6-18GHz 12W GaN PA MMIC

ICP1240

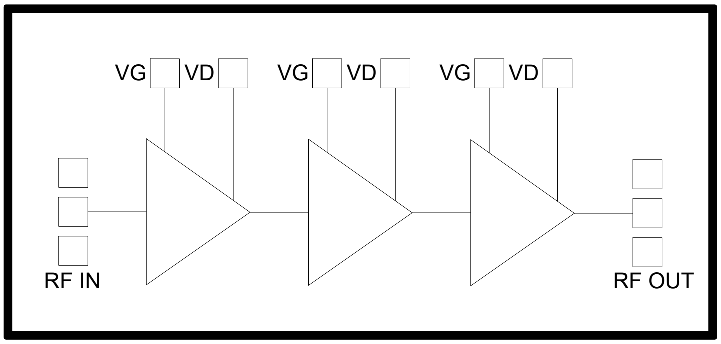
Product Overview

ICP1240 is a 3 stage MMIC power amplifier in bare die form, fabricated using GaN on SiC technology. ICP1240 operates from 6-18GHz with 41dBm output power, >20% PAE and 23dB typical small signal gain. ICP1240 is well suited to a variety of commercial, aerospace and defense applications.

Key Features

- **Frequency Range: 6-18GHz**
- **P_{out}: 41dBm @P_{in}=24dBm**
- **PAE: 20% @P_{in}=24dBm**
- **Small Signal Gain: 23dB**
- **Bias: V_D=24V, I_{DQ}=280mA**
- **Technology: GaN on SiC**
- **Lead-free and RoHS compliant**
- **CW operation**
- **Die Size: 5.01mm x 3.3mm**

Functional Block Diagram



Applications

- Test and Measurement
- Aerospace & Defense

Electrical Specifications

Parameter	Min.	Typ.	Max.	Units	Conditions[1]
Frequency	6		18	GHz	
Output Power @P_{sat}	40	41		dBm	P_{in}=24dBm
Gain @P_{sat}	17	18.5	20		P_{in}=24dBm
Power Added Efficiency, PAE @P_{sat}		20		%	P_{in}=24dBm
Drain current (I_d) @P_{sat}	2200		3850	mA	P_{in}=24dBm
Gate voltage (V_G) for I_{DQ}	-1.7		-2.2	V	
Gate current (I_g)	-2		10	mA	P_{in}=24dBm
Small Signal Gain, S_{21}		23		dB	
Input Return Loss		15		dB	
Output Return Loss		7		dB	
Recommended operating voltage	18	24	24	V	

Note: (1) Test conditions unless otherwise stated V_D=24V, I_{DQ}=280mA, T_A=25°C, CW

Table of Contents

Product Overview........1

1. Electrical Specification........3
    1.1. Absolute Maximum Ratings........3
    1.2. Small Signal Performance........4
    1.3. Large Signal Performance........6

2. Mechanical Drawing........11

3. Application Circuit........12

4. Evaluation Board........13

5. Other considerations........14

6. Ordering, Shipping, and Handling........15

Microchip Information........16
    The Microchip Website........16
    Product Change Notification Service........16
    Customer Support........16
    Microchip Devices Code Protection Feature........16
    Legal Notice........16
    Trademarks........17
    Quality Management System........18
    Worldwide Sales and Service........19

1. Electrical Specification

1.1 Absolute Maximum Ratings

Parameter	Absolute Maximum
Drain Voltage (V_D)	30V
CW Drain Current (I_D), T_A=25°C	6A
Gate Voltage Range (V_G)	-5 to 0V
Gate Current (I_G)	14mA
Power Dissipation (CW) T_A=25°C Power Dissipation (CW) T_A=85°C	140W 110W
CW Input Power 50Ohm, T_A=25°C	+29dBm
Input Power VSWR (2:1) V_D=20V, I_{DQ}=280mA V_D=24V, I_{DQ}=280mA	+27dBm
Channel Temperature	275°C
Storage Temperature	-65°C to +150°C
Eutetric Die Attached Temperature (30s)	320°C

Thermal and Reliability

Parameter	Value
Thermal Resistance	1.71°C/W

- Assumes silver sintered epoxy attach (15µm thick) mounted on CuMo carrier.
- Base temperature is assumed at the top of the CuMo carrier
- Thermal resistance calculated using IR measurement of the channel temperature.

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 Data over V_D

Test conditions: I_{DQ}=280mA, T_A=25°C

Figure 1-1. S_{21} vs Freq

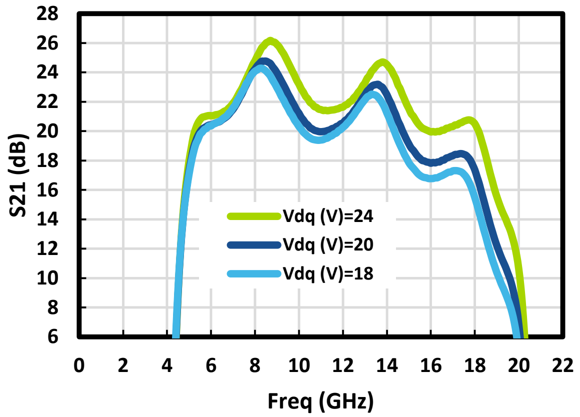


Figure 1-2. S_{11} vs Freq

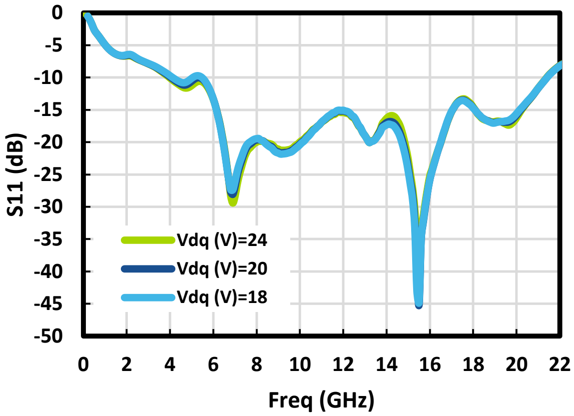
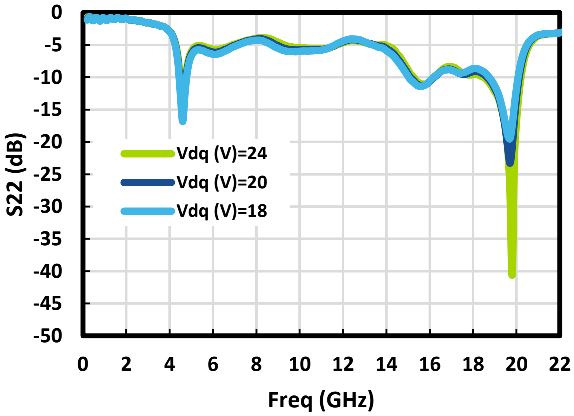


