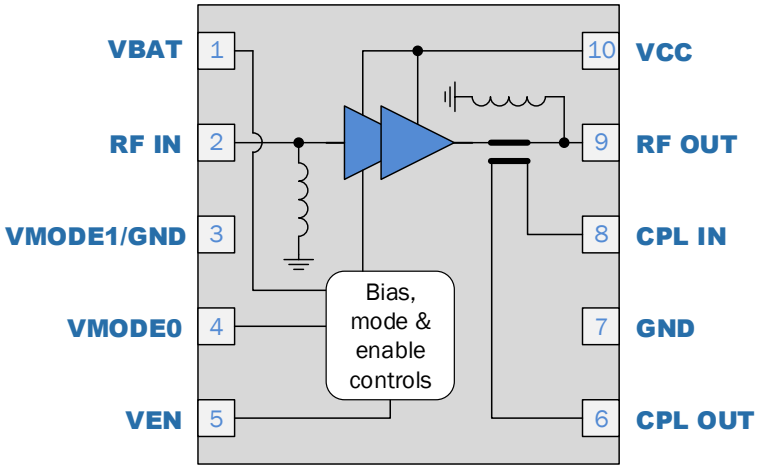
# RFPA0802

## Integrated Power Amplifier
## 700MHz to 950MHz


Package: MCM, 10-pin,
2.0mm x 2.5mm x 0.9mm

The RFPA0802 has over 28dB of small signal gain over 700MHz to 950MHz. When used with DPD at 3.3V, the RFPA0802 can deliver 24dBm LTE Downlink (CFR 7.5dB) with ACPR <-50dBc. Two digital control pins select high, medium or low power modes if desired to optimize performance and current drain at different power levels. The RFPA0802 has an integrated directional coupler, integrated biasing circuitry, and integrated matching to 50Ω. No external DC blocking is required as the RF pins are at DC ground.




Functional Block Diagram

## Features

- $P_{OUT}$ = 24dBm, 26% PAE, with 3.3V, 20MHz LTE DL, CFR 7.5dB
- ACP <-50dBc with DPD
- 28dB Gain over 700MHz to 950MHz
- Instantaneous P3dB = 32dBm at 3.3V
- Designed to Support Flexible $V_{CC}$ 0.5V to 4.5V for PAE Optimization
- Envelope Tracking Compatible
- Integrated Power Coupler
- Integrated 50Ω Matching
- Integrated Biasing
- No External DC Block Needed
- 3 Power Mode Operation
- GPIO Interface
- Ultra Small and Low Profile

## Applications

- Power Amplifier, Power Amplifier Driver
- Small Cell Base Stations
- Wideband Instrumentation
- Customer Premise Equipment
- Data Cards

## Ordering Information

| | |
|---|---|
| RFPA0802SQ | Sample bag with 25 pieces |
| RFPA0802SR | 7" Reel with 100 pieces |
| RFPA0802TR7 | 7" Reel with 2500 pieces |
| RFPA0802PCK-410 | 700MHz to 950MHz PCBA with 5-piece sample bag |

RF Micro Devices Inc. 7628 Thorndike Road, Greensboro, NC 27409-9421
For sales or technical support, contact RFMD at +1.336.678.5570 or customerservice@rfmd.com.

DS150209

## Absolute Maximum Ratings

| Parameter | Rating | Unit |
|---|---|---|
| Supply Voltage in Standby Mode | 6.0 | V |
| Supply Voltage in Idle Mode | 6.0 | V |
| Supply Voltage in Operating Mode | 6.0 | V |
| Supply Voltage, $V_{BATT}$ | 6.0 | V |
| Control Voltage, $V_{EN}$, $V_{MODE0}$, $V_{MODE1}$ | 3.5 | V |
| RF – Input Power (CW, $V_{CC}$ = 3.3V, 50Ω Load) | +10 | dBm |
| RF – Output Power (CW, 50Ω Load) | +30 | dBm |
| Output Load VSWR (LTE DL 7.5dB CFR, $V_{CC}$ = 4.5V, $P_{FORWARD}$ <24dBm) | 8:1 | |
| ESD Rating, All Pins, HBM, JESD22-A114 | 2000 | V |
| ESD Rating, All Pins, CDM, JESD22-C101 | 1000 | V |
| Moisture Sensitivity Level | MSL3 | |

**Caution!** ESD sensitive device.

RFMD Green: RoHS status based on EU Directive 2011/65/EU (at time of this document revision), halogen free per IEC 61249-2-21, < 1000ppm each of antimony trioxide in polymeric materials and red phosphorus as a flame retardant, and <2% antimony in solder.

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability. Specified typical performance or functional operation of the device under Absolute Maximum Rating conditions is not implied.

