OKI Semiconductor

This version: Jan. 1998
Previous version: Nov. 1996

MSM7532

Single Chip MSK Modem with Compandor for Cordless Telephone

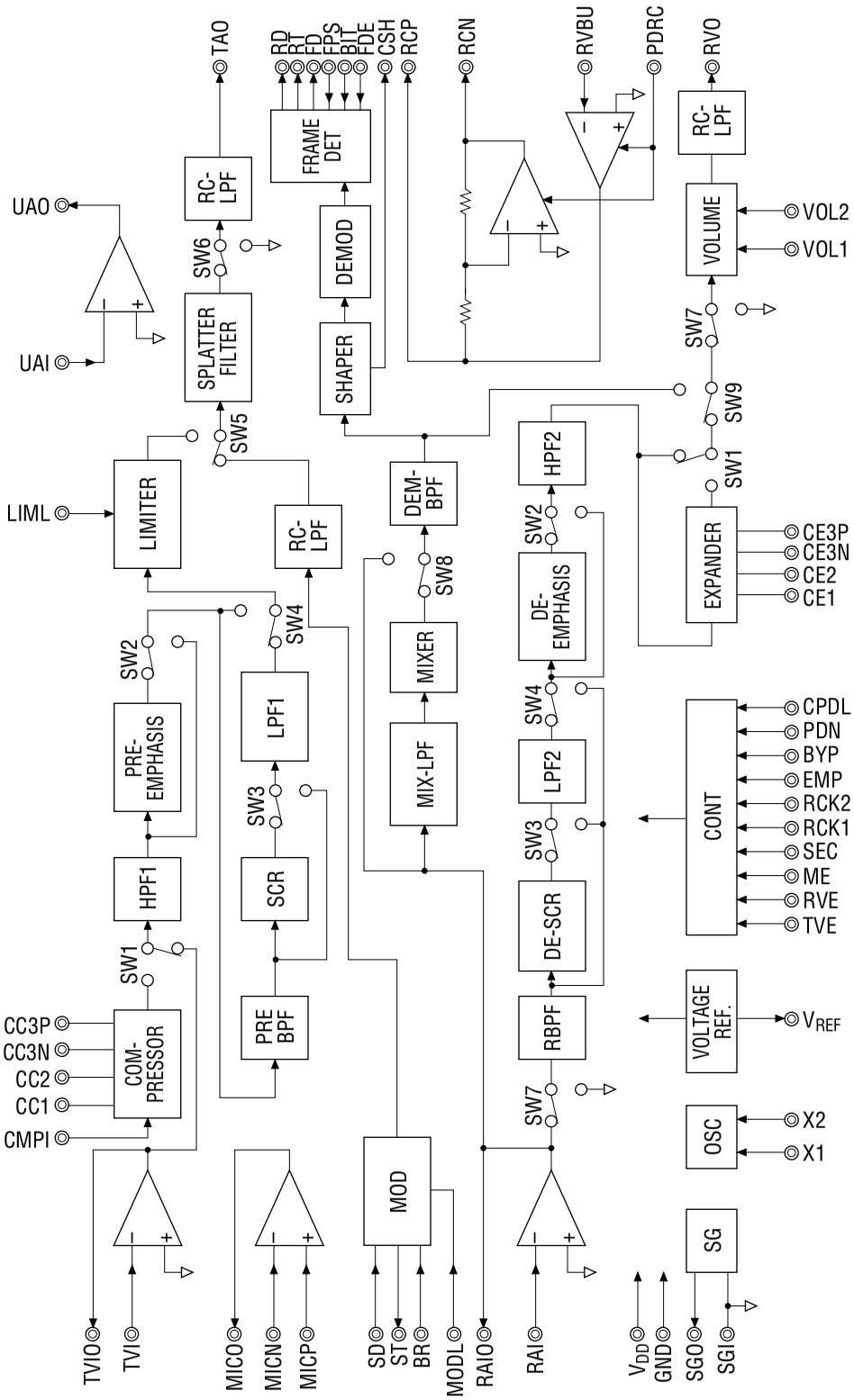
GENERAL DESCRIPTION

The MSM7532 is a baseband device with a modem function and a baseband voice signal processing function for analog cordless telephone. The voice signal transmitter in this IC consists of a high-pass filter, compressor, scrambler, pre-emphasis, limiter, and splatter filter.
The voice signal receiver consists of a bandpass filter, a de-scrambler , a de-emphasis, an expander, an electronic volume, and a ceramic receiver driving circuit.
The MODEM in this IC transmits and receives MSK (Minimum Shift Keying) modem signals.

