

PCT303DW FEATURES

Complete DAA includes:

- Programmable line interface
 - AC termination
 - DC termination
 - Ringer impedance
 - Ringer threshold
- 86 dB dynamic range TX/RX paths
- Integrated ring detector
- Up to 4000 V isolation
- Support for Caller ID
- Low-profile SOIC packages
- Low power consumption (15mW operating @3.3V)
- 3.3 or 5 V analog/digital power supply
- Direct interface to DSPs
- Integrated analog front end (AFE)
- 2–4-wire hybrid
- Daisy-chaining for up to eight devices

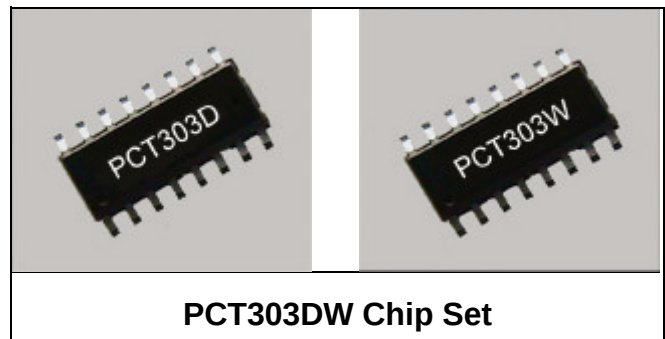
PCT303DW APPLICATIONS

- Modems

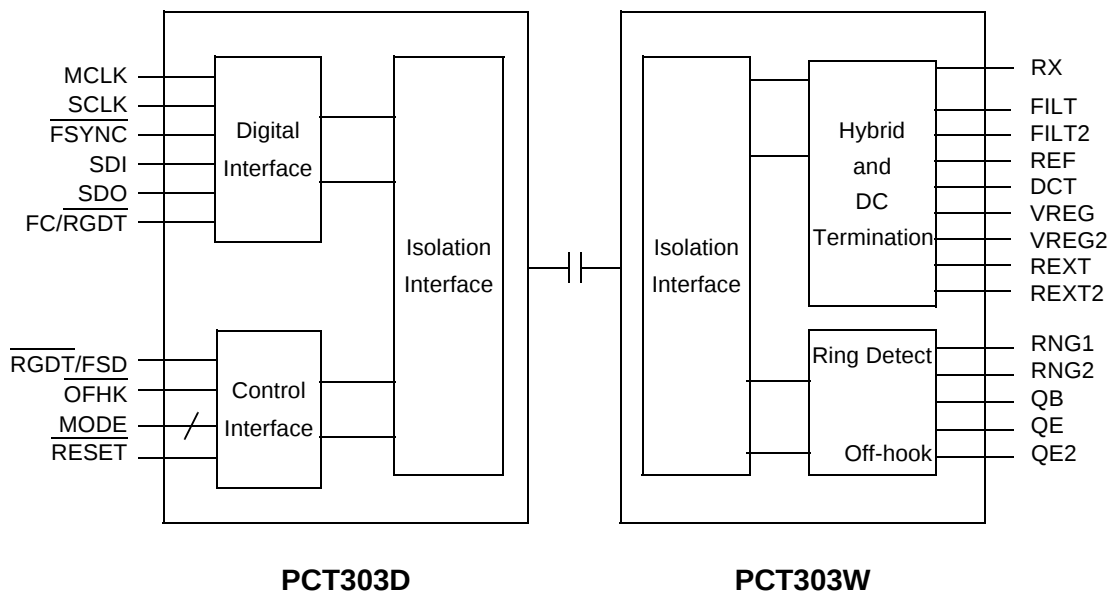
- Phone line interface systems

PCT303DW FUNCTIONAL DESCRIPTION

The PCT303DW is an integrated direct access arrangement (DAA) that provides a programmable line interface to meet international telephone line requirements. Available in two 16-pin small outline packages, it eliminates the need for an analog front end (AFE), an isolation transformer, relays, opto-isolators, and 2- to 4-wire hybrid. The PCT303DW dramatically reduces the number of discrete components and cost required to achieve compliance with international regulatory requirements. The PCT303DW interfaces directly to standard modem DSPs.



PCT303DW FUNCTIONAL BLOCK DIAGRAM



PCT303DW APPLICATION CIRCUITS

Typical Application (CTR21 International Design)

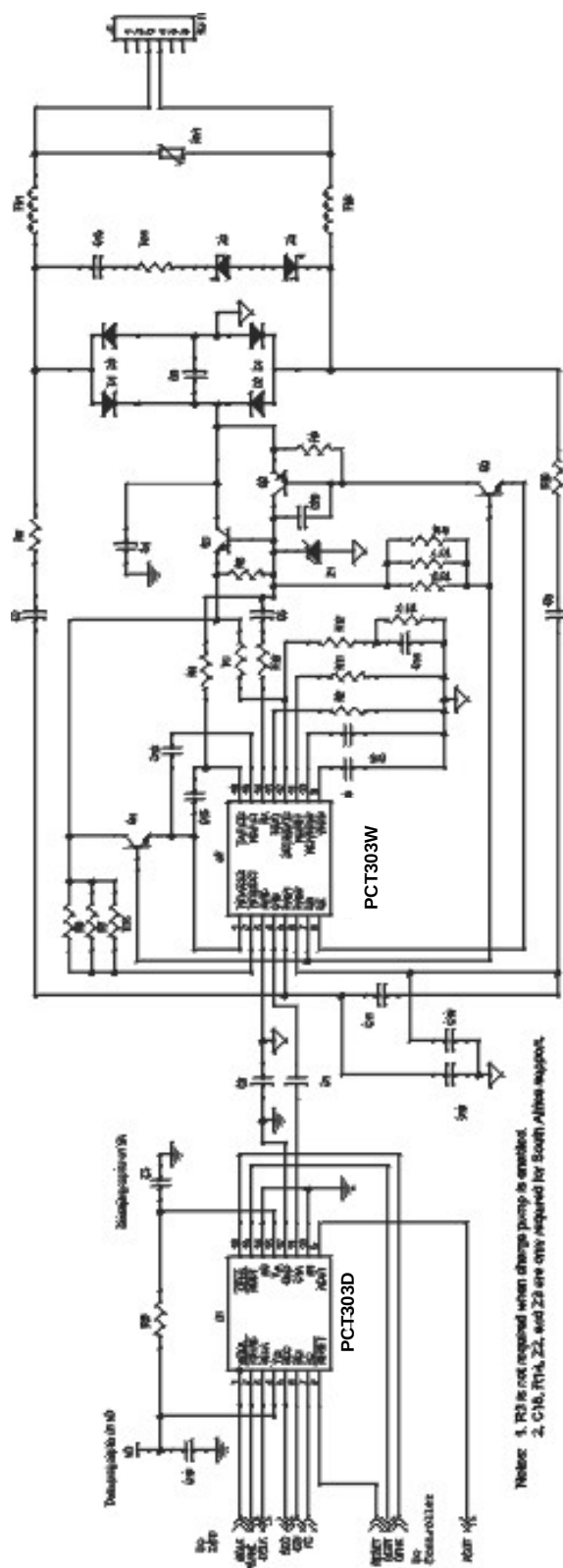


Figure 2 PCT303DW Typical Applications Circuit (CRT21 International Design)

Typical Application Component Values

Table 1 PCT303DW Typical Application Component Values (CTR21 International Design)

Symbol	North American Value	International Value
C1	150pF, 2kV, X7R, ±20%	150pF, 3kV, X7R, ±20%
C2,C4	1000pF, 2kV, X7R, ±20%	1000pF, 3kV, X7R, ±20%
C3,C10	0.1μF, 16V, X7R, ±20%	Same as North American
C5	0.47μF, 16V, X7R, ±20%	0.1μF, 50V, X7R, ±20%
C6	0.047μF, 16V, X7R, ±20%	0.1μF, 16V, X7R, ±20%
C7,C8	2200pF, 250V, X7R, ±20%	680pF, 250V, X7R, ±20%
C9	15nF, 250V, X7R, ±20%	22nF, 250V, X7R, ±10%
C11	5600pF, 16V, X7R, ±20%	Not Installed
C12	Not Installed	0.22μF, 16V, X7R, ±20%
C13,C16	Not Installed	0.1μF, 16V, X7R, ±20%
C14	Not Installed	560nF, 16V, X7R, ±20%
C15 ^a	Not Installed	0.47μF, 250V, ±20%
C18,C19	Not Installed	3900pF, 16V, X7R, ±20%
C20	Not Installed	47pF, 250V, X7R, ±20%
R1	51Ω, 1/2W ±5%	Not Installed
R2	15Ω, 1/4W ±5%	402 Ω, 1/10 W, ±1%
R3 ^b	10Ω, 1/10W, ±5%	Same as North American
R4	604Ω, 1/4W, ±1%	Not Installed
R5	36kΩ, 1/10W ±5%	Same as North American
R6	36kΩ, 1/10W ±5%	121kΩ, 1/10W, ±5%
R7,R8,R15,R16,R17,R19	Not Installed	4.87kΩ, 1/4W, ±1%
R9,R10	10kΩ, 1/4W ±5%	30kΩ, 1/4W, ±5%
R11	Not Installed	10kΩ, 1/10W, ±1%
R12	Not Installed	140Ω, 1/10W, ±1%
R13	Not Installed	442Ω, 1/10W, ±1%
R14 ^a	Not Installed	18.7kΩ, 1/4W, ±1%
R18	0Ω	2.2kΩ, 1/10W, ±5%
Z1	Zener Diode, 18V	Not Installed
Z2,Z3 ^a	Not Installed	Zener Diode, 3V
Q1,Q3	Motorola MMBTA42LT1	Same as North American
Q2	Motorola MMBTA92LT1	Same as North American
Q4	Not Installed	Motorola PZT2222AT1, 1/2W
D1–D4	1N4004	Same as North American
FB1,FB2	Ferrite Bead	Same as North American
RV1	Sidactor 275V, 100A	Same as North American

a. C14, R15, Z2, and Z3 required only for South Africa support.

b. R3 not required when charge pump is enabled.

Analog Output

Figure 3 illustrates an optional application circuit to support the analog output capability of the PCT303DW for call progress monitoring purposes.

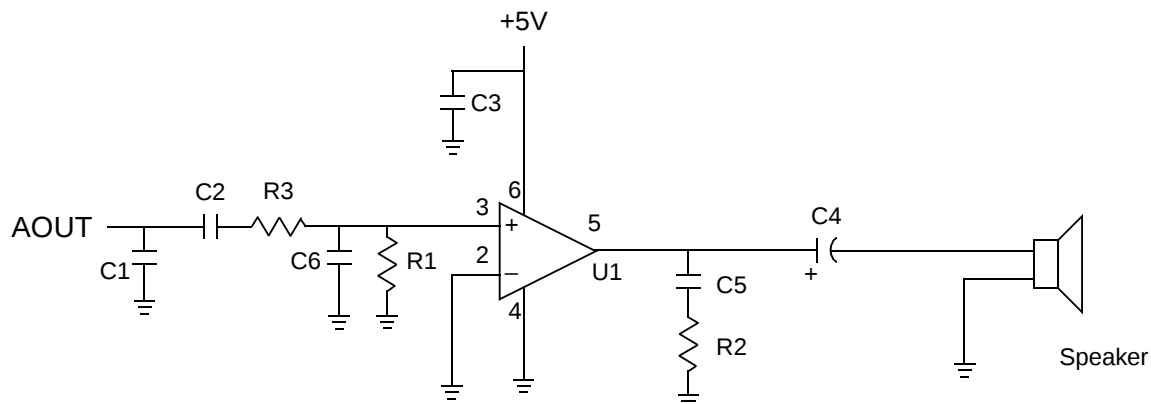


Figure 3 Optional Connection to AOUT For a Call Progress Speaker

Table 2 Optional Connection Component Values

Symbol	Value
C1	2200pF, 16V, $\pm 20\%$
C2, C3, C5	0.1 μ F, 16V, $\pm 20\%$
C4	100 μ F, 16V, Elec. $\pm 20\%$
C6	820pF, 16V, $\pm 20\%$
R1	10k Ω , 1/10W, $\pm 5\%$
R2	10 Ω , 1/10W, $\pm 5\%$
R3	47k Ω , 1/10W, $\pm 5\%$
U1	LM386

PCT303DW PINOUTS

PCT303D Pinout

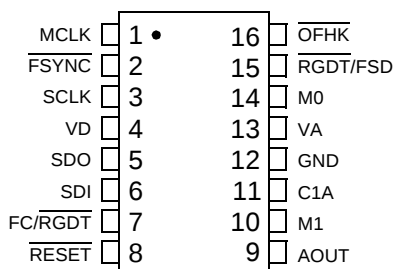


Figure 5 PCT303D 16-Pin SOIC

PCT303W Pinout

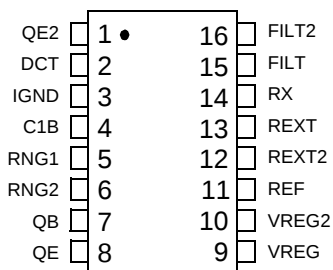


Figure 6 PCT303W 16-Pin SOIC

PCT303DW PIN DESCRIPTIONS

PCT303D Pin Description

Table 5 PCT303D Pin Description

Name	Number	I/O	Description
Serial Interface			
MCLK	1		Master clock input. High speed master clock input. Generally supplied by the system crystal clock or modem/DSP.
SCLK	3		Serial port bit clock output. Controls the serial data on SDOUT and latches the data on SDIN.
SDI	6		Serial port data in. Serial communication and control data that is generated by the modem/DSP and presented as an input to the PCT303D.
SDO	5		Serial port data out. Serial communication data that is provided by the PCT303D to the Modem/DSP.
FSYNC	2		Frame sync output. Data framing signal that is used to indicate the start and stop of a communication data frame.
FC/ RGDT	7		Secondary transfer request input/Ring detect. As FC, this pin is an optional signal to instruct the PCT303D that control data is being requested in a <u>secondary</u> frame. When daisy-chain is enabled, this pin becomes the ring detect output, RGDT, which produces an active-low, half-wave rectified version of the ring signal.
Control Interface			
RGDT/ FSD	15		Ring detect/Delayed frame sync. As RGDT, this pin is an output signal that indicates the status of a ring signal, which produces an active-low, half-wave rectified version of the ring signal. When daisy-chain is enabled, this signal becomes a delayed frame sync, FSD, to drive a slave device.
OFHK	16		Off hook. Input control signal that provides a termination across tip and ring for line seizing and pulse dialing, active-low.
RESET	8		Reset input. An active-low input that is used to reset all control registers to a defined, initialized state. Also used to bring the PCT303DW out of sleep mode.
M0	14		Mode select 0. One of two mode select pins that is used to select the operation of the serial port/DSP interface.
M1	10		Mode select 1. The second of two mode select pins that is used to select the operation of the serial port/DSP interface.
Miscellaneous Signals			
AOUT	9		Analog speaker output. Provides an analog output signal for driving a call progress speaker.
C1A	11		Isolation capacitor 1A. Connects to one side of the isolation capacitor C1.
Power Signals			
VD	4		Digital supply voltage. Provides the digital supply voltage to the PCT303D. Nominally either 5V or 3.3V.
VA	13		Analog supply voltage. Provides the analog supply voltage for the PCT303D. Nominally either 5V or 3.3V. The 3.3V supply is internally generated with an on-chip charge pump set through a control register.
GND	12		Ground. Connects to the system digital ground.

