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**MSM7540/7560**

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**Single Rail ADPCM CODEC**

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**GENERAL DESCRIPTION**

The MSM7540/7560 are single channel ADPCM CODEC ICs which perform mutual transcoding between an analog voice band signal 300 to 3400 Hz and 32 kbps ADPCM serial data.

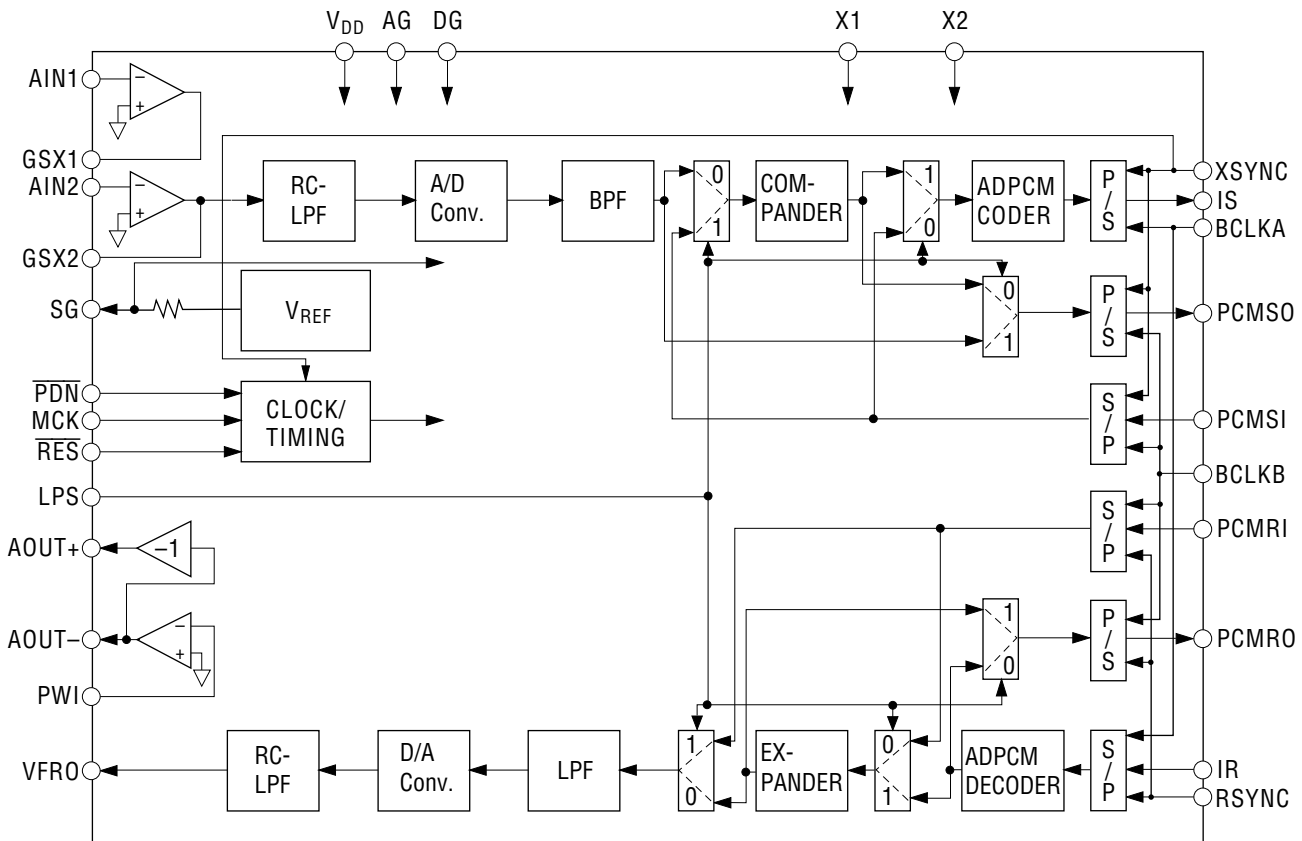
Using advanced circuit technology, these devices operate using a single 5 V power supply and have low power consumption.

The MSM7540/7560 are optimized for advanced digital cordless telephone system applications.

