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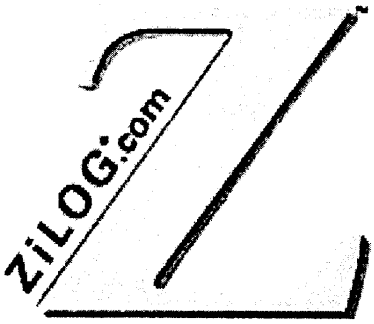
DATA SHEET



Z0221500ZCO

Z02215 MODEM EVALUATION KIT

KEY FEATURES

- Z02215™ Single-Chip modem DSP, Analog Front End, controller, and on-chip ROM/ RAM to hold the Controller and Datapump firmware
- Diplomat™ Utility to program the external EEPROM, and hence the Z02215, with specific country needs
- RS-232 DB25 port interface
- Telephone line interface with RJ-11 jack
- LED indicators
- Speaker
- Operates from single 12V AC, 1 Amp wall adapter power supply

OVERVIEW

The Z02215 Modem Evaluation Kit (Z0221500ZCO) provides a platform that allows evaluation of the ZiLOG Z02215 single-chip modem. The evaluation board (including the Z02215 Single-Chip Modem) is a fully-functional modem that supports AT commands.

Modem code contained in Z02215's on-chip ROM includes V.22bis, V.22, V.21, V.23, Bell 103, Bell 212A, Bell 202, and Bell 202T as well as basic data pump driver routines, AT commands, plus other controller code.

The evaluation board provides one serial port interface with a DB25 connector and a phone line interface through the RJ-11 connector. A power supply is provided that converts 110V AC power to +12VAC.

RELATED ZILOG PRODUCTS

Device	Description
Z02215	2400 bps Single-Chip Modem
Z02202	2400 bps Modem Data Pump + Analog Front End
Z02923	9600 bps Modem Data Pump + Analog Front End
Z02205	Modem Controller

HARDWARE SPECIFICATIONS

Dimensions	4.50-in. height x 6.00-in. width
Oscillator Frequency (OSC)	24.576 MHz for Z02215
Host Interface	RS-232 DB25 serial interface
Date Rate from Telephone line	2400 bps (max)
Serial Data Rate from Terminal	9600 bps (max)
Power Supply Voltage	+12V AC
Power Supply Current	1 Amp
Operating Temperature	20° C, ±10° C
Operating Humidity	10-90% RH (non condensing)

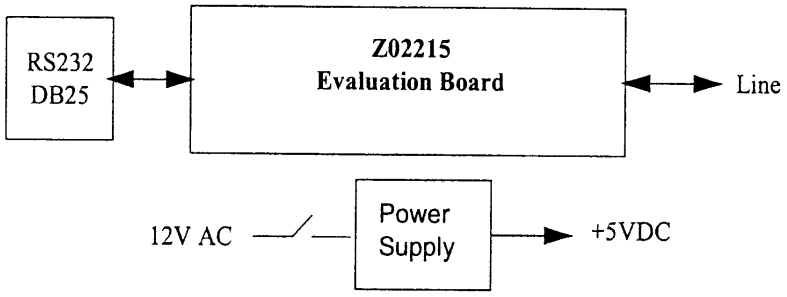


Figure 0-1. Z02215 Modem Evaluation Kit Functional Block Diagram

KIT CONTENTS

Hardware

- Z02215 V.22bis modem evaluation board
- 12V AC power converter (110V wall supply)
- Connector - female, 2.1 MM (inner diameter) by 5.5 MM (outer diameter)
- RJ11 phone cord (6-ft. length)

Software

- Diplomat Utility, including partial table files and hex files for the following countries: UK, Germany, Italy, Japan, Korea, North America, Portugal, Spain, Australia, China, France
- Biquad Filter Design Utility

Documentation

- *Z02215 Modem Evaluation Kit User's Manual*
- *Z02215 Single-Chip Modem with Integrated Controller, Data Pump, and Analog Front End Product Specification*
- Board schematic print files
- Evaluation board OrCAD and Gerber files

ADDITIONAL REQUIRED AND OPTIONAL ITEMS

Required Items Not Supplied With Kit

- IBM PC (or compatible) with the following minimum recommended configuration:
  - 486 CPU, 66 MHz
  - 4-MB RAM
  - Hard disk drive (1-MB free space)
  - VGA video adapter
  - 3.5-inch high-density floppy disk drive
  - RS-232C communications port
  - Windows 95

NOTE:

1. For increased performance, ZiLOG recommends a 486- or Pentium-based machine operating at 66 MHz or faster with 8-MB of RAM.

Information Integrity

The information contained within this document has been verified according to the general principles of electrical and mechanical engineering. Any applicable source code illustrated in the document was either written by an authorized ZiLOG employee or licensed consultant. Permission to use these codes in any form, besides the intended application, must be approved through a license agreement between both parties. ZiLOG will not be responsible for any code(s) used beyond the intended application. Contact the local ZiLOG Sales Office to obtain necessary license agreements.

Document Disclaimer

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ZiLOG

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PRODUCT SPECIFICATION

Z02215

SINGLE-CHIP MODEM WITH INTEGRATED CONTROLLER, DATA PUMP, AND ANALOG FRONT END

FEATURES

- Complete modem Integrated Circuit with integrated controller, data pump and Analog Front End (AFE) with active hybrid
- Includes an AT command set interpreter in the on-chip ROM with no external memory required
- Interface to serial EEPROM allows configuration of controller code through the Diplomat™ utility that simplifies country qualifications
- Automatic determination of AT command speed and parity
- Includes V.14 asynchronous to synchronous conversion
- Accepts asynchronous or synchronous terminal data
- Speed matching and RTC/CTS flow control between the modem and the terminal
- Voice answer detection
  - Line-In-Use detection before connection
  - Pick-up detection during connections
- Supports Tone or Pulse dialing
- Call progress monitoring controls
- Guard tone controls
- Line quality monitoring and auto-retrain
- Auto-Dial and Auto-Answer
- Supports telephone dial blacklisting
- Data modem throughput to 2400 bps
  - ITU V.22bis, V.23, V.22, V.21
  - Bell 212A, Bell 103, Bell 202, Bell 202T
- FSK (V.23 1200/75 bps, Bell 202/Bell 202T 1200/150 bps, V.21/Bell 103 300 bps), DPSK (V.22/Bell 212A 1200 bps), or QAM Encoding (V.22bis 2400 bps)
- V.23 with Minitel line reversal
- Programmable bi-quad call progress tone detectors
- Adaptive equalization to compensate for a wide variety of line conditions
- Programmable transmit attenuation and selectable receive threshold
- Fully-programmable call progress detectors for precise call program monitoring, including signal quality detectors, tone detectors, tone generators, and transmit signal levels that aid in rapid country qualifications
- On-chip peripheral, a full-duplex voice band AFE with 12-bit resolution
- Dynamic power management: power-saving SLEEP modes
- North American Type-I Caller ID
- 44-Pin PLCC, 44-Pin VQFP footprint
- Single +5 VDC power supply
- Minimal external logic
- 0°C to +70°C standard temperature range and –40°C to +85°C extended temperature range

Note: International Telecommunications Union (ITU, formerly known as CCITT)

GENERAL DESCRIPTION

The Z02215 is a synchronous single-chip V.22bis modem capable of 2400 bps full-duplex over dial-up lines. It is a full-featured, self-controlled modem that includes a modem controller, DSP, and Analog Front End (AFE) functions. This device is specifically designed for use in embedded modem applications where space, performance, and low-power consumption are key requirements.

Operating over the Public Switched Telephone Network (PSTN), the Z02215 meets the modem standards for V.22bis, V.22, V.23 (Minitel), V.21, Bell 212A, Bell 202, Bell 202T, and Bell 103.

A typical modem can be created by simply adding a phone-line interface (DAA), and DTE interface.

All modulation, demodulation, filtering, Analog to Digital (A/D), and Digital to Analog (D/A) conversion functions for transmission and reception are provided on-chip. Automatic compromise equalizers are included to optimize performance over a wide range of line types.

The Z02215 device compensates for a wide variety of adverse line conditions by using adaptive equalizers.

The Z02215 provides comprehensive selectable and programmable tone generation and detection.

Transmit drivers and receive amplifiers can be connected directly to a Data Access Arrangement (DAA) by adding a transformer, or a silicon DAA, reducing the external circuits to a minimum.

In addition, the Z02215 provides further system-level savings by providing built-in filters for both the transmitter analog output and the receiver analog Input. This configuration eliminates the need for external filtering components.

The analog front end of the Z02215 includes an active hybrid circuit that improves modem performance and reduces system-level costs by reducing the requirement for external components.

