# AN6494NSA

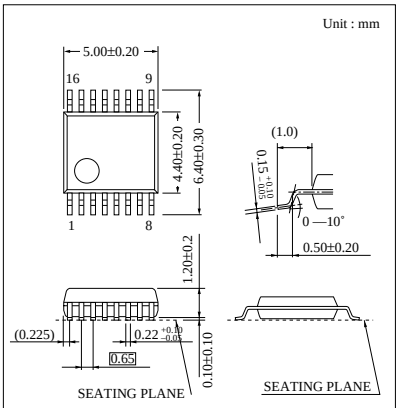
## Digital Communication Orthogonal Modulator IC

### ■ Overview

The AN6494NSA is an orthogonal modulator IC for digital cellular telephones. It incorporates a phase shifter and an APC circuit for indirect modulation in the 1.5GHz band. It efficiently prevents power from leaking to adjacent channels. When provided with an LC filter, it can efficiently suppress IF-band local harmonic spurious.

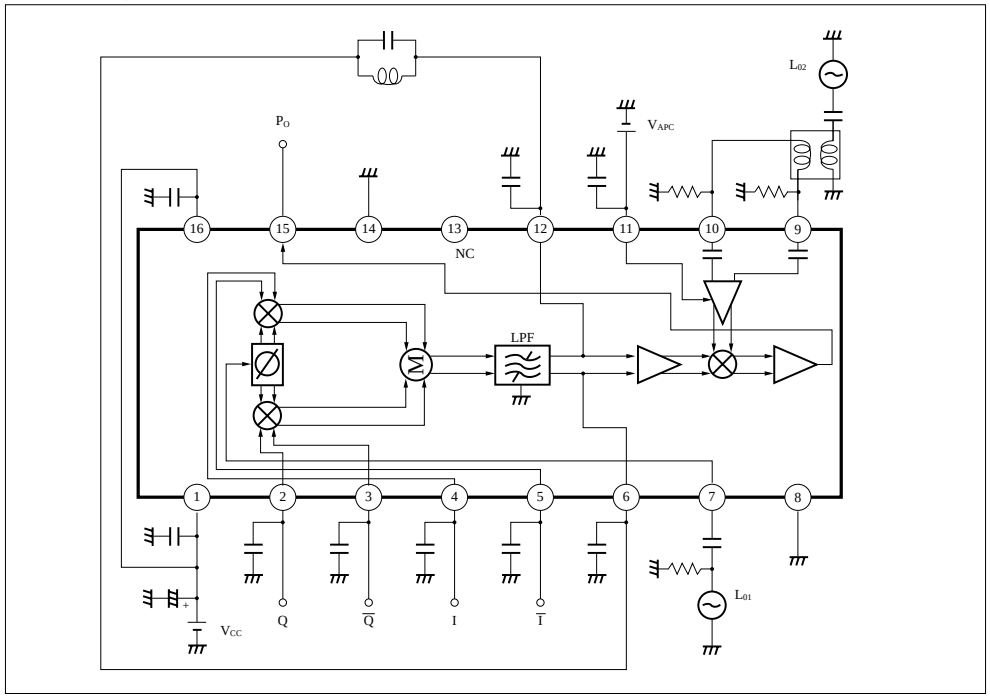
### ■ Features

- Operating supply voltage range : 2.7V to 4.0V
- 1.5GHz indirect modulation
- LO1's eighth-order harmonic suppression : –65dBc or better
- Output power level : –13dBm
- Variable range : APC = typ. 38dB (at fout=1.5GHz)
- Phase shifter frequency : 178MHz
- Package : SSOP016-P-0225A with 0.65mm pitch




SOP package with 16 pins (SSOP016-P-0225A)