PCT303W Pin Descriptions

Table 6 PCT303W Pin Descriptions

Name	Number	I/O	Description
Line Interface			
FILT	15		Filter. Sets the time constant for the DC termination circuit.
FILT2	16		Filter 2. Sets the time constant for the DC termination circuit.
RX	14		Receive input. Serves as the receive side input from the telephone network.
DCT	2		DC termination. Provides DC termination to the telephone network.
REXT	13		External resistor. Sets the real AC termination impedance.
REXT2	12		External resistor 2. Sets the complex AC termination impedance.
RNG1	5		Ring 1. Connects through a 680pF capacitor to the “Tip” lead of the telephone line. Provides the ring and caller ID signals to the PCT303DW.
RNG2	6		Ring 2. Connects through a 680pF capacitor to the “Ring” lead of the telephone line. Provides the ring and caller ID signals to the PCT303DW.
QB	7		Transistor base. Connects to the base of transistor Q3.
QE	8		Transistor emitter. Connects to the emitter of transistor Q3.
QE2	1		Transistor emitter 2. Connects to the emitter of transistor Q4.
REF	11		Reference. Connects to an external resistor to provide a high-accuracy reference current.
Isolation			
C1B	4		Isolation capacitor 1B. Connects to one side of isolation capacitor C1.
IGND	3		Isolated ground. Connects to ground on the line-side interface. Also connects to capacitor C2.
Miscellaneous Signals			
VREG	9		Voltage regulator. Connects to an external capacitor to provide bypassing for an internal power supply.
VREG2	10		Voltage regulator 2. Connects to an external capacitor to provide bypassing for an internal power supply.

PIN COMPARISON OF PCT301L AND PCT303W

Table 7 PCT301L/PCT303W Pin Comparison

Pin Number	Pin Name	
	PCT301L	PCT303W
1	TSTA	QE2
2	TSTB	DCT
3	IGND	IGND
4	C1B	C1B
5	RNG1	RNG1
6	RNG2	RNG2
7	QB	QB
8	QE	QE

Pin Number	Pin Name	
	PCT301L	PCT303W
9	VREG	VREG
10	NC	VREG2
11	NC	REF
12	DCT	REXT2
13	REXT	REXT
14	RX	RX
15	NC	FILT
16	TX	FILT2

PCT303DW FUNCTIONAL DESCRIPTION

The PCT303DW is an integrated direct access arrangement (DAA) that provides a programmable line interface to meet international telephone-line requirements. The device implements Silicon Laboratories' proprietary ISOLink™ technology which offers the highest level of integration by replacing an analog front end (AFE), an isolation transformer, relays, opto-isolators, and a 2–4-wire hybrid with two 16-pin small outline packages (SOIC). The chipset can be fully programmed to meet international requirements, and the device is compliant with FCC, NET4, CTR21, JATE, and country-specific PTT specifications. In addition, the PCT303DW has been designed to meet the most stringent world-wide requirements for out-of-band energy, billing-tone immunity, lightning surges, and safety requirements.

The PCT303DW solution needs only a few low-cost discrete components to achieve global compliance. See Figure 2 on page 6 for a typical application circuit.

Isolation Barrier

The PCT303DW achieves an isolation barrier through a low-cost, high-voltage capacitor in conjunction with ISOLink signal processing techniques. These techniques eliminate any signal degradation due to capacitor mismatches, common mode interference, or noise coupling. As shown in Figure 2, the C1, C2, and C4 capacitors isolate the PCT303D (DSP side) from the PCT303W (line side). All transmit, receive, control, and caller ID data are communicated through this barrier.

The Isolation Pass is disabled by default. To enable it, the PDL bit in register 6 must be cleared. No communication between the PCT303D and PCT303W can occur until this bit is cleared. The clock generator must be programmed to an acceptable sample rate prior to clearing the PDL bit.

AC Termination

The PCT303DW supports international AC Termination requirements with two selectable impedances, one real and one complex. Mode 0 is a nominal 600-ohm termination that supports the FCC 68 requirement in addition to the requirement of many European countries. Mode 1 is a complex impedance as dictated by countries such as the UK and Germany, and also specified by CTR21. This complex impedance is set by circuitry internal to the PCT303DW as well as the external components connected to REXT2.

DC Termination

The PCT303DW has four programmable modes related to DC termination. Two bits in register 16 (DCT1, DCT0) set the DC characteristics. While the modes are designed to support the extreme conditions in various countries, the user can determine if a line in a given country can support a mode with a higher transmit power level and switch to the appropriate mode. This decision will depend on the amount of loop current available on the line.

Mode 1 (0,1) is a low-voltage mode with no current limiting; it supports transmit signals up to -2.71 dBm. The low voltage requirement is dictated by countries such as Japan and Australia. See Figure 7.

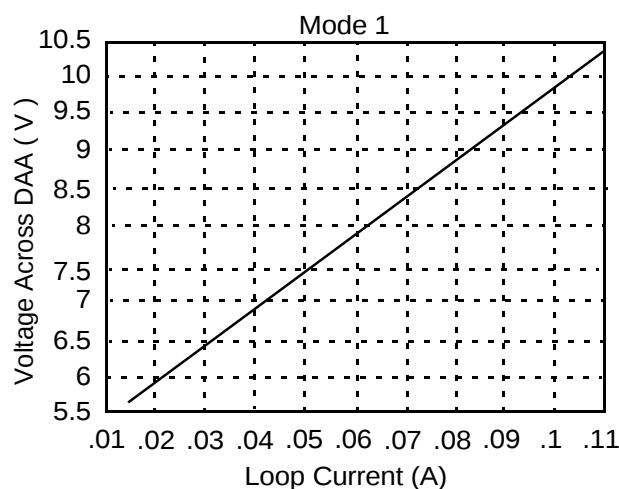


Figure 7 Mode 1 I/V Characteristics (0,1)

Mode 2 (1,0) is the default DC termination mode, with no current limiting, providing a maximum transmit level of -1 dBm at Tip and Ring. This mode meets FCC requirements in addition to the requirements of many European countries. Figure 8 shows the I/V characteristics of mode 2.

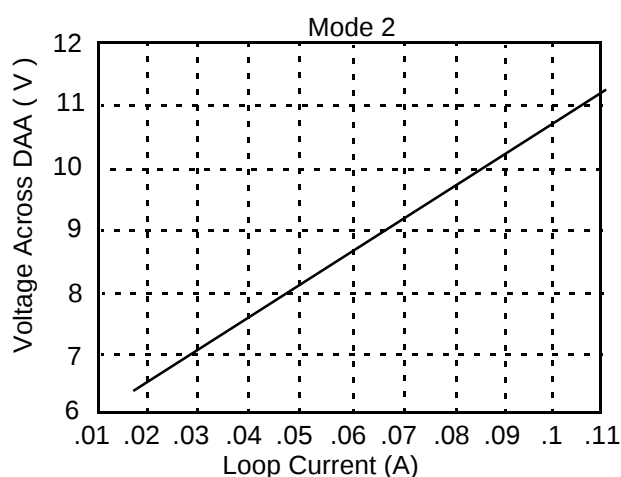


Figure 8 Mode 2 I/V Characteristics (1,0)

Mode 3 (1,1) provides current limiting, while maintaining a transmit level of -1 dBm at Tip and Ring. Figure 9 shows the I/V characteristics of mode 3. In mode 3, the DC termination will current limit before reaching 60 mA.

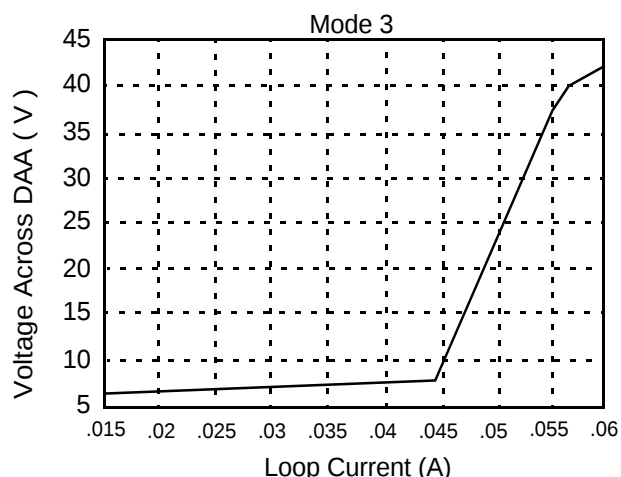


Figure 9 Mode 3 I/V Characteristics (1,1)

The PCT303DW can be fully programmed to meet international requirements, and the device is compliant with FCC, NET4, CTR21, JATE, and country-specific PTT specifications. Figure 2 outlines a limited set of line interface configurations required to support CTR21 and other key countries by setting different AC and DC termination modes. See “Appendix: NET4 Country Support” on page 65 for a more complete set of the line interface configurations required to support NET4 countries.

Table 8 Line Interface Configurations (Register 16)

Country	AC Termination	DC Termination	
	Bit 5	Bit 4	Bit 3
1. FCC	0	1	0
2. Australia	1	0	1
3. Japan	0	0	1
4. New Zealand	1	1	0
5. Singapore ^a	0	0	1
6. South Africa	1	1	0
7. CTR21 ^{b,c}	1	1	1

- Support for loop currents greater than or equal to 20 mA.
- The PCT303DW can also be configured to meet the individual specifications for these countries. (See “Appendix: NET4 Country Support” on page 65.)
- CTR21 includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Liechtenstein, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the UK.

Ring Detection

The ring signal is capacitively coupled from Tip and Ring to the RNG1 and RNG2 pins. The PCT303DW supports either full- or half-wave ring detection. With full-wave ring detection, the designer can detect a polarity reversal as well as the ring signal.

The ring detector output can be monitored in one of three ways. The first method uses the RGDT pin. The second method uses the register bits RDTP, RDTN, and RDT of register 5. The final method uses the SDO output.

The DSP must detect the frequency of the ring signal in order to distinguish a ring from pulse dialing by telephone equipment connected in parallel. If necessary, the DSP can estimate the amplitude of the ring signal based on the ring detect threshold and the duty cycle of the ring detector output.

The PCT303DW can be programmed for both ringer impedance and ringer threshold as described in the “Appendix: NET4 Country Support” on page 65.

Billing Tone Immunity

In some countries, billing tones generated by the central office can cause modem connection difficulties. The PCT303DW enables the modem developer to provide feedback to the user for problems associated with billing tones on the line.

Billing tone detection is enabled by setting the BTE bit of register 16. Depending on line conditions, the billing tone can be large enough to cause major errors related to the modem data. If this situation occurs, the BTD bit of register 17 is set. This bit remains set until the user sets it to zero or a reset of the device is executed.

The billing tone may only be large enough to overdrive the receive input. In this case, the ROV bit of register 17 is set, indicating an overdrive situation. This bit remains set until set to zero or a reset is executed.

Lightning Test

The PCT303DW meets the lightning test requirements of EN6100-4-5 and FCC part 68.

Safety and Isolation

The PCT303DW meets the requirements of the European safety specification EN60950 as well as the requirements of FCC part 68 and UL.

Off-Hook

The communication system generates an off-hook command by applying logic 0 to the OFHK pin or writing a logic 1 to bit 0 of control register 5. The OFHK pin must be enabled by setting bit 1 (OHE) of register 5. With

OFHK at logic 0, the system is in an off-hook state. This state is used to seize the line for incoming/outgoing calls and can also be used for pulse dialing. With OFHK at logic 1, negligible DC current flows through the hookswitch. When a logic 0 is applied to the OFHK pin, the hookswitch transistor pair, Q1 & Q2, turn on. The net effect of the off-hook signal is the application of a termination impedance across tip and ring and the flow of DC loop current. The termination impedance has both an AC and DC component.

When executing an off-hook sequence, the PCT303DW requires 4620/Fs clock cycles to complete the off-hook and provide phone-line data on the serial link. This includes the 12/Fs filter group delay. If necessary, for the shortest delay, a higher Fs may be established prior to executing the off-hook, such as an Fs of 10.286 kHz.

Digital Interface

The PCT303DW has two serial interface modes that support most standard modem DSPs. The M0 and M1 mode pins select the interface mode. The key difference between these two serial modes is the operation of the FSYNC signal. Table 9 summarizes the serial mode definitions.

Table 9 Serial Modes

Mode	M1	M0	Description
0	0	0	FSYNC frames data
1	0	1	FSYNC pulse starts data frame
2	1	0	Slave mode
3	1	1	Reserved

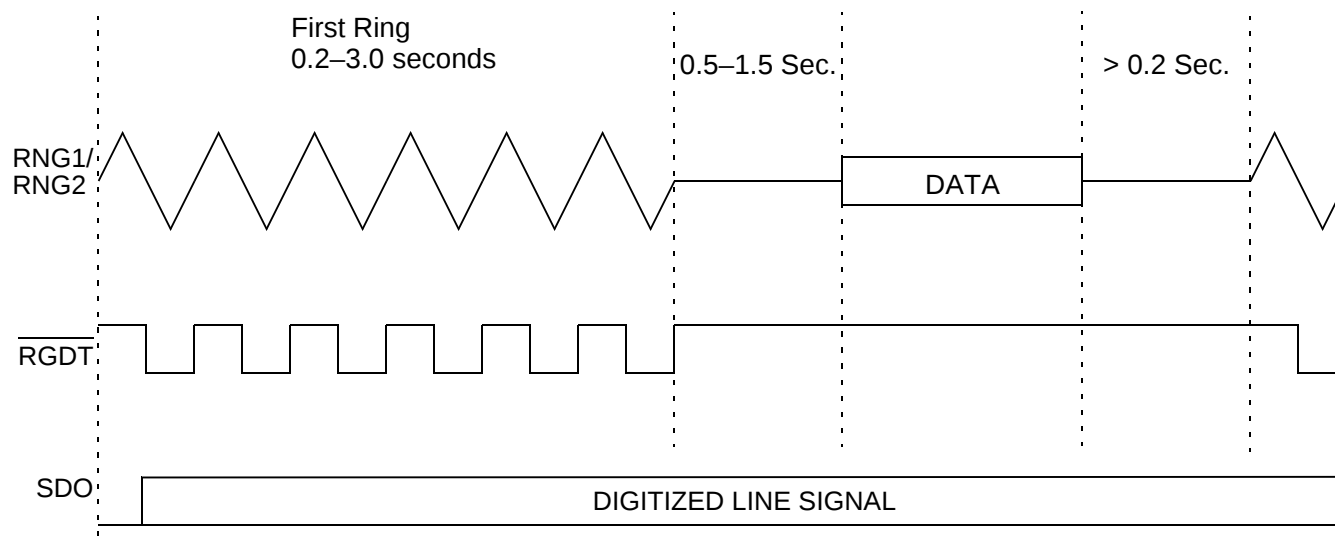


Figure 10 Ring Detect Timing

The digital interface consists of a single, synchronous serial link which communicates both telephony and control data.

In Serial mode 0 or 1, the PCT303D operates as a master, where the master clock (MCLK) is an input, the serial data clock (SCLK) is an output, and the frame sync signal (FSYNC) is an output. The MCLK frequency and the value of the sample rate control registers 7, 8, 9 and 10 determine the sample rate (Fs). The serial port clock, SCLK, runs at 256 bits per frame, where the frame rate is equivalent to the sample rate. Refer to "Clock Generation Subsystem" on page 23 for more details on programming sample rates.

The PCT303DW transfers 16-bit or 15-bit telephony data in the primary timeslot and 16-bit control data in the secondary timeslot. Figure 11 and Figure 12 show the relative timing of the serial frames. Primary frames occur at the frame rate and are always present. To minimize overhead in the external DSP, secondary frames are present only when requested.

Two methods exist for transferring control information in the secondary frame. The default power-up mode uses the LSB of the 16-bit transmit (TX) data word as a flag to request a secondary transfer. In this mode, only 15-bit TX data is transferred, resulting in a loss of SNR but

allowing software control of the secondary frames. As an alternative method, the FC pin can serve as a hardware flag for requesting a secondary frame. The external DSP can turn on the 16-bit TX mode by setting the SB bit of register 1. In the 16-bit TX mode, the hardware FC pin must be used to request secondary transfers.