The Z02215 device operates on a single +5 VDC power supply. During periods of no traffic, the modem can be placed into SLEEP mode, reducing power consumption through Dynamic Power Management.

Note: All signals with an overline, are active Low. For example, B/$\overline{W}$, in which WORD is active Low; and $\overline{B}$/W, in which BYTE is active Low.

Power connections follow these conventional descriptions:

Connection	Circuit	Device
Power	V_{CC}	V_{DD}
Ground	GND	V_{SS}

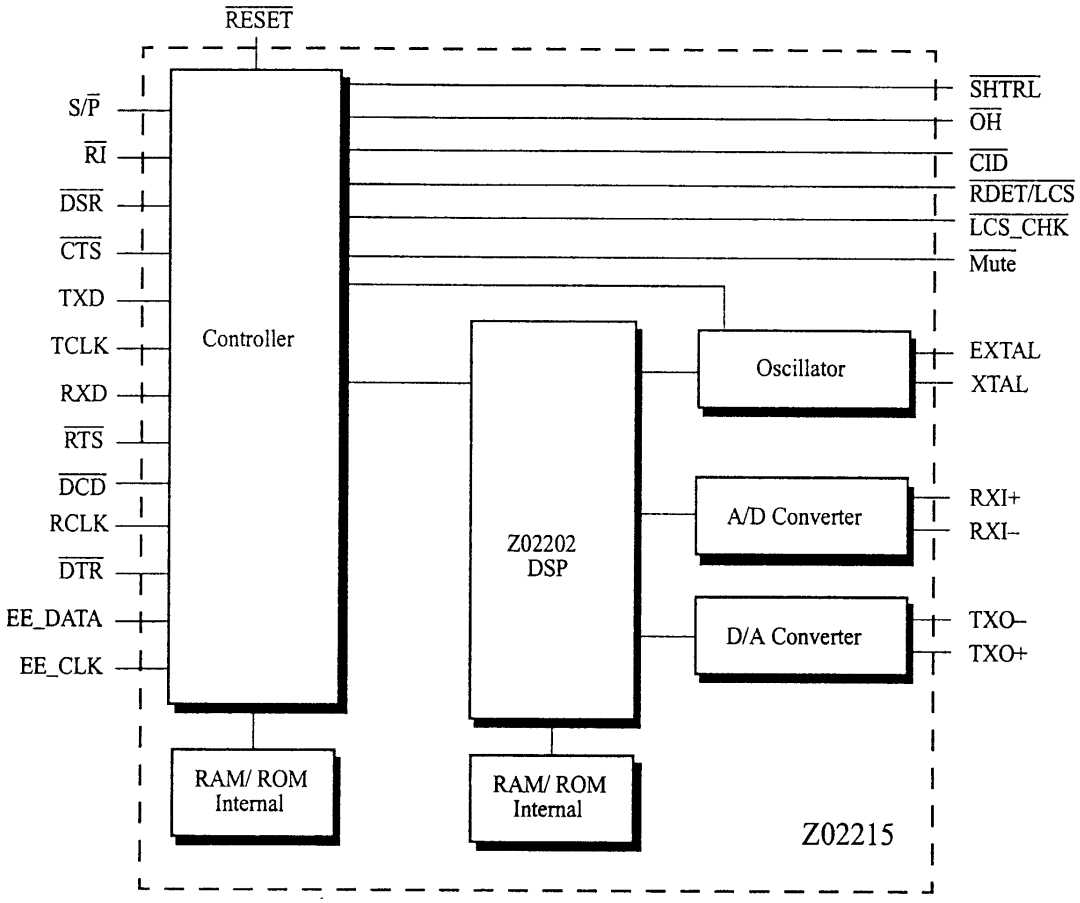


Figure 1. Z02215 Block Diagram

PIN DESCRIPTIONS

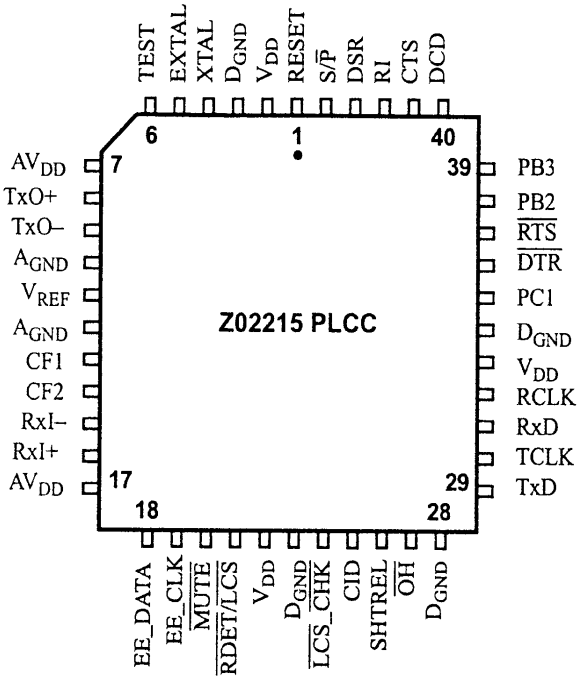


Figure 2. Z02215 44-Lead PLCC Pin Identification

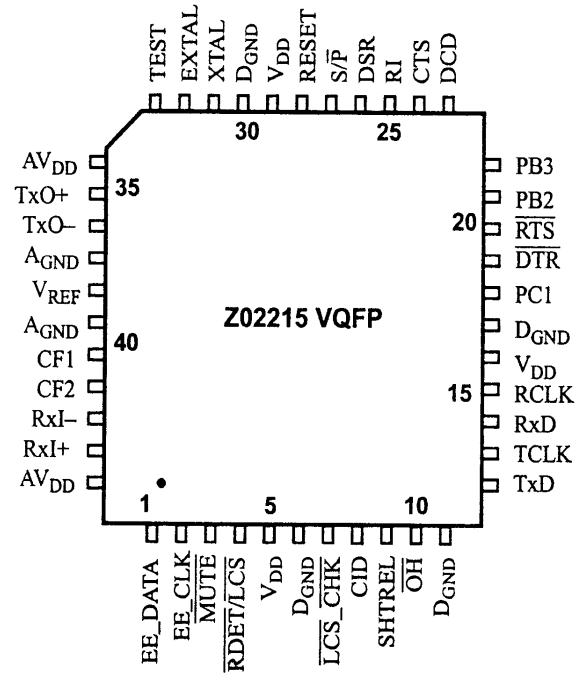


Figure 3. Z02215 44-Lead VQFP Pin Identification

Table 1. Pin Descriptions

Symbol	PLCC Pin #	VQFP Pin #	Function	Direction	Description
$\overline{RESET}$	1	28	Reset (Active low)	Input, Output	The RESET signal sets the modem to a RESET state.
V_{DD}	2	29	Digital Power		
D_{GND}	3	30	Digital Ground		
XTAL	4	31	Crystal (Time-based Output)	Output	This pin connects a parallel-resonant crystal. This pin is left open if an external clock is used instead of a crystal.
EXTAL	5	32	Crystal (Time-based Output)	Input	This pin connects a parallel-resonant crystal. An external clock can be input to the device on this pin when a crystal is not used.
TEST	6	33		Input	This pin is a test pin that must be tied to digital ground.
AV_{DD}	7	34	Analog Power		
TXO+	8	35	Transmit Differential Analog Output Positive	Analog Output	The TXO+ is capable of driving a 600W resistive load over a leased line or public switched telephone network via a Data Access Arrangement (DAA).
TXO–	9	36	Transmit Differential Analog Output Negative	Analog Output	The TXO+ is capable of driving a 600W resistive load over a leased line or public switched telephone network via a Data Access Arrangement (DAA).
A_{GND}	10	37	Analog Ground		
V_{REF}	11	38	Reference Voltage active High	Analog Output	An internally generated DC voltage.
A_{GND}	12	39	Analog Ground		
CF1	13	40	Integration Capacitor PIN 1	Analog Input	Connect an 82pF capacitor between CF2 and CF1 to complete the internal feedback integration filter for improved analog A/D performance.
CF2	14	41	Integration Capacitor PIN 2	Analog Input	Connect an 82pF capacitor between CF2 and CF1 to complete the internal feedback integration filter for improved analog A/D performance.
RXI–	15	42	Receive Differential Analog Output Negative	Analog Input	These are the analog inputs from the DAA.
RXI+	16	43	Receive Differential Analog Output Positive	Analog Input	These are the analog inputs from the DAA.
AV_{DD}	17	44	Analog Power		
EE_DATA	18	1		Input/Output	I^2C EEPROM Data.
EE_CLK	19	2		Output	I^2C EEPROM Clock.
$\overline{MUTE}$	20	3	Speaker Mute Control	Input	Controls speaker muting.
$\overline{RDET}/\overline{LCS}$	21	4	Ring Detect Input Line Current Sense	Input	Signals the presence of a ring signal on the line.The LCS_CHK input is used to detect when a parallel phone is off-hook before dialing or when a parallel phone has been picked up while connected. In either case when LCS goes Low, the connection attempt is dropped with a NO CARRIER message.
V_{DD}	22	5	Digital Power	Output	

