

## DIGITAL TV TUNER IC

Check for Samples: [SN761644](#)

### FEATURES

- Integrated Mixer/Oscillator/PLL and IF GCA
- Mirror Pin Package of [SN761640](#)
- VHF-L, VHF-H, UHF 3-Band Local Oscillator
- RF AGC Detector Circuit
- I<sup>2</sup>C Bus Protocol  
Bidirectional Data Transmission
- High-Voltage Tuning Voltage Output
- Four NPN-Type Band Switch Drivers
- One Auxiliary Port/5-Level ADC
- Crystal Oscillator Output
- Programmable Reference Divider Ratio  
(24/28/32/64/80/128)
- IF GCA Enable/Disable Control
- Selectable digital IFOUT and Analog IFOUT
- Standby Mode
- 5-V Power Supply
- 44-Pin Thin Shrink Small-Outline Package  
(TSSOP)

### APPLICATIONS

- Digital TVs
- Digital CATVs
- Set-Top Boxes

### DESCRIPTION

The SN761644 is a low-phase-noise synthesized tuner IC designed for digital TV tuning systems. The circuit consists of a PLL synthesizer, three-band local oscillator and mixer, RF AGC detector circuit, and IF gain-controlled amplifier. The SN761644 is available in a small-outline package.

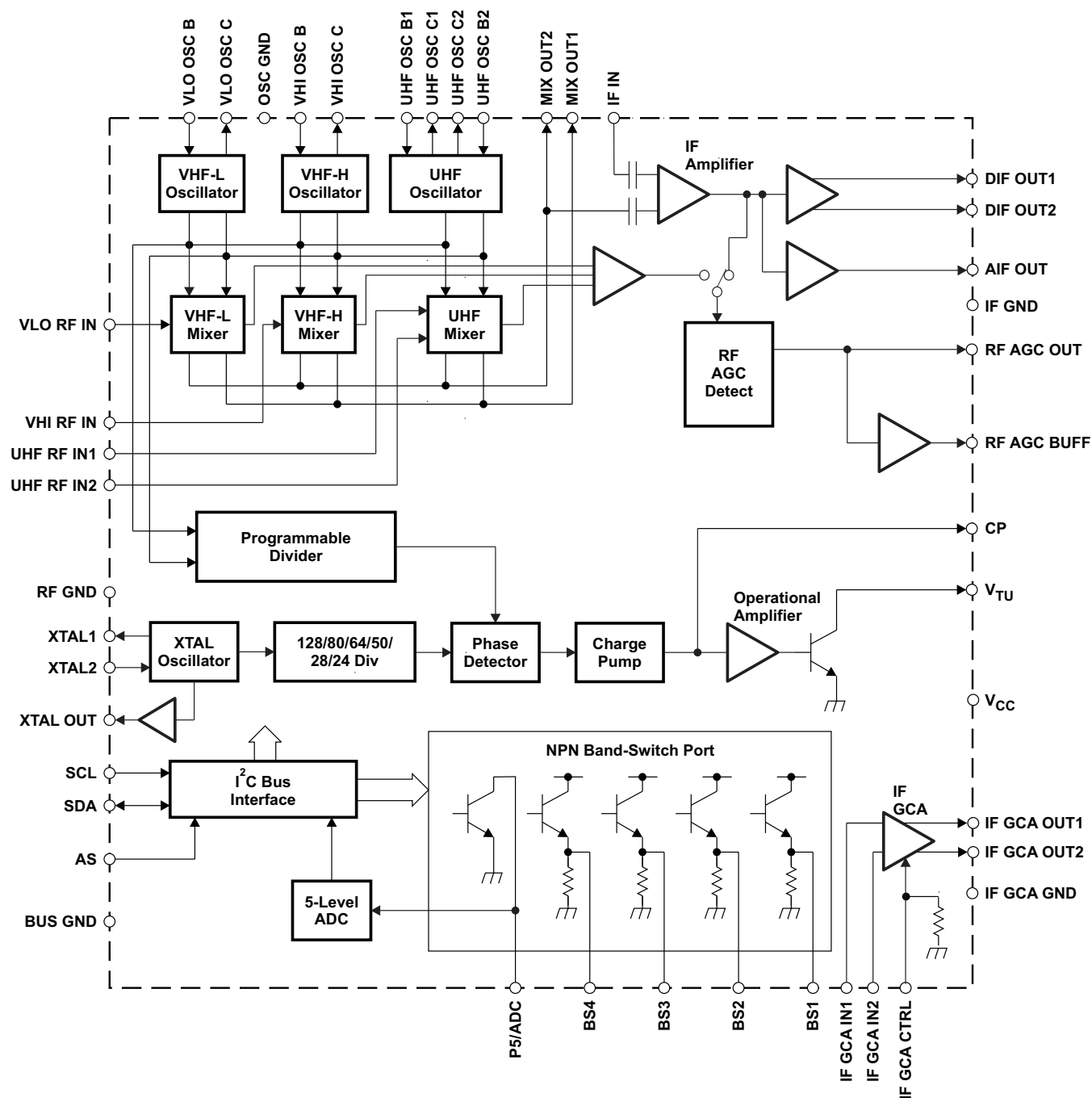
#### DBT PACKAGE (TOP VIEW)

|            |    |    |             |
|------------|----|----|-------------|
| BS4        | 1  | 44 | VLO OSCB    |
| UHF RF IN1 | 2  | 43 | VLO OSC C   |
| UHF RF IN2 | 3  | 42 | VHI OSC B   |
| VHI RF IN  | 4  | 41 | VHI OSC C   |
| VLO RF IN  | 5  | 40 | UHF OSC B1  |
| RF GND     | 6  | 39 | UHF OSC C1  |
| MIX OUT2   | 7  | 38 | UHF OSC C2  |
| MIX OUT1   | 8  | 37 | UHF OSC B2  |
| IF IN      | 9  | 36 | OSC GND     |
| RF AGC OUT | 10 | 35 | CP          |
| RF AGC BUF | 11 | 34 | VTU         |
| BS3        | 12 | 33 | IF GND      |
| BS2        | 13 | 32 | AIF OUT     |
| BS1        | 14 | 31 | DIF OUT1    |
| SDA        | 15 | 30 | DIF OUT2    |
| SCL        | 16 | 29 | IF GCA CTRL |
| AS         | 17 | 28 | VCC         |
| BUS GND    | 18 | 27 | IF GCA IN1  |
| P5/ADC     | 19 | 26 | IF GCA IN2  |
| XTAL OUT   | 20 | 25 | IF GCA GND  |
| XTAL2      | 21 | 24 | IF GCA OUT2 |
| XTAL1      | 22 | 23 | IF GCA OUT1 |



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

## FUNCTIONAL BLOCK DIAGRAM



## TERMINAL FUNCTIONS

**Table 1.**

| TERMINAL        |     | DESCRIPTION                            | SCHEMATIC                 |
|-----------------|-----|----------------------------------------|---------------------------|
| NAME            | NO. |                                        |                           |
| AIF OUT         | 32  | IF amplifier output (analog)           | <a href="#">Figure 8</a>  |
| AS              | 17  | Address selection input                | <a href="#">Figure 1</a>  |
| BS1             | 14  | Band switch 1 output                   | <a href="#">Figure 2</a>  |
| BS2             | 13  | Band switch 2 output                   | <a href="#">Figure 2</a>  |
| BS3             | 12  | Band switch 3 output                   | <a href="#">Figure 2</a>  |
| BS4             | 1   | Band switch 4 output                   | <a href="#">Figure 2</a>  |
| BUS GND         | 18  | BUS ground                             |                           |
| CP              | 35  | Charge-pump output                     | <a href="#">Figure 3</a>  |
| DIF OUT1        | 31  | IF amplifier output 1                  | <a href="#">Figure 9</a>  |
| DIF OUT2        | 30  | IF amplifier output 2                  | <a href="#">Figure 9</a>  |
| IF GCA CTRL     | 29  | IF GCA CTRL voltage inout              | <a href="#">Figure 4</a>  |
| IF GCA GND      | 25  | IF GCA ground                          |                           |
| IF GCA IN1      | 27  | IF GCA input 1                         | <a href="#">Figure 5</a>  |
| IF GCA IN2      | 26  | IF GCA input 2                         | <a href="#">Figure 5</a>  |
| IF GCA OUT1     | 23  | IF GCA output 1                        | <a href="#">Figure 6</a>  |
| IF GCA OUT2     | 24  | IF GCA output 2                        | <a href="#">Figure 6</a>  |
| IF GND          | 33  | IF ground                              |                           |
| IF IN           | 9   | IF amplifier input                     | <a href="#">Figure 7</a>  |
| MIXOUT1         | 8   | Mixer output 1                         | <a href="#">Figure 10</a> |
| MIXOUT2         | 7   | Mixer output 2                         | <a href="#">Figure 10</a> |
| OSC GND         | 36  | Oscillator ground                      |                           |
| P5/ADC          | 19  | Port-5 output/ADC input                | <a href="#">Figure 11</a> |
| RF AGC BUF      | 11  | RF AGC buffer output                   | <a href="#">Figure 12</a> |
| RF AGC OUT      | 10  | RF AGC output                          | <a href="#">Figure 13</a> |
| RF GND          | 6   | RF ground                              |                           |
| SCL             | 16  | Serial clock input                     | <a href="#">Figure 14</a> |
| SDA             | 15  | Serial data input/output               | <a href="#">Figure 15</a> |
| UHF OSC B1      | 40  | UHF oscillator base 1                  | <a href="#">Figure 16</a> |
| UHF OSC B2      | 37  | UHF oscillator base 2                  | <a href="#">Figure 16</a> |
| UHF OSC C1      | 39  | UHF oscillator collector 1             | <a href="#">Figure 16</a> |
| UHF OSC C2      | 38  | UHF oscillator collector 2             | <a href="#">Figure 16</a> |
| UHF RF IN1      | 2   | UHF RF input 1                         | <a href="#">Figure 17</a> |
| UHF RF IN2      | 3   | UHF RF input 2                         | <a href="#">Figure 17</a> |
| V <sub>CC</sub> | 28  | Supply voltage                         |                           |
| VHI OSC B       | 42  | VHF-H oscillator base                  | <a href="#">Figure 18</a> |
| VHI OSC C       | 41  | VHF-H oscillator collector             | <a href="#">Figure 18</a> |
| VHI RF IN       | 4   | VHF-H RF input                         | <a href="#">Figure 19</a> |
| VLO OSC B       | 44  | VHF-L oscillator base                  | <a href="#">Figure 20</a> |
| VLO OSC C       | 43  | VHF-L oscillator collector             | <a href="#">Figure 20</a> |
| VLO RF IN       | 5   | VHF-L RF input                         | <a href="#">Figure 21</a> |
| VTU             | 34  | Tuning voltage amplifier output        | <a href="#">Figure 3</a>  |
| XTAL1           | 22  | 4-MHz crystal oscillator               | <a href="#">Figure 22</a> |
| XTAL2           | 21  | 4-MHz crystal oscillator               | <a href="#">Figure 22</a> |
| XTALOUT         | 20  | 4-MHz crystal oscillator buffer output | <a href="#">Figure 23</a> |