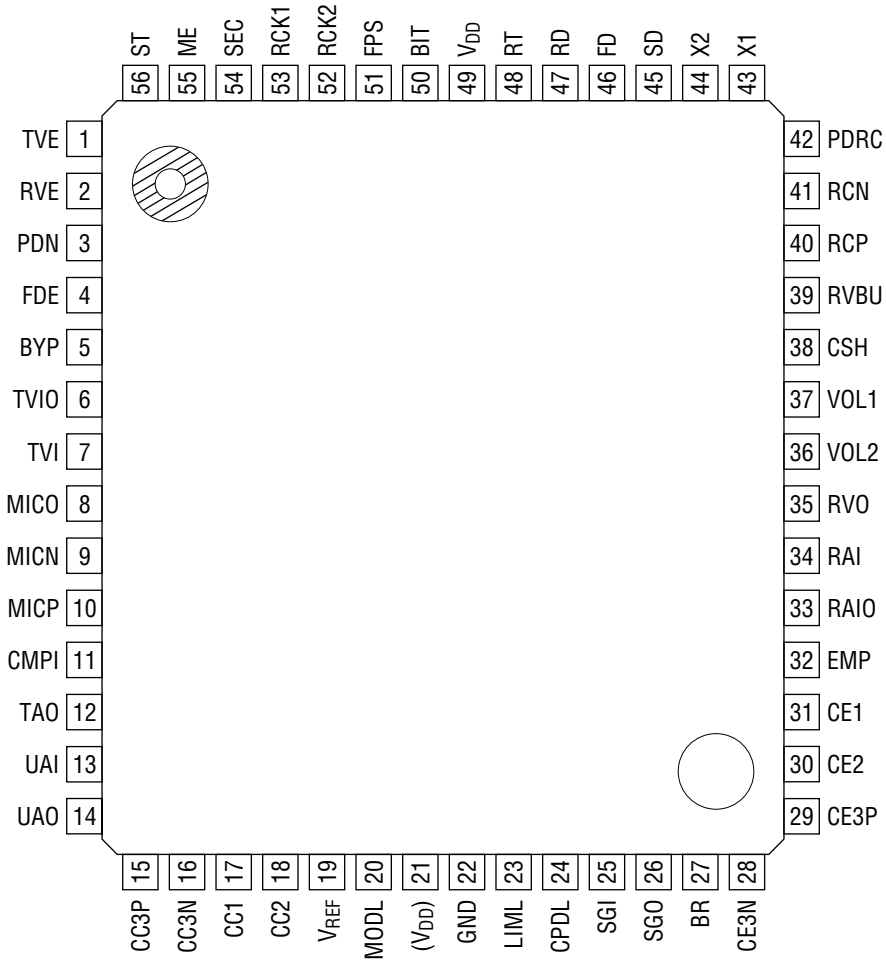
FEATURES

- Built-in ceramic receiver drive amplifiers
- The compander input reference level, limiter level, and modem transmit level are easy to be externally adjusted.
- Built-in 2-bit electronic volume
- A microphone amplifier and an amplifier available for users are built in.
- Mode settings using parallel interfaces
- Built-in compander dynamic range: 70 dB
- Built-in maximum gain limit circuit for expander
- The bit rate of MSK modem is switchable between 2400 bps and 1200 bps.
- Scrambler and emphasis can be used by serially connecting them or can be used separately with each other.
- Three kinds of the reverse frequency of the scrambler are selectable.
- The modem receiver functions detect bit synchronous signals and frame synchronous signals.
- Four-step power down modes
- Built-in crystal oscillation circuit
- Wide range of power supply (1.8 V to 5.5 V)
- Package:
  56-pin plastic QFP (QFP56-P-910-0.65-2K) (Product name : MSM7532GS-2K)

BLOCK DIAGRAM



PIN CONFIGURATION (TOP VIEW)



56-Pin Plastic QFP

Notes: The pin 49 should be used for V_{DD}.
The pin 21 should be connected to V_{DD} or opened.

PIN AND FUNCTIONAL DESCRIPTIONS

TVE
Transmit voice signal output control pin.
Refer to the TAO pin description.

RVE
Receive voice signal output control pin.
Refer to the RVO pin description.

PDN
Power down control pin.
The four-step power down modes are controlled by the PDN, ME, RVE, and TVE pins.

	PDN	RVE	TVE	ME	Voice signal Processing Section	Transmit Modem	Receive Modem	Crystal Oscillation Circuit
Mode 1	1	0	1	X	OFF	OFF	OFF	OFF
Mode 2	1	0	0	X	OFF	OFF	OFF	ON
Mode 3	1	1	X	X	OFF	OFF	ON	ON
Mode 4	0	0	0	1	OFF	ON	ON	ON
Mode 5	Other than above				ON	ON	ON	ON

X: Don't care

In Mode 5, all the circuits are ON.
The MODEM demodulation circuit and FD pin are reset to zero by setting to Mode 1 or Mode 2 (PDN = “1”, RVE = “0”).
After turning the power ON, set the LSI into one of these modes, then reset it before using. To hold the voice signal processing section ON during transmission of MSK signals, set the ME and TVE pins to "1". In this case, the input from TVI is not output to TAO. Refer to the TAO pin description.

FDE
Pin used to control the function of frame synchronous signal detection circuit.
If digital "0" is entered in this pin, the FD pin remains reset at "0" level. The RT and RD pins are always active.
If digital "1" is entered in this pin, the frame synchronous signal detection circuit becomes active. And the RT and RD pins are fixed at "1" level until the FD pin goes to "1" level by detecting the frame synchronous signals.
Refer to Figure 3 "Receive Signal Timing".

BYP
Compander path selection pin.

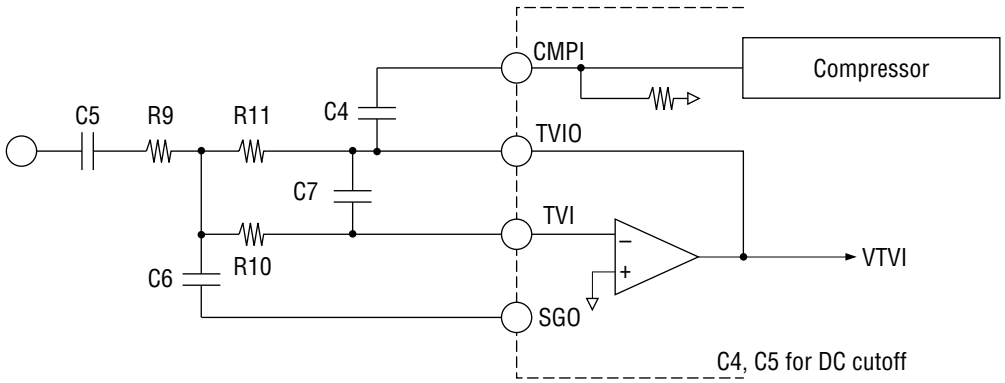
BYP	Transmit side	Receive side	Note
0	Compressor is connected to the path.	Expander is connected to the path.	SW1
1	Compressor is bypassed to the path.	Expander is bypassed to the path.	

When the expander is used, the maximum gain of expander is limited to approximately +12 dB. This tendency will appear as the input signal level is increased when V_{DD} is larger (e. g., 5 V) and V_{CPDL} is smaller (e,g., 0.1 V); the input/output characteristics then change automatically from expander characteristics to linear characteristics with constant gain.

TVI, TVIO

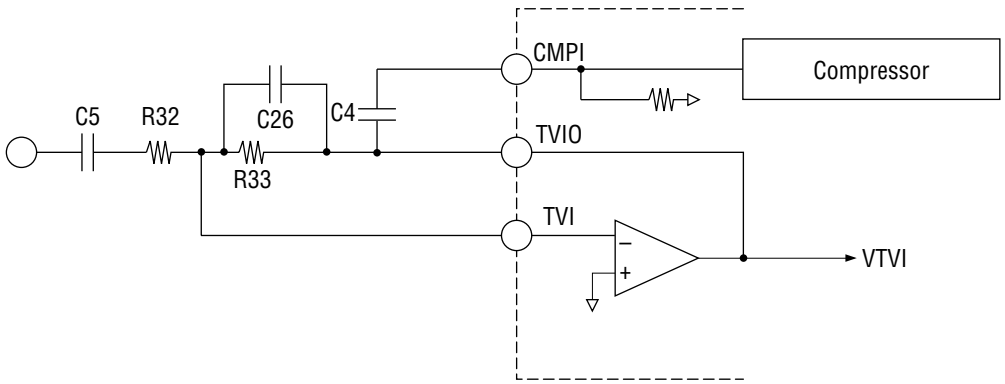
Pins used to constitute an RC-active filter on the transmit input side.
If input signals have frequency components over 50 kHz, these components are output as aliasing noises from the built-in SCF circuit. In order to remove these noises, insert the first or second order RC-active filter with about 10 kHz cut-off frequency, as shown below.