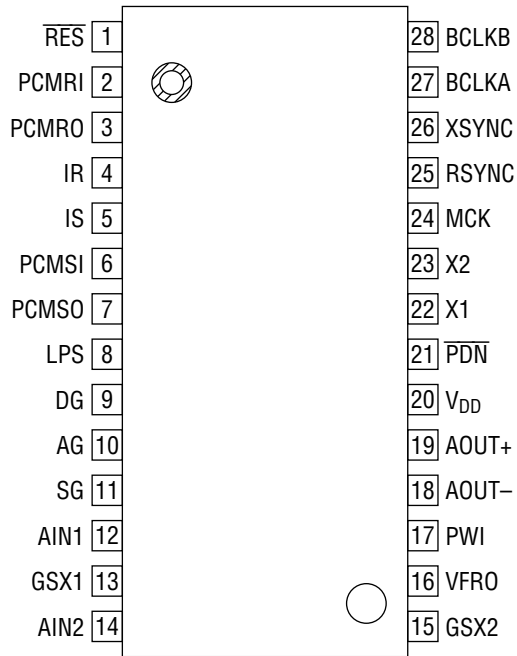
**FEATURES**

- Single 5 V Power Supply Operation
- ADPCM Algorithm : Complies completely with 1988's version ITU-T G.721 (32 kbps)
- Transmit/Receive Full-Duplex Operation
- Transmit/Receive Synchronous Mode Only
- Serial ADPCM Transmission Data Rate : 32 kbps to 2048 kbps
- Serial PCM Transmission Data Rate : 64 kbps to 2048 kbps
- PCM Interface Coding Format
  - MSM7540 : A-law or Linear (14-bit, 2's compliment) Selectable
  - MSM7560 :  $\mu$ -law or Linear (14-bit, 2's compliment) Selectable
- Low Power Consumption
  - Operating Mode : 60 mW Typ.
  - Power-Down Mode : 1.0 mW Typ.
- Two Analog Input Amplifier Stages : Externally Adjustable Gain
- Analog Output Stage : Push-pull Drive (direct drive of 350  $\Omega$  + 120 nF)
- Built-in Crystal Oscillator (10.368 MHz)
- Built-in Reference Voltage Supply
- Option Reset Specified by ITU-T G. 721 / ADPCM
- Package:
  - 28-pin plastic SOP (SOP28-P-430-1.27-K) (Product name: MSM7540GS-K)
  - (Product name: MSM7560GS-K)

**BLOCK DIAGRAM**



**PIN CONFIGURATION (TOP VIEW)**



**28-Pin Plastic SOP**

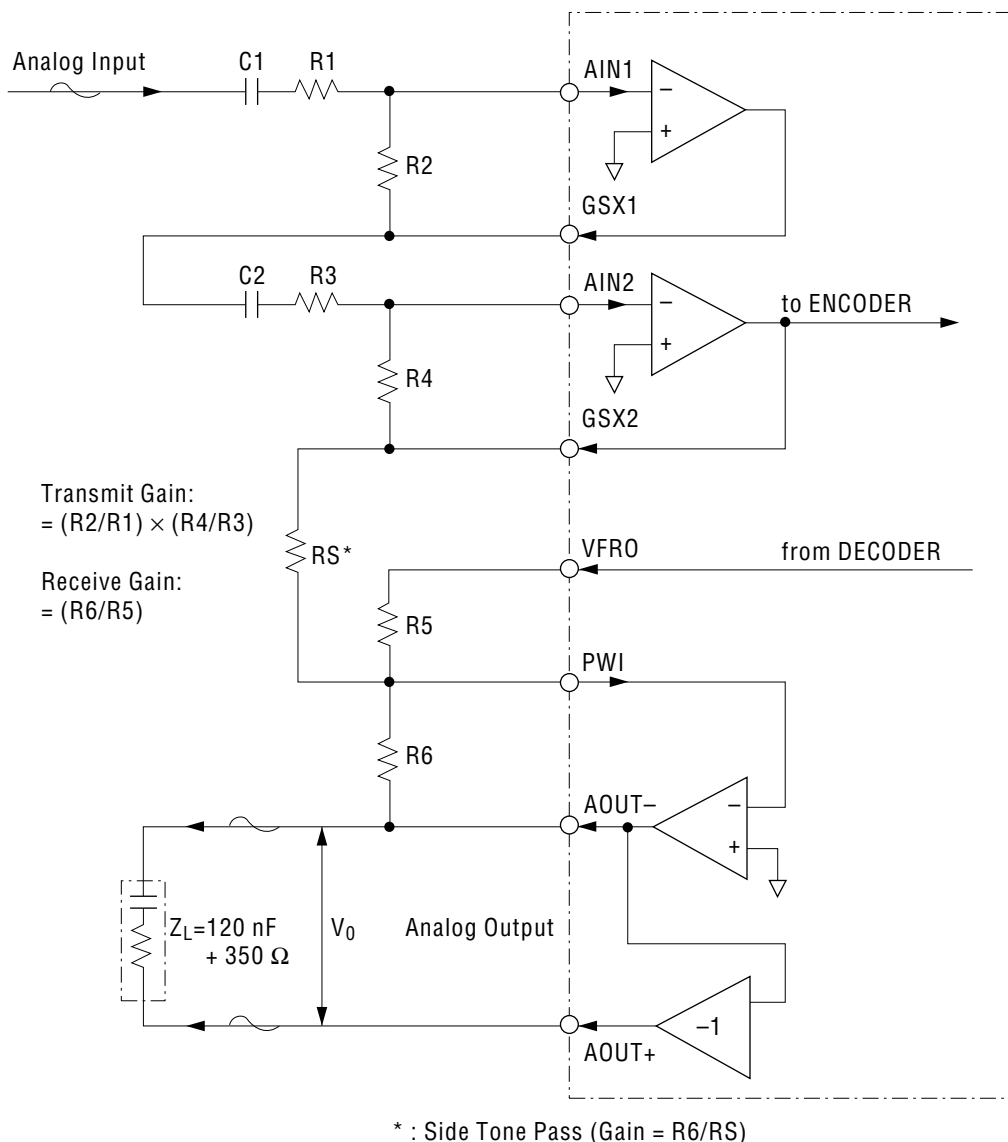
**PIN AND FUNCTIONAL DESCRIPTIONS**

**AIN1, AIN2, GSX1, GSX2**

Transmit analog inputs and the output for transmit gain adjustment. AIN1 (AIN2) connects to the inverting input of the internal transmit amplifier. GSX1 (GSX2) connects to the internal transmit amplifier output. Refer to Fig. 1 for gain adjustment.