## Recommended Operating Condition

| Parameter | Specification | | | Unit |
|---|---|---|---|---|
| | Min | Typ | Max | |
| Operating Temperature Range | -30 | +25 | +85 | °C |
| Operating Junction Temperature | | | 125 | °C |
| $V_{BATT}$ | +3 | +3.3 | +4.5 | V |
| $V_{CC}$[1] | +0.5 | +3.3 | +4.5 | V |

Note: $V_{CC}$ down to 0.5V may be used for backed-off power when using DC-DC converter to conserve battery current

## Nominal Operating Parameters

| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min | Typ | Max | | |
| **General Performance** | | | | | |
| Operating Frequency | 700 | | 950 | MHz | |
| $V_{EN}$, Low Level | 0 | | 0.5 | V | PA Disabled |
| $V_{EN}$, High Level | 1.5 | 1.8 | 3 | V | PA Enabled |
| $V_{MODE0}$, $V_{MODE1}$, Low Level | 0 | | 0.5 | V | For logic “low” |
| $V_{MODE0}$, $V_{MODE1}$, High Level | 1.5 | 1.8 | 3 | V | For logic “high” |
| Maximum Linear Output $P_{OUT}$[1, 2] | | 24 | | dBm | High power mode (HPM); $V_{CC}$ = 3.3V |
| Thermal Resistance | | 37 | | °C/W | To backside of evaluation board |

Notes:

1. For operation at $V_{BATT}$ = 3.0V, de-rate $P_{OUT}$ by 2.0dB
2. $P_{OUT}$ is specified for 20MHz LTE downlink with CFR 7.5dB, -50dBc ACPR using digital or analog predistortion

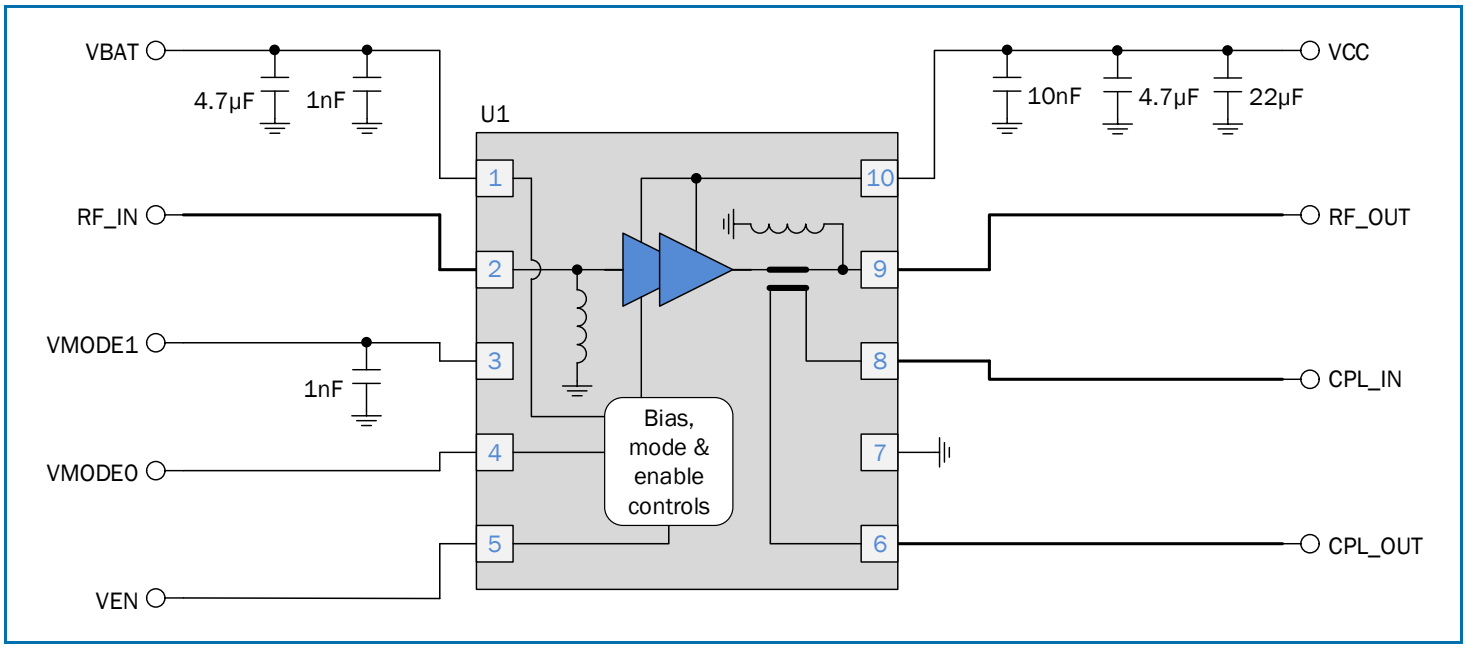
| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min | Typ | Max | | |
| **Band 5 Downlink Electrical Specifications** | | | | | **Unless Otherwise Specified: Temp = 25°C, $V_{BATT}$ = +3.3V, $V_{EN}$ = +1.8V, Freq = 881MHz, 50Ω, 20MHz LTE DL with 7.5dB CFR** |
| Gain | 25 | 28 | 31 | dB | High Power Mode (HPM), $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V |
| | 21 | 24.5 | 27 | dB | Medium Power Mode (MPM), , $P_{OUT}$ = 14dBm, $V_{CC}$ = 1.5V |
| | 15 | 18 | 21 | dB | Low Power Mode (LPM), $P_{OUT}$ = 3dBm, $V_{CC}$ = 0.8V |
| ACLR 1 | | -34 | | dBc | HPM, $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V, without DPD |
| | | -50 | | dBc | HPM, $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V, with DPD |
| ACLR 2 | | -43 | | dBc | HPM, $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V, without DPD |
| | | -60 | | dBc | HPM, $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V, with DPD |
| PA Efficiency (PAE) | | 26 | | % | HPM, $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V |
| PA Current Drain | | 291 | | mA | HPM, $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V |
| PA Quiescent Current | | 118 | | mA | HPM, $V_{CC}$ = 3.3V |
| | | 84 | | mA | MPM, $V_{CC}$ = 1.5V |
| | | 40 | | mA | LPM, $V_{CC}$ = 0.8V |
| Noise Figure | | 3.7 | | dB | |
| Input Impedance | | 1.4:1 | 2:1 | VSWR | No external matching, $P_{OUT}$ ≤ 24dBm, all modes |
| IM3 | | -20 | | dBm | Two tones passed 600kHz, HPM, Total $P_{OUT}$ ≤ 24dBm, $V_{CC}$ = 3.3V |
| IM5 | | -20 | | dBm | Two tones passed 600kHz, HPM, Total $P_{OUT}$ ≤ 24dBm, $V_{CC}$ = 3.3V |
| Harmonics 2f0 | | -13 | | dBm | CW $P_{OUT}$ ≤ 24dBm, all power modes |
| Harmonics 3f0 | | -15 | | dBm | CW $P_{OUT}$ ≤ 24dBm, all power modes |
| Enable Current | | 0.1 | | mA | Sources or sink current, $V_{EN}$ = 1.8V |
| Mode Current | | 0.1 | | mA | Source or sink current, $V_{MODE0}$, $V_{MODE1}$ = 1.8V |
| Leakage Current | | | 5 | µA | DC only; $V_{CC}$ = $V_{BATT}$ = 4.5V, $V_{EN}$ = $V_{MODE0}$ =$V_{MODE1}$ = 0V |
| DC Enable Time | | | 10 | µs | DC only; Time from $V_{EN}$ = high to stable idle current (90% of steady state value) |
| RF Rise/Fall Time | | | 10 | µs | $P_{OUT}$ ≤ 24dBm, all modes, 90% of target, DC settled prior to RF |
| Coupling Factor | 16.5 | 18.5 | 20.5 | dB | $P_{OUT}$ ≤ 24dBm, all modes |
| Coupling Accuracy – Temp / Voltage | -0.5 | | 0.5 | dB | $P_{OUT}$ ≤ 24dBm, all modes 30°C ≤ T ≤ 85°C , $V_{CC}$ as required, referenced to 25°C, 3.3V conditions |
| Coupling Accuracy – VSWR | -0.8 | | 0.8 | dB | $P_{OUT}$ ≤ 24dBm, all modes, load VSWR = 2.5:1 |
| Output Load VSWR Stability (Spurious Emissions) | | | -60 | dBc | $P_{OUT}$ ≤ 24dBm, all conditions, load VSWR = 8:1, all phase angles |

| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min | Typ | Max | | |
| **Band 8 Downlink Electrical Specifications** | | | | | **Unless Otherwise Specified: Temp = 25°C, $V_{BATT}$ = +3.3V, $V_{EN}$ = +1.8V, Freq = 950MHz, 50Ω, 20MHz LTE DL with 7.5dB CFR** |
| Gain | 24.5 | 27.5 | 30.5 | dB | High Power Mode (HPM), $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V |
| | 21.5 | 24.5 | 27.5 | dB | Medium Power Mode (MPM), $P_{OUT}$ = 14dBm, $V_{CC}$ = 1.5V |
| | 14 | 17 | 20 | dB | Low Power Mode (LPM), $P_{OUT}$ = 3dBm, $V_{CC}$ = 0.8V |
| ACLR 1 | | -34 | | dBc | HPM, $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V, without DPD |
| | | -50 | | dBc | HPM, $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V, with DPD |
| ACLR 2 | | -43 | | dBc | HPM, $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V, without DPD |
| | | -60 | | dBc | HPM, $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V, with DPD |
| PA Efficiency (PAE) | | 25 | | % | HPM, $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V |
| PA Current Drain | | 298 | | mA | HPM, $P_{OUT}$ = 24dBm, $V_{CC}$ = 3.3V |
| Noise Figure | | 3.7 | | dB | |
| Input Impedance | | 1.6:1 | 2:1 | VSWR | No external matching, $P_{OUT}$ ≤ 24dBm, all modes |
| IM3 | | -20 | | dBm | Two tones passed 600kHz, HPM, Total $P_{OUT}$ ≤ 24dBm, $V_{CC}$ = 3.3V |
| IM5 | | -20 | | dBm | Two tones passed 600kHz, HPM, Total $P_{OUT}$ ≤ 24dBm, $V_{CC}$ = 3.3V |
| Harmonics 2f0 | | -15 | | dBm | CW $P_{OUT}$ ≤ 24dBm, all power modes |
| Harmonics 3f0 | | -19 | | dBm | CW $P_{OUT}$ ≤ 24dBm, all power modes |
| Enable Current | | 0.1 | | mA | Sources or sink current, $V_{EN}$ = 1.8V |
| Mode Current | | 0.1 | | mA | Source or sink current, $V_{MODE0}$, $V_{MODE1}$ = 1.8V |
| Leakage Current | | | 5 | µA | DC only; $V_{CC}$ = $V_{BATT}$ = 4.5V, $V_{EN}$ = $V_{MODE0}$ =$V_{MODE1}$ = 0V |
| DC Enable Time | | | 10 | µs | DC only; Time from $V_{EN}$ = high to stable idle current (90% of steady state value) |
| RF Rise/Fall Time | | | 10 | µs | $P_{OUT}$ ≤ 24dBm, all modes, 90% of target, DC settled prior to RF |
| Coupling Factor | 16 | 18 | 20 | dB | $P_{OUT}$ ≤ 24dBm, all modes |
| Coupling Accuracy – Temp / Voltage | -0.5 | | 0.5 | dB | $P_{OUT}$ ≤ 24dBm, all modes 30°C ≤ T ≤ 85°C , $V_{CC}$ as required, referenced to 25°C, 3.3V conditions |
| Coupling Accuracy – VSWR | -0.8 | | 0.8 | dB | $P_{OUT}$ ≤ 24dBm, all modes, load VSWR = 2.5:1 |
| Output Load VSWR Stability (Spurious Emissions) | | | -60 | dBc | $P_{OUT}$ ≤ 24dBm, all conditions, load VSWR = 8:1, all phase angles |

