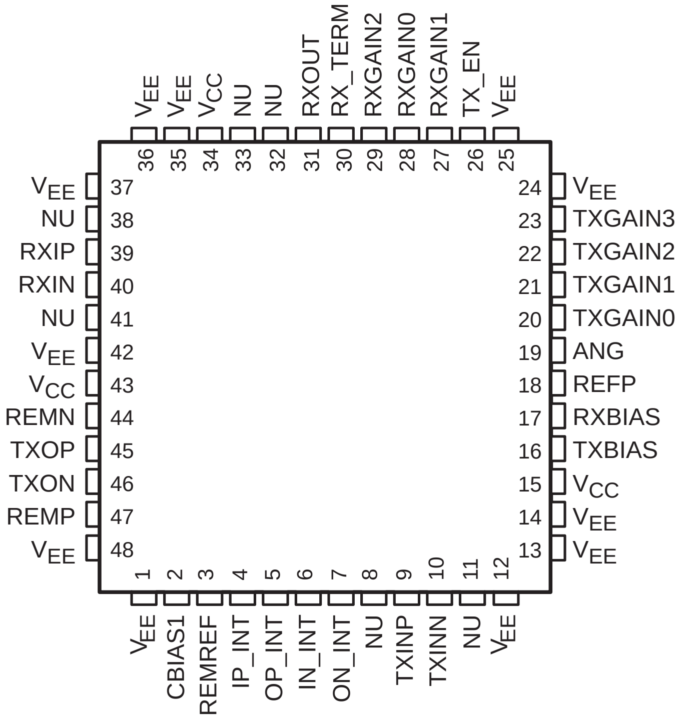
- **Single-Chip EtherLoop Transceiver**
- **Programmable Transmit (TX) and Receive (RX) Gain Via Digital Interface**
- **Low Overall Power Consumption**
- **Power-Down Mode Minimizes Server Modem Power Consumption in Multiplexed Applications**
- **Low Noise**
- **Low Distortion**
- **All Terminals Protected to Survive, Without Damage, a Simulated Static Discharge of 1 kV From a 100-pF Capacitor Applied Through a 1.5-kΩ Resistor With Respect to Chip Ground (V_{EE})**
- **Single-Rail 5-V Power Supply**
- **Operating Temperature –40°C to 85°C Ambient**
  - **Allows Operation in Central Office and Distributed-Server Modem Applications**
- **48-Pin Thin Plastic Quad Flatpack**

PT PACKAGE
(TOP VIEW)



NU – Not used

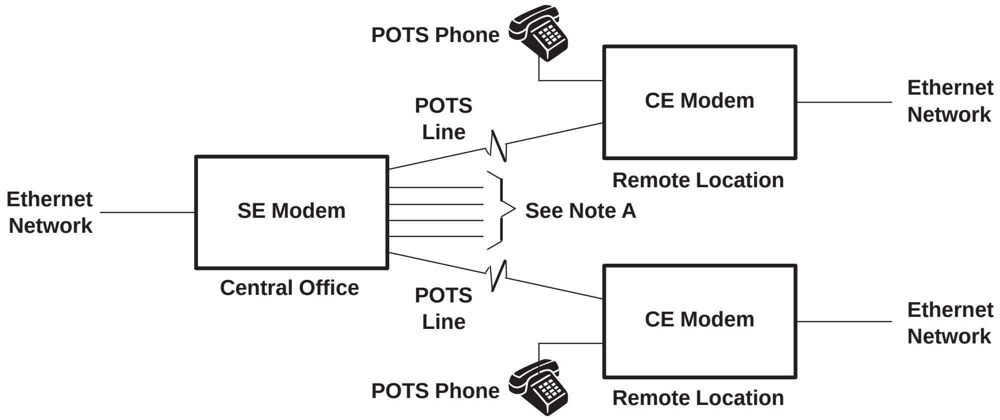
PRODUCT PREVIEW

description

The TNETEL1400 is an Etherloop transceiver. EtherLoop technology enables simultaneous voice and Ethernet communication over local-loop plain old telephone service (POTS) wiring. The TNETEL1400 supports data rates of up to 6 Mbit/s and POTS wire lengths of up to 21,000 feet. Figure 1 shows a typical system with an EtherLoop modem located at each end of the POTS line. Each EtherLoop modem has a 10Base-T Ethernet interface and is responsible for buffering Ethernet data before sending it over the POTS wire. The server-end (SE) EtherLoop modem is located in a central switching office and can communicate with several client-end (CE) EtherLoop modems, based on a round-robin arbitration scheme. The CE EtherLoop modem typically is located at a remote site.

EtherLoop is a trademark of Elastic Networks.

description (continued)



NOTE A: Flexible multiplexing scheme allows one SE modem to interface with many CE modems.

Figure 1. Typical EtherLoop System

Figure 2 shows a block diagram of a typical CE EtherLoop modem. Ethernet data destined for the POTS wire is received via 10Base-T interface and presented to the EtherLoop processor. The EtherLoop processor performs Ethernet frame processing and buffer management. The EtherLoop processor sends buffered Ethernet frames to the TNETEL1200 EtherLoop modem. The TNETEL1200 performs data modulation before passing the modulated digital data to a digital-to-analog (DAC) converter. The resulting analog signal passes to the TNETEL1400 transceiver, which acts as the line interface. The modem uses a half-duplex communication protocol over the POTS wire, and data received from the POTS wire follows the reverse path back to the Ethernet framer.

