AT Command Reference Manual for the RC288ACi and RC288ACL Modem Families (Preliminary)

This document is provided electronically for use for the express purpose of assisting software developers and end users answer frequently asked questions about Rockwell modem products.

This manual ONLY describes the GENERIC Rockwell AT command set. Modem vendors often change, add, and delete commands based on their particular product and feature set. Thus this document does not necessarily describe the AT commands used within your modem, even if it is based on Rockwell chipset products. Always consult your modem vendor's documentation first.

Rockwell International
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NOTICE

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1. INTRODUCTION

1.1. OVERVIEW

This manual describes the AT commands for the following Rockwell modem families:

RC288ACi and RC288ACL Modem Families

The descriptions apply to all these modems with any differences between modem product families noted.

1.1.1. Command Syntax

The fundamental DTE interface command syntax is described in Section 2.

1.1.2. Command Descriptions

These commands are grouped into the following categories:

AT commands	Section 3
S-Registers	Section 4
V.25 commands	Section 5
Fax Class 1 commands	Section 6
Fax Class 2 commands	Section 7
Voice/Audio commands	Section 8

The AT commands are implemented in microcontroller (MCU) firmware for specific modem models. The support for a command category is identified by modem model in the modem designer's guide. Additional configuration and implementation information is available in release notes and/or readme files that accompany MCU firmware release.

1.1.3. Call Progress and Blacklisting Parameters

The modem MCU firmware may be provided either in reconfigurable form or preconfigured form. Consult the specific firmware release notes for exact configuration information.

Reconfigurable Form. The modem MCU firmware can be configured for operation in specific countries by the PC-compatible ConfigurACE II program. The call progress and blacklisting parameters described the ConfigurACE II User's Manual can be altered and loaded for a number of countries by this program.

Preconfigured Form. Specific MCU firmware configurations may be released that can be directly installed without requiring the use of ConfigurACE II.

1.1.4. ConfigurACE II

The ConfigurACE II User's Manual describes the use of ConfigurACE II and the country modifiable parameters. Consult any readme files accompanying the ConfigurACE II program for additional or later information.

1.2. REFERENCE DOCUMENTATION

Order No.	Description
MD127	RC288ACi and RC288ACL Modem Data Sheet
1027	RC288ACi and RC288ACL Modem Designer's Guide
893	ConfigurACE II User's Manual

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2. COMMAND SYNTAX

2.1. DTE/DCE INTERCHANGE CIRCUITS

Communication between the DTE and modem is half duplex (i.e., only one entity 'talks' at a time).

2.2. COMMAND SYNTAX AND GUIDELINES

2.2.1. DTE Commands

The ISO 646 character set (CCITT T.50 International Alphabet 5, American Standard Code for Information Interchange) is used for the issuance of commands and responses. Only the low-order 7 bits of each character are used for commands or parameters; the high-order bit is ignored. Upper case characters are equivalent to lower case characters.

2.2.2. DTE Command Lines

A command line is a string of characters sent from a DTE to the DCE while the DCE is in a command state. Command lines have a prefix, a body, and a terminator. The prefix consists of the ASCII characters “AT” (065, 084) or “at” (097, 116). The body is a string of commands restricted to printable ASCII characters (032 - 126). Space characters (ASCII 032) and control characters other than carriage return <CR> (default value = ASCII 013 = 0Dh, see register S3), backspace <BS> (default value = ASCII 008 = 08h, see register S5), and cancel <cntrl-x> (ASCII 024 = 18h) in the command string are ignored. The default terminator is the <CR> character. Characters that precede the AT prefix are ignored.

2.3. AT COMMAND GUIDELINES

Modem operation is controlled by generic AT commands. These AT commands may be basic AT (i.e., commands preceded by AT, AT&, AT%, AT*, AT\, AT), AT-, or AT#), S-Register (e.g., S6=n), Fax class 1 (e.g., +FTM), Fax class 2 (e.g., +FDCS:), or voice (e.g., #VBS) commands. The command syntax and operation guidelines governing each of these command categories are described in subsequent sections.

2.3.1. Basic Command Syntax

Characters within the command line are parsed as commands with associated parameter values. The basic commands consist of single ASCII characters, or single characters preceded by a prefix character, followed by a decimal parameter (e.g., “&D1"). Missing decimal parameters are evaluated as 0.

2.3.2. Extended Command Syntax

The facsimile commands use extended syntax. They are preceded by the “+F” characters, and they are terminated by the semicolon “:” character (ASCII 059) or by the <CR> that terminates the command line.

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3. AT COMMAND SET

3.1. AT COMMAND GUIDELINES

The basic AT commands used to control modem operation are defined in this section. These commands are summarized in Appendix A. All these commands may not be available in a specific product depending upon supported data rates and modes. The default values are typical of a fully configured modem supporting all data rates and options. The actual default value is dependent upon modem firmware as defined by the firmware release notes.

3.1.1. AT Commands, DTE Adaption

Under AT operation, the serial interfaced modem performs an autobaud/autoparity/autolength function on each AT header entered. The autolength/autoparity facility can detect 7- or 8-bit characters of even, odd, or no parity with one stop bit. This is not necessary for the parallel interfaced modem since it has direct access to the UART registers.

3.1.2. AT Command Format

A command line is a string of characters sent from a DTE to the modem (DCE) while the modem is in a command state. A command line has a prefix, a body, and a terminator. Each command line (with the exception of the A/ command) must begin with the character sequence AT and must be terminated by a carriage return. Commands entered in upper case or lower case are accepted, but both the A and T must be of the same case, i.e., "AT" = ASCII 065, 084 or “at” = ASCII 097, 116. The body is a string of commands restricted to printable ASCII characters (032 - 126). Space characters (ASCII 032) and control characters other than CR (ASCII 013) and BS (ASCII 010) in the command string are ignored. The default terminator is the ASCII <CR> character. Characters that precede the AT prefix are ignored. The command line interpretation begins upon receipt of the carriage return character.

Characters within the command line are parsed as commands with associated parameter values. The basic commands consist of single ASCII characters, or single characters preceded by a prefix character (e.g., “&"), followed by a decimal parameter. Missing decimal parameters are evaluated as 0.

The modem supports the editing of command lines by recognizing a backspace character. When modem echo is enabled, the modem responds to receipt of a backspace or delete by echoing a backspace character, a space character, and another backspace. The hex value to be used for the backspace character is programmable through register S5. Values equal to 0 or greater than 127, or the value which corresponds to the carriage return character, cannot be used for the backspace character. This editing is not applicable to the AT header of a command. A command line may be aborted at any time by entering < cntrl-x > (18h).

The AT sequence may be followed by any number of commands in sequence, except for commands such as Z, D, or A. Commands following commands Z, D, or A on the same command line will be ignored. The maximum number of characters on any command line is 39 (including "A" and "T"). If a syntax error is found anywhere in a command line command, the remainder of the line will be ignored and the ERROR result code will be returned.

Most commands entered with parameters out of range will not be accepted and the ERROR response will be returned to the DTE.

Commands will only be accepted by the modem once the previous command has been fully executed, which is normally indicated by the return of an appropriate result code. Execution of commands D and A, either as a result of a direct command or a re-execute command, will be aborted if another character is entered before completion of the handshake.

3.1.3. Escape Code Sequence

When the modem has established a connection and has entered on-line data mode, it is possible to break into the data transmission in order to issue further commands to the modem in an on-line command mode. This is achieved by the DTE sending to the modem a sequence of three ASCII characters specified by register S2. The default character is '+'. The timing of the three characters must comply with specific time constraints. There is a guard time before the first character (the pre-sequence time), a guard time following the third character (the post-sequence time), and a guard time-out between the first and second characters and between the second and third characters (the inter-character time). These times are controlled by the value recorded in register S12.

3.2. AT COMMAND SET

The modem will respond to the commands detailed below. Parameters applicable to each command are listed with the command description. The defaults shown for each configuration command are those used in the Rockwell factory profile 0.

3.2.1. AT Commands

A/ - Re-execute Command

The modem behaves as though the last command line had been re-sent by the DTE. "A/" will repeat all the commands in the command buffer.

The principal application of this command is to place another call (using the Dial command) that failed to connect due to a busy line, no answer, or a wrong number. This command must appear alone on a command line. This command should not be terminated by a carriage return.

AT= x - Write to Selected S-Register

This command writes the value x to the currently selected S-Register. An S-Register can be selected by using the ATSn command. All of the S-Registers will return the OK response if x is a number. Some registers may not be written due to country specific PTT limitations.

Result Codes

OK	For all arguments.

AT? - Read Selected S-Register

This command reads and displays the selected S-Register. An S-Register can be selected by using the ATSn command.

Result Codes:

OK	For all arguments.

A - Answer

The modem will go off-hook and attempt to answer an incoming call if correct conditions are met. Upon successful completion of answer handshake, the modem will go on-line in answer mode. This command may be affected by the state of Line Current Sense, if enabled. (Most countries do not require Line Current Sense.) Operation is also dependent upon +FCLASS command and country-specific requirements.

If +FCLASS=0 is selected, the modem will enter the connect state after exchanging carrier with the remote modem. If no carrier is detected within a period specified in register S7, the modem hangs up. Any character entered during the connect sequence will abort the connection attempt.

If +FCLASS=1 or 2 is selected, the modem will go off-hook in V.21 answer mode. It will generate the V.21 2100 Hz answer tone for 3 ± 0.5 seconds and, following a delay of 70 ms, will proceed as if the +FTH=3 command were issued. At any stage up to (but excluding) the +FTH=3 command state, any character will abort the communication. (See the description of the +FTH command for details.)