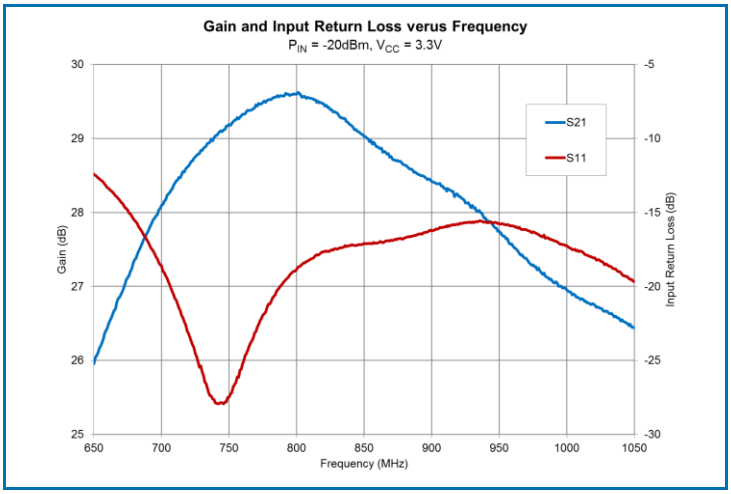
## Mode Control Table

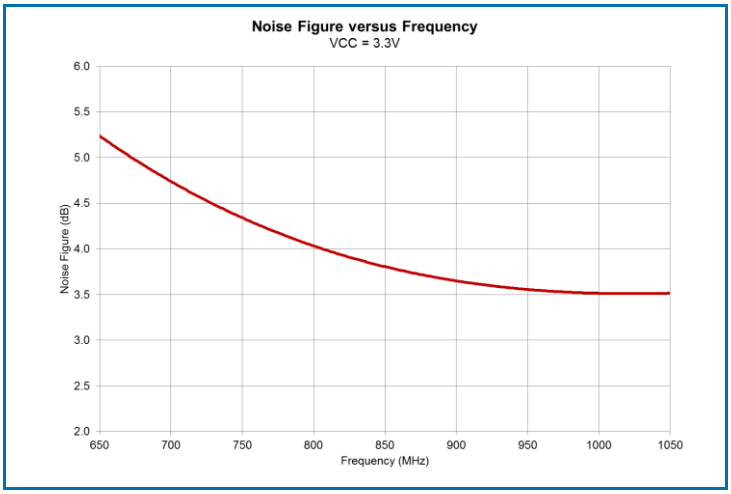
| Mode of Operation | $V_{EN}$ | $V_{MODE0}$ | $V_{MODE1}$ | $V_{CC}$ |
|---|---|---|---|---|
| Power Down | Low | Low | Low | X |
| Standby Mode | Low | X | X | On |
| High Power Mode (HPM) | High | Low | Low | On |
| Medium Power Mode (MPM) | High | High | Low | On |
| Low Power Mode (LPM) | High | High | High | On |

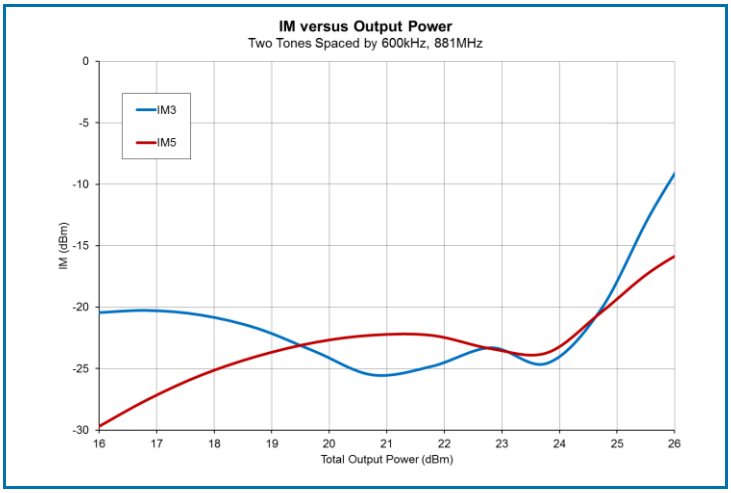
## Typical Application Schematic 700MHz to 950MHz Application Circuit

