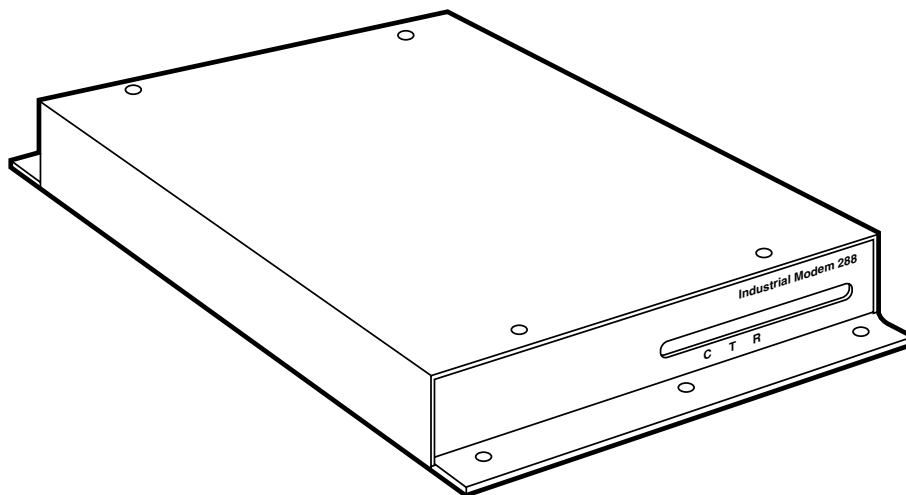




Industrial Modem 288



**CUSTOMER
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INFORMATION**

Order **toll-free** in the U.S.: Call **877-877-BBOX** (outside U.S. call **724-746-5500**)
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Mailing address: **Black Box Corporation**, 1000 Park Drive, Lawrence, PA 15055-1018
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**FEDERAL COMMUNICATIONS COMMISSION
AND
INDUSTRY CANADA
RADIO FREQUENCY INTERFERENCE STATEMENTS**

Class B Digital Device. This equipment has been tested and found to comply with the limits for a Class B computing device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. This equipment generates, uses, and can radiate radio frequency energy, and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. If this equipment does cause harmful interference to radio or telephone reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult an experienced radio/TV technician for help.

CAUTION

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

To meet FCC requirements, shielded cables and power cords are required to connect this device to a personal computer or other Class B certified device.

This digital apparatus does not exceed the Class B limits for radio noise emission from digital apparatus set out in the Radio Interference Regulation of Industry Canada

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de classe B prescrites dans le Règlement sur le brouillage radioélectrique publié par Industrie Canada.



NORMAS OFICIALES MEXICANAS (NOM)
ELECTRICAL SAFETY STATEMENT

INSTRUCCIONES DE SEGURIDAD

1. Todas las instrucciones de seguridad y operación deberán ser leídas antes de que el aparato eléctrico sea operado.
2. Las instrucciones de seguridad y operación deberán ser guardadas para referencia futura.
3. Todas las advertencias en el aparato eléctrico y en sus instrucciones de operación deben ser respetadas.
4. Todas las instrucciones de operación y uso deben ser seguidas.
5. El aparato eléctrico no deberá ser usado cerca del agua—por ejemplo, cerca de la tina de baño, lavabo, sótano mojado o cerca de una alberca, etc..
6. El aparato eléctrico debe ser usado únicamente con carritos o pedestales que sean recomendados por el fabricante.
7. El aparato eléctrico debe ser montado a la pared o al techo sólo como sea recomendado por el fabricante.
8. Servicio—El usuario no debe intentar dar servicio al equipo eléctrico más allá a lo descrito en las instrucciones de operación. Todo otro servicio deberá ser referido a personal de servicio calificado.
9. El aparato eléctrico debe ser situado de tal manera que su posición no interfiera su uso. La colocación del aparato eléctrico sobre una cama, sofá, alfombra o superficie similar puede bloquea la ventilación, no se debe colocar en libreros o gabinetes que impidan el flujo de aire por los orificios de ventilación.
10. El equipo eléctrico debe ser situado fuera del alcance de fuentes de calor como radiadores, registros de calor, estufas u otros aparatos (incluyendo amplificadores) que producen calor.

apareato eléctrico deberá ser conectado a una fuente de poder sólo del modo descrito en el instructivo de operación, o como se indique en el aparato.

La conexión debe ser tomada de tal manera que la tierra física y la polarización de tipo no sea eliminada.

Los cables de la fuente de poder deben ser guiados de tal manera que no estén expuestos ni pellizcados por objetos colocados sobre o contra ellos, prestando particular atención a los contactos y receptáculos donde salen del aparato.

El aparato eléctrico debe ser limpiado únicamente de acuerdo a las recomendaciones del fabricante.

Si no existe, una antena externa deberá ser localizada lejos de las líneas de energía.

El cable de corriente deberá ser desconectado del equipo cuando el equipo no sea usado por un largo periodo de tiempo.

El equipo debe ser tomado de tal manera que los objetos líquidos no sean derramados sobre la cubierta u orificios de ventilación.

El equipo por personal calificado deberá ser provisto cuando:

El cable de poder o el contacto ha sido dañado; u

Los objetos han caído o líquido ha sido derramado dentro del aparato; o

El aparato ha sido expuesto a la lluvia; o

El aparato parece no operar normalmente o muestra un cambio en su desempeño; o

El aparato ha sido tirado o su cubierta ha sido dañada.

FCC REQUIREMENTS FOR TELEPHONE-LINE EQUIPMENT

1. The Federal Communications Commission (FCC) has established rules which permit this device to be directly connected to the telephone network with standardized jacks. This equipment should not be used on party lines or coin lines.
2. If this device is malfunctioning, it may also be causing harm to the telephone network; this device should be disconnected until the source of the problem can be determined and until the repair has been made. If this is not done, the telephone company may temporarily disconnect service.
3. If you have problems with your telephone equipment after installing this device, disconnect this device from the line to see if it is causing the problem. If it is, contact your supplier or an authorized agent.
4. The telephone company may make changes in its technical operations and procedures. If any such changes affect the compatibility or use of this device, the telephone company is required to give adequate notice of the changes.
5. If the telephone company requests information on what equipment is connected to their lines, inform them of:
 - a. The telephone number that this unit is connected to.
 - b. The ringer equivalence number.
 - c. The USOC jack required: RJ-11C.
 - d. The FCC registration number.

Items (b) and (d) can be found on the unit's FCC label. The ringer equivalence number (REN) is used to determine how many devices can be connected to your telephone line. In most areas, the sum of the RENs of all devices on any one line should not exceed five. If too many devices are attached, they may not ring properly.

6. In the event of an equipment malfunction, all repairs should be performed by your supplier or an authorized agent. It is the responsibility of users requiring service to report the need for service to the supplier or to an authorized agent.



CERTIFICATION NOTICE FOR EQUIPMENT USED IN CANADA

The Canadian Department of Communications label identifies certified equipment. This certification means that the equipment meets certain telecommunications-network protective, operation, and safety requirements. The Department does not guarantee the equipment will operate to the user's satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. In some cases, the company's inside wiring associated with a single-line individual service may be extended by means of a certified connector assembly (extension cord). The customer should be aware that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be made by an authorized Canadian maintenance facility—in this case, Black Box. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines, and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

CAUTION

Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

The LOAD NUMBER (LN) assigned to each terminal device denotes the percentage of the total load to be connected to a telephone loop which is used by the device, to prevent overloading. The termination on a loop may consist of any combination of devices, subject only to the requirement that the total of the load numbers of all the devices does not exceed 100.

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1. Specifications

Compliance: EMI/RFI: FCC Part 15 Class B, DOC Class/MDC classe B;
Phone-Line Compatibility: FCC Part 68

FCC Part 68 Registration Number: 1XZTA1-20589-MM-E

Ringer-Equivalence Number: 0.47 B

Standards: Modem Communication: ITU-TSS (CCITT) V.34, V.32 bis, V.32, V.23, V.22 bis, V.22, and V.21; Bell 212A and 103;
Error Correction: ITU-TSS (CCITT) V.42 and MNP® levels 2 through 4;
Data Compression: ITU-TSS (CCITT) V.42 bis and MNP Level 5

Interfaces: To line: Modular telco;
To DTE: TIA RS-232, DCE

Protocol: Asynchronous

Data Format: 8 data bits, 1 stop bit, no parity (fixed)

Flow Control: Many user-selectable options; see entries for the “\Gn”, “\Qn”, and “\Xn” commands in **Appendix A**

Operation: Across dialup or 2-wire leased lines

Data Rate: 28.8, 26.4, 24, 21.6, 19.2, 16.8, 14.4, 12, 9.6, 7.2, 4.8, 2.4, or 1.2 kbps, or 600, 300, or 75 bps (auto-negotiating or user-selectable); automatic retraining (fallback/fall forward) to different rates as line conditions change

DTE Speeds Supported: 115.2, 57.6, 38.4, 19.2, 9.6, 7.2, 4.8, 2.4, and 1.2 kbps, and 600, 300, and 75 bps

Dial Type: Touchtone, pulse, or adaptive (user-selectable)

Dial Features: All user-selectable:
Flash and wait for silent answer (PBX);
Wait for second dial tone;
Reverse-, speed-, and fallback-dialing; and
Power-on autodialing and autoconnection

Transmission Level: 0 to -15 dBm

Receiver Sensitivity: -43 dBm

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Maximum Distance: 50 ft. (15.2 m) from IM288 to local DTE

Internal Memory: RAM: 40-character command buffer;

NVRAM:

- 2 factory-default configuration profiles;
- 2 user-defined configuration profiles; and
- 10 stored telephone numbers, each up to 36 characters long but totaling not more than 100 characters