### ■ Block Diagram



## ■ Pin Descriptions

| Pin No. | Description | Pin No. | Description |
|---|---|---|---|
| 1 | $V_{CC}$ (mod) | 9 | LO2R |
| 2 | Q input | 10 | LO2 |
| 3 | $\overline{Q}$ input | 11 | APC/BS |
| 4 | I input | 12 | LC2 |
| 5 | $\overline{I}$ input | 13 | NC |
| 6 | LC1 | 14 | GND |
| 7 | LO1 | 15 | RFoutput |
| 8 | GND | 16 | $V_{CC}$ (UP–MIX) |

## ■ Absolute Maximum Ratings (Ta=25˚C)

| Parameter | Symbol | Rating | Unit |
|---|---|---|---|
| Supply voltage | $V_{CC}$ | 4.2 | V |
| Supply current | $I_{CC}$ | 60 | mA |
| Power dissipation | $P_D$ | 252 (Ta=80˚C) | mW |
| Operating ambient temperature | $T_{opr}$ | –30 to + 80 | ˚C |
| Storage temperature | $T_{stg}$ | –55 to + 125 | ˚C |

## ■ Recommended Operating Range

| Parameter | Symbol | Range |
|---|---|---|
| Operating supply voltage range | $V_{CC}$ | 2.7V to 4.0V |

## ■ Electrical Characteristics (Ta=25±2˚C)

| Parameter | Symbol | Condition | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Output level (1) | $P_{O1}$ | $L_O$1=178MHz, –20dBm<br>$L_O$2=1607MHz, –25dBm<br>VAPC=2.5V | –16 | –13 | –10 | dBm |
| Output level (2) | $P_{O2}$ | $L_O$1=178MHz, –20dBm<br>$L_O$2=1631MHz, –25dBm<br>VAPC=2.5V | –16 | –13 | –10 | dBm |
| Current consumption | $I_{CC}$ | $L_O$1=178MHz, –20dBm<br>$L_O$2=1619MHz, –25dBm<br>VAPC=2.5V | — | 38 | 48 | mA |
| Sleep current | $I_{SL}$ | $L_O$1=178MHz, –20dBm<br>$L_O$2=1619MHz, –25dBm<br>VAPC=0V | — | 0 | 10 | µA |
| Minimum output level | $P_{min}$ | $L_O$1=178MHz, –20dBm<br>$L_O$2=1619MHz, –25dBm<br>VAPC=1.0V | — | –52 | –45 | dBm |

Note) $V_{CC}$=3.7V
IQ signal : 0.5$V_{P-P}$ (single phase), π/4 QPSK modulated
$P_{O1}$ output frequency : 1428.0025MHz
$P_{O2}$ output frequency : 1453.0025MHz
$P_{min}$ output frequency : 1441.0025MHz

■ Electrical Characteristics (Design Values for Reference) (Ta=25±2˚C)
The following are design values for reference only (not guaranteed).