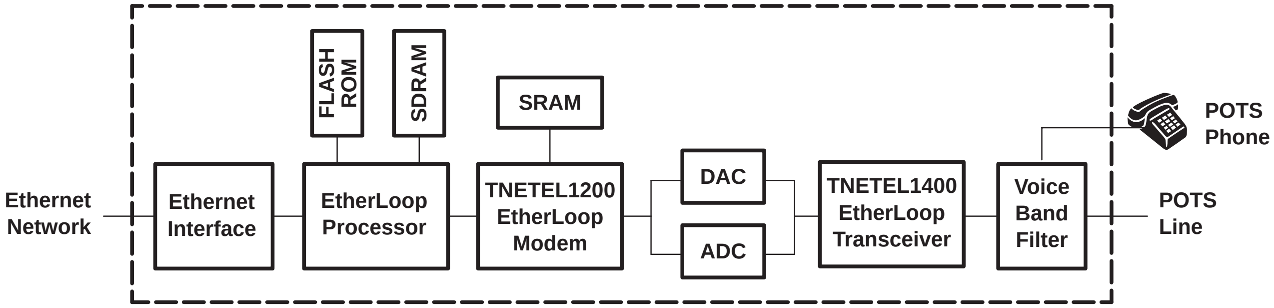


Figure 2. Typical CE EtherLoop Modem

Figure 3 shows a block diagram of a typical SE EtherLoop modem. Data flow follows the same path as in the CE EtherLoop modem. In the SE application, the EtherLoop processor also performs round-robin arbitration between each of the attached TNETEL1400 devices.

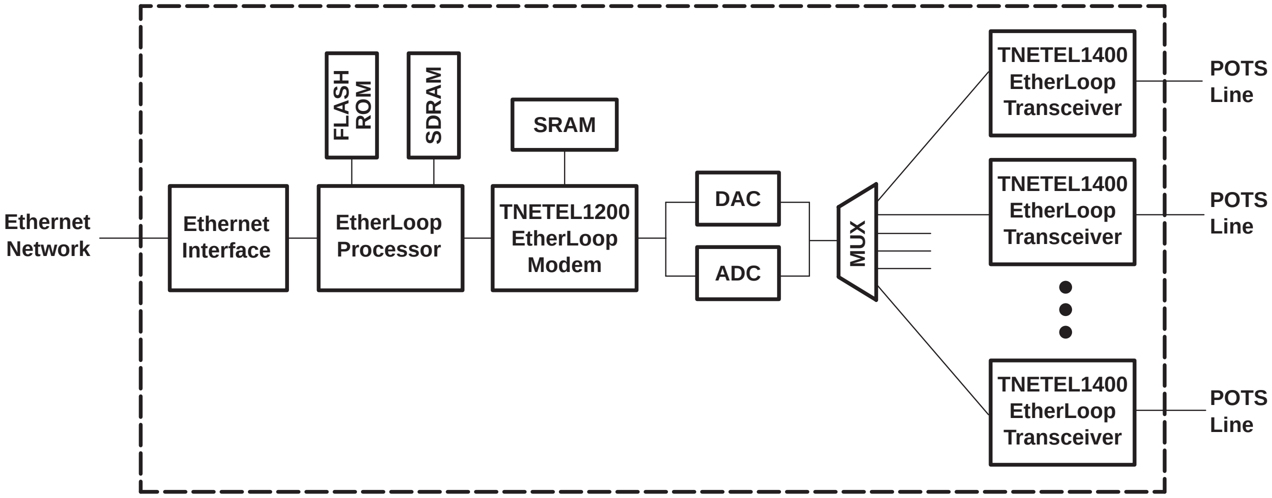
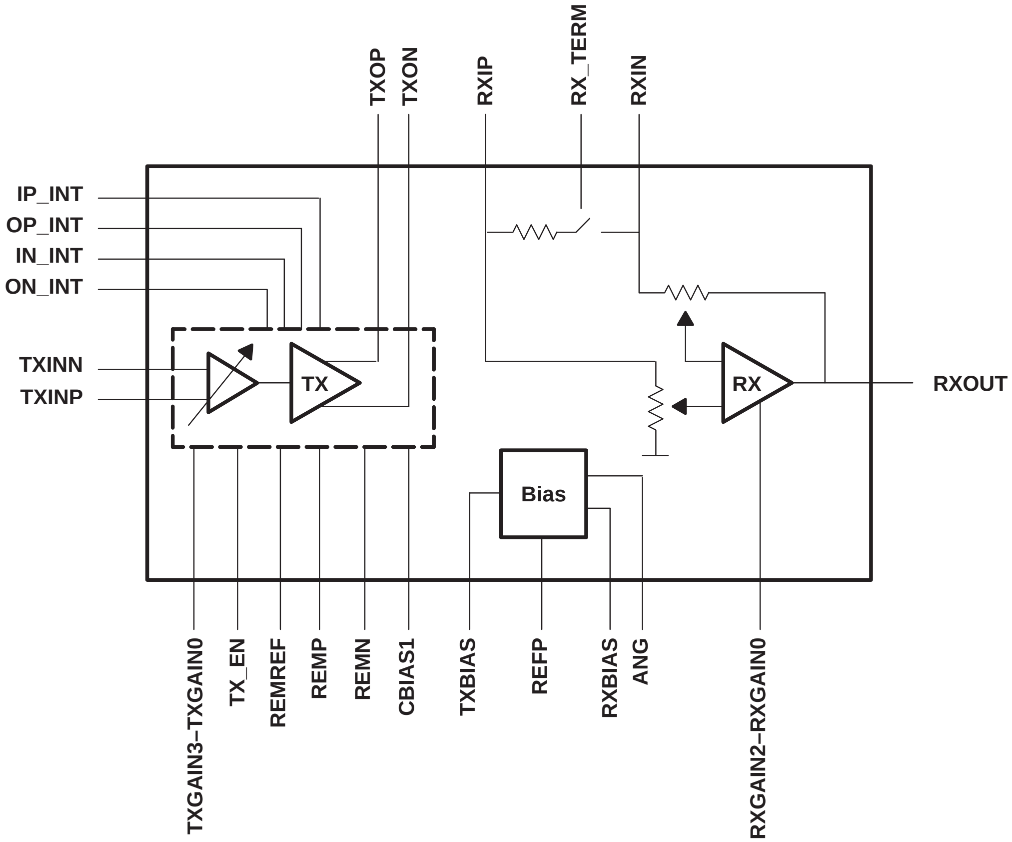


