DATA SHEET



SKY77768 Power Amplifier Module for WCDMA / HSDPA / HSUPA / HSPA+ / LTE – Band VIII (880 MHz–915 MHz)

Applications

- WCDMA handsets
- HSDPA
- HSUPA
- HSPA+
- LTE

Features

- Low voltage positive bias supply 3.2 V to 4.2 V
- · Good linearity
- High efficiency
 50% at 28.5 dBm
- Large dynamic range
- Small, low profile package
- 3 mm x 3 mm x 0.9 mm
- 10-pad configuration
- Power down control
- InGaP
- Supports low collector voltage operation
- Digital Enable
- No VREF required
- CMOS compatible control signals
- Integrated Directional Coupler



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Description

The SKY77768 Power Amplifier Module (PAM) is a fully matched 10-pad surface mount module developed for Wideband Code Division Multiple Access (WCDMA) applications. This small and efficient module packs full 880-915 MHz bandwidth coverage into a single compact package. Because of high efficiencies attained throughout the entire power range, the SKY77768 delivers unsurpassed talk-time advantages. The SKY77768 meets the stringent spectral linearity requirements of High Speed Downlink Packet Access (HSDPA), High Speed Uplink Packet Access (HSUPA), and Long Term Evolution (LTE) data transmission with high power added efficiency. An integrated directional coupler eliminates the need for any external coupler.

The Gallium Arsenide (GaAs) Microwave Monolithic Integrated Circuit (MMIC) contains all amplifier active circuitry, including input and interstage matching circuits. The silicon CMOS support die, providing precision biasing for the MMIC affords a true CMOS-compatible control interface. Output match into a 50-ohm load, realized off-chip within the module package, optimizes efficiency and power performance.

The SKY77768 is manufactured with Skyworks' InGaP GaAs Heterojunction Bipolar Transistor (HBT) process which provides for all positive voltage DC supply operation and maintains high efficiency and good linearity. While primary bias to the SKY77768 can be supplied directly from any suitable battery with an output of 3.2 V to 4.2 V, optimal performance is obtained with VCC2 sourced from a DCDC power supply adjusted within 0.5 V to 3.6 V based on target output power levels. Power down executes by setting VENABLE to zero volts. No external supply side switch is needed as typical "off" leakage is a few microamperes with full primary voltage supplied from the battery.



FIGURE 1. SKY77768 FUNCTIONAL BLOCK DIAGRAM

°C

+110

+150

Electrical Specifications

The following tables list the electrical characteristics of the SKY77768 Power Amplifier. Table 1 lists the absolute maximum ratings and Table 2 shows the recommended operating conditions. Electrical specifications for nominal operating conditions are listed in Table 4. Table 3 presents a truth table for the power settings. Tables 5 through 8 provide the standard test configurations for WCDMA (STC1), HSDPA (STC2), and HSUPA (STC3, STC4) respectively.

TABLE 1. ABSOLUTE MAXIMUM OPERATING CONDITIONS

No damage assuming only one parameter set at limit at a time with all other parameters set at nominal value. Parameter Symbol Minimum Nominal Maximum Unit **RF Input Power** Pin _ 0 10 dBm Supply Voltage¹ No RF VCC1 3.8 6.0 Volts _ With RF 3.8 5.0 No RF 3.4 6.0 Vcc2 _ With RF 3.4 ___ 4.6 1.8 4.2 **Enable Control Voltage** Ven Volts _ Mode Control Voltage VMODEO 1.8 4.2 Volts _ **V**MODE1 1.8 4.2

¹ Overvoltage shutdown circuitry turns on at approximately 5 V.

Case Temperature²

² Case Operating Temperature (TCASE) refers to the temperature of the GROUND PAD at the underside of the package.

TCASE

TSTG

Operating

Storage

| Parameter | | Symbol Minimum Nominal | | Maximum | Unit | |
|---|-------|------------------------|------------------|---------|-------|-------|
| RF Output Power ¹ | WCDMA | Pout_max | 28.50 | _ | — | dBm |
| | HSDPA | | 27.50 | — | — | |
| | HSUPA | | 24.85 | — | — | |
| | LTE | | 27.50 | — | — | |
| Operating Frequency | | f0 | 880.0 | 897.5 | 915.0 | MHz |
| Supply Voltage | | Vcc1 | 3.0 ² | 3.4 | 4.5 | Volts |
| | | Vcc2 | 0.5 | — | 3.6 | |
| Enable Control Voltage | Low | Ven_l | 0.0 | 0.0 | 0.5 | Volts |
| | High | Ven_h | 1.35 | 1.8 | 3.1 | |
| Mode Control Voltage | Low | VMODEO | 0.0 | 0.0 | 0.5 | Volts |
| | | VMODE1 | 0.0 | 0.0 | 0.5 | |
| | High | VMODEO | 1.35 | 1.8 | 3.1 | |
| | | VMODE1 | 1.35 | 1.8 | 3.1 | |
| Case Operating Temperature ³ | | TCASE | -20 | +25 | +85 | °C |

TABLE 2. RECOMMENDED OPERATING CONDITIONS

-30

-40

+25

¹ For VCC < 3.4 V, output power back-off = 0.5 dB.