Figure 1-3. S_{22} vs Freq



Typical Data over T_A

Test conditions: V_D=24V, I_{DQ}=280mA

Figure 1-4. S_{21} vs Freq

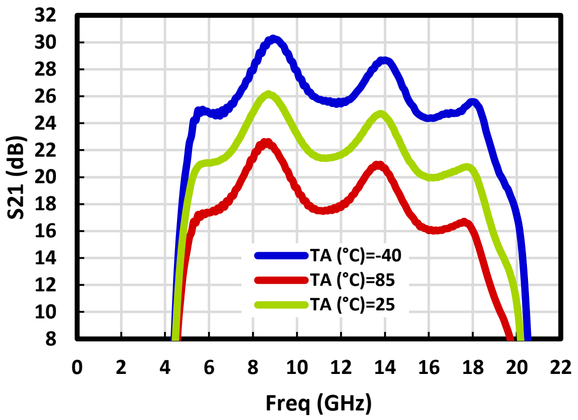


Figure 1-5. S_{11} vs Freq

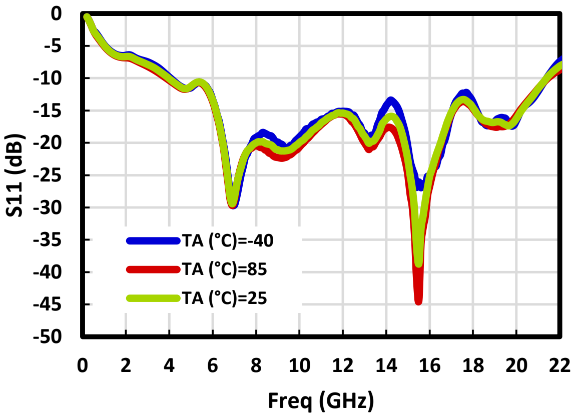
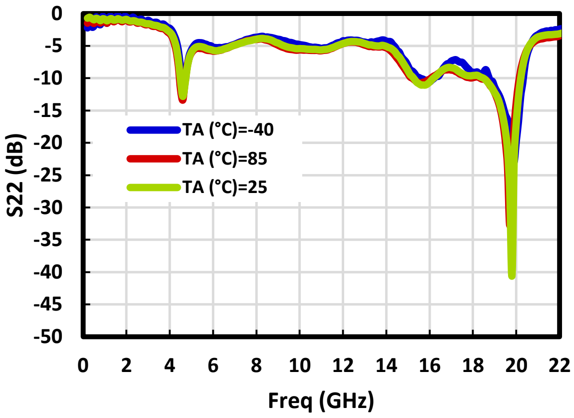


Figure 1-6. S_{22} vs Freq



1.3 Large Signal Performance

Typical CW Power Data

Test conditions: V_D=24V, I_{DQ}=280mA, T_A=25°C, CW

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

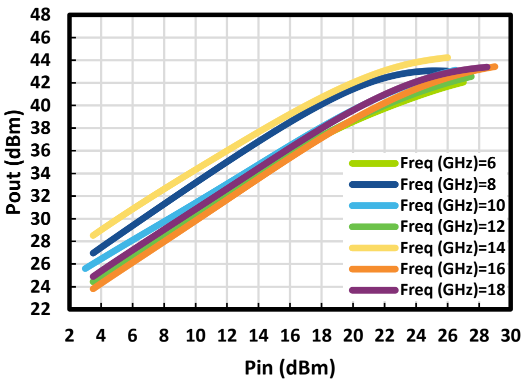


Figure 1-8. Gain vs. P_{out}

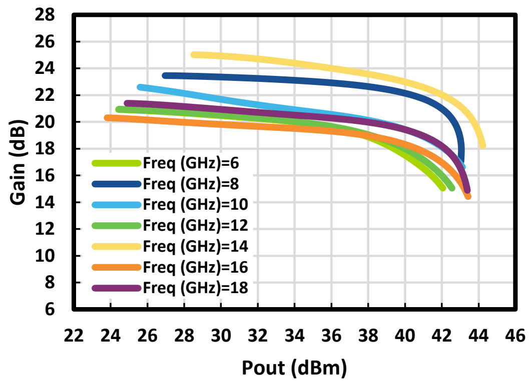


Figure 1-9. PAE vs. P_{out}

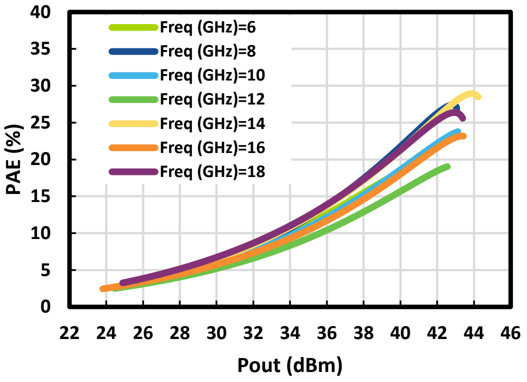


Figure 1-10. I_D vs. P_{out}

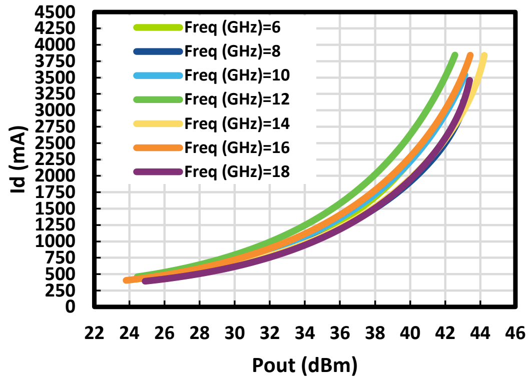


Figure 1-11. P_{out} vs. Freq.