<Second order RC-active filter configuration>



In the case of fc = 10 kHz, gain : 0 dB { R9 = R10 = R11 = 68 kΩ ; C5 = 0.22 µF, C6 = 510 pF, C7 = 110 pF }

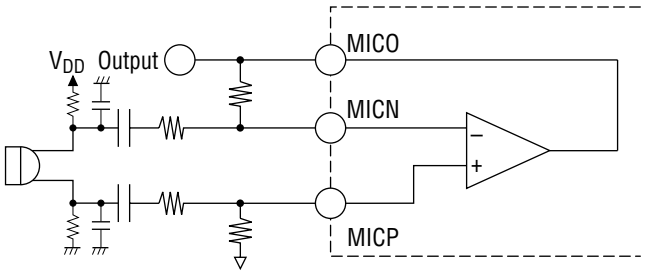
<First order RC-active filter configuration>



In the case of fc = 10 kHz, gain : 0 dB { R32 = R33 = 51 kΩ ; C5 = 0.22 µF, C26 = 300 pF }

MICO, MICN, MICP

MICN is the microphone amplifier inverting input pin, MICP is the non-inverting input pin, and MICO is the output pin. Only during power down mode 1 or 2, the amplifier is powered down and the MICO potential is undefined.
These pins can also be used for applications other than microphone amplifier.



CMPI

Input pin to the compressor.
Connect this pin to the TVIO pin with a 0.1 µF capacitor in order to prevent the malfunction of the compressor which may occur if DC input offset exists.

TAO

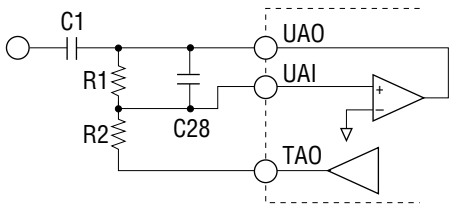
Transmit analog signal output pin.
According to control data on ME and TVE, TAO is set as shown below.

ME	TVE	TAO	Note
0	0	No signal output (potential = V_{SG})	SW6
0	1	Voice signal output (signal from TVI, TVIO)	SW5
1	X	MSK modulator output	

X: Don't care

UAI, UAO

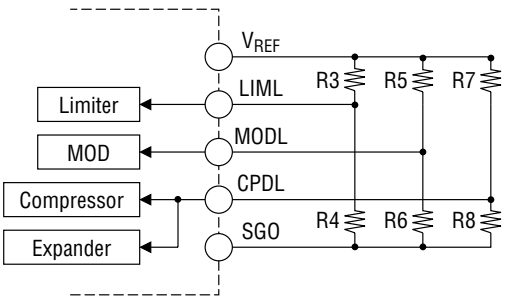
Inverting input pin (UAI) and output pin (UAO) for the amplifier available for users.
These pins are used as a gain control amplifier that can match the internal signal level of the LSI with the input level of the radio circuit.
The amplifier can drive a resistance over 2 kΩ.
In the power down mode 1 and 2, the amplifier enters power down mode.
Since the amplifier uses the power supply for the built-in transmitter, the amplifier should be used to control signals for the transmitter. C28 is a capacitor for oscillation prevention. Be sure to use a capacitor of 20 pF or more. If this amplifier is not used, connect UAI to UAO directly and remove R1, R2, C1, and C28.



CC3P, CC3N
Pins used to connect a capacitor for defining a time constant of output transient response for the compressor.
Insert a 0.22 µF capacitor between CC3N and CC3P.

CC2, CC1
Pins used to connect capacitors for removing DC offset in the compressor.
Insert a 0.22 µF capacitor between CC2 and SGO, and between CC1 and SGO.

V_{REF}
Output pin for internal reference voltage source.
The V_{REF} output voltage is V_{SG} +0.5 V.
The voltages into which the voltage between V_{REF} pin and SGO pin is divided by the resistors should be supplied to the LIML, MODL, and CPDL pin, respectively.
The V_{REF} pin can be directly connected to the LIML pin, MODL pin, or CPDL pin.



MODL
DC voltage input pin used to define a transmit output level for MODEM.
One of the voltages into which the voltage between V_{REF} pin and SGO pin is divided by the resistors should be supplied to this pin.
Refer to the V_{REF} description for voltage division by the resistors.
If the potential difference between this pin and the SGO pin is V_{MODL} (V), the TAO output level is expressed as follows.

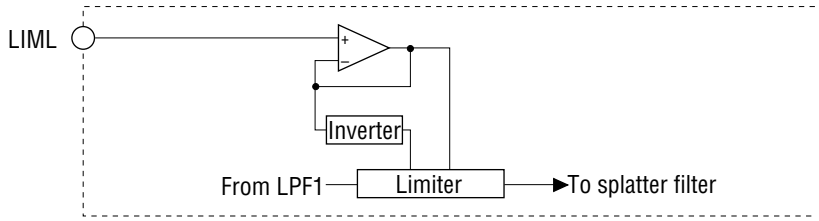
$$V_{OX} = 20 \cdot \log (V_{MODL}) + 0.5 \text{ (dBV)}$$

GND
Ground pin (0V).

LIML
Clamp voltage input pin for deviation limiter.
The voice signal maximum RF modulation can be controlled by supplying, to this pin, one of the voltages into which the voltage between V_{REF} pin and SGO pin is divided by the resistors.
Refer to the V_{REF} description for voltage division by the resistors.
If the potential difference between this pin and the SGO pin is V_{LIML} (V), the limiter level is expressed as follows.

$$V_{LIML} = 20 \cdot \log (V_{LIML}) - 3.0 \text{ (dBV)}$$

The DC clamp level is $V_{SG} \pm V_{LIML}$.



CPDL

Input DC voltage reference level definition pin for compander.
One of the voltages into which the voltage between V_{REF} pin and SGO pin is divided by the resistors should be supplied to this pin. Refor to the V_{REF} description for voltage division by the resistors.
If the potential difference between this pin and the SGO pin is V_{CPDL}, the compressor and expander input reference levels are expressed as follows.

$$V_{ICS} = V_{IES} = 20 \cdot \log (V_{CPDL}) - 5.8 \text{ (dBV)}$$

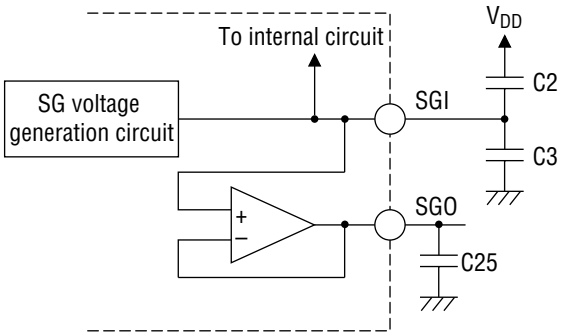
The compressor input reference level and expander input reference level change simultaneously.

SGI

Built-in signal ground that is reference voltage to be supplied to analog circuit.
The DC voltage is one half of the supply voltage.
When the power has fewer noises and fewer ripples, the idle noise can be improved by inserting a bypass capacitor over 1 µF between SGI and GND, and between SGI and V_{DD}. If the power has a lot of noises, do not insert a bypass capacitor between SGI and V_{DD} to reduce supply noises.
Other capacitors and resistors should be connected to the SGO pin.

