

Keysight 1GC1-4288

3 to 10 GHz Variable Threshold Differential-Output Amplifier



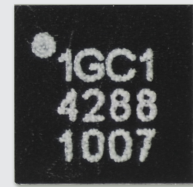
Data Sheet

Features

- Frequency range: 3 to 10 GHz
- Input power range: 0 to 15 dB
- Output power: > +14.5
- Limiting range: 20 dBm
- Return loss:
 - Input: 8 dB typical
 - Output: 8 dB typical
- Harmonics @ $P_{out} = 15$ dBm
 - 2nd: -17.5 dBc
- Single supply operation
 - V_{CC} : 5.0 Volts
- 3 x 3 24-lead QFN package
- RoHS compatible

Description

The 1GC1-4288 is a 3-10 GHz amplifier featuring high gain, medium output power, and variable threshold limiting. This four-stage amplifier provides dual outputs to allow either dual channel or single-channel operation. This amplifier is fabricated using the Keysight Technologies, Inc. InGaP/GaAs heterojunction bipolar transistor (HBT) process which provides excellent process uniformity, reliability and 1/f noise performance. The 1GC1-4288 also features good harmonic performance and high reverse isolation. DC power dissipation is less than 1.2 watts. This device is in a 3 x 3 24L QFN package. **This device uses only one output bias (Vcc2 or Vcc3) for correct operation. See Biasing section for additional information.**



- Package type: 24-lead quad flat no-lead (QFN) plastic with heat sink
- Package dimensions: 3 x 3 mm (79 x 79 mils)
- Package thickness: 0.90 mm (23 mils)
- Package leads: 0.20 x 0.40 mm (7.9 x 15.7 mils) width x pitch

Absolute maximum ratings^{1 2}

Symbol	Parameters/conditions	Min	Max	Units
V_{CC}	Positive collector voltage		7	V
V_{CTRL}	Control voltage	0	5.5	V
I_{CTRL}	Total control current		10	mA
I_{CC}	Maximum collector current		280	mA
P_{IN}	CW input power		23	dBm
T_{bs}	Maximum backside temperature		75	°C
T_{stg}	Storage temperature	-65	165	°C
T_{max}^2	Maximum assembly temperature		260	°C

1. Operation in excess of any one of these conditions may result in permanent damage to this device.

$T_A = 25^\circ\text{C}$ except for T_{bs} , T_{stg} , and T_{max} .

2. Refer to JEDEC J-STD-020D for detailed reflow profile, 3 reflows max.

DC specifications/physical properties¹

Symbol	Parameters/conditions	Min	Typ	Max	Units
I_{CC1}	Operating current ($V_{CC1} = 5\text{ V}$, $V_{CTRL} = 5\text{ V}$)		92	110	mA
I_{CC2}^2	Operating current ($V_{CC2} = 5\text{ V}$, $V_{CTRL} = 5\text{ V}$)		163	170	mA
I_{CC3}^2	Operating current ($V_{CC3} = 5\text{ V}$, $V_{CTRL} = 5\text{ V}$)		163	170	mA
I_{CTRL}^3	Operating current ($V_{CTRL} = 5\text{ V}$)		6		mA

1. Parameters specified at $T_A = 25^\circ\text{C}$, except for temperature specifications. All current polarities positive into MMIC.

2. Use I_{CC2} or I_{CC3} . Do not use both. Use of both supplies simultaneously will result in excess power consumption and potential damage.