Figure 3. Typical SE EtherLoop Modem

summary of TNETEL1400 EtherLoop transceiver

- Drives POTS line with signal generated by DAC
- Interfaces signal received from POTS line to ADC

functional block diagram



APPLICATION INFORMATION[†]

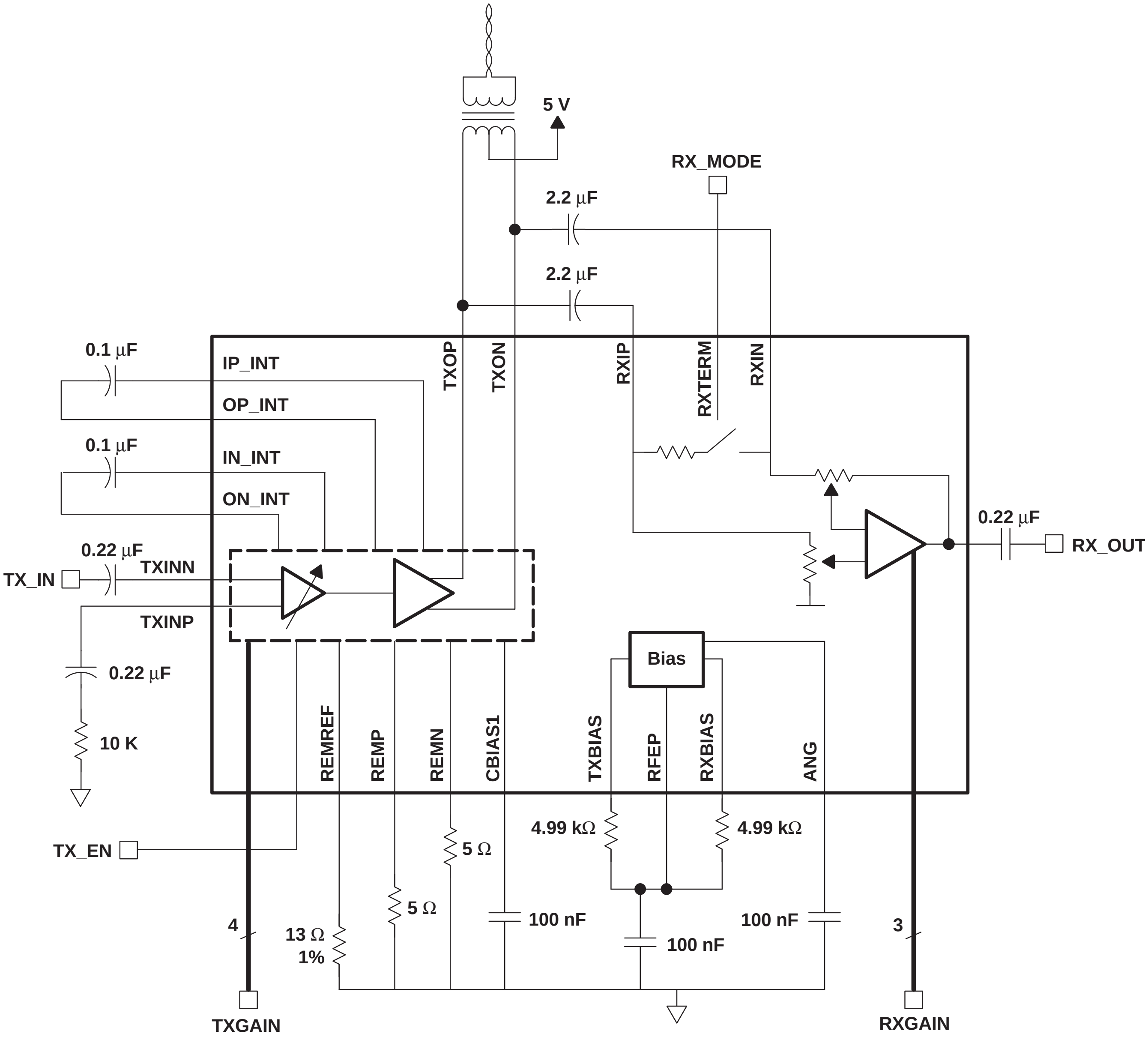


Figure 4. EtherLoop Front-End Application (CE)

[†] All bias resistors should be 1% tolerance. The resistors on REMP, REMN, and REMREF also should be 1% and placed as close as possible to their respective pins.

Terminal Functions

transmit (TX)

TERMINAL NAME	 NO.	I/O[†]	DESCRIPTION
CBIAS1	2	I/O	Transmit voltage bias decoupling
IN_INT	6	I	Transmit interstage ac coupling pin 1 (negative side)
IP_INT	4	I	Transmit interstage ac coupling pin 2 (positive side)
ON_INT	7	O	Transmit interstage ac coupling pin 2 (negative side)
OP_INT	5	O	Transmit interstage ac coupling pin 1 (positive side)
REMREF	3	O	Transmit temperature-compensating bias reference
TX_EN	26	I	Transmit enable 1 = Transmitter enabled 0 = Transmitter disabled
TXBIAS	16	I	Transmit current bias
TXGAIN3 TXGAIN2 TXGAIN1 TXGAIN0	23 (MSB) 22 21 20 (LSB)	I	Transmit preattenuation select (0 to –30 dB in –3-dB steps) 0000 = 0 dB 0001 = – 3 dB • • • 1010 = –30 dB 1011 = TX OFF • • • 1110 = TX OFF 1111 = TX OFF
TXINN	10	I	Transmit input negative. TXINN can be coupled to ground for SE input).
TXINP	9	I	Transmit input positive. TXINP can be coupled to ground for SE input).
TXON	46	O	Transmitter output negative
TXOP	45	O	Transmitter output positive

