PRELIMINARY DATA SHEET

Z02400

V.22 BIS MODEM MODULE

FEATURES

- Quick and Easy Integration
- Small Footprint 1.00" x 2.50"
- Asynchronous Operation; Full Duplex 2400bps
- Supported Protocols: V.22bis, V.22 and Bell 212A
- Low Power Consumption
- Synchronous Serial TTL Interface to the DTE
- Single +5V Supply Operation
- FCC Part 68 User Transferable
- FCC Part 15B Compliant
- UL Recognized Component

APPLICATIONS

- Vending/Gaming Machines
- Set Top Box Back Channel
- Direct Broadcast Satellite
- Utility Meters
- Point of Sale Terminals
- Remote Diagnostics
- Remote Telemetry
- Remote Monitoring
- Embedded Applications

GENERAL DESCRIPTION

The Z02400 is an asynchronous 2400 bit per second (bps) embedded modem module intended for applications that require a data communications link to the North American Public Switched Telephone Network (PSTN). The Z02400 is a complete modem module on a small 1.0" x 2.5" printed circuit board that can be socketed or soldered into a host system mother board. The module is FCC Part 68 approved, and includes a user transferable registration number (it also is a UL recognized component). The Z02400 can be used in a variety of applications that require an embedded modem, including set top box back channel communications, vending machines, remote utility metering, and remote data acquisition. The Z02400 supports a standard TTL synchronous serial interface to the DTE equipment.

FUNCTIONAL DESCRIPTION

The Z02400 is a small, full featured, 2400 bit per second (bps) modem intended for embedded applications. This modem is fully FCC Part 68 compliant. The Z02400 includes a user transferable FCC registration number, which the end product must display (see *FCC Part 68* section for more details). The module consists of a Data Access Arrangement (DAA), V.22bis data pump, and a microcontroller on a 1.0" x 2.5" PCB.

The Z02400 connects to telephone lines, using TIP and RING leads through an approved RJ-11 jack. The Z02400 supports an industry standard AT command set (see *AT Command Set* section for further details).

The Z02400 operates off a single +5V supply, supporting low power modes of operation. When the device is not in use, it automatically enters sleep mode, thereby reducing

FUNCTIONAL DESCRIPTION (Continued)

supply current to a minimum. An incoming RING signal from the phone line powers up the device (wake on ring).

An evaluation board is available for testing the Z02400 (the ordering number is Z0240002ZCO—see page 19 for additional ordering information). This evaluation board includes an RS232 line driver, LED status indicators, and an amplified speaker circuit. When used with the evaluation board, the Z02400 also meets the FCC Part 15B emissions test. Contact ZiLOG, Inc. for availability and pricing of the Z02400 evaluation kit.

DAA

The DAA portion of the Z02400 has been designed to interface directly with the U.S. PSTN (as governed by the FCC). The DAA includes the circuitry for hookswitch, ring detection, gyrator, surge protection, and an analog signal coupling transformer. The DAA circuitry provides up to 1000 VRMS of longitudinal surge protection. For countries using a PSTN similar to the U.S. (Canada, Japan), the product using the Z02400 must be submitted to a suitable test house for approval. Consult ZiLOG, Inc. for further information.

FCC Part 68: Connecting to the PSTN

General

ZiLOG's Z02400 is fully compliant with FCC Part 68 rules, which regulate equipment connected to the telephone network. The Z02400 provides a user transferable Part 68 registration, which means that a customer can use ZiLOG's registration. Customers may choose to register the modem under their name. Registration assigns the customer a unique registration number. No additional FCC Part 68 submittal is required for equipment using ZiLOG's Z02400.

Repairs

The FCC requires that ZiLOG, Inc. makes all necessary repairs to the modem. If you are experiencing problems with the Z02400, contact ZiLOG at (408) 558-8500 for further information. If repairs are necessary after the modem has been installed in your product, the modem must be removed and sent back to the vendor.

Label Instructions

A label similar to the example in Table 1 should be made visible on the outside of the end user product. The FCC assigns Registration Numbers in the following format:

1. AAABBB–G's company code.
2. BBB is the country in which the product is manufactured in.
3. XXXXX is the sequential number assigned to the Z02400.
4. YY is the type of equipment being registered.
5. Z is the type of dialing performed.

Table 1. Sample Label

Complies with Part 68 of FCC Rules
Registration Number
Ringer Equivalence
Required Connection

Design Guidelines

The following design guidelines should be followed to insure compatibility to FCC Part 68 tests:

1. The Z02400, the RJ-11 jack, and the interface circuitry must be mounted on a PCB that should meet the UL 94V–0 flammability standard.
2. TIP and RING traces from the Z02400 to the RJ-11 jack should be isolated by a minimum of 1.5mm (0.06in) to prevent breakdown. Traces must exhibit a minimum width of 0.5mm (.02in).
3. Ensure that the module is securely installed into the host system. Vibration and drop tests will loosen components that are not securely mounted. One of two methods for securing the module should be used:
   a. Solder to the main PCB. This method is well suited for harsh environments where the end product may be subjected to shock and vibration (as in industrial environments—equipment monitoring, etc.).
   b. Socket to the main PCB. This method is well suited for environments where the end product is not subjected to shock and vibrations (as in consumer applications—set top boxes, etc.).
4. Components used must be able to withstand temperature and humidity extremes per the FCC Part 68 specifications.
5. When connecting to the PSTN, an FCC approved telephone jack must be used in the host system. The jack must also meet the mechanical requirements for the FCC (Part 68.3, Subpart F). For RJ-11 jacks, refer to the FCC Public Notice #42269 for a list of approved vendors.
6. The supplied FCC Registration Number (including REN) must be visible on the outside of the end user product.