SGO

Signal ground voltage output pin for LSI external circuits.
The DC voltage is one half of the supply voltage.
Insert a 1 µF capacitor between SGO and GND.



BR

MODEM data signaling rate switching input.

BR	Data Signaling Rate	Note
0	1200 bps	SW8
1	2400 bps	

CE3P, CE3N

Pins used to connect a capacitor for defining a time constant of output transient response for the expander.
Insert a 0.22 µF capacitor between CE3N and CE3P.

CE1, CE2

Pins used to connect a capacitor for removing DC offset in the expander.
Insert a 0.22 µF capacitor between CE1 and SGO, an 1 µF capacitor between CE2 and SGO.

EMP

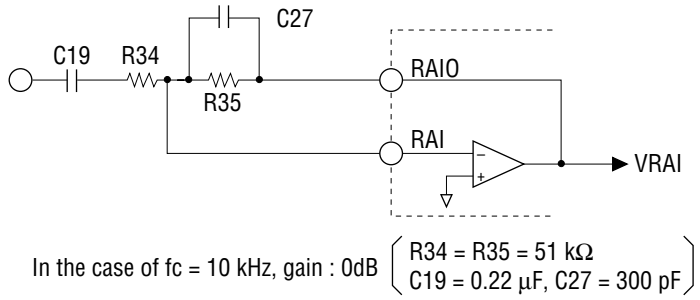
Emphasis path selection pin.

EMP	Transmit side	Receive side	Note
0	Pre-emphasis circuit is bypassed to the path	De-emphasis circuit is bypassed to the path	SW2
1	Pre-emphasis circuit is connected to the path	De-emphasis circuit is connected to the path	

RAIO, RAI

Pins used to constitute RC-active filter on the receive signal input side.
Refer to the TVIO and TVI description.
If the Scrambler circuit is used, using the first order RC-active filter is recommended. In this case, configure the filter so that either R34 or R35, or both of them, is 60 kΩ or less.

<First order RC-active filter configuration>



RVO

Receive voice signal output pin.
The RVO state is controlled depending on the digital data set to RVE.

RVE	RVO	Note
0	No signal output (voltage = V_{SG})	SW7
1	Output of signals input to RAI and RAIO	

VOL1, VOL2

Pins used to set up a gain for the electronic volume.
The volume at the stage next to expander is controlled by the pins.

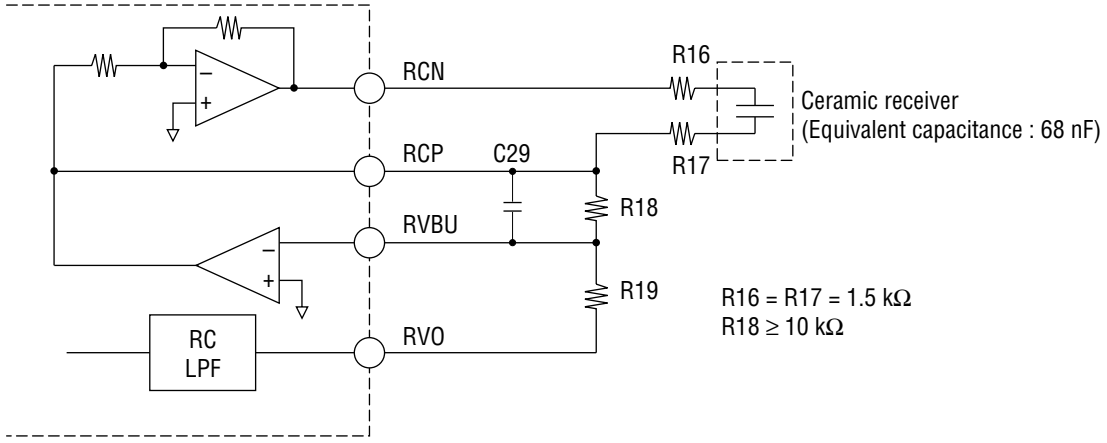
VOL2	VOL1	Gain
0	1	+6 dB
0	0	0 dB
1	1	–6 dB
1	0	–12 dB

CSH

Pin used to connect a capacitor for removing DC offset in shaper of modem receiver.
Insert a 1 µF capacitor between this pin and GND.

RVBU
Ceramic receiver amplifier input pin.
Refer to the RCN, RCP description.

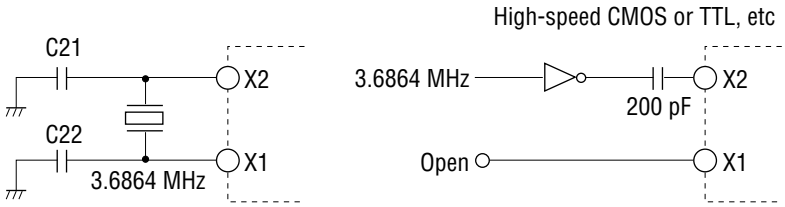
RCP, RCN
Ceramic receiver amplifier output pins.



C29 is a capacitor for oscillation prevention. Be sure to use a capacitor of 20 pF or more.
If no ceramic receiver amplifier is used, RVBU should be directly connected to RCP, RCN be open, and R16 to R19, and C29 be removed.

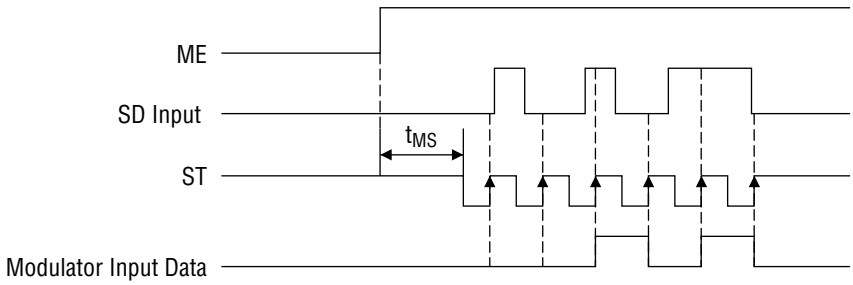
PDRC
Pin used to control power down of the ceramic receiver amplifier.
If digital "1" is input in this pin, the two ceramic receiver amplifiers are powered down. If the LSI is in power-down mode 1 or 2 (PDN = "1", RVE = "0"), the ceramic receiver amplifiers are powered down even when the PDRC is at "0".

X1, X2
Crystal oscillator connection pins.
3.6864 MHz crystal oscillator should be connected.
If the load capacitance of the crystal oscillator is 16 pF, insert a 12 pF capacitor between X1 and GND and between X2 and GND.
If an external clock is used, with X1 opened, the clock should be input from X2 through a 200 pF capacitor.



SD

Transmit data input pin.
The data on the SD pin is accepted as the modulator input signals in synchronization with the rising edges of ST.