Table 1. Pin Descriptions(Continued)

Symbol	PLCC Pin #	VQFP Pin #	Function	Direction	Description
D_{GND}	23	6	Digital Ground		
$\overline{LCS\_CHK}$	24	7	Line Current Sense	Output	This signal is used to enable the Line Current Sense circuits in the DAA when checking for parallel phone off-hook condition prior to taking the phone line off-hook.
$\overline{CID}$	25	8	Caller ID Relay	Output	This signal is used to turn on the Caller ID relay in the DAA.
$\overline{SHTREL}$	26	9	Pulse Dial Shunt Relay Output	Output	SHTREL works in conjunction with pulse dial *make/break*. It offers extra-low resistance across the tip and ring. When all relays are closed, it provides100 Ohms (Low) instead of 600 Ohms.
$\overline{OH}$	27	10	Off-Hook Relay Output	Output	This signal is used to turn on the off-hook relay in the DAA.
D_{GND}	28	11	Digital Ground		
TXD	29	12	Transmit Data	Input	Serial transmit data to the DSP is presented on this pin.
TCLK	30	13	Transmit Data Clock	Output	This pin is a synchronous data clock used to transfer serial data via TXD to the DTE. The clock frequencies are 2400,1200, and 300 Hz.
RXD	31	14	Receive Data	Output	The serial receive data from the DSP is presented on this pin.
RCLK	32	15	Receive Data Clock	Output	This pin is a synchronous data clock used to transfer serial data via RXD to the DTE. The clock frequencies are 2400, 1200 Hz, and 300 Hz.
V_{DD}	33	16	Digital Power		
D_{GND}	34	17	Digital Ground		
PC1	35	18	Port C	Input/Output, Serial mode only	This line can be configured as an input or output.
$\overline{DTR}$	36	19	Data Terminal Ready	Input	This signal is asserted by the DTE when it is ready to receive data.
$\overline{RTS}$	37	20	Request To Send	Input	This signal indicates that the DTE is ready to send data to the modem. When the modem is ready, it asserts $\overline{CTS}$ (see below).
PB2	38	21	General Purpose Output	Output	Programmable using Diplomat™.
PB3	39	22	General Purpose Output	Output	Programmable using Diplomat™.
$\overline{DCD}$	40	23	Data Carrier Detect	Output	This signal indicates that a modem carrier signal has been detected on the line.
$\overline{CTS}$	41	24	Clear To Send	Output	This signal indicates that the modem is ready for the DTE to send data to it.
$\overline{RI}$	42	25	Ring Indicator	Output	When active, this signal indicates that a ring signal on the phone line is detected by the modem.
$\overline{DSR}$	43	26	Data Set Ready	Output	This pin is the Data Set Ready pin and indicates when the modem is ready to transmit data. Refer to the &S command for details.

Table 1. Pin Descriptions(Continued)

Symbol	PLCC Pin #	VQFP Pin #	Function	Direction	Description
S/$\overline{P}$	44	27	Serial or Parallel Mode	Input	Configures the modem interface to serial or parallel mode.

MODEM STATES OF OPERATION

The Modem Controller software has several different states of operation.

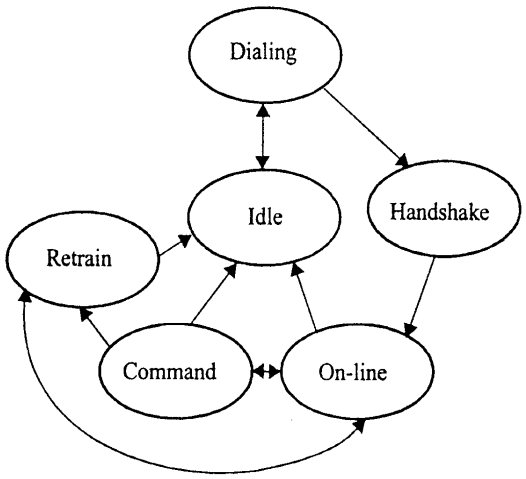


Figure 4. Modem State Diagram

Idle

When the modem is in the Idle state it is not communicating with another modem. The modem accepts AT commands from the terminal while Idle.

Dialing

When the modem dials it does the same things a person does to dial a telephone. The modem does not accept AT commands or data from the terminal while Dialing.

Handshake

When the modem handshakes it communicates with another modem to determine the data rate the two modems should use to communicate. Handshaking takes place at the beginning of each connection between two modems. The originator and answerer of a connection perform different actions while handshaking. The modem does not accept AT commands or pass data from the terminal while Handshaking.

On-Line

After successfully completing Handshaking the modems enter the On-Line state. When a modem is in the On-Line state, data received from its terminal is sent over the telephone line the other modem. Data received from the other modem is sent to the terminal.

Command

If the terminal sends a special *escape sequence* to a modem in the On-Line state, the modem enters the Command state. During Command state the modem maintains the connection with the other modem but does not pass data between the terminal and the other modem. Instead, data received from the terminal is treated as AT commands in the same way as if the modem was in the Idle state. The modem can be returned to the On-Line state by the O command. Data received from the other modem while a modem is in Command state is discarded unless the modem can buffer it for display on the terminal when the modem re-enters the On-line state.

Retrain

During a telephone line connection, the modem tries to remain synchronized with the remote modem by adapting to changes in telephone line connection and bridging transient noises such as call waiting, analog switching and cross talk. In V.22bis and higher speed data modes, if the modem loses synchronization with the remote modem data can not be received until synchronization is restored by a process called retraining. During Retraining the modem accepts data and commands from the terminal but does not transmit data to, or receive data from, the other modem.

AT COMMAND SET

Command lines are typed to the modem from the terminal when the modem is in the IDLE or COMMAND state. The modem does not execute any of the commands in a command line until after the command line is ended by the end-of-line character <CR>. A command line is a string of characters starting with the A and T characters and ending with a special end-of-line character, <CR>. Characters typed before the AT are ignored. Command lines contain, at most, 40 characters after the AT. The modem does not execute any of the commands in a command line that is too long.

To echo command line characters, use the E1 command.

Typing mistakes can be aborted by using a special BackSpace character, <BS>, after the initial A and T characters are entered.

A partial command line can be aborted by typing a Ctrl-X character. The modem returns an OK result code and ignores the partial AT command line.

Command lines may contain several commands one after another. The Answer (A), Dial (D), and Go on-line (O) commands usually cause the following commands in the command line to be ignored.

Command Line Execution

The characters in a command line are executed one at a time. Any unexpected characters (except control characters) stop command line execution and return an ERROR result code. Unexpected characters include numbers outside the range of values accepted by the command. All control characters in a command line except Ctrl-X (and the special characters such as <CR> and <BS>) are ignored.

The numerical argument of a command is assumed to be 0 if it is not provided. For example, the commands ATH<CR> and ATH0<CR> both hang up the telephone line.

When the modem has executed a command line, the result code of the most recent command executed is returned to the terminal.

If the value written to a modem S-register is outside the range of values accepted by the S-register, then its value is set to the nearest allowed value.

Leading 0s in numeric arguments, including S-register numbers, are ignored. For example, both set S-register S1 to 2:

```
ATS1=2
ATS01=2
```

All numeric arguments, including S-register numbers, are decimal (base 10).

AT Command Prefix

Each modem command line begins with the letters A and T. The modem uses these characters to determine the data rate and parity from the terminal.

A/ Repeat Last Command

To repeat the commands in the most recent command line, type the letters A and / instead of A and T.

<CR> End-of-Line Character

This character is typed to end a command line. The value of the <CR> character is stored in S-register S3. The default value is 13 (the ASCII carriage return character).

When the <CR> character is entered, the modem executes the commands in the command line.

Table 2. AT Command Set

North American default values are designated by **bold type.** The operation of these commands, and the default values of option commands, are configurable for operation in different countries.