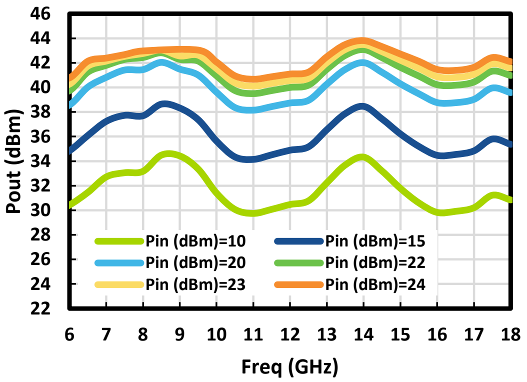
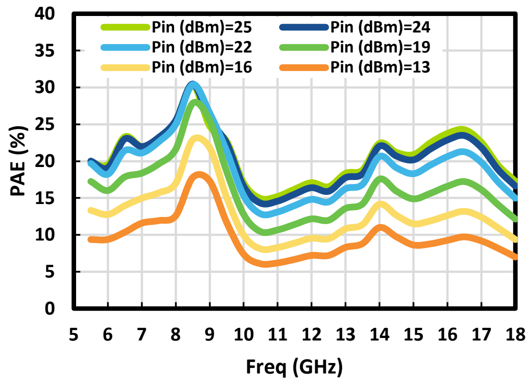


Figure 1-12. PAE vs. Freq.



Typical CW Power Data over V_D

Test conditions: I_{DQ}=280mA, T_A=25°C, CW

Figure 1-13. Gain vs. P_{in} at 6GHz

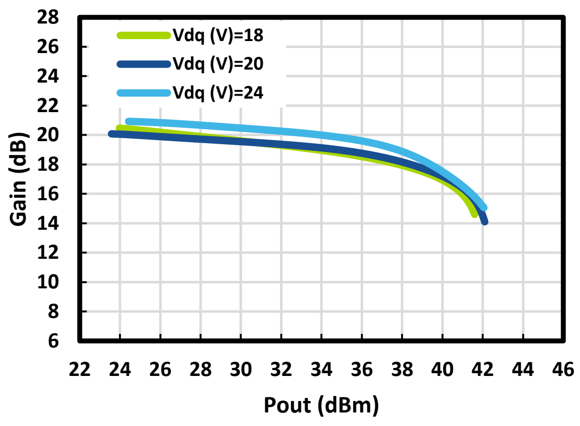


Figure 1-14. Gain vs. P_{out} at 10GHz

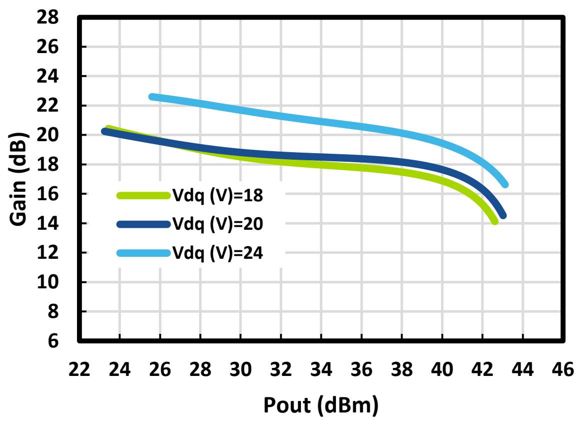


Figure 1-15. Gain vs. P_{in} at 14GHz

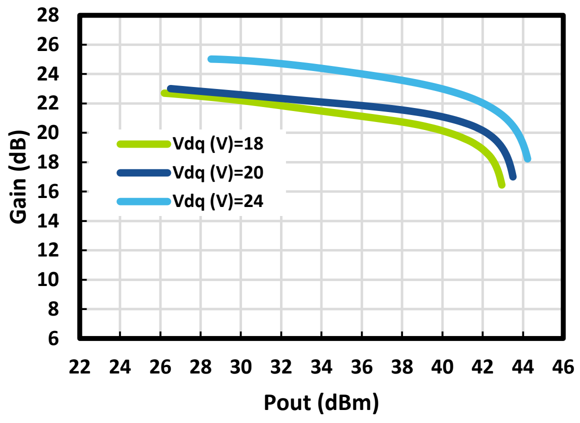


Figure 1-16. Gain vs. P_{out} at 18GHz

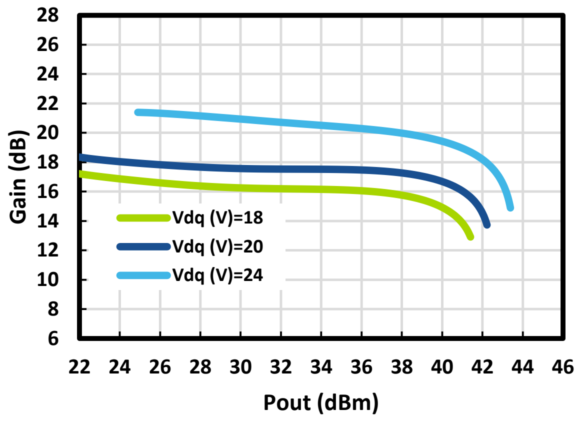


Figure 1-17. P_{out} vs. Freq.

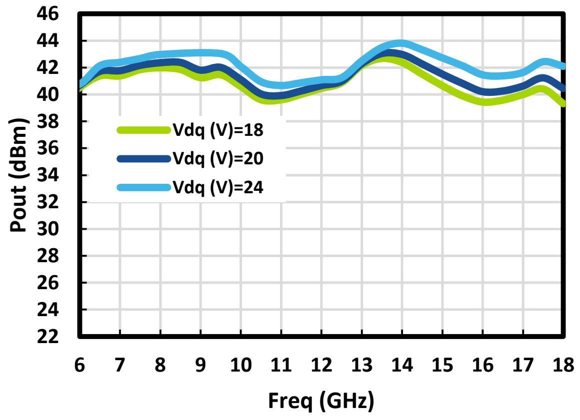
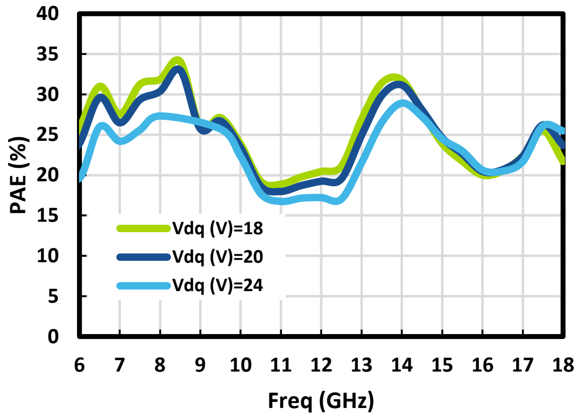


Figure 1-18. PAE vs. Freq.



