum number of external components.

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
CGY2144UH/C2	Die

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

AC Electrical Specifications:
On Wafer, Freq. = DC - 54 GHz, V_{DD} = 5 V, RL = 50 Ω, T_A = +25°C

(When the amplifier is treated as a TIA, the following parameters are assumed: Photodiode and input parasitic capacitance CPH = 50 fF, total photodiode bonding inductance LPH = 0.3 nH, RPH = 15 Ω)

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Serial Data Rate	NRZ	Gb/s	43	—	—
Reference Gain	500 MHz[3]	dB	11	13	—
Gain Ripple[4]	500 MHz - 35 GHz 35 GHz - frequency cutoff	dB	— -3.0	±0.5 +1.0	±1.0 +3.0
Frequency Cutoff	High (Gain 3 GHz - 3 dB) See note 5	GHz	45	54	—
Group Delay	3 - 33 GHz 33 - 40 GHz	ps	— 6	7 —	9 25
Rise/Fall Time	See note 6	Ps	—	—	10
Input Return Loss	F = 500 MHz to 45 GHz F = 45 GHz to 50 GHz	dB	—	-13 -11	-10 -7.0
Output Return Loss	F = 500 MHz to 35 GHz F = 35 GHz to 50 GHz	dB	—	-13 -12	-10 -7
Jitter	See note 6	ps-rms	—	—	1
Noise Figure	5 - 35 GHz	dB	—	4	—
Low Frequency Transimpedance Gain	F=500 MHz[7]	dBOhm	45	49	—
Transimpedance high frequency cut-off FC_ZT	|ZT|LF -3 dB	GHz	45	50	—
Transimpedance ripple	F = 500 MHz to 35 GHz F = 35 GHz to FC_ZT	dBOhm	-3	±1.0 1	±1.5 3
Peak input current before input overload	—	mApk	—	—	3.5
Equivalent Input Noise Current	F = 3 GHz to 36 GHz	pA/Hz$^{1/2}$	—	6≤Ieq≤15	—
Microwave Stability Factor	-10°C to +85°C, All passive source and load	-	1.2	—	—

3. Measurement is guaranteed by correlation down to the lower frequency cut-off. 500 MHz is specified as a reference for convenience of measurement.
4. Low frequency gain ripple assumes the use of drain decoupling close to the chip, as proposed on the figure 1 and 2.
5. The input and output are DC coupled. The low frequency cut-off is set by the choice of the input blocking capacitor or by the output bias tee used for drain current supply voltage.
6. Measurement limited by the input reference signal, cable losses, probes and connectors.
7. Measurement is guaranteed down to the lower frequency cut-off. 500 MHz is specified as a reference for convenience of measurement.

DC Electrical Specifications: Freq. = DC - 54 GHz, V_{DD} = 5 V, T_A = +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Total Supply Current	—	mA	—	100	150
Power Consumption	—	mW	—	500	750
Input Voltage	See note 1	V	—	0	—
Output Voltage	See note 2	V	2.2	2.8	3.7

1- V_{INDC}: DC voltage available at the input of the TIA.
2- V_{OUTDC}: DC voltage available at the output of the TIA.

Absolute Maximum Ratings[7,8]

Parameter	Absolute Maximum
Supply Voltage	+8.0 V
Supply Current	150 mA
Gate Voltage 1	-7 to +7 V
Gate Voltage 2	-0.5 to +5.0 V
Junction Temperature	+150°C
Storage Temperature	-55°C to +150°C

7. Exceeding any one or combination of these limits may cause permanent damage to this device.
8. MACOM does not recommend sustained operation near these survivability limits.