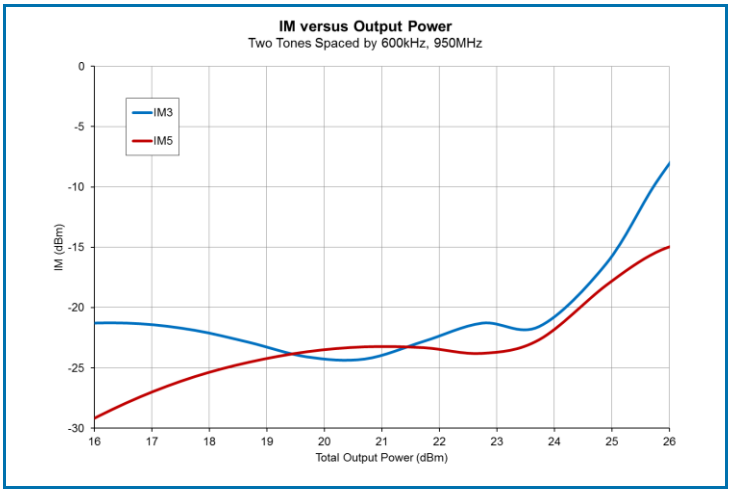


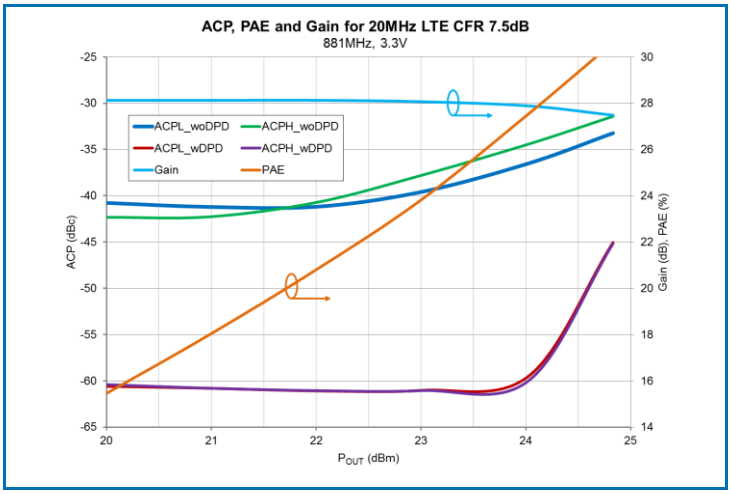
## Typical Performance: $V_{CC}$ = 3.3V unless otherwise noted