Leads/Signals Supported: DB25 connector: See **Appendix B**;

RJ-12 connector: Pins 2 through 5 (dialup) or Pins 3 and 4 (2-wire leased line);

4-screw terminal block on optional RS-485 modules:

MD3315: Center two screws;

MD3316: All four screws

User Controls: Standard AT command set (see **Appendix A**);

- (1) Rear-mounted on/off toggle switch;
- (1) Internal “smart/dumb” jumper;
- (1) Internal RS-485 jumper

Diagnostics: Testing available through “&Tn” commands; see **Section 6.3**

Connectors: All rear-mounted:

- (1) DB25 female (to DTE; optional RS-485 module, if installed, replaces this with a 4-screw terminal block);
- (2) RJ-12 (“6-wire RJ-11”) female (one to phone, one to line);
- (1) Barrel jack for power

Indicators: (8) Front-mounted LEDs for Power, DTR, CD (RLSD), TD, RD, High Speed, Auto-Answer, and Off Hook

Temperature Tolerance: Operating: 32 to 131°F (0 to 55°C);

Storage: 32 to 158°F (0 to 70°C);

Humidity Tolerance: Up to 90% noncondensing

Power: From wallmount power supply:

Input: 114 to 126 VAC, 57 to 63 Hz, at up to 100 mA;

Output: 8.6 to 9.4 VAC at up to 800 mA;

Power consumption: 3 watts rms maximum;

Current consumption during initial connect sequence: 300 mA maximum

Size: 1.4"H x 7.5"W x 11.3"D (3.6 x 19.1 x 28.7 cm)

Weight: 4.5 lb. (2 kg)

2. Introduction

Many modems have to be kept in cloistered, electrically “quiet” areas, away from motors, generators, compressors, and other heavy machinery. But the Industrial Modem 288 (IM288) is different. Its electronics are specially designed to resist electrical and radio interference. This makes it ideal for use in industrial sites, where such interference would play havoc with unprotected transmissions. The IM288 is also capable of data rates up to 28.8 kbps, so you don’t have to sacrifice speed for this robustness.

This chapter discusses the physical characteristics of your IM288, as well as those of some of the equipment you will be using with it.

2.1 The Front Panel

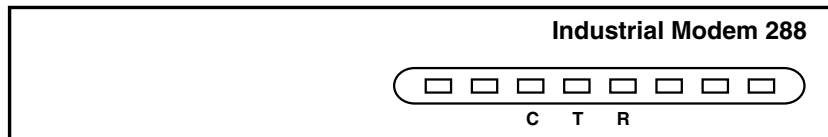


Figure 2-1. LEDs on the front panel.

The LED indicators on the Industrial Modem 288’s front panel display current operation and status:

1. **Modem Ready**
Steadily lit when the modem is turned ON, receiving power, and in normal operation. Dark when the modem is off or not receiving power. Flashes when the modem is in test mode.
2. **Data Terminal Ready (DTR)**
Flashes when the RS-232 DTR signal is detected from the attached DTE (PC, terminal, etc.). Dark otherwise.
3. **“C”— Carrier Detect (CD [RLSD])**
Steadily lit when a carrier signal is detected from a remote modem. Dark otherwise.
4. **“T”— Transmit Data (TD)**
Flashes when the modem is sending data to the remote modem or receiving data from the local DTE. Dark otherwise.

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5. **“R”— Receive Data (RD)**

Flashes when the modem is receiving data from the remote modem or sending data to the local DTE. Dark otherwise.

6. **High Speed**

Steadily lit when the data rate to and from the remote modem (“line speed”) is 2400 bps or above. Dark otherwise.

7. **Auto-Answer**

Steadily lit when the modem is set for auto-answer. Flashes when incoming ring is detected. Dark otherwise.

8. **Off-Hook**

Lit when the modem is “off hook” (that is, when the modem is using the telephone line). Dark when the modem is “on hook” (not using the line)

2.2 The Rear Panel

On the Industrial Modem 288’s rear panel you’ll find the unit’s power switch, power-inlet socket, DTE (RS-232) connector, and modular jacks for phone-line input and output. See Figure 2-2 below.

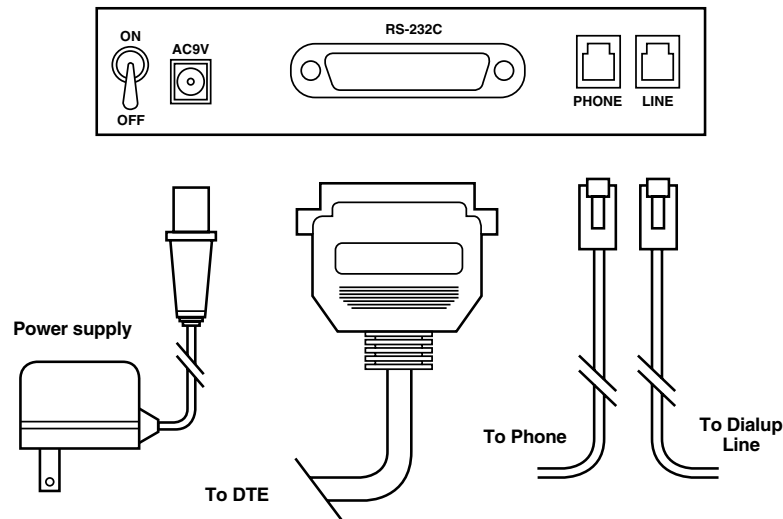


Figure 2-2. Connections on the rear panel.

You can turn the IM288 ON or OFF by toggling the power switch to the appropriate setting. Always turn your computer ON before you turn ON the IM288; always turn the IM288 OFF before turning OFF your computer.

The 9-VAC power-inlet socket (a barrel jack) mates with the barrel plug on the output cord of the IM288's included power supply. Never use an out-of-specification power-supply adapter; doing so could damage both the IM288 and the adapter.

The DB25 female connector mates with the DB25 male connector on the RS-232 cable (see **Section 2.3**) that will connect your DTE (terminal, computer, or programmable logic controller ["PLC"]) to the IM288. It uses a subset of the pins and signals specified in the RS-232C standard.

You can run standard phone cable with RJ-11 (4-wire) or RJ-12 (6-wire) plugs between the IM288's RJ-12 "PHONE" jack—the one on the left—and a voice telephone or fax machine. (If you are not using a phone or fax at the IM288's location, don't plug anything into the PHONE jack.) You will be able to use this phone or fax when the IM288 is not communicating with another modem (but not when the IM288 is unplugged or turned OFF). (Be aware that if you take this phone or fax off hook during modem communication, the modem link could be disrupted or disconnected.)

You can run standard phone cable with RJ-11 or RJ-12 plugs between the IM288's RJ-12 "LINE" jack—the one on the right—and the wall jack for the phone line.

2.3 The Serial Port and the RS-232 Cable

In order for you to use the Industrial Modem 288 in normal RS-232 applications, your attached DTE (terminal, computer, or PLC) must have an industry-standard TIA RS-232 DTE serial port. This port will be either a DB25 male connector or a DB9 male connector pinned to the TIA-574 standard. (The 8-pin mini-DIN serial ports of Apple® Macintosh® and compatible machines use TIA RS-422 and RS-423 signals instead of RS-232 and cannot be attached to an IM288 without special cables or converters.) If your DTE has no RS-232 serial port, consult Black Box or your DTE supplier about the possibility of getting an RS-232 interface card for it.

You'll also need a serial cable to run between your modem and your DTE's serial port. This cable must have the following characteristics:

1. Shielding.
2. A DB25 male connector at the modem end.

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3. A connector on the DTE end that will mate with the DTE's serial port: DB25 female if the DTE's serial port is DB25 male, or DB9 female if the DTE's serial port is DB9 male.
4. "Straight-through" pinning if both connectors are DB25 (Pin 1 on one end wired to Pin 1 on the other, Pin 2 to Pin 2, etc.); "straight-signal" pinning if the DTE connector is DB9 (the TD signal on DB25 Pin 2 wired to the TD signal on DB9 Pin 3, RD to RD, RTS to RTS, etc.).

Since the IM288's serial connector is a standard RS-232 DCE (modem) port, you should be able to use a standard modem cable with the IM288. However, you might want to refer to **Appendix B** to check the pinout of the IM288's port.

2.4 The Telephone-Line Test and the Phone Cable

The quality of the telephone line significantly affects the reliability of data communication. Make sure that both the telephone system and telephone lines are in good order before you hook the Industrial Modem 288 up to them.

First, test the condition of the line by attaching a telephone handset to it. You should hear a clear dial tone. Then try placing a few calls. If the calls do not go through properly or the sound is not loud and clear, there is probably a problem on the line; contact your telephone-service provider to have the problem cleared.

We recommend that you connect your IM288 directly to an outside telephone line. If you connect it to a private branch exchange (PBX) telephone system, you might have to use a modified dial-out command string and notify callers that they will have to use modified call-in procedures.

You can connect the IM288 to the phone line (or a phone to the IM288, for that matter) with any standard 4- or 6-wire phone cable.

3. Installation

3.1 The Complete Package

Before you install your Industrial Modem 288, make sure you received everything that should have come with the unit. The complete package includes:

- The IM288 unit itself;
- Its power supply;
- A phone cable with RJ-11 connectors; and
- This manual.

Also, carefully inspect the package and the components for damage. If you find any, contact Black Box and the shipping carrier immediately.

3.2 The RS-485 Module and Jumper

If you want to install one of the optional RS-485 interface modules (our product code MD3315 for the 2-wire module or MD3316 for the 4-wire module) in the Industrial Modem 288, do so now (refer to the instructions that came with the module). Once you've finished this, but while the IM288's enclosure is still open, place a jumper (provided with the module) on the jumper location marked "12 VDC" (see Figure 3-1 on the next page) in order for the module to receive the +12-VDC power that it needs to operate.