[†] I = input, O = output

PRODUCT PREVIEW

Terminal Functions (Continued)

receive (RX)

TERMINAL NAME	TERMINAL NO.	I/O†	DESCRIPTION
RX_TERM	30	I	Receive passive termination RX_TERM = 1: 110 Ω switched IN RX_TERM = 0: 110 Ω switched OUT
RXBIAS	17	I	Receive current bias
RXGAIN2 RXGAIN1 RXGAIN0	29 (MSB) 27 28 (LSB)	I	Receive gain select 000 = RX OFF • • • 011 = RX OFF 100 = 0 dB 101 = 12 dB 110 = 24 dB 111 = 30 dB
RXIN	40	I	Receiver input negative/TX feedback
RXIP	39	I	Receiver input positive/TX feedback
RXOUT	31	O	Receiver output (single ended)

† I = input, O = output

miscellaneous

TERMINAL NAME	TERMINAL NO.	I/O†	DESCRIPTION
ANG	19	O	Analog ground (2.5 V) reference
REFP	18	O	4-V bandgap reference
REMN	44	I/O	Negative external emitter resistor
REMP	47	I/O	Positive external emitter resistor

† I = input, O = output

power supply

TERMINAL NAME	TERMINAL NO.	DESCRIPTION
NU	8, 11, 32, 33, 38, 41	Not used
V_{CC}	15, 34, 43	5-V power
V_{EE}	1, 12, 13, 14, 24, 25, 35, 36, 37, 42, 48	Ground

absolute maximum ratings over operating free-air temperature (unless otherwise noted)†

Supply-voltage range, V_{CC} . . . . 4.3 V to V_{CC} to 0.7 V
Input-voltage range: Analog inputs . . . . –0.7 V to V_{CC} to 0.7 V
Output-voltage range, V_O . . . .
Storage temperature range, T_{stg} . . . . -55°C to 25°C

† 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.

recommended operating conditions

		MIN	MAX	UNIT
V_{CC}	Supply voltage	4.75	5.25	V
V_{IH}	High-level input voltage	2.1		V
V_{IL}	Low-level input voltage		1	V
I_{OH}	High-level input current			mA
I_{OL}	Low-level input current			mA
T_A	Operating free-air temperature range	–40	85	°C

PRODUCT PREVIEW

electrical characteristics over recommended operating conditions

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
I_{CC}	Supply current	Normal operation	25		50	µA
		Power-down mode	1.5		3	
V_{REF}	4-V reference voltage		3.88	4	4.12	V
V_{ANG}	2.5-V reference voltage		2.38	2.5	2.62	V
I_{REFP}	4-V reference current	Source			1	mA
I_{ANG}	2.5-V reference current	Source/sink			100	mA

† All typical values are at V_{CC} = 5 V, T_A = 25°C (unless otherwise noted).

transmitter (see Figure 5)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
TX maximum output level		V_{CC} = 5 V, R_L = 110 Ω, RX_TERM = 0, TX_EN = 1, $V_{(TXINP)}$ = 1.2 V_{PP} sinusoid at f = 500 kHz (see Note 1)	TXGAIN = 0000, RXGAIN = 0XX	21	22	23	dBm
TX attentuator accuracy (relative to maximum output) TX attentuator accuracy (relative to maximum output)		V_{CC} = 5 V, R_L = 110 Ω, RX_TERM = 0, TX_EN = 1, RXGAIN = 0XX, $V_{(TXINP)}$ = 1.2 V_{PP} sinusoid at f = 500 kHz [output is measured at IN_INT and IP_INT (ac coupled)]	TXGAIN = 0001	–3.3	–3	–2.7	dB
			TXGAIN = 0010	–6.3	–6	–5.7	
			TXGAIN = 0011	–9.3	–9	–8.7	
			TXGAIN = 0100	–12.3	–12	–11.7	
			TXGAIN = 0101	–15.3	–15	–14.7	
			TXGAIN = 0110	–18.3	–18	–17.7	
			TXGAIN = 0111	–21.3	–21	–20.7	
			TXGAIN = 1000	–24.3	–24	–23.7	
			TXGAIN = 1001	–27.3	–27	–26.7	
			TXGAIN = 1010	–30.3	–30	–29.7	
TX output level variation over frequency		30 kHz < f < 2.5 MHz monotonically decreasing for f > 3 MHz, R_L = 110 Ω, RX_TERM = 0, TX_EN = 1, $V_{(TXINP)}$ = 1.2 V_{PP} sinusoid at f = 500 kHz with transformer connected as in Figure 1 (see Note 1)	TXGAIN = 0000, RXGAIN = 0XX			1	dB
TX output distortion (all gain settings)	Odd harmonics	V_{CC} = 5 V, R_L = 110 Ω, RX_TERM = 0, TX_EN = 1, $V_{(TXINP)}$ = 1.2 V_{PP} sinusoid at f = 500 kHz (see Note 1)	TXGAIN = 0000, RXGAIN = 0XX	–35			dBc
	Even harmonics			–50			
TX output signal-to-noise ratio (SNR) (all gain settings)		V_{CC} = 5 V, R_L = 110 Ω, RX_TERM = 0, TX_EN = 1, $V_{(TXINP)}$ = 1.2 V_{PP} sinusoid at f = 500 kHz (see Note 1)	TXGAIN = 0000, RXGAIN = 0XX	50			dB
TX maximum output-level variation with V_{CC}		V_{CC} = 5 V ± 0.25 V, R_L = 110 Ω, RX_TERM = 0, TX_EN = 1, $V_{(TXINP)}$ = 1.2 V_{PP} sinusoid at f = 500 kHz (see Note 1)	TXGAIN = 0000, RXGAIN = 0XX			1	dB/V
$Z_{in(TXIN)}$	TX input impedance	TXGAIN = 0000, RXGAIN = 0XX (see Note 1)			1400	TYP+ 30%	Ω
TX input impedance variation as percent of $Z_{in(TXIN)}$		TXGAIN = 0000, RXGAIN = 0XX		–30%		30%	

† All typical values are at V_{CC} = 5 V, T_A = 25°C (unless otherwise noted).