Figure 13 and Figure 14 illustrate the secondary frame read cycle and write cycle, respectively. During a read cycle, the R/W bit is high and the 5-bit address field contains the address of the register to be read. The contents of the 8-bit control register are placed on the SDO signal. During a write cycle, the R/W bit is low and the 5-bit address field contains the address of the register to be written. The 8-bit data to be written immediately follows the address on SDI. Only one register can be read or written during each secondary frame. See "PCT303DW Control Registers" on page 41 for the register addresses and functions.

In serial mode 2, the PCT303D operates as a slave device, where the MCLK is an input, the SCLK is a no connect, and the FSYNC is an input. In addition, the RGDT/FSD pin operates as a delayed frame sync (FSD) and the FC/RGDT pin operates as ring detect (RGDT). Note that in this mode, FC operation is not supported.

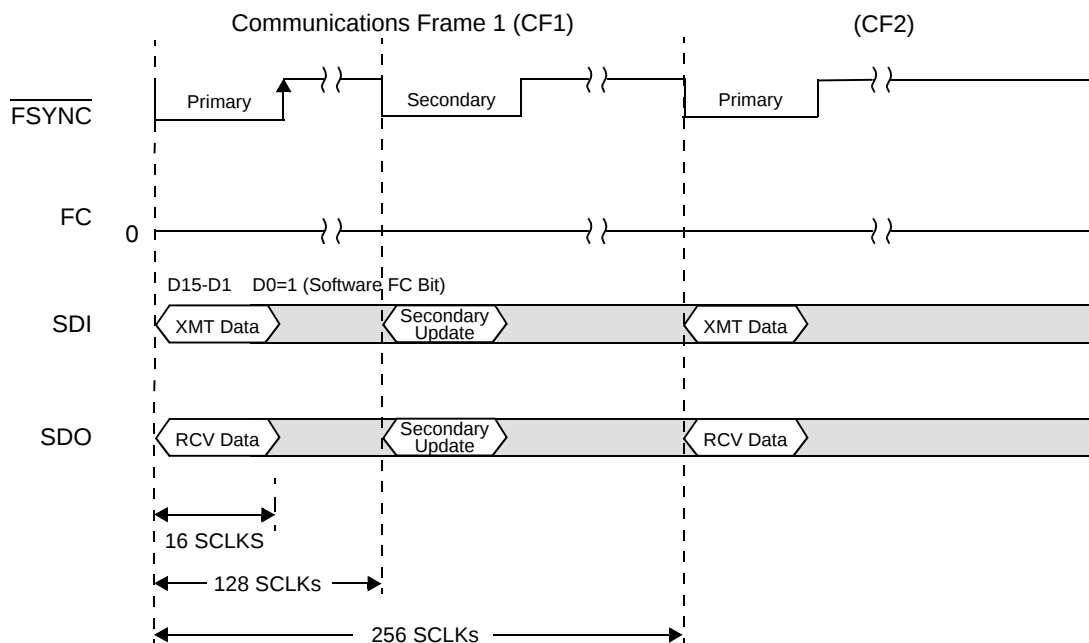


Figure 11 Software FC/RGDT Secondary Request

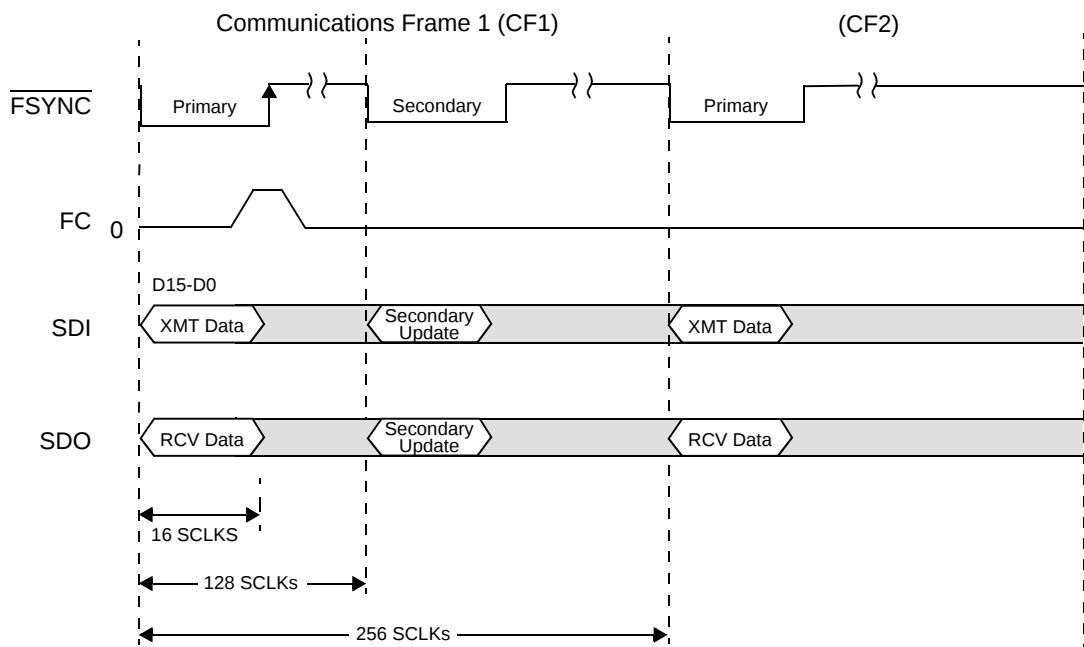


Figure 12 Hardware FC/RGDT Secondary Request

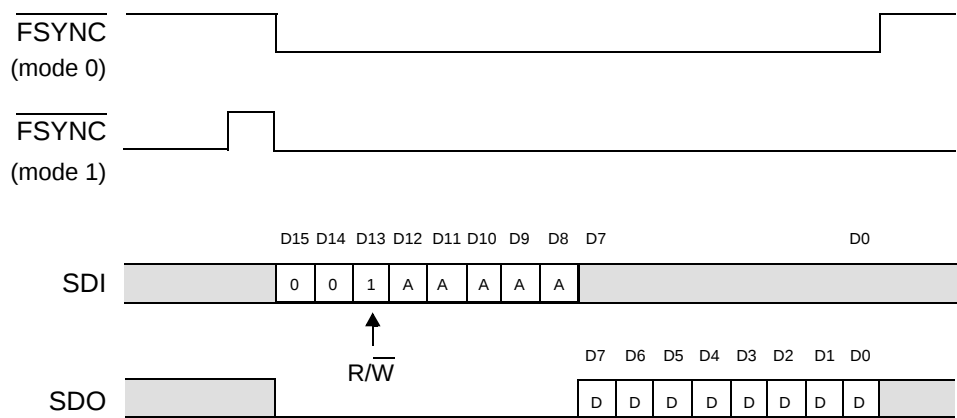


Figure 13 Secondary Communication Data Format - Read Cycle

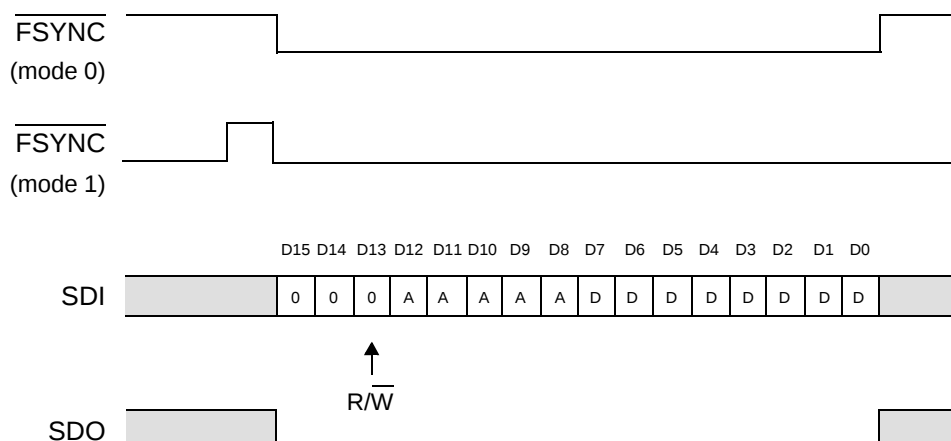


Figure 14 Secondary Communication Data Format - Write Cycle

Clock Generation Subsystem

The PCT303DW contains an on-chip clock generator. Using a single MCLK input frequency, the PCT303DW can generate all the desired standard modem sample rates, as well as the common 11.025 kHz rate for audio playback.

The clock generator consists of two phase-locked loops (PLL1 and PLL2) that achieve the desired sample frequencies. Figure 15 illustrates the clock generator. The architecture of the dual PLL scheme allows for fast lock time on initial start-up, fast lock time when changing modem sample rates, high noise immunity, and the ability to change modem sample rates with a single register write. A large number of MCLK frequencies between 1 MHz and 60 MHz are supported.

In serial mode 2, the PCT303D operates as a slave device. The clock generator is configured (by default) to set the SCLK output equal to the MCLK input. The net effect is the clock generator multiplies the MCLK input by 20.

Programming the Clock Generator

As noted in Figure 15, the clock generator must output a clock equal to 1024*Fs, where Fs is the desired sample rate. The 1024*Fs clock is determined through programming of the following registers:

- Register 7—N1 divider, 8 bits.
- Register 8—M1 divider, 8 bits.
- Register 9—N2/M2 dividers, 4 bits/4 bits.
- Register 10—CGM, 1 bit.

When using the PCT303DW for modem applications, the clock generator can be programmed to allow for a single register write to change the modem sampling rate. These standard sample rates are shown in Table 10. The programming method is described below.

Table 10 N2, M2 Values (CGM = 0, 1)

Fs (Hz)	N2	M2
7200	2	2
8000	9	10
8229	7	8
8400	6	7
9000	4	5
9600	3	4
10286	7	10

The main design consideration is the generation of a base frequency, defined as the following:

$$F_{Base} = \frac{F_{MCLK} \cdot M1}{N1} = 36.864MHz, CGM = 0$$

$$F_{Base} = \frac{F_{MCLK} \cdot M1 \cdot 16}{N1 \cdot 25} = 36.864MHz, CGM = 1$$

N1 (register 7) and M1 (register 8) are 8-bit unsigned values. F_{MCLK} is the clock provided to the MCLK pin. Table 11 lists several standard crystal oscillator rates that could be supplied to MCLK. This list simply represents a sample of MCLK frequency choices. Many more are possible.

After the first PLL has been setup, the second PLL can be programmed easily. The values for N2 and M2 (register 9) are shown in Table 10. N2 and M2 are 4-bit unsigned values.

When programming the registers of the clock generator, the order of register writes is important. For PLL1 updates, N1 (register 7) must always be written first, immediately followed by a write to M1 (register 8). For PLL2, the CGM bit must be set as desired prior to writing N2/M2 (register 9). Changes to CGM only take effect when N2/M2 are written.

NOTE: The values shown in Table 10 and Table 11 satisfy the equations above. However, when programming the registers for N1, M1, N2, and M2, the value placed in these registers must be one less than the value calculated from the equations. For example, for CGM = 0 with a MCLK of 48.0 MHz, the values placed in the N1 and M1 registers would be 7Ch and 5Fh, respectively. If CGM = 1, a non-zero value must be programmed to register 9 in order for the 16/25 ratio to take effect.

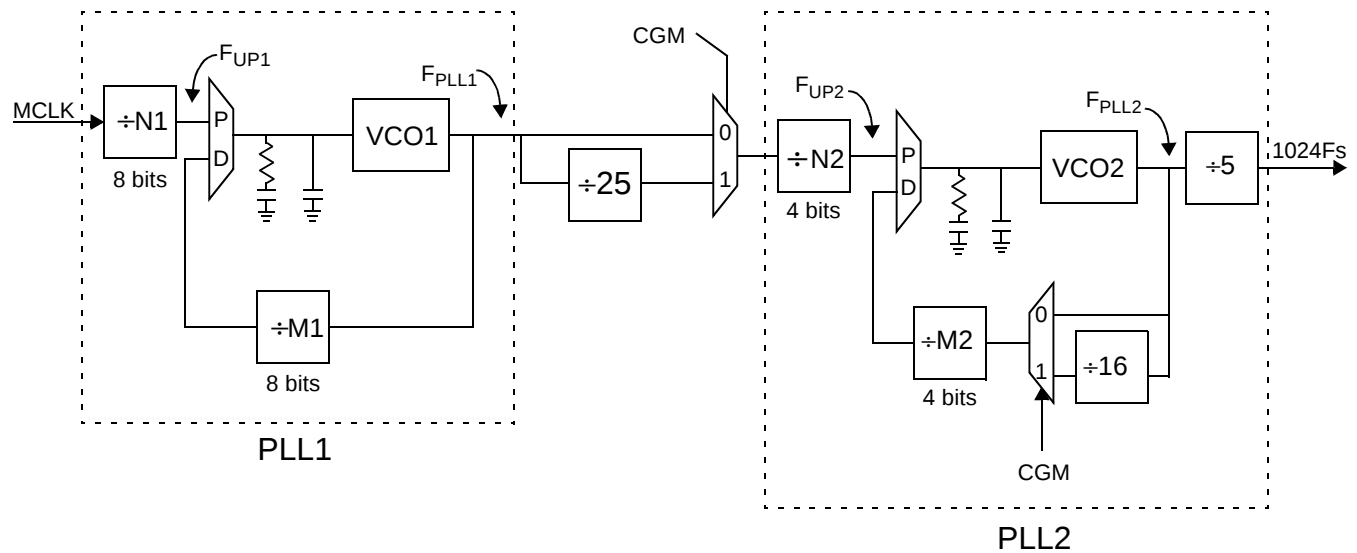


Figure 15 Clock Generation Subsystem

PLL Lock Times

The PCT303DW changes sample rates very quickly. However, lock time varies based on the programming of the clock generator. The major factor contributing to PLL lock time is the CGM bit. When the CGM bit is used (set to one), PLL2 locks slower than when CGM is zero. The following relationships describe the boundaries on PLL locking time:

$$\text{PLL1 lock time} < 1 \text{ ms (CGM} = 0,1)$$

$$\text{PLL2 lock time} < 100 \text{ us (CGM} = 0)$$

$$\text{PLL2 lock time} < 1 \text{ ms (CGM} = 1)$$

For modem designs, it is recommended that PLL1 be programmed during initialization. No further programming of PLL1 is necessary. The CGM bit and PLL2 can be programmed for the desired initial sample rate, typically 7200 Hz. All further sample rate changes are made by simply writing to register 9 to update PLL2.

The final design consideration for the clock generator is the update rate of PLL1. The following criteria must be satisfied in order for the PLLs to remain stable:

$$F_{UP1} = F_{MCLK} / (N1) \geq 144 \text{ kHz}$$

Where F_{UP1} is shown in Figure 15.

Setting Generic Sample Rates

The above clock generation description focuses on the common modem sample rates. An application may require a sample rate not listed in Table 10, such as the common audio rate of 11.025 kHz. The restrictions and equations above still apply; however, a more generic relationship between MCLK and F_s (the desired sample rate) is needed. The following equation describes this relationship:

$$\frac{M1? \cdot M2?}{N1? \cdot N2?} = \text{ratio} \cdot \frac{5 \cdot 1024 \cdot F_s}{MCLK?}$$

where F_s is the sample frequency, $ratio$ is 1 for CGM=0 and 25/16 for CGM = 1, and all other symbols are shown in Figure 15.

Table 11 MCLK Examples

MCLK (MHz)	N1	M1	CGM
1.8432	1	20	0
4.0000	5	72	1
4.0960	1	9	0
5.0688	11	80	0
6.0000	5	48	1
6.1440	1	6	0
8.1920	32	225	1
9.2160	1	4	0
10.0000	25	144	1
10.3680	9	32	0
11.0592	3	10	0
12.288	1	3	0
14.7456	2	5	0
16.0000	5	18	1
18.4320	1	2	0
24.5760	2	3	0
25.8048	7	10	0
33.8688	147	160	0
44.2368	96	125	1
46.0800	5	4	0
47.9232	13	10	0
48.0000	125	96	0
56.0000	35	36	1
60.0000	25	24	1

Knowing the MCLK frequency and desired sample rate the values for the M1, N1, M2, N2 registers can be determined. When determining these values, remember to consider the range for each register as well as the minimum update rate for the first PLL.