Command		Function and Description
A	Answer	The A command causes the modem to go off-hook and respond to an incoming call. This command is issued after the modem has returned the RING result code. If the modems successfully complete the answering process, each returns a CONNECT result code and enters the on-line state. If no transmit carrier signal is received from the calling modem within the time specified in S-register S7, the modem hangs up, returns the NO CARRIER result code, and enters the IDLE state. If the modem is in the COMMAND state or &Q2 or &Q3 is selected then the ERROR result code is returned. Any commands following the A command on the command line are ignored. This command is aborted if a character is received from the terminal before the answer process is completed, or when DTR drops if certain options in the &Q or &D commands have been used.
B	Communication Standard Option	The B command specifies special telephone line modulation standards required for the connection. The modem can be configured to use: 1 – Bell 212A instead of ITU-T V.22 at 1200 bps 2 – Bell 103 instead of ITU-T V.21 at 300 bps 3 – ITU-T V.23 or Bell 202 in data modes with receive and transmit speeds that differ whether the caller or answerer transmits data at a higher data rate. 4 – In ITU-T V.23 data mode, Minitel line reversals. 5 – ITU-T V.23 or Bell 202T in data modes when the receive and transmit speeds are different, and with a 4-wire telephone interface instead of a 2-wire telephone interface When on-line in data modes with differing receive and transmit speeds (V.23, Bell 202), the modem recognizes only the Escape Sequence (+++) and modem commands at the higher of the speeds. S-register S37 also contributes to the selection of the modulation standard. This register sets the telephone line data rate, and the split rate data mode (Bell 202/ Bell 202T or V.23). Both modems must be configured identically to prevent communication failures caused by incompatible telephone line modulation standards.

Table 2. AT Command Set (Continued)

North American default values are designated by **bold type.** The operation of these commands, and the default values of option commands, are configurable for operation in different countries.

Command	Function and Description	
	B0	This option specifies the ITU-T modulation standards for all telephone line data rates unless S-register S37 is 2. These rates include V.22 for the 1200 bps telephone line data rate, and V.21 for the 300-bps telephone line data rate. When the value of S-register S37 is 1and the originating modem is transmitting at 75 bps and receiving at 1200 bps, V.23 is utilized. The answering modem transmits data at 1200 bps and receives data at 75 bps. When the value of S37 is 2 and the originating modem is transmitting at 150 bps and receiving at 1200 bps, Bell 202 is utilized. The answering modem transmits data at 1200 bps and receives data at 150 bps.
	B1	This option specifies the Bell modulation standards for 1200 bps and 300 bps telephone line data rates, unless S-register S37 is 1. Bell 212A at 1200 bps is utilized instead of V.22. Bell 212A, V.22 is the default value for North America. Bell 103 is utilized when a 300 bps telephone line data rate is required. If neither the 1200 bps nor 300 bps telephone line data rate are required, then a setting of B1 is ignored and the modem operates as if B0 was set.
	B2	When the value of S-register S37 is 1 and when the originating modem is transmitting at 1200 bps and receiving at 75 bps V.23 B1 is selected. The answering modem transmits data at 75 bps and receives data at 1200 bps. When the value of S register S37 is 2 and when the originating modem is transmitting at 1200 bps and receiving at 150 bps, Bell 202 is utilized. The answering modem transmits data at 150 bps and receives data at 1200 bps. When S-register S37 is set to any value other than 1 or 2, then a setting of B2 operates as if B0 is set.
	B3	This option is the same as B0.
	B4	The Minitel compatibility mode is activated by this command. It defaults to master mode (Tx75/Rx1200) if the modem is the originator. If S-register S37 is 1, Minitel line reversals are supported. Minitel allows a modem using V.23 and transmitting at 75 bps to simultaneously switch its transmitter to 1200 bps and receiver to 75 bps. The other V.23 Minitel modem detects the rate change and switches its transmitter to 75 bps and receiver to 1200 bps. The \R and R commands describe methods of causing a Minitel line reversal during a V.23 connection. When S-register S37 is set to any value other than 1, then a setting of B4 operates as if B0 was set.

This method is the fastest method of executing the line turnaround.

At execution of the R command, the Carrier Detect signal (CD) goes inactive, the modem reverses (its carrier changes from 390 Hz to 1300 Hz), and waits for a 390Hz carrier for 440ms.

- If the modem detects more than 40 ms of a 390 Hz carrier within 440 ms, it sends the CONNECT 1200/75 result code to the Host. CD goes active.
- If the modem does not detect more than 40 ms of a 390 Hz carrier within 440 ms, it hangs up and sends the NO CARRIER code to the Host.

Reverse Turnaround

The modem performs a Reverse turnaround w hen it detects a carrier drop longer than 20 ms. The Carrier Detect (CD) signal goes inactive and the modem reverses it carrier (from 1300 Hz to 390 Hz) and waits for a 1300 Hz carrier for 220 ms.

- If the modem detects more than 40 ms of a 1300 Hz carrier within 220 ms, it send the CONNECT 75/1200 code to the Host. CD goes active.
- If the modem does not detect more than 40 ms of a 1300 Hz carrier within 220 ms, it reverses again and waits for a 390 Hz carrier for 220 ms.
  - If the modem detects more than 40 ms of a 390 Hz carrier within 220 ms, it sends the CONNECT 1200/75 code to the Host. CD goes active (there was a short carrier dropout).
  - If the modem does not detect more than 40 ms of a 390 Hz carrier within 220 ms, it hangs up and sends the NO CARRIER code to the Host.

If the modem is in REVERSE mode and receives the R command, it sends the ERROR code to the Host.

STATIC REVERSE Mode

If the command ATR has been executed, the following ATD command forces the modem to try to connect in REVERSE mode.

ESCAPE SEQUENCES

An escape sequence is one or more particular characters sent from the terminal to the modem during the on-line state. This sequence is activated to switch the modem to the command state so modem commands may be entered during a telephone line connection. The Escape Sequence characters are typically sent to the other modem as data.

An escape sequence must not occur accidentally during an exchange of data between two modems. Unfortunately, it is impossible to guarantee that any escape sequence never occurs accidentally, because there are no restrictions on the data or timing between characters sent between two modems during the ONLINE state.

The only method of switching from the ONLINE state to the COMMAND state that never occurs accidentally during an exchange of data is the Data Terminal Ready signal (the &D1 command). The terminal has complete control of this signal, and it is not part of the data exchanged between the modems.

TIES Escape Sequence

TIES is a sequence of three escape characters (+ characters by default). When these characters are recognized, the modem enters the Command state without sending a confirming result code to the terminal. The modem then starts a prompt delay timer. During the prompt delay, the following situations may occur:

- If one of the recognized AT commands is received before the timer expires, the timer is stopped, the command is executed, and its result code is sent to the terminal.
- If any other data is received while the timer is running, the timer is stopped, the modem returns to the On-line state, and the received data is sent to the other modem.
- If the timer expires, a confirming result code is sent to the terminal, indicating the modem is in the COMMAND state.

The escape character and prompt delay timer can be changed by writing new values to S-registers S2 and S12.

CARRIER DETECTION

After handshaking, the modem determines if a telephone line connection exists by detecting the carrier signal from the other modem. If the carrier is not detected for a specified period of time, the modem assumes the telephone line connection with the other modem has been broken. The modem uses S-register S9 to determine how long a carrier must be present before it is detected. The modem uses S-register S10 to determine how long a carrier may not be detected before the telephone line is disconnected.

BLACKLISTING MANAGEMENT

Blacklisting applies separately to each number dialed, and indicates the call blocking capability for specific phone numbers. To minimize RAM, calls are treated as if they are all to the same number.

The first connection attempt after modem reset or a successful connection is always allowed. If a connection attempt is not successful, then each following connection attempt is checked as follows:

a. If voice answer was detected too many times the attempt is not allowed, the modem returns a BLACKLISTED result code.

b. If the attempt occurred too quickly (within the inter-call timing period) then the attempt is not allowed, and the modem returns a DELAYED result code.

c. If there is a blacklisting period limiting the number of attempts that may be made within the period, and too many attempts are made, then the attempt is not allowed, the modem returns a DELAYED (if a call may be made later) or BLACKLISTED result code (if no calls may be made later).

The following Blacklisting parameters can be controlled through Diplomat™:

- Minimum delay in seconds between successive dial attempts
- Number of successive dial attempts after which (c) applies
- Minimum delay in seconds between successive dial attempts after (b) unsuccessful dial attempts
- Maximum number of dial attempts permitted in a series of dial attempts
- Blacklisting period in minutes for each series of dial attempts

TECHNICAL SPECIFICATIONS

Configurations and Data Rates

The Z02215 can be configured to any of the V.22bis operation modes. Table 8 provides the selectable options, the supported data rate, and the baud rate, and frequency to be modulated.

Data Encoding

The data encoding for the Z02215 meets ITU–T recommendations as well as Bell standards.