Bn - CCITT or Bell

When the modem is configured to allow either option, the modem will select Bell or CCITT modulation for a line speed connection of 300 or 1200 bps according to the parameter supplied. Any other line speed will use a CCITT modulation standard. The parameter value, if valid, is written to S27 bit 6. (Also, see ATFn command.)

B0	Selects CCITT operation at 300 or 1200 bps during Call Establishment and a subsequent connection. (Default for W-class models.)
B1	Selects BELL operation at 300 or 1200 bps during Call Establishment and a subsequent connection. (Default for US models.)

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

Cn - Carrier Control

This command is included for compatibility only, and has no effect other than returning a result code. The only valid parameter is 1.

Result Codes:

OK	n = 1.
ERROR	Otherwise.

Dn - Dial

This command directs the modem to go on-line, dial according to the string entered and attempt to establish a connection. If no dial string is supplied, the modem will go on-line and attempt the handshake in originate mode. In W-class models, the action of going off-hook is affected by the status of the Line Current Sense input, if line current sensing is enabled, and by the blacklist and delayed list. **NOTE:** If the ATD command is issued before the S1 register has cleared, the modem will respond with the NO CARRIER result code.

If +FCLASS=0 is selected, the modem will behave as a data modem and will attempt to connect to another data modem. The modem will have up to the period of time specified by register S6 or S7 to wait for carrier and complete the handshake. If this time expires before the modem can complete the handshake, the modem will go on-hook with the NO CARRIER response. This command will be aborted in progress upon receipt of any DTE character before completion of the handshake.

If +FCLASS=1 or 2 is selected, the modem will behave as a facsimile modem and attempt to connect to a facsimile machine (or modem) by entering the HDLC V.21 channel 2 receive state (as if +FRH=3 had been issued). This command will be aborted upon receipt of any DTE character if the modem has not finished dialing. In this case, the modem will go on-hook and return to command mode after displaying the NO CARRIER message. If the modem has finished dialing, it proceeds as if the +FRH=3 command has been issued. (Refer to the +FRH command to determine how the modem behaves following this stage.)

Dial Modifiers. The valid dial string parameters are described below. Punctuation characters may be used for clarity, with parentheses, hyphen, and spaces being ignored.

0-9	DTMF digits 0 to 9.
*	The 'star' digit (tone dialing only).
#	The 'gate' digit (tone dialing only).
A-D	DTMF digits A, B, C, and D. Some countries may prohibit sending of these digits during dialing.
J	Perform MNP 10 link negotiation at 1200 bps (for this call only). (See *H.)
K	Enable power level adjustment during MNP 10 link negotiation (for this call only). (See)Mn.)
L	Re-dial last number: the modem will re-dial the last valid telephone number. The L must be immediately after the D with all the following characters ignored).
P	Select pulse dialing: pulse dial the numbers that follow until a "T" is encountered. Affects current and subsequent dialing. Some countries prevent changing dialing modes after the first digit is dialed.
T	Select tone dialing: tone dial the numbers that follow until a "P" is encountered. Affects current and subsequent dialing. Some countries prevent changing dialing modes after the first digit is dialed.
R	This command will be accepted, but not acted on.
S=n	Dial the number stored in the directory (n = 0 to 3). (See &Z.)
!	Flash: the modem will go on-hook for a time defined by the value of S29. Country requirements may limit the time imposed.
W	Wait for dial tone: the modem will wait for dial tone before dialing the digits following "W". If dial tone is not detected within the time specified by S7 (US) or S6 (W-class), the modem will abort the rest of the sequence, return on-hook, and generate an error message.

@	Wait for silence: the modem will wait for at least 5 seconds of silence in the call progress frequency band before continuing with the next dial string parameter. If the modem does not detect these 5 seconds of silence before the expiration of the call abort timer (S7), the modem will terminate the call attempt with a NO ANSWER message. If busy detection is enabled, the modem may terminate the call with the BUSY result code. If answer tone arrives during execution of this parameter, the modem handshakes.
&	Wait for credit card dialing tone before continuing with the dial string. If bong is not detected within the time specified by S7 (US models) or S6 (W-class models), the modem will abort the rest of the sequence, return on-hook, and generate an error message.
,	Dial pause: the modem will pause for a time specified by S8 before dialing the digits following ",".
;	Return to command state. Added to the end of a dial string, this causes the modem to return to the command state after it processes the portion of the dial string preceding the ";". This allows the user to issue additional AT commands while remaining off-hook. The additional AT commands may be placed in the original command line following the ";" and/or may be entered on subsequent command lines. The modem will enter call progress only after an additional dial command is issued without the ";" terminator. Use "H" to abort the dial in progress, and go back on-hook.
^	Toggles calling tone enable/disable: applicable to current dial attempt only.
( )	Ignored: may be used to format the dial string.
-	Ignored: may be used to format the dial string.
<space>	Ignored: may be used to format the dial string.
<i>	Invalid character: will be ignored.
>	If enabled by country specific parameter, the modem will generate a grounding pulse on the EARTH relay output.

En - Command Echo

The modem enables or disables the echo of characters to the DTE according to the parameter supplied. The parameter value, if valid, is written to S14 bit 1.

E0	Disables command echo.
E1	Enables command echo. (Default.)

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

Hn - Disconnect (Hang-Up)

This command initiates a hang up sequence.

This command may not be available for some countries due to PTT restrictions.

H0	The modem will release the line if the modem is currently on-line, and will terminate any test (AT&T) that is in progress. Country specific, modulation specific, and error correction protocol specific (S38) processing is handled outside of the H0 command.
H1	If on-hook, the modem will go off-hook and enter command mode. For US models, the modem will remain off-hook. For W-class models, the modem will return on-hook after a period of time determined by S7.

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

In - Identification

The modem reports to the DTE the requested result according to the command parameter.

I0	Reports product code (e.g., "28800").
I1	Reports a precomputed checksum (see firmware release notes).
I2	Reports "OK".
I3	Reports firmware revision (VX.XXX)-model code (A = 64K US, C = 128K US, D = 128K W-Class), interface type (S = serial; P = parallel), and MCU model (39 = L39) (e.g.,"V1.297-CS39").
I4	Reports OEM defined identifier string (e.g., "RC288ACi") in either Hayes-compatible binary format (default) or ASCII format (selectable by ConfigureACE).
I5	Reports Country Code parameter (e.g., "022").
I6	Reports modem data pump model and internal code revision (e.g, RC288DPi Rev CE).
I7	Reports the DAA code resulting from MCU interrogation of the DAA for auto DAA recognition (e.g., 000 for US or Canada, 016 for Japan, 033 for Belgium, 034 for Finland, 035 for France, 037 for Italy, 038 for Netherlands, 039 for Sweden, 040 for Switzerland, and 041 for UK).

Result Codes:

OK	n = 0 to 7.
ERROR	Otherwise.

Ln - Speaker Volume

The modem sets the speaker volume control according to the parameter supplied. The parameter value, if valid, is written to S22 bits 0 and 1.

L0	Low volume.
L1	Low volume. (Default.)
L2	Medium volume.
L3	High volume.

Result Codes:

OK	n = 0 to 3.
ERROR	Otherwise.

Mn - Speaker Control

This command selects when the speaker will be on or off. The parameter value, if valid, is written to S22 bits 2 and 3.

M0	Speaker is always off.
M1	Speaker is on during call establishment, but off when receiving carrier. (Default.)
M2	Speaker is always on.
M3	Speaker is off when receiving carrier and during dialing, but on during answering.

Result Codes:

OK	n = 0 to 3.
ERROR	Otherwise.

Nn - Automode Enable

This command enables or disables automode detection. The parameter value, if valid, is written to S31 bit 1.

N0	Automode detection is disabled (equivalent to setting the +MS <automode> subparameter to 0). A subsequent handshake will be conducted according to the contents of S37 or, if S37 is zero, according to the most recently sensed DTE speed.
N1	Automode detection is enabled (equivalent to setting the +MS <automode> subparameter to 1). A subsequent handshake will be conducted according to the contents of S37 or, if S37 is zero, starting at 28800 bps V.34. (Default.)

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

Notes:

1. The Nn and S37=x commands override the +MS command settings. When the N0 or N1 command is issued, the +MS subparameters are updated to reflect the Nn and S37 values (see +MS command and S37 register). For example:

   N1S37=10 updates the +MS command subparameters to reflect +MS=10,1,300,12000

   N0S37=10 updates the +MS command subparameters to reflect +MS=10,0,12000,12000

2. Use of the +MS command is recommended instead of the Nn and S37=x commands. Nn and S37=x commands are supported for compatibility with existing communication software.

On - Return to On-Line Data Mode

This command determines how the modem will enter the on-line data mode. If the modem is in the on-line command mode, the enters the on-line data mode with or without a retrain. If the modem is in the off-line command mode (no connection), ERROR is reported.

O0	Enters on-line data mode without a retrain. Handling is determined by the Call Establishment task. Generally, if a connection exists, this command connects the DTE back to the remote modem after an escape (+++).
O1	Enters on-line data mode with a retrain before returning to on-line data mode.

Result Codes:

OK	n = 0 or 1 and a connection exists.
ERROR	Otherwise or if not connected.

P - Set Pulse Dial Default

This command forces pulse dialing until the next T dial modifier or T command is received. Sets S14 bit 5.

As soon as a dial command is executed which explicitly specifies the dialing mode for that particular call (e.g., ATDT...), this command is overridden so that all future dialing will be tone dialed. (See T command.)

This command may not be permitted in some countries.

Result Code:

OK

Qn - Quiet Results Codes Control

The command enables or disables the sending of result codes to the DTE according to the parameter supplied. The parameter value, if valid, is written to S14 bit 2.

Q0	Enables result codes to the DTE. (Default.)
Q1	Disables result codes to the DTE.