NOTE

Do not set the "smart/dumb" jumper now—wait until you have fully configured the unit. See Section 4.4.

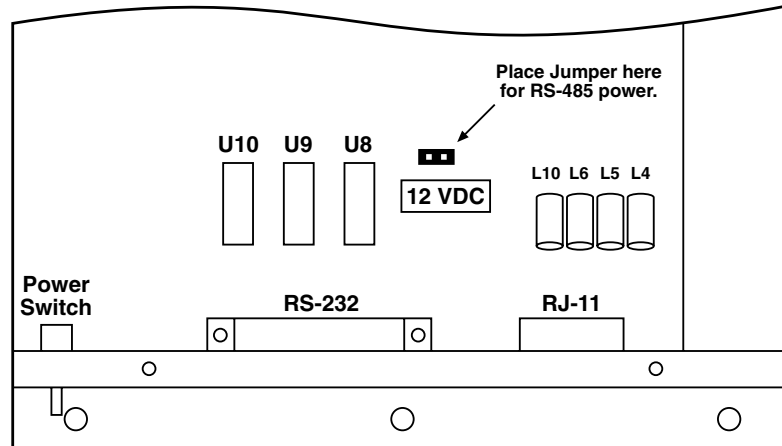


Figure 3-1. Where to put the RS-485 jumper.

3.3 Placement

The Industrial Modem 288 is designed to be placed on a desktop, and can support the weight of a standard telephone set if you want to place one on top of it. You can also mount the IM288 in any convenient location by driving bolts or screws through the mounting holes in its enclosure flanges. Of course, the IM288 and the DTE cannot be farther apart than the length of your RS-232 cable. (If you need the DTE to be more than 50 ft. [15.2 m] away from the IM288, you will need special shielded cables or distance extenders—call Black Box for technical support.) As you decide where to put the IM288, keep these considerations in mind:

- The location should be cool and dry;
- The location should be close to a reliable AC outlet, a phone-line jack, and the DTE; and
- You should be able to easily see the IM288's LEDs, reach its power switch, and hear its speaker.

3.4 The Installation Procedure

Once you have chosen a location for the Industrial Modem 288, follow the procedures below to connect the hardware:

1. Make sure that both the IM288 and the DTE are turned OFF.
- 2A. *For RS-232 applications:* Connect the IM288 to the DTE by plugging (a) the DB25 male end of the shielded RS-232 cable into the IM288 and (b) the DB25 or DB9 female end of the cable into your DTE's serial port. (Tighten all of the connector screws to make sure the connectors are secure.)
- 2B. *For 2-wire RS-485 applications:* Connect the IM288 to the DTE, or to the nearest of your chained RS-485 DTEs, by (a) attaching two wires in your RS-485 cable to the center two terminals on the terminal block of the IM288's RS-485 module and (b) attaching the other ends of the same two wires to the RS-485 terminals or other connector on the DTE (terminate the cable as necessary on the DTE end).
- 2C. *For 4-wire RS-485 applications:* Connect the IM288 to the DTE, or to the nearest of your chained RS-485 DTEs, by (a) attaching four wires in your RS-485 cable to the four terminals on the terminal block of the IM288's RS-485 module and (b) attaching the other ends of the same four wires to the RS-485 terminals or other connector on the DTE (terminate the cable as necessary on the DTE end).

NOTE

If your DTE is a PC, write down which of the PC's serial ports ("COM1," "COM2," etc.) the IM288 is connected to. (Your communications software will need to know this.) If you aren't sure about which of your serial ports is which, refer to the manuals for the PC and (if any of your ports were purchased and installed separately) the serial-port cards.

- 3A. *For dialup applications:* Connect the IM288 to the phone line by running a 4- or 6-wire, straight-through-pinned cable from the site's phone-line jack to the IM288's "LINE" jack.
- 3B. *For leased-line applications:* Connect the IM288 to a 2-wire leased line through its "LINE" jack. This connection will use the LINE jack's two center conductors (Pins 3 and 4) and any two wires in a standard phone cable; because the connection has no polarity, either wire can be connected to either pin.

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4. If you want to, connect a telephone set by running a 4- or 6-wire, straight-through-pinned cable from the phone to the IM288's "PHONE" jack. (If you haven't already done so, you might want to test the condition of the phone line as described in **Section 2.4.**)
5. Plug the output cord of the IM288's power supply into the IM288's 9-VAC barrel jack, then plug the power-supply transformer into a working AC outlet.
6. Turn ON the IM288 and the DTE.
7. *Leased-line applications:* Use an IM288 at both ends of the line. Repeat steps 1 through 6 for the remote IM288.

The IM288 is now installed and ready to be configured.

4. Configuration

4.1 Configuring the DTE and IM288: Communications Software

Before configuring the Industrial Modem 288, make sure that the attached DTE is configured properly.

If your DTE is a dumb terminal, you might need to configure its serial port directly. See the terminal's manual.

If your DTE is a PC, you might need to configure its communications software, which will control the PC's serial port as well as some aspects of the IM288's operation. (You can use almost any popular communications-software package, because the IM288 uses an industry-standard version of the AT command set.) Make sure the software is configured with these settings:

1. The serial port to which the IM288 is connected (COM1 or COM2, or, if you've installed any "extra" serial ports, COM3 or COM4).
2. The desired type of communication standards: ITU-TSS (CCITT) or Bell. If you will be using the ITU-TSS standards, you might also have to specify a few other characteristics: maximum modem-to-modem data rate or "line speed" (28,800, 14,400, 9600, or fewer bps), maximum DTE speed (up to four times the data rate [for V.42 bis compression] or up to twice the data rate [for MNP 5 compression]), and so on.
3. The proper data format: 8 data bits, no parity bits, and 1 stop bit.

For the IM288 to successfully communicate with another modem, the two modems must be configured the same way. For example, because the IM288 has to use a data format of 8 data bits, no parity, and one stop bit, you'll need to configure the modem on the other end the same way. Conversely, if the remote modem has to use the Bell standards, you'll need to configure your IM288 to use them too. If the two modems aren't set up the same way, connections will probably fail, and even if they don't, the data sent across the link will probably be garbled.

4.2 Configuring the IM288: AT Commands and Initialization Strings

To configure the Industrial Modem 288, you must send it "AT commands" made up of series of ASCII characters, so called because most of them begin with the two ASCII "attention" characters "AT". Sometimes this can be done by selecting options in PC communications software that send the appropriate AT commands

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automatically. Usually, however, these commands are typed in directly from a terminal or from PC terminal-emulation software.

Here are some examples of AT-command strings. (For the meaning of each individual command, refer to **Appendix A**.)

ATS0=2	Tells the IM288 to auto-answer incoming calls on the third ring.
ATX4 DT9 W n	“X4” tells the IM288 to use a certain set of messages to respond to future commands. “DT9W n ” tells the IM288 to tone-dial the number “9” (the “dial-out” number for many PBXes), hold the line until it detects a dial tone, and then tone-dial the phone number n .
ATS6=10 DP n	“S6=10” tells the IM288 to wait for 10 seconds after going off-hook before starting to dial phone numbers. “DP n ” tells the IM288 to pulse-dial the phone number n .
ATM2L3	Turns on the IM288’s monitoring speaker and sets it to high volume.
ATB0	Tells the IM288 to use the ITU-TSS (CCITT) V.22 and V.21 standards (rather than Bell standards) to establish connections with remote modems at 1200 and 300 bps respectively.
AT&P1	Tells the IM288 to pulse-dial with the 33/67 make/break ratio used in most European countries.
AT&P0P	First tells the IM288 to pulse-dial with the 39/61 make/break ratio used in the US, then tells it to pulse-dial as its default dialing method.
AT/N1	Tells the IM288 not to use error correction or data compression (“ECDC”).

The following two examples set the modem for auto-reliable mode, RTS/CTS flow control, ECDC-extended response-code sets, and automatic data-rate adjustment:

ATJ0\N3\Q3\V4 %C1	(Also enables data compression—not recommended for most industrial apps.)
ATJ0\N3\Q3\V4 %C0	(Disables data compression.)

Many popular communications-software packages allow users to specify a command string which will be sent to the modem prior to a dialing session. This string, usually called a “dialing prefix” or “initialization string,” will reconfigure the attached modem before the modem dials a phone number or goes on line. In some applications, you may want to occasionally use such initialization strings to reconfigure your Industrial Modem 288 on the fly. In other applications, especially industrial ones, you should never use initialization strings, so that the IM288’s default configuration is always in force.

4.3 The Factory-Default and User-Defined Configuration Profiles

The Industrial Modem 288 stores four sets of configuration parameters, called “configuration profiles,” in its nonvolatile memory (NVRAM). Because they are stored in NVRAM, these profiles are always available and are not lost when the IM288 is turned off. Two of these, called Stored Configuration Profiles (“SCPs”), can be defined by users; the other two, called Factory-Default Profiles (“FDPs”) are permanently fixed at the factory.

The first FDP, “FDP0”—useful for general PC applications with V.42 error correction and V.42 bis data compression (ECDC)—is the equivalent of the “AT\J0\N3\Q3\V4” command string and can be loaded with the “AT&F0” command. The second FDP, “FDP1”—useful for industrial applications without ECDC—is the equivalent of the “AT\J1\N1\Q0\V0” command string and can be loaded with the “AT&F1” command.

Both SCPs are identical to FDP0 when the IM288 comes from the factory. To change them, you must configure your IM288 to your desired settings, then save the configuration with the “AT&W n ” command. Save to SCP0 with “AT&W0” and load it with “ATZ0”; save to SCP1 with “AT&W1” and load it with “ATZ1”. (To view both SCPs, issue the “AT&V” command.)