NOTE 1: While the RX circuit is disabled during transmission, it is still connected and, therefore, must withstand the signal levels placed at its input terminals.

transmitter (see Figure 5) (continued)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
$I_{rms(TXOP)}$– $I_{rms(TXON)}$	TX output current balance	V_{CC} = 5 V, R_L = 110 Ω, RX_TERM = 0, TX_EN = 1, $V_{(TXINP)}$ = 1.2 V_{PP} sinusoid at f = 500 kHz (see Note 1)	TXGAIN = 0000, RXGAIN = 0XX	–5		5	mA
TX output stability		Source impedance ≤ 50 Ω, Supply impedance ≤ 10 Ω, Z_{loads}: voltage standing-wave ratio (VSWR) 4:1 and open circuit	TXGAIN = 0000, RXGAIN = 0XX				
TX supply current		V_{OUT} = 0,	TXGAIN = 0000		35	45	mA
		V_{OUT} = MAX,	TXGAIN = 0000			120	
TX output return loss		TXGAIN = 0000, RXGAIN = 0XX		18			dB
TX power-up time		TXGAIN = 0000, RXGAIN = 0XX (see Note 2)				100	µs

† All typical values are at V_{CC} = 5 V, T_A = 25°C (unless otherwise noted).

NOTES: 1. While the RX circuit is disabled during transmission, it is still connected and, therefore, must withstand the signal levels placed at its input terminals.

2. The power-up/power-down time is the time it takes for the signal path to completely settle and meet all the transmission specifications after TXGAIN and RXGAIN are set to power-up condition or switched from one gain setting to another. This time consists of slewing and exponential settling of bias and AC coupling capacitors and, therefore, the values of these components must be as shown in the application diagram, Figure 4.

receiver (see Figures 6 and 7)

PARAMETER	TEST CONDITIONS		MIN	TYP†	MAX	UNIT
RX idle channel noise	R_L = 2 kΩ, C_L = 20 pF, 30 kHz < f < 2.75 MHz, RX_TERM = 1, TX_EN = 0, $V_{(RXIP – RXIN)}$ = 0.04 V_{PP} sinusoid at f = 500 kHz (see Note 3)	RXGAIN = 11			691	µV RMS
		RXGAIN = 10			478	
		RXGAIN = 01			266	
		RXGAIN = 00			160	
RX gain accuracy	V_{CC} = 5 V, R_L = 2 kΩ, C_L = 20 pF, 30 kHz < f < 2.75 MHz, RX_TERM = 1, TX_EN = 0, $V_{(RXIP – RXIN)}$ = 0.04 V_{PP} sinusoid at f = 500 kHz	RXGAIN = 11	24	30	31	dB
		RXGAIN = 10	23	24	25	
		RXGAIN = 01	11	12	13	
		RXGAIN = 00	–1	0	1	
RX gain over frequency (WRT gain at 500 kHz)	R_L = 2 kΩ, C_L = 20 pF, 30 kHz < f < 2.75 MHz, 30 kHz < f < 2.5 MHz monotically decreasing for f > 3 MHz, TX_EN = 0, $V_{(RXIP – RXIN)}$ = 0.04 V_{PP} sinusoid at f = 500 kHz	RX_TERM = 1, RXGAIN = 111	–1		1	dB
RX power-supply rejection (WRT V_{CC} only)	R_L = 2 kΩ, C_L = 20 pF, dc < f < 3 MHz, TX_EN = 0, $V_{(RXIP – RXIN)}$ = 0.04 V_{PP} sinusoid at f = 500 kHz	RX_TERM = 1, RXGAIN = 111			0.03	V/V
RX common-mode rejection	R_L = 2 kΩ, C_L = 20 pF, TX_EN = 0, $V_{(RXIN)}$ = 1.5 V_{PP}, $V_{(RXIP – RXIN)}$ = 0.04 V_{PP} sinusoid at f = 500 kHz	RX_TERM = 1, RXGAIN = 111	30			dB
RX IIP3 intercept	R_L = 2 kΩ, C_L = 20 pF, TX_EN = 0, $V_{(RXIP – RXIN)}$ = 0.04 V_{PP} sinusoid at f = 500 kHz (see Note 4)	RX_TERM = 1, RXGAIN = 111	17			dBm

† All typical values are at V_{CC} = 5 V, T_A = 25°C (unless otherwise noted).

NOTES: 3. Idle channel noise is the noise (V_{rms}) measured at RXOUT with no signal at RXIN. This voltage is integrated over the 30-KHz to 2.75-MHz band. This specification is in place of the original noise-figure specification, and is correlated to NF with laboratory measurements.

