WJA1500

+5 V Active-Bias InGaP HBT Gain Block

Applications

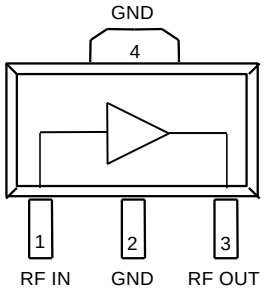
- IF Amplifier
- VHF / UHF Transmission
- Wireless Infrastructure
- CATV / SATV / MoCA
- General Purpose Wireless

SOT-89 Package

Product Features

- 50 Ohm Cascadable Gain Block
- 50 – 1000 MHz
- 19.5 dB Gain at 200 MHz
- +20.5 dBm P1dB at 200 MHz
- +43.5 dBm Output IP3 at 200 MHz
- +60 dBm Output IP2 at 200 MHz
- Single +5 V Supply, 95 mA Current
- Robust 1000 V ESD, Class 1C
- SOT-89 Package

Functional Block Diagram



General Description

The WJA1500 is a cascadable gain block that offers high linearity in a low-cost surface-mount package. At 200 MHz, the WJA1500 typically provides 19.5 dB gain, +43.5 dBm OIP3, and +20.5 dBm P1dB. The device is housed in a RoHS-compliant SOT-89 industry-standard SMT package using Annealed Matte Tin or NiPdAu plating to reduce or eliminate the possibility of tin whiskers.

The WJA1500 consists of Darlington pair amplifiers using a high reliability InGaP / GaAs HBT process technology. The MMIC amplifier is internally matched to 50 Ω and only requires DC-blocking capacitors and a bias inductor for operation. An internal active bias is designed to enable stable performance over temperature. A dropping bias resistor is not required allowing the device to be biased directly from +5 V supply voltage.

The amplifier is targeted for high performance IF applications in existing and next generation wireless technologies. The WJA1500 is ideal for general purpose applications such as LO buffering, IF amplification and pre-driver stages within the 50 to 1000 MHz frequency range.

Pin Configuration

Pin No.	Label
1	RF IN
3	RF OUT
2, 4	GND

Ordering Information

Part No.	Description
WJA1500	1,000 pieces on a 7” reel (standard)
WJA1500-PCB	50 – 1000 MHz Evaluation Board

Absolute Maximum Ratings

Parameter	Rating
Storage Temperature	−55 to 150 °C
RF Input Power, CW, 50 Ω, T=25 °C	+24 dBm
Supply Voltage	+6.5 V

Operation of this device outside the parameter ranges given above may cause permanent damage.

Recommended Operating Conditions

Parameter	Min	Typ	Max	Units
V_{CC}	+4.75	+5	+5.25	V
T_{CASE}	−40		+85	°C
Tj for >10^6 hours MTTF			+150	°C

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

Electrical Specifications

Test conditions unless otherwise noted: V_{SUPPLY} = +5 V, T_{CASE}= +25 °C, 50 Ω system

Parameter	Conditions	Min	Typ	Max	Units
Operational Frequency Range		50		1000	MHz
Test Frequency			200		MHz
Gain		17.8	19.4	20.8	dB
Input Return Loss			17		dB
Output Return Loss			21		dB
Output P1dB			+20.5		dBm
Output IP3	Pout=+8 dBm/tone, Δf= 1 MHz	+39	+43.7		dBm
Output IP2			+59.8		dBm
Noise Figure			5.0		dB
Device Current, (I_{CC})		79	95	99	mA
Thermal Resistance, (θ_{jc})	Junction to case (1)			78	°C/W

Notes:
1. Thermal path is from the device junction through the package ground tab (pins 2, 4) to the backside mounting surface.