Table 8. Selectable Configurations

Configuration	Modulation[1,2]	Carrier Frequency	Data Rate (bps)	Symbol Rate (baud)	Bits Per Symbol	Constellation Points
V.22 bis 2400	QAM	1200/2400	2400	600	4	16
V.22 bis 1200	DPSK	1200/2400	1200	600	2	4
V.22 1200	DPSK	1200/2400	1200	600	2	4
V.23 1200/75	FSK	1700/420	1200/75	1200/75	1	–
V.21	FSK	1080/1750	300	300	1	–
Bell 212A	DPSK	1200/2400	1200	600	2	4
Bell 103	FSK	1170/2125	300	300	1	–
Bell 202/ Bell 202T 1200/150	FSK	1700/437	1200/150	1200/150	1	–

Notes:
1. QAM is Quadrature Amplitude Modulation FSK is Frequency Shift Key
2. Tone is Single or Dual Tone (DTMF), TM is Trellis Modulation, DPSK is Dual Phase Shift Keying

TRANSMITTED DATA SPECTRUM

The transmitted data spectrum, with compromised equalization disabled, is shaped in the baseband of the finite impulse response (FIR) filter. Table 9 reflects the spectrum characteristics.

Table 9. Spectral Shaping

Mode	Carrier Freq	Spectral Power Shaping Function
V.22	1200/2400	square root 75% Raised Cosine at 600 baud
V.22bis	1200/2400	square root 75% Raised Cosine at 600 baud
Bell 212A	1200/2400	square root 75% Raised Cosine at 600 baud

Note: The carrier and the spectral shaping are selected automatically according to the Configuration.

ACTIVE HYBRID CIRCUIT AND RELAY DRIVER

An active hybrid circuit is added to the Analog Front End (AFE) of the Z02215 to improve the received signal quality level by 20dB and to improve the modem performance. The on-chip active hybrid reduces system level costs by reducing the requirement for external components making the designs cost effective and space efficient.

The 2-wire to 4-wire hybrid interfaces to Telecom coupling transformers in the Data Access Arrangement (DAA). The off-hook and shunt relay drivers provides a drive capability of 30 mA to allow the use of commonly available mechanical Telecom relays.

OPERATING NOTES

Dynamic Power Management

The Z02215 incorporates a low-power SLEEP mode. In this mode, the clock is stopped.

The modem controller software automatically puts the modem's data pump into a power-saving SLEEP mode when it is not in use. The modem controller software also puts the modem controller to SLEEP when possible.

This sleep feature operates transparently to the modem's operation. Approximately 58 mA of power is saved when both the modem data pump and controller are put in SLEEP mode.

When the Modem Controller is in SLEEP mode, it stays asleep until an interrupt is issued for a condition, such as:

- Start bit is received from the terminal.
- Telephone line ring is detected from the telephone line interface

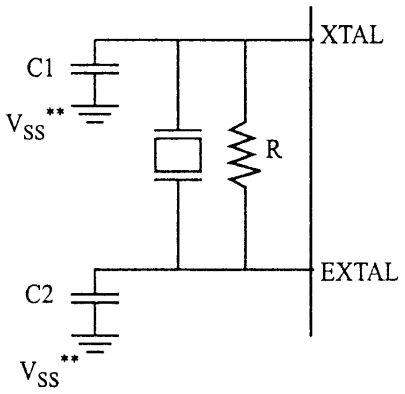
The modem controller cannot be in SLEEP mode if dial blacklisting is enabled in the country parameters and is being timed. The modem controller cannot be in SLEEP mode if AT&D3 is set because a DTR ON-to-OFF transition cannot change the modem's state out of SLEEP mode.

Clock Oscillator Description

Clock. The Z02215 on-chip oscillator has a high-gain, parallel-resonant amplifier, for connection to a crystal (XTAL is Output, EXTAL is Input). The crystal is AT cut, 24.576 MHz, with a series resistance (RS) of less than or equal to 100 Ohms.

The crystal is connected across XTAL and EXTAL using the vendor's recommended capacitor values from each pin directly to the device Ground pin to reduce ground-noise injection into the oscillator.

Note: For better noise immunity, the capacitors must be tied directly to the device Ground pin (V_{SS}).



Ceramic Resonator or Crystal
C1, C2 = 22 pF TYP*
R = 100K - 1M W
f = 8 MHz

* Preliminary value including pin parasitics
** Device ground pin

Figure 5. Oscillator Configuration

Table 10. Crystal Specifications

Parameter	Value
Temperature Range (Standard) Temperature Range (Extended)	0°C to +70°C –40°C to +85°C
Nominal Frequency @ 25°C	24.576 MHz
Frequency Tolerance @ 25°C	±20 PPM
Temperature Stability @ 0°C to 70°C	±25 PPM
Calibration Mode	Parallel Resonant
Shunt Capacitance	7 pF Max.
Load Capacitance	20 ±0.3 pF
Drive Level	1.0 mW max.
Aging, per Year Max.	±5 PPM
Oscillation Mode	Fundamental
Series Resistance	100Ω max.
Max. Frequency Variation with 28.8 or 35.2 pF load	±30 PPM

Country Configuration

The Z02215 contains modem controller code that is targeted to operate over a North America-style telephone network with the DAA configuration illustrated in the schematics at the end of this product specification. The customer may choose to configure the modem for use on other telephone networks. This capability is enabled by the addition of a serial EEPROM to hold various country tables. The EEPROM may be omitted from the application if the customer chooses to operate with the default North America-style parameters.

The Z02215 provides a means of loading information into the EEPROM for setting homologation or country approval tables. One way to set these tables is by choosing the desired geographic region to be served in a DOS program, supplied by ZiLOG, called Diplomat™. This program interfaces to the modem through the serial port using hidden AT commands, allowing reprogramming of the EEPROM.

Typical Performance Data

The Bit Error Rate (BER) and Block Error Rate (BLER) curves in Figure 6 are *representative* of a typical V.22 and V.22bis performance over a variety of signal-to-noise ratio (SNR) conditions.

Note: Modems usually exhibit lower bit error rates receiving in the low band as opposed to the high band.

For each BER curve illustrated, one connection is made, after which the Adaptive Equalizer (AEQ) was frozen. BER measurements are taken in 1 dB SNR steps from low noise levels to high noise levels. These tests were conducted using a Consultronics TCS500 Telephone Line Simulator and a Hewlett Packard 4951B protocol analyzer/BERT tester, under the following conditions:

Line Simulation	Flat
Transmit Level	–10 dBm
Receive Level	–30.0 dBm
Data Transmitted	511 pseudorandom pattern
Number of Bits Sent	10,000,000 in V.22bis, V.22 and Bell 212A.
Bits per Block	1,000
AEQ	Frozen after link establishment
Noise Calibration	C-message

Data Access Arrangement

Figure 8 indicates an example DAA configuration for North America. Isolation transformer (T1) couples the primary (line) and secondary (modem) sides, while providing high voltage isolation. This *wet* transformer (allowing DC current) simplifies the circuit and reduces the cost of the DAA.

On the Secondary side, the transmit (TxA+ and TxA–) and receive (RxA+ and RxA–) are combined in the 4-wire to 2-wire hybrid circuit.

On the Primary side, the off-hook relay switches the phone line between a local handset (phone) or the modem. The ring detect circuit consists of DC blocking capacitor C304, current limiting resistor R305, zener diodes CR303 and CR304, optocoupler U303, and its reverse protection diode D304. Protection elements RV301, F301, C301, and C302 (and transformer T1's isolation) provide higher voltage capability for approval in some foreign markets. C201 and C202, for example, may require replacement by Metal Oxide Varistors (MOVs) or Gas Discharge Tubes (GDTs). The shunt relay reduces the DAA impedance during pulse dialing. This relay is required for certain country approvals. The CID relay provides a signal path (through C4) to receive Caller ID signals without taking the line off-hook.