Operating Conditions

Parameter	Details
Supply Voltage	+4.75 V to +5.25 V
Operating Temperature	-10°C to +85°C
Input Interface	DC coupled in a TIA configuration ; All other cases : AC coupled via an external DC block
Output Interface	Must be AC coupled via an external DC block

Handling Procedures

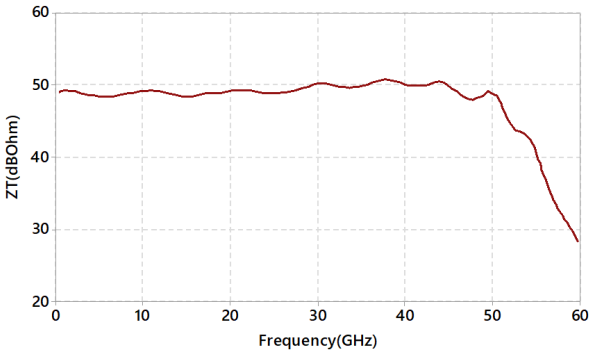
Please observe the following precautions to avoid damage:

Static Sensitivity

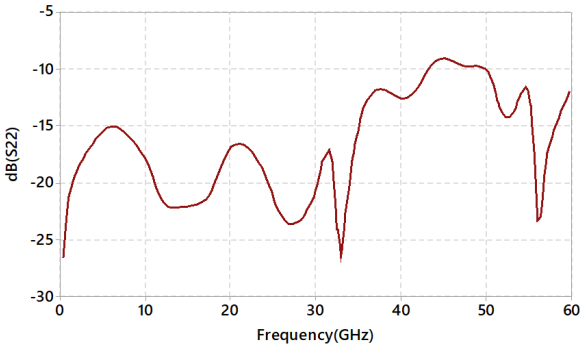
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

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

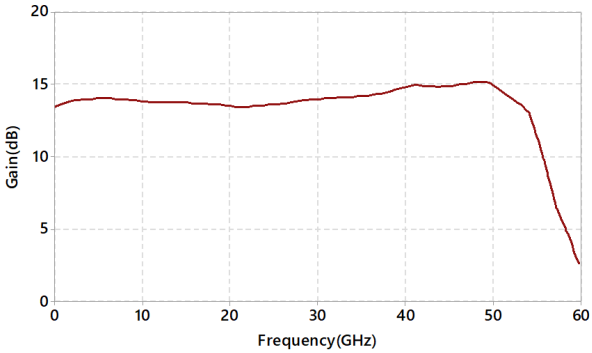
Transimpedance Gain



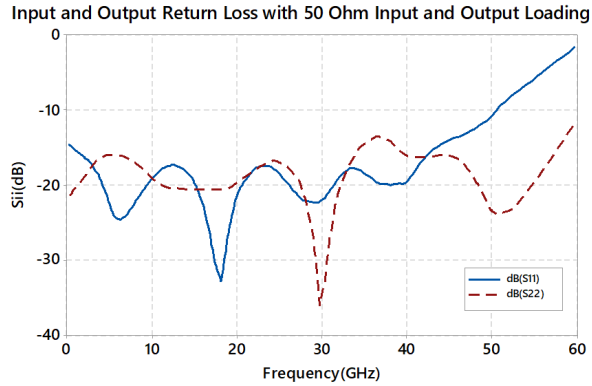
Output Returen Loss with Photodiode Input Loading



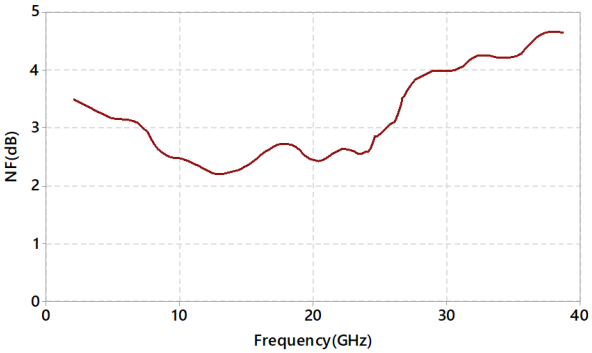
Gain



Input and Output Return Loss with 50 Ohm Input and Output Loading



NF



Measured transimpedance gain and output return loss for an input loading conditions : photodiode elements :
C_{PH} = 50 fF, L_{PH} = 0.3 nH, R_{PH} = 15 Ω.