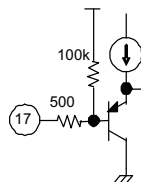


Figure 1. AS

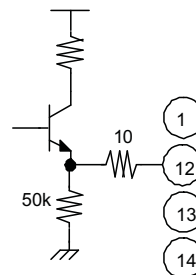


Figure 2. BS1, BS2, BS3, and BS4

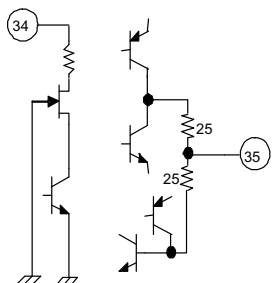


Figure 3. CP and VTU

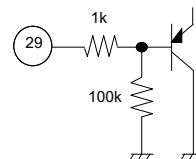


Figure 4. IF GCA CTRL

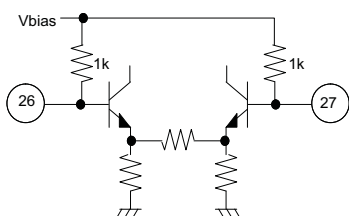


Figure 5. IF GCA IN1 and IF GCA IN2

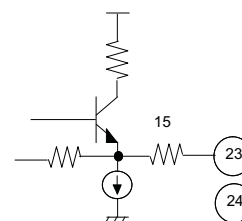


Figure 6. IF GCA OUT1 and IF GCA OUT2

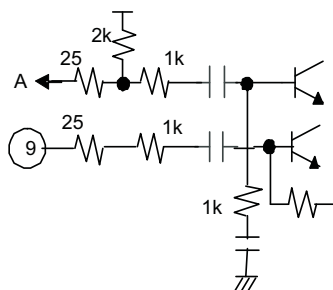


Figure 7. IF IN

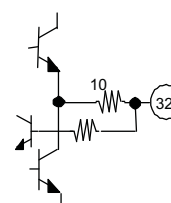


Figure 8. AIF OUT

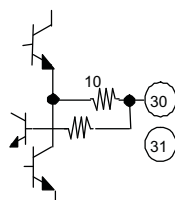


Figure 9. DIF OUT1 and DIF OUT2

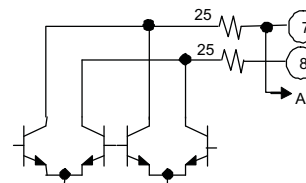
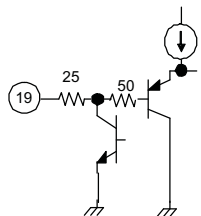
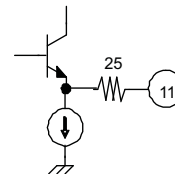


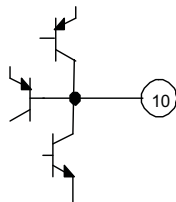
Figure 10. MIXOUT1 and MIXOUT2



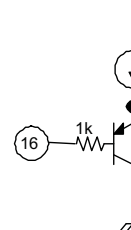
**Figure 11. P5/ADC**



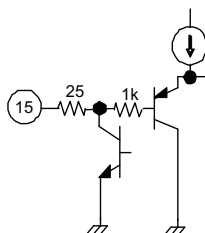
**Figure 12. RF AGC BUF**



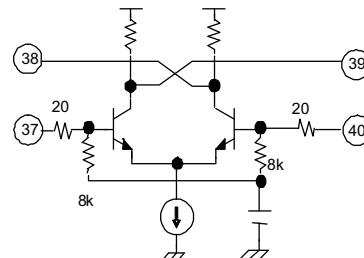
**Figure 13. RF AGC OUT**



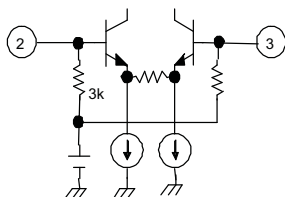
**Figure 14. SCL**



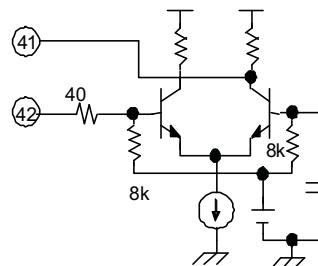
**Figure 15. SDA**



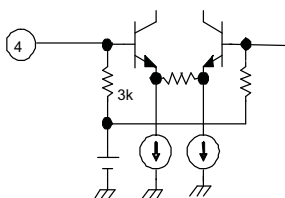
**Figure 16. UHF OSC B1, UHF OSC B2, UHF OSC C1, and UHF OSC C2**



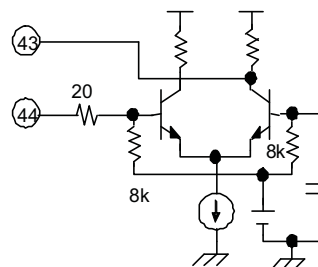
**Figure 17. UHF RF IN1 and UHF RF IN2**



**Figure 18. VHI OSC B and VHI OSC C**



**Figure 19. VHI RF IN**



**Figure 20. VLO OSC B and VLO OSC C**

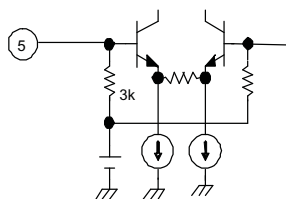


Figure 21. VLO RF IN

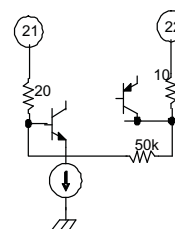


Figure 22. XTAL1 and XTAL2

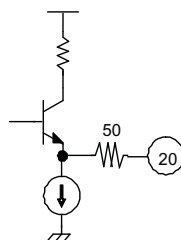


Figure 23. XTALOUT

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

over recommended operating free-air temperature range (unless otherwise noted)

|                      |                                             |                                       | MIN  | MAX  | UNIT |
|----------------------|---------------------------------------------|---------------------------------------|------|------|------|
| V <sub>CC</sub>      | Supply voltage range <sup>(2)</sup>         | V <sub>CC</sub>                       | –0.4 | 6.5  | V    |
| V <sub>GND</sub>     | Input voltage range 1 <sup>(2)</sup>        | RF GND, OSC GND                       | –0.4 | 0.4  | V    |
| V <sub>VTU</sub>     | Input voltage range 2 <sup>(2)</sup>        | VTU                                   | –0.4 | 35   | V    |
| V <sub>IN</sub>      | Input voltage range 3 <sup>(2)</sup>        | Other pins                            | –0.4 | 6.5  | V    |
| P <sub>D</sub>       | Continuous total dissipation <sup>(3)</sup> | T <sub>A</sub> ≤ 25°C                 |      | 1438 | mW   |
| T <sub>A</sub>       | Operating free-air temperature range        |                                       | –20  | 85   | °C   |
| T <sub>stg</sub>     | Storage temperature range                   |                                       | –65  | 150  | °C   |
| T <sub>J</sub>       | Maximum junction temperature                |                                       |      | 150  | °C   |
| t <sub>SC(max)</sub> | Maximum short-circuit time                  | Each pin to V <sub>CC</sub> or to GND |      | 10   | s    |

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) Voltage values are with respect to the IF GND of the circuit.

(3) Derating factor is 11.5 mW/°C for T<sub>A</sub> ≥ 25°C.

## RECOMMENDED OPERATING CONDITIONS

|                  |                                |                               | MIN | NOM | MAX | UNIT |
|------------------|--------------------------------|-------------------------------|-----|-----|-----|------|
| V <sub>CC</sub>  | Supply voltage                 | V <sub>CC</sub>               | 4.5 | 5   | 5.5 | V    |
| V <sub>VTU</sub> | Tuning supply voltage          | VTU                           |     | 30  | 33  | V    |
| I <sub>BS</sub>  | Output current of band switch  | BS1 – BS4, one band switch on |     |     | 10  | mA   |
| I <sub>P5</sub>  | Output current of port 5       | P5/ADC                        |     |     | –5  | mA   |
| T <sub>A</sub>   | Operating free-air temperature |                               | –20 |     | 85  | °C   |



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

IF IN1, MIXOUT1, and MIXOUT2 (pins 7–9) withstand 1.5 kV, and all other pins withstand 2 kV, according to the Human-Body Model (1.5 kΩ, 100 pF).

## ELECTRICAL CHARACTERISTICS

### Total Device and Serial Interface

$V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ,  $T_A = -20^{\circ}\text{C to }85^{\circ}\text{C}$  (unless otherwise noted)

| PARAMETER                       |                                                                                              | TEST CONDITIONS                                           | MIN | TYP | MAX      | UNIT          |
|---------------------------------|----------------------------------------------------------------------------------------------|-----------------------------------------------------------|-----|-----|----------|---------------|
| $I_{CC1}$                       | Supply current 1                                                                             | BS[1:4] = 0100, IFGCA disabled                            |     | 90  | 120      | mA            |
| $I_{CC2}$                       | Supply current 2                                                                             | BS[1:4] = 0100, IFGCA enabled                             |     | 115 | 145      | mA            |
| $I_{CC3}$                       | Supply current 3                                                                             | BS[1:4] = 0100, IFGCA enabled,<br>$I_{BS} = 10\text{ mA}$ |     | 125 | 155      | mA            |
| $I_{CC-STBY}$                   | Standby supply current                                                                       | BS[1:4] = 1100                                            |     | 9   |          | mA            |
| $V_{IH}$                        | High-level input voltage (SCL, SDA)                                                          |                                                           | 2.3 |     |          | V             |
| $V_{IL}$                        | Low-level input voltage (SCL, SDA)                                                           |                                                           |     |     | 1.05     | V             |
| $I_{IH}$                        | High-level input current (SCL, SDA)                                                          |                                                           |     |     | 10       | $\mu\text{A}$ |
| $I_{IL}$                        | Low-level input current (SCL, SDA)                                                           |                                                           | -10 |     |          | $\mu\text{A}$ |
| $V_{POR}$                       | Power-on-reset supply voltage (threshold of supply voltage between reset and operation mode) |                                                           | 2.1 | 2.8 | 3.5      | V             |
| <b>I<sup>2</sup>C Interface</b> |                                                                                              |                                                           |     |     |          |               |
| $V_{ASH}$                       | Address-select high-input voltage (AS)                                                       | $V_{CC} = 5\text{ V}$                                     | 4.5 |     | 5        | V             |
| $V_{ASM1}$                      | Address-select mid-input 1 voltage (AS)                                                      | $V_{CC} = 5\text{ V}$                                     | 2   |     | 3        | V             |
| $V_{ASM2}$                      | Address-select mid-input 2 voltage (AS)                                                      | $V_{CC} = 5\text{ V}$                                     | 1   |     | 1.5      | V             |
| $V_{ASL}$                       | Address-select low-input voltage (AS)                                                        | $V_{CC} = 5\text{ V}$                                     |     |     | 0.5      | V             |
| $I_{ASH}$                       | Address-select high-input current (AS)                                                       |                                                           |     |     | 50       | $\mu\text{A}$ |
| $I_{ASL}$                       | Address-select low-input current (AS)                                                        |                                                           | -10 |     |          | $\mu\text{A}$ |
| $V_{ADC}$                       | ADC input voltage                                                                            | See <a href="#">Table 11</a>                              | 0   |     | $V_{CC}$ | V             |
| $I_{ADH}$                       | ADC high-level input current                                                                 | $V_{ADC} = V_{CC}$                                        |     |     | 10       | $\mu\text{A}$ |
| $I_{ADL}$                       | ADC low-level input current                                                                  | $V_{ADC} = 0\text{ V}$                                    | -10 |     |          | $\mu\text{A}$ |
| $V_{OL}$                        | Low-level output voltage (SDA)                                                               | $V_{CC} = 5\text{ V}$ , $I_{OL} = 3\text{ mA}$            |     |     | 0.4      | V             |
| $I_{SDAH}$                      | High-level output leakage current (SDA)                                                      | $V_{SDA} = 5.5\text{ V}$                                  |     |     | 10       | $\mu\text{A}$ |
| $f_{SCL}$                       | Clock frequency (SCL)                                                                        |                                                           |     | 100 | 400      | kHz           |
| $t_{HD-DAT}$                    | Data hold time                                                                               | See <a href="#">Figure 24</a>                             | 0   |     | 0.9      | $\mu\text{s}$ |
| $t_{BUF}$                       | Bus free time                                                                                |                                                           | 1.3 |     |          | $\mu\text{s}$ |
| $t_{HD-STA}$                    | Start hold time                                                                              |                                                           | 0.6 |     |          | $\mu\text{s}$ |
| $t_{LOW}$                       | SCL-low hold time                                                                            |                                                           | 1.3 |     |          | $\mu\text{s}$ |
| $t_{HIGH}$                      | SCL-high hold time                                                                           |                                                           | 0.6 |     |          | $\mu\text{s}$ |
| $t_{SU-STA}$                    | Start setup time                                                                             |                                                           | 0.6 |     |          | $\mu\text{s}$ |
| $t_{SU-DAT}$                    | Data setup time                                                                              |                                                           | 0.1 |     |          | $\mu\text{s}$ |
| $t_r$                           | Rise time (SCL, SDA )                                                                        |                                                           |     |     | 0.3      | $\mu\text{s}$ |
| $t_f$                           | Fall time (SCL, SDA)                                                                         |                                                           |     |     | 0.3      | $\mu\text{s}$ |
| $t_{SU-STO}$                    | Stop setup time                                                                              |                                                           | 0.6 |     |          | $\mu\text{s}$ |