At the start of data transmission, the synchronization with the receive modem is required. Therefore bit synchronous signals (the alternating patterns of "1" and "0") more than 18 bits should be input in SD.
If a radio transmission path is better in S/N ratio, the receive section can properly operate with bit synchronous signals more than 11 bits.

FD

Frame synchronous detection signal output pin.
If the contents of received data in the LSI matches the patterns defined by FPS and BIT in a state where FDE is at "1" level, FD holds "1" level. If FDE is at"0" level, FD is fixed at "0" level. FD is also fixed at "0" in power-down mode 1 or 2 (PDN = "1", RVE = "0").
Take the following procedure to detect frame synchronization:
(1) Set the synchronous patterns to be detected at BIT and FPS.
(2) Drive FDE at "0" level for 1 ms or more, and then at "1" level. FD is reset to "0" and RT and PD are fixed at "1" level.
(3) When a frame synchronous signal has been detected, FD is driven at "1" level and RT and RD become active. To ensure detection of frame synchronous signals, lock in PLL of the receive modem. At the beginning of transmission, transmit synchronous patterns after synchronizing with the opposite modem using a bit synchronous signal of 18 bits or more.
Refor to "Receiver Signal Timing" in Fig. 3.

RD

Receive data output pin.
Outputs demodulation serial data for receive signals.
Since the RD data is output in synchronization with the falling edges of re-generated timing clock pulse RT, it is recommended that the data be latched on the rising edge of RT.
If FDE is at "1" level and FD is at "0" level, RD remains set at "1" level.

RT
Receive data timing re-generation clock output pin.
Outputs synchronous clock re-generated by built-in PLL. The data from RD and signals from FD are output in synchronization with falling edges of signals from the RT pin. If FDE is at "1" level and FD is at "0" level, RD remains set at "1" level.
Refer to "Receive Signal Timing" in Fig. 3.

V_{DD}
Power supply pin.
A bypass capacitor more than 10 µF should be inserted between this pin and GND.

BIT
Bit synchronous signal detector control input pin.
The FD pin goes to "1" level when the BIT pin and FDE pin are at "1" level, and a 4-bit synchronous signal and 16-bit frame synchronous signal are successively detected.
The FD pin goes to "1" level when the BIT pin is at "0" level and the FDE pin is at "1" level, and a 16-bit frame synchronous signal is detected.
Refer to the FPS description.

FPS
Frame synchronous pattern setup input pin.

BIT	FPS	Detection Pattern	Receiver
0	0	1001 0011 0011 0110 (= 9336H)	Handset
0	1	1100 0100 1101 0110 (= C4D6H)	Base station
1	0	1010 1001 0011 0011 0110 (= A9336H)	Handset
1	1	1010 1100 0100 1101 0110 (= AC4D6H)	Base station

(These synchronous patterns are for Japanese cordless telephones.)

RCK1, RCK2, SEC
Reverse frequency selection pins of voice scrambler.
These pins are also used to select filter and scrambler bypass mode.

SEC	PCK1	PCK2	Transmit side	Receive side	Note
0	0	0	Pre-BPF, SCR and LPF1 are bypassed	DE-SCR and LPF2 are bypassed	SW4
0	0	1	Pre-BPF and LPF1 are connected but Scrambler circuit (SCR) is bypassed	LPF2 is connected but De-scrambler (DE-SCR) is bypassed	SW3 SW4
0	1	0			
0	1	1			
1	0	0	Pre-BPF, SCR and LPF1 are bypassed	DEM-BPF output is connected to RVO pin via RC-LPF (for IC test)	SW9
1	0	1	Scrambler works	De-scrambler circuit works	SW3 SW4
1	1	0			
1	1	1			

RCK1	RCK2	Reverse freq.
0	1	3200 Hz
1	0	3291 Hz
1	1	3388 Hz

ME

Pin used to control MSK modulator output.
If digital "1" is entered to this pin, MSK modulator output is connected to splatter filter input. Refer to the TAO description.
If digital "1" is entered to the ME pin and digital "0" to the PDN, RVE and TVE pins, the voice signal processing system is powered down. Refer to the PDN pin description.

ST

Transmit data timing clock output pin.
Signals on the SD pin are accepted in synchronization with the leading edges of the signals from the ST pin. If ME is at "0" level, ST remains set at "1" level.

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage	V_{DD}	Ta = 25°C Referred to GND	–0.3 to 7	V
Analog Input Voltage *1	V_{IA}		–0.3 to V_{DD}+0.3	
Digital Input Voltage *2	V_{ID}			
Operating Temperature	T_{op}	—	–30 to +70	°C
Storage Temperature	T_{STG}	—	–55 to +150	

*1: TVI, MICN, MICP, CMPI, UAI, MODL, LIML, CPDL, RAI, RVBU
*2: TVE, RVE, PDN, FDE, BYP, BR, EMP, VOL1, VOL2, PDRC, X2, SD, BIT, FPS, RCK1, RCK2, SEC, ME

RECOMMENDED OPERATING CONDITIONS

Parameter		Symbol	Condition		Min	Typ	Max	Unit
Power Supply Voltage		V_{DD}	Referred to GND		+1.8	+2.4	+5.5	V
Operating Temperature		T_{op}	—		–30	+25	+70	°C
Data Signaling Rate		Ts	BR = "0"		—	1200	—	bit/sec
			BR = "1"		—	2400	—	
Analog Signal Input Level		V_{IA}	TVIO, RAIO level	V_{DD} = 2.1 V to 5.5 V	—	—	–6	dBV
				V_{DD} = 4.5 V to 5.5 V	—	—	0	
DC Input Range		V_{MODL}	Referred to V_{SG}	MODL	0.05	0.25	$\frac{1}{3}V_{DD}$ –0.2	V
		V_{LIML}		LIML	0.1	0.25	$\frac{1}{2}V_{DD}$ –0.3	
		V_{CPDL}		CPDL	0.1	0.25	0.5	
Microphone Amplifier Common Mode Input Voltage Range		V_{IM}	MICN, MICP		0.85	—	V_{DD} –0.8	
C2, C3, C13, C15, C25		—	—		—	1.0	—	µF
C10, C11, C12, C14, C16		—	—		—	0.22	—	
C4		—	—		—	0.1	—	
C20		—	—		—	10	—	
C21, C22		—	—		—	12	—	pF
C28, C29		—	—		20	—	—	
Crystal Resonator	Frequency	—	—		—	3.6864	—	MHz
	Freq, Tolerance	—	25 ±5°C		–100	—	100	ppm
	Temp, Coefficient	—	–30 to 70°C		–100	—	100	
	Equivalent Series Resistance	—	—		—	—	100	Ω
	Load Capacitance	—	—		—	16	—	pF

ELECTRICAL CHARACTERISTICS

DC and Digital Interface Characteristics

(V_{DD} = 2.1 V to 5.5 V, Ta = –30 to 70°C)