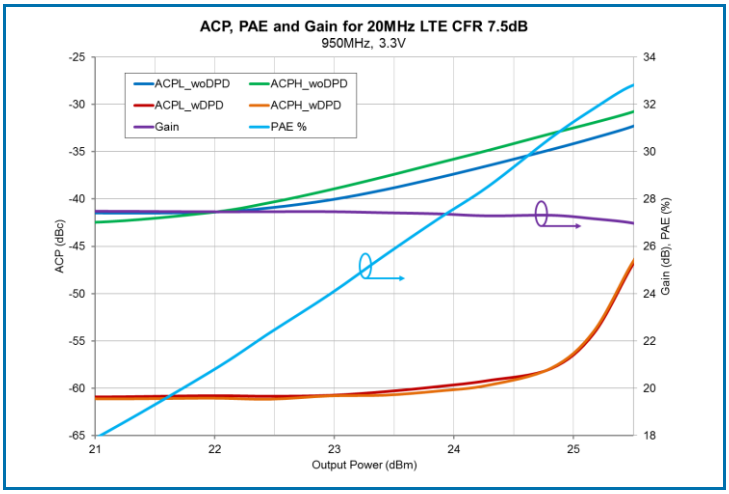


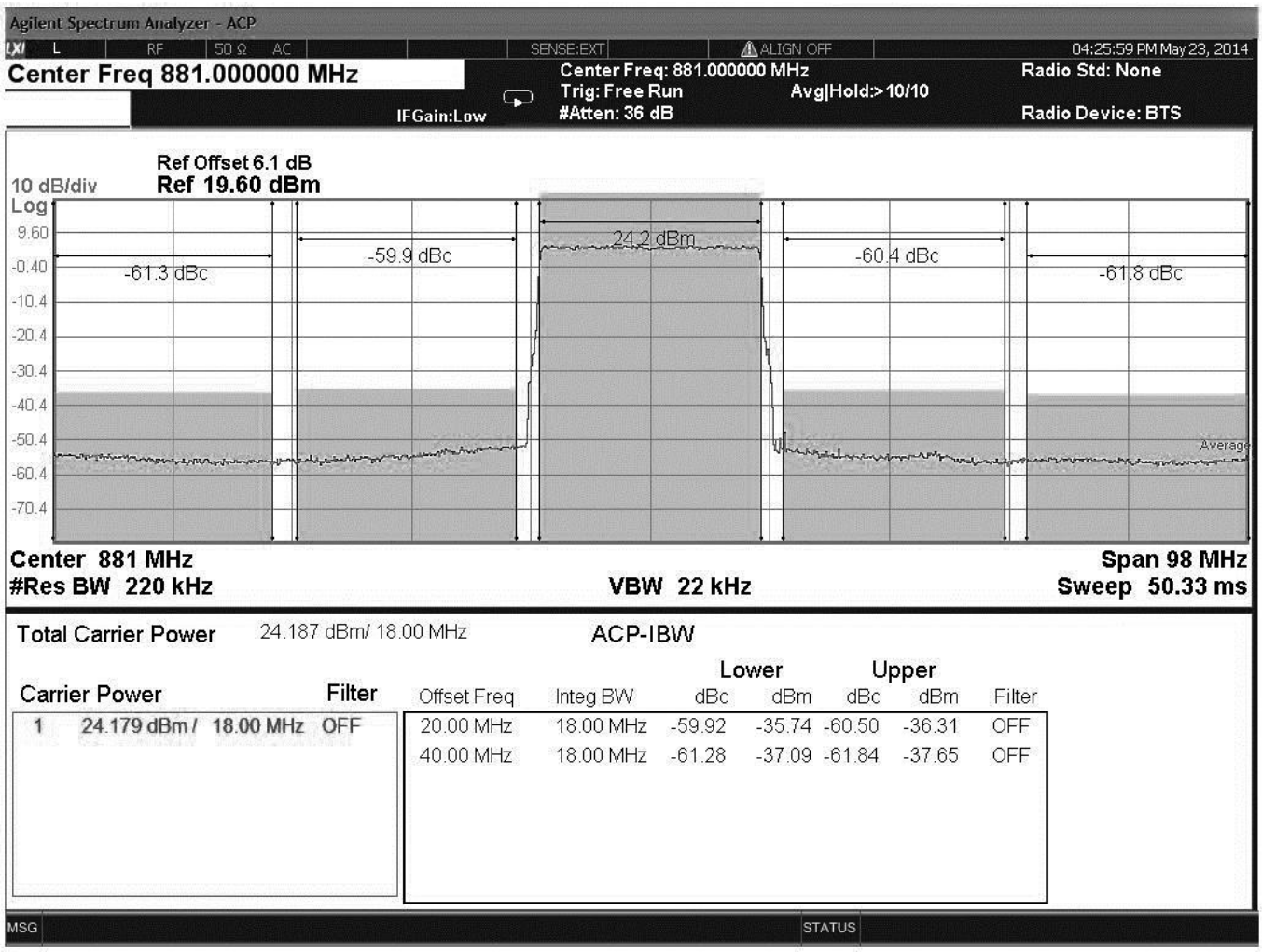



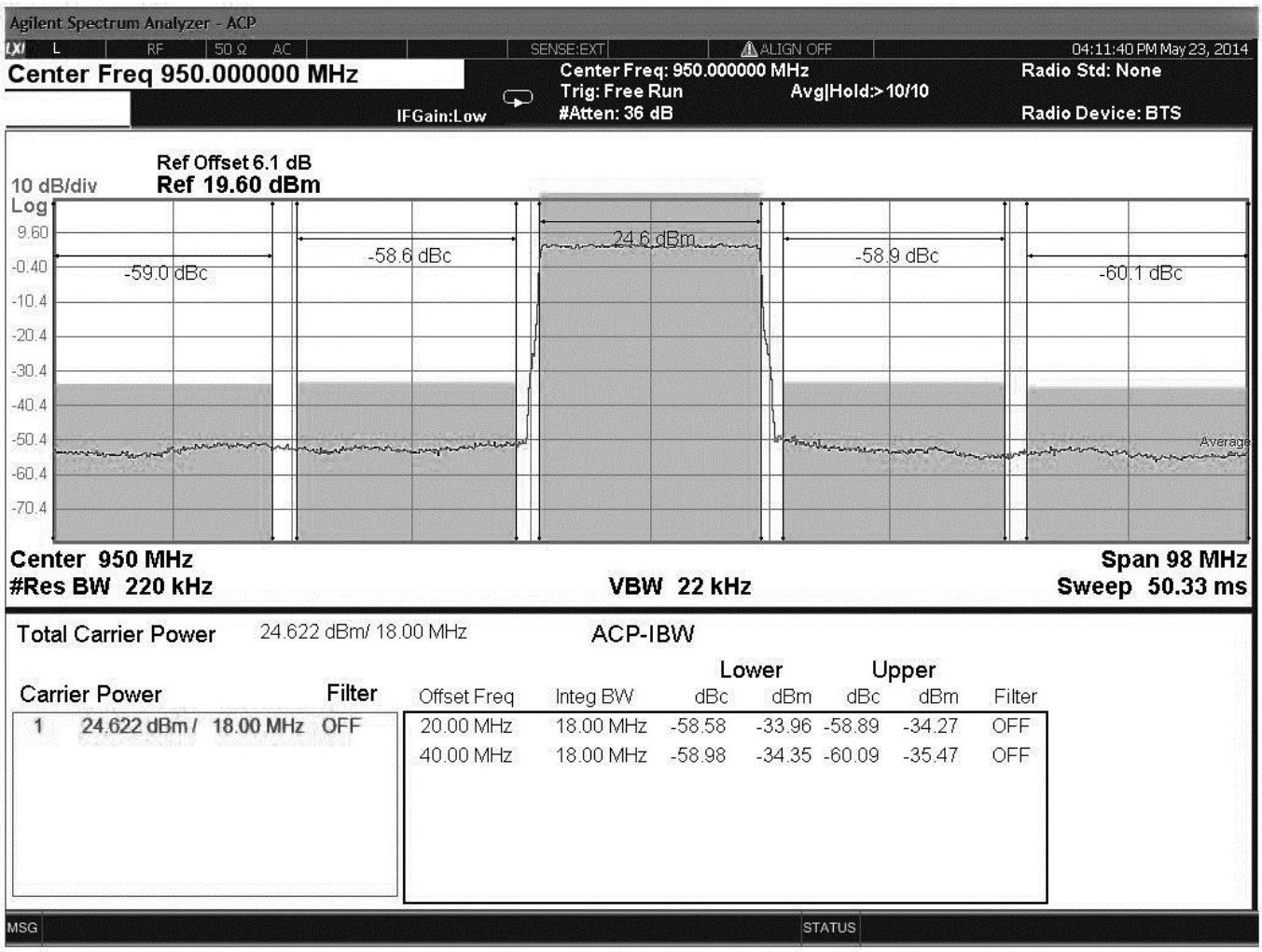



