32-38GHz 12W GaN PA MMIC

ICP3540

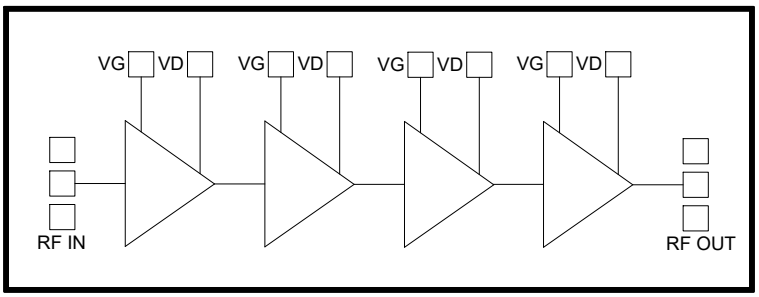
Product Overview

ICONICRF's ICP3540 is a four stage MMIC power amplifier in bare die form, fabricated using GaN on SiC technology. The PA operates from 32-38GHz with 41dBm output power, greater than 18% PAE and 24dB small signal gain. The die has integrated DC blocking capacitors and is matched to 50ohms on the RF input and output ports. ICP3540 is well suited to a variety of commercial and defense applications.

Key Features

- **Frequency Range: 32-38GHz**
- **P_{out}: 41dBm @P_{in}=19dBm**
- **PAE: 18% @P_{in}=19dBm**
- **Small Signal Gain: 24dB**
- **Bias: V_D=28V, I_{DQ}=180mA**
- **Technology: GaN on SiC**
- **Lead-free and RoHS compliant**
- **Die Dimensions: 3.55mm x 2.80mm**
- **Unconditionally Stable**

Functional Block Diagram



Applications

- Test and Measurement
- Communications
- Aerospace & Defense

Electrical Specifications

Test Conditions unless otherwise stated: V_D=28V, I_{DQ}=180mA, T_A=25°C, Pulsed 10% (100µs/1ms)

Parameter	Min.	Typ.	Max.	Units	Conditions[1]
Frequency	32		38	GHz	
Output Power		41		dBm	P_{in} = 19dBm
Power Added Efficiency, PAE		18		%	P_{in} = 19dBm
Small Signal Gain, S_{21}		24		dB	
Input Return Loss		12		dB	
Output Return Loss		7		dB	

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1. Electrical Specification

1.1 Absolute Maximum Ratings

Parameter	Absolute Maximum
Drain Voltage (V_D)	30V
CW Input Power 50 ohm, T_A = 25°C	+24dBm
Channel Temperature	275°C
Storage Temperature	-65°C to +150°C
Eutectic Die Attach Temperature (30s)	320°C

Note:

Exceeding any one or combination of these limits may cause permanent damage to this device.

Microchip Technology Inc. does not recommend sustained operation near these survivability limits.

