

# 10 W High Power Amplifier MMIC

## 17-20.5 GHz



Product Datasheet

### K-HPA10W-1721

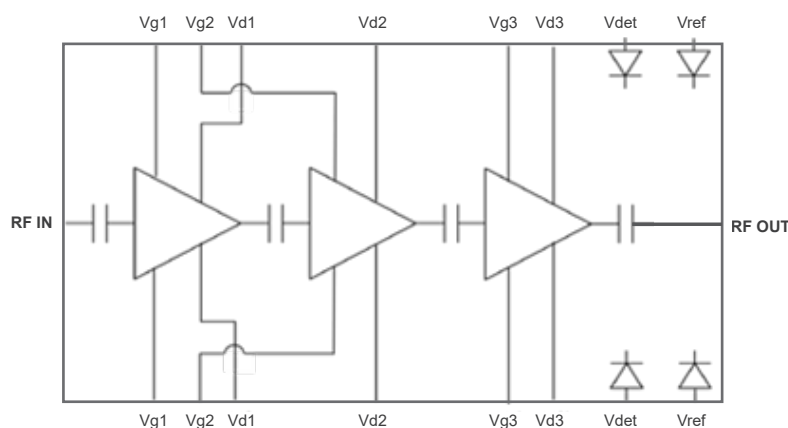
10 W GaN MMIC High Power Amplifier for K-band.

### Overview

K-HPA10W-1721 is a High Power MMIC Amplifier fabricated on Space Qualified 0.25  $\mu\text{m}$  GaN on SiC. This MMIC operates from 17-20.5 GHz and delivers >10 W saturated output power across the band, with power-added efficiency in excess of 25% and large-signal gain of 20 dB.

The RF ports are matched to 50  $\Omega$  with integrated DC blocking capacitors. The part incorporates an output power detector to assist with system integration and is well suited for satellite communications and point to point applications.

### Functional Diagram



### Features

- Frequency range 17-20.5 GHz
- Power >10 W saturated
- Small signal gain 25 dB
- Large signal gain 20 dB
- Integrated power detector
- PAE: >25% at Pin=20 dBm
- Bias: VD=25 V, IDQ=300 mA, VG~-3.6 V
- Chip dimension: 3.6 x 2.9 x 0.1 mm



### Applications

- Satellite communications
- Radar
- Mobile communications
- 5G

#### Available as

K-HPA10W-1721	17-20.5 GHz bare die GaN HPA
K-HPA10W-1721-EVAL	17-20.5 GHz bare die GaN HPA evaluation board
K-HPA10W-1721-SM	17-20.5 GHz packaged GaN HPA
K-HPA10W-1721-SM-EVAL	17-20.5 GHz packaged GaN HPA evaluation board
K-HPA10W-1721-SSPA	17-20.5 GHz GaN solid state power amplifier

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## Electrical Specification

Freq 17-20.5 GHz,  $T_a=25\text{ }^{\circ}\text{C}$   $V_d=25\text{ V}$ ,  $I_{dq}=300\text{ mA}$ ,  $Z_o=50\text{ }\Omega$

Parameter	Test Conditions	Min	Typ	High	Unit
Operational Frequency Range		17.0		20.5	(GHz)
Small Signal Gain	17-19 GHz		26		(dB)
	19-20.5 GHz		22		
Input Return Loss	17.5-20.5 GHz		10		(dB)
Output Return Loss	17.5-20.5 GHz		10		(dB)
Output Power at Saturation	17.5-19.5 GHz		42		(dBm)
	19.5-20.5 GHz		40		
Power Added Efficiency	Pin=20 dBm		33		(%)
	17.5-19 GHz		25		
	19-20 GHz		20		
	20.5 GHz				
Output Power Temperature Coefficient	19 GHz, Psat -40 to 85 $^{\circ}\text{C}$		0.03		(dB/ $^{\circ}\text{C}$ )