**VFRO, AOUT+, AOUT-, PWI**

Receive analog output and the output for receive gain adjustment. VFRO is the receive filter output. AOUT+ and AOUT- are differential analog signal outputs which can directly drive  $Z_L = 350 \Omega + 120 \text{ nF}$ . Refer to Fig. 1 for gain adjustment.



**Figure 1 Analog Input/Output Interface**

**SG**

Analog signal ground voltage output.

The output voltage of this pin is approximately 2.4 V. Put bypass capacitors between this pin and the AG pin. During power-down this output voltage is 0 V. The external SG voltage, if necessary, should be used via a buffer.

**AG**

Analog ground.

**DG**

Digital ground.

This ground is separated internally from the analog signal ground pin (AG). The DG pin must be kept as close as possible to AG on the PCB.

**V<sub>DD</sub>**

+5 V power supply.

**LPS**

PCM coding law selection.

MSM7540 only ; if this pin goes to a "0" level, PCMSO, PCMSI, PCMRO, and PCMRI become the A-law character signal, and if these pins goes to a "1" level, the signal becomes a linear value character signal (2's complement).

MSM7560 only ; if this pin goes to a "0" level, PCMSO, PCMSI, PCMRO, and PCMRI become the  $\mu$ -law character signal, and if these pins goes to a "1" level, the signal becomes a linear value character signal (2's complement).

 **$\overline{\text{PDN}}$** 

Power down control input.

If this pin is "0", this device is in the power-down state.

Normally, this pin is set to "1".

 **$\overline{\text{RES}}$** 

Optional reset input specified by ITU-T Recommendation G. 721.

If this pin is "0", the device is in the reset state. The reset width (during "L") should be 125 $\mu$ s or more.

**MCK**

Master clock input.

The frequency must be 10.368 MHz. The master clock signal may be asynchronous to BCLKA, BCLKB, XSYNC, and RSYNC.

**PCMSO**

Transmit PCM data output.

PCM is output from MSB in synchronization with the rising edge of BCLKB and XSYNC.

**PCMSI**

Transmit PCM data input.

This signal is converted to the transmit ADPCM data. PCM is shifted in synchronization with the falling edge of BCLKB. Normally, this pin is connected to PCMSO.

**PCMRO**

Receive PCM data output.

PCM is the output signal after ADPCM decoder processing. This signal is output serially from MSB in synchronization with the rising edge of BCLKB and RSYNC.

**PCMRI**

Receive PCM data input.

PCM is shifted on the falling edge of the BCLKB and input from MSB. Normally, this pin is connected to PCMRO.

**IS**

Transmit ADPCM signal output.

After having encoded PCM with ADPCM, this signal is output from MSB in synchronization with the rising edge of BCLKA and XSYNC. This pin is an open drain output and remains in a high impedance state during power-down. IS requires a pull-up resistor.

**IR**

Receive ADPCM signal input.

The ADPCM signal is shifted in series and synchronization with the falling edge of BCLKA and RSYNC, starting with MSB.

**BCLKB**

Shift clock input for the PCM data (PCMSO, PCMSI, PCMRO, PCMRI).

The frequency is set in the 64 kHz to 2048 kHz range.

**XSYNC**

8 kHz synchronous signal input for transmit PCM and ADPCM data.

Synchronize this signal with BCLKA and BCLKB signal. XSYNC is used to indicate the MSB of the serial PCM and ADPCM data stream.

Be sure to input the XSYNC signal because it is also used as the input of the timing generator.

**RSYNC**

8 kHz synchronous signal input for receive PCM and ADPCM data.

Synchronize this signal with BCLKA and BCLKB signal. RSYNC is used to indicate the MSB of the serial PCM and ADPCM data stream.

**BCLKA**

Shift clock input for the ADPCM data (IS, IR).

The frequency is set in the range of 32 kHz to 2048 kHz.

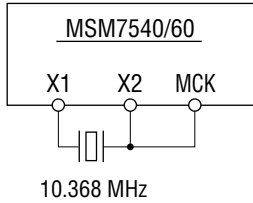
**X1, X2**

Crystal oscillator (10.368 MHz) connection.

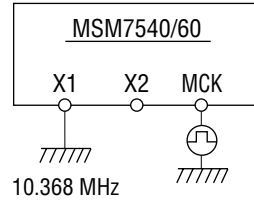
Connect X2, the clock output pin, directly to the MCK pin.

When using a conventional external clock of 10.368 MHz, X1 should be connected to the ground, leave X2 open, and provide the external clock through the MCK pin.