The values determined for M1, N1, M2, and N2 must be adjusted by minus one when determining the value written to the respective registers. This is due to internal logic, which adds one to the value stored in the register. This addition allows the user to write a zero value in any of the registers and the effective divide by is one. A special case occurs when both M1 and N1 and/or M2 and N2 are programmed with a zero value. When M_x and N_x are both zero, the corresponding PLLx is

bypassed. Note that if M2 and N2 are set to zero, the ratio of 25/16 is eliminated and cannot be used in the above equation. In this condition the CGM bit has no effect.

Power Management

The PCT303DW supports four basic power management operation modes. The modes are normal operation, reset operation, sleep mode, and full power down mode. The power management modes are controlled by the PDN and PDL bits of register 6.

On power up, or following a reset, the PCT303DW is in reset operation. In this mode, the PDL bit is set, while the PDN bit is cleared. The PCT303D is fully operational, except for the ISOLink. No communication between the PCT303D and PCT303W can occur during reset operation. Note, any bits associated with the PCT303W are not valid in this mode.

The most common mode of operation is the normal operation. In this mode, the PDL and PDN bits are cleared. The PCT303D is fully operational and the ISOLink is communicating information between the PCT303D and the PCT303W. Note that the clock generator must be programmed to a valid sample rate prior to entering this mode.

The PCT303DW supports a low-power sleep mode. This mode supports the popular wake-up-on-ring feature of many modems. The clock generator registers 7, 8, and 9 must be programmed with valid non-zero values prior to enabling sleep mode. Then, the PDN bit must be set and the PDL bit cleared. When the PCT303DW is in sleep mode, the MCLK signal may be stopped or remain active, but it *must* be active before waking up the PCT303DW. The PCT303D is non-functional except for the ISOLink and RGDT signal. To take the PCT303DW out of sleep mode, pulse the reset pin (RESET) low.

In summary, the power down/up sequence for sleep mode is as follows:

1. Registers 7, 8, and 9 must have valid non-zero values.
2. Set the PDN bit (register 6, bit 3) and clear the PDL bit (register 6, bit 4).
3. MCLK may stay active or stop.
4. Restore MCLK before initiating the power-up sequence.
5. Reset the PCT303DW using RESET pin (after MCLK is present).
6. Program registers to desired settings.

The PCT303DW also supports an additional power-down mode. When both the PDN (register 6, bit 3) and PDL (register 6, bit 4) are set, the chip-set enters a complete power-down mode and draws negligible current. Set the PDL bit either before setting the PDN bit or at the same time. In this mode, the RGDT pin does not function. Normal operation may be restored using the same process for taking the chip-set out of sleep mode.

Analog Output

The PCT303DW supports an analog output (AOUT) for driving the call progress speaker found with most of today's modems. AOUT is an analog signal that is comprised of a mix of the transmit and receive signals. The receive portion of this mixed signal has a 0 dB gain, while the transmit signal has a gain of -20 dB.

The transmit and receive signals of the AOUT signal have independent mute controls. The ATM bit (register 6, bit 6) mutes the transmit portion, while the ARM (register 6, bit 5) mutes the receive portion. Figure 3 on page 8 illustrates a recommended application circuit. Note that in the configuration shown, the LM386 provides a gain of 26 dB. Additional gain adjustments may be made by varying the voltage divider created by R1 and R3 of Figure 3.

On-Hook Line Monitor

The PCT303DW allows the user to detect line activity when the device is in an on-hook state. When the system is on-hook, the line data can be passed to the DSP across the serial port while drawing a small amount of DC current from the line. This feature is similar to the passing of line information (such as caller ID), while on-hook, following a ring signal detection. To activate this feature, set the ONHM bit in register 5.

The on-hook line monitor can also be used to detect whether a phone line is physically connected to the PCT303W and associated circuitry. When the on-hook line monitor is activated (if no line is connected), the output of SDO will move towards a negative full scale value (-32768). The value is guaranteed to be at least 89% of negative full scale.

If a line is present while in on-hook line monitor mode, SDO will have a near zero value. The designer must allow for the group delay of the receive filter before making a decision.

The on-hook line monitor may be used in conjunction with the loop current sense bits to determine if a phone line is physically connected to the PCT303W and

associated circuitry. When on-hook line monitor is active (if a phone line is present), the LCS value will be a 1111b value.

If a phone line is not present, the LCS value will be a zero value. The designer must allow for a 5/Fs delay before making a decision. Refer to "Loop Current Monitor" for more details on the LCS bits.

Loop Current Monitor

When the system is in an off-hook state, the LCS bits of register 12 indicate the approximate amount of DC loop current that is flowing in the loop. The LCS is a 4-bit value ranging from zero to fifteen. Each unit represents approximately 6 mA of loop current. An LCS value of zero means the loop current is less than required for normal operation and the system should be on-hook. An LCS value of 15 means the loop current is greater than 120 mA. To determine a rough approximation of the current (mA) flowing in the loop the following equation may be used:

$$\text{LoopCurrent} \approx 6 \cdot \text{LCS} + 12$$

The LCS detector has a built-in hysteresis of 2 mA of current. This allows for a stable LCS value when the loop current is near a transition level. The LCS value is a rough approximation of the loop current, and the designer is advised to use this value in a relative means rather than an absolute value.

This feature enables the modem to determine if an additional line has "picked up" while the modem is transferring information. In the case of a second phone going off-hook, the loop current falls approximately 50% and is reflected in the value of the LCS bits.

Gain Control

The PCT303DW supports multiple gain and attenuation settings for the receive and transmit paths, respectively. When the ARX bit is set, 6 dB of gain is applied to the receive path. When the ATX bit is set, -3 dB of gain is applied to the transmit path.

Register 15 can be used to provide additional gain control. For register 15 to have an effect on the receive and transmit paths, the ATX and ARX bits of register 13 must be zero.

The receive path can support gains of 0, 3, 6, 9, and 12 dB. The gain is selected by bits 2:0 (ARX2:ARX0). The receive path can also be muted by setting bit 3 (RXM). The transmit path can support attenuations of 0, 3, 6, 9, and 12 dB. The attenuation is selected by bits 6:4 (ATX2:ATX0). The transmit path can also be muted by setting bit 7 (TXM).

Filter Selection

The PCT303D supports additional filter selections for the receive and transmit signals. The IIR bit of register 16, when set, enables the IIR filters defined in Table 29 on page 59. This filter provides a much lower, however non-linear, group delay than the default FIR filters.

Revision Identification

The PCT303DW provides the system designer the ability to determine the revision of the PCT303D and/or the PCT303W. Register 11 identifies the revision of the PCT303D with 4 bits named REVA. Register 13 identifies the revision of the PCT303W with 4 bits named REVB. Table 12 shows the values for the various revisions.

Table 12 Revision Values

Revision	PCT303D	PCT303W
A	0100	0001

In-Circuit Testing

The PCT303DW's advanced design provides the modem manufacturer with increased ability to determine system functionality during production line tests, as well as support for end-user diagnostics. Four loopback modes exist allowing increased coverage of system components. For three of the test modes, a line-side power source is needed. While a standard phone line can be used, the test circuit in Figure 20 on page 60 is adequate. In addition, an off-hook sequence must be performed to connect the power source to the line-side chip.

For the start-up test mode, no line-side power is necessary and no off-hook sequence is required. The start-up test mode is enabled by default. When the PDL bit (register 6, bit 4) is set (the default case), the line side is in a power-down mode and the DSP side is in a digital loop-back mode. In this mode, data received on SDI is passed through the internal filters and transmitted on SDO. This path will introduce approximately 0.9 dB of attenuation on the SDI signal received. The group delay of both transmit and receive filters will exist between SDI and SDO. Clearing the PDL bit disables this mode and the SDO data is switched to the receive data from the line side. Note, when PDL is cleared the FDT bit (register 12, bit 6) will become active, indicating the successful communication between the line side and DSP side. This can be used to verify that the ISOLink is operational.

The remaining test modes require an off-hook sequence to operate. The following sequence defines the off-hook requirement:

1. Power up or reset.
2. Program clock generator to desired sample rate.
3. Enable line side by clearing PDL bit.
4. Issue off-hook
5. Delay 4608/Fs to allow calibration to occur.
6. Set desired test mode.

The ISOLink digital loopback mode allows the data pump to provide a digital input test pattern on SDI and receive that digital test pattern back on SDO. To enable this mode, set the DL bit of register 1. In this mode, the isolation barrier is actually being tested. The digital stream is delivered across the isolation capacitor, C1 of Figure 2 on page 6, to the line side device and returned across the same barrier. Note in this mode, the 0.9 dB attenuation and filter group delays also exist.

The analog loopback mode allows an external device to drive the RX pin of the line-side chip and receive the signal from the TX pin. This mode allows testing of external components connecting the RJ-11 jack (tip and ring) to the line side of the PCT303DW. To enable this mode, set the AL bit of register 2.

The final testing mode, internal analog loopback, allows the system to test the basic operation of the transmit/receive path of the line side and the external components R4 and C5 of Figure 2 on page 6. In this test mode, the data pump provides a digital test waveform on SDI. This data is passed across the isolation barrier, looped from the TX to RX pin, passed back across the isolation barrier, and presented to the data pump on SDO. To enable this mode, clear the HBE bit of register 2.

When the HBE bit is cleared, this will cause a DC offset which affects the signal swing of the transmit signal. In this test mode, it is recommended that the transmit signal be 12 dB lower than normal transmit levels. This lower level will eliminate clipping caused by the DC offset which results from disabling the hybrid. It is assumed in this test that the line AC impedance is nominally 600 Ω .

NOTE: All test modes are mutually exclusive. If more than one test mode is enabled concurrently, the results are unpredictable.

Exception Handling

The PCT303DW provides several mechanisms to determine if an error occurs during operation. Through the secondary frames of the serial link, the controlling DSP can read several status bits. The bit of highest importance is the frame detect bit (FDT, register 12 bit 6). This bit indicates that the DSP side (PCT303D) and line side (PCT303W) devices are communicating. During normal operation, the FDT bit can be checked before reading any bits that indicate information about the line side. If FDT is not set, the following bits related to the line side are invalid—RDT, LCS, CBID, REVB; the RGDT operation will also be non-functional.

Following power-up and reset, the FDT bit is not set because the PDL bit (register 6 bit 4) defaults to 1. In this state, the ISOLink is not operating and no information about the line side can be determined. The user must program the clock generator to a valid configuration for the system and clear the PDL bit to activate the ISOLink. While the DSP and line side are establishing communication, the DSP side does not generate FSYNC signals. Therefore, if the controlling DSP serial interface is interrupt driven, based on the FSYNC signal, the controlling DSP does not require a special delay loop to wait for this event to complete.

The FDT bit can also indicate if the line side executes an off-hook request successfully. If the line side is not connected to a phone line (that is, the user fails to connect a phone line to the modem), the FDT bit remains cleared. The controlling DSP must allow sufficient time for the line side to execute the off-hook request. The maximum time for FDT to be valid following an off-hook request is 10 ms. If the FDT is high, the LCS bits indicate the amount of loop current flowing. If the FDT fails to be set following an off-hook request, the PDL bit in register 6 must be set high for at least 1 ms to reset the line side. For more information, see “Loop Current Monitor” on page 25.

Another useful bit is the communication link error (CLE) bit (register 12 bit 7). The CLE bit indicates a time-out error for the ISOLink following a change to either PLL1 or PLL2. For more information, see “Clock Generation Subsystem” on page 22. When the CLE bit is set, the DSP side chip has failed to receive verification from the line side that the clock change has been accepted in an expected period of time. This condition indicates a severe error in programming the clock generator or possibly a defective line-side chip.

PCT303DW CONTROL REGISTERS

Any register not listed here is reserved and should not be written.

Control 1 (Register 1, R/W)

SR	Reserved					DL	SB
7	6	5	4	3	2	1	0

Reset settings: 00h

Bit Definitions:

Bits	Name	Description
7	SR	Software reset. 1 = Sets all registers to their reset value. 0 = Enables chip for normal operation. Bit automatically clears after being set.
6:2	Reserved	Reserved. Read returns zero.
1	DL	Isolation digital loopback. 1 = Enables digital loopback mode across isolation barrier. Line side must be enabled prior to setting this mode.
0	SB	Serial digital interface mode. 1 = The serial port is operating in 16-bit mode and requires use of the secondary frame sync signal, FC, to initiate control data reads/writes. 0 = Operation is in 15-bit mode and the LSB of the data field indicates whether a secondary frame is required.

Control 2 (Register 2, R/W)

Reserved				AL	Reserved	HBE	RXE
7	6	5	4	3	2	1	0

Reset settings: 03h

Bit Definitions:

Bits	Name	Description
7:4	Reserved	Reserved. Read returns zero.
3	AL	Analog loopback. 1 = Enables analog loopback mode.
2	Reserved	Reserved. Read returns zero.
1	HBE	Hybrid enable. 1 = Connects transmit path in hybrid.
0	RXE	Receive enable. 1 = Enables receive path.

Control 3 (Register 3, R)

Reserved							
7	6	5	4	3	2	1	0

Reset settings: 00h

Bit Definitions:

Bits	Name	Description
7:0	Reserved	Reserved. Read returns zero.

Control 4 **(Register 4, R)**

Reserved							
7	6	5	4	3	2	1	0

Reset settings: 00h

Bit Definitions:

Bits	Name	Description
7:0	Reserved	Reserved. Read returns zero.

DAA Control 1 **(Register 5, R/W)**

Reserved	RDTN	RDTP	OPOL	ONHM	RDT	OHE	OH
7	6	5	4	3	2	1	0

Reset settings: 00h

Bit Definitions:

Bits	Name	Description
7	Reserved	Reserved. Read returns zero.
6	RDTN	Ring detect signal negative. Read-only. When set, a negative ring signal is occurring.
5	RDTP	Ring detect signal positive. Read-only. When set, a positive ring signal is occurring.
4	OPOL	Off-hook polarity. 1 = Off-hook pin is active-high. 0 = Off-hook pin is active-low.
3	ONHM	On-hook line monitor. 1 = Enables low-power monitoring mode allowing the DSP to receive line activity without going off-hook.
2	RDT	Ring detect. Read-only. 1 = Indicates a ring is occurring. 0 = Reset either 4.5–9 seconds after last positive ring is detected or when the system executes an off-hook.
1	OHE	Off-hook pin enable. 1 = Enables the operation of the off-hook pin. 0 = Off-hook pin is ignored.
0	OH	Off-hook. 1 = Causes the line-side chip to go off-hook. This bit operates independently of OHE and is a logic OR with the off-hook pin when enabled.