Typical CW Power Data over T_A

Test conditions: V_D=24V, I_{DQ}=280mA, CW

Figure 1-19. P_{out} vs. P_{in} at 6GHz

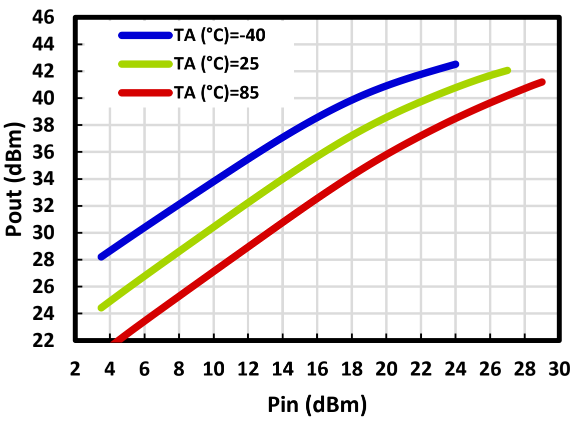


Figure 1-20. Gain vs. P_{out} at 6GHz

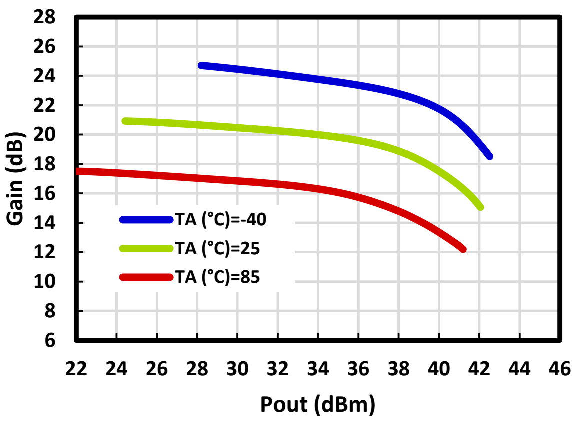


Figure 1-21. P_{out} vs. P_{in} at 12GHz

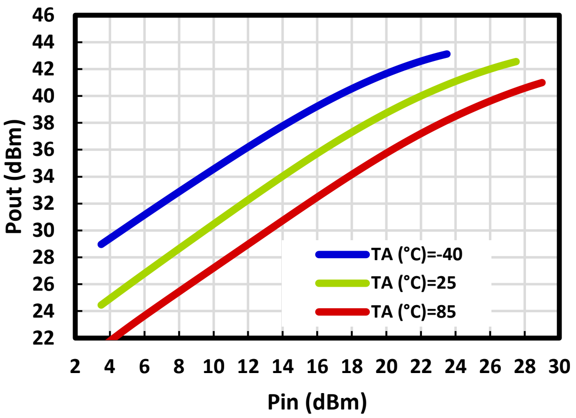


Figure 1-22. Gain vs. P_{out} at 12GHz

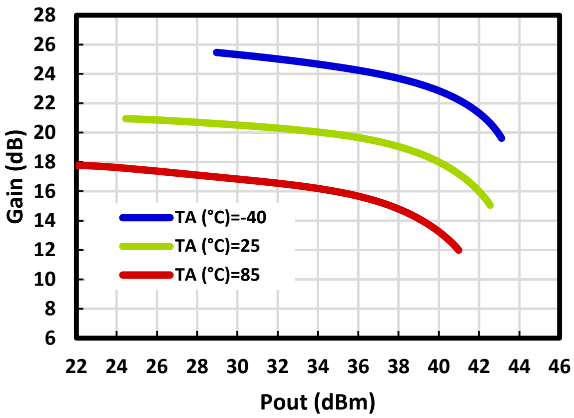


Figure 1-23. P_{out} vs. P_{in} at 18GHz

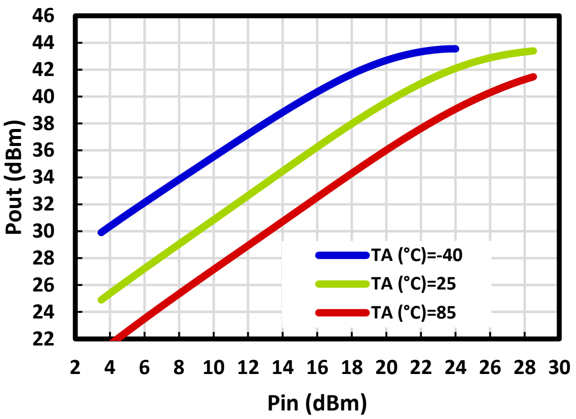
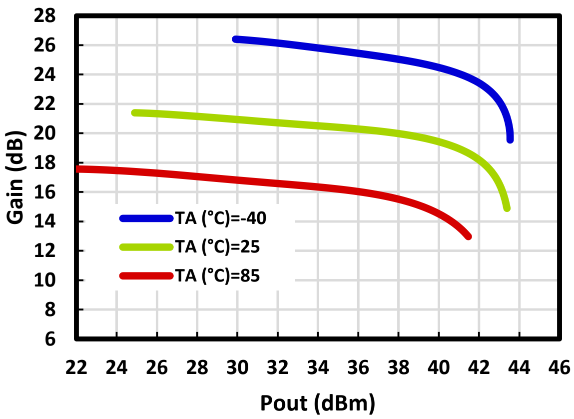


Figure 1-24. Gain vs. P_{out} at 18GHz



Typical CW Power Data over T_A (Continued)