Exhibit J: End User Instructions
This equipment complies with FCC rules, Part 68. In any of the following locations, an information label will be found:

[ ] Front Side [ ] Bottom Side

[ ] Back Side [ ] Top Side

This label contains, among other information, the FCC Registration Number and Ringer Equivalence Number (REN) for this equipment. If requested, provide this information to your telephone company.

The REN is useful in determining the quantity of devices you may connect to your telephone line at one time, while still having all those devices ring when your number is called. In most, but not all areas, the sum of the REN's of all devices should not exceed five (5.0). To be certain of the number of devices you may connect to your line, you should call your local telephone company to determine the maximum REN for your calling area.

If this equipment causes harm to the telephone network, the Telephone Company may discontinue your service temporarily. If possible, they will notify you in advance. If advance notice is not practical, you will be notified as soon as possible. You will be advised of your right to file a complaint with the FCC.

Your telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the proper operation of your equipment. If they do, you will be given advance notice toward maintaining uninterrupted service.

If you experience trouble with this equipment, please contact your local vendor for warranty/repair information. The telephone company may ask that you disconnect this equipment from the network until the problem has been corrected, or until you are sure that the equipment is not malfunctioning.

This equipment may not be used in conjunction with the coin service provided by the telephone company. Connection to party lines is subject to state tariffs.

FCC rules prohibit the use of non-hearing aid compatible telephones in the following locations or applications:

1. All public or semipublic coin-operated or credit card telephones.
2. Elevators, highways, or tunnels (automobile, subway, railroad or pedestrian) where a person with impaired hearing might be isolated in an emergency.
3. Places where telephones are specifically installed to alert emergency authorities such as fire, police, or medical assistance personnel.
4. Hospital rooms, residential health care facilities, convalescent homes, and prisons.
5. Workstations for the hearing impaired.
6. Hotel, motel, or apartment lobbies.
7. Stores where telephones are used by patrons to order merchandise.
8. Public transportation terminals where telephones are used to call taxis.
9. Reserve lodging or rental cars.
10. Hotel and motel rooms. At least ten percent of the rooms must contain hearing aid compatible telephones; or jacks or plug-in hearing aid compatible telephones which will be provided to hearing impaired customers upon request.

Applications

Figure 2 is a schematic of the Z02400 in a typical host system application. The host system communicates to the Z02400 through a standard synchronous serial port (refer to the *Pinout and Definition* section for functional descriptions of the pins). The transmit and receive data is sent over the TXD and RXD pins, while the /DCD and /DTR pins are used for handshaking. The audio output pin (A1) is used for monitoring the analog data for speaker amplification. The /MUTE can be used to enable or disable the speaker. The ferrite beads (FB1 and FB2) may be required to reduce EMI emissions per FCC Part 15. Determining the values for the ferrite beads depends solely on the emissions generated by the end user product.

Figure 3 is a schematic of the Z02400 in a stand-alone RS232-C configuration. This circuit uses the Linear Technologies LT1181A RS232 line driver.

Note: The LT1181A line driver inverts the signals.

Both Figure 2 and Figure 3 are for reference purpose only. Exact component values should be determined by the user.

DC ELECTRICAL CHARACTERISTICS

Table 2. Electrical Characteristics @ 25ºC

Parameters	Conditions	Min	Type	Max	Units
VCC Supply Voltage	—	4.75	5.0	5.25	V
VCC Supply Current	V_{CC} = 5V	—	TBD	TBD	mA
Line Matching Impedance	V_{CC} = 5V	—	600	—	Ω
Ring Detect Sensitivity	V_{CC} = 5V	TBD	TBD	TBD	V
Ringer Equivalence Number (REN)	V_{CC} = 5V	—	0.8B	—	—
Telephone Line Loop Current	V_{CC} = 5V	20	—	120	mA
DTE DC Characteristics					
Input High Voltage V_{IH}	Pins J1,7–9	2	—	V_{CC} +0.3	V
Input Low Voltage V_{IL} (Pins J1,7–9)	—	0	—	0.8	V
Input Leakage Current I_L (Pins J1,7–9)	GND<V_0<V_{CC}	–10	—	10	µA
Output High Voltage V_{OH} (Pins J1,7–9)	I_{OH}= –200mA; V_{CC} = 5V	2.4	—	—	V
Output Low Voltage V_{OL} (Pins J1,7–9)	I_{OI} = –2.2 mA; V_{CC} = 5V	0	—	0.4	V
Input High Voltage V_{IH} (Pins J1,3–6)	V_{CC} = 5V	0.7 V_{CC}	2.6	V_{CC} +0.3	V
Input Low Voltage V_{IL} (Pins J1,3–6)	V_{CC} = 5V	GND–0.3	1.6	0.2 V_{CC}	V
Output High Voltage V_{OH} (Pins J1,3–6)	V_{CC} = 5.5, I_{OH} = –2.0mA	V_{CC}–0.4	4.8	—	V