DAA Control 2**(Register 6, R/W)**

CPE	ATM1	ARM1	PDL	PDN	Reserved	ATM0	ARM0
7	6	5	4	3	2	1	0

Reset settings: 70h

Bit Definitions:

Bits	Name	Description										
7	CPE	Charge pump enable. 1 = Charge pump on. 0 = Charge pump off.										
6,1	ATM[1:0]	AOUT transmit path level control. <table border="1"><thead><tr><th>ATM[1:0]</th><th>Description</th></tr></thead><tbody><tr><td>00</td><td>–20dB transmit path attenuation for call progress AOUT pin only.</td></tr><tr><td>01</td><td>–32dB transmit path attenuation for call progress AOUT pin only.</td></tr><tr><td>10</td><td>Mutes transmit path for call progress AOUT pin only.</td></tr><tr><td>11</td><td>–26dB transmit path attenuation for call progress AOUT pin only.</td></tr></tbody></table>	ATM[1:0]	Description	00	–20dB transmit path attenuation for call progress AOUT pin only.	01	–32dB transmit path attenuation for call progress AOUT pin only.	10	Mutes transmit path for call progress AOUT pin only.	11	–26dB transmit path attenuation for call progress AOUT pin only.
ATM[1:0]	Description											
00	–20dB transmit path attenuation for call progress AOUT pin only.											
01	–32dB transmit path attenuation for call progress AOUT pin only.											
10	Mutes transmit path for call progress AOUT pin only.											
11	–26dB transmit path attenuation for call progress AOUT pin only.											
5,0	ARM[1:0]	AOUT receive path level control. <table border="1"><thead><tr><th>ARM[1:0]</th><th>Description</th></tr></thead><tbody><tr><td>00</td><td>0dB receive path attenuation for call progress AOUT pin only.</td></tr><tr><td>01</td><td>–12dB receive path attenuation for call progress AOUT pin only.</td></tr><tr><td>10</td><td>Mutes receive path for call progress AOUT pin only.</td></tr><tr><td>11</td><td>–6dB receive path attenuation for call progress AOUT pin only.</td></tr></tbody></table>	ARM[1:0]	Description	00	0dB receive path attenuation for call progress AOUT pin only.	01	–12dB receive path attenuation for call progress AOUT pin only.	10	Mutes receive path for call progress AOUT pin only.	11	–6dB receive path attenuation for call progress AOUT pin only.
ARM[1:0]	Description											
00	0dB receive path attenuation for call progress AOUT pin only.											
01	–12dB receive path attenuation for call progress AOUT pin only.											
10	Mutes receive path for call progress AOUT pin only.											
11	–6dB receive path attenuation for call progress AOUT pin only.											
4	PDL	Power down line-side chip. 1 = Places the PCT303W in lower power mode. 0 = Normal operation. Program the clock generator before clearing this bit.										
3	PDN	Power down. 1 = Powers down the PCT303DW. A reset pulse on RESET is required to restore normal operation.										
2	Reserved	Reserved. Read returns zero.										

PLL1 Divide N1**(Register 7, R/W)**

Divider N1							
7	6	5	4	3	2	1	0

Reset settings: 00h (serial mode 0, 1, 2)

Bit Definitions:

Bits	Name	Description
7:0	Divider N1	Contains the (value – 1) for determining the output frequency on PLL1.

PLL1 Multiply M1 (Register 8, R/W)

Multiplier M1							
7	6	5	4	3	2	1	0

Reset settings: 00h (serial mode 0,1)

Reset settings: 13h (serial mode 2)

Bit Definitions:

Bits	Name	Description
7:0	Multiplier M1	Contains the (value – 1) for determining the output frequency on PLL1.

PLL2 Divide/Multiply N2/M2 (Register 9, R/W)

Divider N2				Multiplier M2			
7	6	5	4	3	2	1	0

Reset settings: 00h (serial mode 0, 1, 2)

Bit Definitions:

Bits	Name	Description
7:4	Divider N2	Contains the (value – 1) for determining the output frequency on PLL2.
3:0	Multiplier M2	Contains the (value – 1) for determining the output frequency on PLL2.

PLL Control (Register 10, R/W)

Reserved							CGM
7	6	5	4	3	2	1	0

Reset settings: 00h

Bit Definitions:

Bits	Name	Description
7:1	Reserved	Reserved. Read returns zero.
0	CGM	Clock Generation Mode. 1 = A 25/16 ratio is applied to the PLL allowing for a more flexible choice of MCLK frequencies while slowing down the PLL lock time. 0 = No additional ratio is applied to the PLL and faster lock times are possible.

DSP-Side Chip Revision (Register 11, R)

Reserved				REVA			
7	6	5	4	3	2	1	0

Reset settings: N/A

Bit Definitions:

Bits	Name	Description
7:4	Reserved	Reserved. Read returns zero.
3:0	REVA	Chip revision. Read-only. Four-bit value indicating the revision of the PCT303D (DSP-side) silicon.

Line-Side Status (Register 12, R/W)

CLE	FDT	Reserved	LCS
7	6	5 4	3 2 1 0

Reset settings: N/A

Bit Definitions:

Bits	Name	Description
7	CLE	Communications (ISOLink) error. 1 = Indicates a communication problem between the PCT303D and the PCT303W. When it goes high, it remains high until a logic 0 is written to it.
6	FDT	Frame detect. Read-only. 1 = Indicates ISOLink frame lock has been established. 0 = Indicates ISOLink has not established frame lock.
5:4	Reserved	Reserved. Read returns zero.
3:0	LCS	Loop current sense. Read-only. Four-bit value returning the loop current in 6mA increments. 0 = Loop current < 6mA. 1111 = Loop current > 120mA. See "Loop Current Monitor" on page 25.

Transmit and Receive Gain (Register 13, R/W)

Reserved	CBID	REVB	ARX	ATX
7	6	5 4 3 2	1	0

Reset settings: 00h

Bit Definitions:

Bits	Name	Description
7	Reserved	Reserved. Read returns zero.
6	CBID	Chip B ID. Read-only. 1 = Indicates the line-side has international support. 0 = Indicates the line-side is domestic only.
5:2	REVB	Chip revision. Read-only. Four-bit value indicating the revision of the PCT303W (line-side) silicon.
1	ARX	Receive gain. ^a 1 = A +6dB gain is applied to the receive path. 0 = 0dB gain is applied.
0	ATX	Transmit gain. ^a 1 = A –3dB gain (attenuation) is applied to the transmit path. 0 = 0dB gain is applied.

a. See register 15 for additional transmit/receive gain and attenuation steps.

Daisy-Chain Control (Register 14, R/W)

NSLV[2:0]			SSEL[1:0]		FSD	RPOL	DCE
7	6	5	4	3	2	1	0

Reset settings: 02h (serial mode 0,1)

Reset settings: 3Fh (serial mode 2)

Bit Definitions:

Bits	Name	Description
------	------	-------------

7:5	NSLV[2:0]	Number of slave devices.
-----	-----------	--------------------------

NSLV[2:0]	Description
000	0 slave devices. Simply redefines the FC/RGDT and RGDT/FSD pins.
001	1 slave device.
010	2 slave devices.
011	3 slave devices.
100	4 slave devices. For four or more slave devices, the FSD bit MUST be set.
101	5 slave devices.
110	6 slave devices.
111	7 slave devices.

4:3	SSEL[1:0]	Slave device select.
-----	-----------	----------------------

SSEL[1:0]	Description
00	16-bit SDO receive data.
01	Reserved.
10	15-bit SDO receive data. LSB = 1 for the PCT303DW device.
11	15-bit SDO receive data. LSB = 0 for the PCT303DW device.

2	FSD	Delayed frame sync control. 1 = Sets the number of SCLK periods between frame syncs to 16. 0 = Sets the number of SCLK periods between frame syncs to 32. This bit MUST be set when PCT303DW devices are used as slaves. For the master PCT303DW, only serial mode 1 is allowed in this case.
---	-----	--

1	RPOL	Ring detect polarity. 1 = The FC/RGDT pin (operating as ring detect) is active-high. 0 = The FC/RGDT pin (operating as ring detect) is active-low.
---	------	--

0	DCE	Daisy-chain enable. 1 = Enables the PCT303DW to operate with slave devices on the same serial bus. The FC/RGDT signal (pin 7) becomes the ring detect output and the RGDT/FSD signal (pin 15) becomes the delayed frame sync signal. Note that ALL other bits in this register are ignored if DCE = 0.
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TX/RX Gain Control**(Register 15, R/W)**

TXM	ATX[2:0]			RXM	ARX[2:0]		
7	6	5	4	3	2	1	0

Reset settings: 00h

Bit Definitions:

Bits	Name	Description
7	TXM	Transmit mute. 1 = Mutes the transmit signal.
6:4	ATX[2:0]	Analog transmit attenuation.

ATX[2:0]	Description
000	0dB attenuation.
001	3dB attenuation.
010	6dB attenuation.
011	9dB attenuation.
1xx	12dB attenuation.

NOTE: Register 13 bit 0 (ATX) must be 0 for these bits to work as expected. Unpredictable results can occur if ATX is 1 and these bits are non-zero.

3	RXM	Receive mute. 1 = Mutes the receive signal.
2:0	ARX[2:0]	Analog receive gain.

ATX[2:0]	Description
000	0dB gain.
001	3dB gain.
010	6dB gain.
011	9dB gain.
1xx	12dB gain.

NOTE: Register 13 bit 1 (ARX) must be 0 for these bits to work as expected. Unpredictable results can occur if ARX is 1 and these bits are non-zero.

International Control 1 (Register 16, R/W)

ONS[1:0]		ACT	IIRE	DCT[1:0]		RZ	RT
7	6	5	4	3	2	1	0

Reset settings: 08h

Bit Definitions:

Bits	Name	Description															
7:6	ONS[1:0]	On-hook speed. <table><tr><th>ONS[1:0]</th><th>Description</th></tr><tr><td>00</td><td>The PCT303DW will execute a slow controlled on-hook.</td></tr><tr><td>11</td><td>The PCT303DW will execute a fast on-hook.</td></tr></table>	ONS[1:0]	Description	00	The PCT303DW will execute a slow controlled on-hook.	11	The PCT303DW will execute a fast on-hook.									
ONS[1:0]	Description																
00	The PCT303DW will execute a slow controlled on-hook.																
11	The PCT303DW will execute a fast on-hook.																
5	ACT	AC termination select. 1 = Selects the complex impedance. 0 = Selects the real impedance.															
4	IIRE	IIR filter enable. 1 = IIR filter enabled for transmit and receive filters. (See Figures 25–28 on page 61.) 0 = FIR filter enabled for transmit and receive filters. (See Figures 21–24 on page 60.)															
3:2	DCT[1:0]	DC termination select. <table><tr><th>DCT[1:0]</th><th>Mode</th><th>Description</th></tr><tr><td>00</td><td>0</td><td>Low voltage mode. See “Appendix: NET4 Country Support” on page 65. (Transmit level = –2dBm).</td></tr><tr><td>01</td><td>1</td><td>Low voltage mode. Provides different I/V characteristics than mode 0. (Transmit level = –5dBm).</td></tr><tr><td>10</td><td>2</td><td>Standard voltage mode. (Transmit level = –1dBm).</td></tr><tr><td>11</td><td>3</td><td>Current limiting mode. (Transmit level = –1dBm).</td></tr></table>	DCT[1:0]	Mode	Description	00	0	Low voltage mode. See “Appendix: NET4 Country Support” on page 65. (Transmit level = –2dBm).	01	1	Low voltage mode. Provides different I/V characteristics than mode 0. (Transmit level = –5dBm).	10	2	Standard voltage mode. (Transmit level = –1dBm).	11	3	Current limiting mode. (Transmit level = –1dBm).
DCT[1:0]	Mode	Description															
00	0	Low voltage mode. See “Appendix: NET4 Country Support” on page 65. (Transmit level = –2dBm).															
01	1	Low voltage mode. Provides different I/V characteristics than mode 0. (Transmit level = –5dBm).															
10	2	Standard voltage mode. (Transmit level = –1dBm).															
11	3	Current limiting mode. (Transmit level = –1dBm).															
1	RZ	Ringer impedance select. When set, ringer impedance is decreased to satisfy some countries' ringer requirements.															
0	RT	Ringer threshold select. Used to satisfy country requirements on ring detection. Signals below the lower level will not generate a ring detection; signals above the upper level are guaranteed to generate a ring detection. 1 = 15 ±5 Vrms 0 = 21.5 ±4.5 Vrms															

International Control 2**(Register 17, R/W)**

Reserved					BTE	ROV	BTD
7	6	5	4	3	2	1	0

Reset settings: 00h

Bit Definitions:

<u>Bits</u>	<u>Name</u>	<u>Description</u>
7:3	Reserved	Reserved. Read returns zero.
2	BTE	Billing tone detector enable. When set, the PCT303DW can detect a billing tone signal on the line and maintain off-hook through the billing tone. If a billing tone is detected, bit 0 (BTD) is set to indicate the event.
1	ROV	Receive overload. Read-only. This bit is set when the receive input detects an excessive input level. This bit is cleared by writing a zero to this location.
0	BTD	Billing tone detected. Read-only. This bit is set if bit 2 (BTE) is enabled and a billing tone is detected. This bit is cleared by writing a zero to this location.

International Control 3**(Register 18, R/W)**

Reserved						RFWE	SQLCH
7	6	5	4	3	2	1	0

Reset settings: 00h

Bit Definitions:

<u>Bits</u>	<u>Name</u>	<u>Description</u>
7:2	Reserved	Reserved. Read returns zero.
1	RFWE	Ring detector full-wave rectifier enable. Read-only. When set, the ring-detection circuitry provides full-wave rectification. This effects the data stream presented on SDO during ring detection.
0	SQLCH	Ring detect network squelch. This bit must be set, then cleared, following a polarity reversal detection.

PCT303DW Electrical Characteristics

PCT303DW Recommended Operating Conditions

Table 18 PCT303DW Recommended Operating Conditions

Parameter ^a	Symbol	Test Condition	Min ^b	Typ	Max ^a	Unit
Ambient temperature	T_A	K-grade	0	25	70	°C
Ambient temperature	T_A	B-grade	−40	25	85	°C
PCT303D supply voltage, analog	V_A		3.0	3.3/5.0	5.25	V
PCT303D supply voltage, digital ^c	V_D		3.0	3.3/5.0	5.25	V

- The PCT303DW specifications are guaranteed when the typical application circuit (including component tolerance) and any PCT303D and PCT303W are used. See Figure 2 for typical application circuit.
- All minimum and maximum specifications are guaranteed and apply across the recommended operating conditions. Typical values apply at nominal supply voltages and an operating temperature of 25°C unless otherwise stated.
- The digital supply, V_D , can operate from either 3.3V or 5.0V. The PCT303D supports interface to 3.3V logic when operating from 3.3V. The 3.3V operation applies to both the serial port and the digital signals RGDT/FSD, OFHK, RESET, M0, and M1.

PCT303DW Absolute Maximum Ratings

Permanent device damage may occur if the absolute maximum ratings are exceeded. Functional operation should be restricted to the conditions as specified in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 19 PCT303DW Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
DC supply voltage	V_D, V_A	−0.5 to +6.0	V
Input current, PCT303D digital input pins	I_{IN}	±10	mA
Digital input voltage	V_{IND}	−0.3 to ($V_D+0.3$)	V
Operating temperature range	T_A	−10 to +100	°C
Storage temperature range	T_{STG}	−40 to +150	°C

PCT303DW Loop Characteristics

Given values are: V_A = charge pump, V_D = +3.3 V $\pm$ 5%; T_A = 0 °C to 70 °C for K-grade, -40 °C to +85 °C for B-grade; refer to Figure 20 on page 60.

Table 20 PCT303DW Loop Characteristics

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
DC termination voltage	V_{DCT}	$I_L = 20\text{mA}$			7.7	V
DC termination voltage	V_{DCT}	$I_L = 120\text{mA}$	12			V
DC ring current (with Caller ID)	I_{RDC}				500	μA
DC ring current (w/o Caller ID)	I_{RDC}				20	μA
AC termination impedance	Z_{ACT}			600		Ω
Operating loop current	I_{LP}		20		100	mA
Ring voltage detect	V_{RD}		13	18	26	V_{RMS}
Ring frequency	F_R		15		68	Hz
On-hook leakage current	I_{LK}	$V_{BAT} = -48\text{V}$			1	μA
Ringer equivalence num. (with Caller ID)	REN				1.2	
Ringer equivalence num. (w/o Caller ID)	REN				0.2	

PCT303DW DC Characteristics

$V_D = 5\text{V}$

Given values are: V_A = +5 V $\pm$ 5%; V_D = +5 V $\pm$ 5%; T_A = 0 °C to 70 °C for K-grade, -40 °C to +85 °C for B-grade.