<Using a self-oscillation circuit>



<Using an external clock>



### ABSOLUTE MAXIMUM RATINGS

| Parameter             | Symbol           | Condition | Rating                        | Unit |
|-----------------------|------------------|-----------|-------------------------------|------|
| Power Supply Voltage  | V <sub>DD</sub>  | —         | -0.3 to +7                    | V    |
| Analog Input Voltage  | V <sub>AIN</sub> | —         | -0.3 to V <sub>DD</sub> + 0.3 | V    |
| Digital Input Voltage | V <sub>DIN</sub> | —         | -0.3 to V <sub>DD</sub> + 0.3 | V    |
| Storage Temperature   | T <sub>STG</sub> | —         | -55 to +150                   | °C   |

### RECOMMENDED OPERATING CONDITIONS

| Parameter                         | Symbol            | Condition  | Min.   | Typ.     | Max.            | Unit |
|-----------------------------------|-------------------|--|--------|----------|-----------------|------|
| Power Supply Voltage              | V <sub>DD</sub>   | Voltage must be fixed  | 4.5    | —        | 5.5             | V    |
| Operating Temperature             | T <sub>a</sub>    | —  | -25    | +25      | +70             | °C   |
| Input High Voltage                | V <sub>IH</sub>   | MCK, XSYNC, RSYNC, PCMRI, PCMSI, BCLKA, BCLKB, IR, LPS, PDN, RES | 2.2    | —        | V <sub>DD</sub> | V    |
| Input Low Voltage                 | V <sub>IL</sub>   | MCK, XSYNC, RSYNC, PCMRI, PCMSI, BCLKA, BCLKB, IR, LPS, PDN, RES | 0      | —        | 0.6             | V    |
| Master Clock Frequency            | f <sub>MCK</sub>  | MCK  | -0.01% | 10.368   | +0.01%          | MHz  |
| Bit Clock Frequency               | f <sub>BCKA</sub> | BCLKA  | 32     | —        | 2048            | kHz  |
|                                   | f <sub>BCKB</sub> | BCLKB  | 64     | —        | 2048            | kHz  |
| Synchronous Signal Frequency      | f <sub>SYMC</sub> | XSYNC, RSYNC   | —      | 8.0      | —               | kHz  |
| Clock Duty Ratio                  | D <sub>C</sub>    | MCK, BCLKA, BCLKB  | 30     | 50       | 70              | %    |
| Digital Input Rise Time           | t <sub>ir</sub>   | MCK, XSYNC, RSYNC, PCMRI, PCMSI, BCLKA, BCLKB, IR, LPS, PDN, RES | —      | —        | 50              | ns   |
| Digital Input Fall Time           | t <sub>if</sub>   | MCK, XSYNC, RSYNC, PCMRI, PCMSI, BCLKA, BCLKB, IR, LPS, PDN, RES | —      | —        | 50              | ns   |
| Transmit Sync Signal Setting Time | t <sub>XS</sub>   | BCLKA, BCLKB to XSYNC  | 100    | —        | —               | ns   |
|                                   | t <sub>XS</sub>   | XSYNC to BCLKA, BCLKB  | 100    | —        | —               | ns   |
| Receive Sync Signal Setting Time  | t <sub>RS</sub>   | BCLKA, BCLKB to RSYNC  | 100    | —        | —               | ns   |
|                                   | t <sub>SR</sub>   | RSYNC to BCLKA, BCLKB  | 100    | —        | —               | ns   |
| Synchronous Signal Width          | t <sub>WS</sub>   | XSYNC, RSYNC   | 1 BCLK | —        | 100             | μs   |
| PCM, ADPCM Set-up Time            | t <sub>DS</sub>   | —  | 100    | —        | —               | ns   |
| PCM, ADPCM Hold Time              | t <sub>DH</sub>   | —  | 100    | —        | —               | ns   |
| Digital Output Load               | R <sub>DL</sub>   | IS (Pull-up Resistor)  | 500    | —        | —               | Ω    |
|                                   | C <sub>DL</sub>   | IS, PCMSO, PCMRO   | —      | —        | 100             | pF   |
| Bypass Capacitor for SG           | C <sub>SG</sub>   | SG↔GND   | —      | 10 + 0.1 | —               | μF   |



## ELECTRICAL CHARACTERISTICS

### DC and Digital Interface Characteristics

( $V_{DD} = 4.5\text{ V to }5.5\text{ V}$ ,  $T_a = -25^\circ\text{C to }+70^\circ\text{C}$ )

| Parameter              | Symbol    | Condition   | Min. | Typ. | Max.     | Unit          |
|------------------------|-----------|---|------|------|----------|---------------|
| Power Supply Current   | $I_{DD1}$ | Operating Mode,<br>(When no signal, and $V_{DD} = 5.0\text{ V}$ ) | —    | 12   | 24       | mA            |
|                        | $I_{DD2}$ | Power Down Mode<br>(When $V_{DD} = 5.0\text{ V}$ )                | —    | 0.2  | 0.5      | mA            |
| Input High Voltage     | $V_{IH}$  | —   | 2.2  | —    | $V_{DD}$ | V             |
| Input Low Voltage      | $V_{IL}$  | —   | 0.0  | —    | 0.6      | V             |
| Input Leakage Current  | $I_{IH}$  | $V_I = V_{DD}$  | —    | —    | 2.0      | $\mu\text{A}$ |
|                        | $I_{IL}$  | $V_I = 0\text{ V}$  | —    | —    | 0.5      | $\mu\text{A}$ |
| Output Low Voltage     | $V_{OL}$  | 1 LSTTL, Pull-up: $500\ \Omega$                                   | 0.0  | 0.2  | 0.4      | V             |
| Output Leakage Current | $I_O$     | IS  | —    | —    | 10       | $\mu\text{A}$ |
| Input Capacitance      | $C_{IN}$  | —   | —    | 5    | —        | pF            |