PIN DESCRIPTION

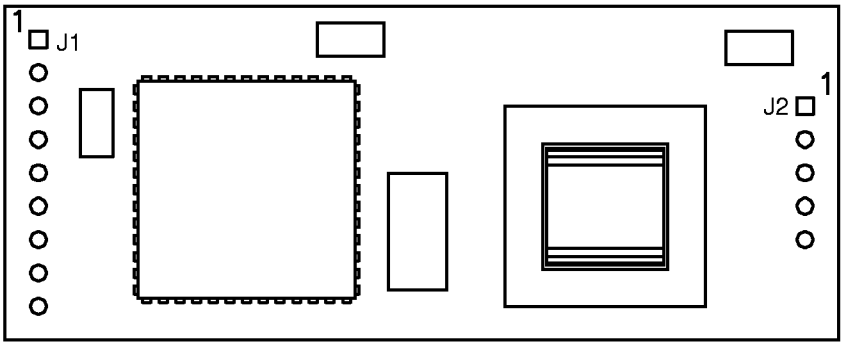


Figure 1. Pin Configuration

Table 3. Pin Identification

Pin	Input/Output	Name	Function
J1–1	I	VCC	Connects to external host power source.
J1–2	I	GND	Power supply return.
J1–3	I	/DTR	Data Terminal Ready Input. An active Low input on this pin indicates that the host system is ready to communicate with the modem.
J1–4	O	/DCD	Data Carrier Detect Output. When active, indicates carrier has been detected. For reference, see AT Command section under &C command.
J1–5	O	/MUTE	Mutes external speaker.
J1–6	O	A1	Analog output that can be used to monitor modem activity via an external audio amplifier.
J1–7	–	N/C	No connection.
J1–8	I	RXD	Serial data input from host DTE.
J1–9	O	TXD	Serial data output to host DTE.
J2–1	–	N/C	No connection.
J2–2	I/O	TIP	Tip connection to telephone line.
J2–3	–	N/C	No connection.
J2–4	I/O	RING	Ring connection to telephone line.
J2–5	–	N/C	No connection.

AT COMMAND SET

When the modem is in the Idle or Command state, command lines are typed into the modem from the terminal. 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 (not counting spaces). 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 Back-Space character, <BS>, after the initial A and T characters have been entered.

A partial command line can be aborted by typing a Ctrl–X character. The modem returns an OK result code, ignoring 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 any 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 was 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 resulting code of the most recent command executed is returned to the terminal.

If the value to be 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 zeros in numeric arguments, including S-register numbers, are ignored. For example, ATS1=2 and ATS01=2 both set S-register S1 to 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 is 13 (the ASCII carriage return character).

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

Note: Default values in Table 4 are in **boldface** type.

DIAL MODIFIERS

Table 4. AT Command Set

Command		Function and Description	
A	Answer	The A command makes the modem go off-hook and respond to an incoming call. This command is used after the modem has returned to the RING result code. If the modem successfully completes the answering process, the modem will return a CONNECT result code and enter 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. Any commands following the answer command on the command line are ignored. This command is aborted if a key is pressed before the answer process is completed, or when DTR is off (if some options in the &Q or &D commands have been used).	
B	Communication Standard Option	The B command tells the modem which special telephone line modulation standards to use. The modem can be configured to use:	
		B0	This configuration uses the ITU-T modulation standards for all telephone line data rates. This includes V.22 for the 1200 bps telephone line data rate.
		B1	If the 1200 bps telephone line data rate is required, Bell 212A is used instead of V.22. This is the default value for North America. The 1200 bps telephone line data rate is required only if: • S-register S37 is set to 5, or • S-register S37 is set to 0, and the terminal data rate is 1200 bps.
		B2	Reserved
		B3	Reserved
&C	Data Carrier Detect Options	&C determines how the modem's DCD signal relates to the carrier signal from the other modem. This option takes effect only at the beginning of a telephone line connection. If &C is issued from the Command state, it will not have an immediate effect.	
		&C0	DCD is on at all times.
		&C1	This configuration reflects the state of the carrier signal from the other modem using S-registers S9 and S10.
D	Dial	The D command makes the modem dial a telephone call according to the digits and dial modifiers in the dial string following the command. Any commands following the dial string on a command line are ignored, unless the semicolon dial modifier is the most recent character in the dial string. If the modem was already off-hook when the Dial command was provided, the modem dials immediately without trying to detect a dial tone. Characters other than digits and dial modifiers in a dial string are ignored; however, they are counted as characters in the command line buffer. If line current sensing is enabled, and line current is detected before the modem is taken off-hook when the modem must dial, a NO CARRIER result code is displayed and the modem enters the Idle state. If the modem does not have to dial (that is, ATD with no dial string), the modem assumes the call was manually established and attempts to make a connection. The D command is not valid when the modem is in the On-Line state. See DIAL MODIFIERS and MODEM RESULT CODES for more information.	