To make one of your SCPs the “primary” or “major” profile that will always be loaded when the IM288 powers up, send the appropriate “AT&W n ” command: “AT&Y0” makes SCP0 the primary profile, and “AT&Y1” makes SCP1 the primary profile. Once you’ve done this, you can save the current configuration to the primary profile—whichever of the SCPs it is—by sending just “AT&W”.

4.4 Setting the “Smart/Dumb” Jumper

The setting of the Industrial Modem 288’s “smart/dumb” jumper determines whether or not the IM288 recognizes commands and answers them with response codes: In “smart” mode (the default setting, appropriate for most dialup applications), it will; in “dumb” mode, it won’t recognize commands or respond to them in any way.

If you will even occasionally be sending commands to the IM288 while it’s operating, leave the “smart/dumb” jumper alone; go to **Chapter 5**. If you’ve configured your IM288 so that it will operate automatically, even if it loses power or if it’s turned off and back on—for a dedicated leased-line autoconnect application (see **Section 5.6.2**), for example—and you need to “lock” the unit so that its configuration and operation won’t be affected by any further commands, move the “smart/dumb” jumper to the “dumb” position.

To reach the jumper, first make sure the IM288 is turned OFF and unplugged; then unscrew the four top-mounted corner screws that hold the IM288’s enclosure together, and then remove the top cover of the enclosure. The jumper, labeled “Y5,” is located behind the Industrial Modem 288’s front panel, to the left of the LED indicators. It should be in the default “smart” setting with the jumper on the left-hand and center posts to set it to the “dumb” setting, move the jumper so that it connects the center and right-hand posts.

NOTE

If you need to change the IM288’s configuration, or send it any other commands, at any time after having set this jumper to “dumb,” you will temporarily have to set the jumper back to “smart.”

5. Operation

5.1 Autodialing at Power-Up (Dialup Lines Only)

The Industrial Modem 288 can automatically dial a stored telephone number each time it is turned on. To use the autodial feature:

1. Make sure the IM288 is in command mode so that it will accept your commands. If the IM288 is in data mode (actively sending/receiving data), either wait for the end of the call, or issue an escape sequence to the unit to force command mode.
2. Store the telephone number you want the IM288 to autodial by issuing the command “AT&Zn=x”, where n is the single-digit identifier (“0” to “9”) of the Stored Telephone Number (“STN”) and x is the phone number or dial string.
3. Use the “AT&An” command to set the IM288 to autodial STNn at power-up.
4. Save these settings to your primary Stored Configuration Profile (SCP) by issuing the “AT&W” command. (To view the current active configuration and both SCPs, issue the “AT&V” command.)

Now each time you turn on your IM288, it will dial the stored telephone number and try to establish a connection with the dialed site. (If you need to disable autodialing later, send the “AT&A99” command.)

5.2 Speed-Dialing

Once you’ve stored a telephone number with “AT&Zn=x” as described in the previous section, you can speed-dial that number with the abbreviated code “S=n” or “/n”. For example, if you saved the phone number “555-3378” as Stored Telephone Number 2 (STN2) with the command “AT&Z2=555-3378”, you could send these speed-dialing commands:

ATDTS=2 Tone-dials 555-3378

ATDT/2 Tone-dials 555-3378

ATDT1-555-/2 Tone-dials 1-555-555-3378

ATDPS=2,,,,,T164 Pulse-dials 555-3378, waits ten seconds, then tone-dials 164

The code “/n” or “S=n” is counted as 2 or 3 digits respectively, regardless of how

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many digits long STN n is. This is especially useful when a string you need to dial—with phone numbers, extensions, calling-card numbers, access codes, etc.—would otherwise be so long that the command buffer would overflow.

5.3 Fallback Dialing

With fallback dialing (also called “swap-dialing”), the Industrial Modem 288 will automatically dial a second telephone number when the first one is busy. To use the fallback-dialing function, first enable line-busy detection by issuing the “ATX3” or “ATX4” command, then specify two phone numbers in a dial string separated by the fallback-dialing code “N”. For example, if you sent the IM288 the command string “ATX4 DT555-3378 N 555-2590”, the IM288 would first turn busy detection ON, then tone-dial 555-3378; if that number were busy, the IM288 would then hang up and dial 555-2590.

You can also combine speed-dialing (see the previous section) with fallback dialing. For example: Assuming busy detection has already been enabled, either “ATDTS=2 N S=5” or “ATDT/2N/5” will cause the IM288 to dial STN2 first, then—if that’s busy—dial STN5.

5.4 Redialing

The Industrial Modem 288 can automatically redial a call if the line is busy on the first attempt if you issue the appropriate “ATN= n ” and “ATN5= n ” commands. (As with fallback dialing—see the previous section—you also need to enable line-busy detection with the “ATX3” or “ATX4” command.) For example, once busy detection is enabled, the command string “ATN=4 N5=60 DT555-3378” causes the IM288 to redial the number 555-3378 as many as 4 times, once every 60 seconds, if the line is busy on the first attempt.

5.5 V.23 Operation

In ITU-TSS (CCITT) V.23 mode, the Industrial Modem 288 communicates with other modems at 1200 bps in one direction and 75 bps in another. In many countries this protocol is mainly used in the Videotex services, including BTX and Minitel.

To order the IM288 to use the V.23 “back channel” (75-bps transmit and 1200-bps receive, for connections to Videotex services), send the IM288 the “ATB2” command. If the DTE to which the IM288 is attached is itself a V.23 host, order the IM288 to use the V.23 “main channel” (1200-bps transmit, 75-bps receive) with the “ATB3” command.

Regardless of whether the IM288 is using the main channel or the back channel,

once it establishes a V.23 connection with a remote modem it responds with “CONNECT 1200.” The data rate between the IM288 and the attached DTE is fixed at 1200 bps in both directions. (The IM288 buffers communication in the direction in which the IM288-to-DTE link is 1200 bps but the IM288-to-remote-modem link is 75 bps, using RTS/CTS flow control to prevent overflow.)

5.6 Leased-Line Operation

5.6.1 ESTABLISHING A CONNECTION

If you’re using a pair of Industrial Modem 288s for leased-line communication between two sites across a dedicated link, rather than for dialup purposes, first make sure that both IM288s are set to exactly the same configuration settings. Then take these steps to establish a communication session between the two IM288s:

1. Issue the “AT&L1” command to both IM288s to select 2-wire leased-line operation.
2. Issue the “ATDS0=0” command to one of the two IM288s to put it in “originate” mode.
3. Issue the “ATAS0=1” command to the other IM288 to put it in “answer” mode. (The “AA” [Auto-Answer] LED on that IM288’s front panel will light.)

The two IM288s should automatically establish a connection across the leased line.

5.6.2 AUTOCONNECTION AT POWER-UP

If you want the pair of Industrial Modem 288s on your leased line to automatically establish communications sessions as soon they are powered on, for as long as they are powered on, first make very sure that both IM288s are set to exactly the same configuration settings. Then take these steps:

1. Send one of the IM288s the “AT&L1S0=0&W” command string. This string sets this IM288 to 2-wire leased-line operation in “originate” mode and saves the unit’s configuration to the primary SCP.
2. Send the other IM288 the “AT&L1S0=1&W” command string. This string sets this IM288 to 2-wire leased-line operation in “answer” mode and saves the unit’s configuration to the primary SCP.
3. Set both modems’ “smart/dumb” jumpers to “dumb” so that they will not accept further commands (see **Section 4.4**).

6. Troubleshooting

If you have difficulty with your Industrial Modem 288, first look for the problem and possible solutions in **Section 6.1**. If you don't find any help there, make sure all the bases mentioned in **Section 6.2** are covered. If this still doesn't help, and the problem seems to be transmission-related, try the tests discussed in **Section 6.3**. If all else fails, contact Black Box Technical Support as described in **Section 6.4**.

6.1 Common Concerns

This section lists possible actions you can take in response to questions and concerns that might arise about the Industrial Modem 288.

Q1. What if the IM288's MR indicator doesn't light up after the unit is turned ON?

1. Make sure that the IM288 is plugged in and that the output plug of its power supply is securely attached to its 9-VDC jack.
2. Make sure that the outlet the IM288 is plugged into works. (You could try plugging a lamp into it to see if the lamp will light.) If the IM288 is plugged into a power outlet on a PC, you might have to turn the PC ON.
3. Use a power tester to check the output of the IM288's power supply: Is it still putting out 9 VAC? If not, contact Black Box to get the power supply repaired or replaced; do not use any other power supply with the IM288.
4. Check the fuse on the IM288's circuit board, mounted near the 9-VAC barrel jack. If it has blown, you'll have to return the unit; contact Black Box.

Q2. What if the IM288 does not accept commands?

1. Try entering a simple command line such as "AT" or "ATZ." If the IM288 responds with "OK," there might be a problem with the syntax of the command string you're trying to enter: Enter each command individually and check the corresponding entry in **Appendix A** for any command that the IM288 "chokes on" (that it fails to respond to with "OK").
2. The IM288 might be in data mode. Enter the escape sequence "+++" to force it into command mode.
3. Make sure that the cabling between the IM288 and the DTE is securely attached at all connection points, is attached to the correct serial port on the DTE, and is not longer than 50 ft. (15.2 m).

- 4 Check the terminal, PC, or PLC to make sure that data is actually being sent. If it is, check the configuration settings of the DTE or its communications software and make sure that they match those of the IM288.
5. Turn OFF and unplug the IM288, open its enclosure, and check the “smart/dumb” jumper located behind the Industrial Modem 288’s front panel, to the left of the LED indicators. If it is set to “dumb,” move the jumper back to “smart.” See **Section 4.4**.