Test conditions: V_D=24V, I_{DQ}=280mA, CW

Figure 1-25. PAE vs. P_{out} at 6GHz

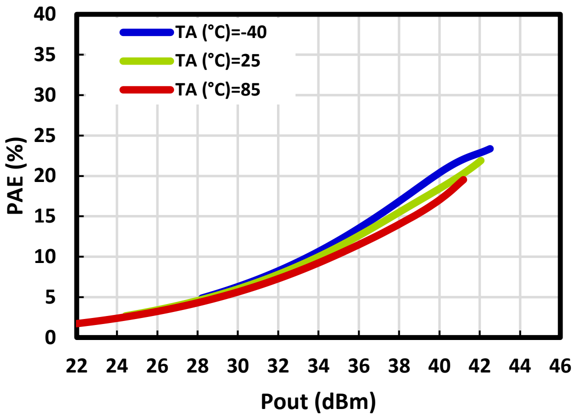


Figure 1-26. I_d vs. P_{out} at 6GHz

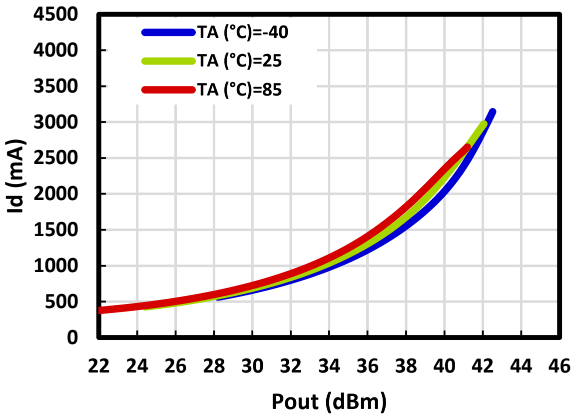


Figure 1-27. PAE vs. P_{out} at 12GHz

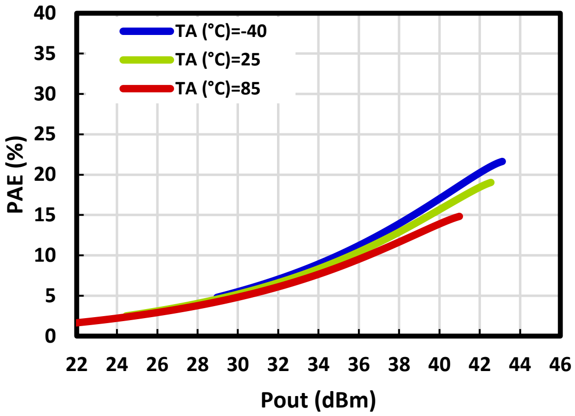


Figure 1-28. I_d vs. P_{out} at 12GHz

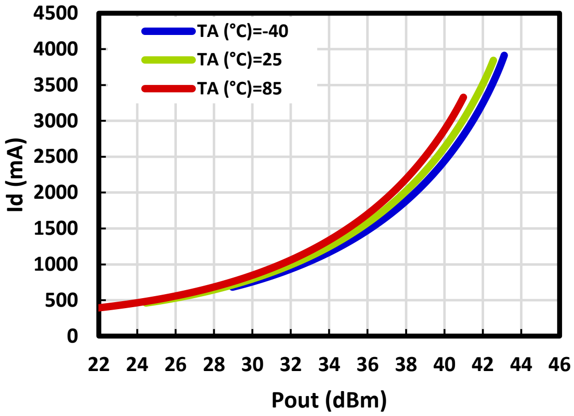


Figure 1-29. PAE vs. P_{out} at 18GHz

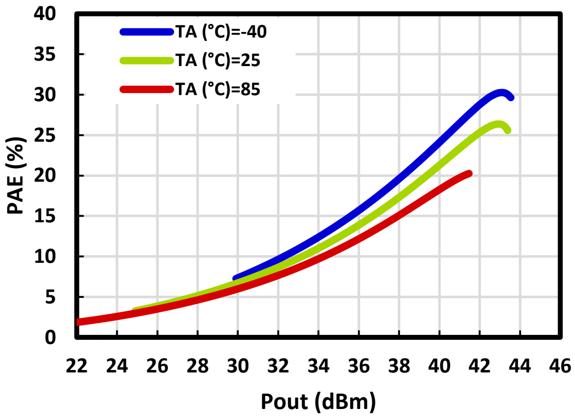
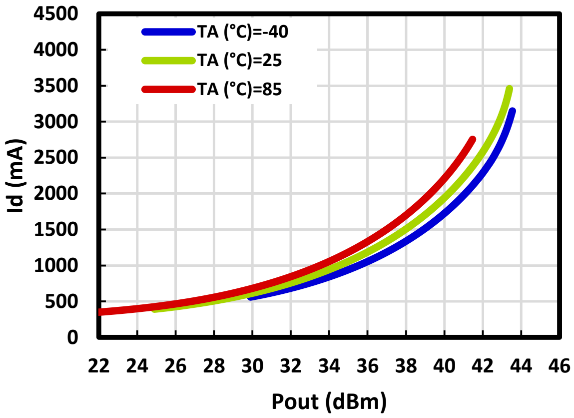


Figure 1-30. I_d vs. P_{out} at 18GHz



Typical CW Power Data over T_A (Continued)

Test conditions: V_D=24V, I_{DQ}=280mA, CW

Figure 1-31. P_{out} vs. Freq.

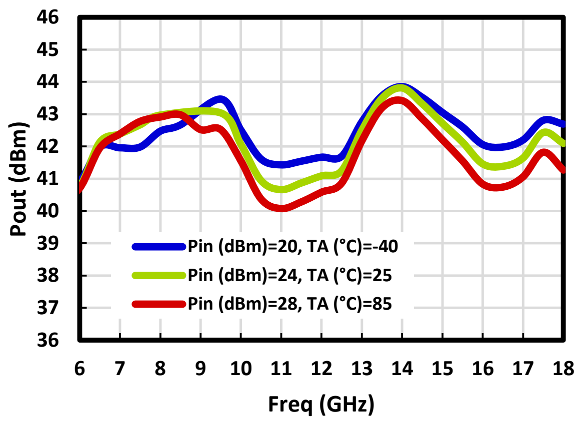
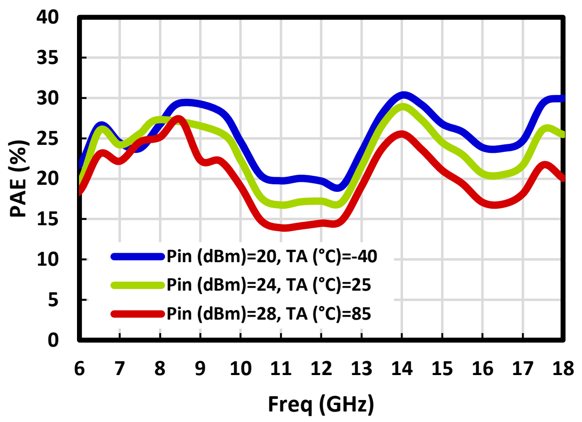


Figure 1-32. Gain vs. Freq.