DIAL MODIFIERS (Continued)

Table 4. AT Command Set (Continued)

Command		Function and Description
&D	Data Terminal Ready Options	&D determines how the modem responds to the DTR signal from the terminal. The country configuration may prevent the modem from detecting terminal DTR. In this case, the modem assumes DTR is always on. In North America, terminal DTR is normally detected. If DTR detection has been prevented, the modem will respond with an ERROR result to this command. The response to changes in DTR also depends on the &Q and &D commands. This table defines what happens when DTR goes off for all possible combinations of the &D and &Q commands. To see what happens when DTR goes on, refer to the &Q command. The default value is &D0 in North America:

	&D0	&D1	&D2	&D3
&Q0	None	B	C	D
&Q1	A	B	C	D

A	The modem hangs up the telephone line and issues an OK result code.
B	If in the On-Line state, the modem goes into the Command state, and issues an OK result code.
C	The modem hangs up the telephone line and issues an OK result code. Auto-Answer is disabled as long as DTR stays off.
D	The modem resets.

Table 4. AT Command Set (Continued)

Command		Function and Description	
E	Command Mode Character Echo	E tells the modem whether or not to echo characters sent from the terminal when the modem is accepting AT commands.	
		E0	Does not echo characters sent from the terminal.
		E1	Echoes characters sent from the terminal. This is the default value in North America.
%E	Automatic Retrain Options	The %E command controls whether the modem will initiate retrain with the other modems during a telephone line connection during operation in data modes supporting retrain. The modem always responds to a retrain operation initiated by the remote modem. The modem can be forced to initiate a retrain by the On-Line (O1) command.	
		%E0	Does not initiate a retrain.
		%E1	Initiates a retrain if the datapump indicates one is required.
&F	Recall Factory Profile	&F changes these AT command options and S-registers to their default values. The default values may be changed for use in different countries. The values for North America are:	
		S-registers	
		S0=0 S1=0 S2=43 S3=13 S4=10 S5=8	
		S6=2 S7=30 S8=2 S9=6 S10=14 S11=95	
		S12=50 S17=10 S25=5 S28=0 S29=25 S37=0	
		Commands	
		B1 E1 M1 P Q0 V1 X4 &C0 &D0 &G0 &P0 &Q0 %E1	
&G	Guard Tone Options	&G tells the modem which guard tone to transmit when the modem is transmitting the high band (that is, answer handshake and answer mode).	
		&G0	No guard tone. This is the default value in North America.
		&G1	550 Hz guard tone (V.22 and V.22bis only)
		&G2	1800 Hz guard tone (V.22 and V.22bis only)
H	Hook	H0	Hangs up the telephone line.
		H1	Goes off-hook without answering a telephone call. This may be disabled in countries prohibiting its use.

DIAL MODIFIERS (Continued)

Table 4. AT Command Set (Continued)

Command		Function and Description	
&HT	PTT Test Command	The &HT command causes the modem to transmit tones for PTT testing. The test tone is generated until a character is typed on the modem's terminal. The country configuration may disable this command. The modem returns an ERROR result if this command is issued.	
		&HT0–9	DTMF tone for digit n where the command was &HTn.
		&HT10	DTMF tone "*"
		&HT11	DTMF tone "#"
		&HT12	DTMF tone "A"
		&HT13	DTMF tone "B"
		&HT14	DTMF tone "C"
		&HT15	DTMF tone "D"
		&HT16	Reserved
		&HT17	Reserved
		&HT18	Reserved
		&HT19	Reserved
		&HT20	Reserved
		&HT21	Reserved
		&HT22	Reserved
		&HT23	Reserved
		&HT24	V.22 originate mode
		&HT25	V.22 answer mode
		&HT26	V.22bis originate mode
		&HT27	V.22bis answer mode
		&HT28	V.25 calling tone
		&HT29	550Hz guard tone
		&HT30	1800Hz guard tone
		&HT31	Silence
I	Identification	The I command asks the modem for information that can be used to determine the modem's compatibility with other software, ensuring the modem is operating properly.	
		I0	Displays product code. The modem reports its product code to the terminal. The modem produces information text dependent upon its features and capabilities.
		I1	Displays ROM checksum. The modem reports the value of its ROM checksum. The decimal number displayed is the eight bit sum (from 0 to 255) of all the bytes in ROM.
		I2	Tests the ROM checksum. The modem checks its ROM to ensure that it is correct. The modem reports a result code indicating whether the ROM is OK or in ERROR.
		I3	Displays Software Versions. The modem reports the modem controller and data pump software versions, and the modem controller software releases data to the terminal.
		I4	Displays Modem Identification. The modem reports a configurable identification message to the terminal.