## Absolute Maximum Ratings

Parameter	Rating
Drain Voltage ( $V_d$ )	30 V
Gate Voltage Range ( $V_g$ )	-8 to 0 V
Drain Current ( $I_d$ )	2.5 A
Power Dissipation (PDISS) 85 $^{\circ}\text{C}$	44 W
Input Power (Pin)	23 dBm
Mounting Temperature (30 seconds)	260 $^{\circ}\text{C}$
Storage Temperature	-55 to 150 $^{\circ}\text{C}$
Junction Temperature	200 $^{\circ}\text{C}$

Exceeding any one or combination of these limits may cause permanent damage to this device. Sustained operation near these survivability limits is not recommended.

## Recommended Operating Conditions

Parameter	Rating
Drain Voltage ( $V_d$ )	20-30 V
Gate Voltage ( $V_g$ )	-3.6 (TYP)
Drain Current, Quiescent ( $I_{dq}$ )	300 mA
Junction Temperature	<200 $^{\circ}\text{C}$

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### Thermal Reliability Information

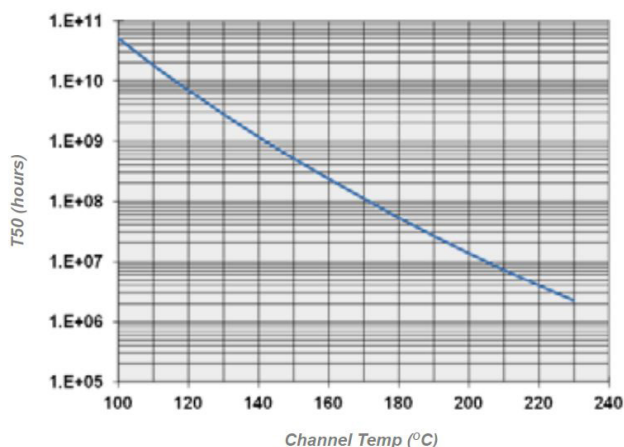
Parameter	Test Conditions	Value	Units
Thermal Resistance ( $\theta_{jc}$ ) <sup>(1)</sup>	$T_{base} = 85^\circ\text{C}$ , $V_d = 25\text{ V}$ , $I_d = 0-1.5\text{ A}$	2.5	$^\circ\text{C/W}$

Notes:

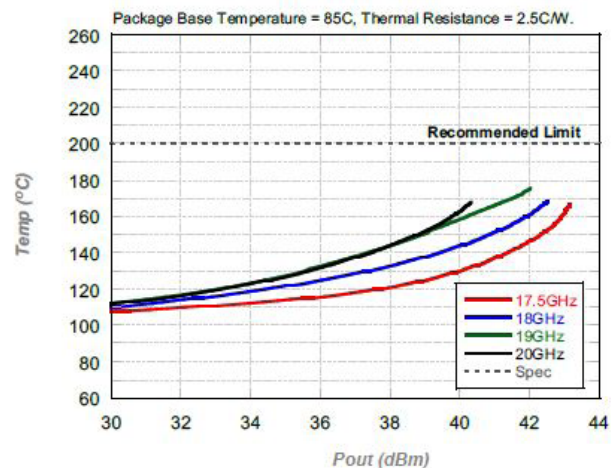
Thermal resistance measured using Raman Thermography on device channel referenced to back of package.