### Transmit Analog Interface Characteristics

| Parameter               | Symbol     | Condition   | Min. | Typ. | Max.   | Unit             |
|-------------------------|------------|---|------|------|--------|------------------|
| Input Resistance        | $R_{INX}$  | AIN1, AIN2  | 10   | —    | —      | $\text{M}\Omega$ |
| Output Load Resistance  | $R_{LGX}$  | GSX1, GSX2  | 50   | —    | —      | $\text{k}\Omega$ |
| Output Load Capacitance | $C_{LGX}$  | GSX1, GSX2  | —    | —    | 100    | pF               |
| Output Amplitude        | $V_{OGX}$  | GSX1, GSX2, $R_L = 50\ \text{k}\Omega$  | —    | —    | *2.226 | $V_{PP}$         |
| Input Offset Voltage    | $V_{OFGX}$ | Pre-OPAMPs  | -20  | —    | +20    | mV               |
| SG Output Voltage       | $V_{SG}$   | —   | —    | 1.4  | —      | V                |
| SG Output Impedance     | $R_{SG}$   | —   | —    | 40   | 80     | $\text{k}\Omega$ |
| SG Rise Time            | $T_{SG}$   | SG $\leftrightarrow$ GND $10\ \mu\text{F} + 0.1\ \mu\text{F}$<br>(Rise time to 90% of max. level) | —    | 700  | —      | ms               |

\*  $-3\ \text{dBm}$  ( $600\ \Omega$ ) =  $0\ \text{dBm}_0$ ,  $+3.14\ \text{dBm}_0 = 2.226\ V_{PP}$  (MSM7540)

$-3\ \text{dBm}$  ( $600\ \Omega$ ) =  $0\ \text{dBm}_0$ ,  $+3.17\ \text{dBm}_0 = 2.226\ V_{PP}$  (MSM7560)

**Receive Analog Interface Characteristics**

| Parameter              | Symbol            | Condition   | Min.                    | Typ. | Max.   | Unit            |                 |
|------------------------|-------------------|---|-------------------------|------|--------|-----------------|-----------------|
| Input Resistance       | R <sub>INPW</sub> | PW1   | 10                      | —    | —      | MΩ              |                 |
| Output Load Resistance | R <sub>LVF</sub>  | VFRO  | 50                      | —    | —      | kΩ              |                 |
|                        | R <sub>LAO</sub>  | AOUT+, AOUT-  | 1.2                     | —    | —      | kΩ              |                 |
| Output Capacitance     | C <sub>LVF</sub>  | VFRO  | —                       | —    | 100    | pF              |                 |
|                        | C <sub>LAO</sub>  | AOUT+, AOUT-  | —                       | —    | 100    | pF              |                 |
| Output Voltage Level   | V <sub>OVF</sub>  | VFRO R <sub>L</sub> = 50 kΩ   | —                       | —    | *2.226 | V <sub>PP</sub> |                 |
|                        | V <sub>OAO</sub>  | AOUT+, AOUT-<br>Z <sub>L</sub> = 350 Ω + 120 nF(See Fig.1)                | R <sub>L</sub> = 1.2 kΩ | —    | —      | *2.226          | V <sub>PP</sub> |
|                        |                   |   | —                       | —    | —      | *2.226          | V <sub>PP</sub> |
| Offset Voltage         | V <sub>OVF</sub>  | VFRO  | -100                    | —    | +100   | mV              |                 |
|                        | V <sub>OFAO</sub> | AOUT+, AOUT- (GAIN = 0 dB),<br>Power amp only                             | -20                     | —    | +20    | mV              |                 |
| Open Loop Gain         | G <sub>DB</sub>   | Power amp (0.3 to 3.4 kHz,<br>Z <sub>L</sub> = 350 Ω + 120 nF)(See Fig.1) | 40                      | —    | —      | dB              |                 |

\* -3 dBm (600 Ω) = 0 dBm<sub>0</sub>, + 3.14 dBm<sub>0</sub> = 2.226 V<sub>PP</sub> (MSM7540)  
 -3 dBm (600 Ω) = 0 dBm<sub>0</sub>, + 3.17 dBm<sub>0</sub> = 2.226 V<sub>PP</sub> (MSM7560)