Typical CW Liniearity Power Data

Test conditions: V_D=24V, I_{DQ}=280mA, T_A=25°C, CW

Figure 1-33. IM_3 vs. P_{out}

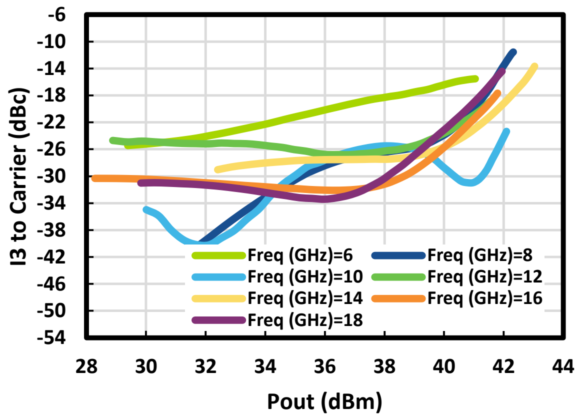
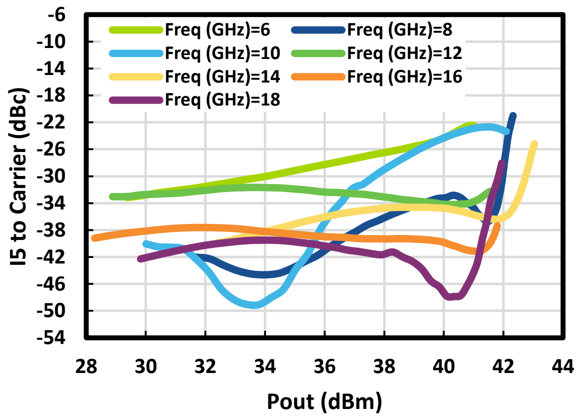
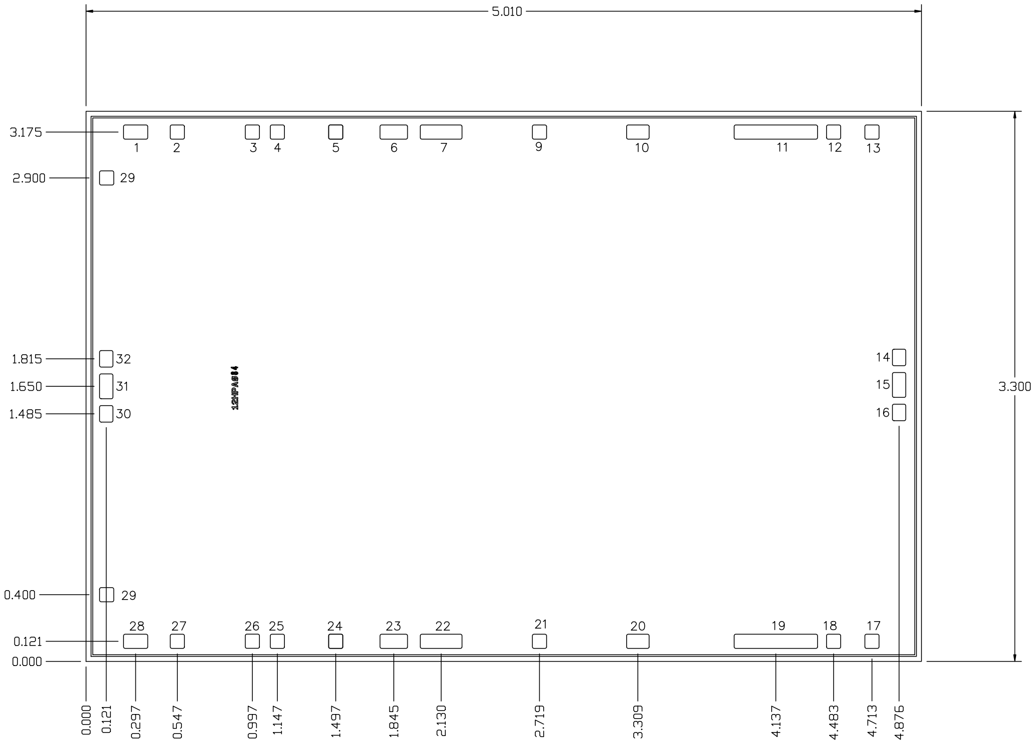


