# 15W Power Packaged Transistor

## GaN HEMT on SiC

## Description

The CHK015A-SMA is an unmatched packaged Gallium Nitride High Electron Mobility Transistor. It offers general purpose and broadband solutions for a variety of RF power applications. It is well suited for multi-purpose applications such as radar and telecommunication

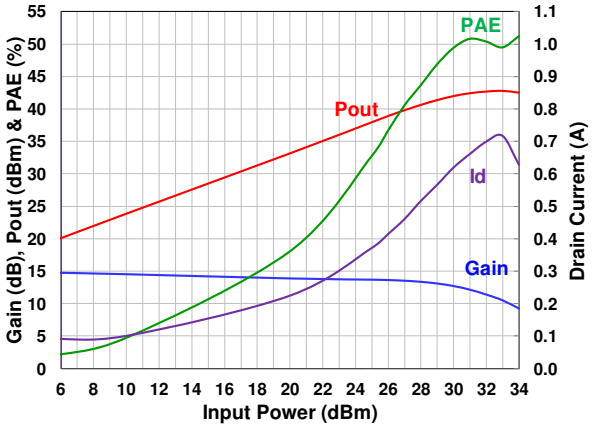
The CHK015A-SMA is developed on a 0.5µm gate length GaN HEMT process. It requires an external matching circuitry.

The CHK015A-SMA is available in a ceramic-metal flange power package providing low parasitic and low thermal resistance.


## Main Features

- Wide band capability: up to 6GHz
- Pulsed and CW operating modes
- High power: > 15W
- High Efficiency: up to 70%
- DC bias: $V_{DS}$ = 50V @ $I_{D\_Q}$ = 100mA
- MTTF > $10^6$ hours @ Tj = 200°C
- RoHS Flange Ceramic package

$V_{DS}$ = 50V, $I_{D\_Q}$ = 100mA, Freq = 5.6GHz
CW mode




Intrinsic performances of the packaged device

## Main Electrical Characteristics

Tcase= +25°C, **CW mode**, F = 5.6GHz, $V_{DS}$=50V, $I_{D\_Q}$=100mA

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $G_{SS}$ | Small Signal Gain | | 15 | - | dB |
| $P_{SAT}$ | Saturated Output Power | 15 | 18 | - | W |
| PAE | Max Power Added Efficiency | 45 | 50 | - | % |
| $G_{PAE\_MAX}$ | Associated Gain at Max PAE | | 11 | - | dB |



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## Recommended DC Operating Ratings

Tcase= +25°C

| Symbol | Parameter | Min | Typ | Max | Unit | Conditions |
|---|---|---|---|---|---|---|
| $V_{DS}$ | Drain to Source Voltage | 20 | | 50 | V | |
| $V_{GS\_Q}$ | Gate to Source Voltage | | -1.9 | | V | $V_D$ = 50V, $I_{D\_Q}$ = 100mA |
| $I_{D\_Q}$ | Quiescent Drain Current | | 0.1 | 0.35 | A | $V_D$ = 50V |
| $I_{D\_MAX}$ | Drain Current | | 0.65 | (1) | A | $V_D$ = 50V, Compressed mode |
| $I_{G\_MAX}$ | Gate Current (forward mode) | | 0 | 8 | mA | Compressed mode |
| $T_{j\_MAX}$ | Junction temperature | | | 200 | °C | |

(1) Limited by dissipated power

## DC Characteristics

Tcase= +25°C

| Symbol | Parameter | Min | Typ | Max | Unit | Conditions |
|---|---|---|---|---|---|---|
| $V_P$ | Pinch-Off Voltage | -3 | -2 | -1 | V | $V_D$ = 50V, $I_D$ =$I_{DSS}$/100 |
| $I_{D\_SAT}$ | Saturated Drain Current | | 2.7 (1) | | A | $V_D$ = 7V, $V_G$ = 2V |
| $I_{G\_leak}$ | Gate Leakage Current (reverse mode) | -1 | | | mA | $V_D$ = 50V, $V_G$ = -7V |
| $V_{BDS}$ | Drain-Source Break-down Voltage | | 200 | | V | $V_G$ = -7V, $I_D$ = 20mA |
| $R_{TH}$ | Thermal Resistance | | 6.4 | | °C/W | |