3. CTRL1 and CTRL2 must be connected.

RF specifications¹

Symbol	Parameters/conditions	Min	Typ	Max	Units
S_{21}	Small signal gain		22.5	-9	dB
ΔS_{21}	Small signal gain flatness		± 1		dB
RL_{IN}	Input return loss		-13		dB
RL_{OUT}	Output return loss		-14		dB
ISO	Isolation, reverse		-63		dB
P_{OUT1}^3	Output power for 0 dBm P_{IN} at RL_{OUT1}	+15.5	+17.5		dBm
P_{OUT2}^3	Output power for 0 dBm P_{IN} at RL_{OUT2}	+15.5	+17.5		dBm
P_{IN}	Input power range for limiting	-0		+15	dBm
P_{OUT}	Output power range		20		dB
ΔP_{OUT}	Output power flatness vs input power		± 1		dBm
ΔP_{OUT}	Output power flatness vs frequency		± 1		dBm
Harm.	2nd harmonic at RF_{OUT1} , $P_{OUT} = +17$ dBm (fund = 3 -10 GHz)			- 17.5	dBc
Harm.	2nd harmonic at RF_{OUT2} , $P_{OUT} = +17$ dBm (fund = 3 -10 GHz)			- 17.5	dBc

- $V_{CC} = +5$ V, CTRL = +5 V, $T_A = 25$ °C.
- These RF specifications can be achieved when the device is properly biased and heat sunk. Specifications are per output and based on performance attained with a mounted on a PC board test fixture.
- RF_{out1} and RF_{out2} cannot be used simultaneously.

S-parameter typical values¹

Freq (GHz)	OUT1				OUT2			
	S_{11}	S_{21}	S_{12}	S_{22}	S_{11}	S_{21}	S_{12}	S_{22}
3	-13.84	21.85	-65.82	-18.29	-13.83	22.28	-65.04	-17.94
4	-13.68	22.38	-64.86	-16.11	-13.70	22.64	-65.13	-16.52
5	-15.40	22.62	-64.21	-13.97	-15.42	22.87	-63.81	-15.24
6	-15.42	22.67	-63.41	-10.63	-15.40	22.98	-62.89	-11.16
7	-13.65	22.65	-63.44	-10.31	-13.64	22.97	-63.64	-10.78
8	-12.34	22.93	-65.08	-14.50	-12.37	23.13	-63.83	-15.27
9	-10.75	22.45	-63.76	-16.95	-10.76	22.58	-64.15	-15.64
10	-10.51	21.52	-62.88	-19.08	-10.52	21.64	-61.62	-22.18

- $V_{CC} = +5$ V, CTRL = +5 V, $T_A = 25$ °C.
- These RF specifications can be achieved when the device is properly biased and heat sunk. Specifications are per output and based on performance attained with a mounted on a PC board test fixture.