## PLL and Band Switch

 $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ,  $T_A = -20^{\circ}\text{C to }85^{\circ}\text{C}$  (unless otherwise noted)

| PARAMETER    |                                              | TEST CONDITIONS                                                                  | MIN | TYP  | MAX   | UNIT          |
|--------------|----------------------------------------------|----------------------------------------------------------------------------------|-----|------|-------|---------------|
| N            | Divider ratio                                | 15-bit frequency word                                                            | 512 |      | 32767 |               |
| $f_{XTAL}$   | Crystal oscillator frequency                 | $R_{XTAL} = 25\ \Omega$ to $300\ \Omega$                                         |     | 4    |       | MHz           |
| $Z_{XTAL}$   | Crystal oscillator input impedance           |                                                                                  | 1.6 | 2.4  |       | k $\Omega$    |
| $V_{XLO}$    | XTALOUT output voltage                       | Load = 10 pF/5.1 k $\Omega$ , $V_{CC} = 5\text{ V}$ , $T_A = 25^{\circ}\text{C}$ |     | 0.48 |       | Vp-p          |
| $V_{VTUL}$   | Tuning amplifier low-level output voltage    | $R_L = 20\text{ k}\Omega$ , $VTU = 30\text{ V}$                                  | 0.2 | 0.3  | 0.46  | V             |
| $I_{VTUOFF}$ | Tuning amplifier leakage current             | Tuning amplifier = off, $VTU = 30\text{ V}$                                      |     |      | 10    | $\mu\text{A}$ |
| $I_{CP11}$   | Charge-pump current                          | CP[2:0] = 011                                                                    |     | 600  |       | $\mu\text{A}$ |
| $I_{CP10}$   |                                              | CP[2:0] = 010                                                                    |     | 350  |       |               |
| $I_{CP01}$   |                                              | CP[2:0] = 001                                                                    |     | 140  |       |               |
| $I_{CP00}$   |                                              | CP[2:0] = 000                                                                    |     | 70   |       |               |
| $I_{CP100}$  |                                              | CP[2:0] = 100, Mode = 1                                                          |     | 900  |       |               |
| $V_{CP}$     | Charge-pump output voltage                   | PLL locked                                                                       |     | 1.95 |       | V             |
| $I_{CPOFF}$  | Charge-pump leakage current                  | $V_{CP} = 2\text{ V}$ , $T_A = 25^{\circ}\text{C}$                               | -15 |      | 15    | nA            |
| $I_{BS}$     | Band switch driver output current (BS1–BS4)  |                                                                                  |     |      | 10    | mA            |
| $V_{BS1}$    | Band switch driver output voltage (BS1–BS4)  | $I_{BS} = 10\text{ mA}$                                                          |     | 3    |       | V             |
| $V_{BS2}$    |                                              | $I_{BS} = 10\text{ mA}$ , $V_{CC} = 5\text{ V}$ , $T_A = 25^{\circ}\text{C}$     | 3.5 | 3.7  |       |               |
| $I_{BSOFF}$  | Band switch driver leakage current (BS1–BS4) | $V_{BS} = 0\text{ V}$                                                            |     |      | 8     | $\mu\text{A}$ |
| $I_{P5}$     | Band switch port sink current (P5/ADC)       |                                                                                  |     |      | -5    | mA            |
| $V_{P5ON}$   | Band switch port output voltage (P5/ADC)     | $I_{P5} = -2\text{ mA}$ , $V_{CC} = 5\text{ V}$ , $T_A = 25^{\circ}\text{C}$     |     |      | 0.6   | V             |

## RF AGC<sup>(1)</sup>

 $V_{CC} = 5\text{ V}$ ,  $T_A = 25^{\circ}\text{C}$ , measured in [Figure 25](#) reference measurement circuit at 50- $\Omega$  system,  $I_F = 44\text{ MHz}$ , IF filter characteristics:  $f_{peak} = 44\text{ MHz}$  (unless otherwise noted)

| PARAMETER      |                                          | TEST CONDITIONS | MIN | TYP | MAX | UNIT             |
|----------------|------------------------------------------|-----------------|-----|-----|-----|------------------|
| $I_{OAGC0}$    | RF AGCOUT output source current          | ATC = 0         |     | 300 |     | nA               |
| $I_{OAGC1}$    |                                          | ATC = 1         |     | 9   |     | $\mu\text{A}$    |
| $I_{OAGCSINK}$ | RF AGCOUT peak output sink current       | ATC = 0         |     | 100 |     | $\mu\text{A}$    |
| $V_{OAGCH}$    | RFAGCOUT output high voltage (max level) | ATC = 1         | 3.5 | 4   | 4.5 | V                |
| $V_{OAGCL}$    | RFAGCOUT output low voltage (min level)  | ATC = 1         |     | 0.3 |     | V                |
| $I_{AGCBUF}$   | RFAGCBUF output current                  | ATC = 0         |     | 1.5 |     | mA               |
| $V_{OAGCBFH}$  | RFAGCBUF output high voltage (max level) | ATC = 1         | 3.5 | 4   | 4.5 | V                |
| $V_{OAGCBFL}$  | RFAGCBUF output low voltage (min level)  | ATC = 1         |     | 0.3 |     | V                |
| $V_{AGCSP00}$  | Start-point IF output level              | ATP[2:0] = 000  |     | 114 |     | dB $\mu\text{V}$ |
| $V_{AGCSP01}$  |                                          | ATP[2:0] = 001  |     | 112 |     |                  |
| $V_{AGCSP02}$  |                                          | ATP[2:0] = 010  |     | 110 |     |                  |
| $V_{AGCSP03}$  |                                          | ATP[2:0] = 011  |     | 108 |     |                  |
| $V_{AGCSP04}$  |                                          | ATP[2:0] = 100  |     | 106 |     |                  |
| $V_{AGCSP05}$  |                                          | ATP[2:0] = 101  |     | 104 |     |                  |
| $V_{AGCSP06}$  |                                          | ATP[2:0] = 110  |     | 102 |     |                  |

(1) When AISL=1, RF AGC function is not available at VHF-L band (output level is undefined).

## Mixer, Oscillator, IF Amplifier (DIF OUT)

$V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , measured in [Figure 25](#) reference measurement circuit at 50- $\Omega$  system, IF = 44 MHz, IF filter characteristics:  $f_{\text{peak}} = 44\text{ MHz}$  (unless otherwise noted)

| PARAMETER              |                                                                | TEST CONDITIONS                        | TYP | UNIT             |
|------------------------|----------------------------------------------------------------|----------------------------------------|-----|------------------|
| $G_{C1D}$              | Conversion gain (mixer-IF amplifier), VHF-LOW                  | $f_{\text{in}} = 57\text{ MHz}^{(1)}$  | 35  | dB               |
| $G_{C3D}$              |                                                                | $f_{\text{in}} = 171\text{ MHz}^{(1)}$ | 35  |                  |
| $G_{C4D}$              | Conversion gain (mixer-IF amplifier), VHF-HIGH                 | $f_{\text{in}} = 177\text{ MHz}^{(1)}$ | 35  | dB               |
| $G_{C6D}$              |                                                                | $f_{\text{in}} = 467\text{ MHz}^{(1)}$ | 35  |                  |
| $G_{C7D}$              | Conversion gain (mixer-IF amplifier), UHF                      | $f_{\text{in}} = 473\text{ MHz}^{(1)}$ | 35  | dB               |
| $G_{C9D}$              |                                                                | $f_{\text{in}} = 864\text{ MHz}^{(1)}$ | 35  |                  |
| $NF_{1D}$              | Noise figure, VHF-LOW                                          | $f_{\text{in}} = 57\text{ MHz}$        | 9   | dB               |
| $NF_{3D}$              |                                                                | $f_{\text{in}} = 171\text{ MHz}$       | 9   |                  |
| $NF_{4D}$              | Noise figure, VHF-HIGH                                         | $f_{\text{in}} = 177\text{ MHz}$       | 9   | dB               |
| $NF_{6D}$              |                                                                | $f_{\text{in}} = 467\text{ MHz}$       | 10  |                  |
| $NF_{7D}$              | Noise figure, UHF                                              | $f_{\text{in}} = 473\text{ MHz}$       | 10  | dB               |
| $NF_{9D}$              |                                                                | $f_{\text{in}} = 864\text{ MHz}$       | 12  |                  |
| $CM_{1D}$              | Input voltage causing 1% cross-modulation distortion, VHF-LOW  | $f_{\text{in}} = 57\text{ MHz}^{(2)}$  | 79  | dB $\mu\text{V}$ |
| $CM_{3D}$              |                                                                | $f_{\text{in}} = 171\text{ MHz}^{(2)}$ | 79  |                  |
| $CM_{4D}$              | Input voltage causing 1% cross-modulation distortion, VHF-HIGH | $f_{\text{in}} = 177\text{ MHz}^{(2)}$ | 79  | dB $\mu\text{V}$ |
| $CM_{6D}$              |                                                                | $f_{\text{in}} = 467\text{ MHz}^{(2)}$ | 79  |                  |
| $CM_{7D}$              | Input voltage causing 1% cross-modulation distortion, UHF      | $f_{\text{in}} = 473\text{ MHz}^{(2)}$ | 77  | dB $\mu\text{V}$ |
| $CM_{9D}$              |                                                                | $f_{\text{in}} = 864\text{ MHz}^{(2)}$ | 77  |                  |
| $V_{\text{IFO1D}}$     | IF output voltage, VHF-LOW                                     | $f_{\text{in}} = 57\text{ MHz}$        | 117 | dB $\mu\text{V}$ |
| $V_{\text{IFO3D}}$     |                                                                | $f_{\text{in}} = 171\text{ MHz}$       | 117 |                  |
| $V_{\text{IFO4D}}$     | IF output voltage, VHF-HIGH                                    | $f_{\text{in}} = 177\text{ MHz}$       | 117 | dB $\mu\text{V}$ |
| $V_{\text{IFO6D}}$     |                                                                | $f_{\text{in}} = 467\text{ MHz}$       | 117 |                  |
| $V_{\text{IFO7D}}$     | IF output voltage, UHF                                         | $f_{\text{in}} = 473\text{ MHz}$       | 117 | dB $\mu\text{V}$ |
| $V_{\text{IFO9D}}$     |                                                                | $f_{\text{in}} = 864\text{ MHz}$       | 117 |                  |
| $\Phi_{\text{PLVL1D}}$ | Phase noise, VHF-LOW                                           | $f_{\text{in}} = 57\text{ MHz}^{(3)}$  | -90 | dBc/Hz           |
| $\Phi_{\text{PLVL3D}}$ |                                                                | $f_{\text{in}} = 171\text{ MHz}^{(4)}$ | -85 |                  |
| $\Phi_{\text{PLVL4D}}$ | Phase noise, VHF-HIGH                                          | $f_{\text{in}} = 177\text{ MHz}^{(3)}$ | -85 | dBc/Hz           |
| $\Phi_{\text{PLVL6D}}$ |                                                                | $f_{\text{in}} = 467\text{ MHz}^{(4)}$ | -77 |                  |
| $\Phi_{\text{PLVL7D}}$ | Phase noise, UHF                                               | $f_{\text{in}} = 473\text{ MHz}^{(3)}$ | -80 | dBc/Hz           |
| $\Phi_{\text{PLVL9D}}$ |                                                                | $f_{\text{in}} = 864\text{ MHz}^{(4)}$ | -77 |                  |