1.2 Small Signal Performance

Typical Power Dataover T_A

Test conditions: V_D=28V, I_{DQ}=180mA

Figure 1-1. S_{21} vs Freq

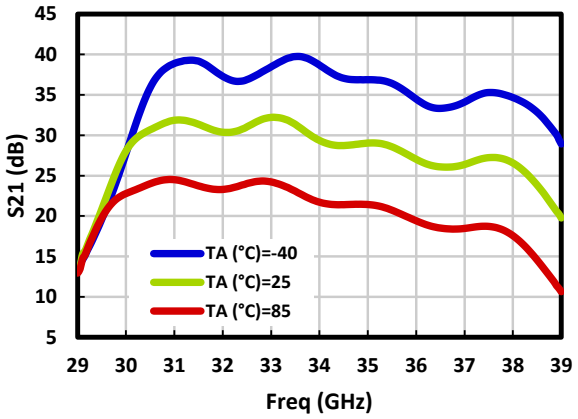


Figure 1-2. S_{11} vs Freq

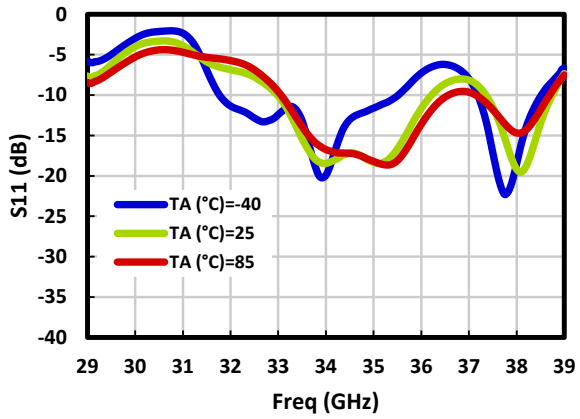
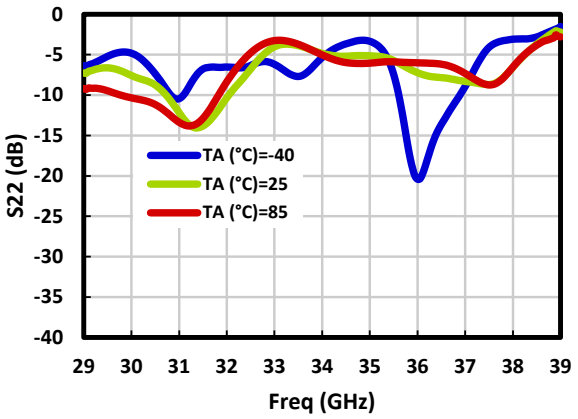


Figure 1-3. S_{22} vs Freq



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1.3 Large Signal Performance

Typical Pulsed Power Data

Test conditions: V_D=28V, I_{DQ}=180mA, T_A=25°C, Pulsed 10% (100µs/1ms)

Figure 1-4. P_{out} vs. P_{in}

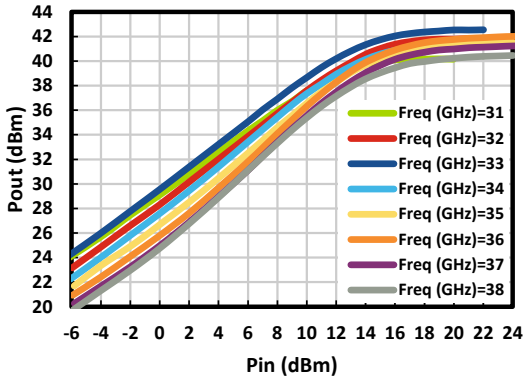


Figure 1-5. Gain vs. P_{out}

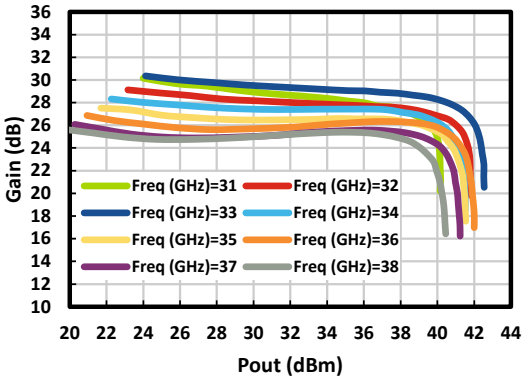


Figure 1-6. PAE vs. P_{out}

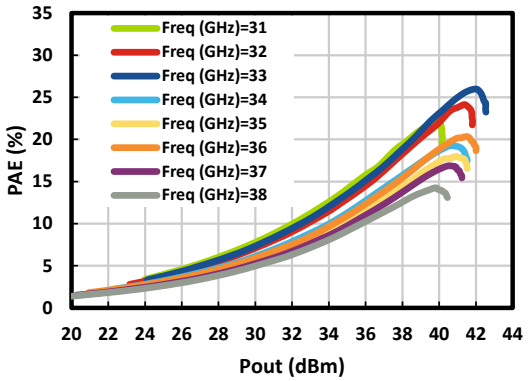


Figure 1-7. I_D vs. P_{out}

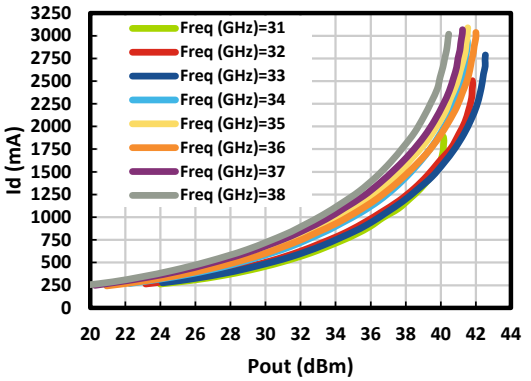


Figure 1-8. P_{out} vs. Freq.