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

Sn - Read/Write S-Register

The modem selects an S-Register, performs an S-Register read or write function, or reports the value of an S-Register.

n	Establishes S-Register n as the last register accessed.
n=v	Sets S-Register n to the value v.
n?	Reports the value of S-Register n.

The parameter n can be omitted, in which case the last S-Register accessed will be assumed. The S can be omitted for AT= and AT?, in which case the last S-Register accessed will be assumed.

For example:

ATS7 establishes S7 as the last accessed register.

AT=40 sets the contents of the last register accessed to 40.

ATS=20 sets the contents of the last register accessed to 20.

If the number "n" is beyond the range of the S-Registers available, the modem will return the ERROR message. The value "v" is "MOD"ed with 256. If the result is outside the range permitted for a given S-Register the values will still be stored, but functionally the lower and higher limits will be observed. Input and output are always in decimal format. Note that some S-Registers are read-only.

In some cases, writing to the S-Register will appear to be accepted but the value will not actually be written.

Due to country restrictions, some commands will be accepted, but the value may be limited and replaced by a maximum or minimum value.

Minimum, maximum, and default values for S-Registers may be altered with ConfigurACE.

T - Set Tone Dial Default

This command forces DTMF dialing until the next P dial modifier or P command is received. The modem will set an S-Register bit to indicate that all subsequent dialing should be conducted in tone mode. Note that the DP command will override this command. Clears S14 bit 5.

This command may not be permitted in some countries. (See P.)

Result Code:

OK

Vn - Result Code Form

This command selects the sending of short-form or long-form result codes to the DTE. The parameter, if valid, is written to S14 bit 3.

V0	Enables short-form (terse) result codes. Line feed is not issued before a short-form result code.
V1	Enables long-form (verbose) result codes. (Default.)

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

Wn - Connect Message Control

This command controls the format of CONNECT messages. The parameter value, if valid, is written to S31 bits 2 and 3. Note that the Wn command can be overridden by register S95 bits (see S95 description).

W0	Upon connection, the modem reports only the DTE speed (e.g., CONNECT 57600). Subsequent responses are disabled. (Default.)
W1	Upon connection, the modem reports the line speed, the error correction protocol, and the DTE speed, respectively. Subsequent responses are disabled.
W2	Upon connection, the modem reports the DCE speed (e.g., CONNECT 28800). Subsequent responses are disabled.

Result Codes:

OK	n = 0, 1, or 2.
ERROR	Otherwise.

Xn - Extended Result Codes:

This command selects which subset of the result messages will be used by the modem to inform the DTE of the results of commands.

Blind dialing is enabled or disabled by country parameters. If the user wishes to enforce dial tone detection, a "W" can be placed in the dial string (see D command). Note that the information below is based upon the default implementation of the X results table. Table 3-1 indicates the messages which are enabled for each X value.

If the modem is in facsimile mode (+FCLASS=1 or 2), the only message sent to indicate a connection is CONNECT without a speed indication.

X0	Disables monitoring of busy tones unless forced otherwise by country requirements; send only OK, CONNECT, RING, NO CARRIER, ERROR, and NO ANSWER result codes. Blind dialing is enabled/disabled by country parameters. If busy tone detection is enforced and busy tone is detected, NO CARRIER will be reported. If dial tone detection is enforced or selected and dial tone is not detected, NO CARRIER will be reported instead of NO DIAL TONE. The value 000b is written to S22 bits 6, 5, and 4, respectively.
X1	Disables monitoring of busy tones unless forced otherwise by country requirements; send only OK, CONNECT, RING, NO CARRIER, ERROR, NO ANSWER, and CONNECT XXXX (XXXX = rate). Blind dialing enabled/disabled by country parameters. If busy tone detection is enforced and busy tone is detected, NO CARRIER will be reported instead of BUSY. If dial tone detection is enforced or selected and dial tone is not detected, NO CARRIER will be reported instead of NO DIAL TONE. The value 100b is written to S22 bits 6, 5, and 4, respectively.
X2	Disables monitoring of busy tones unless forced otherwise by country requirements; send only OK, CONNECT, RING, NO CARRIER, ERROR, NO DIALTONE, NO ANSWER, and CONNECT XXXX. If busy tone detection is enforced and busy tone is detected, NO CARRIER will be reported instead of BUSY. If dial tone detection is enforced or selected and dial tone is not detected, NO DIAL TONE will be reported instead of NO CARRIER. The value 101b is written to S22 bits 6, 5, and 4, respectively.
X3	Enables monitoring of busy tones; send only OK, CONNECT, RING, NO CARRIER, ERROR, NO ANSWER, and CONNECT XXXX. Blind dialing is enabled/disabled by country parameters. If dial tone detection is enforced and dial tone is not detected, NO CARRIER will be reported. The value 110b is written to S22 bits 6, 5, and 4, respectively.
X4	Enables monitoring of busy tones; send all messages. The value 111b is written to S22 bits 6, 5, and 4, respectively. (Default.)

Result Codes:

OK	n = 0 to 4.
ERROR	Otherwise.

Table 3-1. Result Codes

Short Form	Long Form	n Value in ATXn Command				
		0	1	2	3	4
0	OK	x	x	x	x	x
1	CONNECT	x	x	x	x	x
2	RING	x	x	x	x	x
3	NO CARRIER	x	x	x	x	x
4	ERROR	x	x	x	x	x
5	CONNECT 1200	1	x	x	x	x
6	NO DIALTONE	3	3	x	x	x
7	BUSY	3	3	3	x	x
8	NO ANSWER	x	x	x	x	x
9	CONNECT 0600	1	x	x	x	x
10	CONNECT 2400	1	x	x	x	x
11	CONNECT 4800	1	x	x	x	x
12	CONNECT 9600	1	x	x	x	x
13	CONNECT 7200	1	x	x	x	x
14	CONNECT 12000	1	x	x	x	x
15	CONNECT 14400	1	x	x	x	x
16	CONNECT 19200	1	x	x	x	x
17	CONNECT 38400	1	x	x	x	x
18	CONNECT 57600	1	x	x	x	x
19	CONNECT 115200	1	x	x	x	x
22	CONNECT 75TX/1200RX	1	x	x	x	x
23	CONNECT 1200TX/75RX	1	x	x	x	x
24	DELAYED	4	4	4	4	x
32	BLACKLISTED	4	4	4	4	x
33	FAX	x	x	x	x	x
35	DATA	x	x	x	x	x
40	CARRIER 300	x	x	x	x	x
44	CARRIER 1200/75	x	x	x	x	x
45	CARRIER 75/1200	x	x	x	x	x
46	CARRIER 1200	x	x	x	x	x
47	CARRIER 2400	x	x	x	x	x
48	CARRIER 4800	x	x	x	x	x
49	CARRIER 7200	x	x	x	x	x
50	CARRIER 9600	x	x	x	x	x
51	CARRIER 12000	x	x	x	x	x
52	CARRIER 14400	x	x	x	x	x
53	CARRIER 16800	x	x	x	x	x
54	CARRIER 19200	x	x	x	x	x
55	CARRIER 21600	x	x	x	x	x
56	CARRIER 24000	x	x	x	x	x
57	CARRIER 26400	x	x	x	x	x
58	CARRIER 28800	x	x	x	x	x
59	CONNECT 16800	1	x	x	x	x
61	CONNECT 21600	1	x	x	x	x
62	CONNECT 24000	1	x	x	x	x

Table 3-1. Result Codes (Cont'd)

Short Form	Long Form	n Value in ATXn Command				
		0	1	2	3	4
63	CONNECT 26400	1	x	x	x	x
64	CONNECT 28800	1	x	x	x	x
66	COMPRESSION: CLASS 5	x	x	x	x	x
67	COMPRESSION: V.42 bis	x	x	x	x	x
69	COMPRESSION: NONE	x	x	x	x	x
76	PROTOCOL: NONE	x	x	x	x	x
77	PROTOCOL: LAPM	x	x	x	x	x
80	PROTOCOL: ALT	x	x	x	x	x
81	PROTOCOL: ALT-CELLULAR	x	x	x	x	x
+F4	+FCERROR	x	x	x	x	x

Note: An 'x' in a column indicates that the message (either the long form if verbose, or the value only for short form) will be generated when that particular value of 'n' (shown at the top of the column) has been selected by the use of ATXn. If the column is blank, then no message will be generated for that x option. A numeral indicates which less explicit message (verbose or short form) will be output for that X option. (Also, see Section 3.3).

Yn - Long Space Disconnect

This command enables/disables the generation and response to long space disconnect. The parameter value, if valid, is written to S21 bit 7.

Y0	Disables long space disconnect. (default.)
Y1	Enables long space disconnect. In non-error correction mode, the modem will send a long space of four seconds prior to going on-hook. In error correction mode, the modem will respond to the receipt of a long space (i.e., a break signal greater than 1.6 seconds) by going on-hook.

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

Zn - Soft Reset and Restore Profile

The modem performs a soft reset and restores (recalls) the configuration profile according to the parameter supplied. If no parameter is specified, zero is assumed.

Z0	Soft reset and restore stored profile 0.
Z1	Soft reset and restore stored profile 1.

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

3.2.2. AT& Commands

&Cn - RLSD (DCD) Option

The modem controls the RLSD output in accordance with the parameter supplied. The parameter value, if valid, is written to S21 bit 5.

&C0	RLSD remains ON at all times. (Default.)
&C1	RLSD follows the state of the carrier.

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

&Dn - DTR Option

This command interprets the ON to OFF transition of the DTR signal from the DTE in accordance with the parameter supplied. The parameter value, if valid, is written to S21 bits 3 and 4. Also, see S25.

&D0 - DTR drop is interpreted according to the current &Qn setting as follows: (Default.)