(1) IF = 44 MHz, RF input level = 70 dB $\mu\text{V}$ , differential output

(2)  $f_{\text{undes}} = f_{\text{des}} \pm 6\text{ MHz}$ ,  $P_{\text{in}} = 70\text{ dB}\mu\text{V}$ , AM 1 kHz, 30%, DES/CM = S/I = 46 dB

(3) Offset = 1 kHz, CP current = 350  $\mu\text{A}$ , reference divider = 64

(4) Offset = 1 kHz, CP current = 900  $\mu\text{A}$ , reference divider = 64

## Mixer, Oscillator, IF Amplifier (AIF OUT)

$V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , measured in [Figure 25](#) reference measurement circuit at 50- $\Omega$  system, IF = 45.75 MHz,  
IF filter characteristics:  $f_{\text{peak}} = 44\text{ MHz}$  (unless otherwise noted)

| PARAMETER              |                                                                | TEST CONDITIONS                           | TYP | UNIT             |
|------------------------|----------------------------------------------------------------|-------------------------------------------|-----|------------------|
| $G_{C1A}$              | Conversion gain (mixer-IF amplifier), VHF-LOW                  | $f_{\text{in}} = 55.25\text{ MHz}^{(1)}$  | 29  | dB               |
| $G_{C3A}$              |                                                                | $f_{\text{in}} = 169.25\text{ MHz}^{(1)}$ | 29  |                  |
| $G_{C4A}$              | Conversion gain (mixer-IF amplifier), VHF-HIGH                 | $f_{\text{in}} = 175.25\text{ MHz}^{(1)}$ | 29  | dB               |
| $G_{C6A}$              |                                                                | $f_{\text{in}} = 465.25\text{ MHz}^{(1)}$ | 29  |                  |
| $G_{C7A}$              | Conversion gain (mixer-IF amplifier), UHF                      | $f_{\text{in}} = 471.25\text{ MHz}^{(1)}$ | 29  | dB               |
| $G_{C9A}$              |                                                                | $f_{\text{in}} = 862.25\text{ MHz}^{(1)}$ | 29  |                  |
| $NF_{1A}$              | Noise figure, VHF-LOW                                          | $f_{\text{in}} = 55.25\text{ MHz}$        | 9   | dB               |
| $NF_{3A}$              |                                                                | $f_{\text{in}} = 169.25\text{ MHz}$       | 9   |                  |
| $NF_{4A}$              | Noise figure, VHF-HIGH                                         | $f_{\text{in}} = 175.25\text{ MHz}$       | 9   | dB               |
| $NF_{6A}$              |                                                                | $f_{\text{in}} = 465.25\text{ MHz}$       | 10  |                  |
| $NF_{7A}$              | Noise figure, UHF                                              | $f_{\text{in}} = 471.25\text{ MHz}$       | 10  | dB               |
| $NF_{9A}$              |                                                                | $f_{\text{in}} = 862.25\text{ MHz}$       | 12  |                  |
| $CM_{1A}$              | Input voltage causing 1% cross-modulation distortion, VHF-LOW  | $f_{\text{in}} = 55.25\text{ MHz}^{(2)}$  | 79  | dB $\mu\text{V}$ |
| $CM_{3A}$              |                                                                | $f_{\text{in}} = 169.25\text{ MHz}^{(2)}$ | 79  |                  |
| $CM_{4A}$              | Input voltage causing 1% cross-modulation distortion, VHF-HIGH | $f_{\text{in}} = 175.25\text{ MHz}^{(2)}$ | 79  | dB $\mu\text{V}$ |
| $CM_{6A}$              |                                                                | $f_{\text{in}} = 465.25\text{ MHz}^{(2)}$ | 79  |                  |
| $CM_{7A}$              | Input voltage causing 1% cross-modulation distortion, UHF      | $f_{\text{in}} = 471.25\text{ MHz}^{(2)}$ | 79  | dB $\mu\text{V}$ |
| $CM_{9A}$              |                                                                | $f_{\text{in}} = 862.25\text{ MHz}^{(2)}$ | 77  |                  |
| $V_{\text{IFO1A}}$     | IF output voltage, VHF-LOW                                     | $f_{\text{in}} = 55.25\text{ MHz}$        | 117 | dB $\mu\text{V}$ |
| $V_{\text{IFO3A}}$     |                                                                | $f_{\text{in}} = 169.25\text{ MHz}$       | 117 |                  |
| $V_{\text{IFO4A}}$     | IF output voltage, VHF-HIGH                                    | $f_{\text{in}} = 175.25\text{ MHz}$       | 117 | dB $\mu\text{V}$ |
| $V_{\text{IFO6A}}$     |                                                                | $f_{\text{in}} = 465.25\text{ MHz}$       | 117 |                  |
| $V_{\text{IFO7A}}$     | IF output voltage, UHF                                         | $f_{\text{in}} = 471.25\text{ MHz}$       | 117 | dB $\mu\text{V}$ |
| $V_{\text{IFO9A}}$     |                                                                | $f_{\text{in}} = 862.25\text{ MHz}$       | 117 |                  |
| $\Phi_{\text{PLVL1A}}$ | Phase noise, VHF-LOW                                           | $f_{\text{in}} = 55.25\text{ MHz}^{(3)}$  | -95 | dBc/Hz           |
| $\Phi_{\text{PLVL3A}}$ |                                                                | $f_{\text{in}} = 169.25\text{ MHz}^{(3)}$ | -95 |                  |
| $\Phi_{\text{PLVL4A}}$ | Phase noise, VHF-HIGH                                          | $f_{\text{in}} = 175.25\text{ MHz}^{(3)}$ | -90 | dBc/Hz           |
| $\Phi_{\text{PLVL6A}}$ |                                                                | $f_{\text{in}} = 465.25\text{ MHz}^{(3)}$ | -90 |                  |
| $\Phi_{\text{PLVL7A}}$ | Phase noise, UHF                                               | $f_{\text{in}} = 471.25\text{ MHz}^{(3)}$ | -85 | dBc/Hz           |
| $\Phi_{\text{PLVL9A}}$ |                                                                | $f_{\text{in}} = 862.25\text{ MHz}^{(3)}$ | -90 |                  |

(1) IF = 44 MHz, RF input level = 70 dB $\mu\text{V}$

(2)  $f_{\text{undes}} = f_{\text{des}} \pm 6\text{ MHz}$ ,  $P_{\text{in}} = 70\text{ dB}\mu\text{V}$ , AM 1 kHz, 30%, DES/CM = S/I = 46 dB

(3) Offset = 10 kHz, CP current = 70  $\mu\text{A}$ , reference divider = 128

## IF Gain Controlled Amplifier

$V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , measured in [Figure 25](#) reference measurement circuit at 50- $\Omega$  system,  $f_F = 44\text{ MHz}$  (unless otherwise noted)

| PARAMETER      |                                              | TEST CONDITIONS                                                                                                                      | MIN | TYP | MAX      | UNIT          |
|----------------|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-----|-----|----------|---------------|
| $I_{IFGCA}$    | Input current (IF GCA CTRL)                  | $V_{IFGCA} = 3\text{ V}$                                                                                                             |     | 30  | 60       | $\mu\text{A}$ |
| $V_{IFGCAMAX}$ | Maximum gain control voltage                 | Gain maximum                                                                                                                         | 3   |     | $V_{CC}$ | V             |
| $V_{IFGCAMIN}$ | Minimum gain control voltage                 | Gain minimum                                                                                                                         | 0   |     | 0.2      | V             |
| $G_{IFGCAMAX}$ | Maximum gain                                 | $V_{IFGCA} = 3\text{ V}$                                                                                                             |     | 65  |          | dB            |
| $G_{IFGCAMIN}$ | Minimum gain                                 | $V_{IFGCA} = 0\text{ V}$                                                                                                             |     | -1  |          | dB            |
| $GCR_{IFGCA}$  | Gain control range                           | $V_{IFGCA} = 0\text{ V to } 3\text{ V}$                                                                                              |     | 66  |          | dB            |
| $V_{IFGCAOUT}$ | Output voltage                               | Single-ended output,<br>$V_{IFGCA} = 3\text{ V}$                                                                                     |     | 2.1 |          | Vp-p          |
| $NF_{IFGCA}$   | Noise figure                                 | $V_{IFGCA} = 3\text{ V}$                                                                                                             |     | 11  |          | dB            |
| $IM3_{IFGCA}$  | Third order intermodulation distortion       | $f_{IFGCAIN1} = 43\text{ MHz}$ ,<br>$f_{IFGCAIN2} = 44\text{ MHz}$ ,<br>$V_{IFGCAOUT} = -2\text{ dBm}$ ,<br>$V_{IFGCA} = 3\text{ V}$ |     | -50 |          | dBc           |
| $IIP3_{IFGCA}$ | Input intercept point                        | $V_{IFGCA} = 0\text{ V}$                                                                                                             |     | 11  |          | dBm           |
| $R_{IFGCAIN}$  | Input resistance (IF GCA IN1, IF GCA IN2)    |                                                                                                                                      |     | 1   |          | k $\Omega$    |
| $R_{IFGCAOUT}$ | Output resistance (IF GCA OUT1, IF GCA OUT2) |                                                                                                                                      |     | 25  |          | $\Omega$      |

## FUNCTIONAL DESCRIPTION

### I<sup>2</sup>C Bus Mode

#### I<sup>2</sup>C Write Mode ( $\overline{R/W} = 0$ )

**Table 2. Write Data Format**

|                       | MSB |     |      |      |           |         |        | LSB                  |                  |
|-----------------------|-----|-----|------|------|-----------|---------|--------|----------------------|------------------|
| Address byte (ADB)    | 1   | 1   | 0    | 0    | 0         | MA1     | MA0    | $\overline{R/W} = 0$ | A <sup>(1)</sup> |
| Divider byte 1 (DB1)  | 0   | N14 | N13  | N12  | N11       | N10     | N9     | N8                   | A <sup>(1)</sup> |
| Divider byte 2 (DB2)  | N7  | N6  | N5   | N4   | N3        | N2      | N1     | N0                   | A <sup>(1)</sup> |
| Control byte 1 (CB1)  | 1   | 0   | ATP2 | ATP1 | ATP0      | RS2     | RS1    | RS0                  | A <sup>(1)</sup> |
| Band switch byte (BB) | CP1 | CP0 | AISL | P5   | BS4       | BS3     | BS2    | BS1                  | A <sup>(1)</sup> |
| Control byte 2 (CB2)  | 1   | 1   | ATC  | MODE | T3/DISGCA | T2/IFDA | T1/CP2 | T0/XLO               | A <sup>(1)</sup> |