Table 21 PCT303DW DC Characteristics, $V_D = +5\text{V}$

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
High-level input voltage	V_{IH}		3.5			V
Low-level input voltage	V_{IL}				0.8	V
High-level output voltage	V_{OH}	$I_O = -2\text{mA}$	2.4			V
Low-level output voltage	V_{OL}	$I_O = +2\text{mA}$			0.4	V
Input leakage current	I_L				± 10	μA
Power supply current, analog	I_A	V_A pin		1	6	mA
Power supply current, digital	I_D	V_D pin		13	17	mA
Total supply current, sleep mode					1.5	mA

$V_D = 3.3V$

Given values are: V_A = charge pump; $V_D = +3.3 V \pm 10\%$; $T_A = 0\text{ }^{\circ}\text{C}$ to $70\text{ }^{\circ}\text{C}$ for K-grade, $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ for B-grade.

Table 22 PCT303DW DC Characteristics, $V_D = +3.3V$

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
High-level input voltage	V_{IH}		2.0			V
Low-level input voltage	V_{IL}				0.8	V
High-level output voltage	V_{OH}	$I_O = -2\text{mA}$	2.4			V
Low-level output voltage	V_{OL}	$I_O = +2\text{mA}$			0.35	V
Input leakage current	I_L				± 10	μA
Power supply current, analog	I_A	V_A pin		1	6	mA
Power supply current, digital	I_D	V_D pin		8	11	mA
Total supply current, sleep mode					1.5	mA

PCT303DW AC Characteristics

Given values are: V_A = charge pump, $V_D = +3.3 \text{ V} \pm 5\%$; $T_A = 0^\circ\text{C}$ to 70°C for K-grade, -40°C to $+85^\circ\text{C}$ for B-grade.

Table 23 PCT303DW AC Characteristics

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Freq response, transmit ^{a,b}	F_{RT}	Low -3dB corner		33		Hz
Freq response, transmit ^{a,b}	F_{RT}	300Hz	-0.2		0	dB
Freq response, transmit ^b	F_{RT}	3400Hz	-0.2		0	dB
Transmit full scale level ^c (0dB gain)	V_{TX}			0.98		V_{peak}
Freq response, receive ^{a,b}	F_{RR}	Low -3dB corner		33		Hz
Freq response, receive ^{a,b}	F_{RR}	300Hz	-0.01		0	dB
Freq response, receive ^b	F_{RR}	3400Hz	-0.2		0	dB
Receive full scale level ^{c,d} (0dB gain)	V_{RX}			0.98		V_{peak}
Dynamic range ^e	DR	$VIN = 1\text{kHz}$, -60dB		84		dB
Total harmonic distortion ^f	THD	$VIN = 1\text{kHz}$, -3dB			-84	dB
Gain drift	A_T	$VIN = 1\text{kHz}$		0.002		dB/ $^\circ\text{C}$
Dynamic range (call progress AOUT)	DR_{AO}	$VIN = 1\text{kHz}$	60			dB
THD (call progress AOUT)	THD_{AO}	$VIN = 1\text{kHz}$			1.0	%
AOUT full scale level				$0.75V_A$		V_{p-p}
AOUT output impedance				10		$k\Omega$
Mute level (call progress AOUT)			-90			dB
Dynamic range (Caller ID mode)	DR_{CID}	$VIN = 1\text{kHz}$, -60dB		60		dB
Caller ID full scale level (0dB gain) ^c	V_{CID}			0.8		V_{peak}

- These characteristics are determined by external components. See Figure 2 on page 6.
- Sample rate = 8 kHz
- Parameter measured at Tip and Ring of Figure 2 on page 6.
- Full scale receive level produces -0.9dBFS at SDO.
- $DR = 60\text{dB} + 20 \log (\text{RMS signal}/\text{RMS noise})$. Applies to both the transmit and receive paths. Measurement bandwidth is 10Hz to 3400Hz. Valid sample rate ranges between 7200Hz and 11025Hz.
- $THD = 20 \log (\text{RMS distortion}/\text{RMS signal})$. Applies to both the transmit and receive paths. Valid sample rate ranges between 7200Hz and 11025Hz.

SWITCHING CHARACTERISTICS

General Inputs

Given values are: V_A = charge pump, $V_D = +3.3 \text{ V} \pm 5\%$; $T_A = 70^\circ\text{C}$ for K-grade, 85°C for B-grade; $C_L = 20 \text{ pF}$.

All timing is referenced to the 50% level of the waveform. Input test levels are: $V_{IH} = V_D - 0.4\text{V}$, $V_{IL} = 0.4\text{V}$.

Table 24 Switching Characteristics—General Inputs

Parameter	Symbol	Min	Typ	Max	Unit
Cycle time, MCLK	t_{mc}	16.67			ns
MCLK duty cycle	t_{dty}	40	50	60	%
Rise time, MCLK	t_r			5	ns
Fall time, MCLK	t_f			5	ns
MCLK before RESET $\uparrow$	t_{mr}	10			cycles
RESET pulse width ^a	t_{rl}	250			ns
M0, M1 before RESET $\uparrow$ ^b	t_{mxr}	20			ns

- a. The minimum RESET pulse width is the greater of 250ns or 10 MCLK cycle times.
b. M0 and M1 are typically connected to V_D or GND and should not be changed during normal operation.

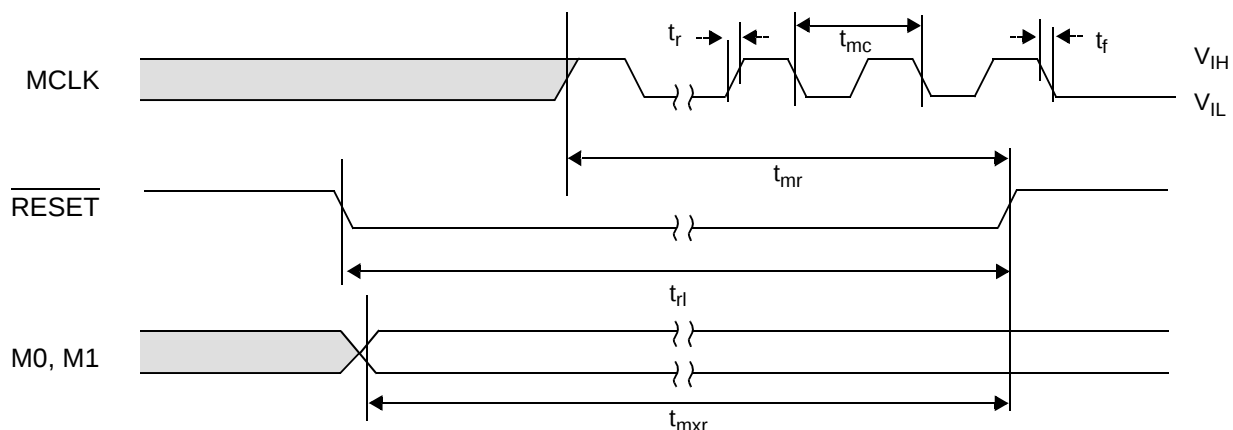


Figure 16 General Inputs Timing Diagram

Serial Interface (DCE = 0)

Given values are: V_A = charge pump, $V_D = +3.3 \text{ V} \pm 5\%$; $T_A = 70^\circ \text{C}$ for K-grade, 85°C for B-grade; $C_L = 20 \text{ pF}$.

All timing is referenced to the 50% level of the waveform. Input test levels are: $V_{IH} = V_D - 0.4\text{V}$, $V_{IL} = 0.4\text{V}$.

Table 25 Switching Characteristics—Serial Interface (DCE = 0)

Parameter	Symbol	Min	Typ	Max	Unit
Cycle time, SCLK	t_c	354	$1/256 F_s$		ns
SCLK duty cycle	t_{dty}		50		%
Delay time, SCLK $\uparrow$ to FSYNC $\downarrow$	t_{d1}			10	ns
Delay time, SCLK $\uparrow$ to SDO valid	t_{d2}			20	ns
Delay time, SCLK $\uparrow$ to FSYNC $\uparrow$	t_{d3}			10	ns
Setup time, SDI before SCLK $\downarrow$	t_{su}	25			ns
Hold time, SDI after SCLK $\downarrow$	t_h	20			ns
Setup time, FC $\uparrow$ before SCLK $\uparrow$	t_{sfc}	40			ns
Hold time, FC $\uparrow$ after SCLK $\uparrow$	t_{hfc}	40			ns

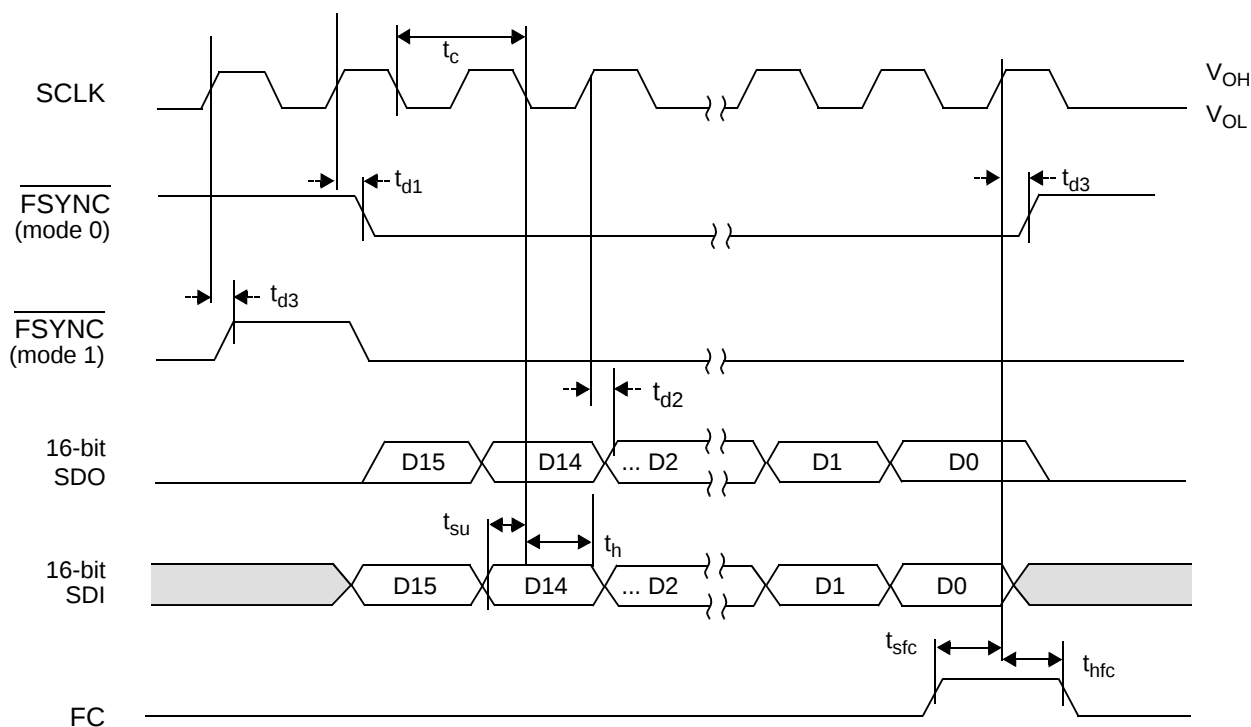


Figure 17 Serial Interface Timing Diagram (DCE = 0)

Serial Interface (DCE = 1, FSD = 0)

Given values are: V_A = charge pump, $V_D = +3.3 \text{ V} \pm 5\%$; $T_A = 70 \text{ }^\circ\text{C}$ for K-grade, $85 \text{ }^\circ\text{C}$ for B-grade; $C_L = 20 \text{ pF}$.

All timing is referenced to the 50% level of the waveform. Input test levels are: $V_{IH} = V_D - 0.4\text{V}$, $V_{IL} = 0.4\text{V}$.

Table 26 Switching Characteristics—Serial Interface (DCE = 1, FSD = 0)

Parameter	Symbol	Min	Typ	Max	Unit
SCLK duty cycle	t_{dty}		50		%
Delay time, SCLK $\uparrow$ to FSYNC $\uparrow$	t_{d1}			10	ns
Delay time, SCLK $\uparrow$ to FSYNC $\downarrow$	t_{d2}			10	ns
Delay time, SCLK $\uparrow$ to SDO valid	t_{d3}			20	ns
Delay time, SCLK $\uparrow$ to SDO Hi-Z	t_{d4}			20	ns
Setup time, SDO before SCLK $\downarrow$	t_{su}	25			ns
Hold time, SDO after SCLK $\downarrow$	t_h	20			ns
Setup time, SDI before SCLK $\downarrow$	t_{su2}	25			ns
Hold time, SDI after SCLK $\downarrow$	t_{h2}	20			ns

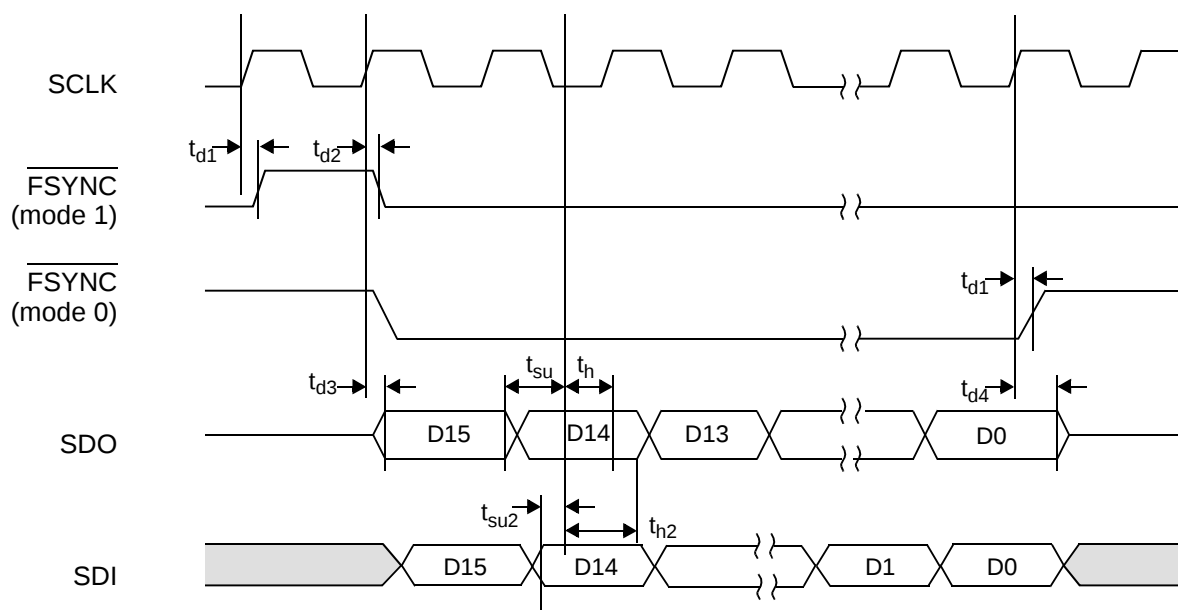


Figure 18 Serial Interface Timing Diagram (DCE = 1, FSD = 0)

Serial Interface (DCE = 1, FSD = 1)

Given values are: V_A = charge pump, $V_D = +3.3 \text{ V} \pm 5\%$; $T_A = 70^\circ \text{C}$ for K-grade, 85°C for B-grade; $C_L = 20 \text{ pF}$.

All timing is referenced to the 50% level of the waveform. Input test levels are: $V_{IH} = V_D - 0.4\text{V}$, $V_{IL} = 0.4\text{V}$.

