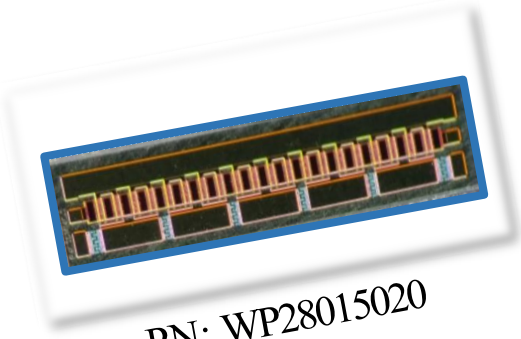
WAVE PIA IC DESIGN

# WP28015020

## 20W, 28V GaN HEMT Die



PN: WP28015020

The WP28015020 is a 20W gallium nitride (GaN) High Electron Mobility Transistor (HEMT). This GaN HEMT is a wideband transistor optimized for X-band operation in a user-friendly device for high bandwidth applications. Gallium nitride (GaN) HEMT is a device optimized for 5G. GaN HEMT resistance is only 1/10 that of silicon transistors, making it capable of switching frequencies faster for greater energy efficiency.

### Features

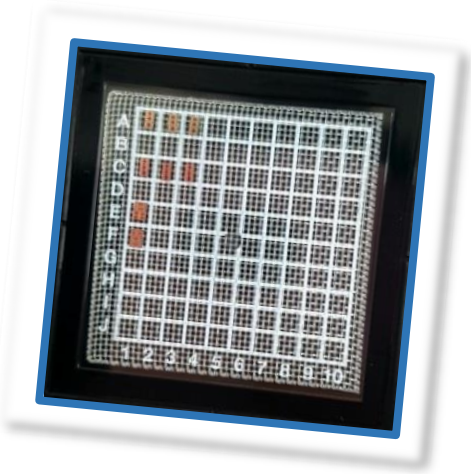
- Up to 15 GHz Operation
- 10.0 dB Typical Small Signal Gain @ 8.15 GHz
- 20 W Typical Psat @8.15GHz
- 28V Operation
- High Breakdown Voltage
- High Breakdown Voltage
- High Efficiency
- Reliability Monitoring Supporting

### Applications

- U/VHF Amplifiers
- Broadband Amplifiers
- Base Station Communications
- Drone, UAV
- WiMAX, LTE, WCDMA, GSM
- WPT, V2X
- Radar application

### Packaging Information

- Bare die are shipped in Wafer-level with Expander Ring or Gel-Pak® containers.
- Possible UV Curing for Wafer-level with dicing saw





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## Absolute Maximum Ratings (not simultaneous) at 25˚C

| Parameter | Parameter | Typical Value | Units | Conditions |
|---|---|---|---|---|
| Threshold voltage @ Id=1mA/mm, Vd=10V | $V_{to}$ | -3.2 | V | 25°C |
| Breakdown voltage @ Id=1mA/mm | $V_{DG}$ | >100 | V | 25°C |
| Drain-source current, Id @ Vd=10V, Vg=0 | $I_{dss}$ | 880 | mA/mm | 25°C |
| Operating Junction Temperature | $T_J$ | 225 | °C | |
| Storage Temperature | $T_{STG}$ | -65, +150 | °C | |
| Thermal Resistance, Junction to Case (packaged) | $R_{\theta JC}$ | | °C/W | |
| Thermal Resistance, Junction to Case (die only) | $R_{\theta JC}$ | | °C/W | |
| Mounting Temperature (30 seconds) | $T_S$ | 320 | °C | 30 seconds |

## Electrical Characteristics (Frequency = 8.15 GHz unless otherwise stated; TC = 25˚C)

| Parameter | Parameter | Typical Value | Units | Conditions |
|---|---|---|---|---|
| **DC Characteristics** | | | | |
| Ohmic contact resistance | RC | 0.4 | Ohm-mm | 25°C |
| Maximum Drain-source current, Id @ Vd=10V, Vg=1V (1X125μm device) | $I_{dmax}$ | 1050 | mA/mm | 25°C |
| Max. trans-conductance, @ Vd=10V, Vg=-4V ~ -1V (1X125μm device) | GM_PEAK | 340 | mS/mm | 25°C |
| Maximum Drain-source current, Id @ Vd=10V, Vg=1V (1X125μm device) | $I_{dmax}$ | 1000 | mA/mm | 25°C |
| **RF Characteristics** | | | | |
| Small Signal Gain | $G_{SS}$ | >10 | dB | $V_{DD}$=28V, $I_{DQ}$=300mA |
| Saturated Power Output | $P_{SAT}$ | 20 | W | $V_{DD}$=28V, $I_{DQ}$=300mA |
| Drain Efficiency | $\eta$ | >40 | % | $V_{DD}$=28V, $I_{DQ}$=300mA |
| Intermodulation Distortion | IM3 | <-30 | dBc | $V_{DD}$=28V, $I_{DQ}$=300mA |
| Output Mismatch Stress | VSWR | 10:1 | ψ | |