² Recommended minimum VCC for maximum power output is indicated. VCC2 down to 0.5 V may be used for backed-off power when using DC/DC converter to conserve battery current.

³ Equivalent to –30 °C to +75 °C Ambient Operating Temperature

TABLE 3. MODES OF OPERATION

| Power Setting | ENABLE | VMODEO | VMODE1 | VCC |
|---|--------|--------|--------|-----|
| Power Down Mode | Low | Low | Low | On |
| Standby Mode | Low | | | On |
| High Power Mode (17.0 dBm \leq Pout \leq 28.5 dBm) | High | Low | | On |
| Medium Power Mode (7.0 dBm \leq Pout \leq 17.0 dBm) | High | High | Low | On |
| Low Power Mode (Pout \leq 7.0 dBm) | High | High | High | On |

 Table 4. Electrical Specifications for Nominal Operating Conditions

 Per Table 2 over dynamic range up to 28.5 dBm output power for STC1 modulation, unless otherwise specified.

| Characteristics | Symbol | Condition | Minimum | Typical | Maximum | Unit | |
|--|---------------|--|---------|---------|---------|------|--|
| Gain ¹ | Glow | Роит = 7.0 dBm Vcc2 = 0.8 V | 10.0 | 14.0 | 21.5 | dB | |
| | Gmed | Pouτ = 17.0 dBm Vcc2 = 1.5 V | 19.0 | 24.0 | 28.0 | | |
| | G ніgh | Pout = 28.5 dBm | 25.0 | 28.0 | 31.0 | | |
| Rx Band Gain | RxG | - | — | — | -0.5 | dB | |
| | RxG_gps | - | — | — | -3.0 | | |
| | RxG_ISM | - | — | _ | -6.0 | | |
| Power Added Efficiency | PAELow | Pout = 7.0 dBm | 10.5 | 13.0 | — | % | |
| | PAEMED | Pout = 17.0 dBm | 22.0 | 26.5 | — | | |
| | РАЕнідн | Pout = 28.5 dBm | 43.0 | 50.0 | _ | | |
| Total Supply Current | Icc_low | Pout = 7.0 dBm | | 44 | 55 | mA | |
| | ICC_MED | Pout = 17.0 dBm | _ | 122 | 150 | | |
| | Ісс_нісн | Pout = 28.5 dBm | _ | 420 | 500 | | |
| Quiescent Current | Iq_low | Low Power Mode | | 22 | 28 | mA | |
| | IQ_MED | Medium Power Mode | | 38 | 45 | | |
| Enable Control Current | IEN | _ | | 20 | 40 | μA | |
| Mode Control Current | IMODEO | - | — | 20 | 40 | μA | |
| | IMODE1 | - | — | 20 | 40 | | |
| Total Supply Current in Power Down Mode | IPD | Vcc = 3.4 V Ven = Low VModeo = Low VMode1 = Low | — | _ | 20 | μA | |
| ICC1 Current | Ісс1_нідн | _ | — | | 10 | mA | |
| Adjacent Channel Leakage power Ratio ² 5 MHz offset | ACLR5 | Pout = 7.0 dBm | - | -43 | -40.0 | dBc | |
| | | Pout = 17.0 dBm | — | -45 | -40.0 | | |
| | | Pout = 28.5 dBm | — | -41 | -38.5 | | |
| 10 MHz offset | ACLR10 | POUT = 7.0 dBm | — | -59 | -50.0 | | |
| | | Pout = 17.0 dBm | — | -56 | -50.0 | | |
| | | POUT = 28.5 dBm | — | -58 | -50.0 | | |