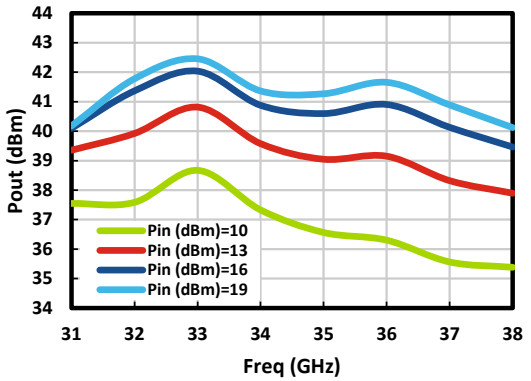
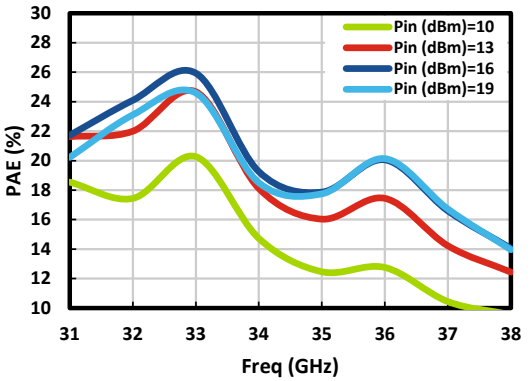


Figure 1-9. PAE vs. Freq.



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Typical Pulsed Power Data over T_A

Test conditions: V_D=28V, I_{DQ}=150mA, Pulsed 10% (100µs/1ms)