(1) For information, limited by $I_{D\_MAX}$, see on Absolute Maximum Ratings

## RF Characteristics

Tcase= +25°C, **CW mode**, F = 5.6GHz, $V_{DS}$=50V, $I_{D\_Q}$=100mA

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $G_{SS}$ | Small Signal Gain | 13 | 15 | - | dB |
| $P_{SAT}$ | Saturated Output Power | 15 | 18 | - | W |
| PAE | Max Power Added Efficiency | 45 | 50 | - | % |
| $G_{PAE\_MAX}$ | Associated Gain at Max PAE | | 11 | - | dB |

These values are the intrinsic performance of the packaged device. They are deduced from measurements and simulations. They are considered in the reference plane defined by the leads of the package, at the connection interface with the PCB.

The typical performance achievable in more than 10% frequency band around 5.5GHz was demonstrated using the reference board 61499546 presented hereafter.



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## Absolute Maximum Ratings

Tcase= +25°C[1], [2], [3]

| Symbol | Parameter | Rating | Unit | Note |
|---|---|---|---|---|
| $V_{DS}$ | Drain-Source Voltage | 60 | V | |
| $V_{GS\_Q}$ | Gate-Source Voltage | -10, +2 | V | [6] |
| $I_{G\_MAX}$ | Maximum Gate Current in forward mode | 25 | mA | |
| $I_{G\_MIN}$ | Maximum Gate Current in reverse mode | -4 | mA | |
| $I_{D\_MAX}$ | Maximum Drain Current | 2 | A | [4] |
| $P_{IN}$ | Maximum Input Power (typical) | 34 | dBm | [5] |
| $T_j$ | Junction Temperature | 220 | °C | |
| $T_{STG}$ | Storage Temperature | -55 to +150 | °C | |
| $T_{Case}$ | Case Operating Temperature | See note | °C | [4] |

[1] Operation of this device above anyone of these parameters may cause permanent damage.
[2] Duration < 1s.
[3] The given values must not be exceeded at the same time even momentarily for any parameter, since each parameter is independent from each other, otherwise deterioration or destruction of the device may occur.
[4] Max junction temperature must be considered
[5] @6GHz - Linked to and limited by $I_{G\_MAX}$ & $I_{G\_MIN}$ values
[6] $V_{GS\_Q}$ max limited by $I_{D\_MAX}$ and $I_{G\_MAX}$ values



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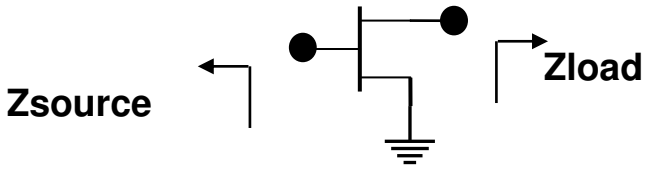
## Simulated Source and Load Impedance

$V_{DS}$ = 50V, $I_{D\_Q}$ = 100mA




| Frequency (MHz) | Source | Load |
|---|---|---|
| 1000 | 1.82 + j9.58 | 42 + j48.6 |
| 2000 | 0.84 – j1.53 | 13.8 + j25.7 |
| 3000 | 1.02 – j8.5 | 6.6 + j12.8 |
| 4000 | 1.86 – j15.82 | 5.1 + j2.6 |
| 5000 | 2.72 – j25.4 | 5.4 – j7.3 |
| 6000 | 2.87 – j41.14 | 6.7 – j17.2 |

These values are given in the reference plane defined by the connection between the package leads and the PCB. A gap of 200µm is considered between the edge of the package and the PCB.