### Median Time To Failure vs Channel Temperature

0.25  $\mu\text{m}$  GaN process

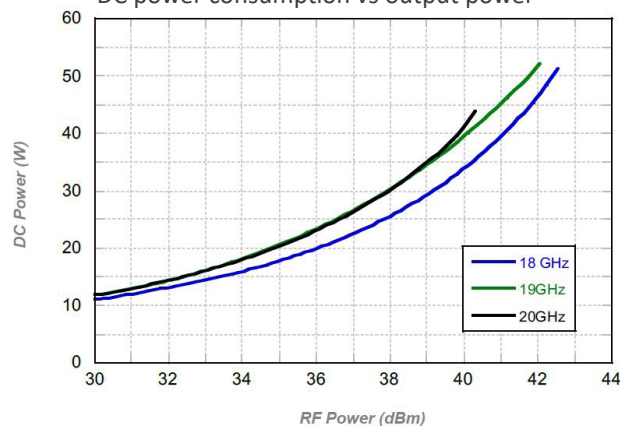


### Channel Temperature vs Pout



### Power Consumption

DC power consumption vs output power



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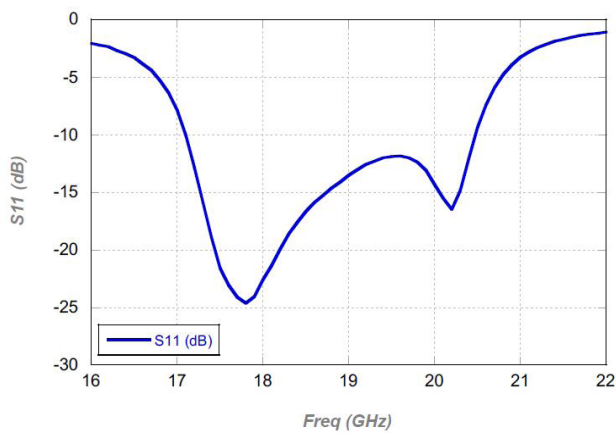


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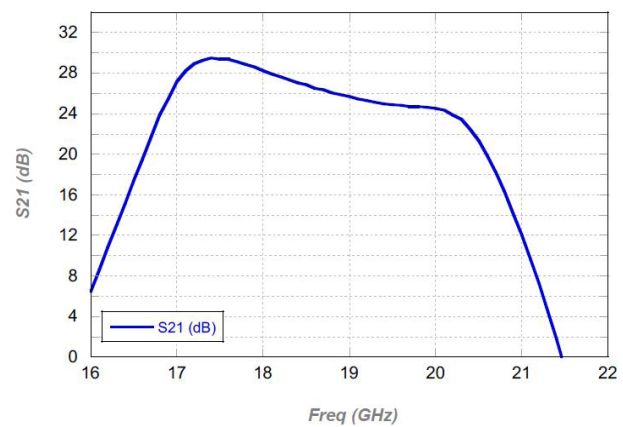
### Small Signal Performance Curves