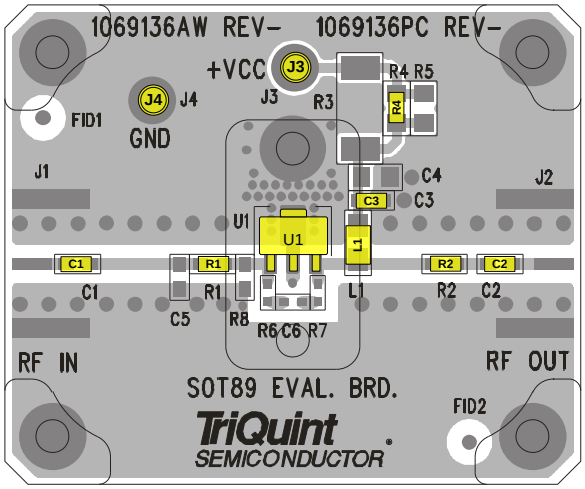
S-Parameters

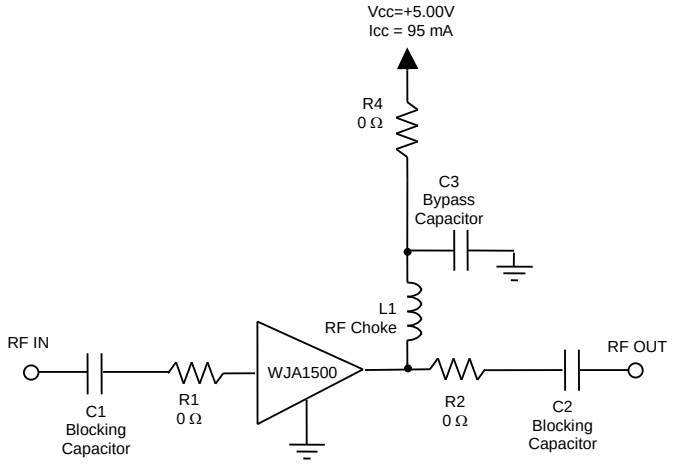
Test Conditions: V_{SUPPLY}=+5 V, I_{CC}=94 mA (typ.), T_{CASE}=+25 °C, fixture measurement, calibrated to device leads

Freq (MHz)	S11 (dB)	S11 (ang)	S21 (dB)	S21 (ang)	S12 (dB)	S12 (ang)	S22 (dB)	S22 (ang)
10	−15.69	−55.09	21.82	171.35	−25.19	11.61	−10.46	−28.13
50	−17.40	−135.23	19.98	168.76	−23.20	4.28	−18.29	−60.10
100	−17.59	−153.75	19.68	167.63	−23.05	0.79	−21.02	−64.45
150	−17.77	−158.44	19.59	164.26	−22.99	−1.17	−21.22	−67.20
200	−17.56	−160.17	19.47	160.44	−22.96	−2.89	−21.01	−73.21
250	−17.54	−160.17	19.42	157.05	−22.91	−4.24	−20.25	−76.35
300	−17.25	−159.36	19.36	153.10	−23.00	−5.88	−19.36	−80.46
350	−17.04	−156.92	19.33	148.71	−22.99	−6.83	−18.55	−83.44
400	−16.88	−156.28	19.26	144.56	−22.97	−8.61	−17.94	−86.00
450	−16.50	−152.39	19.19	140.90	−23.01	−9.69	−16.95	−90.06
500	−16.25	−152.53	19.10	136.81	−22.93	−10.49	−16.62	−92.43
550	−16.04	−151.61	19.01	132.74	−23.00	−12.61	−15.94	−96.08
600	−15.71	−149.87	18.90	128.80	−23.02	−13.57	−15.45	−98.43
650	−15.45	−147.51	18.80	124.94	−23.01	−14.81	−14.87	−101.00
700	−15.11	−146.25	18.69	120.76	−23.04	−15.97	−14.15	−104.13
750	−14.84	−144.74	18.58	117.69	−23.01	−17.76	−13.71	−106.18
800	−14.67	−144.80	18.45	113.29	−23.00	−19.31	−13.28	−108.81
850	−14.45	−143.29	18.38	109.27	−23.05	−19.69	−12.67	−111.55
900	−14.25	−141.96	18.20	105.66	−23.02	−21.32	−12.12	−114.03
950	−14.05	−141.12	18.16	101.96	−23.09	−22.91	−11.61	−116.73
1000	−13.98	−140.85	18.02	97.92	−23.14	−23.65	−11.22	−119.37
1050	−13.75	−140.40	17.84	94.26	−23.06	−24.91	−10.74	−121.30
1100	−13.40	−139.62	17.69	90.54	−23.10	−26.92	−10.34	−123.81
1150	−13.24	−138.81	17.60	86.83	−23.10	−28.23	−9.89	−125.85
1200	−13.05	−138.36	17.43	82.58	−23.24	−29.00	−9.59	−128.24

Device S-parameters are available for download on the WJA1500 product page at **www.qorvo.com**

WJA1500-PCB Evaluation Board





Notes:
1. See Evaluation Board PCB Information section for material and stack-up.
2. All components are of 0603 size unless otherwise stated.