| Parameter | Symbol | Condition | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Carrier leak suppression (fLO2–fLO1) *1 | CL | $L_O1$=178MHz, –20dBm<br>$L_O2$=1619MHz, –25dBm<br>VAPC=2.5V, IQ: $V_{DC}$ offset adjust | — | –35 | –30 | dBc |
| Image leak suppression *1 | IL | $L_O1$=178MHz, –20dBm<br>$L_O2$=1619MHz, –25dBm<br>VAPC=2.5V, IQ: $V_{AC}$ level adjust | — | –40 | –35 | dBc |
| Adjacent spurious suppression *1 | DU | $L_O1$=178MHz, –20dBm<br>$L_O2$=1619MHz, –25dBm<br>VAPC=2.5V | — | –70 | –65 | dBc |
| Base-band distortion suppression *1 | BD | $L_O1$=178MHz, –20dBm<br>$L_O2$=1619MHz, –25dBm<br>VAPC=2.5V | — | –40 | — | dBc |
| 3rd intermodulation distortion suppression *2 (Po = –10dBm) | IM3 | $L_O1$=178MHz, –20dBm<br>$L_O2$=1619MHz, –25dBm<br>VAPC=2.5V | — | –35 | — | dBc |
| Adjacent channel power leak suppression (50kHz separation) *3 | BL1 | $L_O1$=178MHz, –20dBm<br>$L_O2$=1619MHz, –25dBm<br>VAPC=2.5V | — | — | –60 | dBc |
| Adjacent channel power leak suppression (100 kHz separation) *3 | BL2 | $L_O1$=178MHz, –20dBm<br>$L_O2$=1619MHz, –25dBm<br>VAPC=2.5V | — | — | –65 | dBc |
| APC variation range *1 | $L_{APC}$ | $L_O1$=178MHz, –20dBm<br>$L_O2$=1619MHz, –25dBm<br>VAPC=1.0 —2.5V | 30 | 38 | — | dB |
| APC output level control sensitivity *1 | $S_{APC}$ | $L_O1$=178MHz, –20dBm<br>$L_O2$=1619MHz, –25dBm<br>VAPC=1.0 —2.5V | — | 47 | — | dB/V |
| In-band output level deviation *1 | ΔP | $L_O1$=178MHz, –20dBm<br>Lo2=1607MHz—1631MHz, –25dBm<br>VAPC=2.5V | –1.5 | — | +1.5 | dB |
| Direct conversion modulation current consumption *1 | $I_{MD}$ | $L_O1$=178MHz, –20dBm<br>$L_O2$=1619MHz, –25dBm<br>VAPC=2.5V | — | 17 | 22 | mA |
| Up-mixer current consumption * | $I_{UM}$ | $L_O1$=178MHz, –20dBm<br>$L_O2$=1619MHz, –25dBm<br>VAPC=2.5V | — | 21 | 26 | mA |

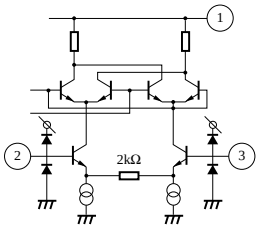
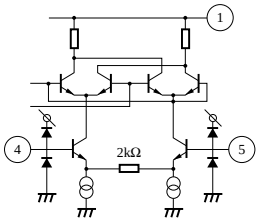
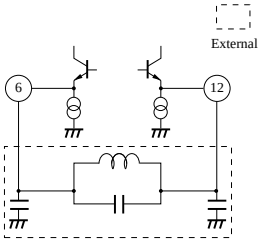
Note) $V_{CC}$= 3.7V
IQsignal : 0.5$V_{P-P}$ (single phase), 1.85$V_{DC}$
*1 : π/4 QPSK modulation
*2 : 3π/4 QPSK modulation
*3 : PN9-stage modulation
APC output level sensitivity was measured with $V_{APC}$=1.0V and $V_{APC}$=1.6V.

■ Usage Note

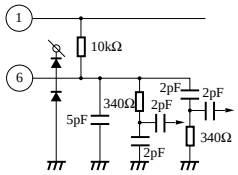
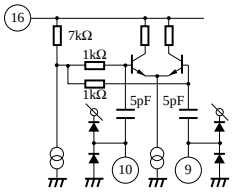
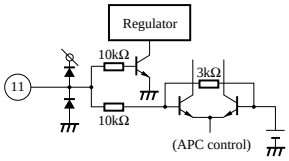
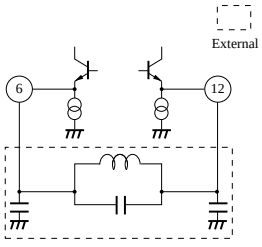
Surge breakdown levels
The following are design values for reference only (not guaranteed).
Condition : C=200pF, and R=0Ω

| Pin No. | Positive breakdown level (V) | Negative breakdown level (V) |
|---|---|---|
| 2 | 90 | 60 |
| 3 | 90 | 50 |
| 4 | 70 | 60 |
| 5 | 80 | 70 |
| 11 | 80 | 70 |
| 12 | 170 | — |