Measured gain (S21) and input/output return loss for an input/output loading conditions : 50Ω.

Application Information

Two module layouts are proposed. Figure 1 illustrates a module with the CGY2144UH/C2 used in a photo receiver application while in figure 2 is pictured the general purpose application module. In both cases, RF accesses are built with microstrip transmission lines. Coplanar transmission lines can be used and will give the same performance. All path lengths and physical sizes of the components should be minimized.

For photo receiver applications, the photodiode capacitance CPH should be lower than 75 fF. A total input inductance value of 0.3 nH is recommended while 0.4 nH should be considered as a maximum value along with a low photodiode series resistance.

For general purpose applications, all RF input and output bonding inductances should be minimized to obtain the best performance from the module. Two gold wires are recommended with maximum separation between the wires. Overall wire length should be kept less than 0.4 mm to keep lead inductance to less than 0.2 nH.

Wedge-Wedge bonding or ribbon bonding is recommended to reduce the bonding wire inductances. The use of too large inductances will lead to degradation in the gain and matching.

In figure 1 and figure 2, C1, C2 and C3 capacitors are used to improve the power supply rejection.

The chip itself 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 the ground of the system. It is extremely important to use an uninterrupted ground plane. AuSn or silver conductive epoxy material can be used for die attachment.

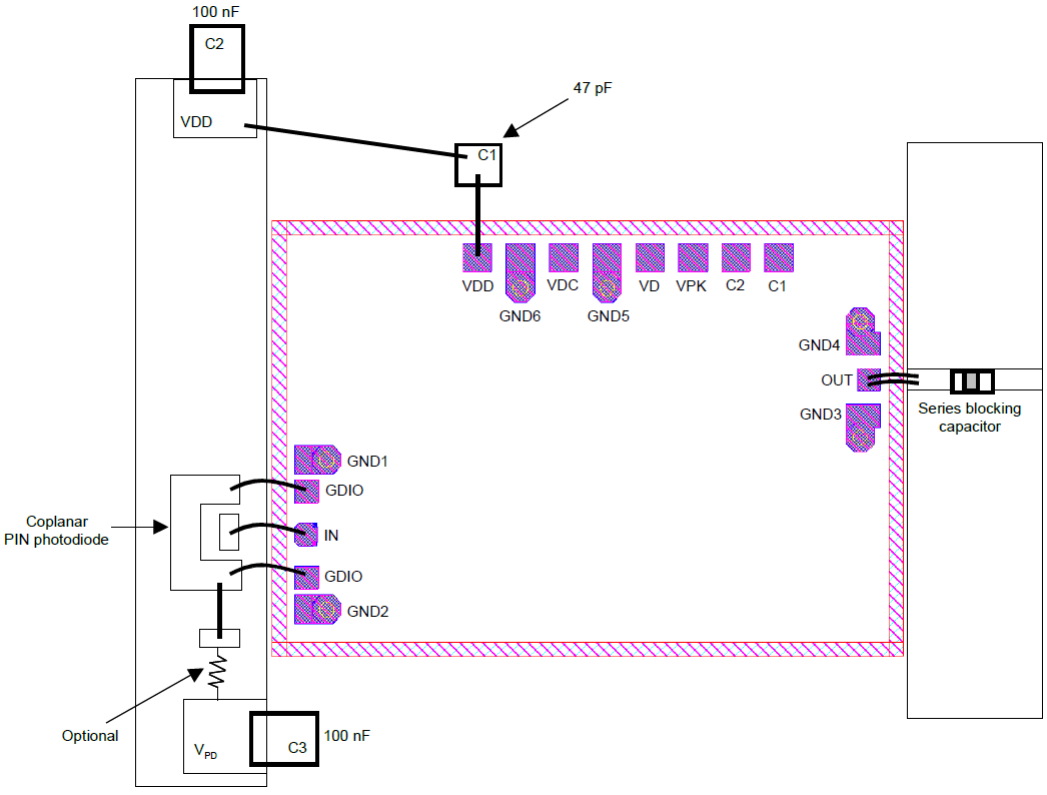


Figure 1: Module Layout: Photo Receiver Application

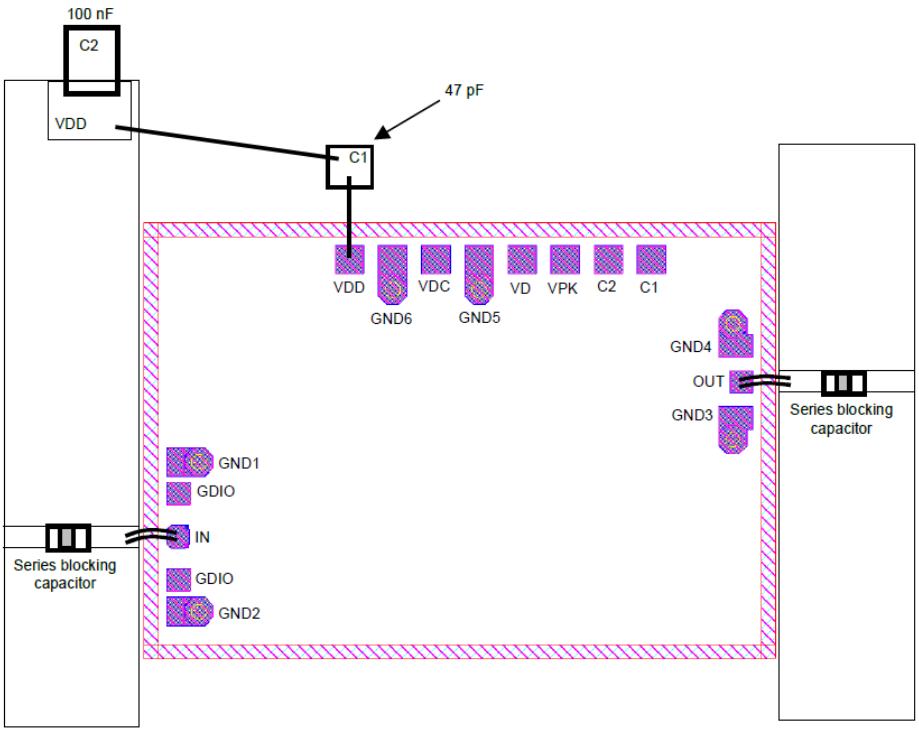


Figure 2: Module Layout: Other Application Cases

Operating & Handling Instructions

This device 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.

a) Photo receiver application

V_{PD}: Photodiode bias
V_{DD}: TIA bias

i) Always turn on the photodiode bias V_{PIN} first or simultaneously with V_{DD}. Since the photodiode is direct coupled to the TIA input, powering V_{DD} first can damage the photodiode through forward bias and excess current.
ii) Apply the input optical signal.