$V_D = 25$  V,  $I_{DQ} = 300$  mA,  $V_G \sim -3.6$  V typical,  $T_A = 25$  °C

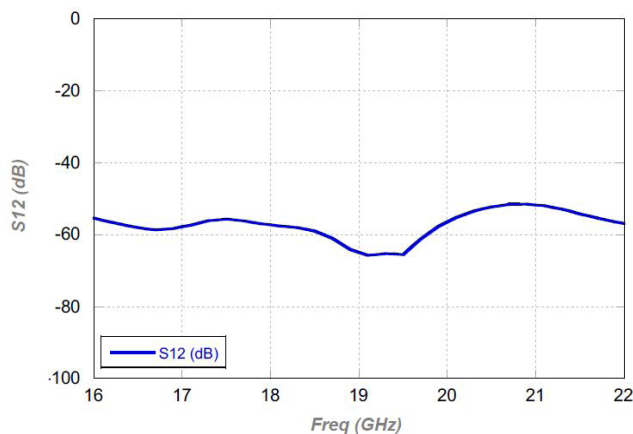
#### Input Return Loss vs Frequency



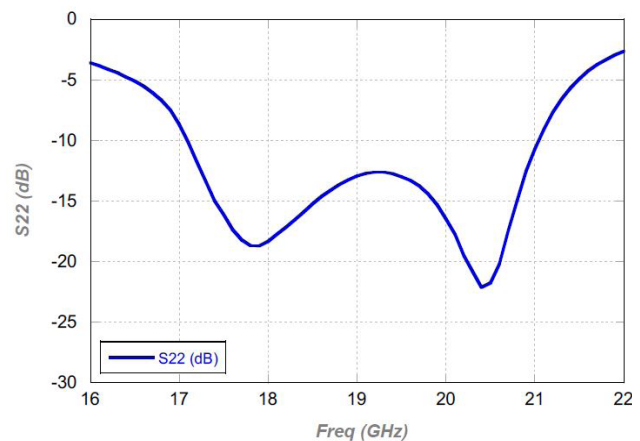
#### Small Signal Gain vs Frequency



#### Reverse Gain vs Frequency



#### Output Return Loss vs Frequency



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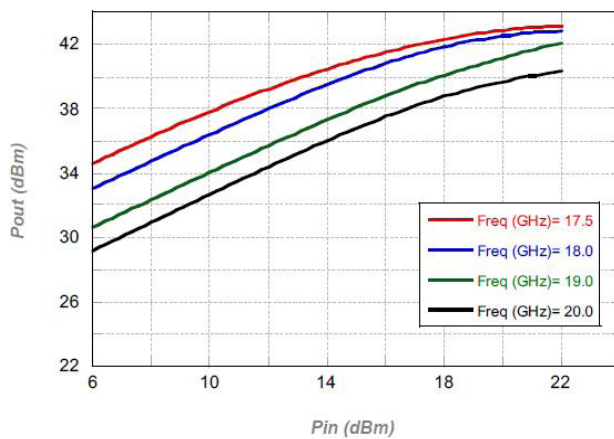


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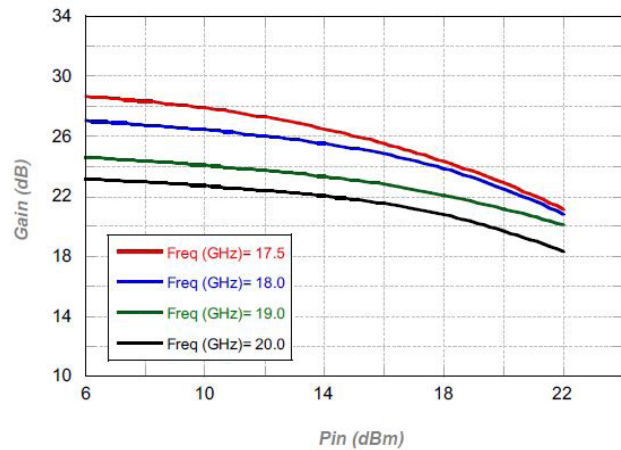
### Large Signal Performance Curves

$V_D=25\text{ V}$ ,  $I_{DQ}=300\text{ mA}$ ,  $V_G\sim-3.6\text{ V}$  typical,  $T_A=25\text{ }^\circ\text{C}$