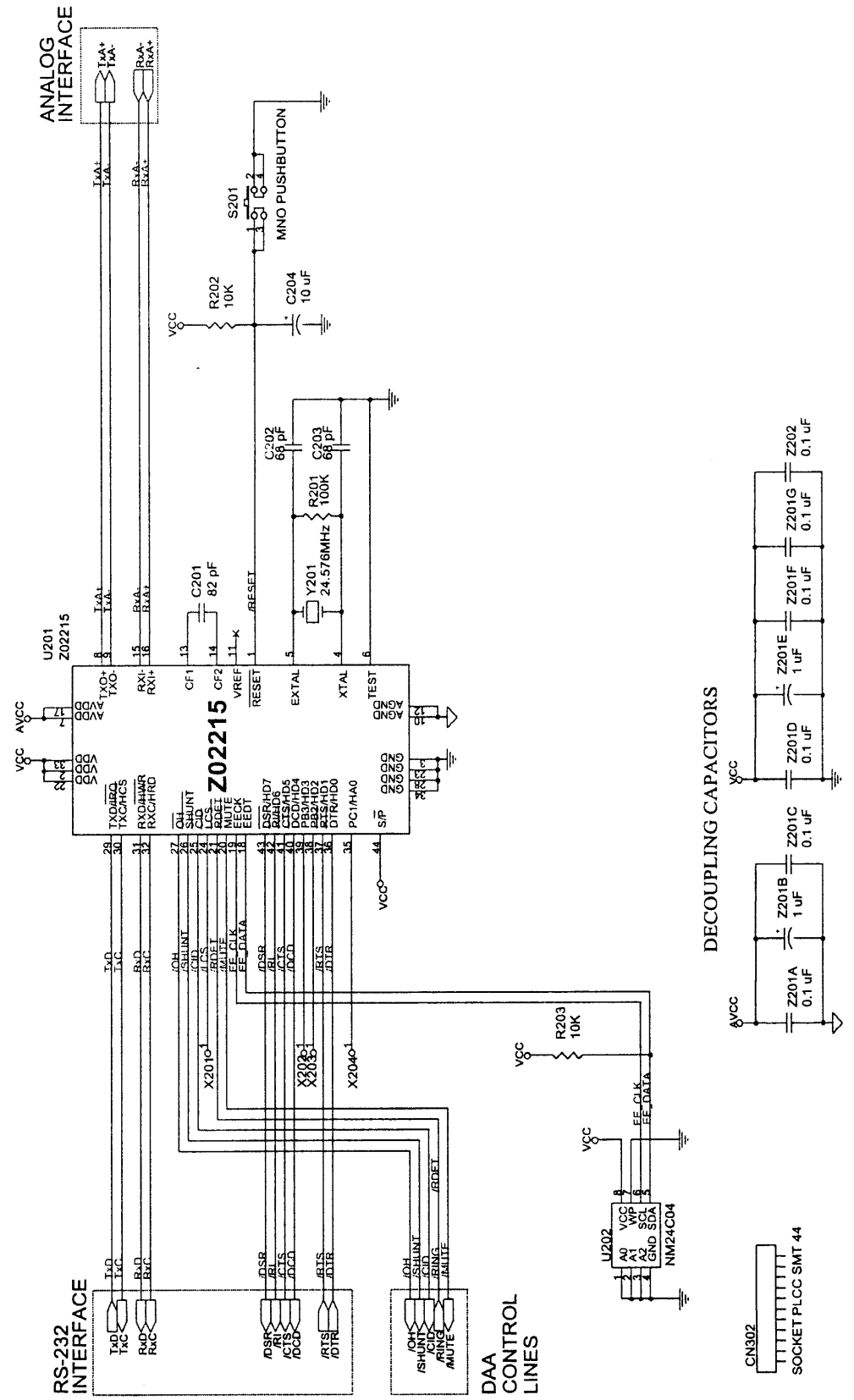


Figure 7. Typical Modem employing the Z02215

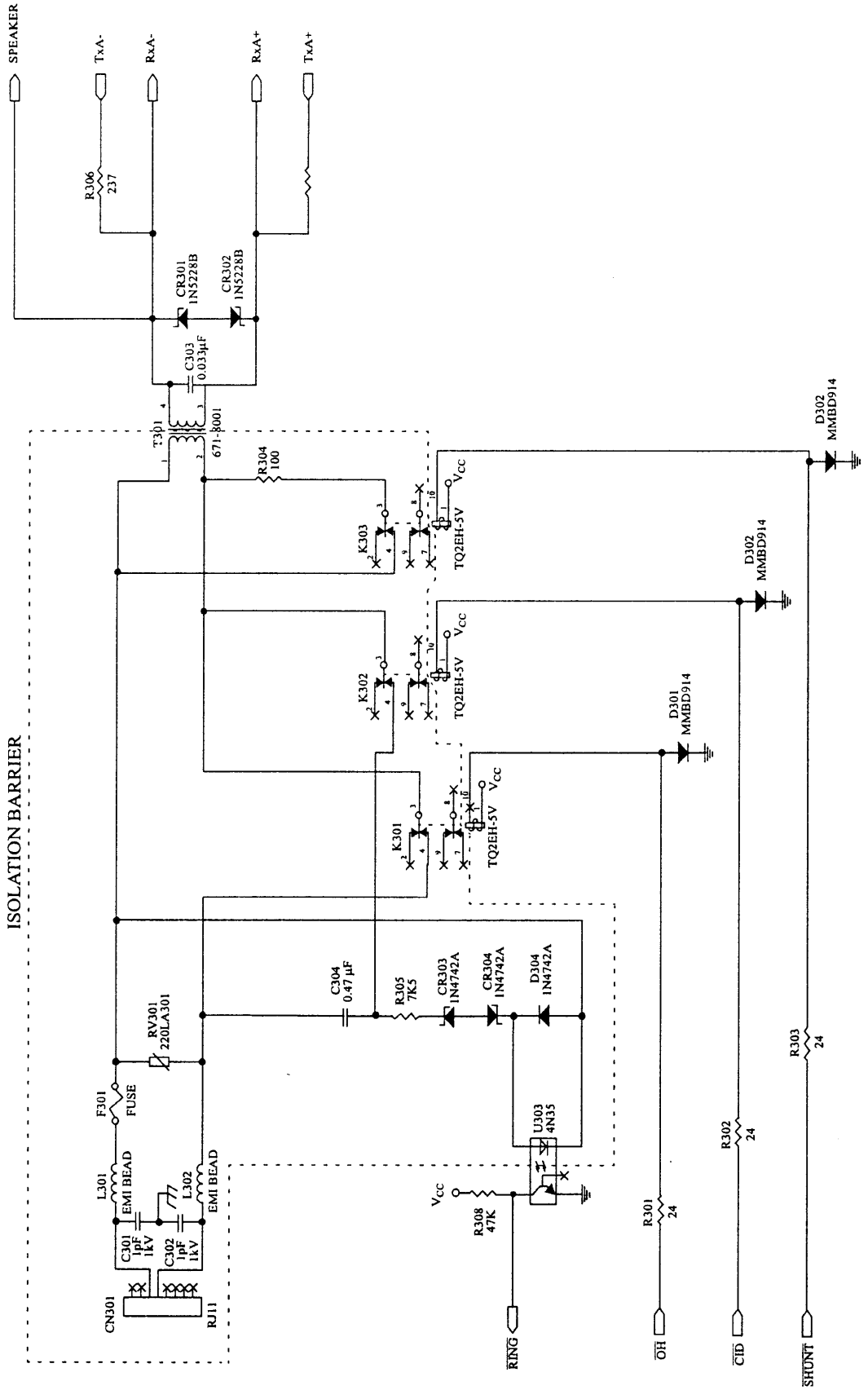


Figure 8. Data Access Arrangement (DAA)

ABSOLUTE MAXIMUM RATINGS

Parameter	Min	Max	Units	Notes
Operating Temperature (T_{OPR})	0	+70	C	
Extended Temperature (T_{EXT})	-40	85	C	
Storage Temperature (T_{STG})	–55	+150	C	
Voltage on any Pin with Respect to V_{SS}	–0.6	+7	V	1
Voltage on V_{DD} Pin with Respect to V_{SS}	–0.3	+7	V	
Voltage on XTAL and $\overline{RESET}$ Pins with Respect to V_{SS}	–0.6	V_{DD}+1	V	2
Total Power Dissipation		TBD	W	
Maximum Allowable Current out of V_{SS}		TBD	mA	
Maximum Allowable Current into V_{DD}		TBD	mA	
Maximum Allowable Current into an Input Pin	TBD	TBD	µA	3
Maximum Allowable Current into an Open-Drain Pin	–600	TBD	µA	4
Maximum Allowable Output Current Sinked by Any I/O Pin		TBD	mA	
Maximum Allowable Output Current Sourced by Any I/O Pin		TBD	mA	

Notes:
1. This parameter applies to all pins except XTAL pins and where otherwise noted.
2. There is no input protection diode from pin to V_{DD} and current into pin is limited to ±600 µA
3. Excludes XTAL pins.
4. Device pin is not at an output low state.

Stresses greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device. This rating is a stress rating only. Functional operation of the device at any condition above those indicated in the operational sections of these specifications is not implied. Exposure to absolute maximum rating conditions for an extended period may affect device reliability.