| Characteristics | iange ap le zere (| Symbol | Condition | Minimum | Tynical | Maximum | Unit |
|---|--------------------|------------|---|---------|---------|---------------|--------|
| | | Symbol | | Mining | Typical | INIGAIITIUITI | Unit |
| Adjacent Channel Leakage power Ratio ³ | EUTRA offset | ACLR_EUTRA | $POUT \leq (POUT_MAX - MPR^4)$ | | -40 | | dBc |
| | UTRA offset | ACLR1_UTRA | | | -42 | — | - |
| | | ACLR2_UTRA | — | | — | — | |
| Harmonic Suppression | Second | fo2 | Pout ≤ 28.5 dBm | — | -45 | -35 | dBc |
| | Third | fo3 | | — | -50 | -45 | |
| Tx Noise in Rx Bands ¹ | Rx Band 1 | | 925 MHz-960 MHz | — | -136 | -134 | dBm/Hz |
| | GPS Rx | | 1574 MHz-1577 MHz | — | _ | -140 | |
| | ISM Rx | | 2400 MHz-2483.5 MHz | — | _ | -143 | |
| EVM | | EVM1 | Pout = Pout_max | — | _ | 3.35 | % |
| | | EVM2 | Pout = Pout_max - 3 | — | | 2.50 | |
| Rise / Fall Time | DC | TON_DC | — | — | - | 20 | μs |
| | | TOFF_DC | — | _ | _ | 20 | |
| | RF | TON_rf | — | - | _ | 6 | |
| | | TOFF_RF | — | - | _ | 6 | |
| Coupling Factor | | CPL | Pout = Pout_max | -22 | -20 | -18 | dB |
| CPL_out / Pout Power Ratio Variation Over Outpu | t VSWR | | 2.5:1 VSWR at POUT all VSWR phases CPL_N 50 Ω terminated | - | ±0.4 | _ | dB |
| Daisy-chain | VSWR | | CPL_IN and CPL_OUT ports 698 MHz to 2620 MHz VEN = Low | — | _ | 1.3:1 | |
| | Insertion Loss | | CPL_IN to CPL_OUT ports 698 MHz to 2620 MHz VEN = Low | - | _ | 0.45 | dB |
| Input Voltage Standing Wave Ratio | | VSWR | _ | _ | 1.2:1 | 1.9:1 | _ |
| Stability (Spurious output) ¹ | | S | 6:1 VSWR All phases | — | _ | -70 | dBc |
| Ruggedness – no damage ^{1,5} | | Ru | Pout \leq 28.5 dBm | 10:1 | _ | _ | VSWR |

TABLE 4. [CONTINUED] ELECTRICAL SPECIFICATIONS FOR NOMINAL OPERATING CONDITIONS

Per Table 2 over dynamic range up to 28.5 dBm output power for STC1 modulation, unless otherwise specified.

¹ Over conditions

² ACLR is expressed as a ratio of total adjacent power to WCDMA modulated in-band, both measured in 3.84 MHz bandwidth at specified offsets.

³ LTE: EVM and ACLR are measured with QPSK modulation with 1.4 MHz bandwidth and 5 resource blocks. (Maximum Power Reduction = 0 dBm per 3GPP TS36.101.

⁴ MPR is the maximum power reduction as defined in 3GPP TS36.101

⁵ All phases, time = 10 seconds.

TABLE 5. STANDARD TEST CONFIGURATION - STC1 WCDMA MODE

| Parameter | Level | Spread Code | Spread Factor | I/Q | βc | βd | βhs | βec | βed | Relative Power (dB) |
|-----------|---------|-------------|---------------|-----|------|-------|-----|-----|-----|---------------------|
| DPCCH | 15 kbps | 0 | 256 | Q | 8/15 | — | — | — | — | -6.547 |
| DPDCH | 60 kbps | 16 | 64 | I | — | 15/15 | — | — | — | -1.087 |

TABLE 6. STANDARD TEST CONFIGURATION - STC2 HSDPA MODE

| Parameter | Level | Spread Code | Spread Factor | I/Q | βc | βd | βhs | βec | βed | Relative Power (dB) |
|-----------|---------|-------------|---------------|-----|-------|-------|-------|-----|-----|---------------------|
| DPCCH | 15 kbps | 0 | 256 | Q | 12/15 | — | — | — | — | -7.095 |
| DPDCH | 60 kbps | 16 | 64 | I | — | 15/15 | — | — | — | -5.157 |
| HS-DPCCH | 15 kbps | 64 | 256 | Q | _ | _ | 24/15 | — | — | -3.012 |

| TABLE 7. | STANDARD | TEST CONFIGURATION - | - STC3 | HSUPA N | IODE |
|----------|----------|-----------------------------|--------|---------|-------------|
|----------|----------|-----------------------------|--------|---------|-------------|

| Parameter | Level | Spread Code | Spread Factor | I/Q | βc | βd | βhs | βec | βed | Relative Power (dB) |
|-----------|----------|-------------|---------------|-----|------|-------|------|-------|---------|---------------------|
| DPCCH | 15 kbps | 0 | 256 | Q | 8/15 | | — | | — | -19.391 |
| DPDCH | 960 kbps | 1 | 4 | I | — | 15/15 | — | | — | -13.931 |
| HS- DPCCH | 15 kbps | 64 | 256 | Q | — | _ | 8/15 | _ | — | -19.391 |
| E-DPCCH | 15 kbps | 1 | 256 | I | — | _ | — | 10/15 | — | -17.338 |
| E-DPDCH | 960 kbps | 2 | 4 | I | — | — | — | — | 71.5/15 | -0.371 |