Table 27 Switching Characteristics—Serial Interface (DCE = 1, FSD = 0)

Parameter	Symbol	Min	Typ	Max	Unit
Cycle time, SCLK	t_c	354	1/256 F_s		ns
SCLK duty cycle	t_{dty}		50		%
Delay time, SCLK $\uparrow$ to FSYNC $\uparrow$	t_{d1}			10	ns
Delay time, SCLK $\uparrow$ to FSYNC $\downarrow$	t_{d2}			10	ns
Delay time, SCLK $\uparrow$ to SDO valid	t_{d3}	$0.25t_c - 20$		$0.25t_c + 20$	ns
Delay time, SCLK $\uparrow$ to SDO Hi-Z	t_{d4}			20	ns
Delay time, SDO before RGDT $\downarrow$	t_{d5}			20	ns
Setup time, SDO before SCLK $\downarrow$	t_{su}	25			ns
Hold time, SDO after SCLK $\downarrow$	t_h	20			ns
Setup time, SDI before SCLK	t_{su2}	25			ns
Hold time, SDI after SCLK	t_{h2}	20			ns

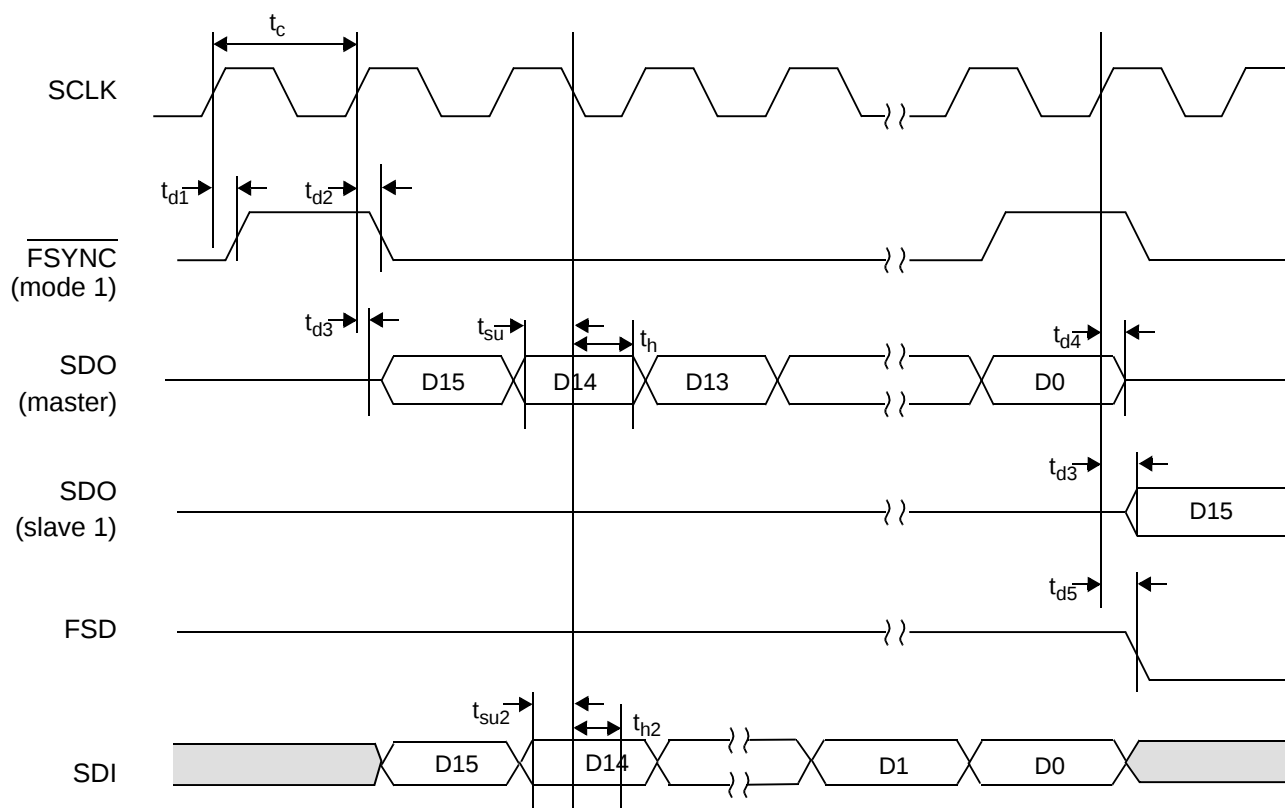


Figure 19 Serial Interface Timing Diagram (DCE = 1, FSD = 1)

DIGITAL FILTER CHARACTERISTICS

Digital FIR Filter Characteristics

Given values are: V_A = charge pump, $V_D = +3.3 \text{ V} \pm 5\%$; sample rate = 8 kHz; $T_A = 70^\circ\text{C}$ for K-grade, 85°C for B-grade.

Typical FIR filter characteristics for $F_s = 8000\text{Hz}$ are shown in Figures 21, 22, 23, and 24.

Table 28 Digital FIR Filter Characteristics—Transmit and Receive

Parameter	Symbol	Min	Typ	Max	Unit
Passband (0.1dB)	$F_{(0.1\text{dB})}$	0		3.3	kHz
Passband (3dB)	$F_{(3\text{dB})}$	0		3.6	kHz
Passband ripple peak-to-peak		-0.1		0.1	dB
Stopband			4.4		kHz
Stopband attenuation		-74			dB
Group delay	t_{gd}		$12/F_s$		sec

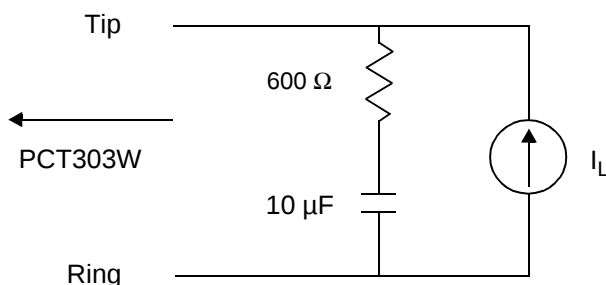
Digital IIR Filter Characteristics

Given values are: V_A = charge pump, $V_D = +3.3 \text{ V} \pm 5\%$; sample rate = 8 kHz; $T_A = 70^\circ\text{C}$ for K-grade, 85°C for B-grade.

Typical IIR filter characteristics for $F_s = 800 \text{ Hz}$ are shown in Figures 25, 26, 27, and 28. Figures 29 and 30 show group delay versus input frequency.

Table 29 Digital IIR Filter Characteristics—Transmit and Receive

Parameter	Symbol	Min	Typ	Max	Unit
Passband (3dB)	$F_{(3\text{dB})}$	0		3.6	kHz
Passband ripple peak-to-peak		-0.2		0.2	dB
Stopband			4.4		kHz
Stopband attenuation		-40			dB
Group delay	t_{gd}		$1.6/F_s$		sec



Note: The remainder of the circuit is identical to the one shown in the Application Diagram.

Figure 20 Test Circuit For Loop Characteristics

Filter Plot Diagrams

For Figures 21, 22, 23, and 24, all filter plots apply to a sample rate of $F_s = 8$ kHz. The filters scale with the sample rate as follows:

$$F_{(0.1 \text{ dB})} = 0.4125 F_s$$

$$F_{(-3 \text{ dB})} = 0.45 F_s$$

where F_s is the sample frequency.