(1) A : acknowledge

**Table 3. Write Data Symbol Description**

| SYMBOL                                           | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                         | DEFAULT                                                               |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|-----|--|---|---|--------|---|---|--------|---|---|-----|---|---|-----------------------------------------------------------------------|---------|
| MA[1:0]                                          | Address-set bits (see <a href="#">Table 4</a> )                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                       |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| N[14:0]                                          | Programmable counter set bits<br>$N = N14 \times 2^{14} + N13 \times 2^{13} + \dots + N1 \times 2 + N0$                                                                                                                                                                                                                                                                                                                                                             | $N14 = N13 = N12 = \dots = N0 = 0$                                    |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| ATP[2:0]                                         | RF AGC start-point control bits (see <a href="#">Table 5</a> )                                                                                                                                                                                                                                                                                                                                                                                                      | ATP[2:0] = 000                                                        |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| RS[2:0]                                          | Reference divider ratio-selection bits (see <a href="#">Table 6</a> )                                                                                                                                                                                                                                                                                                                                                                                               | RS[2:0] = 000                                                         |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| CP[1:0]                                          | Charge-pump current-set bit (see <a href="#">Table 7</a> )                                                                                                                                                                                                                                                                                                                                                                                                          | CP[1:0] = 00                                                          |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| AISL <sup>(1)</sup>                              | RF AGC detector input selection bit<br>AISL = 0: IF amplifier<br>AISL = 1: Mixer output                                                                                                                                                                                                                                                                                                                                                                             | AISL = 0                                                              |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| P5                                               | Port output/ADC input control bit<br>P5 = 0: ADC INPUT<br>P5 = 1: Tr = ON                                                                                                                                                                                                                                                                                                                                                                                           | P5 = 0                                                                |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| BS[4:1]                                          | Band switch control bits<br>BSn = 0: Tr = OFF<br>BSn = 1: Tr = ON<br><br>Band selection by BS[1:2]<br><table border="1"> <thead> <tr> <th>BS1</th><th>BS2</th><th></th></tr> </thead> <tbody> <tr> <td>1</td><td>0</td><td>VHF-LO</td></tr> <tr> <td>0</td><td>1</td><td>VHF-HI</td></tr> <tr> <td>0</td><td>0</td><td>UHF</td></tr> <tr> <td>1</td><td>1</td><td>Standby mode/stop MOP function (XTALOUT is available in standby mode)</td></tr> </tbody> </table> | BS1                                                                   | BS2 |  | 1 | 0 | VHF-LO | 0 | 1 | VHF-HI | 0 | 0 | UHF | 1 | 1 | Standby mode/stop MOP function (XTALOUT is available in standby mode) | BSn = 0 |
| BS1                                              | BS2                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                       |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| 1                                                | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | VHF-LO                                                                |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| 0                                                | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | VHF-HI                                                                |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| 0                                                | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | UHF                                                                   |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| 1                                                | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Standby mode/stop MOP function (XTALOUT is available in standby mode) |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| ATC                                              | RF AGC current-set bit<br>ATC = 0: Current = 300 nA<br>ATC = 1: Current = 9 $\mu$ A                                                                                                                                                                                                                                                                                                                                                                                 | ATC = 0                                                               |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |
| Mode<br>T3/DISGCA<br>T2/IFDA<br>T1/CP2<br>T0/XLO | Mode = 0 : IFGCA enabled, DIFOUT1, 2 selected<br>T3/DISGCA, T2/IFDA, T1/CP2, T0/XLO are Test bits and XTALOUT control bit (see <a href="#">Table 8</a> )<br><br>Mode = 1 : T3/DISGCA = 0 : IF GCA enabled<br>T3/DISGCA = 1 : IF GCA disabled<br>T2/IFDA = 0 : DIFOUT1, 2 selected<br>T2/IFDA = 1 : AIFOUT selected<br>T1/CP2 : lcp control bit, See <a href="#">Table 7</a><br>T0/XLO = 0 : XTALOUT enabled<br>T0/XLO = 1 : XTALOUT disabled                        | MODE = 0<br>T[3:0] = 0000                                             |     |  |   |   |        |   |   |        |   |   |     |   |   |                                                                       |         |

(1) When AISL = 1, RF AGC function is not available at VHF-L band (Output level is undefined.)

**Table 4. Address Selection**

| MA1 | MA0 | VOLTAGE APPLIED ON AS INPUT                                |
|-----|-----|------------------------------------------------------------|
| 0   | 0   | 0 V to 0.1 V <sub>CC</sub> (Low)                           |
| 0   | 1   | OPEN, or 0.2 V <sub>CC</sub> to 0.3 V <sub>CC</sub> (Mid2) |
| 1   | 0   | 0.4 V <sub>CC</sub> to 0.6 V <sub>CC</sub> (Mid1)          |
| 1   | 1   | 0.9 V <sub>CC</sub> to V <sub>CC</sub> (High)              |

**Table 5. RF AGC Start Point<sup>(1)</sup>**

| ATP2 | ATP1 | ATP0 | IFOUT LEVEL (dBμV) |
|------|------|------|--------------------|
| 0    | 0    | 0    | 114                |
| 0    | 0    | 1    | 112                |
| 0    | 1    | 0    | 110                |
| 0    | 1    | 1    | 108                |
| 1    | 0    | 0    | 106                |
| 1    | 0    | 1    | 104                |
| 1    | 1    | 0    | 102                |
| 1    | 1    | 1    | Disabled           |

(1) When AISL=1, RF AGC function is not available at VHF-L band (output level is undefined).

**Table 6. Reference Divider Ratio**

| RS2 | RS1 | RS0 | REFERENCE DIVIDER RATIO |
|-----|-----|-----|-------------------------|
| 0   | 0   | 0   | 24                      |
| 0   | 0   | 1   | 28                      |
| 0   | 1   | 0   | 32                      |
| 0   | 1   | 1   | 64                      |
| 1   | 0   | 0   | 128                     |
| 1   | X   | 1   | 80                      |

**Table 7. Charge-Pump Current**

| MODE | CP2 | CP1 | CP0 | CHARGE PUMP CURRENT (μA) |
|------|-----|-----|-----|--------------------------|
| X    | 0   | 0   | 0   | 70                       |
| X    | 0   | 0   | 1   | 140                      |
| X    | 0   | 1   | 0   | 350                      |
| X    | 0   | 1   | 1   | 600                      |
| 1    | 1   | 0   | 0   | 900                      |

**Table 8. Test Bits/XTALOUT Control <sup>(1)</sup>**

| MODE | T3/DISGCA | T2/IFDA | T1/CP2 | T0/XLO | DEVICE OPERATION | XTALOUT<br>4-MHz OUTPUT |
|------|-----------|---------|--------|--------|------------------|-------------------------|
| 0    | 0         | 0       | 0      | 0      | Normal operation | Enabled                 |
| 0    | 0         | 0       | 0      | 1      | Normal operation | Disabled                |
| 1    | X         | X       | X      | 0      | Normal operation | Enabled                 |
| 1    | X         | X       | X      | 1      | Normal operation | Disabled                |
| 0    | X         | 1       | X      | X      | Test mode        | Not available           |
| 0    | 1         | X       | X      | X      | Test mode        | Not available           |

(1) RFAGC and XTALOUT are not available in test mode.

## I<sup>2</sup>C Read Mode (R/W = 1)

**Table 9. Read Data Format**

|                    | MSB |    |   |   |   |     |     | LSB     |                  |
|--------------------|-----|----|---|---|---|-----|-----|---------|------------------|
| Address byte (ADB) | 1   | 1  | 0 | 0 | 0 | MA1 | MA0 | R/W = 1 | A <sup>(1)</sup> |
| Status byte (SB)   | POR | FL | 1 | 1 | X | A2  | A1  | A0      | –                |

(1) A : acknowledge

**Table 10. Read Data Symbol Description**

| SYMBOL            | DESCRIPTION                                                                               | DEFAULT |
|-------------------|-------------------------------------------------------------------------------------------|---------|
| MA[1:0]           | Address-set bits (see Table 4)                                                            |         |
| POR               | Power-on reset flag<br>POR set: power on<br>POR reset: end-of-data transmission procedure | POR = 1 |
| FL <sup>(1)</sup> | In-lock flag<br>PLL locked (FL=1), Unlocked (FL=0)                                        |         |
| A[2:0]            | Digital data of ADC (see Table 11)<br>Bit P5 must be set to 0.                            |         |

(1) Lock detector works by using phase error pulse at the phase detector. Lock flag (FL) is set or reset according to this pulse width discriminator. Hence unstableness of PLL may cause the lock detect circuit to malfunction. In order to stable PLL, it is required to evaluate application circuit in various condition of loop-gain (loop filter, CP current), and to verify with whole conditions of actual application.

**Table 11. Address Selection<sup>(1)</sup>**

| A2 | A1 | A0 | VOLTAGE APPLIED ON ADC<br>INPUT             |
|----|----|----|---------------------------------------------|
| 1  | 0  | 0  | 0.6 V <sub>CC</sub> to V <sub>CC</sub>      |
| 0  | 1  | 1  | 0.45 V <sub>CC</sub> to 0.6 V <sub>CC</sub> |
| 0  | 1  | 0  | 0.3 V <sub>CC</sub> to 0.45 V <sub>CC</sub> |
| 0  | 0  | 1  | 0.15 V <sub>CC</sub> to 0.3 V <sub>CC</sub> |
| 0  | 0  | 0  | 0 to 0.15 V <sub>CC</sub>                   |

(1) Accuracy is 0.03 x V<sub>CC</sub>.

## Example I<sup>2</sup>C Data Write Sequences

Telegram examples:

Start-ADB-DB1-DB2-CB1-BB-CB2-Stop

Start-ADB-DB1-DB2-Stop

Start-ADB-CB1-BB-CB2-Stop

Start-ADB-CB1-BB-Stop

Start-ADB-CB2-Stop

Abbreviations:

ADB: Address byte

BB: Band switch byte

CB1: Control byte 1

CB2: Control byte 2

DB1: Divider byte 1

DB2: Divider byte 2

Start: Start condition

Stop: Stop condition

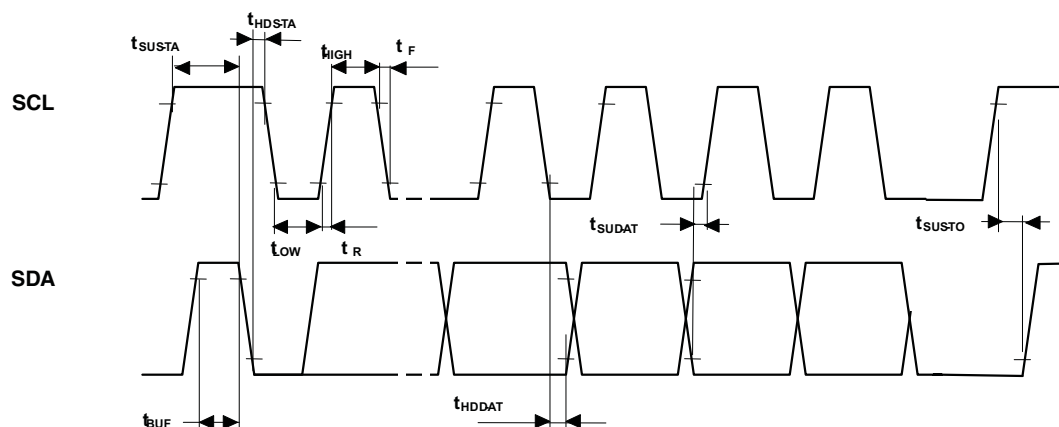
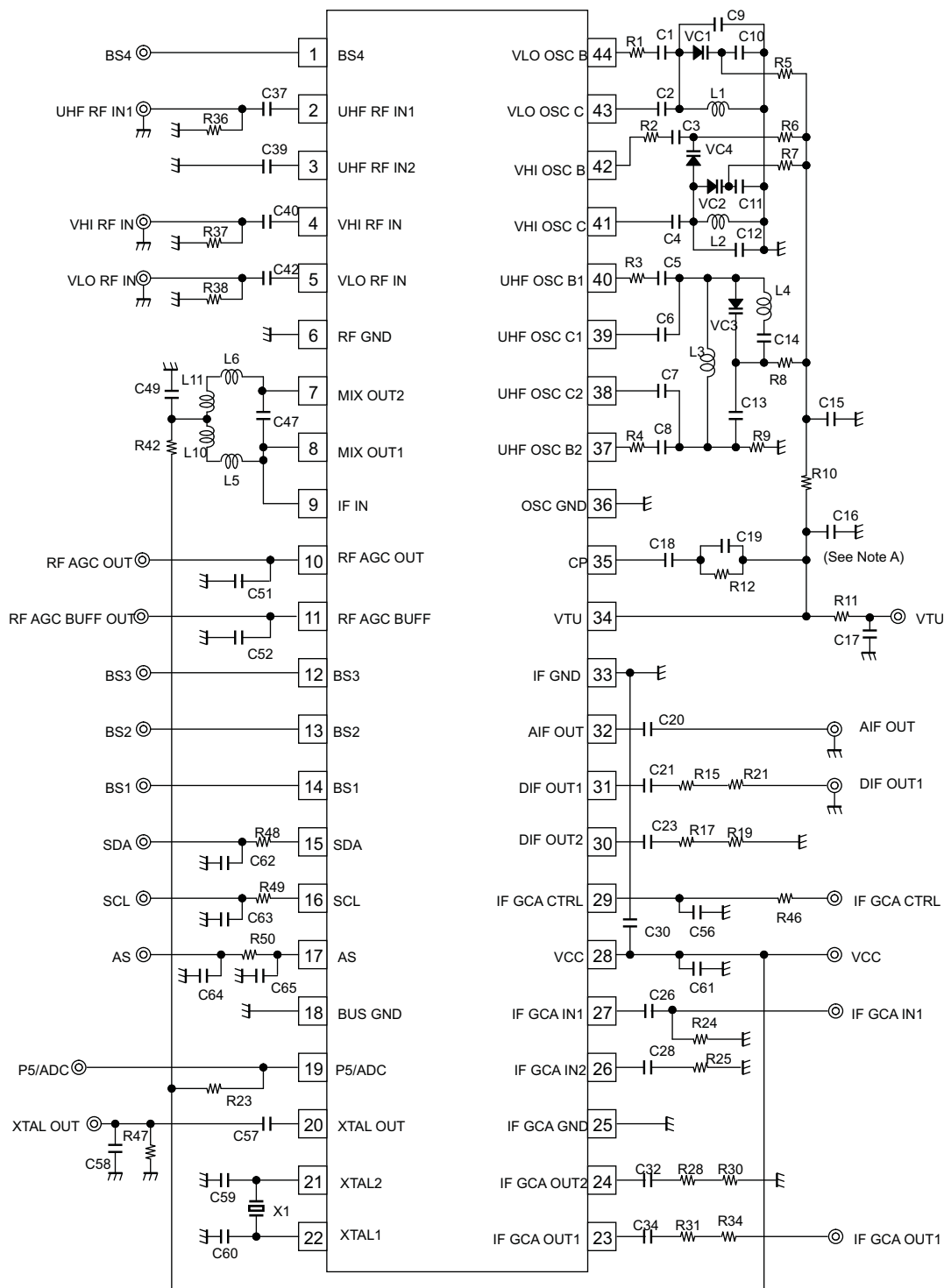


Figure 24. I<sup>2</sup>C Timing Chart



## APPLICATION INFORMATION



- To prevent abnormal oscillation, connect C16, which does not affect a PLL.
- This application information is advisory and performance-check is required at actual application circuits. TI assumes no responsibility for the consequences of use of this circuit, such as an infringement of intellectual property rights or other rights, including patents, of third parties.

**Figure 25. Reference Measurement Circuit**

**Table 12. Component Values for Measurement Circuit<sup>(1)</sup>**

| PARTS NAME        | VALUE            | PARTS NAME        | VALUE                    |
|-------------------|------------------|-------------------|--------------------------|
| C1 (VLO OSC B)    | 1 pF             | L1 (VLO OSC)      | 3.0 mm, 7T, wire 0.32 mm |
| C2 (VLO OSC C)    | 2 pF             | L2 (VHI OSC)      | 2.0 mm, 3T, wire 0.4 mm  |
| C3 (VHI OSC B)    | 7 pF             | L3 (UHF OSC)      | 1.8 mm, 3T, wire 0.4 mm  |
| C4 (VHI OSC C)    | 5 pF             | L4 (UHF OSC)      | 1.8 mm, 3T, wire 0.4 mm  |
| C5 (UHF OSCB1)    | 1.5 pF           | L5 (MIX OUT)      | 680 nH (LK1608R68K-T)    |
| C6 (UHF OSCC1)    | 1 pF             | L6 (MIX OUT)      | 680 nH (LK1608R68K-T)    |
| C7 (UHF OSCC2)    | 1 pF             | L10 (MIX OUT)     | Short                    |
| C8 (UHF OSCB2)    | 1.5 pF           | L11 (MIX OUT)     | Short                    |
| C9 (VLO OSC)      | OPEN             | R1(VLO OSC B)     | 0                        |
| C10(VLO OSC)      | 43 pF            | R2 (VHI OSC B)    | 4.7 $\Omega$             |
| C11 (VHI OSC)     | 51 pF            | R3 (UHF OSC B1)   | 4.7 $\Omega$             |
| C12 (VHI OSC)     | 0.5 pF           | R4 (UHF OSC B2)   | 0                        |
| C13 (UHF OSC)     | 10 pF            | R5 (VLO OSC)      | 3.3 k $\Omega$           |
| C14 (UHF OSC)     | 100 pF           | R6 (VHI OSC)      | 3.3 k $\Omega$           |
| C15 (VTU)         | 2.2 nF/50 V      | R7 (VHI OSC)      | 3.3 k $\Omega$           |
| C16 (CP)          | 150 pF/50 V      | R8 (UHF OSC)      | 1 k $\Omega$             |
| C17 (VTU)         | 2.2 nF/50 V      | R9 (UHF OSC)      | 2.2 k                    |
| C18(CP)           | 0.01 $\mu$ /50 V | R10 (VTU)         | 3 k $\Omega$             |
| C19(CP)           | 22 pF/50 V       | R11 (VTU)         | 20 k $\Omega$            |
| C20 (AIF OUT)     | 2.2 nF           | R12 (CP)          | 47 k $\Omega$            |
| C21 (DIF OUT1)    | 2.2 nF           | R15 (DIF OUT1)    | 200 $\Omega$             |
| C23 (DIF OUT2)    | 2.2 nF           | R17 (DIF OUT2)    | 200 $\Omega$             |
| C26 (IF GCA IN1)  | 2.2 nF           | R19 (DIF OUT2)    | 50 $\Omega$              |
| C28 (IF GCA IN2)  | 2.2 nF           | R21 (DIF OUT1)    | 0                        |
| C30 (VCC)         | 0.1 $\mu$ F      | R23 (P5/ADC)      | Open                     |
| C32 (IF GCA OUT1) | 2.2 nF           | R24 (IF GCA IN1)  | (50 $\Omega$ )           |
| C34 (IF GCA OUT2) | 2.2 nF           | R25 (IF GCA IN2)  | 0                        |
| C37 (UHF RF IN1)  | 2.2 nF           | R28 (IF GCA OUT1) | 200 $\Omega$             |
| C39 (UHF RF IN2)  | 2.2 nF           | R30 (IF GCA OUT1) | 50 $\Omega$              |
| C40 (VHI RF IN)   | 2.2 nF           | R31 (IF GCA OUT2) | 200 $\Omega$             |
| C42 (VLO RF IN)   | 2.2 nF           | R34 (IF GCA OUT2) | 0                        |
| C47 (MIX OUT)     | 6 pF             | R36 (UHF RF IN1)  | (50 $\Omega$ )           |
| C49 (MIX OUT)     | 2.2 nF           | R37 (VHI RF IN)   | (50 $\Omega$ )           |
| C51 (RF AGC OUT)  | 0.15 $\mu$ F     | R38 (VLO RF IN)   | (50 $\Omega$ )           |
| C52 (RF AGC BUF)  | Open             | R42 (MIX OUT)     | 0                        |
| C56 (IFGCA CTRL)  | 0.1 $\mu$ F      | R46 (IFGCA CTRL)  | 0                        |
| C57 (XTAL OUT)    | 0.01 $\mu$ F     | R47 (XTAL OUT)    | 5.1 k $\Omega$           |
| C58 (XTAL OUT)    | 10 pF            | R48 (SDA)         | 330 $\Omega$             |
| C59(XTAL)         | 27 pF            | R49 (SCL)         | 330 $\Omega$             |
| C60 (XTAL)        | 27 pF            | R50 (AS)          | Open                     |
| C61 (VCC)         | 2.2 nF           | VC1 (VLO OSC)     | MA2S374                  |
| C62 (SDA)         | Open             | VC2 (VHI OSC)     | MA2S374                  |
| C63 (SCL)         | Open             | VC3 (UHF OSC)     | MA2S372                  |
| C64 (AS)          | Open             | VC4 (VHI OSC)     | MA2S372                  |
| C65 (AS)          | 22 pF            | X1                | 4-MHz crystal            |

(1) IF frequency = 44 MHz Local frequency range : VHF-LOW=101~215 MHz, VHF-HIGH: 221~511 MHz, UHF: 517~908 MHz

## APPLICATION INFORMATION (CONTINUED)

### Test Circuits

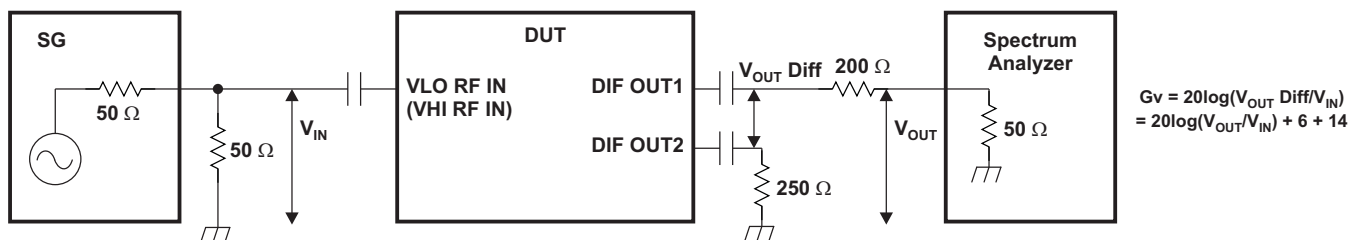


Figure 26. VHF-Conversion Gain-Measurement Circuit (at DIFOUT)

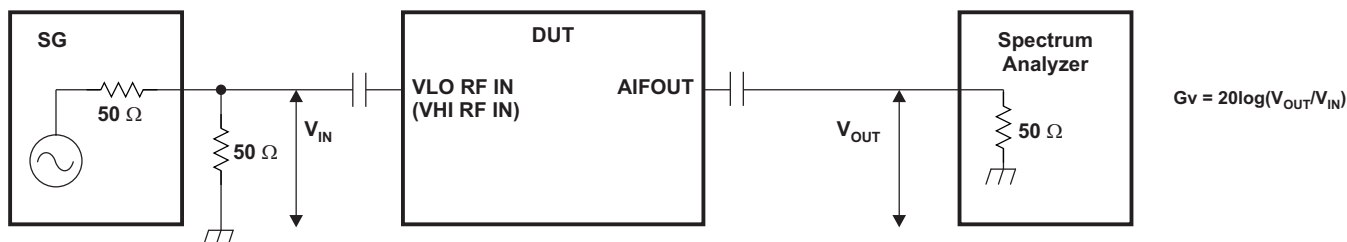


Figure 27. VHF-Conversion Gain Measurement Circuit (at AIFOUT)