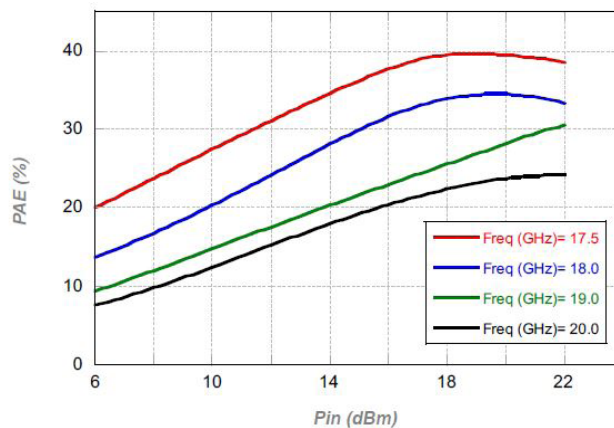
#### Pout vs Pin vs Frequency



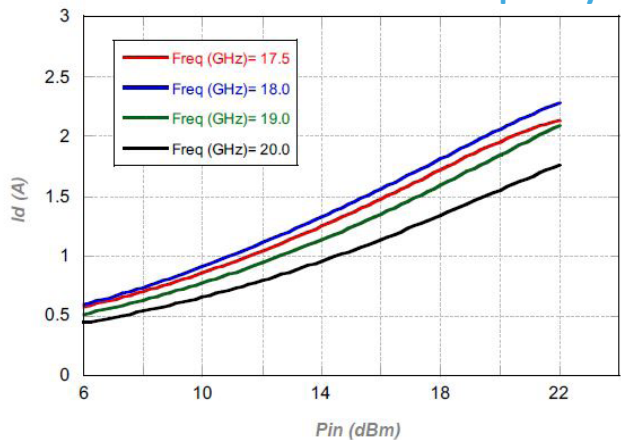
#### Gain vs Pin vs Frequency



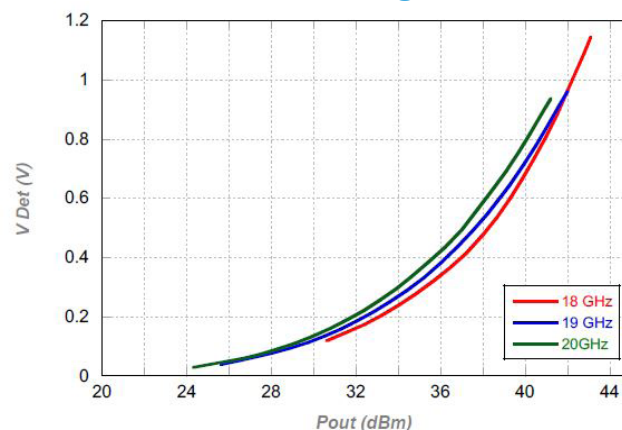
#### PAE vs Pin vs Frequency



#### Drain Current vs Pin vs Frequency



#### Power Detect Voltage vs Pout



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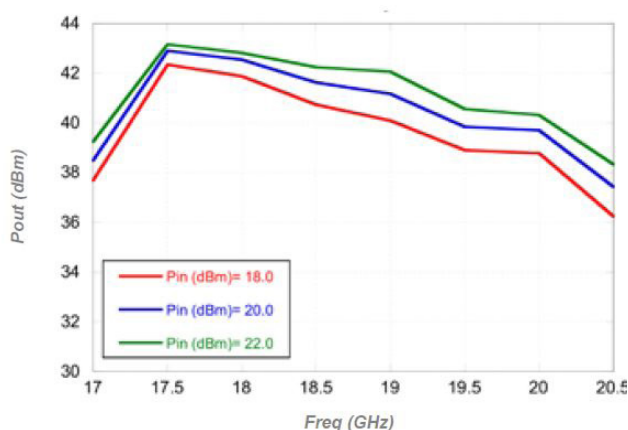


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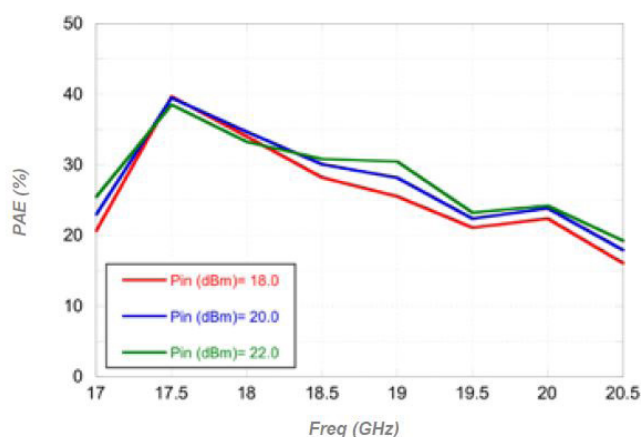
### Large Signal Performance Curves