Table 4. AT Command Set (Continued)

Command		Function and Description	
M	Speaker On/Off Options	The country configuration may disable the speaker. If so, this command will return an ERROR result.	
		M0	Under this configuration, the speaker is always off.
		M1	Under this configuration, the speaker is on until the carrier is detected (the default value in North America).
		M2	Under this configuration, the speaker is always on (stays on after carrier is detected).
		M3	Under this configuration, the speaker is off as digits are dialed, but on during ringback and until the carrier signal is detected.
O	Return to On-Line Mode	This command returns the modem to the on-line mode. It is frequently used after the escape character sequence (+++) to resume communication with the remote modem. If handshaking is started, the modem uses Originate or Answer mode handshaking, depending upon whether the modem originated or answered the telephone call.	
		O0	Returns the modem to the On-Line state from the Command state during a telephone line connection. The modem starts handshaking if there was no telephone line connection and the modem was off-hook.
		O1	Returns the modem to the On-Line state and retrain its data pump during a telephone line connection. The modem starts handshaking if there was no telephone line connection but the modem was off-hook.
&P	Pulse Dial Make/Break Ratios	This command sets the cadence of the pulse dial. The country configuration may disable this command, forcing particular pulse dialing parameters. Under this condition, the modem returns an ERROR result if this command is issued.	
		&P0	39%/61% make/break ratio and 10 pulses per second when pulse dialing. This is the default value.
		&P1	33%/67% make/break ratio and 10 pulses per second when pulse dialing.
		&P2	39%/61% make/break ratio and 20 pulses per second when pulse dialing.
		&P3	33%/67% make/break ratio and 20 pulses per second when pulse dialing.
Q	Result Code Display Options	This command allows the user to either display or not display result codes.	
		Q0	Result codes will be displayed. This is the default value for North America.
		Q1	Result codes will not be displayed.
&Q	Communications Mode Options	The &Q command selects the terminal communication mode.	
		&Q0	The modem handshakes as the originator if S-register S0 is 0, and as the answerer if S0 is 1
		&Q1	Reserved
Sn	Set the current S-register to n	This command sets the current S-register to the value “n” selected by the user. For example, ATS7 will set the current S-register to S7. Default value is 0. Sn addresses a particular S-register number so future commands like “?” and “=” will read and/or write the S-register. Modem reset and the &F command select S0 as the default S-register.	
?	Read an S-Register	This command displays the value of the most recent S-register named in the Sn command.	
=x	Write an S-register	This command writes the value x to the most recent S-register named in the Sn command. The range of valid values for x depends upon which S-register is being written. 0 is assumed if no value is provided for x.	
T	Tone dialing	This command selects the tone method of dialing.	

DIAL MODIFIERS (Continued)

Table 4. AT Command Set (Continued)

Command		Function and Description	
V	Result Code Format	This command changes the format in which result codes are displayed.	
		V0	All result codes will be displayed as numbers.
		V1	All result codes will be displayed as words (verbose form). This is the default value for North America.
X	Call Progress	The X command controls whether or not a busy signal or dial tone should be detected when dialing. The X command also limits the result codes the modem may return when dialing. The operation of the X command is configurable for operation in different countries.	
		X0	Neither busy signal nor dial tone is detected. When a telephone line connection is made, the result code does not indicate the telephone line data rate.
		X1	Neither busy signal nor dial tone is detected. When a telephone line connection is made, the result code indicates the telephone line data rate.
		X2	Busy signal is not detected. Dial tone is detected. When a telephone line connection is made, the result code indicates the telephone line data rate.
		X3	Busy signal is detected. Dial tone is not detected. When a telephone line connection is made, the result code indicates the telephone line data rate.
		X4	Both busy signal and dial tone are detected. When a telephone line connection is made, the result code indicates the telephone line data rate. This is the default value in North America.
		The @ and W dial modifiers are not affected by the X command. The @ dial modifier may return the result codes 8 (NO ANSWER) or 7 (BUSY) each time it appears in the dial string. The W dial modifier may return the result codes 6 (NO DIALTONE) or 7 (BUSY) each time it appears in the dial string.	

MODEM S-REGISTERS

The value of an S-register is modified by ATSn = x, where n is the register number and x is the value to be stored in that particular register. Each S-register has three values that may be configured for different countries: a default value, an upper limit and a lower limit. The values listed in this specification are for North America.