4. The two tones used for this test are at 1.39 MHz and 1.58 MHz, and the in-band IIP3 products are at 1.2 MHz and 1.77 MHz. The IIP3 intercept point is the output power level, where the power of the harmonics equals that of the signal frequencies. This point is an intersection of two straight lines extrapolated from two low-power measurements.

receiver (see Figures 6 and 7) (continued)

PARAMETER	TEST CONDITIONS		MIN	TYP†	MAX	UNIT
RX output total harmonic distortion	R_L = 2 kΩ, C_L = 20 pF, TX_EN = 0, $V_{(RXOUT)}$ = 2 V_{PP}, $V_{(RXIP – RXIN)}$ = 0.04 V_{PP} sinusoid at f = 500 kHz	RX_TERM = 1, RXGAIN = 111			–40	dBc
RX Z_{IN}	R_L = 2 kΩ, C_L = 20 pF, RXGAIN = 111, TX_EN = 0, $V_{(RXIP – RXIN)}$ = 0.04 V_{PP} sinusoid at f = 500 kHz	RX_TERM = 1	77	110	143	Ω
		RX_TERM = 0	10			kΩ
RX maximum supply current	R_L = 2 kΩ, C_L = 20 pF, TX_EN = 0, $V_{(RXOUT)}$ = 4 V_{PP}, $V_{(RXIP – RXIN)}$ = 0.04 V_{PP} sinusoid at f = 500 kHz	RX_TERM = 1, RXGAIN = 111			20	mA
RX power-up time	R_L = 2 kΩ, C_L = 20 pF, TX_EN = 0, $V_{(RXIP – RXIN)}$ = 0.04 V_{PP} sinusoid at f = 500 kHz (see Note 2)	RX_TERM = 1, RXGAIN = 111			30	µs
Power-down supply current	R_L = 2 kΩ, C_L = 20 pF, RX_TERM = 1, TX_EN = 0, $V_{(RXIP – RXIN)}$ = 0.04 V_{PP} sinusoid at f = 500 kHz (see Note 2)	TXGAIN = 1111, RXGAIN = 000			3	mA

† All typical values are at V_{CC} = 5 V, T_A = 25°C (unless otherwise noted).

NOTE 2. The power-up/power-down time is the time it takes for the signal path to completely settle and meet all the transmission specifications after TXGAIN and RXGAIN are set to power-up condition or switched from one gain setting to another. This time consists of slewing and exponential settling of bias and AC coupling capacitors and, therefore, the values of these components must be as shown in the application diagram, Figure 4.