&Q0, &Q5, &Q6	DTR is ignored (assumed ON). Allows operation with DTEs which do not provide DTR.
&Q1, &Q4	DTR drop causes the modem to hang up. Auto-answer is not affected.
&Q2, &Q3	DTR drop causes the modem to hang up. Auto-answer is inhibited.

&D1 DTR drop is interpreted according to the current &Qn setting as follows:

&Q0, &Q1, &Q4, &Q5, &Q6	DTR drop is interpreted by the modem as if the asynchronous escape sequence had been entered. The modem returns to asynchronous command state without disconnecting.
&Q2, &Q3	DTR drop causes the modem to hang up. Auto-answer is inhibited.

&D2 DTR drop is interpreted according to the current &Qn setting as follows:

&Q0 through &Q6	DTR drop causes the modem to hang up. Auto-answer is inhibited.

&D3 DTR drop is interpreted according to the current &Qn setting as follows:

&Q0, &Q1, &Q4, &Q5, &Q6	DTR drop causes the modem to perform a soft reset as if the Z command were received. The &Y setting determines which profile is loaded.
&Q2, &Q3	DTR drop causes the modem to hang up. Auto-answer is inhibited.

If &Q5, &Q6, +FCLASS=1 or +FCLASS=2 is in effect, the action taken is the same as for &Q0.

&Fn - Restore Factory Configuration (Profile)

The modem loads the factory default configuration (profile). The factory defaults are identified for each command and in the S-Register descriptions. A configuration (profile) consists of a subset of S-Registers.

&F0	Restore factory configuration 0.
&F1	Restore factory configuration 1.

Result Codes:

OK	
ERROR	If the modem is connected.

&Gn - Select Guard Tone

The modem generates the guard tone selected by this command according to the parameter supplied (DPSK modulation modes only). The parameter value, if valid, is written to S23 bits 6 and 7.

&G0	Disables guard tone. (Default for US models.)
&G1	Disables guard tone.
&G2	Selects 1800 Hz guard tone. (Default for W-class models.)

This command may not be permitted in some countries.

Result Codes:

OK	n = 0 to 2.
ERROR	Otherwise.

&Jn - Telephone Jack Control

This command is only included for compatibility and performs no function except to load the S-Register. The parameter value, if valid, is written S21 bit 1.

&J0	&J0 command. (Default.)
&J1	&J1 command.

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

&Kn - Flow Control

This command defines the DTE/DCE (terminal/modem) flow control mechanism. The parameter value, if valid, is written to S39 bits 0, 1, and 2.

&K0	Disables flow control.
&K3	Enables RTS/CTS flow control. (Default for data modem modes.)
&K4	Enables XON/XOFF flow control.
&K5	Enables transparent XON/XOFF flow control.
&K6	Enables both RTS/CTS and XON/XOFF flow control. (Default for fax modem and voice modes.)

Result Codes:

OK	n = 0, 3, 4, 5, or 6.
ERROR	Otherwise.

&Ln - Leased Line Operation

This command selects leased or dial-up line operation for compatibility. The OK response is returned for a valid parameter, but no other action is performed. The parameter value, if valid, is written to S27 bit 2.

&L0	Selects dial-up line operation.
&L1	Selects leased line operation.

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

&Mn - Asynchronous/Synchronous Mode Selection

This command determines the DTR operating mode. The modem treats the &M command as a subset of the &Q command.

&M0	Selects direct asynchronous operation. Note that the command sequence &M0\N0 selects normal buffered mode, but the command sequence \N0&M0 selects direct mode. This is because the \N0 command is analogous to the &Q6 command. The value 000b is written to S27 bits 3, 1, and 0, respectively. (See &Q).
&M1	Selects synchronous connect mode with async off-line command mode. The value 001b is written to S27 bits 3, 1, and 0, respectively. (Serial interface operation only.)
&M2	Selects synchronous connect mode with async off-line command mode. Same as &M1 except that &M2 enables DTR dialing of directory slot 0. The modem will disconnect if DTR is OFF for more than the period in S25 (in units of hundredths of a second): the data connection will be synchronous. The value 010b is written to S27 bits 3, 1, and 0, respectively. (Serial interface operation only.)
&M3	Selects synchronous connect mode. This mode allows DTR to act as a talk/data switch. The call is manually initiated while DTR is inactive. When DTR becomes active, the handshake proceeds in originate or answer mode according to S14 bit 7. The value 011b is written to S27 bits 3, 1, and 0, respectively. (Serial interface operation only.)

Result Codes:

OK	n = 0 to 3.
ERROR	Otherwise.

&Pn - Select Pulse Dial Make/Break Ratio

This command determines the make/break ratio used during pulse dialing. It is only effective if the appropriate bit to enable this command is set through the ConfigurACE program. If enabled, it will override the make/break ratios in the OEM parameters in ConfigurACE. The default is country-dependent. The parameter value, if valid, is written to S28 bits 3 and 4.

&P0	Selects 39%-61% make/break ratio at 10 pulses per second. (Default.)
&P1	Selects 33%-67% make/break ratio at 10 pulses per second.
&P2	Selects 39%-61% make/break ratio at 20 pulses per second.
&P3	Selects 33%-67% make/break ratio at 20 pulses per second.

Result Codes:

OK	n = 0 to 3.
ERROR	Otherwise.

&Qn - Sync/Async Mode

This command is an extension of the &M command and is used to control the connection modes permitted. It is used in conjunction with S36 and S48. (Also, see \N.)

NOTE: When the &Q0 to &Q4 command is issued to select the mode, the subsequent connect message will report the DCE speed regardless of the W command and S95 settings.

&Q0	Selects direct asynchronous operation. The value 000b is written to S27 bits 3, 1, and 0, respectively. See &M0.
&Q1	Selects synchronous connect mode with async off-line command mode. The value 001b is written to S27 bits 3, 1, and 0, respectively. See &M1. (Serial interface operation only.)
&Q2	Selects synchronous connect mode with async off-line command modeand enables DTR dialing of directory 0. The value 010b is written to S27 bits 3, 1, and 0, respectively. See &M2. (Serial interface operation only.)
&Q3	Selects synchronous connect mode with async off-line command mode and enables DTR to act as Talk/Data switch. The value 011b is written to S27 bits 3, 1, and 0, respectively. See &M3. (Serial interface operation only.)
&Q4	Selects AutoSync operation. The value 100b is written to S27 bits 3, 1, and 0, respectively. AutoSync operation, when used in conjunction with the Hayes Synchronous Interface (HSI) capability in the DTE, provides synchronous communication capability from an asynchronous terminal. **Starting AutoSync.** Set registers S19, S20, and S25 to the desired values before selecting AutoSync operation with &Q4. After the CONNECT message is issued, the modem waits the period of time specified by S25 before examining DTR. If DTR is on, the modem enters the synchronous operating state; if DTR is off, the modem terminates the line connection and returns to the asynchronous command state. **Stopping AutoSync.** AutoSync operation is stopped upon loss of carrier or the on-to-off transition of DTR. Loss of carrier will cause the modem to return to the asynchronous command state. An on-to-off transition of DTR will cause the modem to return to the asynchronous command state and either not terminate the line connection (&D1 active) or terminate the line connection (any other &Dn command active).
&Q5	The modem will try to negotiate an error-corrected link. The modem can be configured using S36 to determine whether a failure will result in the modem returning on-hook or will result in fallback to an asynchronous connection. The value 101b is written to S27 bits 3, 1, and 0, respectively. (Default.)
&Q6	Selects asynchronous operation in normal mode (speed buffering). The value 110b is written to S27 bits 3, 1, and 0, respectively.

Result Codes:

OK	n = 0 to 6.
ERROR	Otherwise.

&Rn - RTS/CTS Option

This selects how the modem controls CTS. CTS operation is modified if hardware flow control is selected (see &K command). The parameter value, if valid, is written to S21 bit 2.

&R0	In sync mode, CTS tracks the state of RTS; the RTS-to-CTS delay is defined by S26. In async mode, CTS acts according to V.25 bis handshake.
&R1	In sync mode, CTS is always ON (RTS transitions are ignored). In async mode, CTS will only drop if required by flow control. (Default.)

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

&Sn - DSR Override

This command selects how the modem will control DSR. The parameter value, if valid, is written to S21 bit 6.

&S0	DSR will remain ON at all times. (Default.)
&S1	DSR will become active after answer tone has been detected and inactive after the carrier has been lost.

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

&Tn - Test and Diagnostics

The modem will perform selected test and diagnostic functions according to the parameter supplied. A test can be run only when in an asynchronous operation in non-error-correction mode (normal or direct mode). To terminate a test in progress, the escape sequence must be entered first, except for parameters 7 and 8 (see Section 3.1.3). If S18 is non-zero, a test will terminate automatically after the time specified by S18 and display the OK message.

&T0	Terminates test in progress. Clears S16.
&T1	Initiates local analog loopback, V.54 Loop 3. Sets S16 bit 0. If a connection exists when this command is issued, the modem hangs up. The CONNECT XXXX message is displayed upon the start of the test.
&T2	Returns ERROR.
&T3	Initiates local digital loopback, V.54 Loop 2. Sets S16 bit 2. If no connection exists, ERROR is returned. Sets S16 bit 4 when the test is in progress.
&T4	Enables digital loopback acknowledgment for remote request, i.e., an RDL request from a remote modem is allowed. Sets S23 bit 0. (Default.)
&T5	Disables digital loopback acknowledgment for remote request, i.e., an RDL request from a remote modem is denied. Clears S23 bit 0.
&T6	Requests a remote digital loopback (RDL), V.54 Loop 2, without self test. If no connection exists, ERROR is returned. Sets S16 bit 4 when the test is in progress. The CONNECT XXXX message is displayed upon the start of the test.
&T7	Requests a remote digital loopback (RDL),V.54 Loop 2, with self test. (In self test, a test pattern is looped back and checked by the modem.) If no connection exists, ERROR is returned. When the test is terminated either via expiration of S18, or via the &T0 or H command, the number of detected errors is reported to the DTE. Sets S16 bit 5 when the test is in progress.
&T8	Initiates local analog loopback, V.54 Loop 3, with self test. (In self test, a test pattern is looped back and checked by the modem.) If a connection exists, the modem hangs up before the test is initiated. When the test is terminated either via expiration of S18, or via the &T0 or H command, the number of detected errors is reported to the DTE. Sets S16 bit 6 when the test is in progress. This command may not be available in some countries due to PTT restrictions.