Parameter	Symbol	Condition		Min	Typ	Max	Unit
Power Supply Current *1	I_{DD}	Normal mode (mode 5)	2.4 V	—	10	17	mA
			5.5 V	—	16	33	
	I_{DDS1}	Power Down mode 1	5.5 V	—	1.0	50	µA
	I_{DDS2}	Power Down mode 2	2.4 V	—	120	220	
	I_{DDS3}	Power Down mode 3		—	5.3	9.2	mA
	I_{DDS4}	Power Down mode 4		—	6.0	10.5	
Input Leakage Current *2	I_{IL}	V_{IN} = 0 V		–5.0	—	5.0	µA
	I_{IH}	V_{IN} = V_{DD}					
Input Voltage *2	V_{IL}	—		0	—	0.2V_{DD}	V
	V_{IH}			0.8V_{DD}	—	V_{DD}	
Output Voltage *3	V_{OL}	I_{OL} = –20 µA		0	—	0.1	
	V_{OH}	I_{OH} = 20 µA		V_{DD}–0.1	—	V_{DD}	

*1: Refer to PDN in the PIN AND FUNCTIONAL DESCRIPTIONS.
*2: TVE, RVE, PDN, FDE, BYP, BR, EMP, VOL1, VOL2, PDRC, SD, BIT, FPS, RCK1, RCK2, SEC, ME
*3: FD, RD, RT, ST

MODEM AC Characteristics

(V_{DD} = 2.1 V to 5.5 V, Ta = –30 to 70°C)

Parameter		Symbol	Condition		Min	Typ	Max	Unit
Transmit Carrier Frequency		f_{M1}	SD = "1"	BR = "0"	1199	1200	1201	Hz
		f_{S1}	SD = "0"	ME = "1"	1799	1800	1801	
		f_{M2}	SD = "1"	BR = "1"	1199	1200	1201	
		f_{S2}	SD = "0"	ME = "1"	2399	2400	2401	
Transmit Carrier Level		V_{OX}	R5 = R6		–12.7	–11.5	–10.3	dBV
Receive Carrier Level		V_{IR}	V_{DD} = 2.1 V to 5.5 V		–30	—	–3	
			V_{DD} = 4.5 V to 5.5 V		–30	—	+4	
Bit Error Rate	1200 bps	B_{ER}	S/N values measured at RAIO	8 dB	—	1×10^{-3}	—	—
				10 dB	—	5×10^{-5}	—	
	2400 bps			11 dB	—	1×10^{-3}	—	
				13 dB	—	5×10^{-5}	—	
Number of PLL Lock-in data bits *1		B_N	Number of data bits required for the PLL to be Locked in within the phase difference of 22.5° or less		—	—	18	bit
			Number of data bits required for the PLL to be Locked in within the phase difference of 90° or less		—	—	11	

*1: In the case where receive MSK signals are bit synchronous signals (modulated signals with the alternating pattern of "0" and "1")

Voice Signal Processing Characteristics

(V_{DD} = 2.1 V to 5.5 V, Ta = –30 to 70°C)

Parameter		Symbol	Condition		Min	Typ	Max	Unit
Limiter Clamp Level		V_{LIM}	R3 = R4, V_{DD} = 2.4 V		–16	–15	–14	dBV
Transmit Output Distortion		H_{DT}	f_{IN} = 1 kHz, –18 dBV BYP = EMP = "0", R7 = R8		—	–48	–40	dB
Receive Output Distortion		H_{DR}			—	–45	–38	
Transmit Idle Noise		N_{IT}	BYP = EMP = "0" R7 = R8		—	–62	–52	dBV
Receive Idle Noise		N_{IR}			—	–80	—	
Crosstalk	(Receive to transmit)	C_{TT}	BYP = EMP = "0" f_{IN} = 1 kHz, –15 dBV		—	–60	–50	
	(Transmit to receive)	C_{TR}			—	–90	—	
Transmit Gain		G_{T1}	f_{IN} = 1 kHz BYP = "1"	SEC = "0"	–1.5	0	+1	dB
		G_{T2}		SEC = "1"	–1.5	0	+1	
Receive Gain		G_{R1}		SEC = "0"	–1.5	0	+1	
		G_{R2}		SEC = "1"	–1.5	0	+1	
Reverse Frequency of Voice Scrambler		f_R	Common to transmit and receive	3200 Hz	3197	3200	3203	Hz
				3291 Hz	3288	3291	3294	
				3388 Hz	3385	3388	3391	
Transmit Reverse Frequency Leak Level		L_{RT}	No signal input BYP = RCK2 = "0" SEC = RCK1 = "1" R7 = R8		—	–88	–60	dBV
Receive Reverse Frequency Leak Level		L_{RR}			—	–110	—	
Transmit Input Signal Leak Level		L_{IT}	f_{IN} = 1 kHz, –15 dBV BYP = RCK2 = "0" SEC = RCK1 = "1", R7 = R8		—	–55	–48	dB
Receive Input Signal Leak Level		L_{IR}			—	–55	–48	
Transmit Filter		FT1	EMP = "1" BYP = "1" SEC = "0" RCK1 = "0" RCK2 = "0" Reference = 1 kHz	100 Hz	—	–28	–23	
		FT3		300 Hz	–12.5	–10.5	–8.5	
		FT25		2.5 kHz	+6.5	+8.0	+9.5	
		FT30		3 kHz	+7	+9	+11	
		FT50		5 kHz	—	–32	–27	
Receive Filter		FR1		100 Hz	+1.0	+2.5	+4.0	
		FR3		300 Hz	+7.5	+9.0	+10.5	
		FR25		2.5 kHz	–9.5	–8.0	–6.5	
		FR30		3 kHz	–11.5	–9.5	–7.5	
		FR50		5 kHz	—	–35	–30	

Voice Signal Processing Characteristics (Continued)

(V_{DD} = 2.1 V to 5.5 V, Ta = –30 to 70°C)