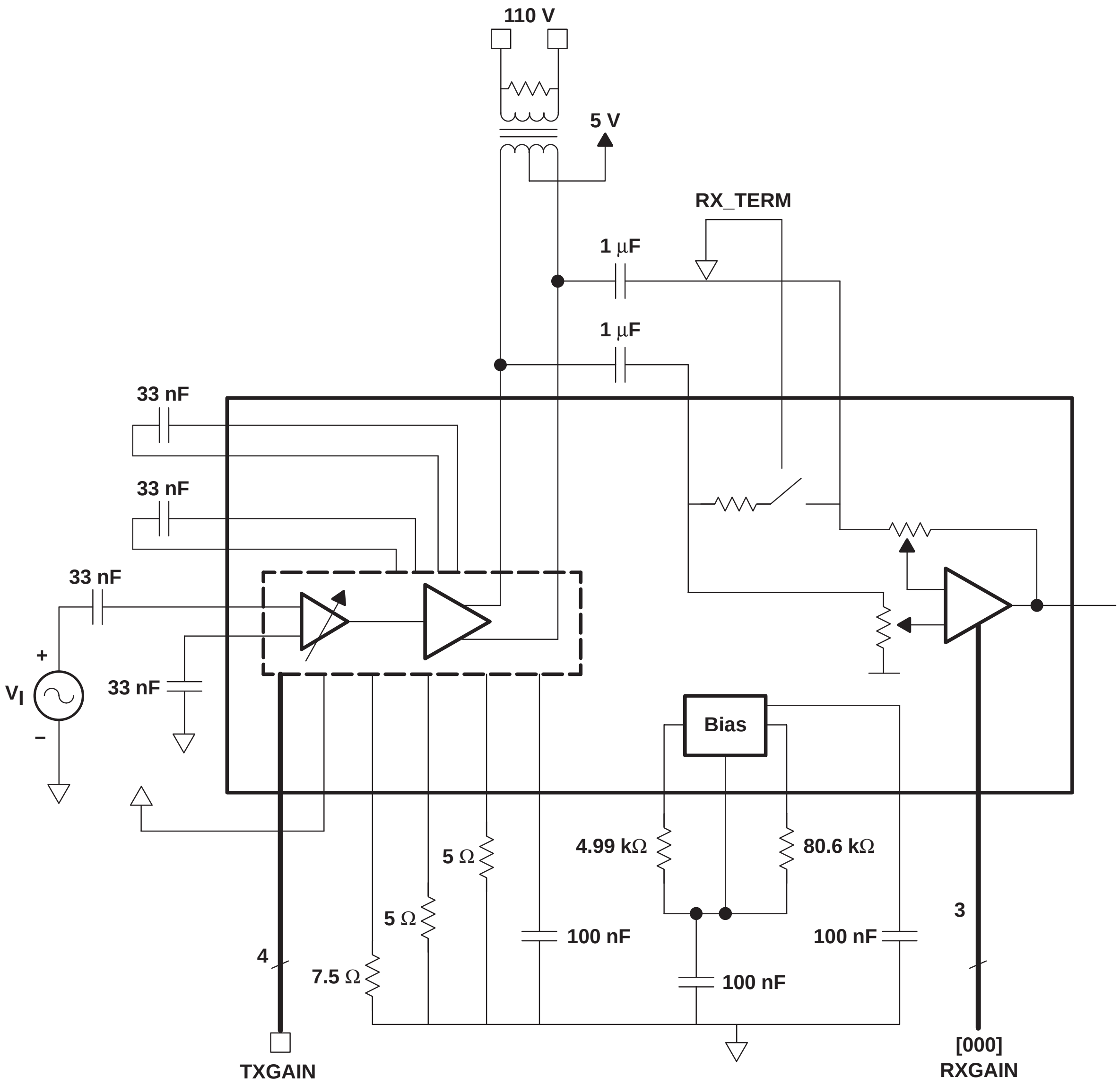


Figure 5. TX Test Circuit

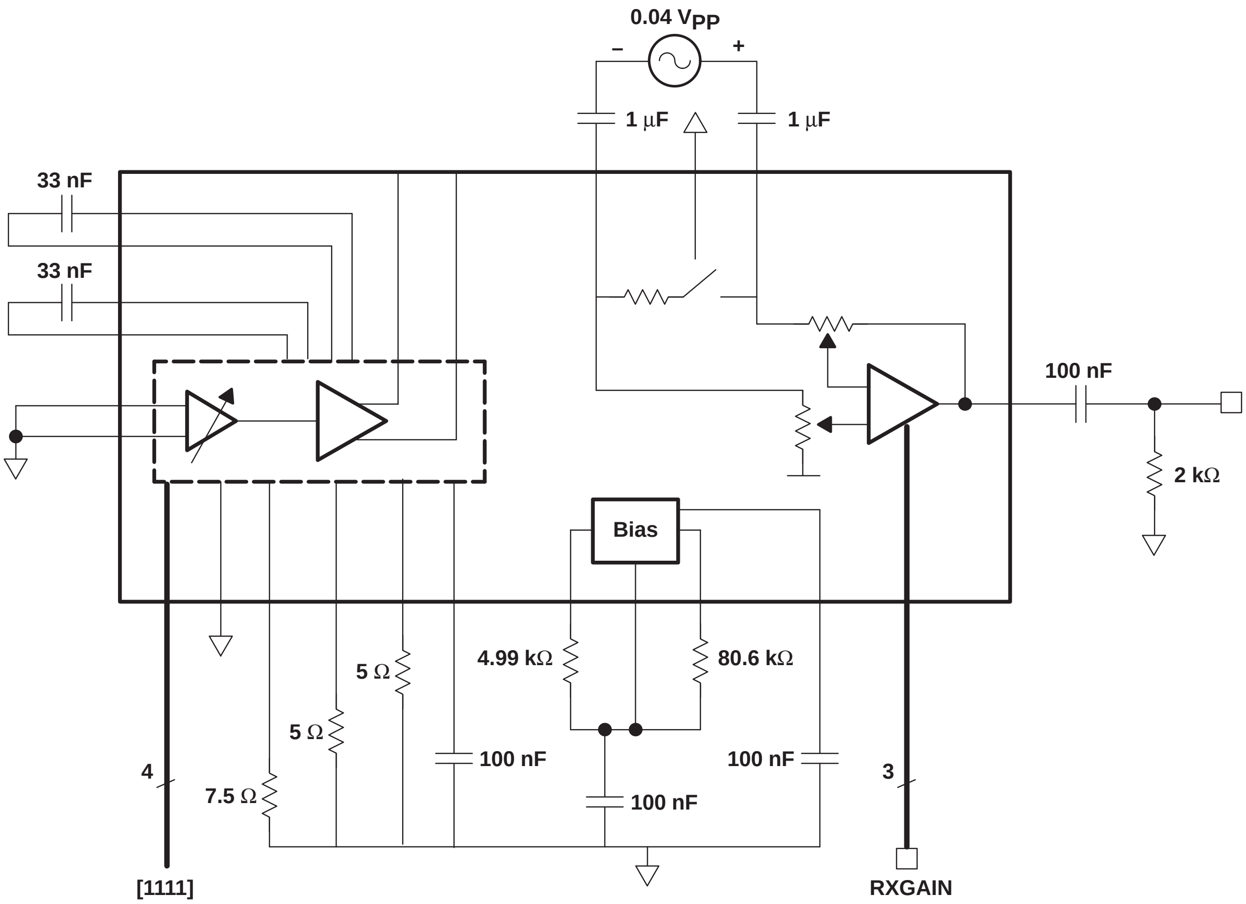


Figure 6. RX Test Circuit

PRODUCT PREVIEW

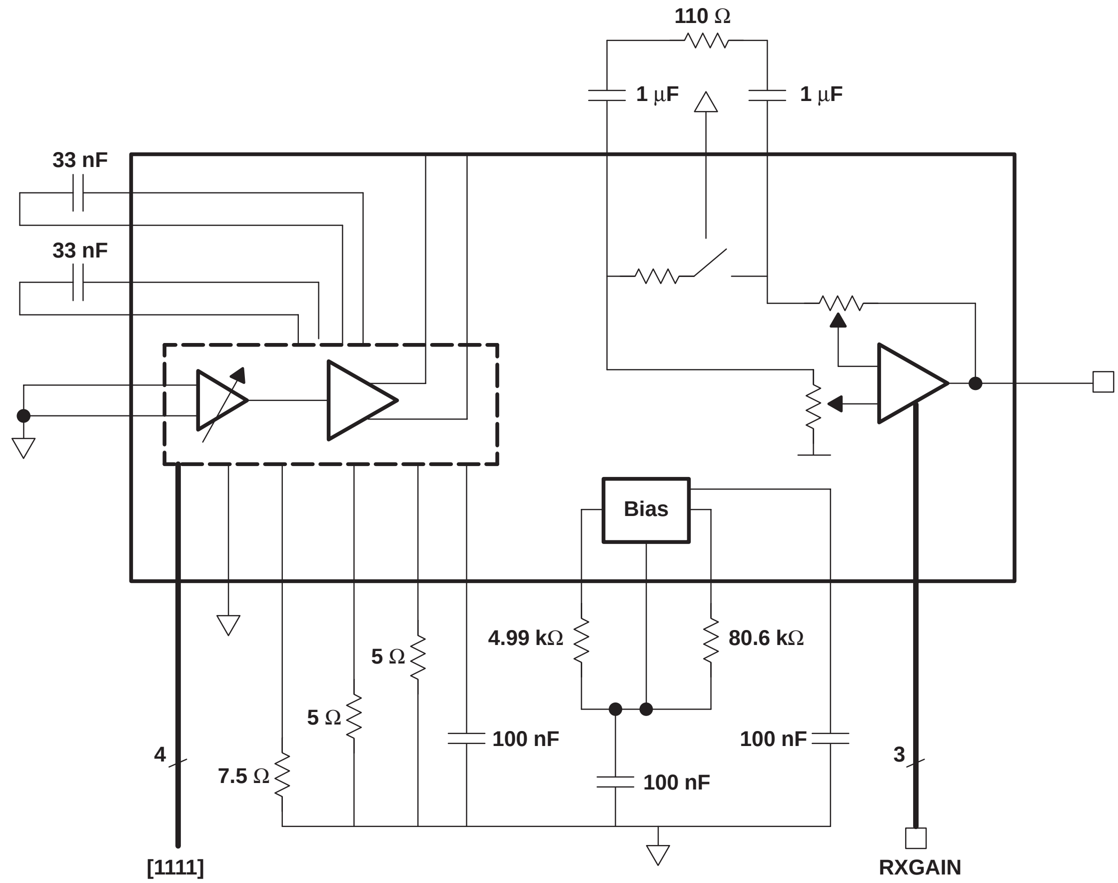
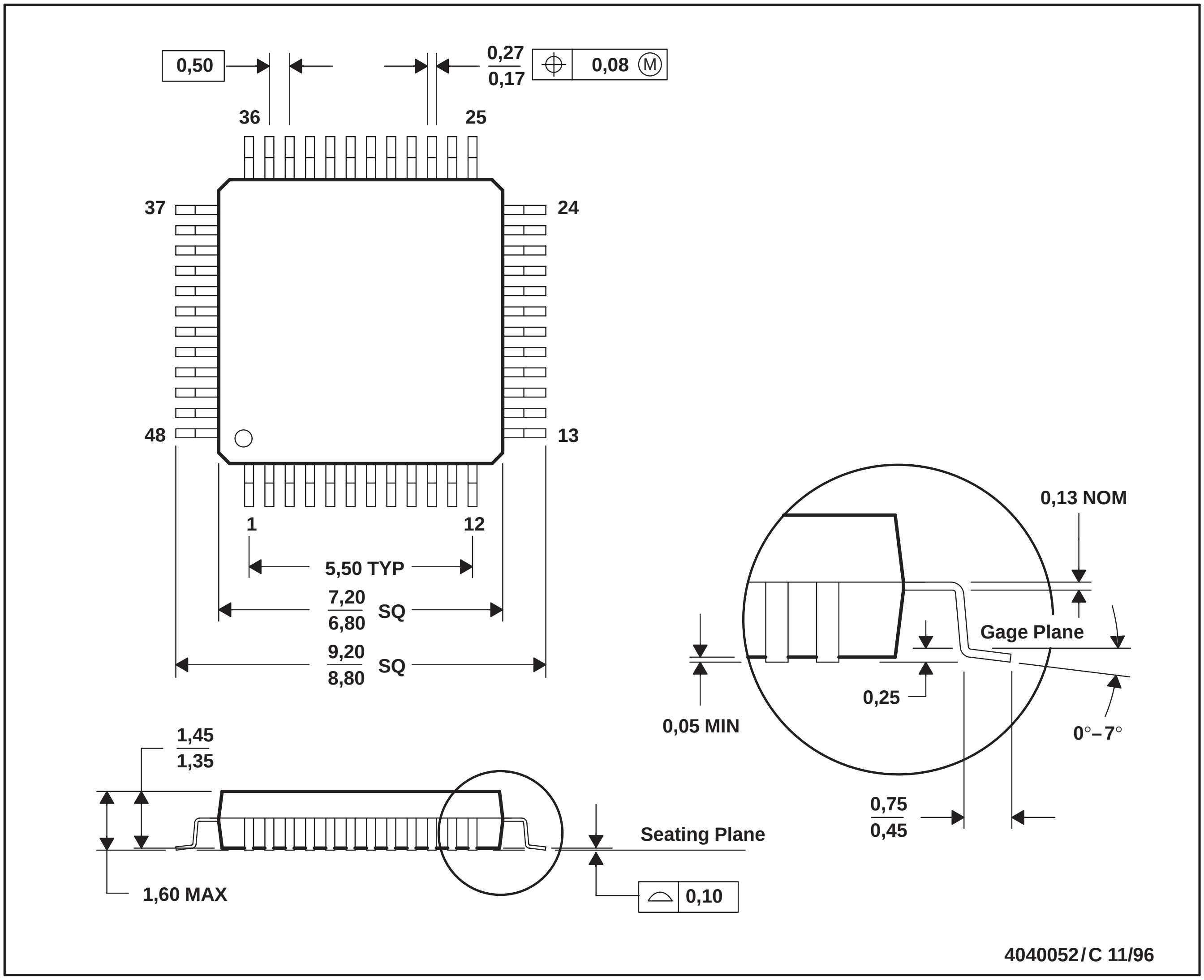


Figure 7. RX Noise Test Circuit

MECHANICAL DATA

PT (S-PQFP-G48) **PLASTIC QUAD FLATPACK**



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-026
D. This may also be a thermally enhanced plastic package with leads conected to the die pads.

PRODUCT PREVIEW

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