TABLE 8. STANDARD TEST CONFIGURATION - STC4 HSUPA MODE

| Parameter | Level | Spread Code | Spread Factor | I/Q | βc | βd | βhs | βec | βed | Relative Power (dB) |
|-----------|----------|-------------|---------------|-----|------|-------|------|-------|-------|---------------------|
| DPCCH | 15 kbps | 0 | 256 | Q | 6/15 | _ | — | _ | — | -12.499 |
| DPDCH | 960 kbps | 1 | 4 | I | — | 15/15 | — | | — | -4.540 |
| HS- DPCCH | 15 kbps | 64 | 256 | Q | — | — | 2/15 | | — | -22.041 |
| E-DPCCH | 15 kbps | 1 | 256 | I | — | — | — | 12/15 | — | -6.478 |
| E-DPDCH | 960 kbps | 2 | 4 | I | — | _ | — | _ | 15/15 | -4.425 |

Evaluation Board Description

The evaluation board is a platform for testing and interfacing design circuitry. To accommodate the interface testing of the SKY77768, the evaluation board schematic and assembly

diagrams are included for preliminary analysis and design. Figure 2 shows the basic schematic of the board for the 880 MHz to 915 MHz range shown in Figure 3. Figure 4 is a schematic of the recommended application shown in Figure 5.



FIGURE 3. EVALUATION BOARD ASSEMBLY DIAGRAM

VCC1 = 3.2 V to 4.2 V from Battery VCC2 = 0.5 V to 4.2 V from DC/DC (10 mA MAX current drain) (400 mA Current Drain) VCC1 VCC2 ⊥ C6 ⊤ 120 pF 880 to 915 MHz 880 to 915 MHz **RF Input from Transceiver** RF Output to Band Duplexer RF_OUT $Z0 = 50 \Omega$ RF_IN $Z0 = 50 \Omega$ VMODE1 Digital Control from Transceiver CPL_IN $Z0 = 50 \Omega$ 4 Hi Z VMODE1 $\leq 50 \Omega$ 1..... VMODE0 Digital Control from Transceiver VMODE2 Hi Z GND VEN Digital 880 to 915 MHz Control from Transceiver Coupled to Power Detector Hi Z CPL_OUT $Z0 = 50 \Omega$ VEN 4 GROUND PAD 1..... 201722_004

FIGURE 4. SKY77768 SCHEMATIC FOR RECOMMENDED APPLICATION DIAGRAM



FIGURE 5. SKY77768 RECOMMENDED APPLICATION DIAGRAM

Package Dimensions

The SKY77768 is a multi-layer laminate base, overmold encapsulated modular package designed for surface mount solder attachment to a printed circuit board. Figure 6 is a mechanical drawing of the pad layout for this package. Figure 7 provides a

recommended phone board layout footprint for the PAM to help the designer attain optimum thermal conductivity, good grounding, and minimum RF discontinuity for the 50-ohm terminals.



NOTES: Unless otherwise specified.

Dimensioning and Tolerancing in accordance with ASME Y14.5M–1994
 All dimensions are in millimeters.

DS_D804_77761 REV 1 2/08/12 201722 006





DS00109-1 REV 1 7/01/09 201722_007

FIGURE 7. PHONE PCB LAYOUT DIAGRAM – 3 mm x 3 mm, 10-PAD PACKAGE – SKY77768

Package Description

Figure 8 shows the pad functions and the pad numbering convention, which starts with pad 1 in the upper left and



Pad layout as seen from Top View looking through the package. GROUND PAD is package underside. 201722 006

FIGURE 8. SKY77768 PAD NAMES AND CONFIGURATION (TOP VIEW)



FIGURE 9. TYPICAL CASE MARKINGS

Package Handling Information

Because of its sensitivity to moisture absorption, this device package is baked and vacuum-packed prior to shipment. Instructions on the shipping container label must be followed regarding exposure to moisture after the container seal is broken, otherwise, problems related to moisture absorption may occur increments counter-clockwise around the package. Typical case markings are illustrated in Figure 9.

when the part is subjected to high temperature during solder assembly.