Total power dissipation must not exceed 1.21 W for the package. Power dissipation is calculated as follows:

```
Total Power  = VDD x [IDD - (sum of IOH)]
Dissipation
             + sum of [(VDD - VOH) x IOH]
             + sum of (V0L x I0L)
```

STANDARD TEST CONDITIONS

The DC Parameters are be tested according to the DC Characteristics detailed in Table 13. The Z02215 tester has active loads which are used to test the loading for I_{OH} and I_{OR}.

Available Operating Temperature Range

Standard = 0°C to +70°C

Extended = –40°C to +85°C

Voltage Supply Range:

```
+4.5 V ≤ VCC ≤ + 5.5 V
```

All AC parameters assume a load capacitance of 100 pF. Add 10 ns delay for each 50 pF increase in load up to a maximum of 150 pF for the data bus and 100 pF for address and control lines.

POWER REQUIREMENTS

The modem power and environmental requirements are indicated in Table 11 and Table 12.

Table 11. Power Requirements

Voltage	Current Typical @ 25°C	Current Maximum @ 0°C
+5 V_{DC}, Operating	TBD	TBD
+5 V_{DC}, Sleep	TBD	TBD

Note: All voltages are ±5% DC and must exhibit ripple less than 0.1V (peak to peak). If a switching supply is used, the frequency may be between 20 kHz and 150 kHz. There must be no component of the switching frequency present outside of the supply greater than a 500 µV peak.

Table 12. Environmental Requirements

Parameter	Value
Ambient Temperature Under Bias (Standard Temperature Range)	0°C to +70°C
Extended Temperature	–40°C to +85°C
Storage Temperature	–55°C to +150°C
Voltage on any pin to V_{SS}	–0.3V to +7V
Power Dissipation	TBS
Soldering Temperature 10 sec	+230°C

DC CHARACTERISTICS

Table 13. DC Characteristics

Parameter	Description	Test Conditions	Minimum	Typical	Maximum	Units
Pin Types I and I/O: Input and Input/Output						
V_{IH}	Input High Voltage		2.0	–	V_{CC} +0.3	V
V_{IL}	Input Low Voltage		-0.3	–	0.8	V
I_L	Input Leakage Current	$GND < V_0 < V_{DD}$	–	–	10	µA
Pin Types O and IO: Output and Input/Output						
V_{OH}	Output High Voltage	I_{OH} = –200 µA	2.4	–	–	V
V_{OL}	Output Low Voltage	I_{OI} = -2.2 mA	–	–	0.4	V
I_{OZ}	Tri-state Leakage Current	$GND < V_0 < V_{DD}$	–	–	1.0	µA
Pin Types I-PU & I-PD: Input with Internal Pull-Up/Pull-Down Resistor						
V_{IH}	Input High Voltage		TBD		TBD	V
V_{IL}	Input Low Voltage		TBD		TBD	V
I_{IL}	Input Current	$GND < V_0 < V_{DD}$	TBD		TBD	mA
Pin Type XI: Crystal Input						
V_{IH}	Input High Voltage		V_{CC} - 0.6		V_{CC} + 0.3	V
V_{IL}	Input Low Voltage		-0.3		0.6	

Table 13. DC Characteristics (Continued)

Parameter	Description	Test Conditions	Minimum	Typical	Maximum	Units
Pin Type O–OD: Output with Open-Drain						
V_{OL}	Output low Voltage	I_{OI} = 2.2 mA	2.4	–	–	V
I_{OZ}	Tri-state Leakage Current	GND < V_0 < V_{DD}	–	–	1.0	µA
Pin Type XO: Crystal Output						
V_{OH}	Output High Voltage	I_{OH} = 1.0 mA	TBD		TBD	V
V_{OL}	Output Low Voltage	I_{OI} = –1.0 mA	TBD		TBD	V
Pin Type AI: Analog Input						
V_{DC}	Input Bias Offset		V_{REF} –15	V_{REF}	V_{REF} +15	mV
V_{OFFI}	Input Offset (Differential)		–20	0	+20	mV
I_L	Input Current		–100	–	100	mA
C_{IN}	Input Capacitance		–	10	–	pF
R_{IN}	Input Resistance		–	20	–	KΩ
Pin Type AO: Analog Output						
V_O	Analog Output Voltage		V_{REF} –1.163	V_{REF}	V_{REF} +1.163	mV
V_{OFF}	Output DC Offset		V_{REF} –40	V_{REF}	V_{REF} +40	mV
V_{OFFO}	Output DC Offset (differential)		–40	0	+40	mV
R_O	Output Resistance		–	0.8	–	Ω
C_O	Output Capacitance		–	10	–	pF
Z_I	Load Impedance		400	600	Infinite	Ω
Pin Type PWR: Power and Ground						
V_{DD}	Digital Supply Voltage	Voltage	4.5	5	5.5	V
AV_{DD}	Analog Supply Voltage		V_{DD}	V_{DD}	V_{DD}	V
I_{DD1}	Digital Supply Current	Operating	–	TBD	TBD	mA
I_{ADD1}	Analog Supply Current	Operating	–	TBD	TBD	mA
I_{DD2}	Digital Supply Current	SLEEP Mode	–	TBD	TBD	µA
I_{ADD2}	Analog Supply Current	SLEEP Mode	–	TBD	TBD	µA

CAPACITANCE

T_A = 25°C, V_{CC} = GND = 0V, f = 1.0 MHz, unmeasured pins to GND.

Parameter	Minimum	Maximum
Input capacitance	0	12 pF
Output capacitance	0	12 pF
I/O capacitance	0	12 pF

Table 14. Microprocessor Interface Timing

Reset Timing	Parameter	Minimum	Typical	Maximum	Units
Reset Pulse Width		1.0	–	–	µs

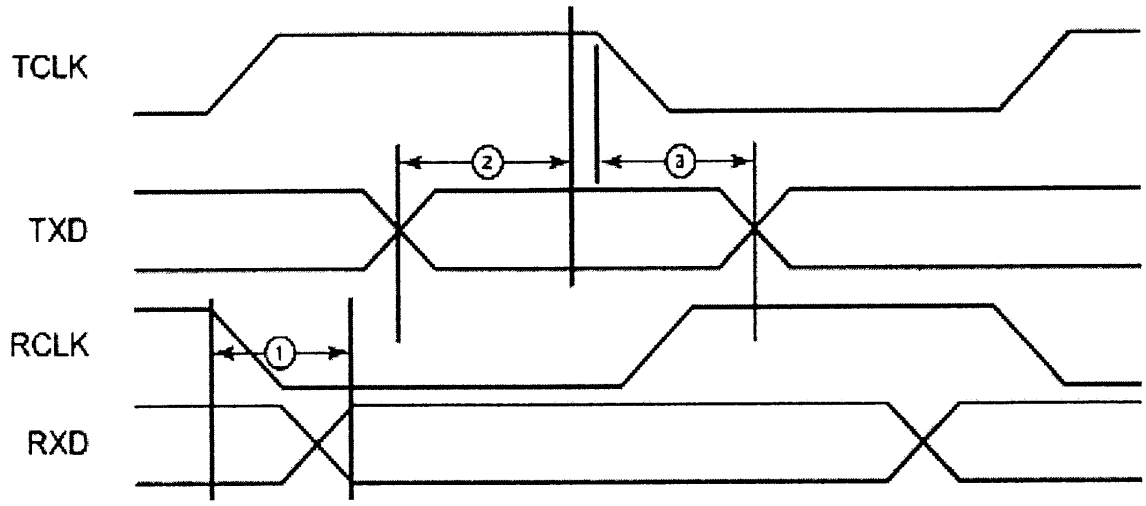


Figure 9. Serial Port Timing Diagram

Table 15. Serial Interface Timing

Description	Parameter	Minimum	Typical	Maximum	Units
RXD Data Valid Delay Time	1	–	12	–	ns
TXD Data Setup Time	2	100	–	–	ns
TXD Data Hold Time	3	100	–	–	ns

Table 16. Analog Characteristics

Description	Parameter	Minimum	Typical	Maximum	Units
Input impedance of transformer interface	1	400	1200	–	Ω
3 dB point of transformer interface	2	21	26.5	32.5	kHz
External integration capacitance Type NPO (COG)	3	73	82	90	pF

Note: NPO and COG are synonymous terms for an industry standard dielectric material used for ceramic capacitors which provides a very low temperature coefficient of capacitance (±30 ppm per °C) and voltage coefficient of capacitance (under 0.01% per Volt). It also has a low dissipation factor (0.1% max at 1 MHz for the values of interest).