Q3. What if the IM288 does not seem to dial in response to ATDT or ATDP commands?

1. Send the IM288 the “ATL2” or “ATL3” command to turn the speaker up and listen to what the unit is doing when you try to dial. (You can turn the speaker down or off later with “ATL1” or “ATL0” respectively.)
2. Make sure that the dial command you are sending the IM288, or the dialing setup of your communication software, is correct: Tone-dial for tone line or pulse-dial for pulse line; correct phone number; etc.
3. The IM288 might not be pausing long enough after going off hook for the telephone company’s central office to apply a dial tone to the line. There are several ways of overcoming this. You can set register S6, which controls this delay, to a value higher than the default of “2” (two seconds). You can add a “W” (wait for dial tone) modifier or one or more comma (two-second pause) modifiers to the start of the dial string: For example, “ATDTW555-4000” would cause the modem to go off hook, wait for dial tone (however long that takes, up to the maximum value stored in register S7), then tone-dial 555-4000; “ATDP,,555-3378” would cause the modem to go off hook, wait eight seconds, then pulse-dial 555-3378. Lastly, you can issue the “ATX3” command, which causes the IM288 to “blind dial” (dial regardless of whether or not it can detect a dial tone).
4. *Pulse lines only:* Confirm that the dialing speed, make/break ratio, and pulse-decoding method you are trying to use match those of the local telephone system. Pulse-dialing speed can be either 10 or 20 pulses per second; the make/break ratio can be either 33/67 or 31/69; and pulse signals can be interpreted differently depending on the telephone system you have (for example, a single pulse signal might be interpreted as the digit 0, 1, or 9); see **Appendix C**. You can set the make/break ratio with the “AT&P” command, but if your phone system’s dialing speed is 20 pps, or its pulse interpretation is wrong (the IM288 always gets a wrong number), you will have to put the IM288 on a tone line.

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Q4. What if the IM288 seems to tone-dial too slowly?

The default value for the duration of each tone plus the pause before the next tone is 95 ms. You can change this duration by setting register S11 to a smaller value: “ATS11=70”, for example, sets the duration to 70 ms.

Q5. What if the IM288 does not auto-answer?

Issue the command “ATS0=1&W” to configure the IM288 for auto-answering applications and then to save that setting.

Q6. What if the IM288 does not hang up when a user quits out of the PC communications software?

The IM288 might be configured to ignore the state of the PC’s DTR signal. Issue the command “AT&D2&W” to configure the IM288 to disconnect when DTR goes low (off) and then to save that setting.

Q7. What if the IM288 attempts handshaking after dialing, but hangs up before a connection is established?

1. Confirm that both the IM288 and the modem it is dialing are set to either the Bell or the ITU-TSS (CCITT) communication standard. (If not, issue the appropriate “ATBx” command to the modem that is set incorrectly.)
2. Confirm that the modems are using the “8 data bits, no parity, 1 stop bit” data format. (This cannot be changed on the IM288; to change this setting on the other modem, consult its manual.)
3. Set register S7 to a higher value to increase the “handshaking timeout period” (the time the IM288 will wait for handshaking to be resolved, and to receive carrier from the remote modem, before hanging up). For example, an “ATS7=90” command would lengthen the timeout to 90 seconds from the default of 50 seconds.
4. If you suspect that the telephone line is low quality and will not sustain a valid carrier consistently, try setting registers S9 and S10 to higher values. The value in S9 corresponds to the length of time, in tenths of seconds, that a carrier signal has to be present before the IM288 recognizes it as such and turns on the RS-232 Carrier Detect signal; for example, an “ATS9=20” command would increase the carrier-recognition time to 2 seconds from the default of 0.6 seconds. The value in S10 corresponds to the length of time, in tenths of seconds, that the IM288 will wait after losing carrier before hanging up; for example, an “ATS10=36” command would increase the carrier-recognition

time to 3.6 seconds from the default of 1.4 seconds. (S10 should always be set higher than S9, because otherwise, even if carrier is restored, the IM288 will disconnect before it has time to recognize the fact.)

5. If steps 1 through 4 haven't helped, put the IM288 somewhere else and try another telephone line. If the IM288 was connected to an extension on a PBX network, try to bypass the PBX by putting the IM288 on a phone line with direct external dialing.

Q8. What if the IM288 is receiving excessive errors?

1. Escape to command mode with “+++” and force the IM288's speaker on with the “ATM2” command. Check the telephone-line connection. If there are recognizable noises or voice sounds on the line, either you are getting crosstalk from another phone line, or a phone connected to the same extension as the modem at either end is off the hook.

If there is static on the line, it might be just a bad connection, so hang up and try again. If you repeatedly hear static, but only after the IM288 establishes a connection to the remote modem, the problem is probably at that site; contact someone there. If you repeatedly hear static, but only while the IM288 is off hook, contact the phone company. If you repeatedly hear static even before the IM288 gets dial tone, you are getting serious electrical interference from something at your site; make sure the cable from the DTE to the IM288 does not come close to any fans, motors, air conditioners, generators, etc.

2. Set your IM288 to use V.42 and/or MNP error correction by issuing the “ATN3” or “ATN4” command, followed by the appropriate “Vn” command (see **Appendix A**). You can also try using an error-checking protocol such as ZMODEM, XMODEM, YMODEM, or Kermit, if your communication software supports it.
3. Send an “AT&T6” command to have the IM288 do a remote digital loopback. If the test fails, something is probably wrong with the telephone-line connection between the two modems; if the problem recurs repeatedly and you can't isolate it, contact the phone company.
4. Send an “AT&T1” command to have the IM288 do a local analog loopback. If the test fails, something is probably wrong with the IM288, the DTE, or the cabling between them; if you can't isolate the problem, contact Black Box Technical Support.
5. Send an “AT&T8” command to have the IM288 do a local analog loopback and a self-test. If the test fails, something is probably wrong with the IM288 itself; contact Black Box Technical Support.

6.2 Line and Dial-Method Testing

6.2.1 TELEPHONE-LINE TEST

For reliable data communications, the telephone line needs to be noise-free and properly amplified. The local telephone company or service provider is responsible for ensuring that line-noise and -amplification standards are met. In general, lines can be tested using voice calls: If reception is clear, static- and hum-free, and at good volume, the line quality is probably satisfactory for reliable modem operation. Direct modem-connection and data-communication tests can then be run.

If possible, it is best to connect the Industrial Modem 288 to a direct outside line, rather than connecting it through a PBX system. Many PBX systems require that you first dial an access code to access an outside line, so this has to be inserted in your dial strings. You might also need to insert a “W” modifier or one or more comma modifiers after the access code to give the PBX time to connect the IM288 call to an outside line.

6.2.2 TONE VS. PULSE LINES

Two kinds of dialing systems are currently in use throughout the world: rotary-pulse and touchtone systems. Touchtone systems are the most common, but there are still pulse systems in operation. Both types are used in some regions; in the US and Canada, for example, phone customers have the option of subscribing to a “pulse line” or a “tone line.” Your telephone company can tell you which type of line you subscribe to or which type of dialing system you have. But you can also perform this simple test:

1. Turn on your DTE and your Industrial Modem 288. If your DTE is a PC, run its communications software and get into terminal mode.
2. Type “ATDT” followed by the telephone number of a public service that you are familiar with, such as a free time-report or weather-report number. If the call goes through, your line or system is touchtone. If it doesn’t, try to dial the same number with the “ATDP” prefix. If the call goes through this time, your line or system is rotary/pulse. (If the call still doesn’t go through, see the entry for question **Q3** in **Section 6.1**.)

6.2.3 THINGS TO REMEMBER ABOUT DIALING WITH THE IM288

Your Industrial Modem 288 supports both the tone- and pulse-dialing methods. Commands and S-registers related to IM288 dialing are:

- “T” Tells the IM288 to use touchtone dialing as its default method.
- S11 Determines the speed of touch-tone dialing.
- “P” Tells the IM288 to use rotary-pulse dialing.
- “&P0” Tells the IM288 to use a 39/61 make/break ratio for pulse dialing (appropriate for the US and Canada).
- “&P1” Tells the IM288 to use a 33/67 make/break ratio for pulse dialing (appropriate for some other regions).

Your IM288 also supports an adaptive dialing function which will make the call whether the dialing system is tone or pulse. You can simply issue the “ATD” command without adding the dialing modifier “T” or “P”. However, adaptive dialing may not work properly with your PBX or local telephone company, so it’s a good idea to specify the dialing method if possible.

6.3 Modem Diagnostic Functions

Your Industrial Modem 288 can help isolate communication problems by performing any of the diagnostic tests listed in this section in response to an “&Tn” command. (Be aware that “&T3”, “&T6”, and “&T7” have no effect when the IM288 is communicating using the Bell 103 standard or the ITU-TSS V.21 or V.23 standard.) Each of these tests will last for the number of seconds indicated by the “test timer,” register S18; to end any test currently in progress before that timer expires, send the IM288 “+++” followed by “AT&T0” or “ATH0”. When a test is over, the IM288 will send a “PASS” or “FAIL” result code back to the DTE.

- “&T1” Local analog loopback (LAL) test
Tests the communications path between the local IM288 and the attached DTE.
- “&T3” Local digital loopback test (LDL)
Tests the path from the remote DTE through the remote modem and the telephone circuit to the local IM288 and back.

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- “&T6” Remote digital loopback test (RDL)
Tests the path from the local DTE through the local IM288 and the telephone circuit to the remote modem and back.
- “&T7” Remote digital loopback with self test (RDLST)
Same as the “&T6” test, except that the IM288 tests its own circuitry as well. If “&T6” passes but this fails, there’s something wrong with the IM288; call Black Box for technical support.
- “&T8” Local analog loopback with self test (LALST)
Same as the “&T1” test, except that the IM288 tests its own circuitry as well. If “&T1” passes but this fails, there’s something wrong with the IM288; call Black Box for technical support.