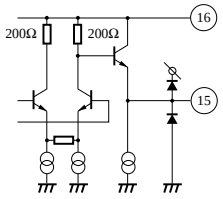
■ Pin Descriptions

<table>
<tr><th>Pin No.</th><th>Symbol</th><th>I/O</th><th>Description</th><th>Equivalent circuit</th></tr>
<tr><td>1</td><td>$V_{CC}$</td><td>I</td><td>This is the supply voltage pin for the direct conversion modulator. The IC incorporates a band-gap regulator to provide a regulated bias independent of $V_{CC}$ or temperature change.</td><td>————</td></tr>
<tr><td>2</td><td>I</td><td>I</td><td>I signal input. The relationship between input DC bias and amplitude is as follows :<br><table><tr><th>DC bias (V)</th><th>Amplitude $V_{P-P}$</th></tr><tr><td>1.7— ($V_{CC}$– 0.9)</td><td>0.5 (single phase)</td></tr></table>Input impedance is 100kΩ or more.</td><td rowspan="2">  </td></tr>
<tr><td>3</td><td>$\overline{I}$</td><td>I</td><td>Inverted-$\overline{I}$ signal input. Apply 1.5— ($V_{CC}$ – 0.9) V for single-phase input mode.</td></tr>
<tr><td>4</td><td>Q</td><td>I</td><td>Q signal input. The relationship between input DC bias and amplitude is as follows :<br><table><tr><th>DC bias (V)</th><th>Amplitude $V_{P-P}$</th></tr><tr><td>1.7— ($V_{CC}$– 0.9)</td><td>0.5 (single phase)</td></tr></table>Input impedance is 100kΩ or more.</td><td rowspan="2">  </td></tr>
<tr><td>5</td><td>$\overline{Q}$</td><td>I</td><td>Inverted-$\overline{Q}$ signal input. Apply 1.5— ($V_{CC}$– 0.9)V for single-phase input mode.</td></tr>
<tr><td>6</td><td>LC1</td><td>—</td><td>An external LC connected to this pin removes spurious from the transmission band by raising up the Lo1 input frequency band. The output is an emitter follower.</td><td>  </td></tr>
</table>

■ Pin Descriptions (cont.)

| Pin No. | Symbol | I/O | Description | Equivalent circuit |
|---|---|---|---|---|
| 7 | Lo1 | I | This is the local input to the orthogonal modulator. The input impedance is 10kΩ. |   |
| 8 | GND | — | This is the ground for the orthogonal modulator. The ground foil pattern for this pin must be wide enough to provide a low impedance. | ——— |
| 9 | Lo2 REF | I | This is a local input to the UP mixer. An external balance coil should be used to provide balanced input. |   |
| 10 | Lo2 | I | This is a local input to the UP mixer. An external balance coil should be used to provide balanced input. | |
| 11 | APC/BS | I | This is the battery save control for all circuits. It also controls RF output power.<br>$V_{APC}$ (V) — Status<br>0 — 0.5 — OFF<br>1.0 — $V_{CC}$ — ON (APC control)<br>The input impedance is 5kΩ or more. |   |
| 12 | LC2 | — | An external LC connected to this pin removes spurious from the transmission band by raising up the Lo1 input frequency band. The output is an emitter follower. |   |

■ Pin Descriptions (cont.)

| Pin No. | Symbol | I/O | Description | Equivalent circuit |
|---|---|---|---|---|
| 13 | NC | — | ——— | ——— |
| 14 | GND | — | This is the ground for the UP mixer and the output amplifier. The ground foil pattern for this pin must be wide enough to provide a low impedance for high frequencies. | ——— |
| 15 | RF output | O | This is the RF output from the output amplifier circuit (emitter follower). |   |
| 16 | $V_{CC}$ | I | This is the power supply for the UP mixer and the output amplifier circuit. It incorporates a regulating circuit to provide a regulated bias independent of $V_{CC}$ or temperature change. | ——— |

■ Characteristics Curve