The SKY77768 is capable of withstanding an MSL3/260 °C solder reflow. Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. If the part is attached in a reflow oven, the temperature ramp rate should not exceed 3 °C per second; maximum temperature should not exceed 260 °C. If the part is manually attached, precaution should be taken to insure that the part is not subjected to temperatures exceeding 260 °C for more than 10 seconds. For details on attachment techniques, precautions, and handling procedures recommended by Skyworks, please refer to Skyworks Application Note: *PCB Design and SMT Assembly/Rework*, Document Number 101752. Additional information on standard SMT reflow profiles can also be found in the JEDEC Standard J-STD-020.

Production quantities of this product are shipped in the standard tape-and-reel format (Figure 10).

Electrostatic Discharge (ESD) Sensitivity

The SKY77768 meets class 1C JESD22-A114 Human Body Model (HBM), class IV JESD22-C101 Charged-Device Model (CDM), and class A JESD22-A115 Machine Model (MM) electrostatic discharge (ESD) sensitivity classification.

To avoid ESD damage, both latent and visible, it is very important that the product assembly and test areas follow the ESD handling precautions listed below.

- Personnel Grounding
 - Wrist Straps
 - Conductive Smocks, Gloves and Finger Cots
 - Antistatic ID Badges
- Protective Workstation
 - Dissipative Table Top
 - Protective Test Equipment (Properly Grounded)
 - Grounded Tip Soldering Irons
 - Solder Conductive Suckers
 - Static Sensors
- Facility
 - Relative Humidity Control and Air Ionizers
 - Dissipative Floors (less than 1,000 $M\Omega$ to GND)
- Protective Packaging and Transportation
 - Bags and Pouches (Faraday Shield)
 - Protective Tote Boxes (Conductive Static Shielding)
 - Protective Trays
 - Grounded Carts
 - Protective Work Order Holders



3.2 ±0.1(A0) SECTION A - A'

NOTES:

- 1. CARRIER TAPE IS BLACK CONDUCTIVE POLYCARBONATE OR POLYSTYRENE.
- 2. COVER TAPE IS TRANSPARENT AND CONDUCTIVE.
- 3. ESD-SURFACE RESISTIVITY IS \leq 1 X 10¹⁰ OHMS/SQUARE PER EIA, JEDEC TNR SPECIFICATION. 4. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE: ±0.2 mm
- 5. Ao & Bo MEASURED ON PLANE 0.3 mm ABOVE THE BOTTOM OF THE POCKET.
- 6. ALL DIMENSIONS ARE IN MILLIMETERS.

CARRIER TAPE OVERMOLD MCM / RFLGA 3 x 3 x 0.75 / 0.90 mm BODY SIZE -108A 201075_008

FIGURE 10. DIMENSIONAL DIAGRAM FOR CARRIER TAPE BODY SIZE - 3 mm x 3 mm x 0.75 / 0.90 mm - MCM

Ordering Information

| Product Name | Order Number | Evaluation Board Part Number | | |
|---------------------------------|--------------|------------------------------|--|--|
| SKY77768 Power Amplifier Module | SKY77768-11 | EN40-D345-003 | | |

Revision History

| Revision | Date | Description |
|----------|--------------------|---|
| А | December 20, 2011 | Initial Release – Information |
| В | January 25, 2012 | Revise: Figure 1; Table 1 |
| С | March 9, 2012 | Revise: Table 4; Figures 2, 3, 6, 7 Add: Figures 4, 5 |
| D | September 19, 2012 | Revise: Figures 2–5; Tables 2, 4; Ordering Information Table (last page) |
| E | October 26, 2012 | Revise: Change Data Sheet status from ADVANCE to FINAL; Table 4; Ordering Information table |
| F | November 29, 2012 | Revise: Table 1 (Supply Voltage, Case Operating Temperature); Table 2 (Case Operating Temperature footnote) |

References

Skyworks Application Note: PCB Design and SMT Assembly/Rework, Document Number 101752.

Standard SMT Reflow Profiles: JEDEC Standard J-STD-020

Electrostatic Discharge Sensitivity (ESD) Testing: JEDEC Standard, JESD22-A114 Human Body Model (HBM)

Electrostatic Discharge Sensitivity (ESD) Testing: JEDEC Standard, JESD22-A115 Machine Model (MM)

Electrostatic Discharge Sensitivity (ESD) Testing: JEDEC Standard, JESD22-C101 Charged Device Model (CDM).

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