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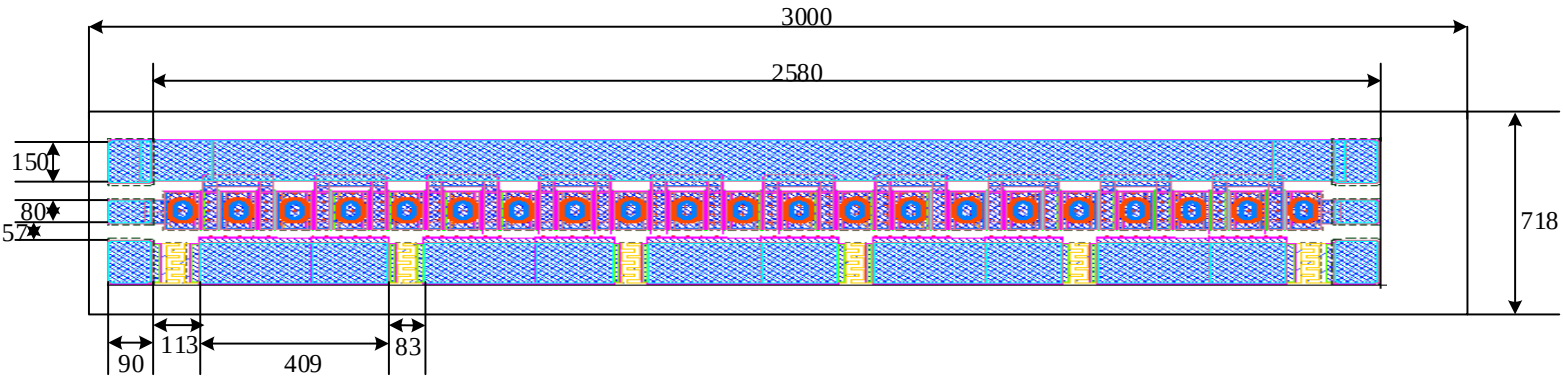
## DIE Dimensions (units in microns)




Overall die size 3000 x 718 (+0/-50) microns, die thickness 100 (+/- 10) microns.
All Gate and Drain pads must be wire bonded for electrical connection.

## Assembly Notes:

- Recommended solder is AuSn (80/20) solder. Refer to Wavepia's guide for the Eutectic Die Bond Procedure
- Vacuum collet is the preferred method of pick-up.
- The backside of the die is the Source (ground) contact.
- Die back side gold plating is 5 microns thick minimum.
- Thermosonic ball or wedge bonding are the preferred connection methods.
- Gold wire must be used for connections.



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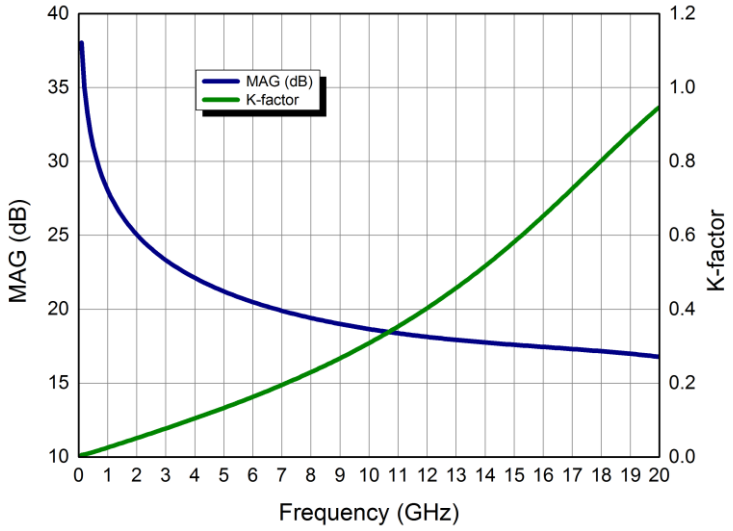
## Typical Performance

**Simulated small-signal gain (S21) and K Factor of the WP28015020**

**$V_{DD}$ = 28 V, $I_{DQ}$ = 300 mA**




Intrinsic die parameters - reference planes at centers of gate and drain bonding pads. No wire bonds assumed.