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## Typical S-parameters

Tcase= +25°C, CW mode, $V_D$=50V, $I_{D\_Q}$=100mA, Phase S(i,j) in °

| *Freq (GHz)* | *Mag S(1,1)* | *Phase S(1,1)* | *Mag S(2,1)* | *Phase S(2,1)* | *Mag S(1,2)* | *Phase S(1,2)* | *Mag S(2,2)* | *Phase S(2,2)* |
|---|---|---|---|---|---|---|---|---|
| **0.25** | 0.912 | -82.5 | 30.268 | 129.4 | 0.014 | 42.4 | 0.649 | -38.3 |
| **0.5** | 0.868 | -123.0 | 19.526 | 102.4 | 0.017 | 18.4 | 0.542 | -58.0 |
| **0.75** | 0.854 | -143.5 | 13.768 | 85.8 | 0.017 | 5.2 | 0.517 | -71.6 |
| **1** | 0.851 | -156.0 | 10.431 | 73.3 | 0.017 | -3.6 | 0.527 | -83.4 |
| **1.25** | 0.852 | -164.9 | 8.291 | 62.9 | 0.015 | -9.6 | 0.551 | -93.9 |
| **1.5** | 0.855 | -171.9 | 6.814 | 53.6 | 0.013 | -13.3 | 0.581 | -103.5 |
| **1.75** | 0.859 | -177.9 | 5.739 | 45.1 | 0.012 | -14.3 | 0.612 | -112.2 |
| **2** | 0.863 | 176.8 | 4.928 | 37.2 | 0.010 | -11.7 | 0.641 | -120.2 |
| **2.25** | 0.866 | 171.8 | 4.298 | 29.9 | 0.008 | -4.0 | 0.668 | -127.6 |
| **2.5** | 0.870 | 167.1 | 3.800 | 22.8 | 0.007 | 9.6 | 0.692 | -134.5 |
| **2.75** | 0.872 | 162.5 | 3.401 | 16.2 | 0.008 | 26.2 | 0.714 | -140.9 |
| **3** | 0.874 | 157.9 | 3.076 | 9.7 | 0.009 | 39.8 | 0.733 | -146.9 |
| **3.25** | 0.875 | 153.3 | 2.809 | 3.4 | 0.011 | 47.8 | 0.750 | -152.6 |
| **3.5** | 0.876 | 148.7 | 2.590 | -2.7 | 0.014 | 51.4 | 0.764 | -158.1 |
| **3.75** | 0.876 | 144.0 | 2.408 | -8.7 | 0.017 | 52.2 | 0.776 | -163.4 |
| **4** | 0.875 | 139.1 | 2.257 | -14.7 | 0.020 | 51.2 | 0.786 | -168.5 |
| **4.25** | 0.873 | 134.0 | 2.131 | -20.6 | 0.024 | 49.0 | 0.794 | -173.5 |
| **4.5** | 0.870 | 128.8 | 2.027 | -26.6 | 0.027 | 45.9 | 0.801 | -178.5 |
| **4.75** | 0.867 | 123.3 | 1.942 | -32.7 | 0.032 | 42.3 | 0.807 | 176.6 |
| **5** | 0.863 | 117.4 | 1.872 | -38.8 | 0.036 | 38.1 | 0.811 | 171.6 |
| **5.25** | 0.858 | 111.3 | 1.815 | -45.2 | 0.040 | 33.4 | 0.814 | 166.6 |
| **5.5** | 0.853 | 104.7 | 1.770 | -51.7 | 0.045 | 28.4 | 0.816 | 161.5 |
| **5.75** | 0.847 | 97.7 | 1.734 | -58.5 | 0.050 | 22.9 | 0.818 | 156.2 |
| **6** | 0.841 | 90.2 | 1.707 | -65.5 | 0.056 | 17.1 | 0.818 | 150.7 |
| **6.25** | 0.835 | 82.2 | 1.687 | -73.0 | 0.061 | 10.8 | 0.818 | 144.9 |
| **6.5** | 0.829 | 73.6 | 1.672 | -80.7 | 0.067 | 4.1 | 0.817 | 138.8 |
| **6.75** | 0.824 | 64.5 | 1.660 | -89.0 | 0.073 | -3.1 | 0.815 | 132.3 |
| **7** | 0.820 | 54.7 | 1.649 | -97.6 | 0.079 | -10.8 | 0.814 | 125.2 |
| **7.25** | 0.817 | 44.3 | 1.638 | -106.8 | 0.086 | -19.0 | 0.811 | 117.4 |
| **7.5** | 0.818 | 33.4 | 1.625 | -116.5 | 0.092 | -27.8 | 0.809 | 108.9 |
| **7.75** | 0.821 | 22.0 | 1.605 | -126.8 | 0.097 | -37.1 | 0.806 | 99.4 |
| **8** | 0.828 | 10.3 | 1.577 | -137.7 | 0.102 | -47.0 | 0.803 | 88.9 |
| **8.5** | 0.851 | -13.5 | 1.486 | -160.9 | 0.109 | -68.4 | 0.799 | 64.3 |
| **9** | 0.883 | -36.8 | 1.334 | 174.1 | 0.109 | -91.5 | 0.802 | 34.9 |
| **9.5** | 0.915 | -58.3 | 1.124 | 148.5 | 0.102 | -115.2 | 0.819 | 2.6 |
| **10** | 0.940 | -77.5 | 0.887 | 123.9 | 0.088 | -138.1 | 0.849 | -29.2 |
| **10.5** | 0.956 | -93.8 | 0.663 | 101.6 | 0.072 | -158.8 | 0.885 | -57.4 |
| **11** | 0.966 | -107.7 | 0.481 | 82.4 | 0.057 | -176.8 | 0.916 | -80.6 |
| **11.5** | 0.973 | -119.4 | 0.346 | 66.3 | 0.045 | 167.7 | 0.94 | -99.4 |
| **12** | 0.976 | -129.5 | 0.249 | 52.7 | 0.035 | 154.0 | 0.956 | -114.6 |
| **12.5** | 0.979 | -138.2 | 0.182 | 41.4 | 0.028 | 141.6 | 0.966 | -127.0 |
| **13** | 0.980 | -145.9 | 0.135 | 31.9 | 0.023 | 130.1 | 0.972 | -137.3 |
| **13.5** | 0.98 | -152.7 | 0.101 | 23.9 | 0.019 | 119.0 | 0.975 | -146.0 |
| **14** | 0.979 | -158.8 | 0.078 | 17.1 | 0.016 | 108.5 | 0.975 | -153.5 |
| **14.5** | 0.977 | -164.3 | 0.061 | 11.5 | 0.014 | 98.7 | 0.975 | -160.1 |
| **15** | 0.976 | -169.4 | 0.049 | 6.7 | 0.012 | 90.0 | 0.974 | -165.9 |