Figure 1-34. IM_5 vs. P_{out}



2. Mechanical Drawing

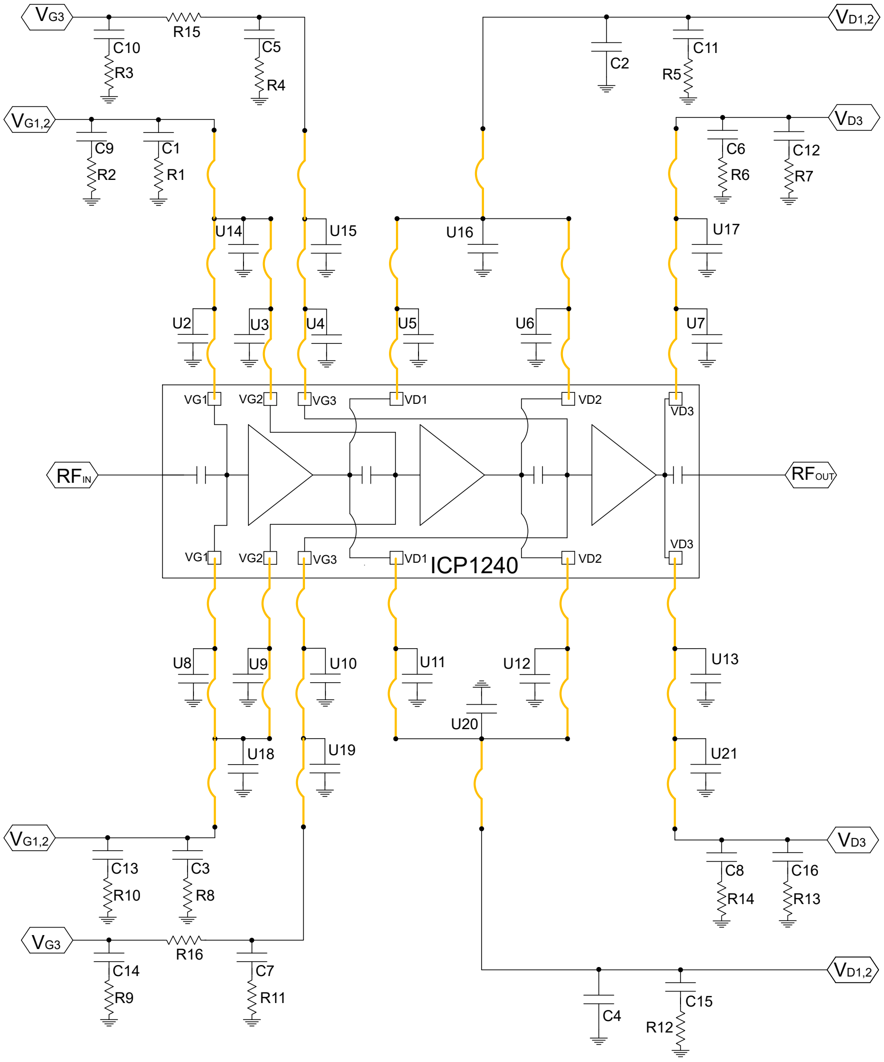


Units: mm | Thickness: 100µm | Backside of Die is RF and DC ground

Pad No.	Pad Dimension (µm)	Function	Description
1, 10, 20, 28	145x85	GND	Ground connection
3, 12, 13, 17, 18, 26	85x85	GND	Ground connection
2, 27	85x85	V_{G1}	First stage north gate bias, decoupling and bypass caps required, must be biased from both sides
4, 25	85x85	V_{G2}	Second stage gate bias, decoupling and bypass caps required, must be biased from both sides
5, 24	85x85	V_{G3}	Third stage gate bias, decoupling and bypass caps required, must be biased from both sides
9, 24	85x85	No Connect	Do not connect
6, 23	165x85	V_{D1}	First stage north drain voltage, decoupling and bypass caps required, must be biased from both sides
7, 22	250x85	V_{D2}	Second stage drain voltage, decoupling and bypass caps required, must be biased from both sides
11, 19	500x85	V_{D3}	Third stage drain voltage, decoupling and bypass caps required, must be biased from both sides
14, 16, 30, 32	85x100	GND	Ground connection
15	80x150	RF_{out}	50 ohm RF output, DC blocked, pad is DC grounded
31	80x150	RF_{in}	50 ohm RF input, DC blocked

1. V_{D1}, V_{D2} and V_{D3} can be connected together in application
2. V_{G1}, V_{G2} and V_{G3} can be connected together in application

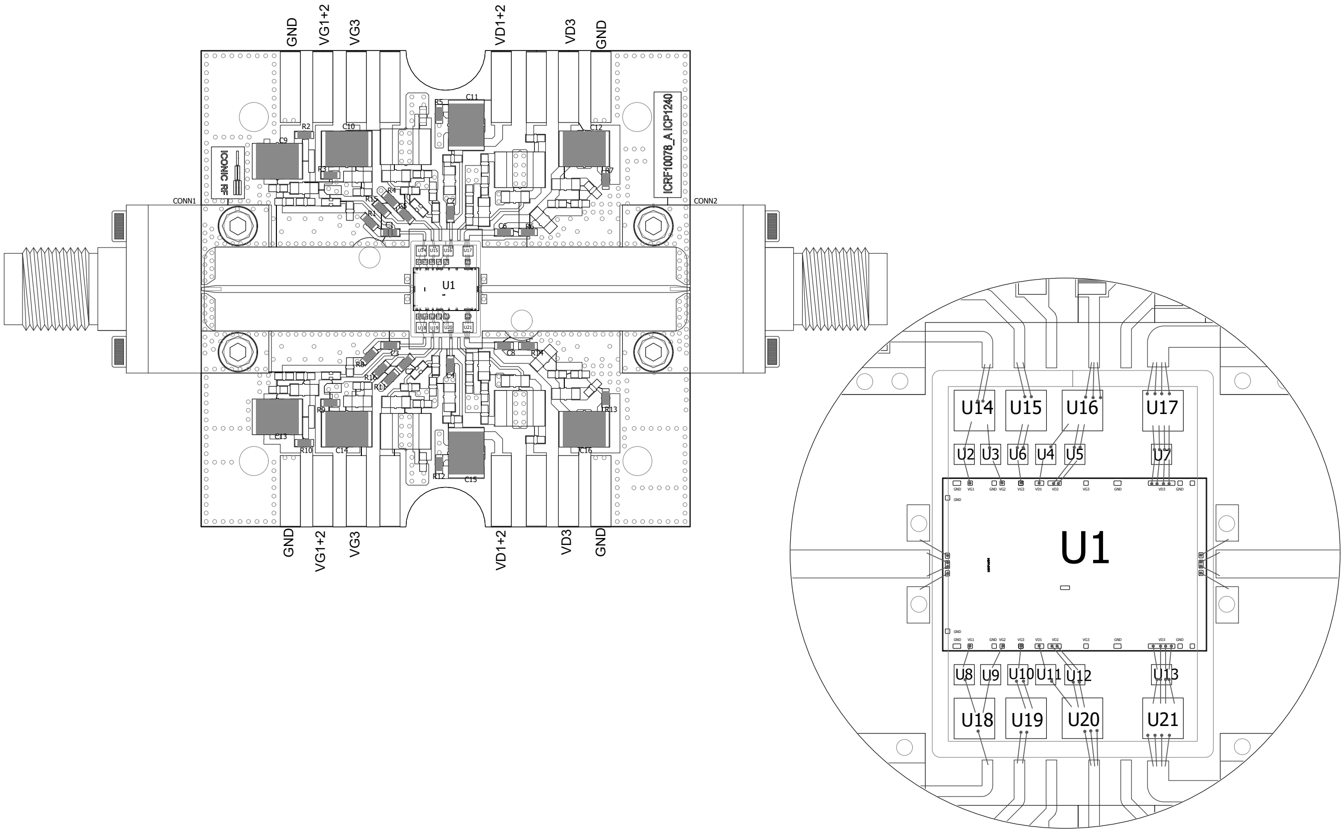
3. Application Circuit



Bill of materials

Component ID	Value	Details	Qty	Manufacturer Part No.
U2-U13	100pF	100pF SLC	12	Johanson Dielectrics Inc.
U14 - U21	10nF	10nF SLC	8	Johanson Dielectrics Inc.
C1, C3, C5, C7	100nF	100nF Capacitor,10%,50V,0402	4	Various
C2, C4, C6, C8	10nF	10nF Capacitor,10%,50V,0402	4	
C9-C16	10µF	10µF Capacitor,10%,50V,1206	8	Various
R1-R5, R7-R13	5.1Ω	5.1 ohm resistor, 0402	12	Various
R6, R14	0Ω	0 Ohms Resistor,0402	2	Various
R15, R16	82Ω	82 Ohms Resistor,0402	2	