&V - Display Current Configuration and Stored Profiles

Reports the current (active) configuration, the stored (user) profiles, and the first four stored telephone numbers. The stored profiles and telephone numbers are not displayed if the NVRAM is not installed or is not operational as detected by the NVRAM test during reset processing.

Result Code:

OK

Example:

```
AT&V
ACTIVE PROFILE:
B0 E1 L1 M1 N1 QO T V1 W0 X4 Y0 &C0 &D0 &G2 &J0 &K3 &Q5 &R1 &S0 &T4 &X0 &Y0
S00:002 S01:000 S02:043 S03:013 S04:010 S05:008 S06:002 S07:030 S08:002 S09:006
S10:014 S11:255 S12:050 S18:000 S25:005 S26:001 S36:007 S37:000 S38:020 S46:138
S48:007 S95:000

STORED PROFILE 0:
B0 E1 L1 M1 N1 QO T V1 W0 X4 Y0 &C0 &D0 &G2 &J0 &K3 &Q5 &R1 &S0 &T4 &X0
S00:002 S02:043 S06:002 S07:030 S08:002 S09:006 S10:014 S11:095 S12:050 S18:000
S36:007 S37:000 S40:105 S41:003 S46:138 S95:000

STORED PROFILE 1:
B0 E1 L1 M1 N1 QO T V1 W0 X4 Y0 &C0 &D0 &G2 &J0 &K3 &Q5 &R1 &S0 &T4 &X0
S00:002 S02:043 S06:002 S07:030 S08:002 S09:006 S10:014 S11:095 S12:050 S18:000
S36:007 S37:000 S40:105 S41:003 S46:138 S95:000

TELEPHONE NUMBERS:
0 =                                                 1 =
2 =                                                 3 =

OK
```

If the NVRAM is not installed or is not operational as detected by the NVRAM test, the following message is displayed:

```
NVRAM FAILED OR NOT INSTALLED
```

&Wn - Store Current Configuration

Saves the current (active) configuration (profile), including S-Registers, in one of the two user profiles in NVRAM as denoted by the parameter value. This command will yield an ERROR message if the NVRAM is not installed or is not operational as detected by the NVRAM test.

The current configuration is comprised of a list of storable parameters illustrated in the &V command. These settings are restored to the active configuration upon receiving an Zn command or at power up (see &Yn command).

&W0	Store the current configuration as profile 0.
&W1	Store the current configuration as profile 1.

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

&Xn - Select Synchronous Clock Source

Selects the source of the transmit clock for the synchronous mode of operation. The parameter value, if valid, is written to S27 bits 4 and 5.

In asynchronous mode, the transmit and receive clocks are turned OFF. In synchronous mode, the clocks are turned ON with the frequency of 1200 Hz or faster corresponding to the speed that is selected for modem operation.

&X0	Selects internal timing. The modem generates the transmit clock signal and applies it to the TXCLK output at the serial interface.
&X1	Selects external timing. The local DTE sources the transmit clock signal on the XTCLK input of the serial interface. The modem applies this clock to the TXCLK output at the serial interface.
&X2	Selects slave receive timing. The modem derives the transmit clock signal from the incoming carrier and applies it to the TXCLK output at the serial interface.

Result Codes:

OK	n = 0 to 2.
ERROR	Otherwise.

&Yn - Designate a Default Reset Profile

Selects which user profile will be used after a hard reset.

&Y0	The modem will use profile 0.
&Y1	The modem will use profile 1.

Result Codes:

OK	n = 0 to 1.
ERROR	If n > 1, or if NVRAM is not installed or is not operational.

&Zn=x - Store Telephone Number

The modem can store up to four telephone numbers and each telephone number dial string can contain up to 35 digits.

&Zn=x	n = 0 to 3 and x = dial string. (Requires 256-byte NVRAM.)

Result Codes:

OK	For n ≤ 3, and x ≤ 35 digits.
ERROR	If n > 3, x > 35 digits, or if NVRAM is not installed or is not operational.

3.2.3. AT% Commands

%En - Enable/Disable Line Quality Monitor and Auto-Retrain or Fallback/Fall Forward

Controls whether or not the modem will automatically monitor the line quality and request a retrain (%E1) or fall back when line quality is insufficient or fall forward when line quality is sufficient (%E2). The parameter value, if valid, is written to S41 bits 2 and 6.

If enabled, the modem attempts to retrain for a maximum of 30 seconds.

%E0	Disable line quality monitor and auto-retrain.
%E1	Enable line quality monitor and auto-retrain.
%E2	Enable line quality monitor and fallback/fall forward. (Default.)

Result Codes:

OK	n = 0, 1, or 2.
ERROR	Otherwise.

Fallback/Fall Forward. When %E2 is active, the modem monitors the line quality (EQM). When line quality is insufficient, the modem will initiate a rate renegotiation to a lower speed within the V.34/V.FC,V.32 bis/V.32 modulation speeds. The modem will keep falling back within the current modulation if necessary until the speed reaches 2400 bps (V.34), 14400 bps (V.FC), or 4800 bps (V.32). Below this rate, the modem will only do retrains if EQM thresholds are exceeded. If the EQM is sufficient for at least one minute, the modem will initiate a rate renegotiation to a higher speed within the current modulation speeds. The rate renegotiations will be done without a retrain if a V.32bis connection is established.

Speeds attempted during fallback/fall forward are those shown to be available in the rate sequences exchanged during the initial connection. Fallback/fall forward is available in error correction and normal modes, but not in direct mode or synchronous mode with external clocks.

%L - Line Signal Level

Returns a value which indicates the received signal level. The value returned is a direct indication (DAA dependent) of the receive level at the MDP, **not** at the telephone line connector. For example, 009 = -9 dBm, 043 = -43 dBm, and so on.

Result Codes:

OK

%Q - Line Signal Quality

Reports the line signal quality (DAA dependent). Returns the higher order byte of the EQM value. Based on the EQM value, retrain or fallback/fall forward may be initiated if enabled by %E1 or %E2.

Example:

```
AT%Q

015
```

Result Codes:

OK	If connected.
ERROR	If not connected, or connected in 300 bps, V.23, or fax modes.

%T - PTT Testing Utilities

Facilitates PTT testing of signal levels by providing continuous signals regardless of whether the modem is connected or not. The signal transmitted is in accordance with the parameter provided.

This is a range of commands that allow the user to initiate a series of signals that are necessary for PTT approval. The signals emitted include answer tone, modulation, carriers, and other pertinent signals. A test is initiated upon receipt of an %TTn (the second T is a password and n is a test number), and the test is aborted when any keyboard character is entered. The modem will continuously transmit the tone or carrier according to the parameter supplied.

%TT00-%TT09	DTMF tone dial digits 0 to 9.
%TT0A	DTMF digit *.
%TT0B	DTMF digit #.
%TT0C	DTMF digit A.
%TT0D	DTMF digit B.
%TT0E	DTMF digit C.
%TT0F	DTMF digit D.
%TT10	V.21 channel 1 mark (originate) symbol.
%TT11	V.21 channel 2 mark symbol.
%TT12	V.23 backward channel mark symbol.
%TT13	V.23 forward channel mark symbol.
%TT15	V.22 originate (call mark) signalling at 1200 bps.
%TT16	V.22 bis originate (call mark) signalling at 2400 bps.
%TT17	V.22 answer signalling (guard tone if PTT required).
%TT18	V.22 bis answer signalling (guard tone if required).
%TT19	V.21 channel 1 space symbol.
%TT1A	V.21 channel 2 space symbol.
%TT1B	V.23 backward channel space symbol.
%TT1C	V.23 forward channel space symbol.
%TT20	V.32 9600 bps.
%TT21	V.32 bis 14400 bps.
%TT30	Silence (on-line), i.e., go off-hook.
%TT31	V.25 answer tone.
%TT32	1800 Hz guard tone.
%TT33	V.25 calling tone (1300 Hz).
%TT34	Fax calling tone (1100 Hz).
%TT40	V.21 channel 2
%TT41	V.27 ter 2400 bps
%TT42	V.27 ter 4800 bps
%TT43	V.29 7200 bps
%TT44	V.29 9600 bps
%TT45	V.17 7200 bps long train
%TT46	V.17 7200 bps short train
%TT47	V.17 9600 bps long train
%TT48	V.17 9600 bps short train
%TT49	V.17 12000 bps long train
%TT4A	V.17 12000 bps short train
%TT4B	V.17 14400 bps long train
%TT4C	V.17 14400 bps short train
%TT5R,S,C,A,P	V.FC modulation, where the R, S, C, A, and P parameters are:

Parameter	Description	Default	V.FC Range	V.FC Parameter
R	Data Rate	-	6-Ch	CONF (+ 41h)
S	Symbol Rate	0 (2400 baud)	0-5 (mask)	Fn60, Addr 101
C	Carrier Offset	0	±n*5Hz	Fn59, Addr 212
A	Aux Channel	0	0/1	SECEN
P	Pre-Emphasis	0	0-15	Fn63, Addr 0E6

Notes:

1. If a parameter is omitted, it will assume its default value. No special error or bounds checking will be done. (For example, a symbol rate mask of 02 is illegal for the RC288DPi/VFC but will not be checked). The user is expected to select meaningful combinations of parameters.
2. Transmit level deviation is disabled.