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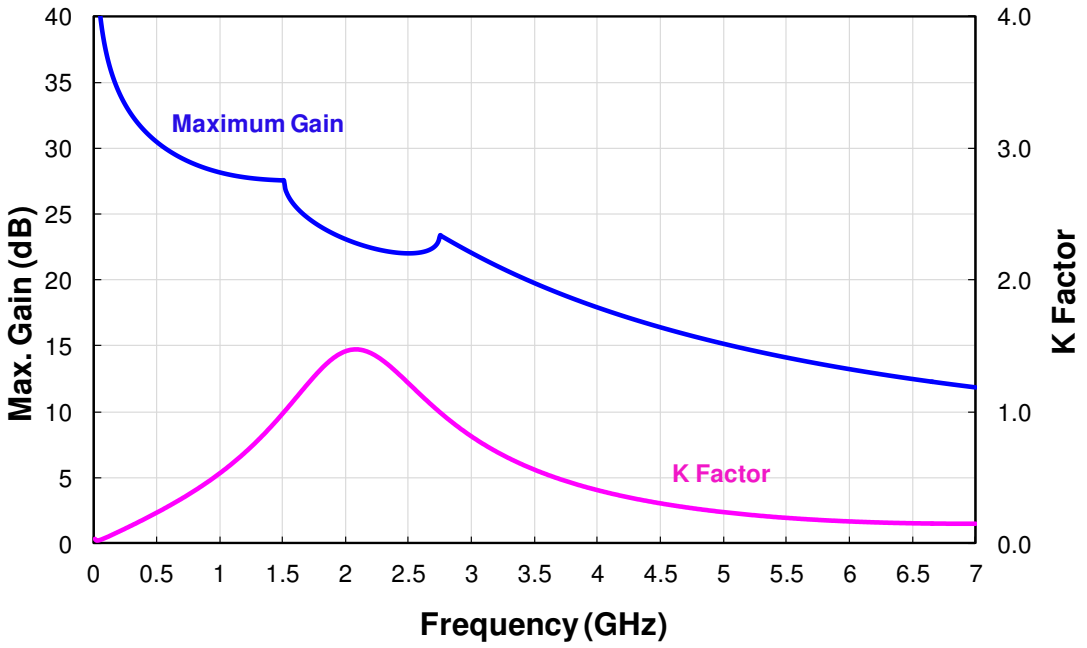
## Maximum Gain & Stability Characteristics