AC Characteristics

(V<sub>DD</sub> = 4.5 V to 5.5 V, T<sub>a</sub> = -25°C to +70°C)

| Parameter                           | Symbol              | Condition   |              |        | Min.      | Typ. | Max.  | Unit |
|-------------------------------------|---------------------|-------------|--------------|--------|-----------|------|-------|------|
|                                     |                     | Freq. (Hz)  | Level (dBm0) | Others |           |      |       |      |
| Transmit Frequency Response         | L <sub>oss</sub> T1 | 0 to 60     | 0            | —      | 25        | —    | —     | dB   |
|                                     | L <sub>oss</sub> T2 | 300 to 3000 |              |        | -0.15     | —    | +0.20 | dB   |
|                                     | L <sub>oss</sub> T3 | 1020        |              |        | Reference |      |       | dB   |
|                                     | L <sub>oss</sub> T4 | 3300        |              |        | -0.15     | —    | +0.80 | dB   |
|                                     | L <sub>oss</sub> T5 | 3400        |              |        | 0         | —    | 0.80  | dB   |
|                                     | L <sub>oss</sub> T6 | 3968.75     |              |        | 14        | —    | —     | dB   |
| Receive Frequency Response          | L <sub>oss</sub> R1 | 0 to 3000   | 0            | —      | -0.15     | —    | +0.20 | dB   |
|                                     | L <sub>oss</sub> R2 | 1020        |              |        | Reference |      |       | dB   |
|                                     | L <sub>oss</sub> R3 | 3300        |              |        | -0.15     | —    | +0.80 | dB   |
|                                     | L <sub>oss</sub> R4 | 3400        |              |        | 0         | —    | 0.80  | dB   |
|                                     | L <sub>oss</sub> R5 | 3968.75     |              |        | 14        | —    | —     | dB   |
| Transmit Signal to Distortion Ratio | SD T1               | 1020        | 3            | (*1)   | 35        | —    | —     | dB   |
|                                     | SD T2               |             | 0            |        | 35        | —    | —     | dB   |
|                                     | SD T3               |             | -30          |        | 35        | —    | —     | dB   |
|                                     | SD T4               |             | -40          |        | 28        | —    | —     | dB   |
|                                     | SD T5               |             | -45          |        | 23        | —    | —     | dB   |
| Receive Signal to Distortion Ratio  | SD R1               | 1020        | 3            | (*1)   | 35        | —    | —     | dB   |
|                                     | SD R2               |             | 0            |        | 35        | —    | —     | dB   |
|                                     | SD R3               |             | -30          |        | 35        | —    | —     | dB   |
|                                     | SD R4               |             | -40          |        | 28        | —    | —     | dB   |
|                                     | SD R5               |             | -45          |        | 23        | —    | —     | dB   |
| Transmit Gain Tracking              | GT T1               | 1020        | 3            | —      | -0.2      | —    | +0.2  | dB   |
|                                     | GT T2               |             | -10          |        | Reference |      |       | dB   |
|                                     | GT T3               |             | -40          |        | -0.2      | —    | +0.2  | dB   |
|                                     | GT T4               |             | -50          |        | -0.5      | —    | +0.5  | dB   |
|                                     | GT T5               |             | -55          |        | -1.2      | —    | +1.2  | dB   |
| Receive Gain Tracking               | GT R1               | 1020        | 3            | —      | -0.2      | —    | +0.2  | dB   |
|                                     | GT R2               |             | -10          |        | Reference |      |       | dB   |
|                                     | GT R3               |             | -40          |        | -0.2      | —    | +0.2  | dB   |
|                                     | GT R4               |             | -50          |        | -0.5      | —    | +0.5  | dB   |
|                                     | GT R5               |             | -55          |        | -1.2      | —    | +1.2  | dB   |

\*1 Use the P-message weighted filter

**AC Characteristics (Continued)**

(V<sub>DD</sub> = 4.5 V to 5.5 V, T<sub>a</sub> = -25°C to +70°C)

| Parameter                          | Symbol            | Condition                 |                                     |              | Min.  | Typ.          | Max.         | Unit             |
|------------------------------------|-------------------|---------------------------|-------------------------------------|--------------|-------|---------------|--------------|------------------|
|                                    |                   | Freq. (Hz)                | Level (dBm0)                        | Others       |       |               |              |                  |
| Idle Channel Noise                 | N <sub>IDLT</sub> | —                         | A <sub>IN</sub> = SG                | (*1)         | —     | —             | -69<br>(-72) | dBm0p<br>(dBmp)  |
|                                    | N <sub>IDLR</sub> | —                         | —                                   | (*1)<br>(*2) | —     | —             | -72<br>(-75) |                  |
| Absolute Signal Amplitude          | A <sub>VT</sub>   | 1020                      | 0                                   | GSX2         | 0.488 | 0.548<br>(*3) | 0.615        | V <sub>rms</sub> |
|                                    | A <sub>VR</sub>   |                           |                                     | VFRO         | 0.488 | 0.548<br>(*3) | 0.615        | V <sub>rms</sub> |
| Power Supply Noise Rejection Ratio | P <sub>SRRT</sub> | Noise Freq. : 0 to 50 kHz | Noise Level : 50 mV <sub>PP</sub>   | —            | 30    | —             | —            | dB               |
|                                    | P <sub>SRRR</sub> |                           |                                     |              | 30    | —             | —            | dB               |
| Digital Output Delay Time          | t <sub>SDX</sub>  | —                         | 1 LSTTL + 100 pF,<br>Pull-up: 500 Ω | —            | 50    | —             | 200          | ns               |
|                                    | t <sub>SDR</sub>  |                           |                                     |              | 50    | —             | 200          | ns               |
|                                    | t <sub>XD1</sub>  |                           |                                     |              | 50    | —             | 200          | ns               |
|                                    | t <sub>XD2</sub>  |                           |                                     |              | 50    | —             | 200          | ns               |
|                                    | t <sub>XD3</sub>  |                           |                                     |              | 50    | —             | 200          | ns               |