ANALOG INPUTS: TYPE AI

AC Characteristics	Symbol	Minimum	Typical	Maximum	Units
Input Impedance (DC to V_{REF})	Z_{IN}	15K	25K	–	Ω
Power Supply Rejection	P_{SRRi}	40	–	–	dB
Input Current	I_i	–80	–	80	mA
Idle Channel Noise (3950 Hz Bandwidth)	I_{CNi}	–	–	–72	dBm
Signal to Distortion	S_{TDi}	30	–	–	dB

The characteristics below are provided for information only. They are not tested except in the functional test vectors.

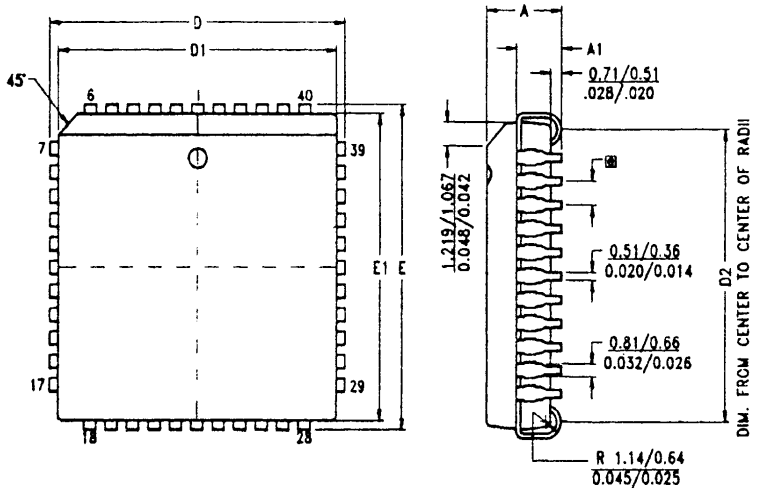
Characteristics	Symbol	Minimum	Typical	Maximum	Units
Input Capacitance	C_{IN}	–	10	–	pF
Input Bias	V_{DCOFF}	–	+2.5	–	V
Analog Input Voltage (peak differential), (23)	V_{PKI}	–2.362	–	+2.362	V
Analog Input Voltage (per RXI+. RXI– pin)	V_{PKIP}	–1.181	–	+1.181	V

ANALOG INPUTS: TYPE A0

AC Characteristics	Symbol	Minimum	Typical	Maximum	Units
Power Supply Rejection	P_{SRRO}	40	–	–	dB
Signal to Distortion	S_{TD0}	35	–	–	dB
Idle Channel Noise (3950 Hz Bandwidth)	I_{CNO}	–	–	–72	dBm
Out-of-Band Noise	N_{qo}				dBm
4–8 kHz	–	–	–20		dBm
8–12 kHz	–	–	–40		dBm
12 kHz and above in 4 kHz bandwidths	–	–	–55		dBm

Characteristics	Symbol	Minimum	Typical	Maximum	Units
Output Impedance	Z_{OUT}	–	0.80	–	Ω
Output Capacitance	C_{OUT}	–	10	–	pF
Analog Output Voltage (peak differential), (24)	V_{PKO}	–2.375	–	+2.375	V
Load Impedance (25)	ZI	400	600	–	–

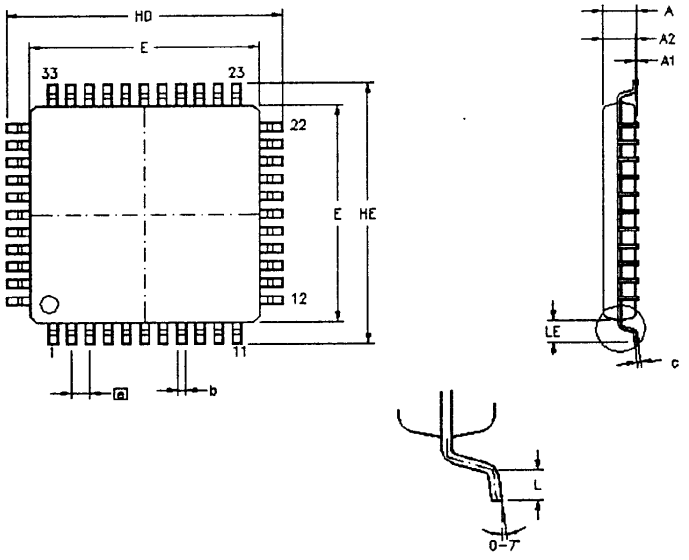
PACKAGE INFORMATION



SYMBOL	MILLIMETER		INCH	
	MIN	MAX	MIN	MAX
A	4.27	4.57	0.168	0.180
A1	2.41	2.92	0.095	0.115
D/E	17.40	17.65	0.685	0.695
D1/E1	16.51	16.66	0.650	0.656
D2	15.24	16.00	0.600	0.630
e	1.27 TYP		0.050 TYP	

NOTES:
1. CONTROLLING DIMENSION : INCH
2. LEADS ARE COPLANAR WITHIN 0.004".
3. DIMENSION : MM / INCH

Figure 10. 44-Lead PLCC Package Diagram



SYMBOL	MILLIMETER		INCH	
	MIN	MAX	MIN	MAX
A	1.40	1.60	0.055	0.063
A1	0.05	0.15	0.002	0.006
A2	1.35	1.45	0.053	0.057
b	0.30	0.45	0.012	0.018
c	0.09	0.20	0.004	0.008
HD	11.75	12.25	0.463	0.482
D	9.90	10.10	0.390	0.398
HE	11.75	12.25	0.463	0.482
E	9.90	10.10	0.390	0.398
e	0.80 BSC		0.031 BSC	
L	0.45	0.75	0.018	0.030
LE	1.00 REF		0.039 REF	

1. CONTROLLING DIMENSIONS : mm
2. MAX. COPLANARITY : .10mm / 0.004"

Figure 11. 44-Lead VQFP Package Diagram

ORDERING INFORMATION

Z02215

Z0221524VSCR4508	PLCC	24.576 MHz	Standard Temp
Z0221524VECR4508	PLCC	24.576 MHz	Extended Temp
Z0221524ASCR4508	VQFP	24.576 MHz	Standard Temp
Z0221524AECR4508	VQFP	24.576 MHz	Extended Temp

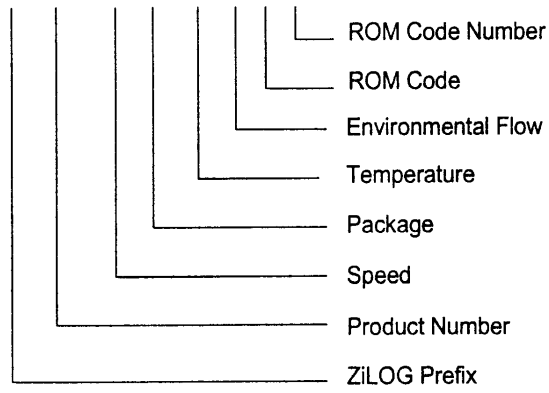
For fast results, contact your local ZiLOG sales office for assistance in ordering the part required.

CODES

Speed	24 = 24.576 MHz
Package	V = Plastic Leaded Chip Carrier A = Very small Quad Flat Pack
Temperature	S = 0°C to +70°C (Standard) E = –40°C to +85°C (Extended)
Environmental	C = Plastic Standard
ROM Code	R4508 = ROM code number 4508 (DSP ROM code Version 0x50, Controller ROM code version 1.2)

Example

Z 02215 24 V S C R 4508 is a Z02215 with ROM code R4508, 24.576 MHz, PLCC, 0°C to +70°C, Plastic Standard Flow



Pre-Characterization Product:

The product represented by this Product Specification (PS) is newly introduced and ZiLOG has not completed the full characterization of the product. The PS states what ZiLOG knows about this product at this time, but additional features or non-conformance with some aspects of the PS may be found, either by ZiLOG or its customers in the course of further application and characterization work. In addition, ZiLOG cautions that delivery may be uncertain at times, due to start-up yield issues.

Development Projects:

Customer is cautioned that while reasonable efforts are employed to meet performance objectives and milestone dates, development is subject to unanticipated problems and delays. No production release is authorized or committed until the Customer and ZiLOG have agreed upon a Customer Procurement Specification for this project.

Low Margin:

Customer is advised that this product does not meet ZiLOG's internal guardbanded test policies for the specification requested and is supplied on an exception basis. Customer is cautioned that delivery may be uncertain and that, in addition to all other limitations on ZiLOG liability stated on the front and back of the acknowledgment, ZiLOG makes no claim as to quality and reliability under the CPS. The product remains subject to standard warranty for replacement due to defects in materials and workmanship.

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