Figure 1-10. P_{out} vs. P_{in}, 32GHz

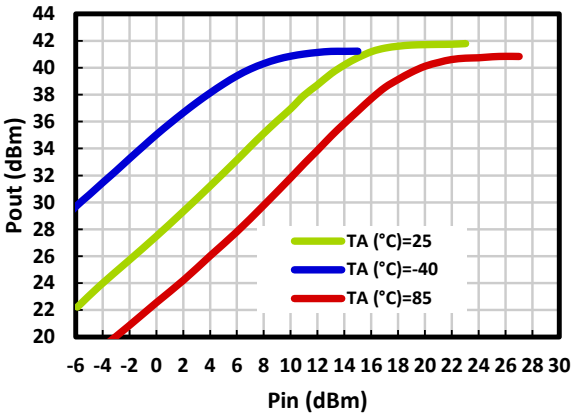


Figure 1-11. PAE vs. P_{out}, 32GHz

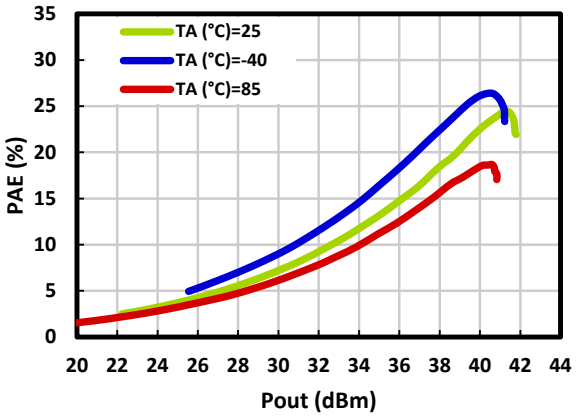


Figure 1-12. P_{out} vs. P_{in}, 33.5GHz

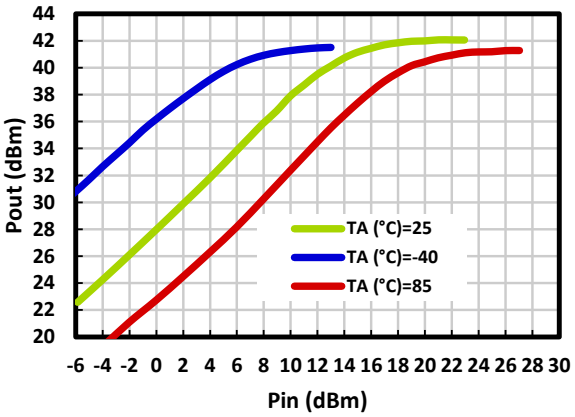


Figure 1-13. PAE vs. P_{out}, 33.5GHz

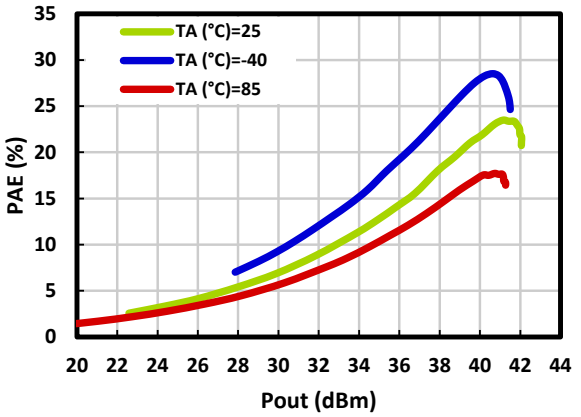


Figure 1-14. P_{out} vs. P_{in}, 35GHz

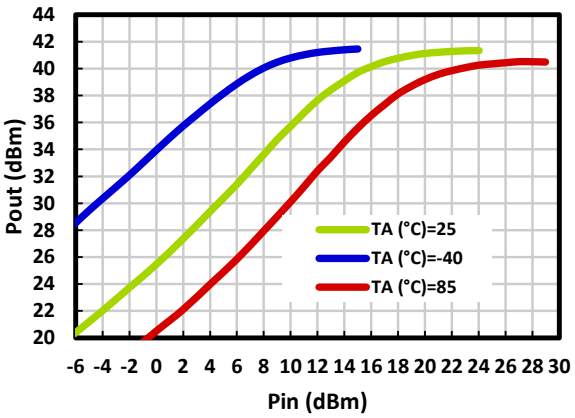
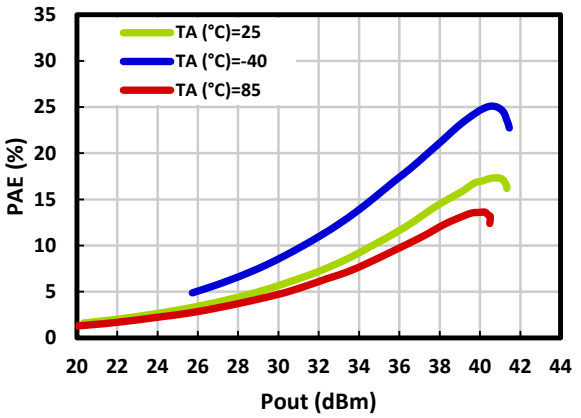


Figure 1-15. PAE vs. P_{out}, 35GHz



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Typical Pulsed Power Data over T_A (continue)

Test conditions: V_D=28V, I_{DQ}=180mA, Pulsed 10% (100µs/1ms)