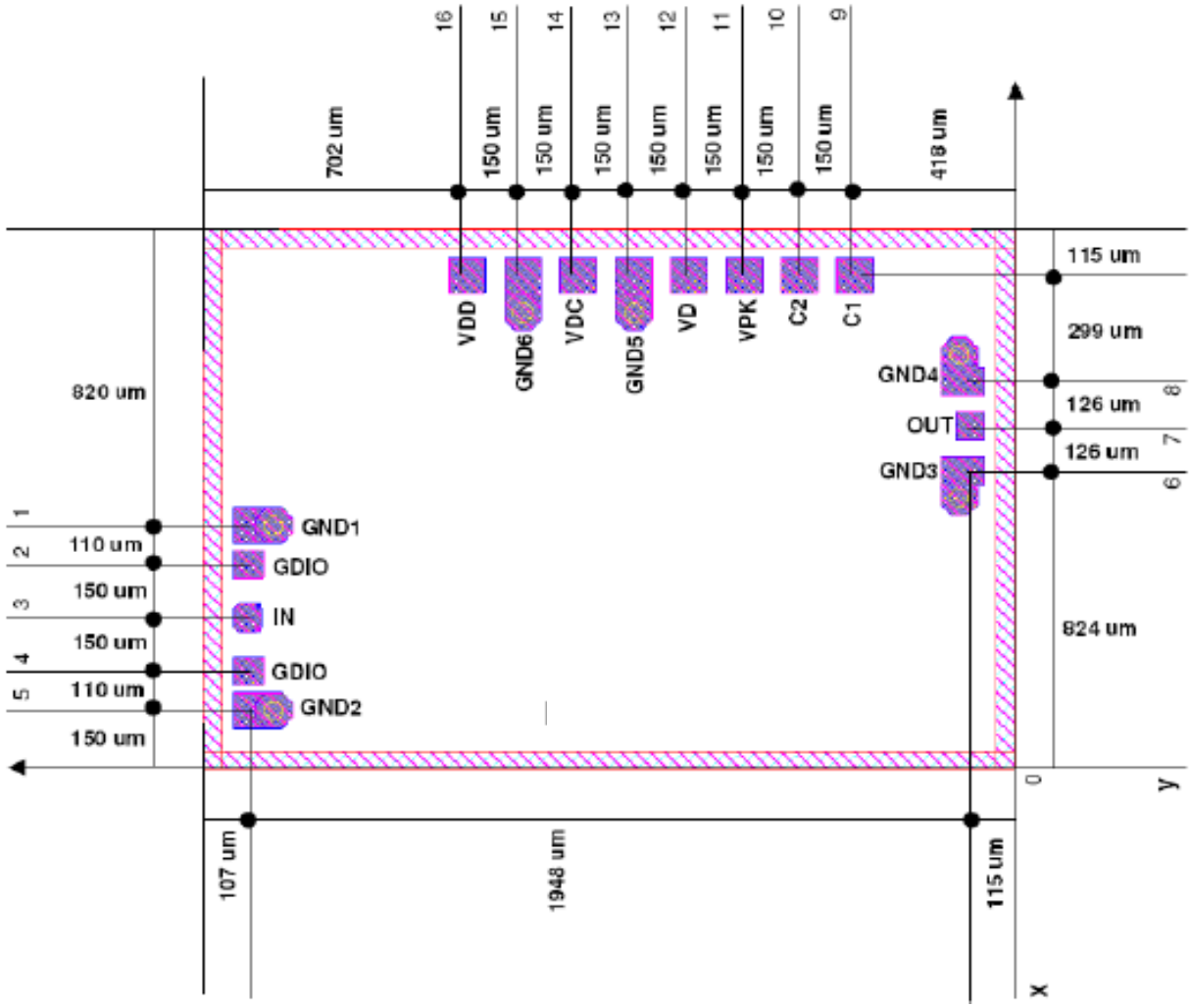
b) General purpose amplifier application

i) Apply V_{DD} at 5 V
ii) 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.

Mechanical Information



Chip Size = 2170 x 1490 µm (Tolerance ± 15 µm)
C1,C2,VPK,VD,GND5,VDC,GND6,VDD Pads = 100 x 100 µm
GND1,GND2 Pads = 100 x 87 µm
GDIO Pads = 85 x 80 µm
IN/OUT Pads = 80 x 80 µm
GND3, GND4 Pads = 120 x 80 µm
Chip Thickness = 100 µm
Backside Metal = TiAu

Pad Position[9]