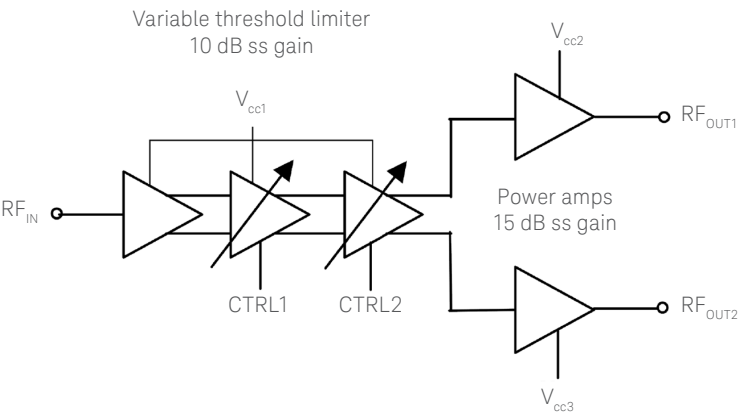


Figure 1. 1GC1-4288 simplified schematic diagram

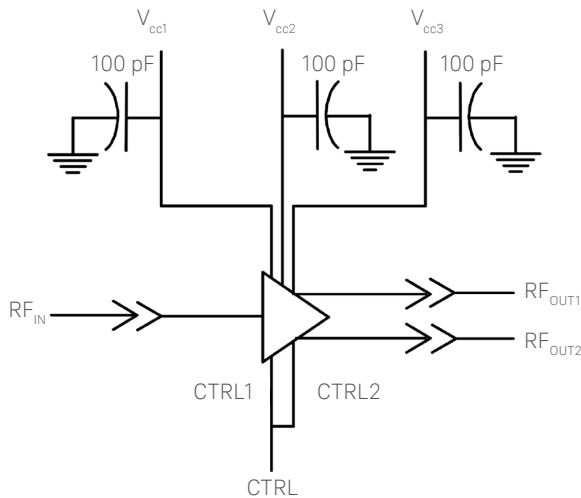


Figure 2. 1GC1-4288 biasing daigram

Biassing

This amplifier is biased with a single collector supply, V_{CC} . The recommended values are $V_{CC} = 5\text{ V}$ and $CTRL = 5\text{ V}$. The control voltage (ctrl1 and ctrl2) is adjusted to achieve the desired output power level. The control voltage is adjustable from 3 V to 5.5 V with 5.5 V providing the highest output power. Total collector current (I_{CC}) is approximately 255 mA. The chip provides two different RF outputs, but only one of the two outputs can be used at a time. To control which RF output is enabled, either V_{CC2} or V_{CC3} is biased. RFout1 is biased using V_{CC2} and RFout2 is biased using V_{CC3} . **Do not bias V_{CC2} and V_{CC3} at the same time.**

Assembly Techniques

GaAs MMICs are ESD sensitive. ESD preventive measures must be employed in all aspects of storage, handling, and assembly.

MMIC ESD precautions, handling considerations, die attach and bonding methods are critical factors in successful GaAs MMIC performance and reliability.

The Keysight Technologies Inc., *GaAs MMIC ESD, Die Attach and Bonding Guidelines - Application Note* (5991-3484EN) provides information on these subjects.

Moisture Compatibility

Injection mold components like the 1GC1-4288 in QFN are moisture-sensitive. The product is tested to the Moisture and Reflow Sensitivity Level 5 as per IPC/Jedec J-STD-020 and must be mounted within **24 hours** of opening the shipping container. Store and handle parts for reflow and for rework per IPC/Jedec J-STD-033B. An example of the moisture sensitivity label is shown in Figure 3.

	CAUTION This bag contains MOISTURE-SENSITIVE DEVICES	See Package
	If Blank, see adjacent bar code label	
1. Calculated shelf life in sealed bag: 12 months at $< 40^{\circ}\text{C}$ and $< 90\%$ relative humidity (RH).		
2. Peak package body temperature: <u>260</u> $^{\circ}\text{C}$ If Blank, see adjacent bar code label		
3. After bag is opened, devices that will be subjected to reflow solder or other high temperature process must		
a) Mounted within: <u>See Package</u> hours of factory If Blank, see adjacent bar code label		
conditions $\leq 30^{\circ}\text{C}/60\%$.		
b) Stored at $<10\%$ RH.		
4. Devices require bake, before mounting, if:		
a) Humidity Indicator Card is $>10\%$ when read at $23 \pm 5^{\circ}\text{C}$		
b) 3a or 3b not met.		
5. If baking is required, devices may be baked for 48 hours at $125 \pm 5^{\circ}\text{C}$.		
Note: If device containers cannot be subjected to high temperature or shorter bake times are desired, reference IPC/JEDEC J-STD-033 for bake procedure.		
Bag Seal Date: <u>See Package</u> If Blank, see adjacent bar code label		
Note: Level and body temperature defined by IPC/JEDEC J-STD-020		

Figure 3. 1GC1-4288 moisture sensitivity level

Tape and Reel

The 1GC1-4288 is available in tape and reel format to facilitate automatic pick and place manufacturing. See Figure 13.

RoHS Compliance

This device is RoHS Compliant. This means the component meets the requirements of the European Parliament and the Council of the European Union Restriction of Hazardous Substances Directive 2011/65/EU, commonly known as RoHS. The six regulated substances are lead, mercury, cadmium, chromium VI (hexavalent), polybrominated biphenyls (PBB) and polybrominated biphenyl ethers (PBDE). RoHS compliance implies that any residual concentration of these substances is below the RoHS Directive's maximum concentration values (MVC); being less than 1000 ppm by weight for all substances except for cadmium which is less than 100 ppm by weight.