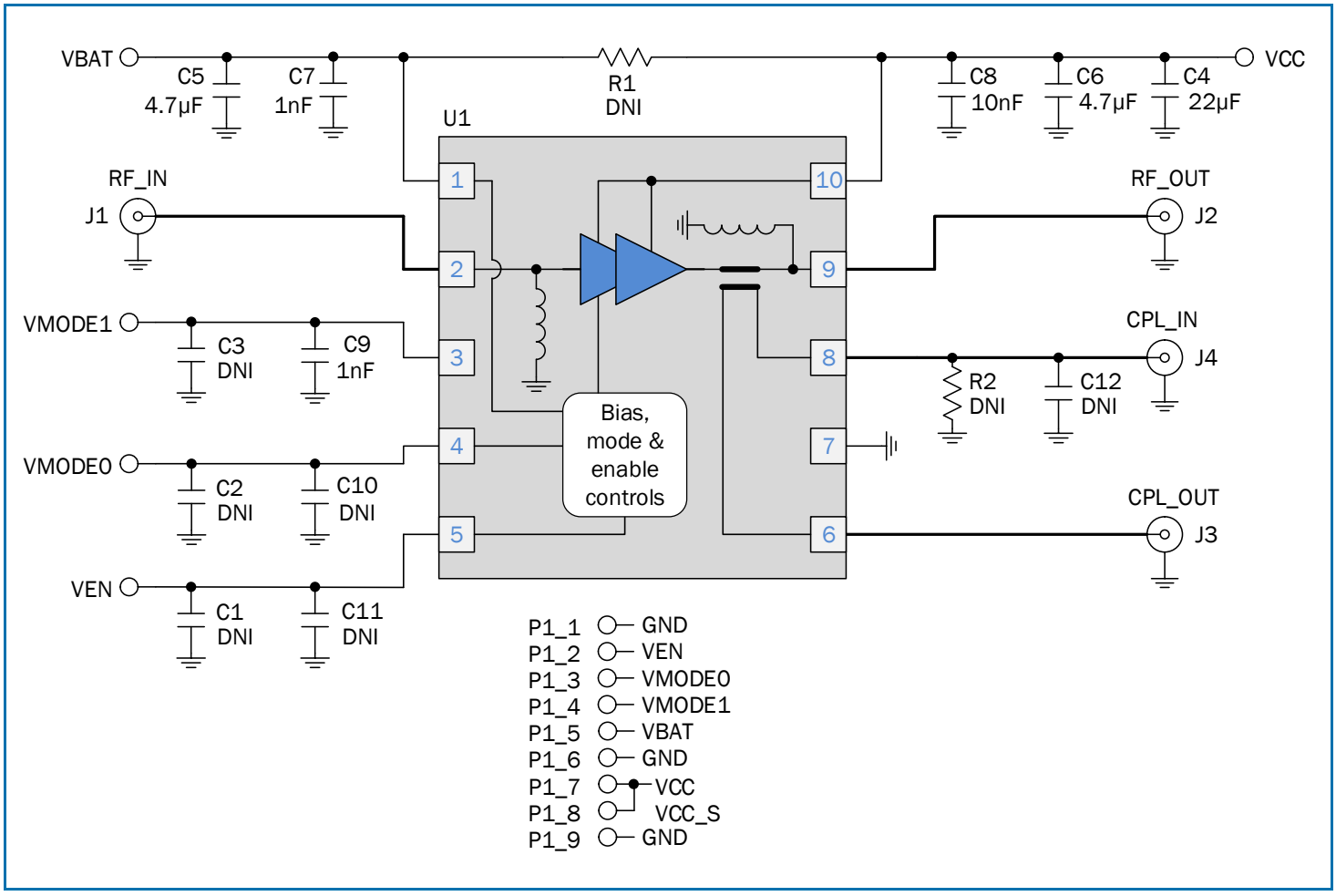
## ACP with DPD, LTE DL 7.5dB CFR $V_{CC}$ = 3.3V, $I_{CC}$ = 283mA, 881MHz