Pad Name	Pad#	Coordinate		Description
		X	Y	
GND1	1	2063	670	Connected to ground with on-chip via holes
GDIO	2	2063	560	Case 1: amplifier used as TIA: to be connected to photodiode cathode pad (see figure 1) Case 2: all other cases, do not bond (see figure 2)
IN	3	2063	410	RF Input
GDIO	4	2063	260	Case 1: amplifier used as TIA: to be connected to photodiode cathode pad (see figure 1) Case 2: all other cases, do not bond (see figure 2)
GND2	5	2063	150	Connected to ground with on-chip via holes
GND3	6	115	824	Connected to ground with on-chip via holes
OUT	7	115	950	RF Output
GND4	8	115	1076	Connected to ground with on-chip via holes
C1	9	418	1375	Do not bond
C2	10	568	1375	Do not bond
VPK	11	718	1375	Do not bond
VD	12	868	1375	Do not bond
GND5	13	1018	1375	Connected to ground with on-chip via holes
VDC	14	1168	1375	DC output voltage monitor
GND6	15	1318	1375	Connected to ground with on-chip via holes
VDD	16	1468	1375	Drain Supply voltage, must be decoupled to ground using external capacitor(s)

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

CGY2144UH/C2 TYPICAL SCATTERING PARAMETERS Tamb = 25°C, Vdd = +5.0 V, RL = 50 Ω.

Frequency (GHz)	MagS11	AngS11	MagS21	AngS21	MagS12	AngS12	Mag(S22)	AngS22
0.3	0.175	-4.1	4.688	175.7	0.0007	178.7	0.044	129.5
0.5	0.177	-6.1	4.715	173.4	0.0003	-119.3	0.06	106.8
0.7	0.173	-8.5	4.764	170.5	0,0000	54.7	0.078	90.9
0.9	0.174	-12.1	4.853	167.6	0.0004	93.4	0.094	75.1
1	0.174	-12.9	4.898	166	0.0006	97.9	0.102	69.2
3	0.143	-38.3	4.955	129.2	0.0011	60.8	0.142	36.4
6	0.047	-54.8	5.047	76.1	0.0022	16.8	0.188	-7.1
9	0.09	16.3	4.943	23.3	0.0031	-24.1	0.131	-39.4
12	0.149	-19.7	4.853	-28.2	0.0038	-61.4	0.078	-20.3
15	0.113	-63.8	4.864	-80.4	0.0045	-88.9	0.104	-20.8
18	0.012	-23.6	4.809	-133.8	0.0077	-130	0.079	-20.1
21	0.121	2.3	4.688	173.3	0.0105	-175.5	0.115	-9.6
24	0.158	-48.6	4.737	121.3	0.0142	138	0.148	-30.3
27	0.077	-106.5	4.87	67.6	0.0181	92.3	0.124	-67.8
30	0.064	22.1	5.006	11.1	0.0227	44.7	0.007	-123.8
33	0.145	-40.8	5.047	-46.2	0.0294	-13.3	0.136	15.9
36	0.12	-120.8	5.129	-102.5	0.0316	-74.2	0.237	-45.7
38	0.068	137.9	5.254	-143.2	0.0305	-106.4	0.213	-101.4
40	0.1	20.9	5.559	174.4	0.0399	-138	0.134	171.1
42	0.157	-62.7	5.546	128.8	0.0507	175.5	0.145	57.4
44	0.202	-145.9	5.496	84.8	0.0553	133.1	0.172	-12
46.5	0.226	113.3	5.591	28.7	0.0648	87	0.151	-76.8
48	0.179	36.7	5.748	-7.2	0.08	54.5	0.113	-121.3
49.5	0.186	-88.5	5.748	-48.4	0.0891	12.4	0.073	-158.8
51	0.37	177.5	5.395	-90.7	0.0865	-25.4	0.058	162.3
52.5	0.487	114.6	4.955	-131.5	0.0842	-62.6	0.064	120.9
54	0.353	33	4.71	179.7	0.0915	-110.9	0.092	54.4
57	0.731	107.5	2.24	90	0.0511	171.7	0.138	-133.4
60	0.715	86.7	1.316	57.4	0.0466	137.2	0.269	161