6.4 Calling Black Box

If you determine that your Industrial Modem 288 is malfunctioning, *do not attempt to alter or repair the unit*. It contains no user-serviceable parts. Call Black Box Technical Support at (412) 746-5500.

Before you do, make a record of the history of the problem. We will be able to provide more efficient and accurate assistance if you have a complete description, including:

- the nature and duration of the problem.
- when the problem occurs.
- the components involved in the problem.
- any particular application that, when used, appears to create the problem or make it worse.

6.5 Shipping and Packaging

If you need to transport or ship your Industrial Modem 288:

- Package it carefully. We recommend that you use the original container.
- If you are shipping the IM288 for repair, make sure you include its power supply and the phone cables you’re using with it. If you are returning the IM288, make sure you include its manual as well. Before you ship, contact Black Box to get a Return Authorization (RA) number.

Appendix A: AT Commands, S-Registers, and Result Codes

This appendix lists the commands supported by the Industrial Modem 288 (including the dial commands and dial-string modifiers), its available S-registers and their functions, and the result codes it reports in various situations.

A.1 The AT Command Set

A.1.1 GENERAL INFORMATION

Standard modem commands are usually referred to as “AT commands” because most of them are preceded by the two-character attention code “AT”. You can send them directly to the Industrial Modem 288 from your terminal or from your PC equipped with terminal-emulation software, and often you can also send them indirectly by selecting control options in PC communication software, because the software responds by issuing AT commands automatically.

Most AT commands have a set of possible arguments, one of which is the default value. This default value is loaded into the active configuration when you turn ON the IM288 or when you load a factory-default or user-defined configuration profile with “AT&F*n*”, “ATZ”, or “ATZ*n*”. If a command *requires* an argument but you don’t enter one, the IM288 uses zero as the default argument. The IM288 responds to invalid commands or arguments with the “ERROR” result code.

Each command line can contain a single command or a series of commands. When you include multiple commands on the same line, you can separate them with spaces for readability. The IM288 tries to execute command lines, which can be up to 40 characters long, when you enter the “terminating character.” The default terminating character is a carriage return (ASCII [CR], hex 0D, decimal 013); though you can select a different character by setting register S3 to a different value, we don’t recommend doing this unless you’re using a terminal that can’t produce a standard carriage return.

You can also edit the command line with the “backspace character.” The default for this character is the ASCII backspace (ASCII [BS], hex 08, decimal 008); though you can select a different character by setting register S5 to a different value, we don’t recommend doing this either unless you’re using a terminal that can’t produce a standard backspace.

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Command lines, including the “AT” attention code, can consist of upper- or lowercase letters. After you enter “AT”, until you send the IM288 the terminating character, you can abort a command line in progress by sending the IM288 the “cancel character” CTRL-X (ASCII [CAN], hex 12, decimal 018); the IM288 will ignore the command line and send back an “OK” result code.

A.1.2 COMMAND SUMMARY

There are three basic commands that do not have to be preceded by the two characters “AT”:

- AT** The attention code itself. When issued alone, without any commands following it, causes the IM288 to respond with “OK”.
- A/** Re-execute the previous command in the command buffer. Does not require a terminating character; as soon as you type the “/”, the previous command will be re-executed.
- +++** The escape sequence; forces the modem out of data mode into command mode. A “guard time” (set using register **S12**—see **Section A.2**), during which the IM288 receives no other characters, must elapse before and after the escape sequence in order for the escape sequence to be acted upon. (The guard time must also be longer than the time intervals between the sequence’s “+” characters.)

All other commands must be part of command lines that begin with “AT”:

- An** Auto-answer after *n* rings (*n*=0 to 3).
- B0** Use ITU-TSS (CCITT) V.22 and V.21 standards for 1200 and 300 bps (default).
- B1** Use Bell 212A and 103 standards for 1200 and 300 bps.
- B2** Use ITU-TSS V.23 standard, user channel (1200/75 bps).
- B3** Use ITU-TSS V.23 standard, host channel (75/1200 bps).
- D** Dial: Go off hook, dial the string that follows, and try to make a connection. Must be the final command in its command line. Can be followed by digits “0” through “9”, touchtone-only letters “A” through “D” (“extra” keys available on some touchtone phones), the touchtone “#” and “*” characters, and any of the dial-string modifiers listed below. (When issued with no arguments, simply causes the modem to go off hook in “originate” mode.)

APPENDIX A: AT Commands, S-Registers, and Result Codes

L	Dial the last (that is, the most recently) dialed number.
P	Pulse-dial what follows.
R	Reverse-dial (call an originate-only modem or a modem in originate mode).
S=<i>n</i> or /<i>n</i>	Dial stored number <i>n</i> (<i>n</i> =0 through 9).
T	Tone-dial what follows.
W	Wait for dial tone (see the entry for S7 in Section A.2).
@ (at sign)	Wait for silence (see the entry for S7 in Section A.2).
, (comma)	Pause (see the entry for S6 in Section A.2).
! (ex. point)	Flash (go on hook for 700 ms, then off again).
; (semicolon)	Return to command state after dialing.
^ (caret)	Turn on 1300-Hz calling tone for this call.
E0	Disable command echo.
E1	Enable command echo (default).
H0	Hang up.
H1	Go off hook.
I0	Display the IM288's product-ID code.
I1	Display the version code of the IM288's firmware.
I2	Display a checksum of the IM288's ROM.
L0	Turn the speaker OFF.
L1	Turn the speaker ON at low volume.
L2	Turn the speaker ON at medium volume (default).
L3	Turn the speaker ON at high volume.
M0	Disable the speaker at all times.
M1	Disable the speaker while receiving carrier from a remote modem (default).
M2	Enable the speaker (keep it ON) at all times.

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- M3** Disable the speaker while receiving carrier from a remote modem and while dialing.
- N?** Display the number of times the IM288 will automatically redial phone numbers if the first attempt fails.
- N=*n*** Set the number of times the IM288 will redial (*n*=0 to 3, default 0).
- N5?** Display the time interval (in seconds) that the IM288 will wait between redialing attempts.
- N5=*n*** Set the redial interval in seconds (*n*=0 to 3).
- O0** Return to the on-line state (data mode) from command mode.
- O1** Return to the on-line state (data mode) from command mode and initiate a retrain sequence.
- P** Use pulse-dialing as the default dialing method.
- Q0** Send result codes to the DTE (default, see **Section A.3**).
- Q1** Don't send result codes to the DTE (see **Section A.3**).
- S*r*?** Display the current setting of S-register *r* (see **Section A.2**).
- S*r*=*n*** Set S-register *r* to value *n* (see **Section A.2**).
- T** Use tone-dialing as the default dialing method.
- V0** Use short-form (numeric) result codes (see **Section A.3**).
- V1** Use long-form (verbal) result codes (default, see **Section A.3**).
- X0** Ignore dial tone and busy signal. Blind-dial after number of seconds indicated by **S6** (see **Section A.2**). Use basic result codes 0 through 4 (see **Section A.3**).
- X1** Ignore dial tone and busy signal. Blind-dial after number of seconds indicated by **S6** (see **Section A.2**). Use result codes 0 through 5 and 10 through 18 (see **Section A.3**).
- X2** Ignore busy signal. Use all standard result codes except 7, BUSY (see **Section A.3**).

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X3	Ignore dial tone. Blind-dial after number of seconds indicated by S6 (see Section A.2). Use all standard result codes except 6, NO DIAL TONE (see Section A.3).
X4	Use all standard result codes (default).
Y0	Disable long-space disconnect (default).
Y1	Enable long-space disconnect.
Z	Reset to the primary SCP (Stored Configuration Profile; see Section 4.3).
Z0	Reset to SCP0 (see Section 4.3).
Z1	Reset to SCP1 (see Section 4.3).
&An	Autodial STN n (Stored Telephone Number n , $n=0$ through 9) at power-up.
&A99	Disable autodialing at power-up.
&C0	Force high (turn ON) the RS-232 RLSD signal (also known as “CD” or “DCD”) at all times.
&C1	Raise or lower RLSD (turn it ON or OFF) in response to carrier from the remote modem (default).
&C2	Raise or lower RLSD (turn it ON or OFF) in response to carrier from the remote modem in data mode; force it high (turn it ON) at all times in command mode.
&D0	Ignore the state of the RS-232 DTR signal received from the DTE (default).
&D1	Go into command mode if DTR is lost.
&D2	Disconnect and disable auto-answering while DTR is lost.
&D3	Perform an “ATZ” reset if DTR is lost.
&F0	Reset to FDP0 (Factory-Default Profile Zero, enables ECDC).
&F1	Reset to FDP1 (Factory-Default Profile One, disables ECDC).
&G0	Disable guard tone (default).
&G1	Use a 550-Hz guard tone.