Figure 1-16. P_{out} vs. P_{in}, 36.5GHz

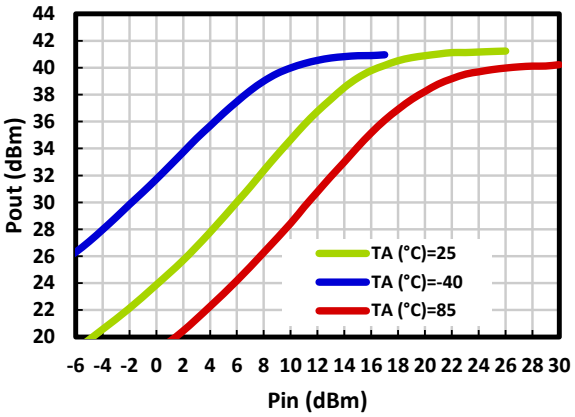


Figure 1-17. PAE vs. P_{out}, 36.5GHz

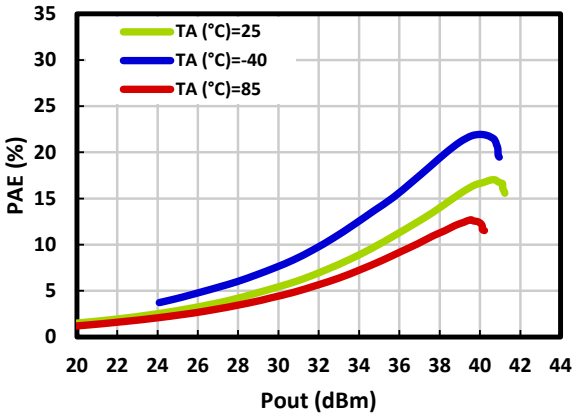


Figure 1-18. P_{out} vs. P_{in}, 36.5GHz

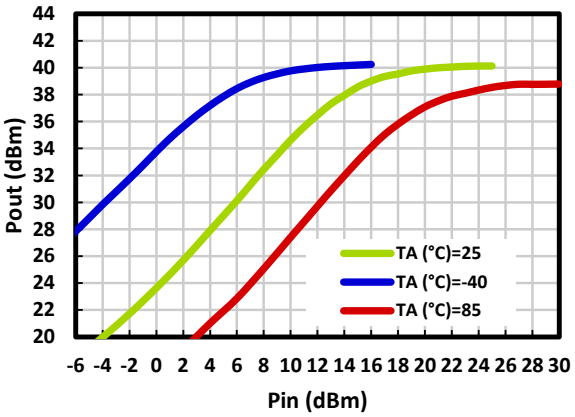