Parameter		Symbol	Condition		Min	Typ	Max	Unit
Ceramic Receiver Amplifier (RCP, RCN)	Output Resistance	R_{OC}	—		—	40	—	Ω
	Output Load Resistance	R_{LC}			1.35	1.5	—	kΩ
	Receiver Equivalent Capacitance	C_{CR}			—	68	75	nF
	Output Level	V_{CR}	f_{IN} = 1 kHz, Distortion Ratio ≤ –30 dB, V_{DD} = 2.4 V		—	—	–4	dBV
	Output Distortion	H_{DC}	f_{IN} = 1 kHz, –18 dBV		—	–68	–45	dB
User-Available Amplifier (UAO)	Output Resistance	R_{OU}	—		—	40	—	Ω
	Output Load Resistance	R_{LU}			2	—	—	kΩ
	Output Level	V_{OU}	Distortion Ratio ≤ –30 dB	V_{DD} = 2.1 V to 5.5 V	—	—	–6	dBV
				V_{DD} = 4.5 V to 5.5 V	—	—	0	
	Output Distortion Ratio	H_{DU}	f_{IN} = 1 kHz, –18 dBV		—	–64	–45	dB
Compressor	Input Reference Level	V_{ICS}	f_{IN} = 1 kHz, R7 = R8		–19.8	–17.8	–15.8	dBV
	Output Level *1	GC2	f_{IN} = 1 kHz, R7 = R8	–20 dB	–10.7	–10	–9.3	dB
		GC4		–40 dB	–21.2	–20	–18.8	
		GC6		–60 dB	—	–30	—	
	Attack Time	T_{AT1}	Input Level, –34 dBV → –22 dBV		—	3.0	—	ms
	Recovery Time	T_{RE1}	Input Level, –22 dBV → –34 dBV		—	16	—	
Expander	Input Reference Level	V_{IES}	f_{IN} = 1 kHz, R7 = R8		–19.8	–17.8	–15.8	dBV
	Maximum Input Level	V_{IEM1}	R7 = R8	V_{DD} = 2.1 V to 5.5 V	—	—	–15	
		V_{IEM2}		V_{DD} = 4.5 V to 5.5 V	—	—	–12	
	Output Level *1	GE1	f_{IN} = 1 kHz, R7 = R8	–10 dB	–21.5	–20	–18.5	dB
		GE2		–20 dB	–42.2	–40	–37.8	
		GE25		–25 dB	—	–50	—	
	Attack Time	T_{AT2}	Input Level, –26 dBV → –20 dBV		—	3.0	—	ms
	Recovery Time	T_{RE2}	Input Level, –20 dBV → –26 dBV		—	16	—	
Electronic Volume Gain		GEV1	VOL1 = VOL2 = "0" Referenced to RVO level at "0"	+6 dB	+5.5	+6.0	+6.5	dB
		GEV2		–6 dB	–6.5	–6.0	–5.5	
		GEV3		–12 dB	–12.5	–12.0	–11.5	

*1: 0 dB is defined as the input level and the output level when the standard input level is input.

Common Characteristics

(V_{DD} = 2.1 V to 5.5 V, Ta = –30 to 70°C)

Parameter	Symbol	Condition		Min	Typ	Max	Unit
Input Resistance	R_{IA}	*1		—	10	—	MΩ
Output Resistance	R_{OX}	$f_O \leq 4$ kHz, *2		—	200	—	Ω
Output Load Resistance	R_{LX1}	Output Level: less than –12 dBV	*3	10	—	—	kΩ
	R_{LX2}	Output Level: within the range of V_{01} and V_{02}	*3	40	—	—	kΩ
	R_{LX3}	V_{REF}, SGO		12	—	—	kΩ
Analog Signal Output Level	V_{01}	R_{LX2} = 40 kΩ*3	V_{DD} = 2.1 V to 5.5 V	—	—	–6	dBV
	V_{02}	R_{LX2} = 40 kΩ*3	V_{DD} = 4.5 V to 5.5 V	—	—	0	dBV
V_{REF} Output DC Voltage	V_{RF}	With respect to V_{SG}		0.45	0.5	0.55	V
SG Output DC Potential	V_{SG}	SGO, SGI		$V_{DD}/2$ –0.1	$V_{DD}/2$	$V_{DD}/2$ +0.1	V
Analog Output DC Potential	V_{AO}	TAO, RVO		$V_{DD}/2$ –0.15	$V_{DD}/2$	$V_{DD}/2$ +0.15	V

*1: On TVI, MICN, MICP, UAI, MODL, LIML, CPDL, RAI, RVBU
*2: On TVIO, MICO, TAO, RAIO, RVO
*3: When the distortion ratio is less than or equal to –30 dB on TVIO, MICO, TAO, RAIO, RVO

Digital Timing Characteristics

(V_{DD} = 2.1 V to 5.5 V, Ta = –30 to 70°C)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Data Setup Time	t_S	Refer to Fig. 1	1	—	—	µs
Data Hold Time	t_H		1	—	—	µs
Receive Data Output (RT→RD, FD)	t_D	Refer to Fig. 2	–300	—	300	ns
Synchronous Signal Output (ME→ST)	t_{MS}	Refer to SD pin description	0	—	834	µs

TIMING DIAGRAM

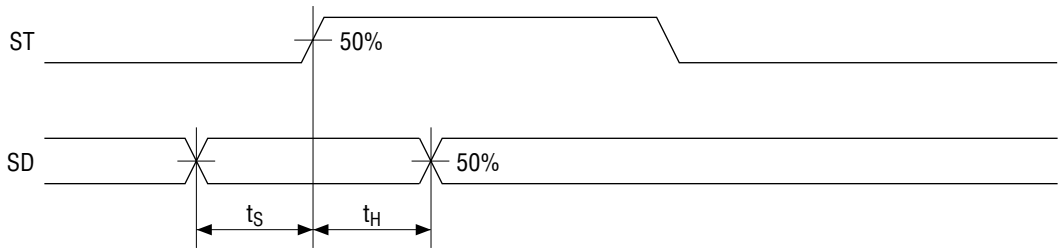


Figure 1 Input Data Timing

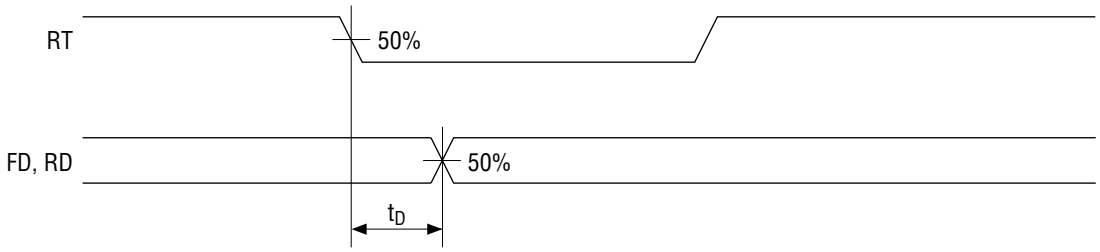
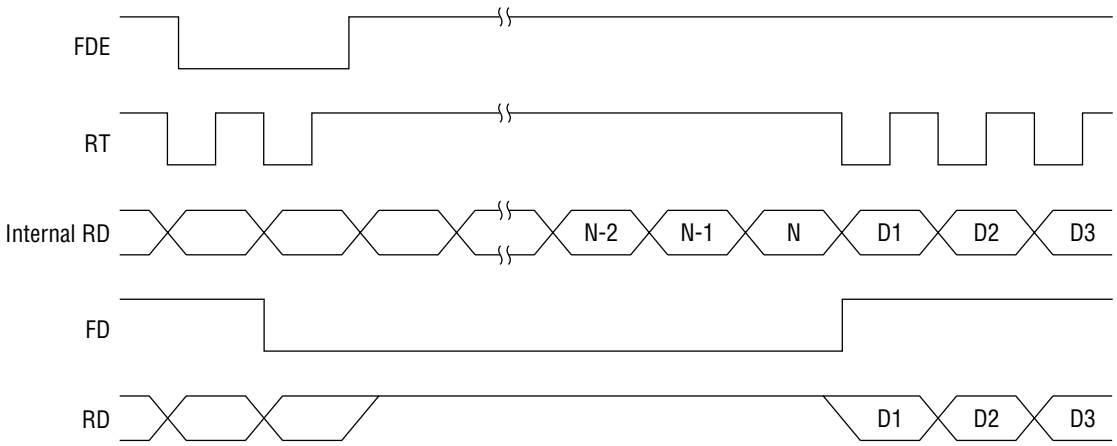