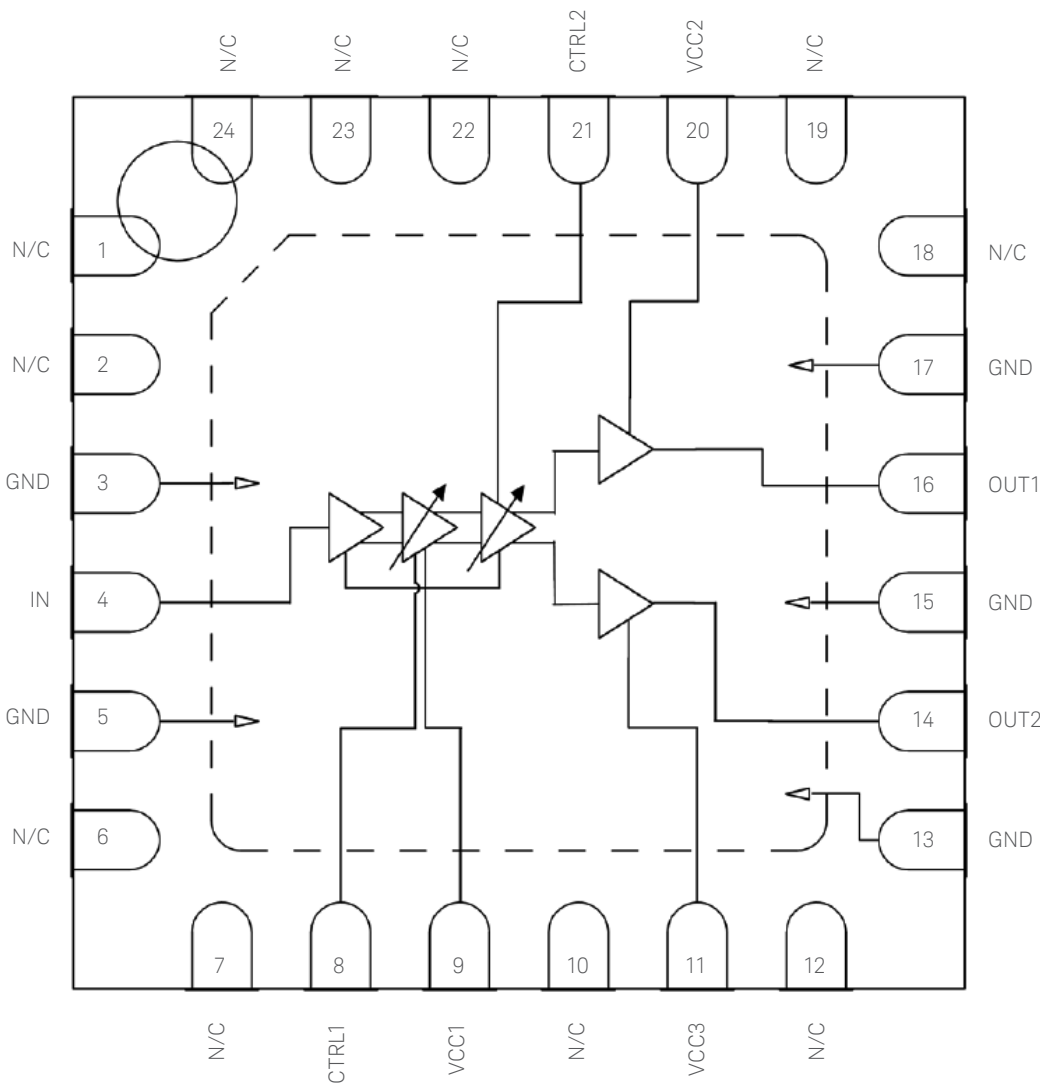


Figure 4. 1GC1-4288 package pinout

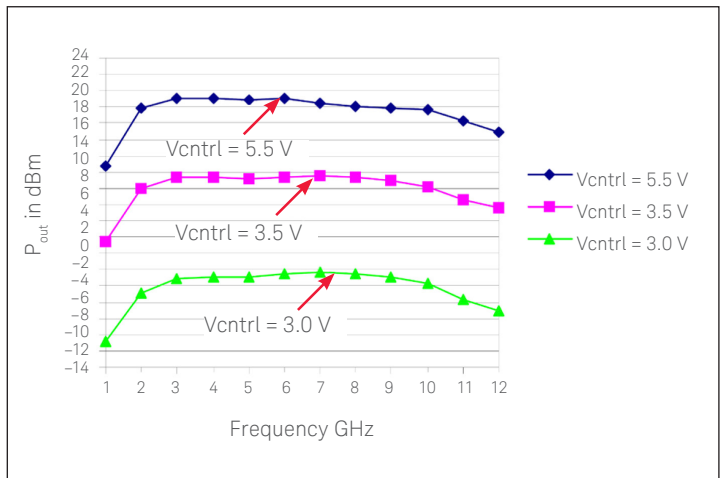


Figure 5. Output power in limiting vs. frequency

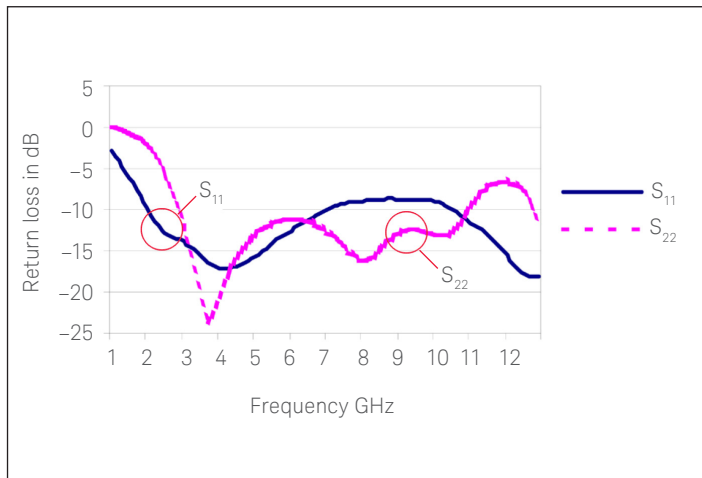


Figure 6. Return loss vs frequency

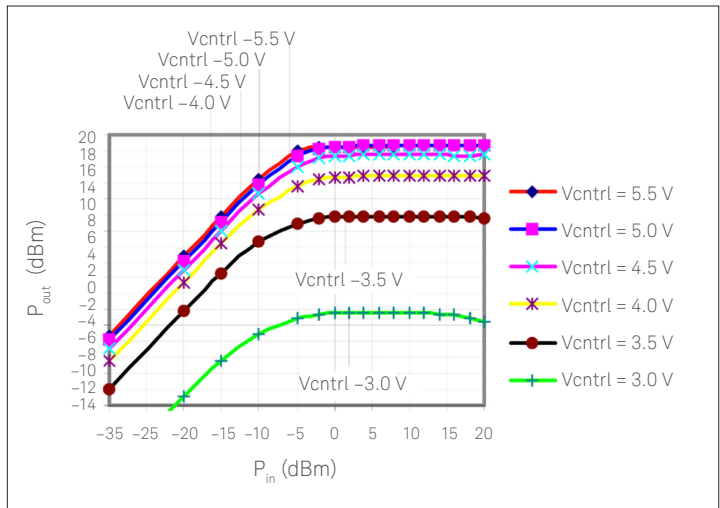


Figure 7. Output power vs. input power at frequency = 7 GHz

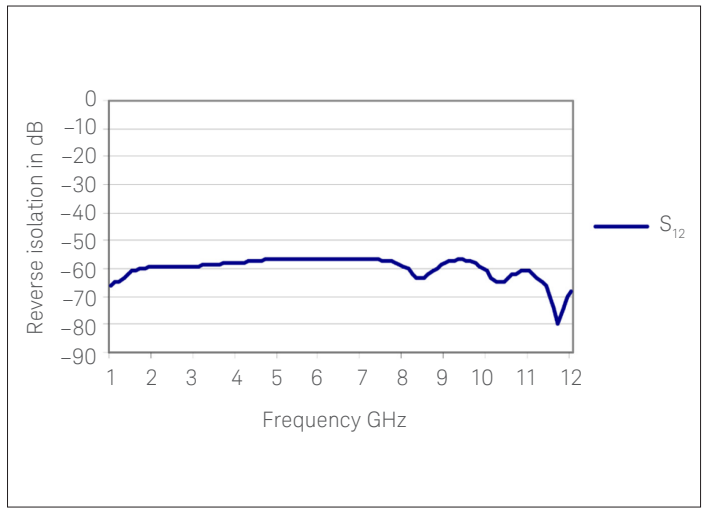


Figure 8. Reverse isolation vs. frequency