Bill of Material – WJA1500-PCB

Reference Des.	Value	Description	Manuf.	Part Number
U1	n/a	InGaP HBT Gain Block	Qorvo	WJA1500
L1	470 nH	Ferrite core wire wound inductor, 0805(1)	various	
C1, C2	1000 pF	Cap, Chip, 0603, 50V, NPO, 5%	various	
C3	0.018 µF	Cap, Chip, 0603, 16V, X7R, 10%	Coilcraft	
R1, R2, R4	0 Ω	Res, Chip, 0603, 1/10W, 5%	various	

Notes:
1. For lower cost and performance (100 – 1000 MHz) option use 470 nH air core wire wound inductor.
2. R1, R2, and R4 may be replaced by copper trace in end user applications.

Typical Performance - WJA1500-PCB

Test conditions unless otherwise stated: V_{SUPPLY}=+5 V, I_{CC}=94 mA (typ.), T_{CASE}=+25 °C

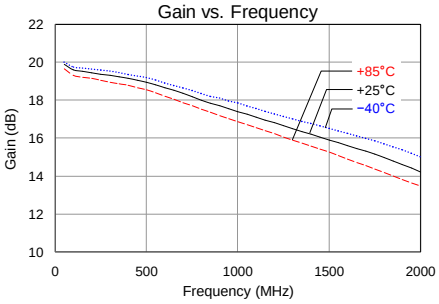
Parameter	Typical Value					Units
Frequency	70	170	240	500	900	MHz
Gain	19.6	19.3	19.2	18.8	17.6	dB
Input Return Loss	14	16	17	17	14	dB
Output Return Loss	25	27	22	15	10	dB
Output P1dB	+20.2	+20.3	+20.4	+20.4	+19.9	dBm
Output IP3 (1)	+42.1	+44.6	+43.8	+38.3	+33.4	dBm
Output IP2	+63.2	+61.1	+58.0	+59.0	+52.0	dBm
Noise Figure	4.9	4.9	5.0	5.2	5.8	dB

Notes:
1. OIP3 measured with two tones at an output power of +8 dBm / tone separated by 1 MHz.

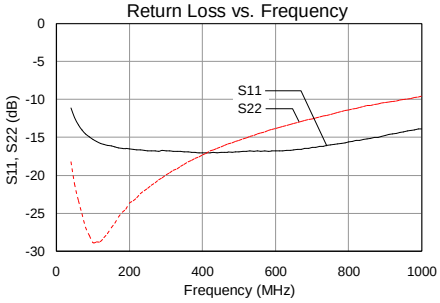
Performance Plots − WJA1500-PCB

Test conditions unless otherwise stated: V_{SUPPLY}=+5 V, I_{CC}=94 mA (typ.), T_{CASE}=+25 °C