\*1 Use the P-message weighted filter

\*2 PCMRI input code "11010101"(MSM7540)

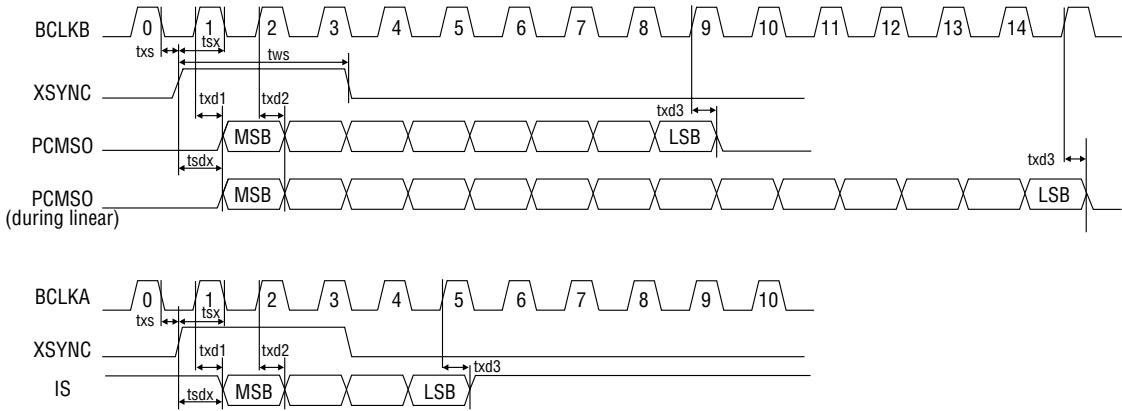
"11111111"(MSM7560)

\*3 0.548 V<sub>rms</sub> = 0 dBm0 = -3 dBm

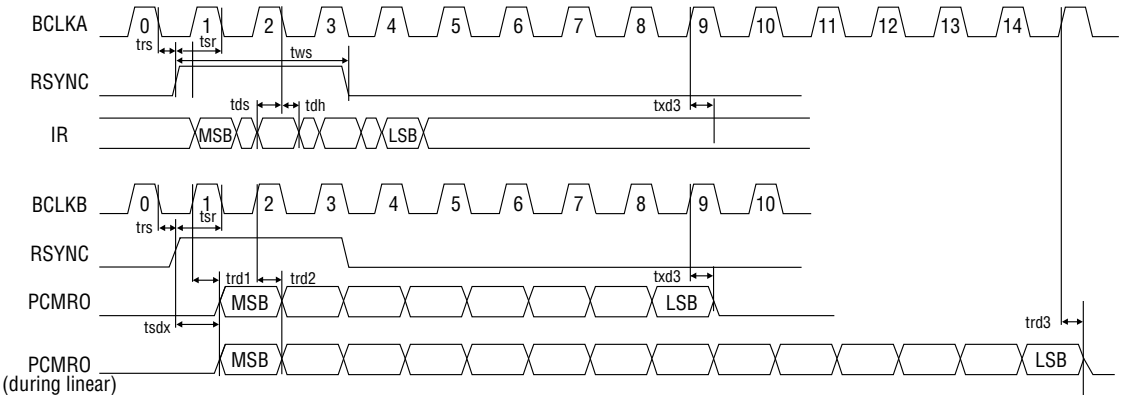
Note: All ADPCM coder and decoder characteristics comply with ITU-T Recommendation G.721.