## Typical Performance

**Simulated Minimum Noise Figure and Maximum Available Gain of the WP28015020**

**$V_{DD}$ = 28 V, $I_{DQ}$ = 300 mA**

# Under construction



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# Typical Die S-Parameters

## (Small Signal, $V_{DS}$ = 28 V, $I_{DQ}$ = 300 mA, magnitude / angle)

| Frequency | Mag S11 | Ang S11 | Mag S21 | Ang S21 | Mag S12 | Ang S12 | Mag S22 | Ang S22 |
|---|---|---|---|---|---|---|---|---|
| 1000MHz | 0.925398 | -164.813 | 10.73122 | 87.98501 | 0.01682 | -0.10401 | 0.627075 | -165.471 |
| 1100MHz | 0.925542 | -166.078 | 9.744127 | 86.46256 | 0.016795 | -1.43146 | 0.630076 | -165.861 |
| 1200MHz | 0.925761 | -167.127 | 8.916816 | 85.0491 | 0.016761 | -2.65002 | 0.633092 | -166.124 |
| 1300MHz | 0.926042 | -168.01 | 8.213213 | 83.72121 | 0.016719 | -3.78302 | 0.636164 | -166.29 |
| 1400MHz | 0.926372 | -168.762 | 7.607314 | 82.46215 | 0.01667 | -4.84714 | 0.639315 | -166.385 |
| 1500MHz | 0.926747 | -169.409 | 7.079918 | 81.25967 | 0.016615 | -5.85458 | 0.642557 | -166.426 |
| 1600MHz | 0.927159 | -169.972 | 6.616541 | 80.1046 | 0.016556 | -6.81446 | 0.645897 | -166.425 |
| 1700MHz | 0.927605 | -170.464 | 6.206057 | 78.98999 | 0.016491 | -7.73371 | 0.649336 | -166.393 |
| 1800MHz | 0.928081 | -170.899 | 5.839783 | 77.91046 | 0.016423 | -8.61769 | 0.652871 | -166.339 |
| 1900MHz | 0.928584 | -171.285 | 5.510841 | 76.86178 | 0.01635 | -9.47058 | 0.656501 | -166.267 |
| 2000MHz | 0.929111 | -171.629 | 5.213716 | 75.84064 | 0.016274 | -10.2957 | 0.660218 | -166.183 |
| 2100MHz | 0.929661 | -171.939 | 4.943933 | 74.84436 | 0.016194 | -11.0956 | 0.664017 | -166.091 |
| 2200MHz | 0.930232 | -172.219 | 4.697826 | 73.87078 | 0.01611 | -11.8726 | 0.667892 | -165.995 |
| 2300MHz | 0.93082 | -172.472 | 4.472359 | 72.91813 | 0.016024 | -12.6283 | 0.671834 | -165.896 |
| 2400MHz | 0.931426 | -172.703 | 4.265001 | 71.98496 | 0.015935 | -13.3642 | 0.675837 | -165.797 |
| 2500MHz | 0.932046 | -172.915 | 4.073622 | 71.07008 | 0.015843 | -14.0814 | 0.679893 | -165.699 |
| 2600MHz | 0.93268 | -173.109 | 3.896417 | 70.17246 | 0.015748 | -14.7809 | 0.683995 | -165.604 |