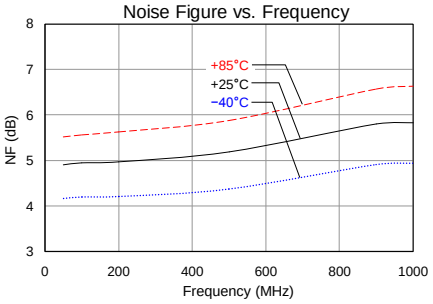
Gain vs. Frequency



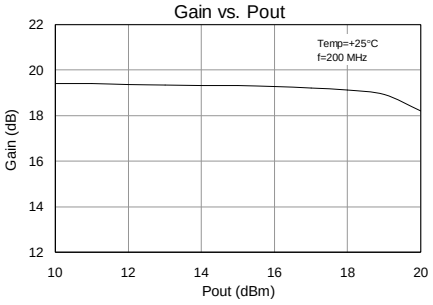
Return Loss vs. Frequency



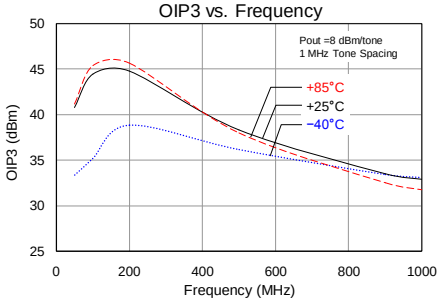
Noise Figure vs. Frequency



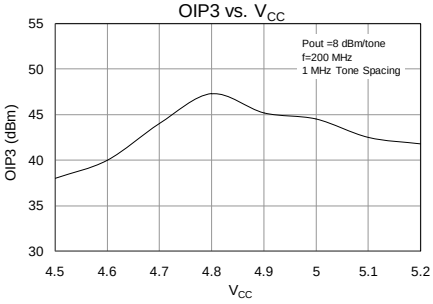
Gain vs. Pout



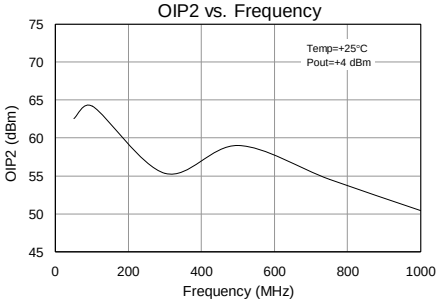
OIP3 vs. Frequency



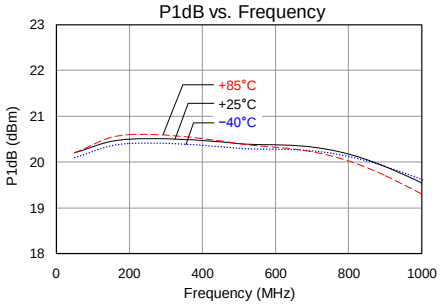
OIP3 vs. V_{CC}



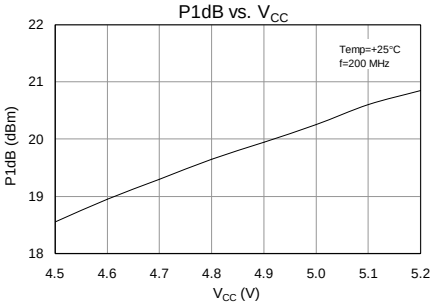
OIP2 vs. Frequency



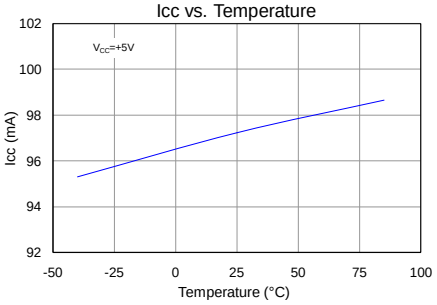
P1dB vs. Frequency



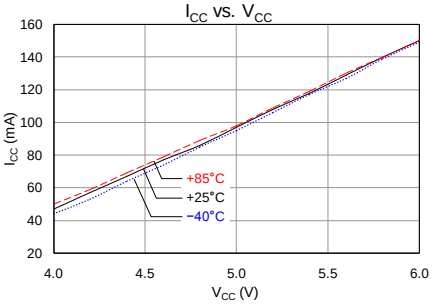
P1dB vs. V_{CC}