## ACP with DPD, LTE DL 7.5dB CFR $V_{CC}$ = 3.3V, $I_{CC}$ = 320mA, 950MHz



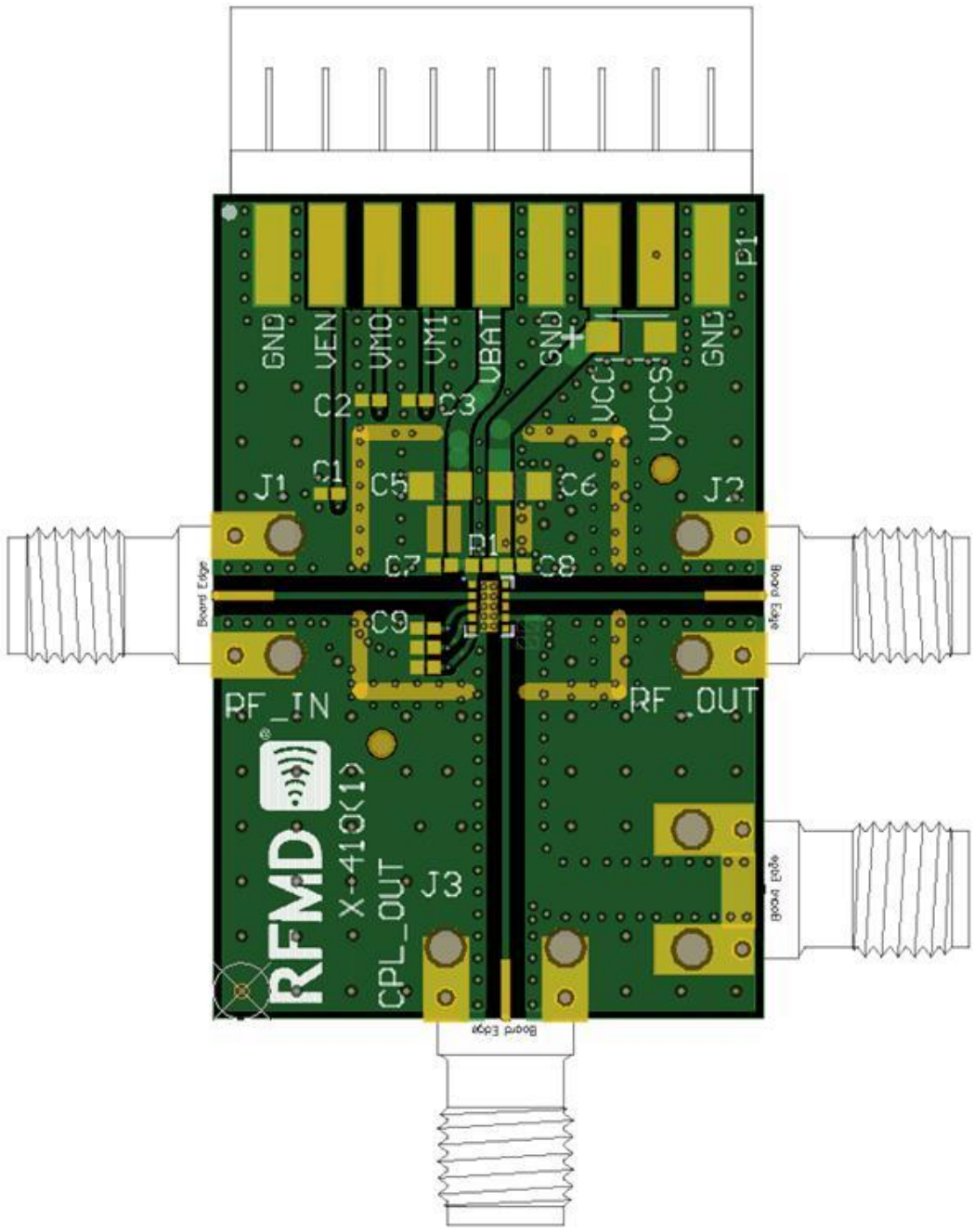
## **Evaluation Board Schematic** 700MHz to 950MHz Application Circuit



## Evaluation Board Bill of Materials (BOM) 700MHz to 950MHz Application Circuit

| Description | Reference Designator | Manufacturer | Manufacturer's P/N |
|---|---|---|---|
| DUT | U1 | RFMD, Inc. | RFPA0802 |
| CAP, 22µF, 10%, 10V, TANT-A | C4 | AVX Corporation | TAJA226K010RNJ |
| CAP, 4.7µF, 10%, 6.3V, X5R, 0805 | C5-C6 | Taiyo Yuden (USA), Inc. | CE MJK212 BJ475KD-T |
| CAP, 1000pF, 10%, 50V, X7R, 0402 | C7, C9 | Taiyo Yuden (USA), Inc. | RM UMK105BJ102KV-F |
| CAP, 10000pF, 10%, 25V, X7R, 0402 | C8 | Taiyo Yuden (USA), Inc. | RM TMK105BJ103KV-F |
| CONN, SMA, EL MINI FLT 0.048" SPE-000311 | J1-J4 | Amphenol RF Asia Corp. | 901-10362 |
| CONN, HDR, ST, PLRZD, 9-PIN | P1 | ITW Pancon | MPSS100-9-C |
| Do Not Place | C1-C3, C10-C12, R1-R2 | | |

## **Evaluation Board Assembly Drawing** 700MHz to 950MHz Application Circuit



## Pin Names and Descriptions

| Pin | Name | Description |
|---|---|---|
| 1 | VBATT | Supply Voltage for bias circuitry |
| 2 | RFIN | RF Input; Connect to 50Ω nominally, presents as DC ground. |
| 3 | VMODE1/GND | Digital control input for power mode selection. Connect to GND if HPM and MPM only operations. |
| 4 | VMODE0 | Digital control input for power mode selection |
| 5 | VEN | Digital control input for enable/disable of PA |
| 6 | CPL_OUT | Coupler Output |
| 7 | GND | Ground |
| 8 | CPL_IN | Coupler Input |
| 9 | RFOUT | RF Output; Connect to 50Ω nominally, present as DC ground |
| 10 | VCC | Supply voltage for PA stages which can be connected to battery supply or output of DC-DC converter |
| PCK BASE | GND | Ground Connection; This package backside should be soldered toa topside ground pad connecting to the PCB ground plane with multiple ground via. The pad should have a low thermal resistance and low electrical impedance to the ground plane. |

## **Package Outline** (Dimensions in millimeters)