$V_D=25$  V,  $I_{DQ}=300$  mA,  $V_G \sim -3.6$  V typical,  $T_A=25$  °C

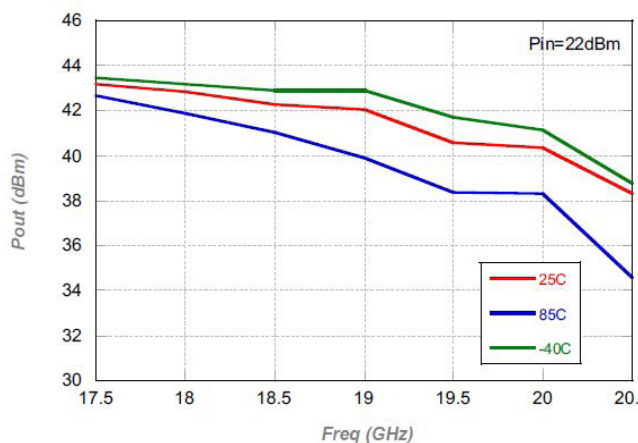
Pout vs Frequency vs Pin



PAE vs Frequency vs Pin



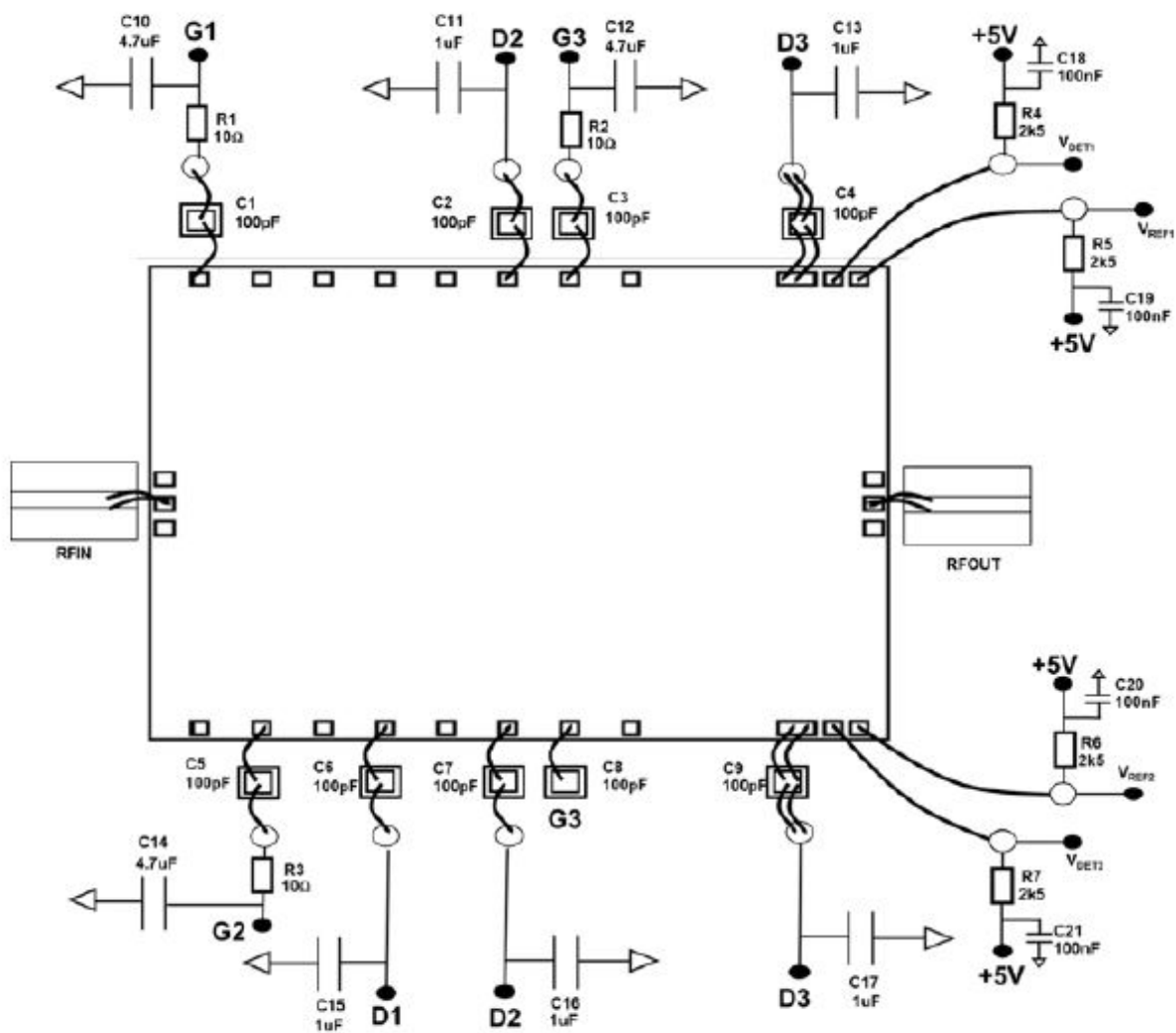
Output Power vs Frequency vs Temperature