| 2700MHz | 0.933326 | -173.288 | 3.731848 | 69.29126 | 0.015651 | -15.4637 | 0.688135 | -165.513 |
| 2800MHz | 0.933982 | -173.454 | 3.578595 | 68.42576 | 0.015552 | -16.1303 | 0.692306 | -165.426 |
| 2900MHz | 0.934648 | -173.608 | 3.435518 | 67.57533 | 0.015451 | -16.7814 | 0.696501 | -165.345 |
| 3000MHz | 0.935321 | -173.751 | 3.301629 | 66.73944 | 0.015348 | -17.4175 | 0.700713 | -165.269 |
| 3100MHz | 0.936002 | -173.885 | 3.176066 | 65.91762 | 0.015243 | -18.0391 | 0.704937 | -165.2 |
| 3200MHz | 0.936687 | -174.011 | 3.058074 | 65.10945 | 0.015136 | -18.6465 | 0.709165 | -165.137 |
| 3300MHz | 0.937378 | -174.129 | 2.946988 | 64.31458 | 0.015028 | -19.2401 | 0.713392 | -165.08 |
| 3400MHz | 0.938072 | -174.241 | 2.842222 | 63.53267 | 0.014919 | -19.8202 | 0.717613 | -165.03 |
| 3500MHz | 0.938768 | -174.346 | 2.743255 | 62.76342 | 0.014808 | -20.387 | 0.721823 | -164.987 |
| 3600MHz | 0.939466 | -174.446 | 2.649623 | 62.00656 | 0.014697 | -20.9409 | 0.726015 | -164.95 |
| 3700MHz | 0.940165 | -174.541 | 2.560911 | 61.26185 | 0.014584 | -21.4821 | 0.730187 | -164.92 |
| 3800MHz | 0.940863 | -174.632 | 2.47675 | 60.52905 | 0.01447 | -22.0107 | 0.734334 | -164.896 |
| 3900MHz | 0.94156 | -174.719 | 2.396804 | 59.80794 | 0.014356 | -22.527 | 0.738453 | -164.878 |
| 4000MHz | 0.942256 | -174.802 | 2.320774 | 59.09831 | 0.014241 | -23.0312 | 0.742538 | -164.867 |
| 4100MHz | 0.942949 | -174.882 | 2.248385 | 58.39998 | 0.014125 | -23.5234 | 0.746589 | -164.861 |
| 4200MHz | 0.94364 | -174.958 | 2.179393 | 57.71274 | 0.014009 | -24.0038 | 0.7506 | -164.861 |
| 4300MHz | 0.944326 | -175.032 | 2.113571 | 57.03642 | 0.013892 | -24.4726 | 0.754571 | -164.867 |
| 4400MHz | 0.945009 | -175.103 | 2.050714 | 56.37085 | 0.013775 | -24.9299 | 0.758497 | -164.877 |
| 4500MHz | 0.945686 | -175.172 | 1.990637 | 55.71585 | 0.013658 | -25.3758 | 0.762378 | -164.893 |
| 4600MHz | 0.946359 | -175.239 | 1.933168 | 55.07125 | 0.013541 | -25.8106 | 0.766212 | -164.914 |
| 4700MHz | 0.947026 | -175.304 | 1.878149 | 54.43689 | 0.013424 | -26.2344 | 0.769996 | -164.939 |
| 4800MHz | 0.947687 | -175.367 | 1.825435 | 53.81261 | 0.013306 | -26.6472 | 0.773729 | -164.968 |