**TIMING DIAGRAM**

**Transmit Side PCM/ADPCM Data Interface**



**Receive Side PCM/ADPCM Data Interface**

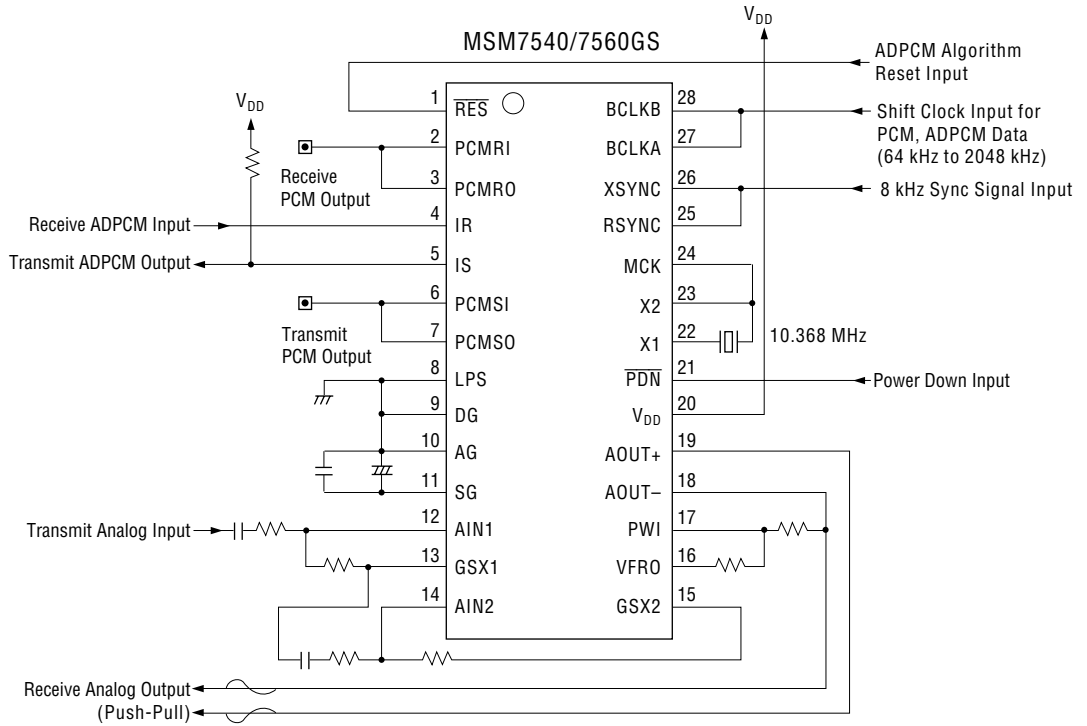


Note: Linear format

A code of an input/output level is determined by the 14-bit 2's complement. Refer to the table below for code format.

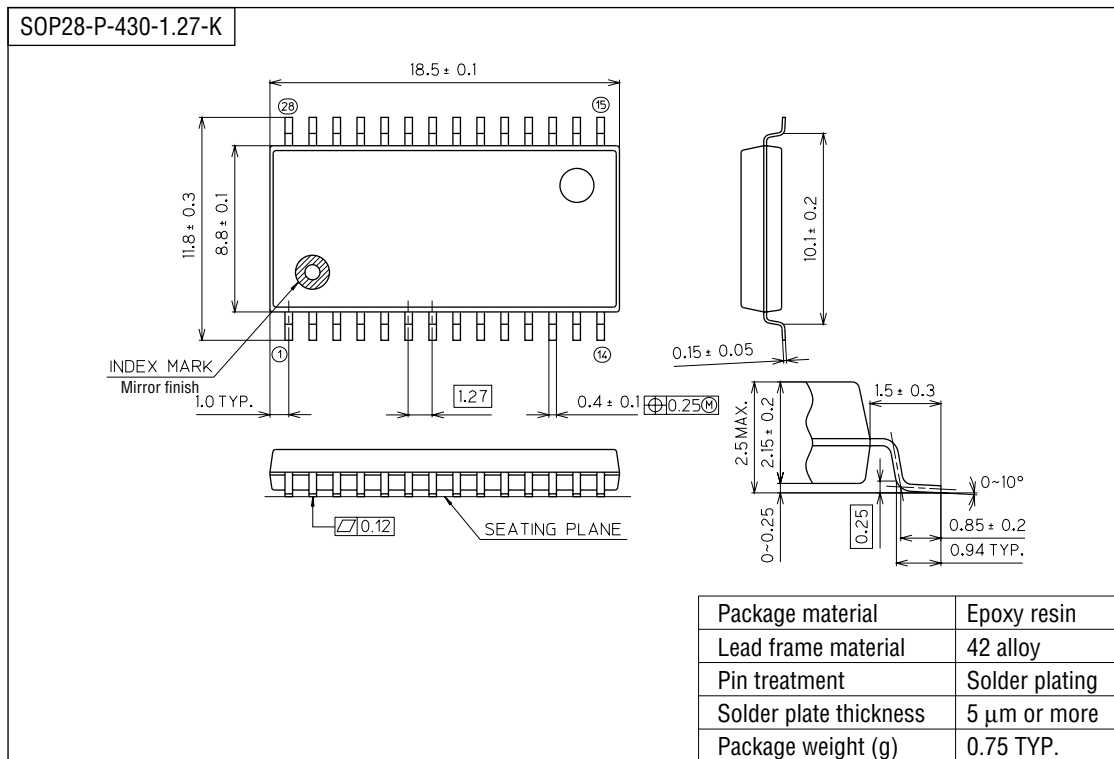
| Input/Output level | MSB to LSB     |
|--------------------|----------------|
| +Full-scal         | 01111111111111 |
| 0                  | 00000000000000 |
| -Full-scal         | 10000000000000 |

APPLICATION CIRCUIT



**PACKAGE DIMENSIONS**

(Unit : mm)



**Notes for Mounting the Surface Mount Type Package**

The SOP, QFP, TSOP, SOJ, QFJ (PLCC), SHP and BGA are surface mount type packages, which are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).