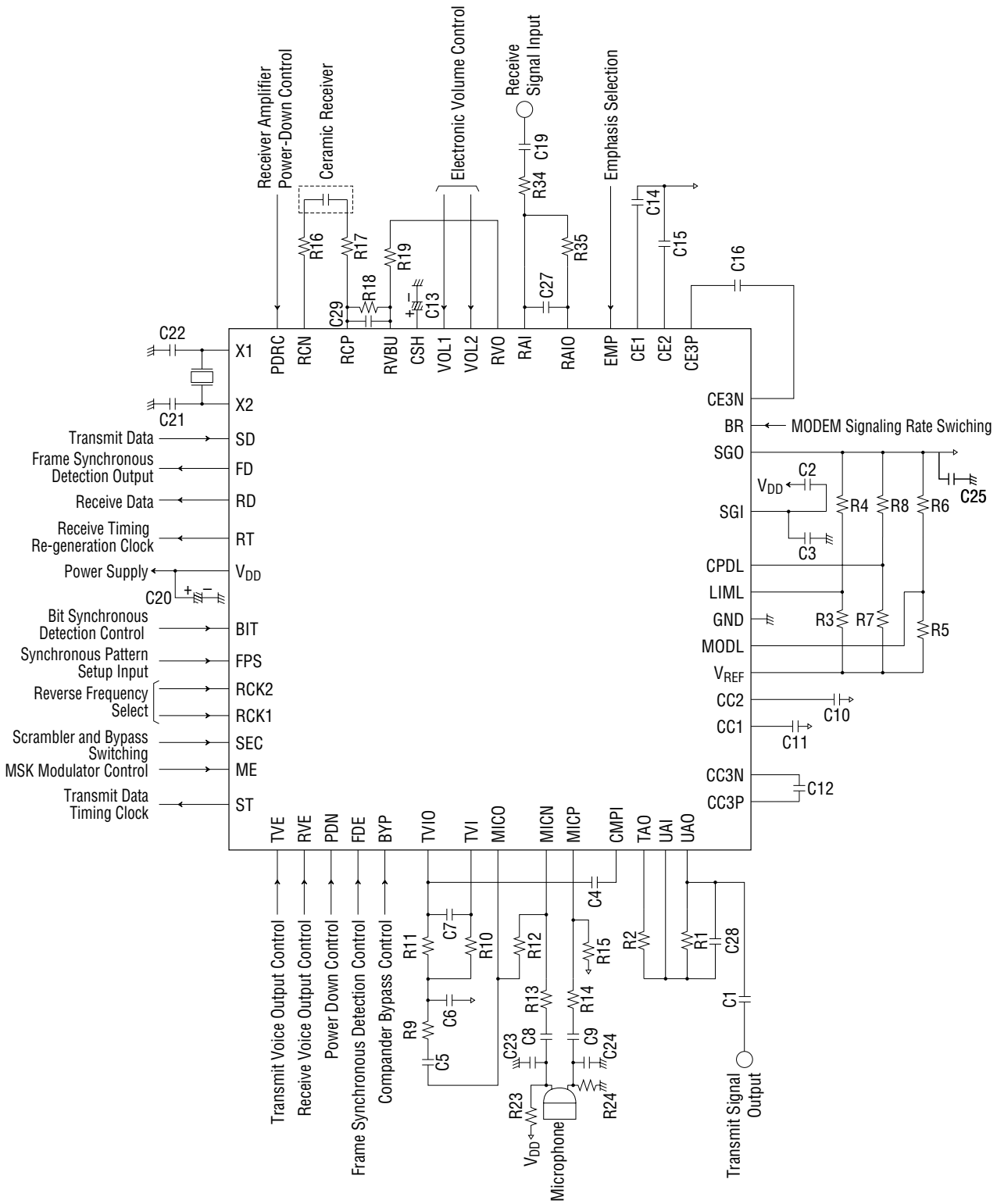
Figure 2 Output Data Timing



N-2, N-1, N : Frame synchronous signal

Figure 3 Receive Signal Timing

APPLICATION CIRCUIT

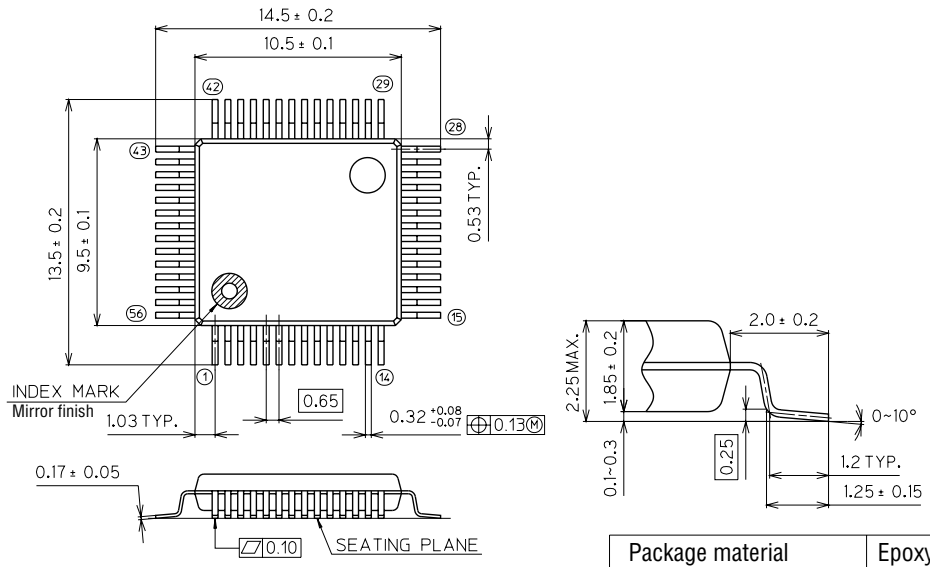


Note: An arrow mark (↓) indicates connection to the SGO pin.

PACKAGE DIMENSIONS

(Unit : mm)

QFP56-P-910-0.65-2K



Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating
Solder plate thickness	5 μm or more
Package weight (g)	0.43 TYP.

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).