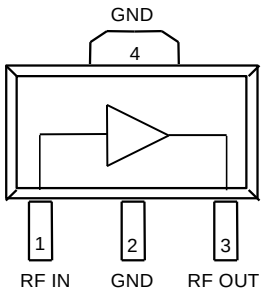
Icc vs. Temperature



I_{CC} vs. V_{CC}



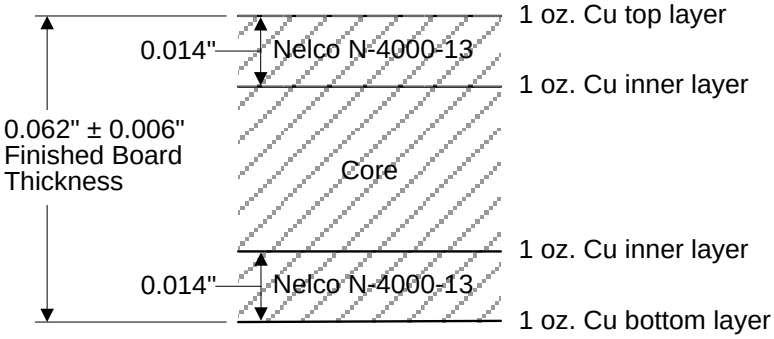
Pin Configuration and Description

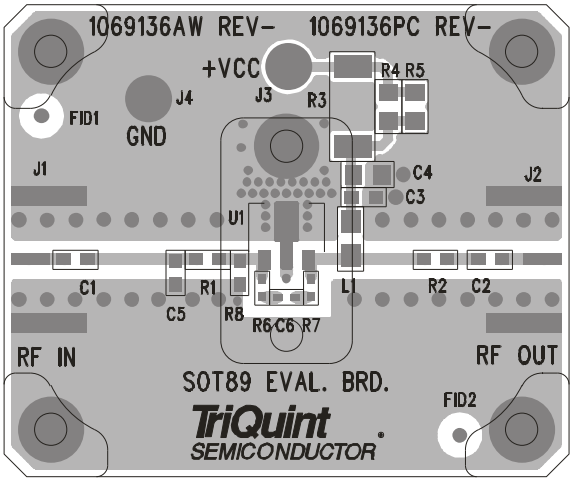


Pin No.	Label	Description
1	RF IN	RF input, matched to 50 ohms. External DC Block is required.
3	RF OUT	RF output / DC supply, matched to 50 ohms. External DC Block, RF choke required.
2, 4	GND	Ground and Backside Paddle. Multiple via holes should be employed to minimize inductance and thermal resistance; see PCB mounting pattern in Mechanical Information section.