Figure 1-19. PAE vs. P_{out}, 36.5GHz

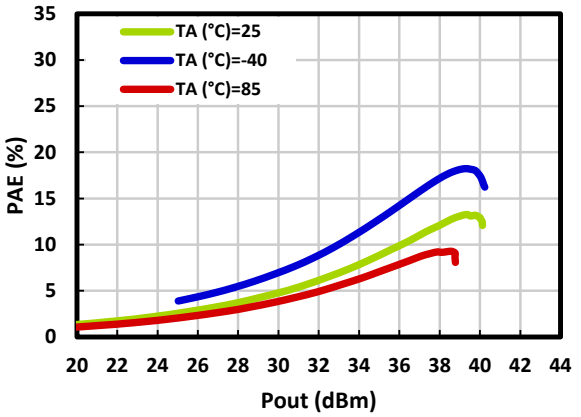


Figure 1-20. P_{out} vs. Freq

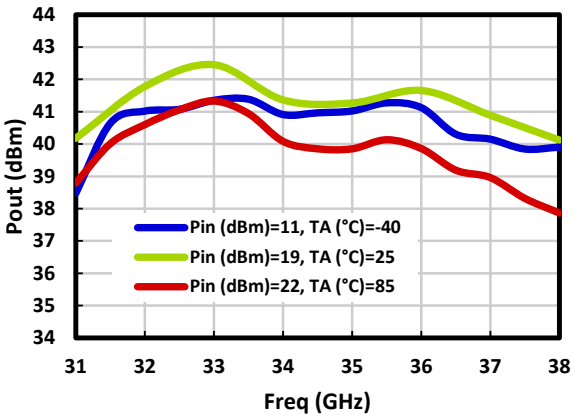
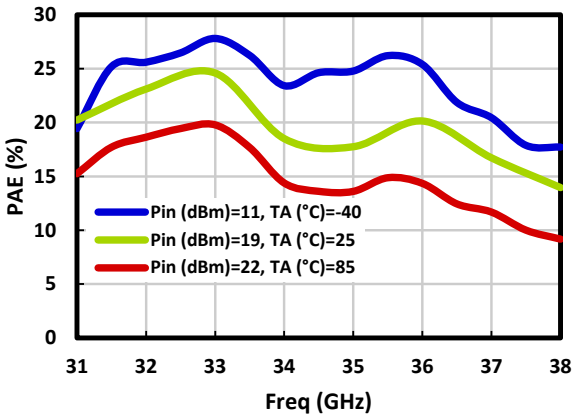
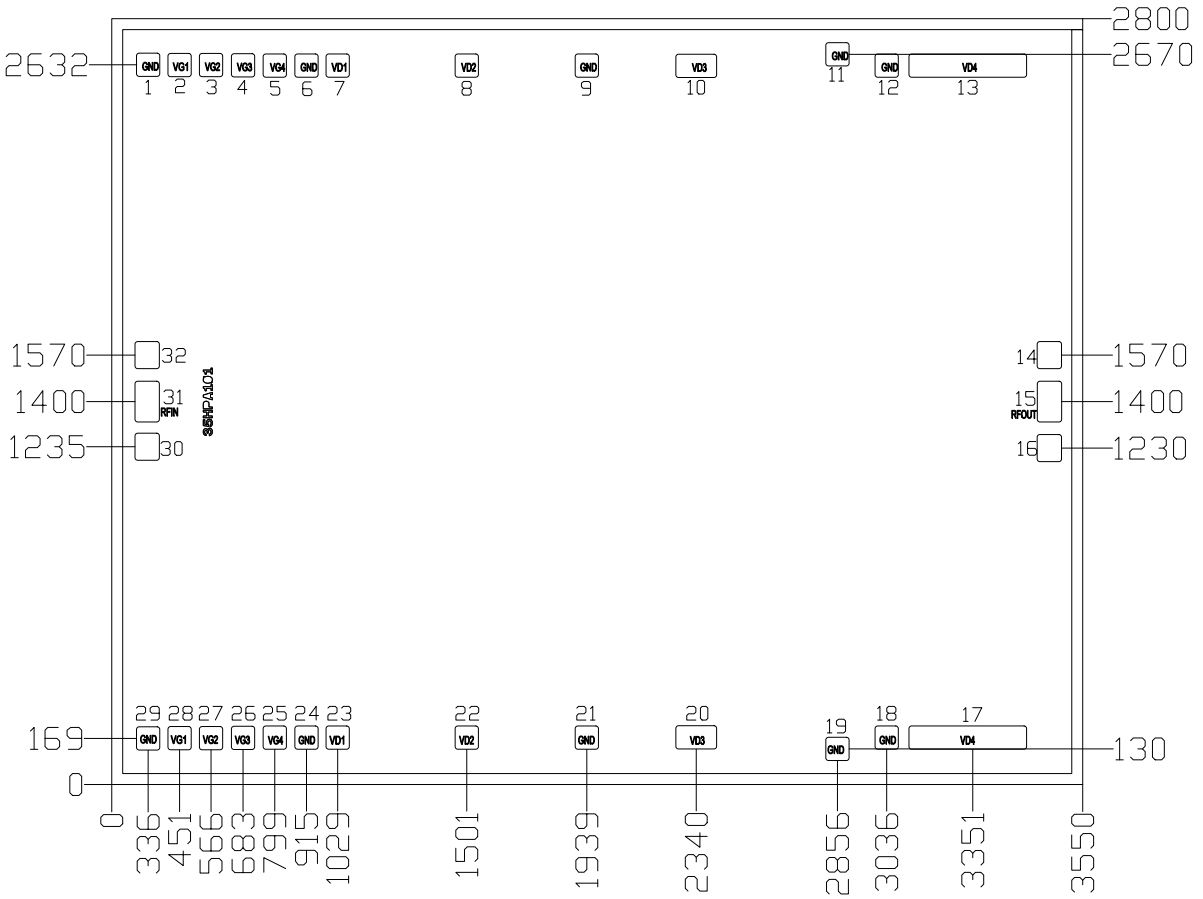