3.2.4. AT\ Commands

\Kn - Break Control

Controls the response of the modem to a break received from the DTE or the remote modem or the \B command according to the parameter supplied. The parameter value, if valid, is written to S40 bits 3, 4, and 5.

The response is different in three separate states.

The first state is where the modem receives a break from the DTE when the modem is operating in data transfer mode:

\K0	Enter on-line command mode, no break sent to the remote modem.
\K1	Clear data buffers and send break to remote modem.
\K2	Same as 0.
\K3	Send break to remote modem immediately.
\K4	Same as 0.
\K5	Send break to remote modem in sequence with transmitted data. (Default.)

The second case is where the modem is in the on-line command state (waiting for AT commands) during a data connection, and the \B is received in order to send a break to the remote modem:

\K0	Clear data buffers and send break to remote modem.
\K1	Clear data buffers and send break to remote modem. (Same as 0.)
\K2	Send break to remote modem immediately.
\K3	Send break to remote modem immediately. (Same as 2.)
\K4	Send break to remote modem in sequence with data.
\K5	Send break to remote modem in sequence with data. (Same as 4.) (Default.)

The third case is where a break is received from a remote modem during a non-error corrected connection:

\K0	Clears data buffers and sends break to the DTE.
\K1	Clears data buffers and sends break to the DTE. (Same as 0.)
\K2	Send a break immediately to DTE.
\K3	Send a break immediately to DTE. (Same as 2.)
\K4	Send a break in sequence with received data to DTE.
\K5	Send a break in sequence with received data to DTE. (Same as 4.) (Default.)

Result Codes:

OK	n = 0 to 5.
ERROR	Otherwise.

\Nn - Operating Mode

This command controls the preferred error correcting mode to be negotiated in a subsequent data connection. This command is affected by the OEM firmware configuration.

\N0	Selects normal speed buffered mode (disables error-correction mode). (Forces &Q6.)
\N1	Serial interface selected - Selects direct mode and is equivalent to &M0, &Q0 mode of operation. (Forces &Q0.)
	Parallel interface selected - Same as \N0.
\N2	Selects reliable (error-correction) mode. The modem will first attempt a LAPM connection and then an MNP connection. Failure to make a reliable connection results in the modem hanging up. (Forces &Q5, S36=4, and S48=7.)
\N3	Selects auto reliable mode. This operates the same as \N2 except failure to make a reliable connection results in the modem falling back to the speed buffered normal mode. (Forces &Q5, S36=7, and S48=7.)
\N4	Selects LAPM error-correction mode. Failure to make an LAPM error-correction connection results in the modem hanging up. (Forces &Q5 and S48=0.) Note: The -K1 command can override the \N4 command.
\N5	Selects MNP error-correction mode. Failure to make an MNP error-correction connection results in the modem hanging up. (Forces &Q5, S36=4, and S48=128.)

Result Codes:

OK	n = 0 to 5.
ERROR	Otherwise.

3.2.5. AT+ Commands

+MS - Select Modulation

This extended-format command selects the modulation, optionally enables or disables automode, and optionally specifies the lowest and highest connection rates using one to four subparameters.The command format is:

+MS= <mod> [,[<automode>][,[<min_rate>][,[<max_rate>]]]]<CR>

Notes:

1. For 14400 bps and lower speeds, the Nn command and S37 register can alternatively be used, in which case the +MS subparameters will modified to reflect the Nn and S37=x settings. Use of the Nn and S37=x commands is not recommended but is provided for compatibility with existing communication software. (S37 is not updated by the +MS command.)
2. Subparameters not entered (enter a comma only or <CR> to skip the last subparameter) remain at their current values.

Reporting Selected Options

The modem can send a string of information to the DTE consisting of selected options using the following command:

+MS?

The response is:

+MS: <mod>,<automode>,<min_rate>,<max_rate>

For example,

+MS: 11,1,300,28800 (shows default values)

Reporting Supported Options

The modem can send a string of information to the DTE consisting of supported options using the following command:

+MS=?

The response is:

+MS: (list of supported <mod> values), (list of supported <automode> values) (list of supported <min_rate> values), (list of supported <max_rate> values)

For example,

+MS: (0, 1, 2, 3, 8, 9, 10, 13, 64, 69, 74), (0,1) (300-28800), (300-28800)

Subparameter Definitions

1. <mod> = A decimal number which specifies the preferred modulation (automode enabled) or the modulation (automode disabled) to use in originating or answering a connection. The options are:

<mod>	Modulation	Possible Rates (bps) [1]	Notes
0	V.21	300	
1	V.22	1200	
2	V.22 bis	2400 or 1200	
3	V.23	1200	See Note 2
9	V.32	9600 or 4800	
10	V.32 bis	14400, 12000, 9600, 7200, or 4800	
11	V.34	28800, 26400, 24000, 21600, 19200, 16800, 14400, 12000, 9600, 7200, 4800, or 2400	Default
64	Bell 103	300	
69	Bell 212	1200	
74	V.FC	28800, 26400, 24000, 21600, 19200, 16800, or 14400	

Notes:

1. See optional <automode>, <min_rate>, and <max_rate> subparameters.
2. For V.23, originating modes transmit at 75 bps and receive at 1200 bps; answering modes transmit at 1200 bps and receive at 75 bps. The rate is always specified as 1200 bps.

The modem may also automatically switch to another modulation (automode), subject to the following constraints:

a. The modem may not be able to automatically switch from the current modulation (specified by <mod>) to some other modulation. For example, there is no standard way to automode from Bell 103 to V.23.

b. The DTE may disable automode operation (see <automode> below).

c. The DTE may constrain the range of modulations available by specifying the lowest and highest rates (see <min_rate> and <max_rate> below).

2. <automode> is an optional numeric value which enables or disables automatic modulation negotiation using V.8 or V.32 bis Annex A. The options are:

<automode>	Option Selected	Notes
0	Automode disabled	
1	Automode enabled using V.8 or V.32 Annex A	Default

The default value is 1, which enables automode. Note, however, there are modulations for which there is no automatic negotiation, e.g., Bell 212 (<mod> = 69).

For <automode> = 0 (automode disabled, i.e., fixed modulation):

a. If <max_rate> is within the rates supported by the selected modulation, the selected rate is that specified by <max_rate>. For example:

+MS=9,0,1200,4800 selects V.32 4800 bps fixed rate.

b. If <max_rate> is greater than the highest speed supported by the modulation specified by <mod>, the starting rate is the highest rate supported by the selected modulation. For example:

+MS=9,0,2400,14400 selects V.32 9600 or 4800 bps.

c. To emulate issuance of the N0S37=x command sequence to select fixed mode operation, specify the <max_rate> and <min_rate> both to be the (same) requested speed, and <mod> to be the modulation for that speed. For example:

+MS=11,0,16800,16800 selects V.34 16800 bps fixed mode (no comparable S37 command).

+MS=9,0,12000,12000 selects V.32 bis 12000 bps fixed mode (same as N0S37=10).

For <automode> = 1 (automode enabled, i.e., automatically selected speed and modulation):

The modem connects at the highest possible rate in accordance with V.8, or V.32 bis Annex A if V.8 is not supported by the remote modem.

a. If <max_rate> is greater than the highest rate supported by the modulation specified by <mod>, the modem automodes down from the highest rate of the selected modulation. For example:

+MS=10,1,1200,24000 selects automoding down from V.32 bis 14400 bps.

b. To emulate issuance of the N1S37=x sequence command, specify the modulation and the rate to start automoding down from using <mod> and <max_rate>, respectively. Set <min_rate> to 300 to allow automoding all the way down to V.21 300 bps. For example:

+MS=11,1,300,16800 selects automode starting at V.34 16800 bps (no comparable S37 command).

+MS=9,1,300,12000 selects automode starting at V.32 bis 12000 bps (same as N1S37=10).

3. <min_rate> is an optional number which specifies the lowest rate at which the modem may establish a connection. The value is decimal coded, in units of bps, e.g., 2400 specifies the lowest rate to be 2400 bps. The default is 300 for 300 bps.

4. <max_rate> is an optional number which specifies the highest rate at which the modem may establish a connection. The value is decimal coded, in units of bps, e.g., 14400 specifies the highest rate to be 14400 bps. The default is 28800 for 28800 bps.

3.2.6. AT** Command

**** - Download to Flash Memory**

The flash memory downloader in the MCU firmware allows flash memory (e.g., ATMEL AT29C010 or compatible device) connected to the MCU memory external bus to be upgraded with revised MCU firmware. This process transfers (uploads) the upgrade program from the host computer to the MCU which transfers (downloads) the data to the flash memory device. Note that this flash memory downloader function must be provided in RC288ACi/VFC or RC288ACL/VFC firmware initially installed in external flash memory if it is not resident in the MCU internal ROM.

The following sequence describes the flash download process:

a. Initiate the download process using the AT**n command, where:

    AT**0 = Download speed is the last sensed speed.

    AT**1 = Download speed is 38.4k bps.

    AT**2 = Download speed is 57.6k bps.