Evaluation Board PCB Information

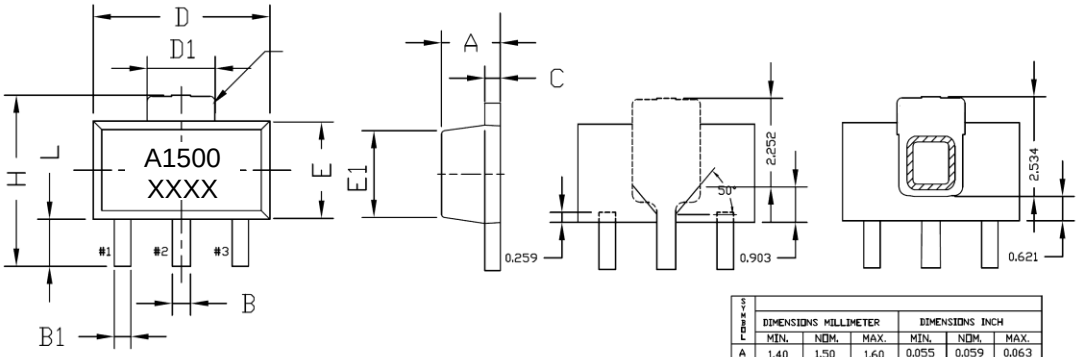
PCB 1069136 Material and Stack-up

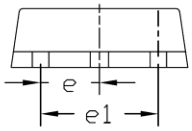




Package Marking and Dimensions

Marking:
Part Number – A1500
Trace Code – XXXX



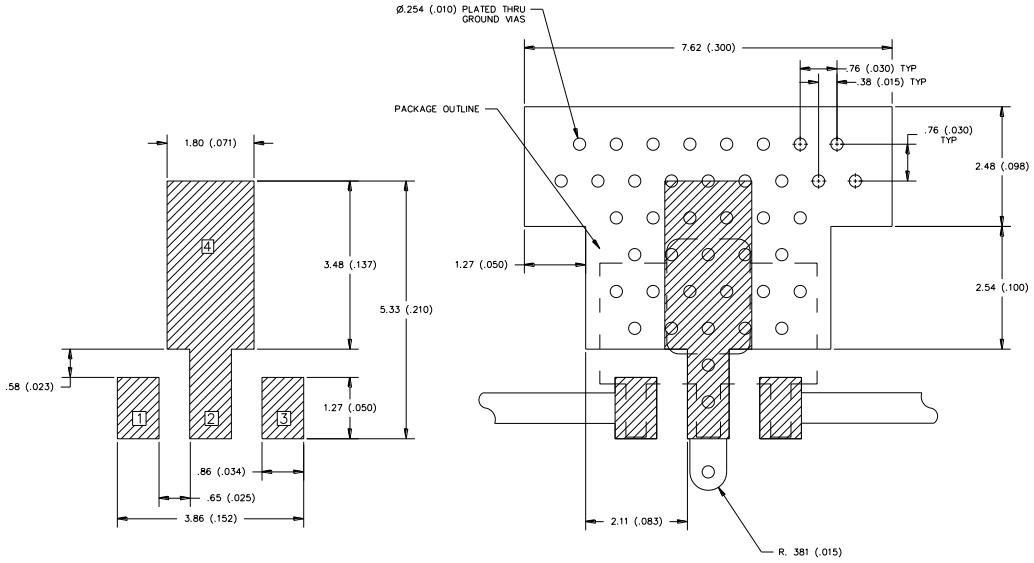


NOTES :
1. DIMENSIONING & TOLERANCING PER ANSI.Y14.5M–1982
2. CONTROLLING DIMENSION : MILLIMETER CONVERTED INCH ARE NOT NECESSARILY EXACT.
3. DIMENSION B1, 2 PLACES.

SYMBOL	DIMENSIONS MILLIMETER			DIMENSIONS INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.40	1.50	1.60	0.055	0.059	0.063
B	0.42	0.49	0.56	0.017	0.019	0.022
B1	0.36	0.42	0.44	0.014	0.016	0.019
C	0.35	0.40	0.43	0.014	0.016	0.017
D	4.39	4.50	4.60	0.173	0.177	0.181
D1	1.40	1.62	1.83	0.055	0.062	0.072
E	2.29	2.44	2.60	0.090	0.098	0.102
E1	1.77	2.03	2.29	0.070	0.074	0.090
e	1.50 BSC			0.059 BSC		
e1	3.00 BSC			0.118 BSC		
H	3.84	4.04	4.25	0.151	0.155	0.167
L	0.74	0.97	1.20	0.029	0.041	0.047

Notes:
1. All dimensions are in millimeters. Angles are in degrees.
2. The terminal #1 identifier and terminal numbering conform to JESD 95-1 SPP-012.
3. Trace Code up to 4 digits assigned by sub-contractor

PCB Mounting Pattern



Notes:
1. All dimensions are in millimeters. Angles are in degrees.
2. Use 1 oz. copper minimum for top and bottom layer metal.
3. Via holes are required under the backside paddle of this device for proper RF/DC grounding and thermal conductivity.
4. Do not remove or minimize via hole structure in the PCB. Thermal and RF grounding is critical.
5. We recommend a 0.35mm (#80/.0135") diameter bit for drilling via holes and a final plated thru diameter of 0.25 mm (0.10”).
6. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.

Product Compliance Information

ESD Sensitivity Ratings

Caution! ESD-Sensitive Device

ESD Rating:	Class 1C
Value:	≥ 1000 V and < 2000 V
Test:	Human Body Model (HBM)
Standard:	JEDEC Standard JS-001-2012

ESD Rating:	Class C3
Value:	≥ 1000 V
Test:	Charged Device Model (CDM)
Standard:	JEDEC Standard JESD22-C101F

MSL Rating

MSL Rating:	Level 3 or better
Test:	260 °C convection reflow
Standard:	JEDEC Standard IPC/JEDEC J-STD-020

Solderability

Compatible with both lead-free (260°C maximum reflow temperature) and tin/lead (245°C maximum reflow temperature) soldering processes.

Contact plating: Annealed Matte Tin or NiPdAu

RoHs Compliance

This part is compliant with EU 2002/95/EC RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment).

This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_4O_2$) Free
- PFOS Free
- SVHC Free

Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:

Web: www.qorvo.com **Tel:** +1-844-890-8163
Email: customer.support@qorvo.com

For technical questions and application information:

Email: appsupport@qorvo.com

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