Table 5. Modem S-Registers

Register	Range	Units	Description
S0	0–255	Rings	This register sets number of rings to auto-answer. The country configuration may disable the modem's ability to detect a telephone line ring signal. In this case, the modem will never automatically answer the telephone regardless of the S0 setting. Default = 0 (auto-answer disabled)
S1	0–255	Rings	This register returns the number of times the phone rings. Default = 0
S2	0–255	ASCII	This register sets Escape Sequence Character. Setting S2 to a value greater than 127 disables the character escape sequence, preventing the modem from returning to Command state when in the On-Line state. Default = 43
S3	0–127	ASCII	This register sets the End of Line character. Default = 13
S4	0–127	ASCII	This register sets the Line Feed Character. Default = 10
S5	0–127	ASCII	This register sets the BackSpace Character. Default = 8
S6	2–255	Seconds	This register delays to Wait Before Performing a Blind Dial. Default = 2 seconds
S7	1–255	Seconds	This register delays to Wait for Carrier after dialing. Default = 30 seconds
S8	0–255	Seconds	This register delays to Wait when a Comma Dial Modifier is Processed. Default = 2 sec.
S9	1–255	1/10th sec	Time Carrier Must be Present Before Being Recognized. Default = 0.6 sec.
S10	1–255	1/10th sec	This register performs the delay Between the Lost Carrier and Hang Up. Setting S-register S10 to 255 makes the modem never hang up the telephone line because of a loss of carrier. Default = 14 tenths of a second
S11	50–255	msec	Multi-Frequency Tone duration. Default = 95 milliseconds
S12	0–255	1/50th sec	This register escapes Prompt delay time. This is the prompt delay time for escape sequences from the On-Line state to the Command state. Default = 50 fiftieths of a second
S13	Reserved	Reserved	Reserved
S14	Reserved	Reserved	Reserved
S15	Reserved	Reserved	Reserved
S16	Reserved	Reserved	Reserved
S17	–6 to –43	–dBm	This register sets Transmit level. Default = –10 dBm
S18	Reserved	Reserved	Reserved
S19	Reserved	Reserved	Reserved
S20	Reserved	Reserved	Reserved

MODEM S-REGISTERS (Continued)

Table 5. Modem S-Registers (Continued)

Register	Range	Units	Description
S21	Reserved	Reserved	Reserved
S22	Reserved	Reserved	Reserved
S23	Reserved	Reserved	Reserved
S24	Reserved	Reserved	
S25	0-255	Seconds or 1/100 sec	DTR Detection. The number of seconds after a telephone line connection is made before the MODEM examines DTR. The default is 5 seconds or hundredths of a second. The default is 5
S26	Reserved	Reserved	Reserved
S27	Reserved	Reserved	Reserved
S28	0–255	minutes	Terminal inactivity timeout.This register hangs up the modem after S28 minutes if no characters are received from the modem's terminal. Default = 0
S29	0–255	1/50th sec	Hook Flash On-Hook time. The amount of time in 20 millisecond units the modem will leave the telephone on-hook while performing a hook-flash according to the "!" dial string modifier. Default = 25 fiftieths of a second.
S37	0–6	code	This register sets the Highest Line Rate. S37 determines the highest telephone line data rate the modem will use when connecting with a remote modem. See "Setting the Highest Line Rate" section on the following page. Default = 0.

SETTING THE HIGHEST LINE RATE

The connect rate can be selected by S-register S37. Table 6 provides the supported connect rates.

Table 6. S-Register 37 Values

S37 Value	Carrier	Data Rate
0		The data rate of the most recent AT command
1		Reserved
2		Reserved
3		Reserved
4		Reserved
5	V.22, Bell 212A	1200 bps. See the B command
6	V.22bis	2400 bps

MODEM RESULT CODES

A result code is a line of text or a number the modem sends to the terminal to indicate the result of a command execution. Some CONNECT result codes indicate the telephone line data rate. The following table provides a list of the available result codes.

Table 7. Modem Result Codes

Number	Word	Result Code Description
0	OK	Command Line Executed without errors
1	CONNECT	The modem is in the on-line state, ready to transfer data.
2	RING	The modem has detected a ring signal on the telephone line. The country configuration may disable the modem's ability to detect a telephone line ring signal.
3	NO CARRIER	Either no carrier signal was detected when answering or placing a telephone call, or the carrier was lost during a call. The modem also returns this response message when the telephone line connection is broken for any reason.
4	ERROR	An invalid command was issued, or there was an error at any place in the command line.
5	CONNECT 1200	The modem is in the on-line state, ready to transfer data.
6	NO DIALTONE	No dial tone was detected when the modem took the telephone line off-hook.
7	BUSY	The modem detected a busy signal on the telephone line.
8	NO ANSWER	Not enough silence was detected when the @ dial modifier was used.
10	CONNECT 2400	The modem is in the on-line state, ready to transfer data. The telephone line data rate is 2400bps.
20	BLACKLISTED	The modem will not allow any number to be dialed until after the modem is reset.
21	DELAYED	The modem will not allow any number to be dialed now, but will allow dialing at some future time.

ESCAPE SEQUENCES

An escape sequence is defined as 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 should not occur accidentally during an exchange of data between two modems. Unfortunately, it is impossible to guarantee that any escape sequence will never occur naturally, because there are no restrictions on the data or timing between characters sent between two modems during the On-Line state.

The only method of switching from the On-Line state to the Command state that does not ever occur naturally 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.