    The "Download initiated" message appears upon issuing the AT**n command.

b. Perform an ASCII upload of the new hex file from the host computer to the modem using an industry standard communications software or an equivalent process. Ensure that ASCII transmit pacing is disabled in the communications package. Note that a flash download capability must be contained in the new download code to enable subsequent flash downloads.

c. A "Device successfully programmed" message is displayed at the completion of a successful download.

d. A "Wrong Device" messages is displayed if an incorrect device is used (e.g., a non-ATMEL AT29C010 compatible device). In this case, turn modem power off, replace the memory device with an ATMEL AT29C010 or compatible device (preprogrammed with the modem firmware object code if the flash downloader is not resident in the MCU internal ROM), power up the modem, and reinitiate the download at step a.

e. A "Wrong Hex file or flow control" message is displayed if an incompatible hex file format is used (non-Motorola S3 format) or if the DTE ignores flow control (the flash download uses both Xon/Xoff and RTS/CTS flow control). If the wrong format was used, reinitiate the download at step a and upload a correctly formatted file in step b. If the DTE ignores flow control, re configure the DTE to support flow control and reinitiate the download at step a.

f. If the download fails to complete (e.g., due to flash memory not responding correctly), initiate a modem power on reset. Upon modem reset completion, the downloader will automatically be restarted using a default download speed of 9600 bps.

3.3. ERROR DETECTION AND DATA COMPRESSION COMMANDS

3.3.1. AT% Commands

%C - Enable/Disable Data Compression

Enables or disables data compression negotiation. The modem can only perform data compression on an error corrected link. The parameter value, if valid, is written to S41 bits 0 and 1.

%C0	Disables data compression. Resets S46 bit 1.
%C1	Enables MNP 5 data compression negotiation. Resets S46 bit 1.
%C2	Enables V.42 bis data compression. Sets S46 bit 1.
%C3	Enables both V.42 bis and MNP 5 data compression. Sets S46 bit 1. (Default.)

Result Codes:

OK	n = 0, 1, 2, or 3.
ERROR	Otherwise.

3.3.2. AT\ Commands

\An - Select Maximum MNP Block Size

The modem will operate an MNP error corrected link using a maximum block size controlled by the parameter supplied. The parameter value, if valid, is written to S40 bits 6 and 7.

\A0	64 characters.
\A1	128 characters. (Default.)
\A2	192 characters.
\A3	256 characters.

Result Codes:

OK	n = 0 to 3.
ERROR	Otherwise.

\Bn - Transmit Break to Remote

In non-error correction mode, the modem will transmit a break signal to the remote modem with a length in multiples of 100 ms according to parameter specified. If a number in excess of 9 is entered, 9 is used. The command works in conjunction with the \K command.

In error correction mode, the modem will signal a break through the active error correction protocol, giving no indication of the length.

\B1-\B9	Break length in 100 ms units. (Default = 3.) (Non-error corrected mode only.)

Result Codes:

OK	If connected in data modem mode.
NO CARRIER	If not connected or connected in fax modem mode.

Note: When the modem receives a break from the remote modem, break is passed to the DTE as follows: In non-error correction mode direct, the break length is passed; in non-error correction mode normal and in error correction mode, a 300 ms break is passed.

3.4. MNP 10 COMMANDS

)Mn - Enable Cellular Power Level Adjustment

Enables or disables automatic adjustment of the transmit power level to accommodate the signalling requirements of cellular telephone equipment. The parameter value, if valid, is written to S40 bit 2.

)M0	Disables transmit power level adjustment during MNP 10 link negotiation. The)M0 command allows transmit power adjustment if cellular operation is requested by the remote modem. Uses wireline power level for initial cellular connection. (Default.)
)M1	Enables transmit power level adjustment during MNP 10 link negotiation. Uses the @Mn value to establish initial cellular connection. After connection, the optimal power level is determined by the modem. **NOTE:**)M1 should not be used with *H2.
)M2	Enables transmit power level adjustment during MNP 10 link negotiation. Uses the @Mn value to establish initial cellular connection. After connection, the power level remains fixed.

Result Codes:

OK	n = 0 to 2.
ERROR	Otherwise.

Notes:

1. For both cellular and land based modems in both originate or answer modes, if either)M1 or)M2 is set, the transmit power level used for non-MNP10 or fax connections is the @Mn value.

*Hn - Link Negotiation Speed

This command controls the connection speed for link negotiations before upshift occurs between two MNP 10 modems. The parameter value, if valid, is written to S28 bits 6 and 7.

*H0	Link negotiation occurs at the highest supported speed. (Default.)
*H1	Link negotiation occurs at 1200 bps; used primarily for establishing cellular connections.
*H2	Link negotiation occurs at 4800 bps; used primarily to negotiate an MNP 10 connection on less than average quality telephone lines

Result Codes:

OK	n = 0 to 2.
ERROR	Otherwise.

-Kn - MNP Extended Services

Enables or disables conversion of a V.42 LAPM connection to an MNP 10 connection. The parameter value, if valid, is written to S40 bits 0 and 1.

-K0	Disables V.42 LAPM to MNP 10 conversion.
-K1	Enables V.42 LAPM to MNP 10 conversion. (Default.)
-K2	Enables V.42 LAPM to MNP 10 conversion; inhibits MNP Extended Services initiation during V.42 LAPM answer mode detection phase.

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

-Qn - Enable Fallback to V.22 bis/V.22

Enables or disables fallback from MNP 10 to V.22 bis/V.22. The parameter value, if valid, is written to S41 bit 7.

-Q0	Disables fallback to 2400 bps (V.22bis) and 1200 bps (V.22). Fallback is enabled only to 4800 bps.
-Q1	Enables fallback to 2400 bps (V.22bis) and 1200 bps (V.22). (Default.)

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

@Mn - Initial Cellular Power Level Setting

Sets the initial transmit power level for upshift at connect until line conditions can be determined. @M0 corresponds to -26 dBm, @M1 corresponds to -30 dBm, @M2 through @M10 correspond to -10 dBm, and @M11 through @M31 correspond to -11 dBm to -31 dBm, respectively. The parameter value, if valid, is written to S201 bits 0-4.

@M0	-26 dBm (Default.)
@M1	-30 dBm
@M2	-10 dBm
@M3 - @M10	-10 dBm
@M11	-11 dBm
@M12	-12 dBm
.	
.	
.	
@M30	-30 dBm
@M31	-31 dBm

Result Codes:

OK	n = 0 to 31.
ERROR	Otherwise.

:E - Compromise Equalizer Enable Command

Enables or disables the V.32 compromise equalizer. The parameter value, if valid, is written to S201 bit 5. This command can be used when the modem is attached to either a flat line or a cellular connection.

:E0	Disables the equalizer
:E1	Enables the equalizer (Default.)

Result Codes:

OK	n = 0 or 1.
ERROR	Otherwise.

3.5. W-CLASS COMMANDS

3.5.1. AT* Commands

***B - Display Blacklisted Numbers**

This command requests the modem to return a list of blacklisted numbers to the DTE. The format of the response is shown by the example below. Permanently forbidden numbers as defined by country requirements will not appear on this list. If no numbers are blacklisted, only the OK result code is issued.

Example:

```
NO. - PHONE NUMBER -

------ ------------------------------

1;      4175537660
2;      8288924961
3;      3887278862
4;      3124839442
5;      6284664


OK
```

***D - Display Delayed Numbers**

This command causes the modem to send a list of the delayed numbers together with the delay associated with each. The modem will return a list of delayed telephone numbers as defined in the *B command. The format of the response is shown by the example below (delay times are shown as hours:minutes:seconds). If no numbers are delayed, only the OK result code is issued.

Example:

```
NO. - PHONE NUMBER -DELAY

------ -------------------------------------------

1;      8264734660      2:00:00
2;      7532634661      2:00:00
3;      2587334662      0:02:00
4;      7532651663      0:03:25
5;      7459931664      0:01:45


OK
```

***NCnn - Country Select**

Up to 20 sets of country parameters may be stored in the EPROM. This command checks to see if the entered number matches the country code of one of the countries stored in the EPROM. If found, the modem stores the location of that country in NVRAM. Upon power up or a soft reset (Z command), the modem uses this location to load the parameters for the corresponding country. The default value of zero is used if no NVRAM is installed or the NVRAM failed self test during reset.

Note: Automatic DAA country code recognition is enabled by the NC0 command (the 0 country code is reserved for this function). Automatic DAA country code recognition is disabled by the NCnn command selecting any other valid country code.

*NCnn   Select country parameters corresponding to entered country code (nn). The country codes are:

Country	Code (nn)
Australia	40
Austria	1
Belgium	2
Bulgaria	27
Canada	20
Czech Republic	19
Denmark	3
Finland	4
France	5
Germany	6
Greece	17
Hungary	23
Ireland	7
Israel	18
Italy	8
Japan	43
Luxembourg	9
Mexico	21
Netherlands	10
New Zealand	48
Norway	11
Poland	24
Portugal	12
Russia	25
Singapore	47
Slovac Republic	26
Spain	13
Sweden	14
Switzerland	15
United Kingdom	16
United States	22

Result Codes:

OK	If parameters corresponding to entered country code are present in EPROM.
ERROR	Otherwise.

3.6. CALLER ID COMMANDS

3.6.1. AT#CID Command

#CIDn - Caller ID

Enables or disables Caller ID.

#CID=0	Disables Caller ID. (Default.)
#CID=1	Enables Caller ID with formatted presentation to the DTE. The modem will present the data items in a <Tag><Value> pair format. The expected pairs are data, time, caller code (telephone number), and name.
#CID=2	Enables Caller ID with unformatted presentation to the DTE. The modem will present the entire packet of information, excluding the leading U's, in ASCII printable hex numbers.

Result Codes:

OK	n = 0 or 2.
ERROR	Otherwise.

Inquiries

#CID?	Retrieves the current Caller ID mode from the modem.
#CID=?	Returns the mode capabilities of the modem in a list with each element separated by commas.

Formatted Form Reporting

The modem presents the data in the <tag> = <value> pair format as described in the table below. Spaces are present on both sides of the equal sign.