Tcase= +25°C, CW mode, $V_D$=50V, $I_{D\_Q}$=100mA



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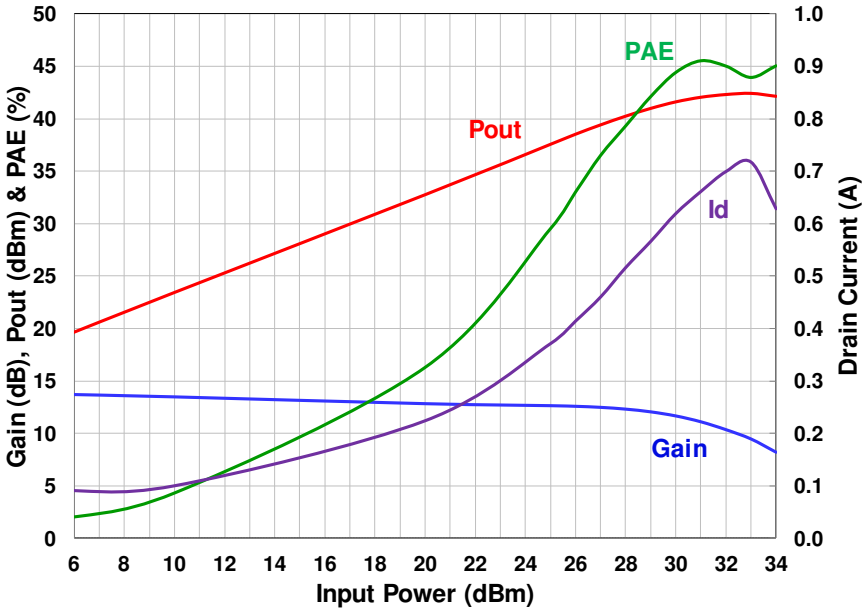
## Typical Performance on Demonstration Board (Ref. 61499546)

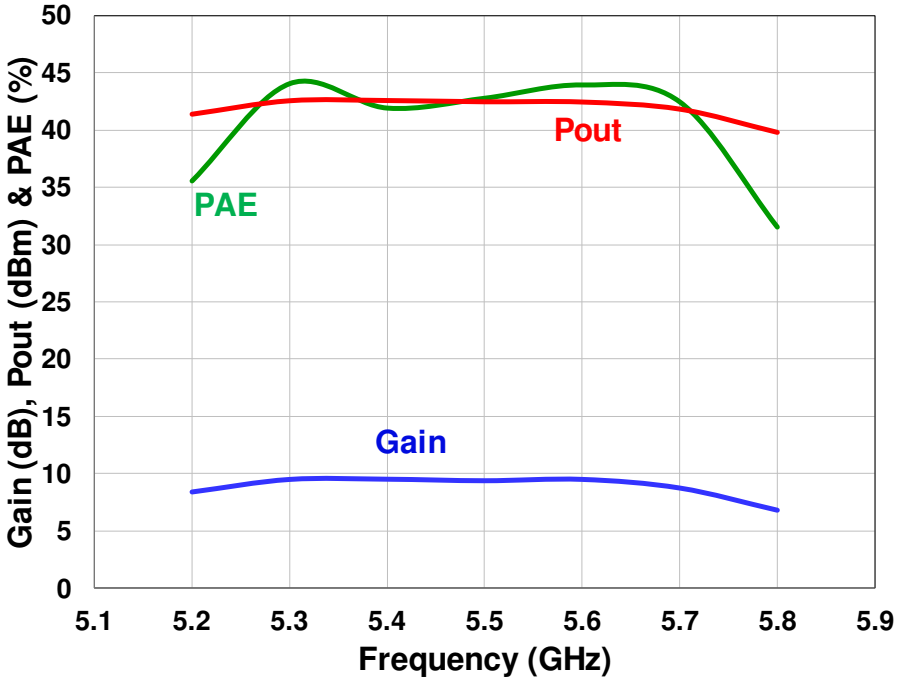
Calibration and measurements are done on the connector reference accesses of the demonstration boards.