The Hayes Escape Sequence was adopted by many modem manufacturers and communication programs before Hayes was granted a patent for the escape sequence guard times. Now the unpatented Time Independent Escape Sequence (TIES) has gained popularity with many modem manufacturers.

TIES Escape Sequence

TIES was developed by a number of modem manufacturers in response to Hayes enforcing patent rights for their escape sequence guard time patent.

The Time Independent Escape Sequence is a sequence of 3 escape characters (+ characters by default). Once these characters have been recognized, the modem enters the Command state without sending a confirming result code to the terminal. The modem then starts a prompt delay timer. From that point:

1. 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.
2. 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.
3. 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 long enough 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 hung up.

CARRIER DETECTION (Continued)

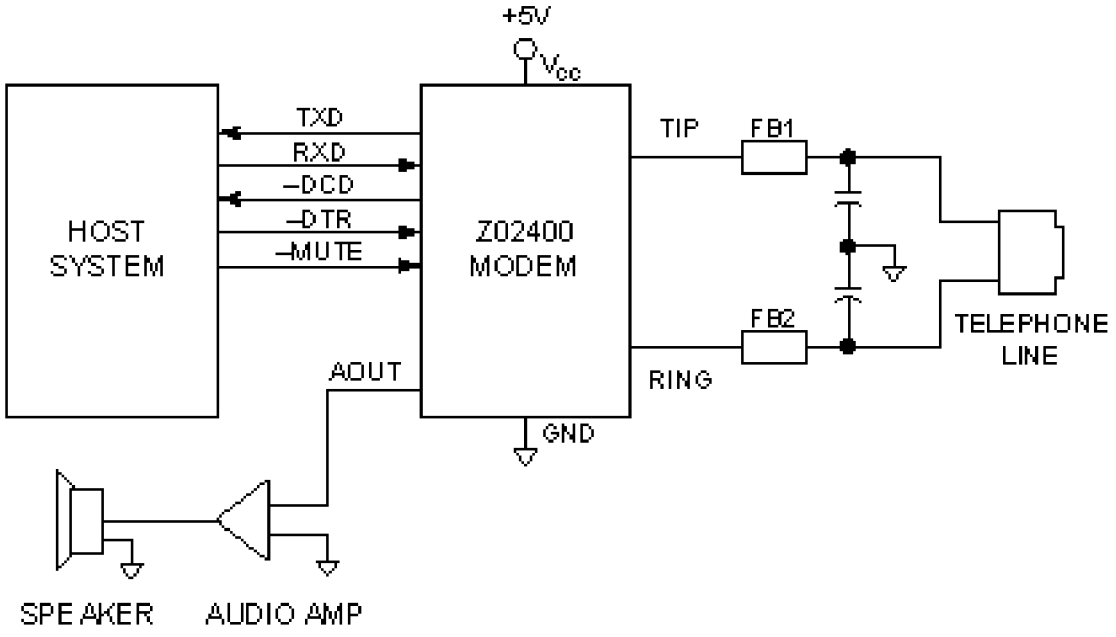


Figure 2. Z02400 System Environment

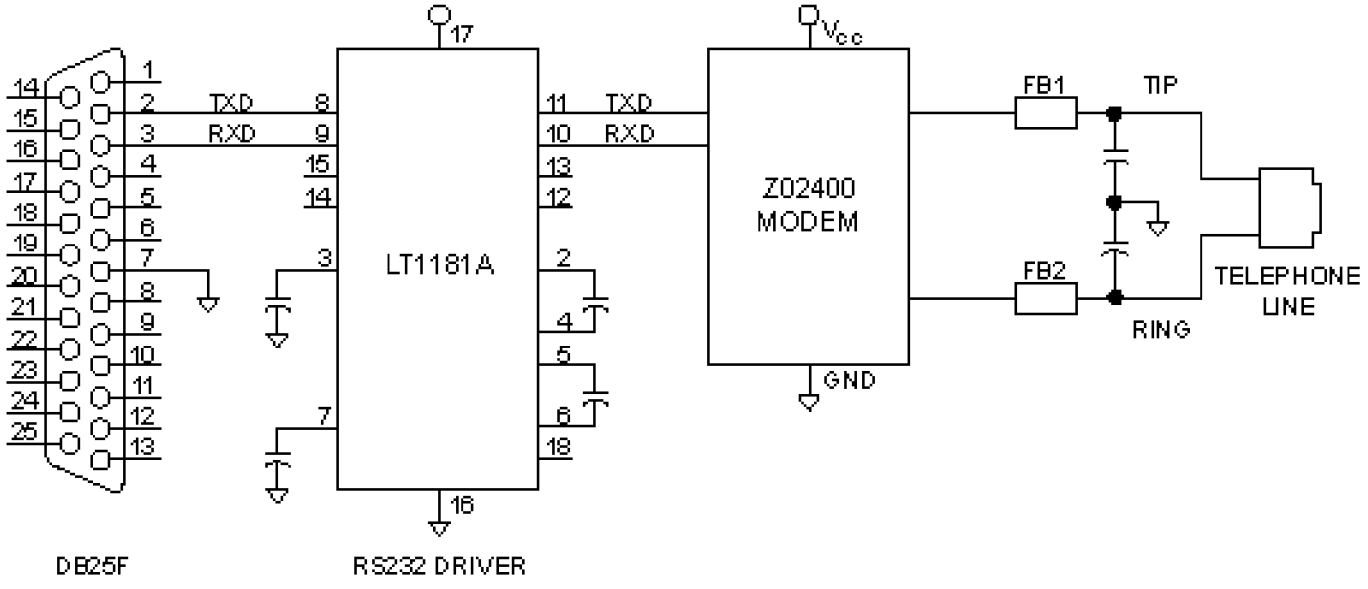
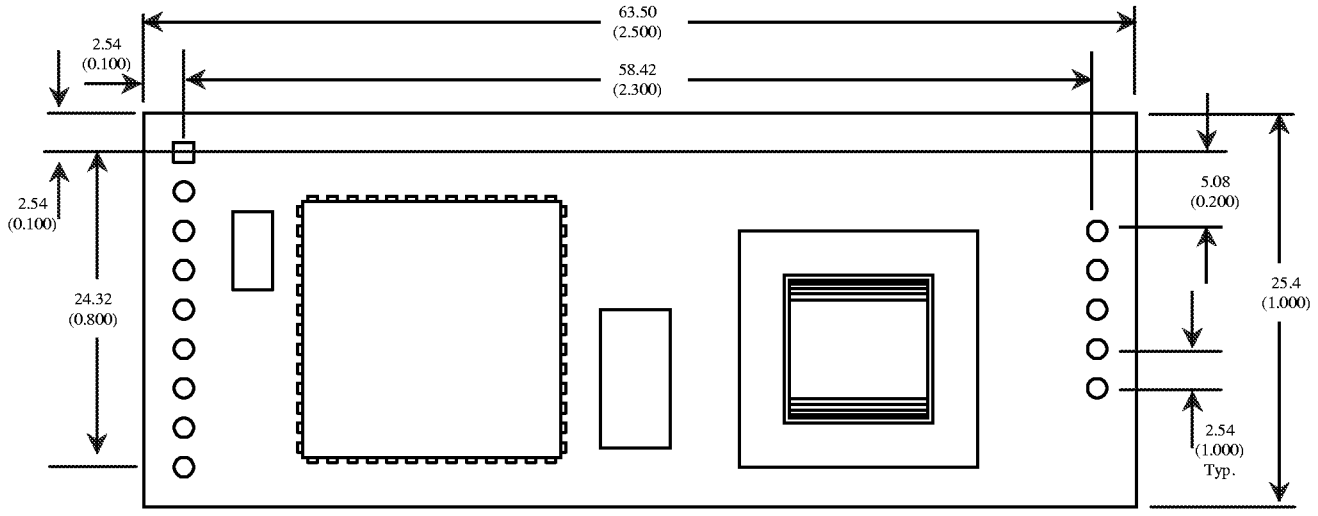
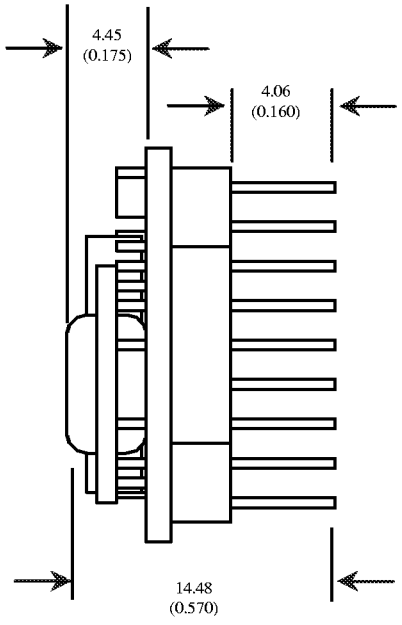


Figure 3. Stand-Alone Modem with RS232-C Interface

PACKAGE INFORMATION



Top View



DIMENSIONS
mm
(inches)

Side View

Figure 4. Mechanical Dimensions

ORDERING INFORMATION

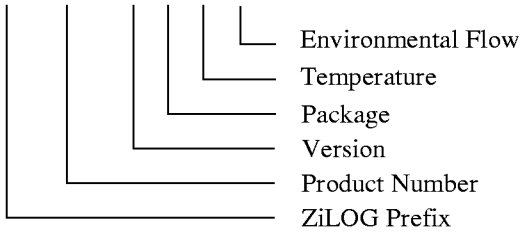
14-pin Module	Z0240002ISC

Codes

Package	I = Module
Standard Temperature	S = 0°C to +70°C
Version	02 = North America
Environmental	C = Plastic Standard

Example:

Z 02400 02 I S C is a Z02400, 16 MHz, North America, Module, 0°C to +70°C, Plastic Standard Flow



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ZiLOG, Inc.
910 East Hamilton Avenue, Suite 110
Campbell, CA 95008
Telephone (408) 558-8500
FAX 408 558-8300
Internet: http://www.zilog.com