Figure 1-21. PAE vs. Freq



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2. Mechanical Drawing

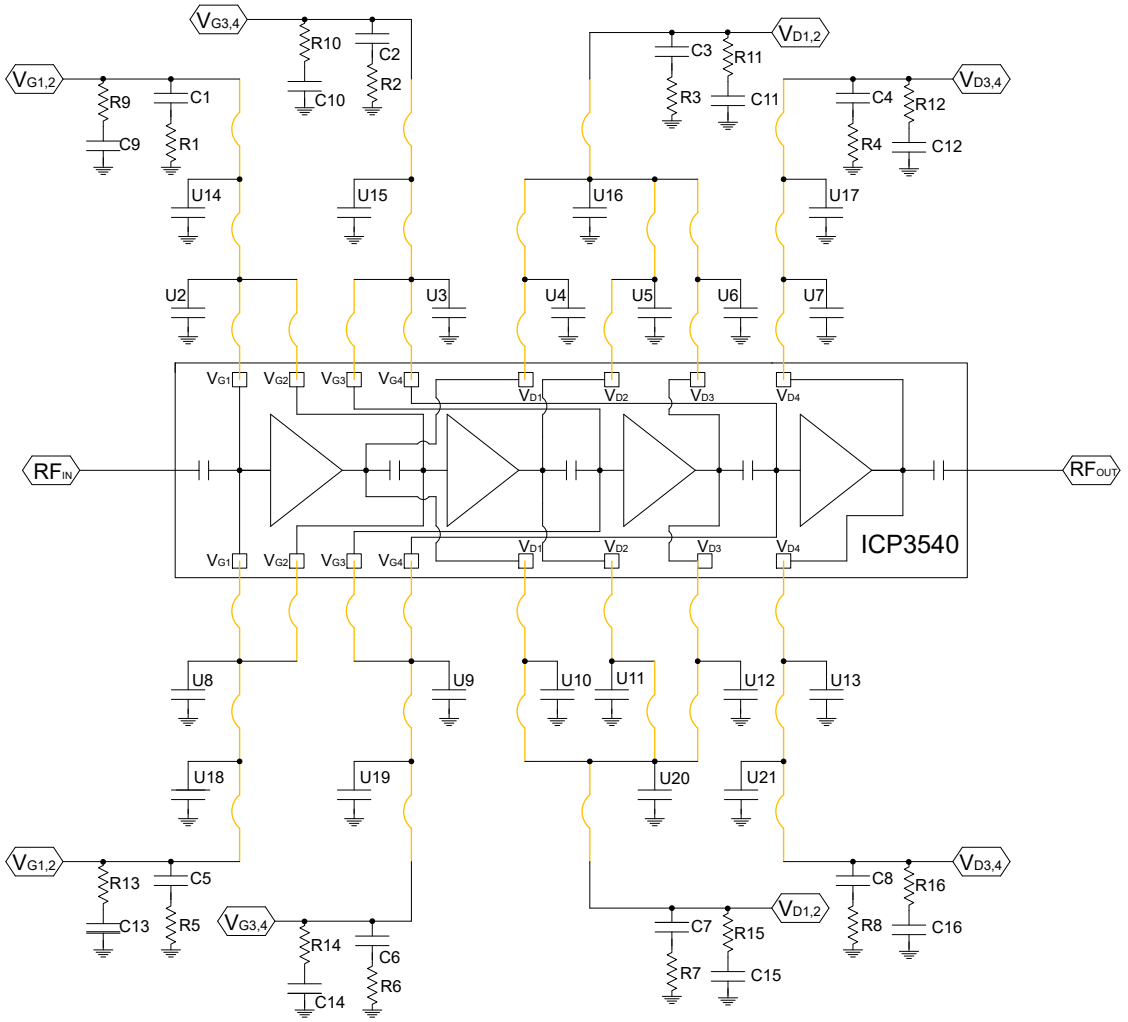


Units: µm | Thickness: 50µm | Backside of Die is RF and DC ground

Pad No	Pad Size (µm)	Function	Description
1, 6, 9, 11, 12, 18, 19, 21, 24, 29	85x85	GND	Ground Pads
2, 28	85x85	V_{G1}	First stage gate voltage, decoupling and bypass caps required
3, 27	85x85	V_{G2}	Second stage gate voltage, decoupling and bypass caps required
4, 26	85x85	V_{G3}	Third stage gate voltage, decoupling and bypass caps required
5, 25	85x85	V_{G4}	Fourth stage gate voltage, decoupling and bypass caps required
7, 23	85x85	V_{D1}	First stage drain voltage, decoupling and bypass caps required
8, 22	85x85	V_{D2}	Second stage drain voltage, decoupling and bypass caps required
10, 20	150x85	V_{D3}	Third stage drain voltage, decoupling and bypass caps required
13, 17	430x85	V_{D4}	Fourth stage drain voltage, decoupling and bypass caps required
14, 16, 30, 32	90x100	GND	Ground Pads
15	90x150	RF_{OUT}	50ohm RF output, DC blocked
31	90x150	RF_{IN}	50ohm RF input, DC blocked