**Tcase = +25°C, CW mode**

Measured Id, Pout, Gain & PAE
F = 5.6GHz, $V_{DS}$ = 50V, $I_{D\_Q}$ = 100mA




Measured Pout, Gain & PAE
Pin=33dBm, $V_{DS}$ = 50V, $I_{D\_Q}$ = 100mA



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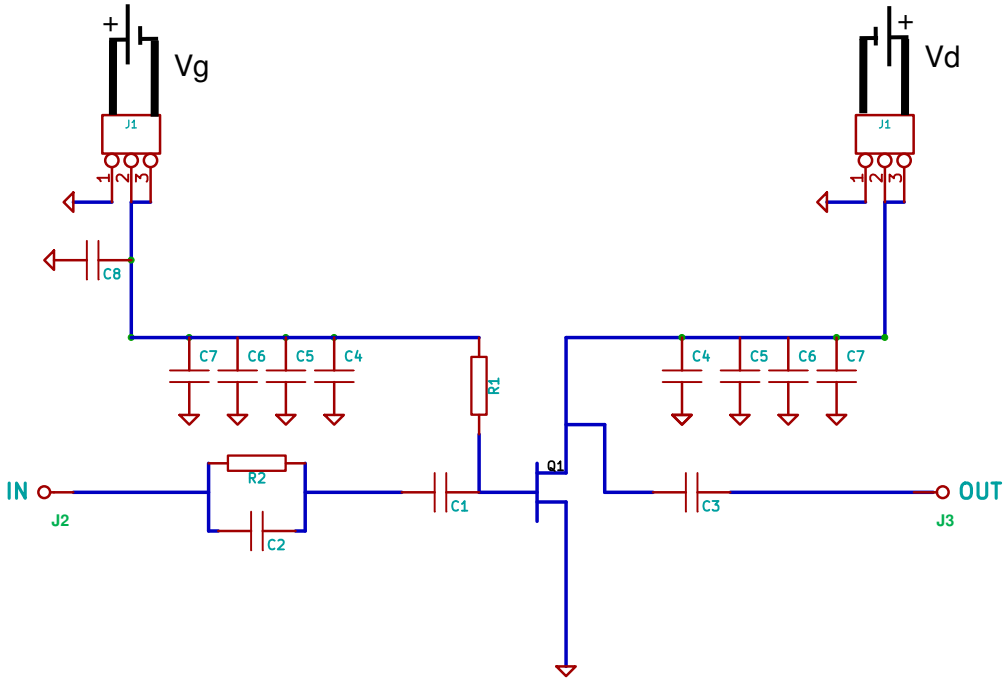
## Demonstration Amplifier Low Frequency Equivalent Schematic (Ref. 61499546)




## Demonstration Amplifier / Bill of Materials (Ref. 61499546)

| Designator | Type | Value - Description | Qty |
|---|---|---|---|
| C1 | Capacitor | 0.2pF, +/- 0.05pF, 0603 | 1 |
| C2 | Capacitor | 1.2pF, +/- 0.1pF, 0603 | 1 |
| C3 | Capacitor | 2pF, +/- 0.1pF, 0603 | 1 |
| C4 | Capacitor | 18pF, +/- 5%, 0603 | 2 |
| C5 | Capacitor | 39pF, +/- 5%, 0805 | 2 |
| C6 | Capacitor | 180nF, +/- 5%, 0805 | 2 |
| C7 | Capacitor | 10nF, +/- 5%, 0805 | 2 |
| C8 | Capacitor | 1µF, +/- 10%, 1204 | 1 |
| R1 | Resistor | 360Ω, +/- 1%, 0603 | 1 |
| R2 | Resistor | 220Ω +/- 1%, 0603 | 1 |
| J1 | Connector | CMS 3cts | 2 |
| J2, J3 | Connector | N | 2 |
| Q1 | Packaged Transistor | CHK015A-SMA | 1 |
| - | PCB | RO4003, Er=3.55, h=0.508mm | - |