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- &G2** Use an 1800-Hz guard tone.
- &L0** Operate on a dialup line (default).
- &L1** Operate on a 2-wire leased line.
- &P0** Use the 39% make, 61% break ratio when pulse-dialing (default).
- &P1** Use the 33% make, 67% break ratio when pulse-dialing.
- &R0** After the delay interval specified in **S26** (see **Section A.2**), raise or lower the RS-232 CTS signal (turn it ON or OFF) in response to the RTS signal from the attached DTE (default).
- &R1** Force CTS high (keep it ON) at all times.
- &S0** Force the RS-232 DSR signal high (keep it ON) at all times (default).
- &S1** Handle DSR “by the book,” strictly according to the RS-232-D specification.
- &T0** End any **&Tn** test in progress. (The escape sequence “+++” must be sent first, to return the IM288 to command mode.)
- &T1** Perform a local analog loopback (LAL) test. The local IM288 “loops back” the data coming out of its transmitter circuitry through its own receiver circuitry and back to the attached DTE; this tests the integrity of the local DTE-to-modem link.
- (**&T2** is reserved for manufacturer use.)
- &T3** Perform a local digital loopback (LDL) test. The local IM288 “loops back” the data coming into its receiver circuitry through its own transmitter circuitry and back to the remote modem and remote DTE. This tests the integrity of the modem-to-modem and remote modem-to-DTE links.
- &T4** Enable requests for remote digital loopback (RDL) from the remote modem. (An RDL test initiated by the remote modem would be the same as a local digital loopback test initiated by the local IM288; see **&T3**.)
- &T5** Disable requests for RDL from the remote modem.

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- &T6** Perform a remote digital loopback (RDL) test. The remote modem, at the request of the local IM288, “loops back” the data coming into its receiver circuitry through its own transmitter circuitry and back to the local IM288 and the local DTE. This tests the integrity of the modem-to-modem and local-IM288-to-DTE links.
- &T7** Perform a remote digital loopback (RDL) test (see **&T6**) as well as a self-test of the IM288’s circuitry.
- &T8** Perform a local analog loopback (LAL) test (see **&T3**) as well as a self-test of the IM288’s circuitry.
- &V0** Display the active configuration and the two Stored Configuration Profiles (SCPs; see **Section 4.3**).
- &V1** Display the contents of the ten NVRAM locations for Stored Telephone Numbers (STNs).
- &W** Save the active configuration to the primary Stored Configuration Profile (SCP) designated with **&Yn** (see **Section 4.3**).
- &W0** Save the active configuration to Stored Configuration Profile Zero (SCP0; see **Section 4.3**).
- &W1** Save the active configuration to Stored Configuration Profile One (SCP1; see **Section 4.3**).
- &Y0** Use Stored Configuration Profile Zero (SCP0) as the primary profile that will be loaded at power-up.
- &Y1** Use Stored Configuration Profile One (SCP1) as the primary profile.
- &Zn=x** Save dial string *x* to Stored Telephone Number *n* (STN*n*).
- \A0** Set block size for MNP error correction to 64 characters.
- \A1** Set MNP block size to 128 characters.
- \A2** Set MNP block size to 192 characters.
- \A3** Set MNP block size to 256 characters.
- \Bn** Transmit a break signal to the remote modem for *n* x 100 ms (*n*=1 to 9, default 3 [300 ms]).

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\Cn	Determines how the IM288 handles buffering in auto-reliable (ECDC) mode (\N3):
<i>n=0</i>	Do not buffer data.
<i>n=1</i>	Buffer all data for 4 seconds, until 200 characters have been buffered.
<i>n=2</i>	Do not buffer data; switch to normal mode (\N0) upon receipt of the character specified by %Ax.
\G0	Disable modem-to-modem flow control for normal-mode (non-error-corrected) communication sessions (default).
\G1	Use X-ON/X-OFF (software) modem-to-modem flow control for normal-mode communication sessions.
\J0	Disable data-rate adjustment.
\J1	Enable data-rate adjustment.
\Kn	Determines how the IM288 behaves when it receives a break signal from the remote modem:
<i>n=0, 2, 4</i>	Enter command mode.
<i>n=1</i>	Clear the DTE and modem buffers and send a break signal back to the remote modem.
<i>n=3</i>	Send a break signal back to the remote modem.
<i>n=5</i>	Send a break signal back to the remote modem in sequence with any transmitted data (default).
\N0	Operate in normal mode: Don't use error correction, but use buffers to compensate for differences between the modem-to-modem data rate and the DTE speed.
\N1	Operate in direct mode: Don't use error correction or buffering; modem-to-modem data rate and DTE speed must match.
\N2	Operate in MNP reliable mode: Use MNP error correction and MNP 5 data compression only.
\N3	Operate in auto-reliable (ECDC) mode: Use V.42 or MNP error correction and V.42 bis or MNP 5 data compression.
\N4	Operate in ITU-TSS reliable mode: Use V.42 error correction and V.42 bis data compression only.

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\Q0	Disable serial-port flow control.
\Q1	Use bidirectional X-ON/X-OFF (software) flow control between the IM288 and the attached DTE.
\Q2	Use unidirectional RTS/CTS (hardware) flow control: Accept RTS/CTS from the DTE, but do not flow-control the DTE.
\Q3	Use bidirectional RTS/CTS (hardware) flow control between the IM288 and the attached DTE.
\Q4	Use unidirectional X-ON/X-OFF (software) flow control: Accept X-ON/X-OFF from the DTE, but do not flow-control the DTE.
\Tn	Set the inactivity timer: During any connection, wait <i>n</i> minutes for data from the DTE and hang up if none is received (<i>n</i> =0 to 42, default 0 [timer disabled]). In MNP reliable mode (\N2), data received from the remote modem will reset the timer as well as data from the DTE. This timer is disabled in direct mode (\N1). The timer value is stored in register S30 .
\V0	Display CONNECT <i>n</i> result codes with <i>n</i> =modem-to-modem data rate; do not use ECDC result codes 20 to 71 (see Section A.3).
\V1	Display CONNECT <i>n</i> result codes with <i>n</i> =DTE speed; do not use data-compression result codes 40 to 71 (see Section A.3).
\V2	Display CONNECT <i>n</i> result codes with <i>n</i> =modem-to-modem data rate; do not use data-compression result codes 40 to 71 (see Section A.3).
\V3	Display CONNECT <i>n</i> result codes with <i>n</i> =DTE speed.
\V4	Display CONNECT <i>n</i> result codes with <i>n</i> =modem-to-modem data rate.
\V5	Display CONNECT <i>n</i> result codes with <i>n</i> =DTE speed; do not use ECDC result codes 20 to 71 (see Section A.3).
\X0	Disable X-ON/X/OFF passthrough (default).
\X1	Enable X-ON/X/OFF passthrough: Transparently pass X-ON/X-OFF flow control between the local DTE and the remote modem (or, if the remote modem also has passthrough enabled, to the remote DTE).

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- %Ax** Designate x as the “auto-reliable fallback character”: During any auto-reliable (**\N3**) connection in which **\C2** is active, fall back to normal (**\N0**) mode when this character is received from the DTE.
- %Bn** Force connections at modem-to-modem data rate of n bps: $n=28800$, 14400, 9600, etc.; see the entry for **Data Rate** in **Chapter 1**. Default is 0 (disabled—IM288 automatically negotiates fastest rate as normal).
- %C0** Disable data compression.
- %C1** Enable V.42 bis and MNP 5 data compression (default).
- %Dn** For error-corrected links, set the forced-disconnect delay: After receiving a disconnect command from the DTE, wait n seconds ($n=0$ to 255, default 0) for the remote modem to acknowledge receiving all data in the modem buffer before hanging up. If the remote modem acknowledges the data, respond to the disconnect command with “OK”; otherwise, respond with “NO CARRIER”. If you set n to 255, the IM288 will never force a disconnection; it will keep trying to send the data until it loses carrier or gets a response from the remote modem. This value is stored in register **S38**.
- %E0** Disable auto-retraining.
- %E1** Enable auto-retraining (default).

A.2 The S-Registers

The Industrial Modem 288 stores many of its configuration settings in memory locations called “S-registers.” You can see the current setting of S-register r by sending the IM288 the “ATS r ” command; you can directly set S-register r to value n by sending the IM288 the “ATS $r=n$ ” command. The “Default” column in the table lists the factory-default settings of each register, which can be reloaded at any time with the “AT&F0” or “AT&F1” command. The contents of the registers marked with an asterisk (“*”) can be saved to either of the user-defined Stored Configuration Profiles (SCPs) with the “AT&W0” or “AT&W1” command, and reloaded from that profile with the “ATZ0” or “ATZ1” command respectively (see **Section 4.3**).

APPENDIX A: AT Commands, S-Registers, and Result Codes

Register	Range	Unit	Default	Description
S0*	0–255	Rings	0	Ring to auto-answer on; auto-answer disabled when set to zero
S1	0–255	Rings	0	Ring count; reset to zero if eight seconds elapse without a ring being detected
S2	0–127	ASCII	43	Escape character
S3	0–127	ASCII	13	Carriage-return character
S4	0–127	ASCII	10	Line-feed character
S5	0–32, 127	ASCII	8	Backspace character
S6*	2–255	Seconds	2	Wait time before blind dialing; ignored if “ATX2” or “ATX4” is in effect; can be overridden with the “W” dial modifier
S7*	2–255	Seconds	45	Wait time for carrier after dialing; also, wait time for dial tone when “W” dial modifier is used
S8*	0–255	Seconds	2	Pause time when “,” (comma) dial modifier is used
S9*	1–255	Tenths of a second	6	Response time for recognition of carrier detection
S10*	1–255	Tenths of a second	14	Wait time from lost carrier to hang up; when set to 255, IM288 will hang up in error-correction modes, or behave as if carrier is always present in other modes

*Setting can be saved to NVRAM.

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Register	Range	Unit	Default	Description
S11*	70–255	Milliseconds	95	Duration of each tone-plus-intertone-pause for tone-dialing
S12*	0–255	Fiftieths of a second	50	Escape-code guard time
S18*	0–255	Seconds	0	Test timer
S25*	0–255	Hundredths of a second	5	Response time for recognition of DTR-change detection
S26*	0–255	Hundredths of a second	0	RTS-to-CTS delay interval when CTS tracks RTS (“AT&R0”)
S30*	0–255	Seconds	0	Inactivity timer (disabled when set to zero)
S38*	0–255	Seconds	0	Delay before forced disconnect in error-correction mode; forced disconnect disabled if set to 255 (IM288 tries to send buffered data until connection is lost or data is delivered)

*Setting can be saved to NVRAM.