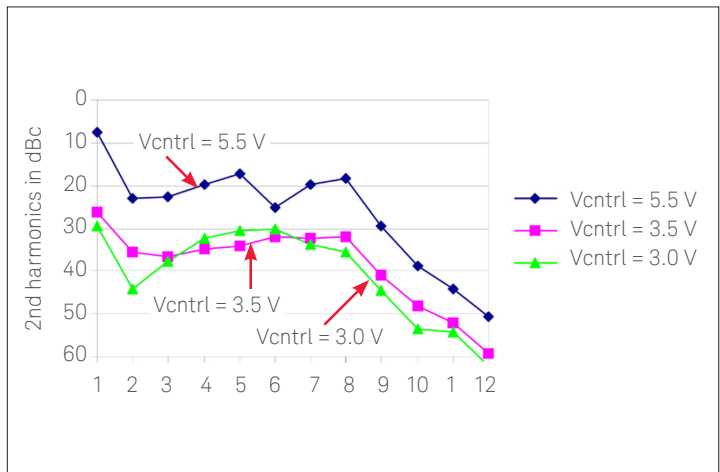


Figure 9. Second harmonics vs. fundamental frequency at $P_{in} = 0$ dBm

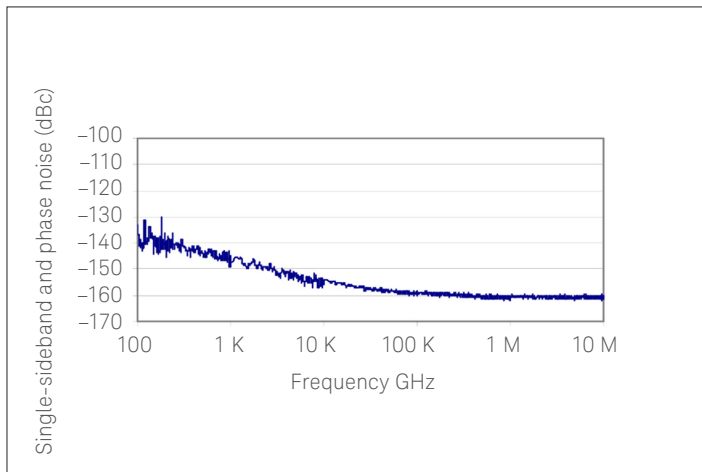


Figure 10. Phase noise @ 7.2 GHz and $P_{out} = +17$ dBm

All data was taken with $T_A = 25^\circ\text{C}$ and was measured at one of the 1GC1-4288 outputs. $V_{CC} = 5\text{ V}$, $I_{CC} = 420\text{ mA}$

This footprint is optimized for 10 mil Rogers 4350 layer 1 - 2 microstrip with a width of 20 mils.

Exposed Cu Vias must be filled and plated over VIPPO recommend 7.9 mil FHS (no solder mask)

Use grounded 'area fill' copper on opposite side of the board for proper heatsinking.

Use 'area filled' copper (grounded if possible) on layer 1 (shown) and inner layers for thermal spreading.

Interconnect layers using grounds vias at maximum density (26 mils center to center for 7.9 mil vias) around 15 mm diameter perimeter of part for optimal heatsinking.