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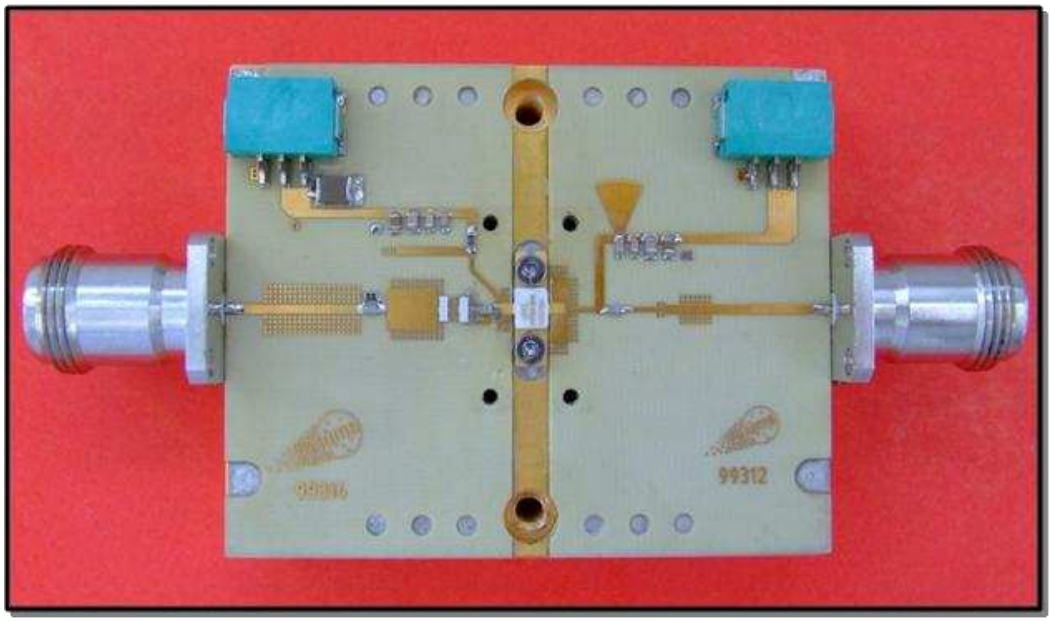
## Demonstration Amplifier Circuit (Ref. 61499546)



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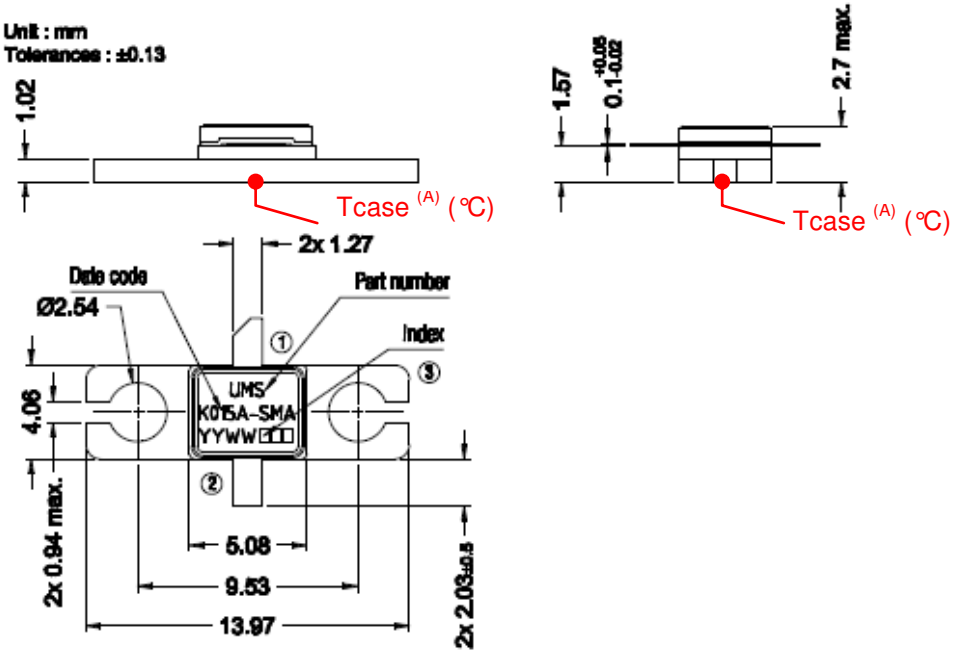
## Package outline




PIN-OUT : 1- GATE
2- DRAIN
3- SOURCE (Gnd)

(A) Tcase locates the reference point used to monitor the device temperature. This point has been taken at the device / system interface to ease system thermal design.
(B) Chamfered lead indicates the gate access of the packaged transistor.