A.3 Result Codes

The Industrial Modem 288 responds to commands by sending “result codes” back to the DTE. For most commands the only possible responses are 0, “OK”, or 4, “ERROR”; however, dial commands and other commands that make or alter connections to remote modems can have many possible results, as you can see. Which of these result codes actually appear in any given situation depends on the settings of various commands, especially “ATX*n*” and “ATV*n*” (see the entries for those commands in **Section A.1**).

APPENDIX A: AT Commands, S-Registers, and Result Codes

In the table below, the “Verbal Code” column lists the codes in verbal form, as the IM288 sends them when “ATV1” (“use long-form codes”) is in effect, and the “Numeric Code” column lists the codes in hexadecimal numeric form, as the IM288 sends them when “ATV0” (“use short-form codes”) is in effect.

The IM288 responds with the verbal codes that end with “/V42” (numeric codes 20 through 31) when it is using V.42 error correction but no data compression. (If the IM288 is using MNP error correction instead of V.42, it substitutes “/REL” for “/V42” in the verbal code.) The IM288 responds with the verbal codes that end with “/V42bis” (numeric codes 40 through 51) when it is in “reliable mode” or “auto-reliable mode” and is using V.42 error correction and V.42 bis data compression (ECDC). (If the IM288 is using MNP error correction and MNP 5 data compression instead of V.42 and V.42 bis, it substitutes “/REL COMP” for “/V.42bis” in the verbal code.) If the IM288 has dropped back into normal mode from reliable or auto-reliable mode, it responds with the verbal codes that end with “/NOR” (numeric codes 60 through 71).

Numeric Code	Verbal Code
0	OK
1	CONNECT
2	RING
3	NO CARRIER
4	ERROR
5	CONNECT 1200
6	NO DIAL TONE
7	BUSY
8	NO ANSWER
10	CONNECT 2400
11	CONNECT 4800
12	CONNECT 9600
13	CONNECT 7200
14	CONNECT 19200
15	CONNECT 14400
16	CONNECT 38400
17	CONNECT 57600
18	CONNECT 12000
19	CONNECT 16800
1A	CONNECT 21600
1B	CONNECT 115200

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Numeric Code	Verbal Code
1C	CONNECT 24000
1D	CONNECT 26400
1E	CONNECT 28800
20	CONNECT 300/V42
21	CONNECT 600/V42
22	CONNECT 1200/V42
23	CONNECT 2400/V42
24	CONNECT 4800/V42
25	CONNECT 9600/V42
26	CONNECT 19200/V42
27	CONNECT 7200/V42
28	CONNECT 14400/V42
29	CONNECT 38400/V42
2A	CONNECT 57600/V42
2B	CONNECT 12000/V42
2C	CONNECT 16800/V42
2D	CONNECT 21600/V42
2E	CONNECT 115200/V42
2F	CONNECT 24000/V42
30	CONNECT 26400/V42
31	CONNECT 28800/V42
40	CONNECT 300/V42bis
41	CONNECT 600/V42bis
42	CONNECT 1200/V42bis
43	CONNECT 2400/V42bis
44	CONNECT 4800/V42bis
45	CONNECT 9600/V42bis
46	CONNECT 19200/V42bis
47	CONNECT 7200/V42bis
48	CONNECT 14400/V42bis
49	CONNECT 38400/V42bis
4A	CONNECT 57600/V42bis
4B	CONNECT 12000/V42bis
4C	CONNECT 16800/V42bis
4D	CONNECT 21600/V42bis
4E	CONNECT 115200/V42bis
4F	CONNECT 24000/V42bis
50	CONNECT 26400/V42bis
51	CONNECT 28800/V42bis
60	CONNECT 300/NOR

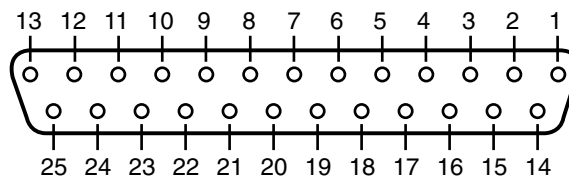
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Numeric Code	Verbal Code
61	CONNECT 600/NOR
62	CONNECT 1200/NOR
63	CONNECT 2400/NOR
64	CONNECT 4800/NOR
65	CONNECT 9600/NOR
66	CONNECT 19200/NOR
67	CONNECT 7200/NOR
68	CONNECT 14400/NOR
69	CONNECT 38400/NOR
6A	CONNECT 57600/NOR
6B	CONNECT 12000/NOR
6C	CONNECT 16800/NOR
6D	CONNECT 21600/NOR
6E	CONNECT 115200/NOR
6F	CONNECT 24000/NOR
70	CONNECT 26400/NOR
71	CONNECT 28800/NOR

Appendix B: The IM288's RS-232 Interface

DB25 Pin	RS-232-C Circuit	V.24 Circuit	Description	Signal Direction
1	AA	101	Protective Ground (PGND)	computer↔modem
2	BA	103	Transmit Data (TD)	computer→modem
3	BB	104	Receive Data (RD)	computer←modem
4	CA	105	Request to Send (RTS)	computer→modem
5	CB	106	Clear to Send (CTS)	computer←modem
6	CC	107	Data Set Ready (DSR)	computer←modem
7	AB	102	Signal Ground (SGND)	computer↔modem
8	CF	109	Rcvd. Ln. Sgnl. Detect (RLSD)*	computer←modem
12	CI	112	Data S. Rate Sel. DCE (DSRSC)*	computer←modem
15	DB	114	Tmit. S. El. Tim. DCE (TSETC)*	computer←modem
17	DD	115	Rcv. S. El. Tim. DCE (RSETC)*	computer←modem
20	CD	108.2	Data Terminal Ready (DTR)	computer→modem
22	CE	125	Ring Indicator (RI)	computer←modem
23	CI	112	Data S. Rate Sel. DCE (DSRSC)*	computer←modem
24	DA	113	Tmit. S. El. Tim. DTE (TSETT)*	computer→modem

*The signals on Pins 8, 12/23, 15, 17, and 24 are often referred to as "Carrier Detect (CD)," "Set Alt. Rate (SAR)," "Transmit Clock (TC)," "Receive Clock (RC)," and "External Clock (EXTC)" respectively.



Appendix C: Dialing Specifications

C.1 Pulse-Dialing Specifications

Pulse-telephone systems in different regions have different specifications for the make/break ratio (what percent of each pulse signal should be on hook vs. off hook), dial-pulse rate (how fast dialing signals should be in pulses per second), and pulse-signal interpretation (which digit corresponds to which number of pulses). The following subsections illustrate these differences.

C.1.1 MAKE/BREAK RATIO

Pulse signals are actually produced by rapidly alternating between the on-hook and off-hook states. The make/break ratio is a measurement of how much of each pulse is spent on hook as opposed to how much is spent off hook. The “AT&P0” command has the Industrial Modem 288 use the 39/61 ratio common in the US and Canada; “AT&P1” has the IM288 use the 33/67 ratio common in some other regions. Table C-1, below, shows the differences between these command options.

Table C-1. Dialing specifications for &P0 and &P1.

Specification	&P0	&P1
Total Dial-Pulse Length	100 ms	100 ms
Make Ratio	39% (39 ms)	33% (33 ms)
Break Ratio	61% (61 ms)	67% (67 ms)
Interdigit Time	789 ms	783 ms

C.1.2 DIAL-PULSE RATE

Pulses can be dialed at different speeds. The Industrial Modem 288 always uses the 10-pulse-per-second (10-pps) speed common in the US, Canada, and elsewhere. It is not compatible with the pulse systems in some regions that expect 20 pulses per second (20 pps); to operate in such regions, the IM288 must use tone-dialing.

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C.1.3 PULSE-SIGNAL INTERPRETATION

Because it is not practical to use “zero pulses” to represent the digit “zero,” phone systems must represent the digits “0” through “9” with one pulse, two pulses, etc., through ten pulses. This has been done in three different ways, as shown in Table C-2 below. The Industrial Modem 288 always uses the Type 1 pulse assignments common in the US and Canada. It is not compatible with Type 2 or Type 3 pulse systems; to operate in regions that use such systems, the IM288 must use tone-dialing.

Table C-2. Numbers of pulses assigned to dialed digits.

Digit Dialed	Number of Pulses		
	Type 1	Type 2	Type 3
0	10	1	10
1	1	2	9
2	2	3	8
3	3	4	7
4	4	5	6
5	5	6	5
6	6	7	4
7	7	8	3
8	8	9	2
9	9	10	1

C.2 Tone-Dialing Specifications

In stark contrast with pulse-dialing, phone systems around the world that support “touchtone” dialing are remarkably uniform. They all use the same DTMF (Dual-Tone Multi-Frequency) sounds in the same way to represent the digits “0” through “9”, the characters “*” and “#”, and (on some phones and systems) the letters “A” through “D”. Table C-3, below, shows how frequencies are combined to represent dialed characters.

Table C-3. Tones assigned to dialed digits.

Low-Group Frequency	High-Group Frequency			
	1209 Hz	1336 Hz	1477 Hz	1633 Hz
697 Hz	1	2	3	A
770 Hz	4	5	5	B
852 Hz	7	8	9	C
941 Hz	*	0	#	D

Although tone duration has no effect on how phone systems interpret touchtones, you might want to change how quickly the Industrial Modem 288 dials them. (Its default value for the duration of each tone plus the interval of silence before the next tone is 95 ms.) You can use the “ATS11=*n*” command to change the duration of the tones the IM288 dials to *n* milliseconds (see **Section A.2**).



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