For footprints compatible with outer layout tools, please contact MMIC_Helpline@keysight.com

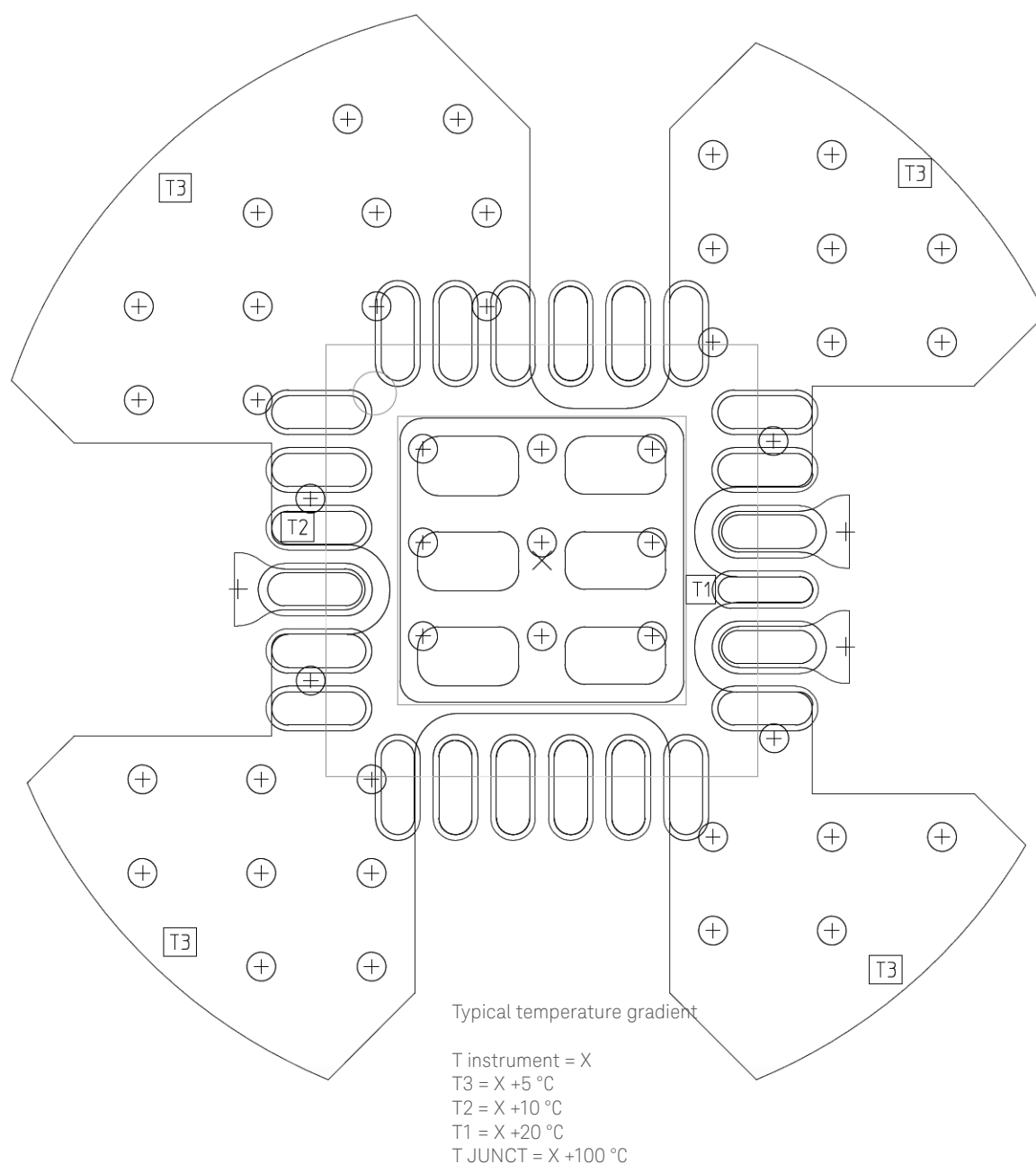


Figure 11. 1GC1-4288 footprint w/temperature gradient

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The product described in this data sheet is RoHS Compliant and RoHS Process Compatible with a maximum temperature of 260 °C and a maximum of 3 temperature cycles.

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