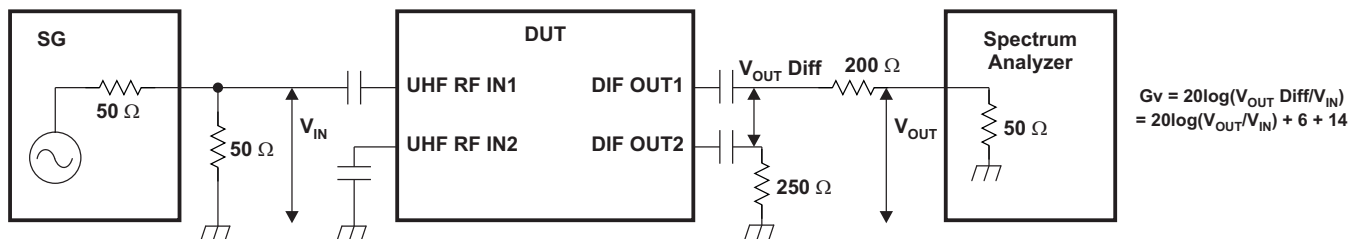


Figure 28. UHF-Conversion Gain-Measurement Circuit (at DIFOUT)

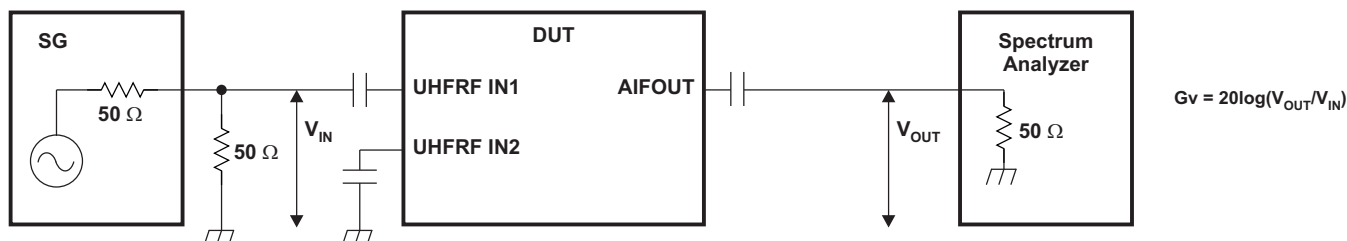


Figure 29. UHF-Conversion Gain Measurement Circuit (at AIFOUT)