4. Evaluation Board



Die Attach Methods

PCB Construction	Material	Dimensions
METAL_1_TOP	Cu + ENIG	1oz Copper plated Electroless Nickel 3-5µm Inmersion Gold 0.5µm
DIELECTRIC	RO4350C	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

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 20V-24V
3. Adjust V_G positive until I_D quiescent is 280mA
4. Limit I_D to 4.5A
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

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
ICP1240-1-110I	Bare Die in Gelpak
EV29N87A	Evaluation Board Development Tool for ICP1240-1-110I

Microchip Information

The Microchip Website

Microchip provides online support via our website at www.microchip.com/. This website is used to make files and information easily available to customers. Some of the content available includes:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip design partner program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

Product Change Notification Service

Microchip's product change notification service helps keep customers current on Microchip products. Subscribers will receive email notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, go to www.microchip.com/pcn and follow the registration instructions.

Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Embedded Solutions Engineer (ESE)
- Technical Support

Customers should contact their distributor, representative or ESE for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in this document.

Technical support is available through the website at: www.microchip.com/support

Microchip Devices Code Protection Feature

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip product is strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is "unbreakable". Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.

Legal Notice

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. Contact your local Microchip sales office for additional support or, obtain additional support at www.microchip.com/en-us/support/design-help/client-support-services.

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSEQUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP'S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION.

Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Trademarks

The Microchip name and logo, the Microchip logo, Adaptec, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, CryptoMemory, CryptoRF, dsPIC, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Kleer, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AgileSwitch, ClockWorks, The Embedded Control Solutions Company, EtherSynch, Flashtec, Hyper Speed Control, HyperLight Load, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet-Wire, SmartFusion, SyncWorld, TimeCesium, TimeHub, TimePictra, TimeProvider, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, Augmented Switching, BlueSky, BodyCom, Clockstudio, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, Espresso T1S, EtherGREEN, EyeOpen, GridTime, IdealBridge, IGaT, In-Circuit Serial Programming, ICSP, INICnet, Intelligent Paralleling, IntelliMOS, Inter-Chip Connectivity, JitterBlocker, Knob-on-Display, MarginLink, maxCrypto, maxView, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, mSiC, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, Power MOS IV, Power MOS 7, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, RTAX, RTG4, SAM-ICE, Serial Quad I/O, simpleMAP, SimpliPHY, SmartBuffer, SmartHLS, SMART-I.S., storClad, SQI, SuperSwitcher, SuperSwitcher II, Switchtec, SynchroPHY, Total Endurance, Trusted Time, TSHARC, Turing, USBCheck, VariSense, VectorBlox, VeriPHY, ViewSpan, WiperLock, XpressConnect, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, and Symmcom are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

ISBN:

Quality Management System

For information regarding Microchip's Quality Management Systems, please visit www.microchip.com/quality.

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
www.microchip.com/support
Web Address:
www.microchip.com
Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455
Austin, TX
Tel: 512-257-3370
Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088
Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075
Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924
Detroit
Novi, MI
Tel: 248-848-4000
Houston, TX
Tel: 281-894-5983
Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453
Tel: 317-536-2380
Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608
Tel: 951-273-7800
Raleigh, NC
Tel: 919-844-7510
New York, NY
Tel: 631-435-6000
San Jose, CA
Tel: 408-735-9110
Tel: 408-436-4270
Canada - Toronto
Tel: 905-695-1980
Fax: 905-695-2078

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733
China - Beijing
Tel: 86-10-8569-7000
China - Chengdu
Tel: 86-28-8665-5511
China - Chongqing
Tel: 86-23-8980-9588
China - Dongguan
Tel: 86-769-8702-9880
China - Guangzhou
Tel: 86-20-8755-8029
China - Hangzhou
Tel: 86-571-8792-8115
China - Hong Kong SAR
Tel: 852-2943-5100
China - Nanjing
Tel: 86-25-8473-2460
China - Qingdao
Tel: 86-532-8502-7355
China - Shanghai
Tel: 86-21-3326-8000
China - Shenyang
Tel: 86-24-2334-2829
China - Shenzhen
Tel: 86-755-8864-2200
China - Suzhou
Tel: 86-186-6233-1526
China - Wuhan
Tel: 86-27-5980-5300
China - Xian
Tel: 86-29-8833-7252
China - Xiamen
Tel: 86-592-2388138
China - Zhuhai
Tel: 86-756-3210040

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444
India - New Delhi
Tel: 91-11-4160-8631
India - Pune
Tel: 91-20-4121-0141
Japan - Osaka
Tel: 81-6-6152-7160
Japan - Tokyo
Tel: 81-3-6880- 3770
Korea - Daegu
Tel: 82-53-744-4301
Korea - Seoul
Tel: 82-2-554-7200
Malaysia - Kuala Lumpur
Tel: 60-3-7651-7906
Malaysia - Penang
Tel: 60-4-227-8870
Philippines - Manila
Tel: 63-2-634-9065
Singapore
Tel: 65-6334-8870
Taiwan - Hsin Chu
Tel: 886-3-577-8366
Taiwan - Kaohsiung
Tel: 886-7-213-7830
Taiwan - Taipei
Tel: 886-2-2508-8600
Thailand - Bangkok
Tel: 66-2-694-1351
Vietnam - Ho Chi Minh
Tel: 84-28-5448-2100

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393
Denmark - Copenhagen
Tel: 45-4485-5910
Fax: 45-4485-2829
Finland - Espoo
Tel: 358-9-4520-820
France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79
Germany - Garching
Tel: 49-8931-9700
Germany - Haan
Tel: 49-2129-3766400
Germany - Heilbronn
Tel: 49-7131-72400
Germany - Karlsruhe
Tel: 49-721-625370
Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44
Germany - Rosenheim
Tel: 49-8031-354-560
Israel - Ra’anana
Tel: 972-9-744-7705
Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781
Italy - Padova
Tel: 39-049-7625286
Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340
Norway - Trondheim
Tel: 47-72884388
Poland - Warsaw
Tel: 48-22-3325737
Romania - Bucharest
Tel: 40-21-407-87-50
Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91
Sweden - Gothenberg
Tel: 46-31-704-60-40
Sweden - Stockholm
Tel: 46-8-5090-4654
UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820