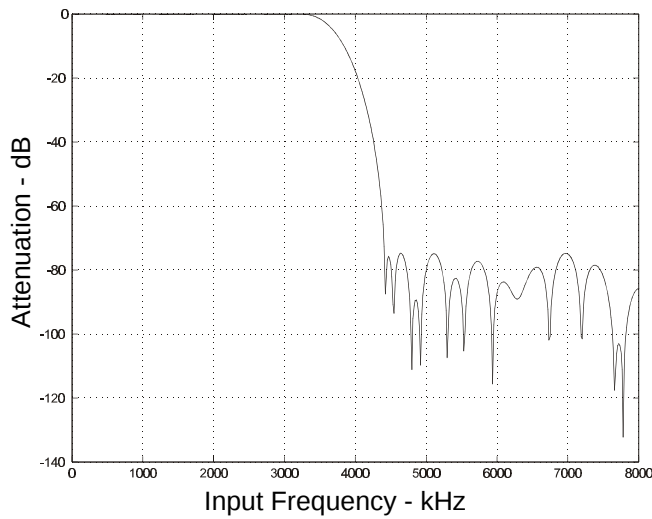


Figure 21 FIR Receive Filter Response

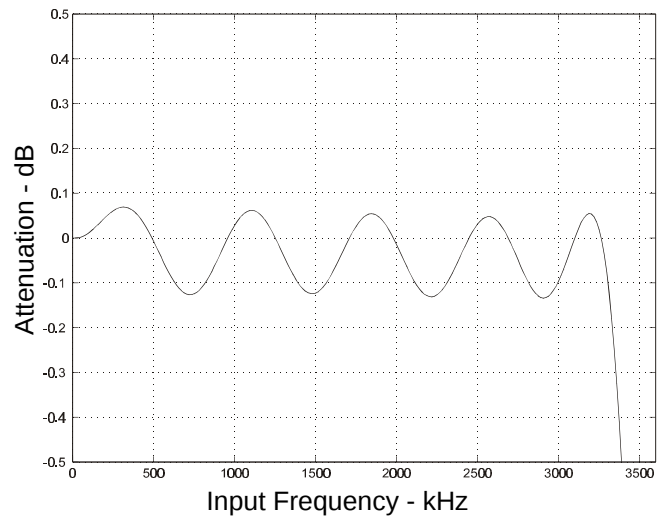


Figure 22 FIR Receive Filter Passband Ripple

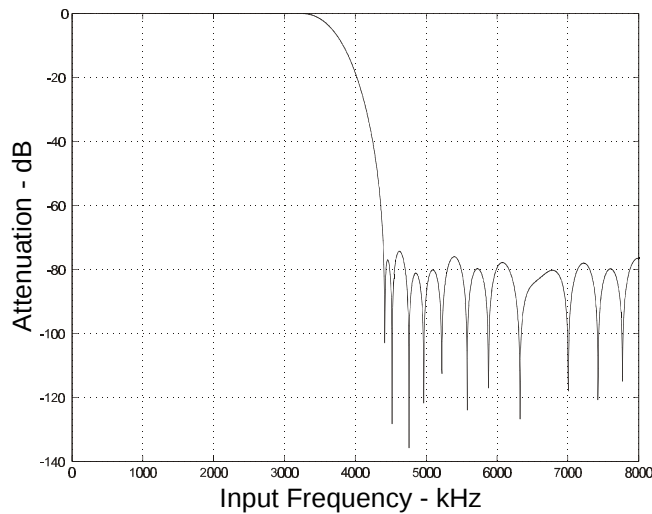


Figure 23 FIR Transmit Filter Response

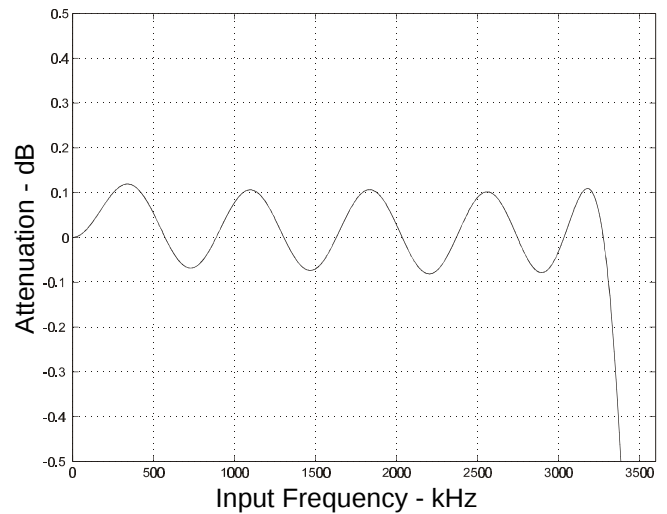


Figure 24 FIR Transmit Filter Passband Ripple

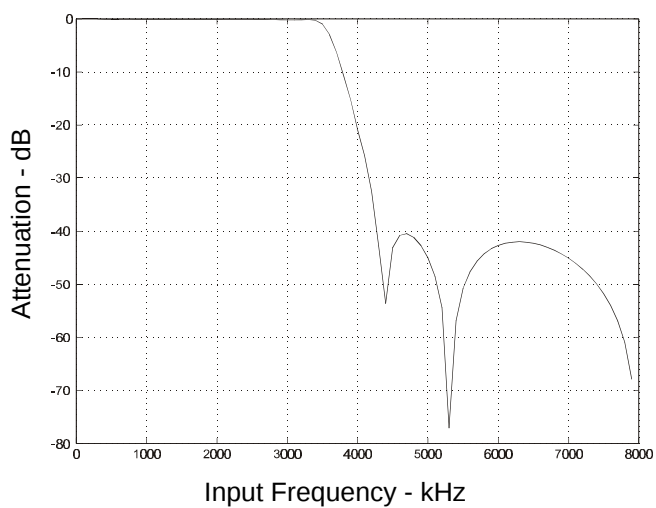


Figure 25 IIR Receive Filter Response

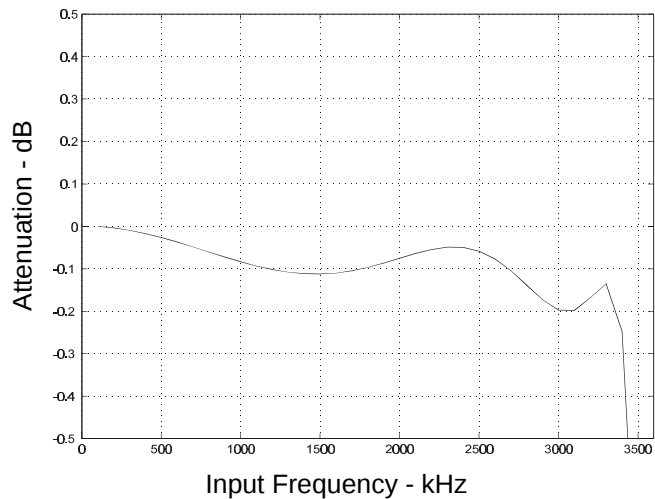


Figure 26 IIR Receive Filter Passband Ripple

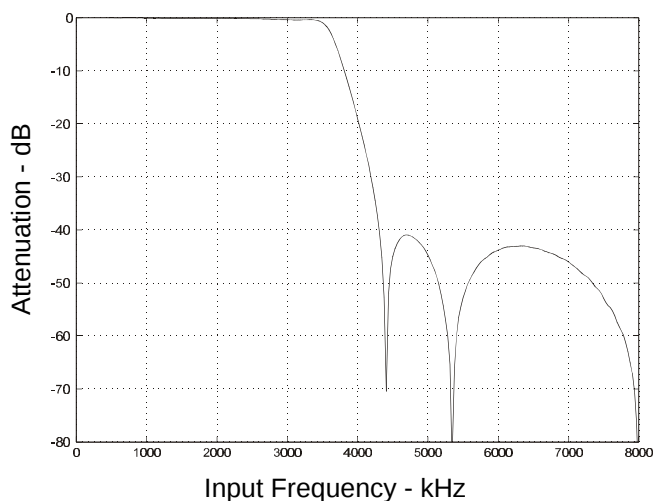


Figure 27 IIR Transmit Filter Response

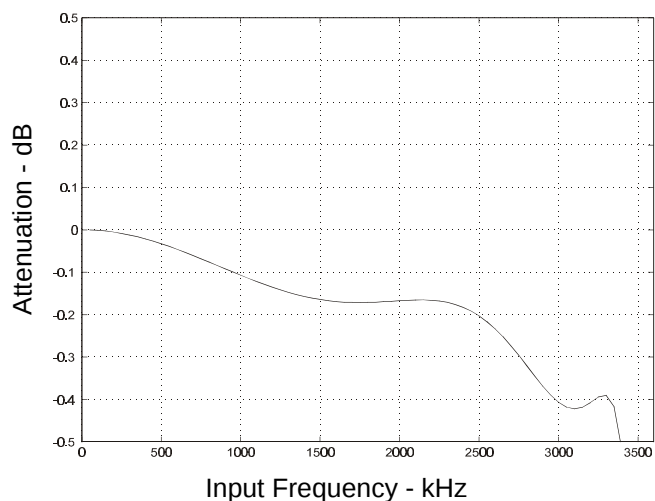


Figure 28 IIR Transmit Filter Passband Ripple

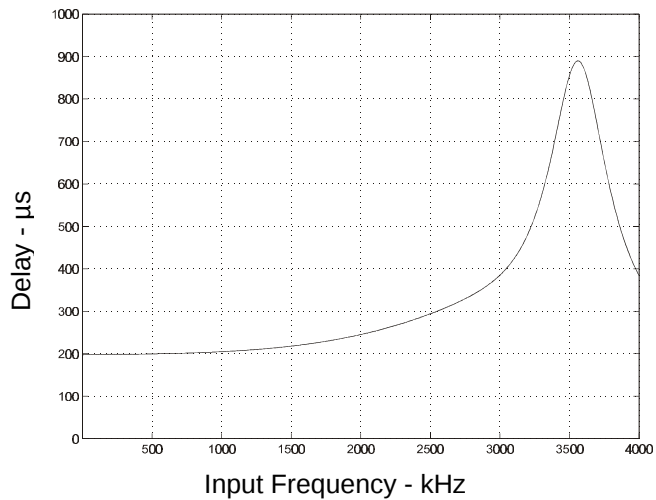


Figure 29 IIR Receive Group Delay

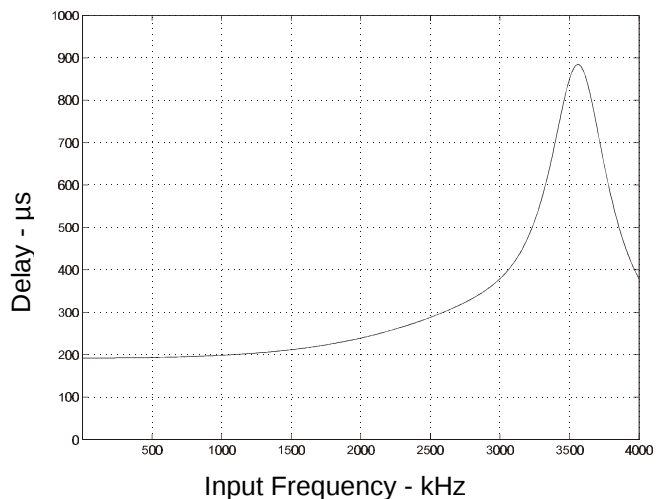


Figure 30 IIR Transmit Group Delay

PCT303DW Mechanical Dimensions

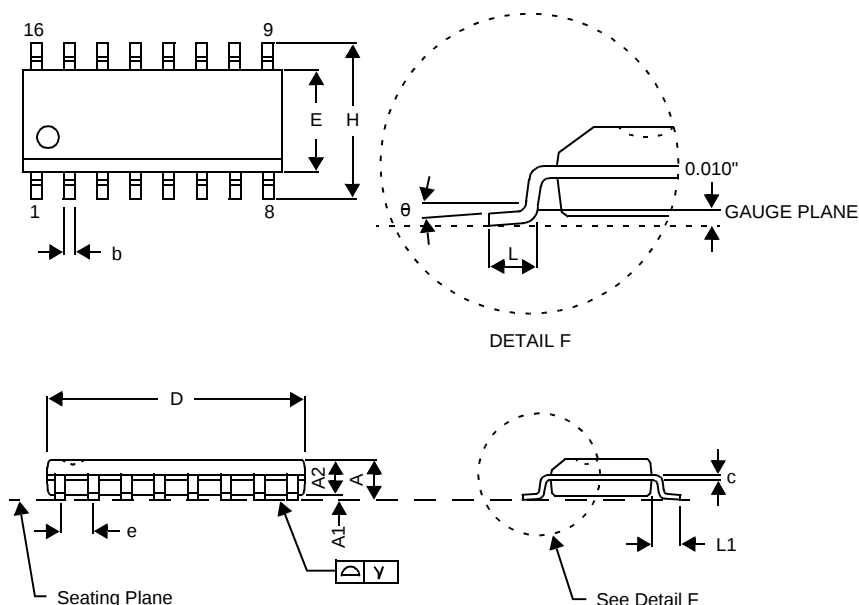


Figure 32 16-pin SOIC Package

Table 31 SOIC Mechanical Dimensions
(Controlling dimension: millimeters)

Symbol	Millimeters		Inches	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.30	1.50	0.051	0.059
b	0.330	0.51	0.013	0.020
c	0.19	0.25	0.007	0.010
D	9.80	10.01	0.386	0.394
E	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
L	0.40	1.27	0.016	0.050
L1	1.07 BSC		0.042 BSC	
g		0.10		0.004
q	0°	8°	0°	8°

APPENDIX: NET4 COUNTRY SUPPORT

Introduction

The international design for the PCT303DW can be implemented to support global requirements targeting compliance with CTR21 or compliance with NET4. This appendix outlines the component changes and control registers required for NET4 support. NET4 support requires different DC termination (mode 0) and programmable ringer impedance and ringer threshold in order to meet country-specific requirements. Some component changes (vs. CTR21 only support) are necessary and are outlined in the notes of Table 32 on page 67.

Mode 0

Mode 0 (0,0) is a low-voltage mode which supports a maximum transmit signal of -5.22 dBm. This mode meets the very low voltage requirements for countries such as Norway. See Figure 33.

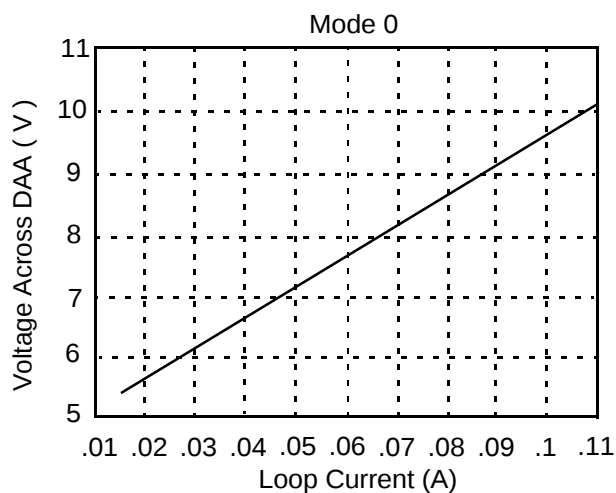


Figure 33 Mode 0 I/V Characteristics (0,0)

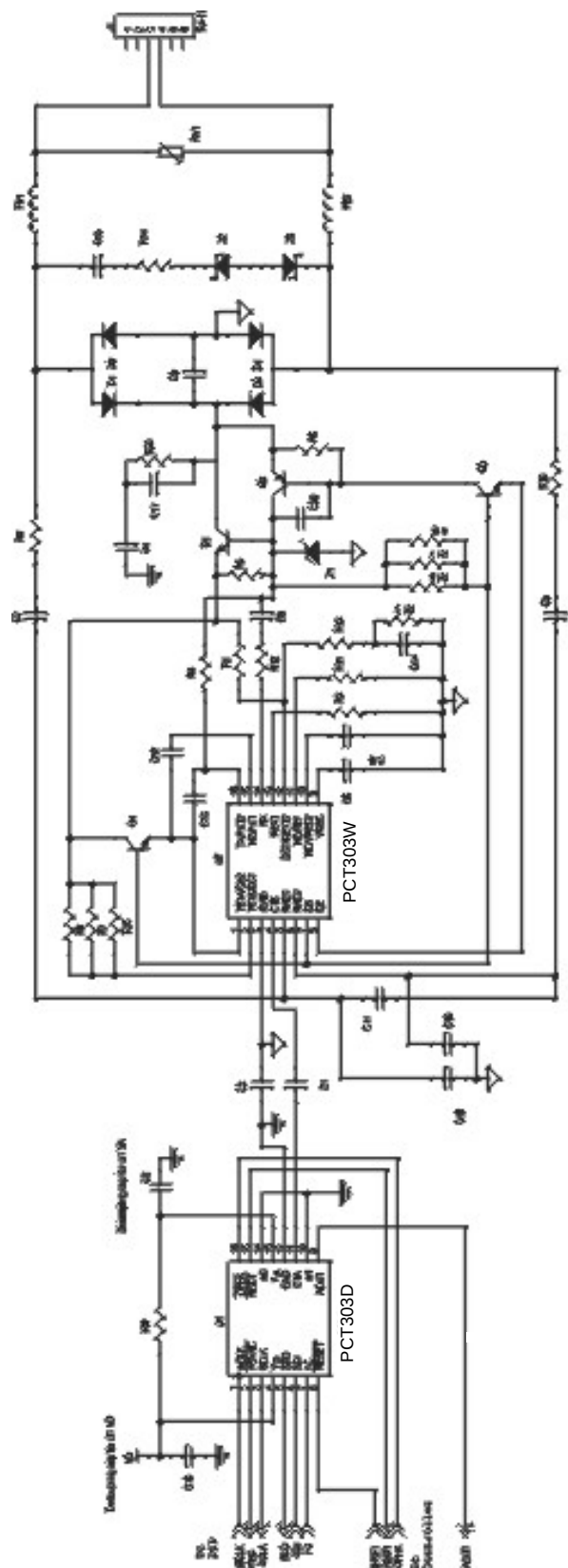
Ringer Impedance

The PCT303DW has a very high impedance ring detector that satisfies the requirements of most countries. In order to meet the maximum impedances of Germany ($20\text{ k}\Omega$) and South Africa ($60\text{ k}\Omega$), while not violating the minimum $20\text{ k}\Omega$ requirement of Austria, a selectable ringer impedance has been included. The default (mode 0) is $24\text{ k}\Omega$ and satisfies most countries. Mode 1 selects a $16\text{ k}\Omega$ impedance, primarily to support Germany. The mode is selected by the RZ bit of register 16.

Ringer Threshold

The PCT303DW has a programmable ringer threshold. Mode 1 sets a ring threshold of $21.5 \pm 5\text{ Vrms}$. The mode is selected by bit 0 (RT) of register 16. Most countries will be programmed as mode 1 except Switzerland, Austria, and Belgium which require mode 0. Many countries can operate in either mode, such as those complying to FCC regulations.

Typical Application (NET4 Specifications)



- Notes:**
1. C28, C29, C30, and C31 require only 20% tolerance for C17A2.7 diagram.
 2. C17A, R17A, Z1, and Z2 are required only for South Africa support.
 3. C17 and R17 are required for Arabia NE14 support (not C17A2.7 diagram). When correct, C2 and C4 decrease to 1000 pF, 3.3V, 10%, ±0.5%.
 4. R1 is not required when charge pump is enabled and $V_{DD} = 3.3V$.

Figure 34 Typical Applications Circuit (NET4 Specifications)

Typical Application Component Values

Table 32 Component Values (NET4 Specifications)

Symbol	North American Value	International Value
C1	150pF, 2kV, X7R, ±20%	150pF, 3kV, X7R, ±20%
C2,C4	1000pF, 2kV, X7R, ±20%	2200pF, 3kV, X7R, ±20%
C3,C10	0.1μF, 16V, X7R, ±20%	Same as North American
C5	0.47μF, 16V, X7R, ±20%	0.1μF, 50V, X7R, ±20%
C6	0.047μF, 16V, X7R, ±20%	0.1μF, 16V, X7R, ±20%
C7	2200pF, 250V, X7R, ±20%	680pF, 250V, X7R, ±20%
C8 ^a	2200pF, 250V, X7R, ±20%	680pF, 250V, X7R, ±10%
C9 ^a	15nF, 250V, X7R, ±20%	22nF, 250V, X7R, ±10%
C11	5600pF, 16V, X7R, ±20%	Not Installed
C12	Not Installed	0.22μF, 16V, X7R, ±20%
C13,C16	Not Installed	0.1μF, 16V, X7R, ±20%
C14	Not Installed	560nF, 16V, X7R, ±20%
C15 ^b	Not Installed	0.47μF, 250V, ±20%
C17 ^c	Not Installed	Not Installed
C18,C19 ^a	Not Installed	3900pF, 16V, X7R, ±10%
C20	Not Installed	47pF, 250V, X7R, ±20%
R1	51Ω, 1/2W ±5%	Not Installed
R2	15Ω, 1/4W ±5%	402Ω, 1/10W ±1%
R3 ^d	10Ω, 1/10W, ±5%	Same as North American
R4	604Ω, 1/4W, ±1%	Not Installed
R5	36kΩ, 1/10W ±5%	Same as North American
R6	36kΩ, 1/10W ±5%	121kΩ, 1/10W ±5%
R7,R8,R15,R16,R17,R19	Not Installed	4.87kΩ, 1/4W ±1%
R9,R10	10kΩ, 1/4W ±5%	30kΩ, 1/4W ±5%
R11	Not Installed	10kΩ, 1/10W ±1%
R12	Not Installed	140Ω, 1/10W ±1%
R13	Not Installed	442Ω, 1/10W ±1%
R14 ^b	Not Installed	18.7kΩ, 1/4W ±1%
R18	0Ω	2.2kΩ, 1/10W ±5%
R20 ^c	0Ω	0Ω
Z1	Zener Diode, 18V	Not Installed
Z2,Z3 ^c	Not Installed	Zener Diode, 3V
Q1,Q3	Motorola MMBTA42LT1	Same as North American
Q2	Motorola MMBTA92LT1	Same as North American
Q4	Not Installed	Motorola PZT2222AT1, 1/2W

Table 32 Component Values (NET4 Specifications) (Continued)

Symbol	North American Value	International Value
D1–D4	1N4004	Same as North American
FB1,FB2	Ferrite Bead	Same as North American
RV1	Sidactor 275V, 100A	Same as North American

- a. C8, C9, C18, and C19 require only 20% tolerance for CTR21 designs.
- b. C14, R15, Z2, and Z3 required only for South Africa support.
- c. C17 and R20 required for Austria Net 4 support (not CTR21 designs). When omitted, C2 and C4 decrease to 1000 pF, 3kV, X7R, $\pm 20\%$.
- d. R3 not required when charge pump is enabled and $V_D = 3.3\text{ V}$.

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NET4 Line Interface Configurations

Table 33 NET4 Country Line Interface Configurations (Register 16)

Country	AC Termination	DC Termination		Ringer Impedance	Ringer Threshold
	Bit 5	Bit 4	Bit 3	Bit 2	Bit 0
1. FCC	0	1	0	0	0
2. Australia	1	0	1	0	0
3. Austria ^a	0	1	0	0	1
4. Belgium ^a	0	1	0	0	1
5. Denmark ^a	1	1	1	0	0
6. Finland ^a	0	1	0	0	0
7. France ^a	0	1	1	0	0
8. Germany ^a	1	1	0	1	0
9. Greece ^a	1	1	1	0	0
10. Hungary ^a	1	1	1	0	0
11. Iceland ^a	1	1	1	0	0
12. Ireland ^a	1	1	0	0	0
13. Italy ^a	0	0	1	0	0
14. Japan	0	0	1	0	0
15. Liechtenstein ^a	1	1	1	0	0
16. Luxembourg ^a	1	1	1	0	0
17. Netherlands ^a	1	1	1	0	0
18. New Zealand	1	1	0	0	0
19. Norway ^a	1	0	0	0	0
20. Portugal ^a	0	1	0	0	0
21. Singapore ^b	0	0	1	0	0
22. South Africa	1	1	0	0	0
23. Spain ^a	0	1	0	0	0
24. Sweden ^a	1	1	1	0	0
25. Switzerland ^a	1	0	1	0	1
26. CTR21	1	1	1	0	0
27. UK ^a	1	1	0	0	1

a. These countries are now accepting CTR21.

b. Support for loop currents greater than or equal to 20 mA.