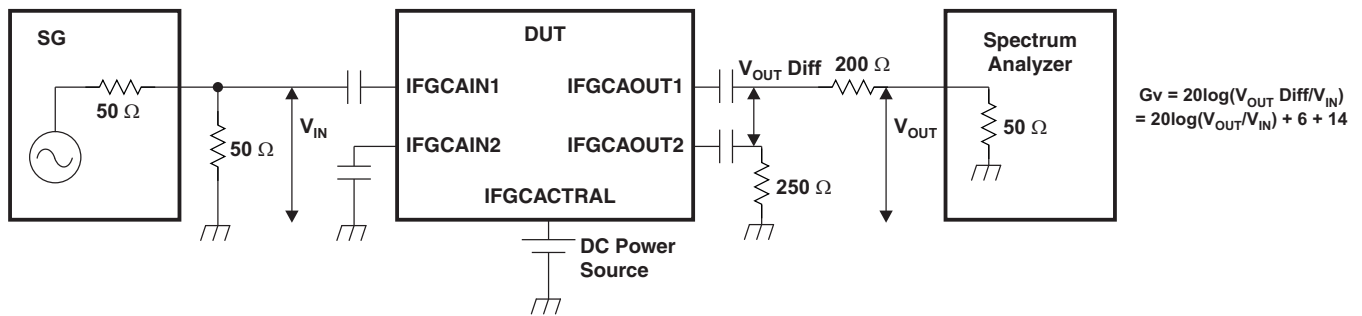


Figure 30. IF GCA Gain Measurement Circuit

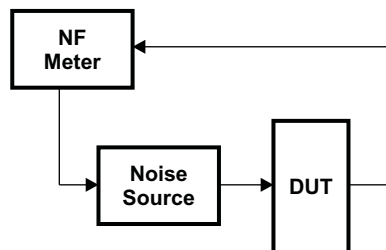


Figure 31. Noise-Figure Measurement Circuit

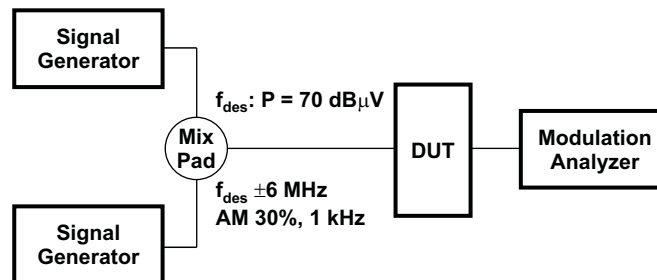


Figure 32. 1% Cross-Modulation Distortion Measurement Circuit

## TYPICAL CHARACTERISTICS

### Band Switch Driver Output Voltage (BS1–BS4)

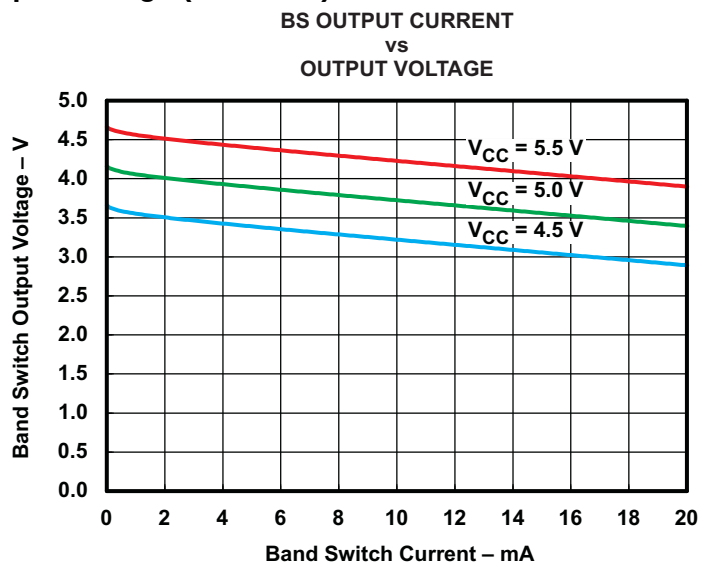


Figure 33. Band Switch Driver Output Voltage

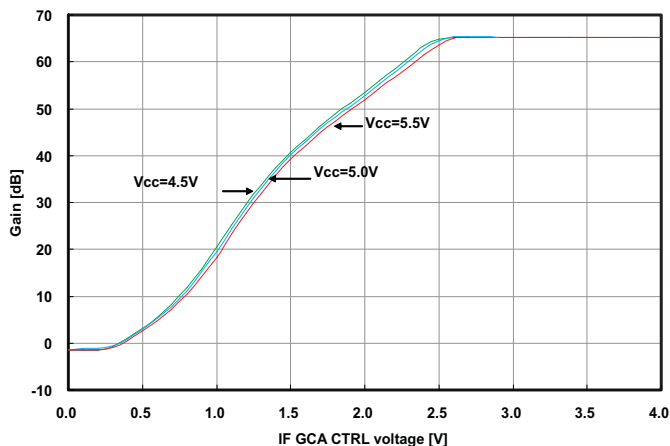


Figure 34. IF GCA Gain vs Control Voltage-1

## TYPICAL CHARACTERISTICS (continued)

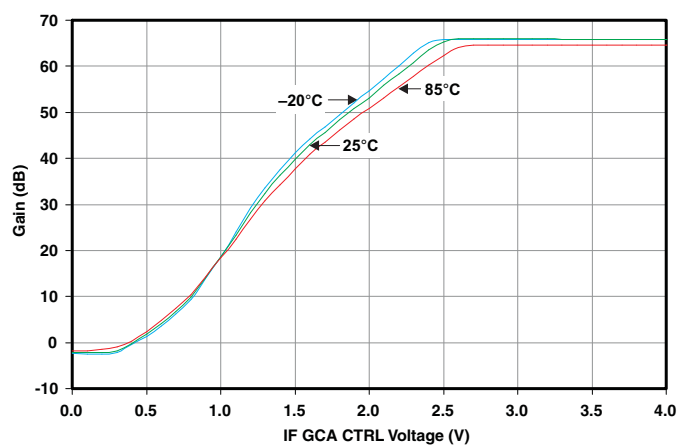


Figure 35. IF GCA Gain vs Control Voltage-2

## S-Parameter

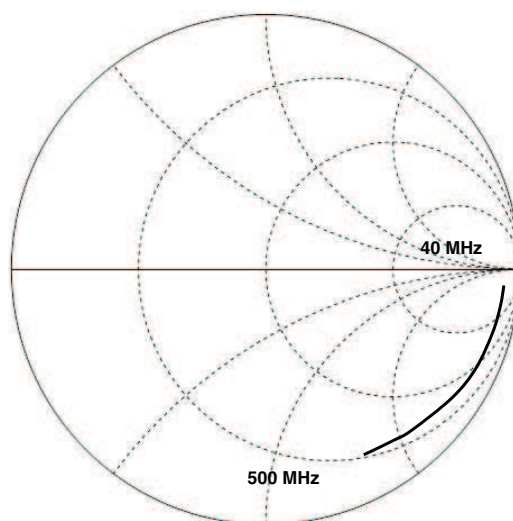


Figure 36. VLO RFIN, VHI RFIN

## TYPICAL CHARACTERISTICS (continued)

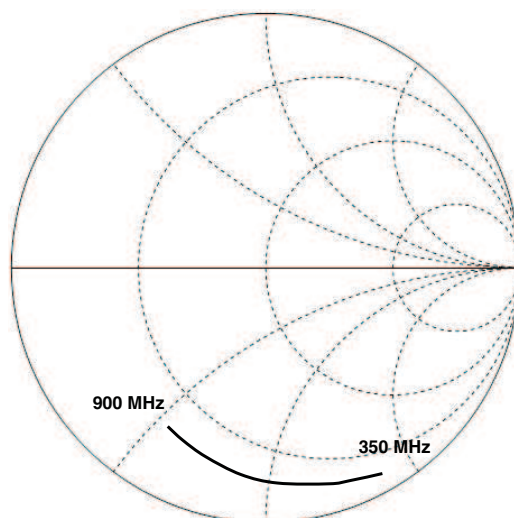


Figure 37. UHF RFIN

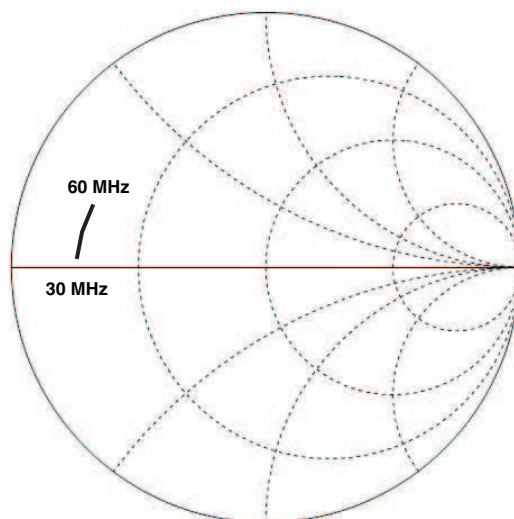


Figure 38. DIFOUT

## TYPICAL CHARACTERISTICS (continued)

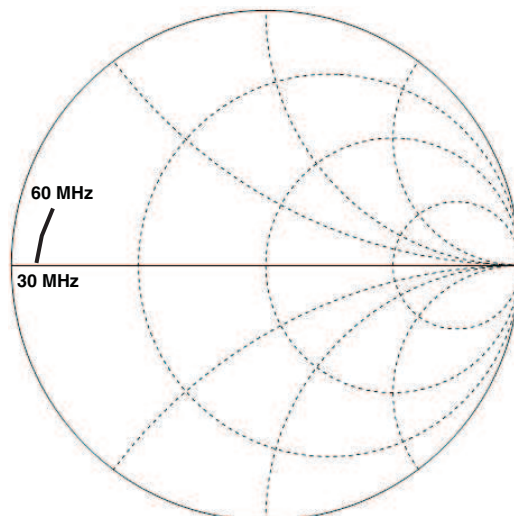


Figure 39. AIFOUT

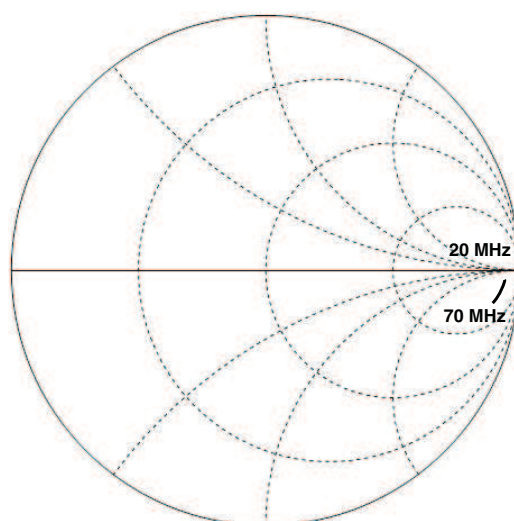
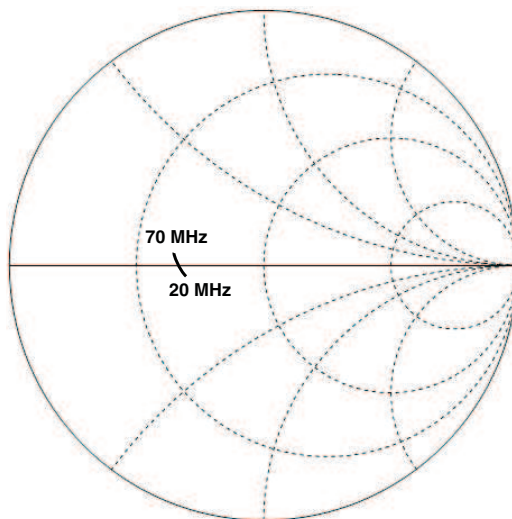


Figure 40. IF GCA IN



**TYPICAL CHARACTERISTICS (continued)**



**Figure 41. IF GCAOUT**

## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2) | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|------------------|----------------------|--------------|-------------------------|---------|
| SN761644DBTR     | OBSOLETE      | TSSOP        | DBT                | 44   |                | TBD             | Call TI          | Call TI              | -20 to 85    | SN761644                |         |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

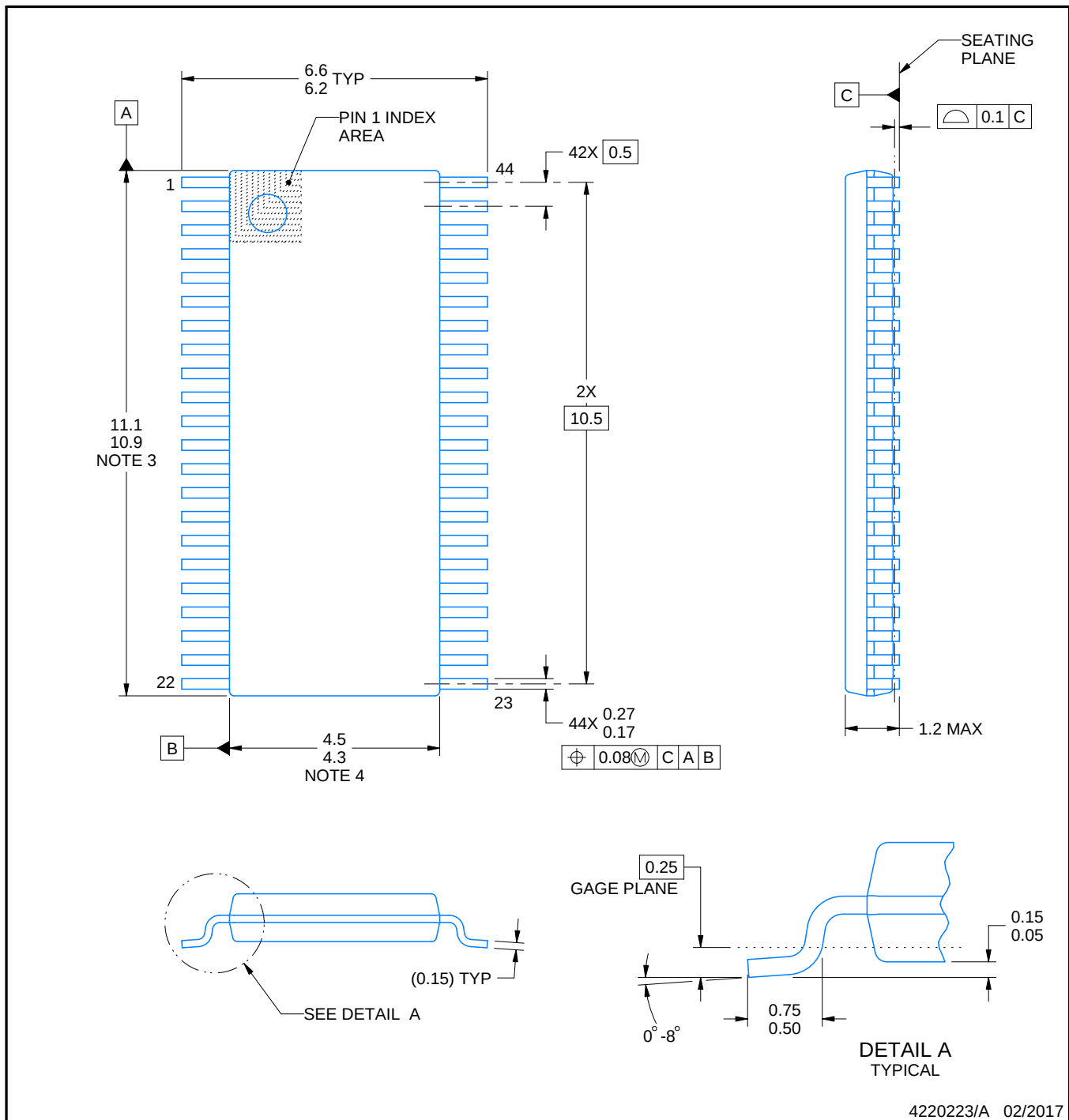
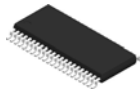
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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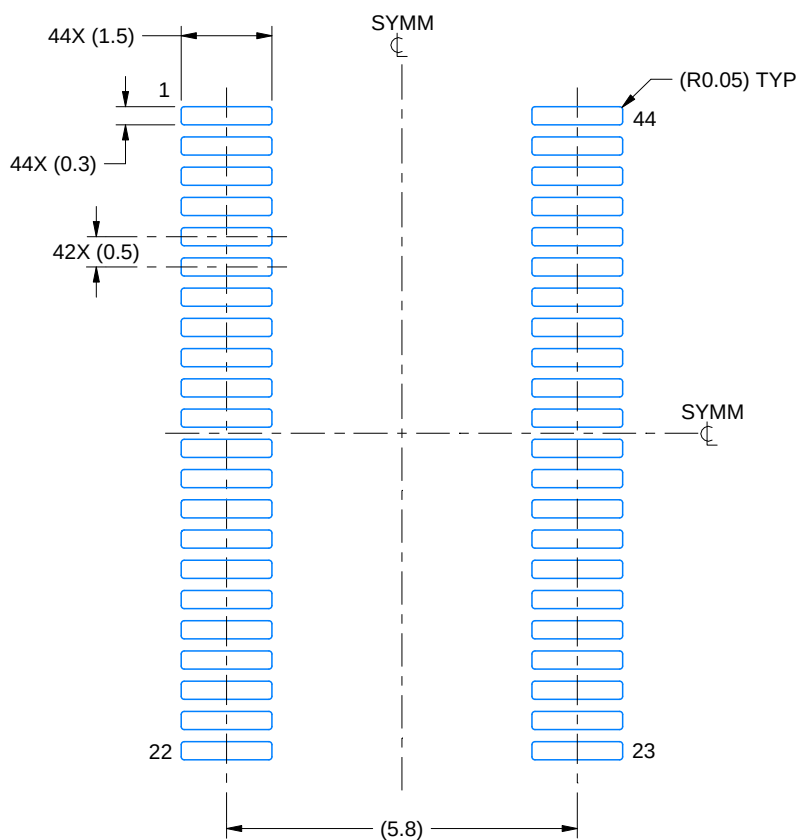
## NOTES:

- All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
- This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.

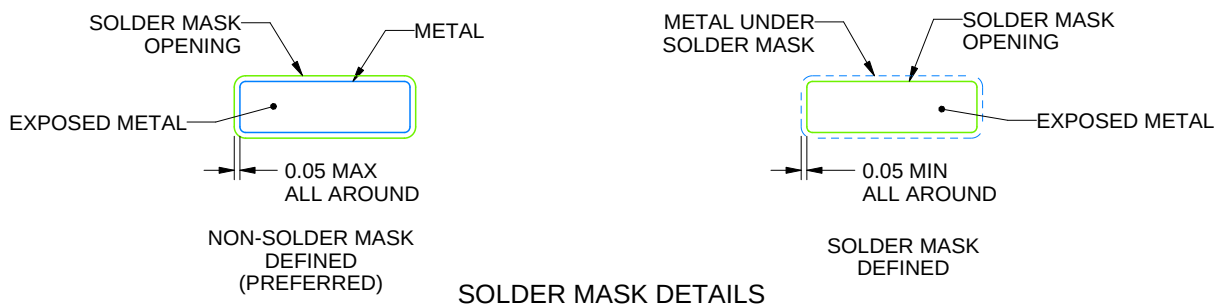
**DBT0044A**

**TSSOP - 1.2 mm max height**

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 8X



4220223/A 02/2017

NOTES: (continued)

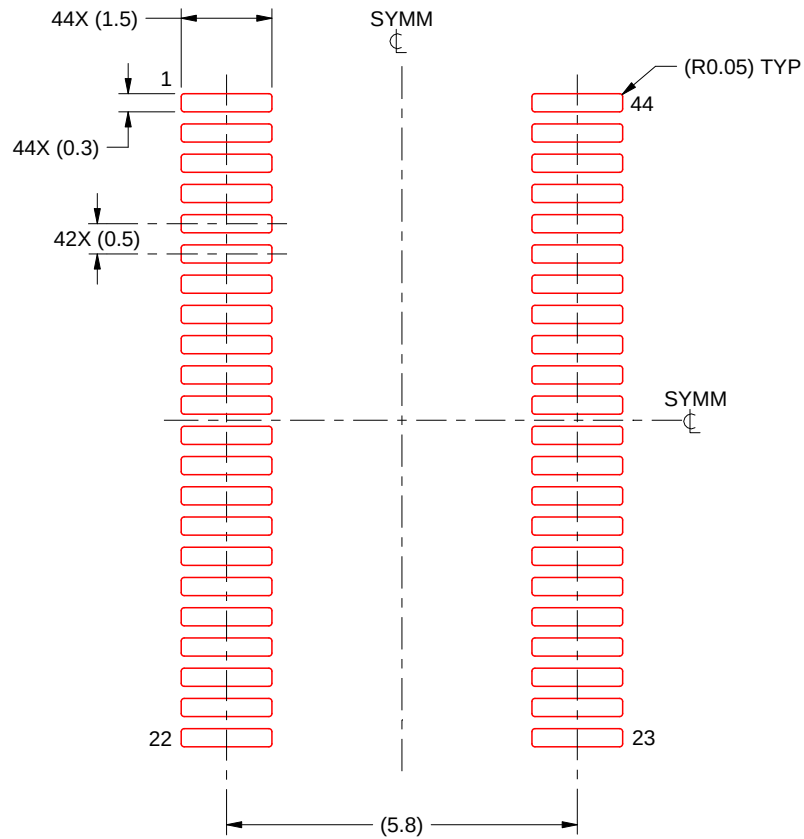
5. Publication IPC-7351 may have alternate designs.  
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DBT0044A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 8X

4220223/A 02/2017

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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