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## Recommended Application Circuit



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### Bill Of Materials

Part	Vale	Case Size
C1, C2, C3, C4, C5. C6. C7, C8, C9	100 pF	SLC
C10, C12, C14	4.7 uF	1608 (0603)
C11, C13, C15, C16, C17	1 uF	1608 (0603)
C18, C19, C20, C21	100 nF	1608 (0603)
R1, R2, R3	10 Ohm	1005 (0402)
R4, R5, R6, R7	2.5k Ohm	1005 (0402)

### Bias Sequences

Bias Up Sequence	Bias Down Sequence
1. Set ID limit to 2.5 A, IG limit to 50 mA	1. Turn off RF supply
2. Apply -5 V to VG	2. Reduce VG to -5 V
3. Apply +25 V to VD; IDQ is ~0 mA	3. Set VD to 0 V
4. Adjust VG until IDQ = 300 mA (VG~ -3.6 V)	4. Turn off VD supply
5. Turn on RF supply	5. Turn off VG supply

### Arrangement

G1, G2, and D1 can be biased from either side, with the non-biased side left open.  
G3 can be biased from either side, with the non-biased side bonded to a 100 pF SLC.  
D2 and D3 must be biased from both sides.  
Drain side capacitors should be 35 V minimum rating.

### Detector Operation

K-HPA10W-1721 includes power detectors on both sides of the device to facilitate integration into larger systems. The power detector requires an external 5V supply. For temperature compensation, the VDET and VREF outputs can be connected to a voltage comparator circuit, the output from which can be fed into an ADC or multimeter for the result.