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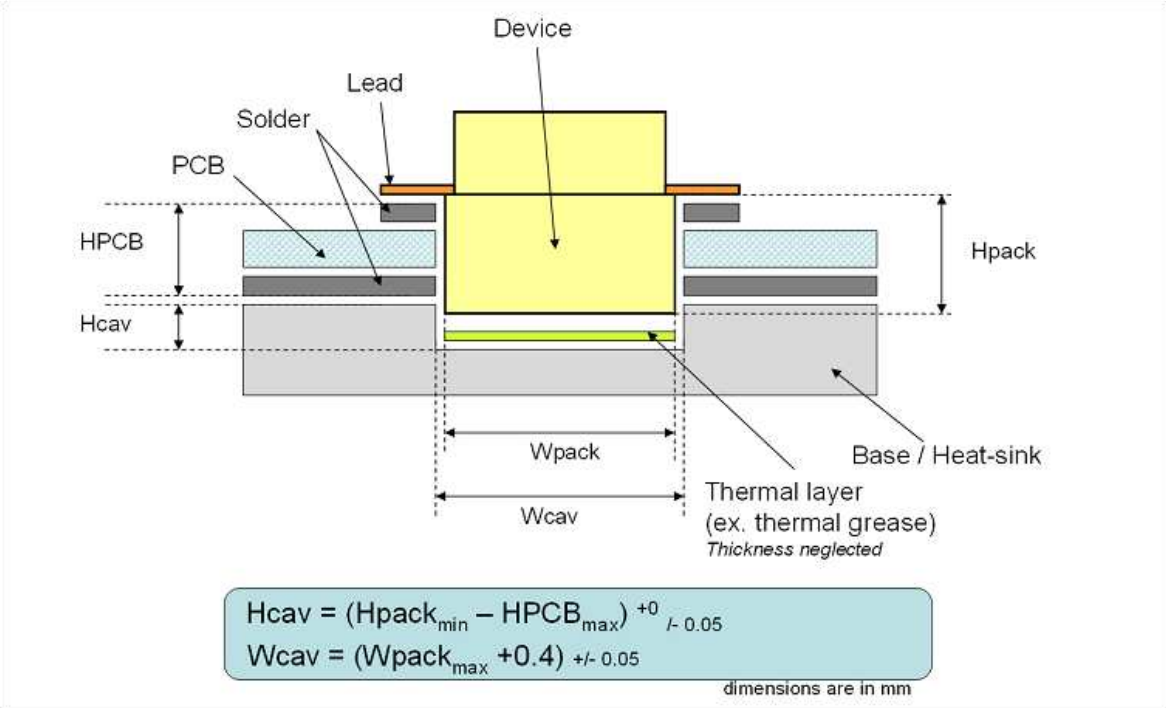
## Recommended Assembly Procedure

CHK015A-SMA is available has a flange package to be bolt down onto a thermal heat sink also used as main electrical ground. Use preferably screw M2 and flat washers.
Thermal and electrical resistance at the package to heat sink interface has to be as low as possible. Thermal electrically conductive grease or conductive thin layer like indium sheets are recommended between the package and the heat sink.
In case a thermal grease is selected, we recommend to use material offering thermal conductivity >5W/m.K and electrical resistivity <0.01 ohm.cm. The grease layer thickness should be about 25µm (1 mil).
Contact interface quality can be improved by cleaning process prior device mounting on the heat-sink. Such operation will enhance the thermal and electrical contact by oxide removal at each interface.
Package leads can be soldered on printed circuit board's traces by using RoHS solder past.
Cavity depth and width to be performed into the heat-sink where the device will be mounted are important to achieve the best performances. These dimensions have to be optimized in order to minimize the distance between device and signal traces made on the printed circuit board (PCB). But they also have to be calculated in order to accommodate device variations in height. The following drawing gives the relationship between device dimensions (Hpack & Wpack) and optimal cavity depth (Hcav) and width (Wcav) depending on the printed circuit-board configuration (HPCB)



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## Recommended environmental management

UMS products are compliant with the regulation in particular with the directives RoHS N°2011/65 and REACh N°1907/2006. More environmental data are available in the application note AN0019 also available at http://www.ums-gaas.com.

## Recommended ESD management

Refer to the application note AN0020 available at http://www.ums-gaas.com for ESD sensitivity and handling recommendations for the UMS package products.

## Ordering Information

| | |
|---|---|
| Package: | CHK015A-SMA/XY |
| | Tray: XY = 26 |





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