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## (Small Signal, $V_{DS}$ = 28 V, $I_{DQ}$ = 300 mA, magnitude / angle)

| Frequency | Mag S11 | Ang S11 | Mag S21 | Ang S21 | Mag S12 | Ang S12 | Mag S22 | Ang S22 |
|---|---|---|---|---|---|---|---|---|
| 4900MHz | 0.948341 | -175.428 | 1.774895 | 53.19825 | 0.013189 | -27.0494 | 0.77741 | -165.002 |
| 5000MHz | 0.948989 | -175.488 | 1.726403 | 52.59366 | 0.013072 | -27.4408 | 0.781038 | -165.039 |
| 5100MHz | 0.94963 | -175.546 | 1.679847 | 51.99868 | 0.012955 | -27.8218 | 0.784612 | -165.08 |
| 5200MHz | 0.950264 | -175.603 | 1.635121 | 51.41315 | 0.012839 | -28.1925 | 0.788132 | -165.125 |
| 5300MHz | 0.95089 | -175.659 | 1.592128 | 50.83693 | 0.012722 | -28.5529 | 0.791596 | -165.173 |
| 5400MHz | 0.951508 | -175.713 | 1.550776 | 50.26987 | 0.012606 | -28.9032 | 0.795004 | -165.223 |
| 5500MHz | 0.952119 | -175.767 | 1.51098 | 49.71181 | 0.012491 | -29.2435 | 0.798356 | -165.277 |
| 5600MHz | 0.952721 | -175.819 | 1.472662 | 49.16262 | 0.012376 | -29.574 | 0.801652 | -165.334 |
| 5700MHz | 0.953315 | -175.87 | 1.435748 | 48.62214 | 0.012261 | -29.8948 | 0.804892 | -165.393 |
| 5800MHz | 0.953901 | -175.921 | 1.40017 | 48.09023 | 0.012147 | -30.206 | 0.808075 | -165.454 |
| 5900MHz | 0.954479 | -175.97 | 1.365861 | 47.56674 | 0.012033 | -30.5076 | 0.811202 | -165.517 |
| 6000MHz | 0.955048 | -176.019 | 1.332763 | 47.05155 | 0.01192 | -30.7999 | 0.814273 | -165.583 |
| 6100MHz | 0.955609 | -176.067 | 1.300818 | 46.5445 | 0.011808 | -31.083 | 0.817289 | -165.65 |
| 6200MHz | 0.956161 | -176.114 | 1.269973 | 46.04545 | 0.011696 | -31.3569 | 0.820249 | -165.719 |
| 6300MHz | 0.956705 | -176.161 | 1.240178 | 45.55428 | 0.011585 | -31.6218 | 0.823155 | -165.79 |
| 6400MHz | 0.95724 | -176.207 | 1.211386 | 45.07084 | 0.011475 | -31.8778 | 0.826006 | -165.862 |
| 6500MHz | 0.957766 | -176.252 | 1.183552 | 44.595 | 0.011366 | -32.125 | 0.828803 | -165.935 |
| 6600MHz | 0.958284 | -176.296 | 1.156634 | 44.12662 | 0.011257 | -32.3635 | 0.831547 | -166.01 |
| 6700MHz | 0.958794 | -176.34 | 1.130593 | 43.66558 | 0.011149 | -32.5934 | 0.834238 | -166.086 |
| 6800MHz | 0.959295 | -176.384 | 1.105391 | 43.21175 | 0.011042 | -32.8148 | 0.836877 | -166.162 |
| 6900MHz | 0.959787 | -176.427 | 1.080993 | 42.765 | 0.010935 | -33.0279 | 0.839465 | -166.24 |
| 7000MHz | 0.960271 | -176.469 | 1.057366 | 42.3252 | 0.01083 | -33.2326 | 0.842003 | -166.318 |
| 7100MHz | 0.960747 | -176.511 | 1.034477 | 41.89223 | 0.010725 | -33.4292 | 0.84449 | -166.398 |
| 7200MHz | 0.961215 | -176.552 | 1.012296 | 41.46596 | 0.010621 | -33.6177 | 0.846929 | -166.477 |
| 7300MHz | 0.961674 | -176.593026 | 0.990796 | 41.04628 | 0.010518 | -33.7982 | 0.849319 | -166.557 |
| 7400MHz | 0.962126 | -176.633436 | 0.969948 | 40.63306 | 0.010416 | -33.9707 | 0.851661 | -166.638 |
| 7500MHz | 0.962569 | -176.673398 | 0.949728 | 40.22619 | 0.010315 | -34.1355 | 0.853957 | -166.719 |
| 7600MHz | 0.963005 | -176.713 | 0.930111 | 39.82556 | 0.010214 | -34.2925 | 0.856207 | -166.801 |
| 7700MHz | 0.963432 | -176.752026 | 0.911072 | 39.43105 | 0.010115 | -34.4419 | 0.858412 | -166.882 |
| 7800MHz | 0.963852 | -176.790715 | 0.892591 | 39.04254 | 0.010016 | -34.5838 | 0.860573 | -166.964 |
| 7900MHz | 0.964265 | -176.829 | 0.874647 | 38.65994 | 0.009918 | -34.7181 | 0.86269 | -167.046 |
| 8000MHz | 0.96467 | -176.866895 | 0.857218 | 38.28312 | 0.009821 | -34.845 | 0.864764 | -167.128 |
| 8100MHz | 0.965067 | -176.904406 | 0.840286 | 37.91199 | 0.009725 | -34.9646 | 0.866797 | -167.21 |
| 8200MHz | 0.965458 | -176.941541 | 0.823833 | 37.54644 | 0.00963 | -35.077 | 0.868789 | -167.292 |
| 8300MHz | 0.965841 | -176.97831 | 0.807841 | 37.18637 | 0.009536 | -35.1822 | 0.87074 | -167.374 |
| 8400MHz | 0.966217 | -177.014719 | 0.792293 | 36.83167 | 0.009443 | -35.2802 | 0.872652 | -167.456 |
| 8500MHz | 0.966586 | -177.050777 | 0.777174 | 36.48226 | 0.00935 | -35.3712 | 0.874525 | -167.538 |
| 8600MHz | 0.966948 | -177.086491 | 0.762468 | 36.13802 | 0.009259 | -35.4552 | 0.876361 | -167.62 |
| 8700MHz | 0.967304 | -177.122 | 0.748161 | 35.79888 | 0.009168 | -35.5323 | 0.87816 | -167.701 |

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