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3. Application Circuit

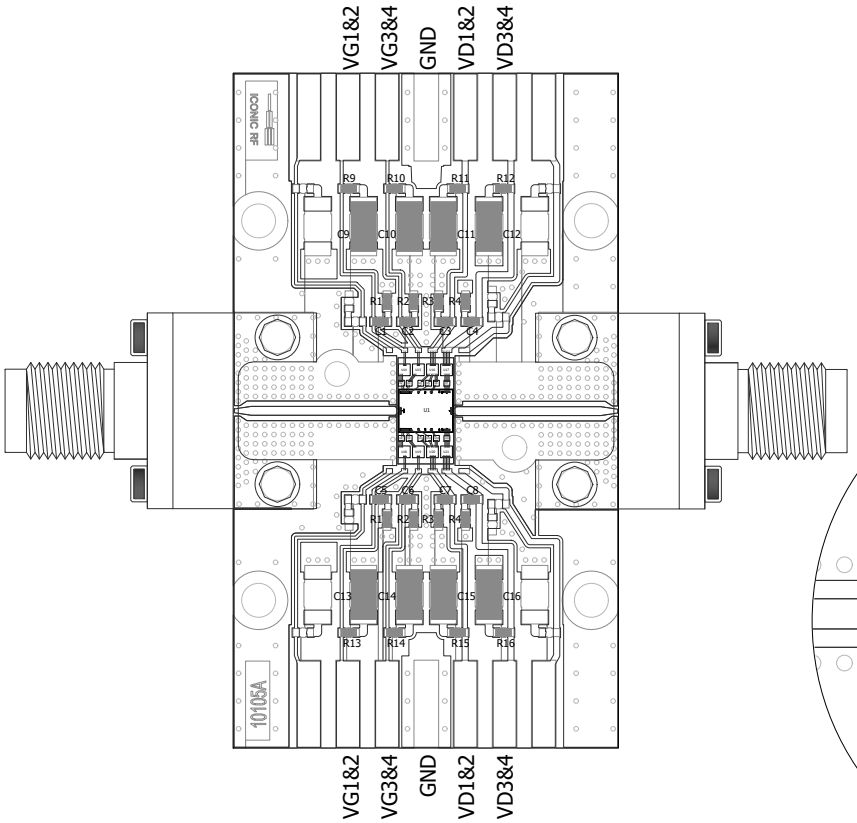


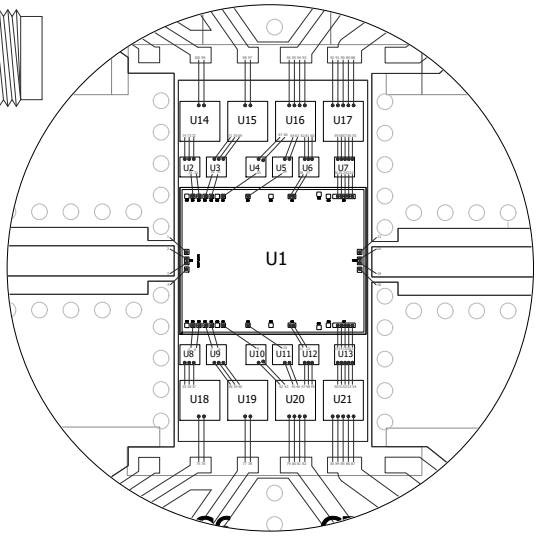
Bill of materials

Component ID	Value	Details	Qty	Manufacturer Part No.
U2-U13	100pF	Johanson 100pF SLC	12	500U01A101MT4W
U14-U21	10nF	10nF SLC	8	V30BZ682M1SX
C1-C8	10nF	10nF Capacitor, 10%, 50V, 0402	8	Various
C9-C16	10µF	10µF Capacitor, 10%, 50V, 1206	8	Various
R1-R16	0Ω	0 Ohms Resistor, 0402	16	Various

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4. Evaluation Board





DETAIL A - BONDING

Die Attach Methods

PCB Construction	Material	Dimensions
METAL_1_TOP	Cu + ENIG	1oz Copper plated Electroless Nickel 3-5µm Inmersion Gold 0.5µm
DIELECTRIC	RO6002	10mils (254µm)
METAL2_BOTTOM	Cu + ENIG	1oz Copper plated Electroless Nickel 3-5µm Inmersion Gold 0.5µm

Key Features	Dimensions
VIA Drill	0.3mm
VIA Plating Thickness	50-70µm
50Ohm LINE WIDTH	525µm

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5. Other considerations

Assembly Guidance

Interconnect assembly Notes	Die attach using Eutectic
· Ball Bonding is preferred technique · Force, time and ultrasonic parameters are critical. · Aluminum wire bonding is not recommended. · Bond Wire diameter of 1mil is recommended.	· Flux-less gold-tin (AuSn) (80% Au, 20% Sn with a melting point of 280ºC) preform is preferred between the die and attached surface. · Recommended preform should be approximately 0.0012" thick. · Die bonder using heated collet with a temperature of 310ºC and die scrubbing should be used to ensure wetting and prevent formation of voids. · Exposure to extreme temperature should be kept to a minimum. · The optimum die attach environment is nitrogen atmosphere.

Die attach of component using adhesive	Re-flow Process
· Vacuum collets are preferred method of pickup. · Pickup method must consider the avoidance of die air bridges. · Die suitable for Eutectic and Epoxy die attach. · Where Epoxy is used, high thermal conductivity Silver Sintered Epoxy is recommended:- · Kyocera CT2700R7S · Namics H9889-1	· Maximum temperature 320ºC for 30 seconds. · Material matching for coefficient of thermal expansion is crucial for long-term reliability

Optimum RF power performance achieved by minimizing output RF bond wire length.

For optimum RF and thermal performance IconicRF recommends the die assembly base plate is adequately bolted to an forced air heat sink using a thermal graphite interface pad (Graphite Interface Material GCSP-017-G 170µm thick) for optimal heat transfer. There are many variables of the second level assembly between the die base plate and heat sink that IconicRF are unable to control and the following guidance is provided as information only. Fixing bolts should be provided as close to the die as possible to ensure an optimum pressure between the base plate and the heat sink. The bolting screws used to attach the PCB assembly to the heat sink must include washers and be tightened with a suitable tightening pattern to ensure a uniform pressure. It is advised all surfaces be cleaned and be free of grease and dust prior to fully aligning the assembly with all screws located and tightened to finger tight. Further torquing of the screws must be achieved in multiple phases using a star shaped pattern to a recommended torque of 2.5N/m.

Bias-up procedure

1. Set V_G to -5V
2. Set V_D to 28V
3. Adjust V_G positive until I_D quiescent is 180mA
4. Limit I_D to 3A
5. Apply RF signal

Bias-down procedure

1. Turn off RF
2. Turn off V_D, allow drain capacitors to discharge
3. Turn off V_G

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6. Ordering, Shipping, and Handling

Handling Recommendations

Integrated circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. It is recommended to follow all procedures and guidelines outlined in the Microsemi application note AN01: GaAs MMIC Handling and Die Attach Recommendations.

Ordering Information

For additional ordering information, contact your Microchip sales representative.

Part Number	Description
ICP3540-1-110I	Bare Die in Gelpak
EV56X26A	Evaluation Board Development Tool for ICP3540-1-110I

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