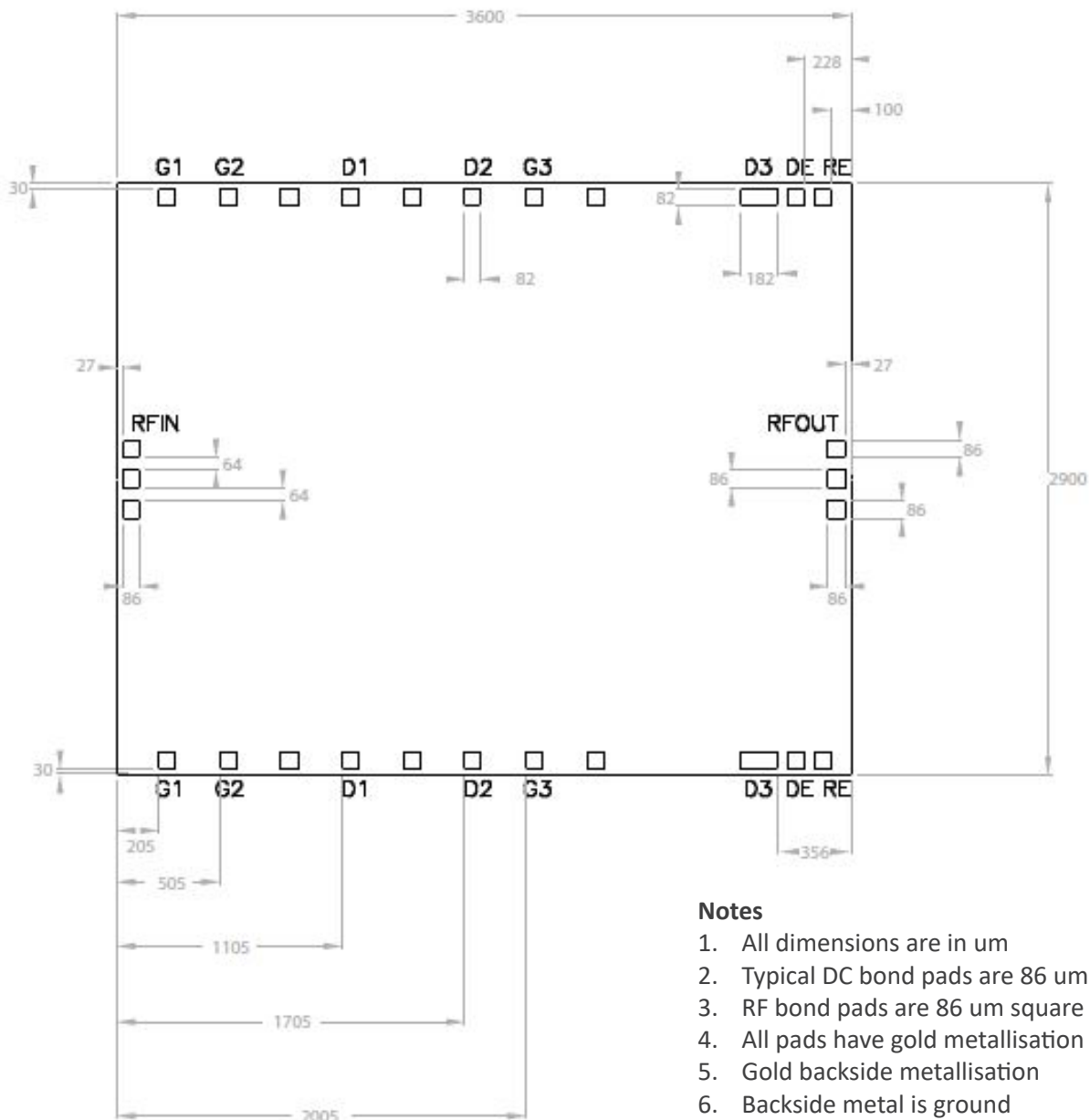
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### Outline drawing



#### Die Packing Information

All die delivered using gel-packs unless otherwise requested.

#### Notes

1. All dimensions are in um
2. Typical DC bond pads are 86 um square
3. RF bond pads are 86 um square
4. All pads have gold metallisation
5. Gold backside metallisation
6. Backside metal is ground
7. Connections are not required for unlabelled bon pads
8. Die thickness is 100 um

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### Pad Descriptions

Name	Description
RFIN	Input RF pad. This pad is AC coupled
RFOUT	Output RF pad. This pad is AC coupled
Dx	Drain bias pad for stage x
Gx	Gate bias pad for stage x
DE	Voltage detector
RE	Voltage reference detector
BOTTOM	The die backside must be connected to RF/DC ground

### General Notes On Assembly

Die should be mounted on conductive material such as gold-plated metal to provide a good ground and suitable heat sink, if necessary.

1. Attaching the die using Au/Sn preforms is preferable. The Eutectic melt for Au/Sn occurs at approximately 280 °C so the die (plus mount and preform) is initially heated up to 180 °C and then it is heated for approximately 10 seconds to 280 °C using a nitrogen heat gun.
2. Pure, dry nitrogen should be used as the heat source.
3. If the devices cannot be lifted/ placed by a vacuum device, then ESD die-lifting tweezers are preferable.
4. Supply lines should be decoupled with 100 pF capacitors.
5. Aluminium wire must not be used.

### Handling Precautions

Parameter	Rating
ESD - Human Bodet Model (HBM)	TBD



**CAUTION!**  
ESD – Sensitive Device

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.

### Contact Information

ReliaSat European Offices

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[www.reliasat.com](http://www.reliasat.com)

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