Tag	Description
DATE	DATE = MMDD where MM is the month number (01 to 12) and DD is the day number (01..31).
TIME	TIME = HHMM where HH is the hour number (00 to 23) and MM is the minute number (00 to 59).
NMBR	NMBR = <number> or P or O where <number> is the telephone number of the caller, where P indicates that the calling number information is not available since the originating caller has requested private service, and where O indicates that the calling number information is not available or out of service at the calling location.
NAME	NAME = <listing name> where <listing name> is the subscription name.
MESG	MESG = <data tag> <length of message> <data> <checksum> in printable ASCII hex numbers. This tag indicates a data item not listed above. The message is only possible for Multiple Message Format.

Notes:

1. The modem does not present any Caller ID information if the DCE detects a checksum error in the Caller ID packet.
2. In the event of an unrecognized data tag, the modem will present the data in ASCII hex numbers following the MESG tag.

Example of Formatted Form Reporting

1. The following example illustrates the standard Caller ID message packet.

```
RING

DATE   =  0321
TIME   =  1405
NMBR   =  5045551234
NAME   =  A N OTHER

RING

RING
```

2. The following example illustrates the case where the tag of the packet is not recognized by the modem.

```
RING

MESG   =  060342424231

RING

RING
```

Unformatted Form Reporting

The modem presents all information and packet control information found in the message. The modem, however, excludes the leading U's (channel seizure information) from the presentation. The packet is presented in ASCII printable hex numbers, the modem does not insert spaces, or line feeds, for formatting between bytes or words of the packet.

The modem does not detect the checksum of the packet.

Example of Unformatted Form Reporting

```
RING

0412303332323234303539313435353132333435

RING

RING
```

3.7. AT COMMAND RESULT CODES

The modem responds to commands from the DTE and to activity on the line by signalling to the DTE in the form of result codes. The result codes that the modem can send are described below.

Two forms of each result code are available: long-form, an English-like "verbose" response, and short-form, a data-like numeric response (included in parentheses following the long-form). The long-form code is preceded and terminated by the sequence < CR> < LF>. The short-form is terminated by < CR>, only with no preceding sequence.

If result messages are suppressed, nothing is returned to the DTE. The long-form results codes can be modified by the OEM through the ConfigurACE Configuration Utility Program. (See ConfigurACE description.)

0- OK

The OK code is returned by the modem to acknowledge execution of a command line.

1- CONNECT

The modem will send this result code upon connecting when:

1. The line speed is 300 bps and the modem has been instructed to report the line speed to the DTE upon connecting, or
2. The DTE speed is 300 bps and the modem has been instructed to report the DTE speed to the DTE upon connecting, or
3. The range of result code responses is restricted by the X command such that no speed reporting is allowed.

2- RING

The modem sends this result code when incoming ringing is detected on the line. What qualifies as a ring signal is determined by country-dependent parameters, modifiable through ConfigurACE.

3- NO CARRIER

The modem sends this result code when attempting to establish a call if:

1. Ringback is detected and later ceases but no carrier is detected within the period of time determined by register S7, or
2. No ringback is detected within the period of time determined by register S7.

This result code is also used when the modem auto-disconnects due to loss of carrier.

Under X0, if busy tone detection is enforced, this result code is used as a response to the detection of busy or circuit busy. Under X0, if dial tone detection is enforced or selected, this result code is used to indicate that dial tone has not been detected.

4- ERROR

The modem returns this result code if the command line contains a syntax error or it is unable to execute a command contained in the command line. It is issued if a command does not exist or if the parameter supplied is outside the permitted range.

Under X0, X1, X2, and X3, this result is used instead of DELAYED and BLACKLISTED.

5- CONNECT 1200

For X1, X2, X3, and X4, the modem sends this result code when:

1. The line speed is 1200 bps and the modem has been instructed to report the line speed to the DTE upon connecting, or
2. The DTE speed is 1200 bps and the modem has been instructed to report the DTE speed to the DTE upon connecting.

(Also, see the W command.)

6- NO DIALTONE

For X2 and X4, the modem sends this result code if it has been instructed to wait for dial tone during dialing but none is received.

7- BUSY

For X3 and X4, if busy tone detection is enforced, the modem sends this result code when attempting to originate a call if the busy (engaged) signal is detected on the line.

8- NO ANSWER

The modem sends this result code when attempting to originate a call if a continuous ringback signal is detected on the line until the expiration of the timer S7.

9- CONNECT 0600

For X1, X2, X3, and X4, the modem sends this result code when:

1. The line speed is 600 bps and the modem has been instructed to report the line speed to the DTE upon connecting, or
2. The DTE speed is 600 bps and the modem has been instructed to report the DTE speed to the DTE upon connecting.

10- CONNECT 2400

For X1, X2, X3, and X4, the modem sends this result code when:

1. The line speed is 2400 bps and the modem has been instructed to report the line speed to the DTE upon connecting, or
2. The DTE speed is 2400 bps and the modem has been instructed to report the DTE speed to the DTE upon connecting.

11- CONNECT 4800

For X1, X2, X3, and X4, the modem sends this result code when:

1. The line speed is 4800 bps and the modem has been instructed to report the line speed to the DTE upon connecting, or
2. The DTE speed is 4800 bps and the modem has been instructed to report the DTE speed to the DTE upon connecting.

12- CONNECT 9600

For X1, X2, X3, and X4, the modem sends this result code when:

1. The line speed is 9600 bps and the modem has been instructed to report the line speed to the DTE upon connecting, or
2. The DTE speed is 9600 bps and the modem has been instructed to report the DTE speed to the DTE upon connecting.

13- CONNECT 7200

For X1, X2, X3, and X4, the modem sends this result code when:

1. The line speed is 7200 bps and the modem has been instructed to report the line speed to the DTE upon connecting, or
2. The DTE speed is 7200 bps and the modem has been instructed to report the DTE speed to the DTE upon connecting.

14- CONNECT 12000

For X1, X2, X3, and X4, the modem sends this result code when:

1. The line speed is 12000 bps and the modem has been instructed to report the line speed to the DTE upon connecting, or
2. The DTE speed is 12000 bps and the modem has been instructed to report the DTE speed to the DTE upon connecting.

15- CONNECT 14400

For X1, X2, X3, and X4, the modem sends this result code upon connecting when the DTE speed is 14400 bps and the modem has been instructed to report the DTE speed to the DTE upon connecting.

16- CONNECT 19200

For X1, X2, X3, and X4, the modem returns this result code upon connecting when the DTE speed is 19200 bps and the modem has been instructed to report the DTE speed upon connecting.

17- CONNECT 38400

For X1, X2, X3, and X4, the modem sends this result code upon connecting when the DTE speed is 38400 bps and the modem has been instructed to report the DTE speed to the DTE upon connecting.

18- CONNECT 57600

For X1, X2, X3, and X4, the modem sends this result code upon connecting when the DTE speed is 57600 bps and the modem has been instructed to report the DTE speed to the DTE upon connecting.

19- CONNECT 115200

For X1, X2, X3, and X4, the modem sends this result code upon connecting when the DTE speed is 115200 bps and the modem has been instructed to report the DTE speed to the DTE upon connecting.

22- CONNECT 75TX/1200RX

For X1, X2, X3, and X4, the modem returns this result code upon establishing a V.23 originate connection when the modem has been instructed to report the DCE speed upon connection.

23- CONNECT 1200TX/75RX

For X1, X2, X3, and X4, the modem returns this result code upon establishing a V.23 answer connection when the modem has been instructed to report the DCE speed upon connection.

24- DELAYED

For X4, the modem returns this result code when a call fails to connect and the number dialed is considered 'delayed' due to country blacklisting requirements.

32- BLACKLISTED

For X4, the modem returns this result code when a call fails to connect and the number dialed is considered 'blacklisted'.

33- FAX

The modem returns this result code when a fax modem connection is established in a facsimile mode.

35- DATA

The modem returns this result code when a data modem connection is established in a facsimile mode.

40- CARRIER 300

The modem returns this result code when a 0-300 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

44- CARRIER 1200/75

The modem sends this result code when the V.23 backward channel carrier has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

45- CARRIER 75/1200

The modem sends this result code when the V.23 forward channel carrier has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

46- CARRIER 1200

The modem sends this result code when a 1200 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

47- CARRIER 2400

The modem sends this result code when a 2400 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

48- CARRIER 4800

The modem sends this result code when a 4800 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

49- CARRIER 7200

The modem sends this result code when a 7200 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

50- CARRIER 9600

The modem sends this result code when a 9600 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

51- CARRIER 12000

The modem sends this result code when a 12000 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

52- CARRIER 14400

The modem sends this result code when a 14400 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

53- CARRIER 16800

The modem sends this result code when a 16800 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

54- CARRIER 19200

The modem sends this result code when a 19200 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

55- CARRIER 21600

The modem sends this result code when a 21600 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

56- CARRIER 24000

The modem sends this result code when a 24000 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

57- CARRIER 26400

The modem sends this result code when a 26400 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

58- CARRIER 28800

The modem sends this result code when a 28800 bps data rate has been detected on the line and carrier reporting has been enabled. (See S95 and Xn.)

59- CONNECT 16800

For X1, X2, X3, and X4, the modem returns this result code upon connecting when the DTE speed is 16800 bps and the modem has been instructed to report the DTE speed upon connecting.

61- CONNECT 21600

For X1, X2, X3, and X4, the modem returns this result code upon connecting when the DTE speed is 21600 bps and the modem has been instructed to report the DTE speed upon connecting.

62- CONNECT 24000

For X1, X2, X3, and X4, the modem returns this result code upon connecting when the DTE speed is 24000 bps and the modem has been instructed to report the DTE speed upon connecting.

63- CONNECT 26400

For X1, X2, X3, and X4, the modem returns this result code upon connecting when the DTE speed is 26400 bps and the modem has been instructed to report the DTE speed upon connecting.

64- CONNECT 28800

For X1, X2, X3, and X4, the modem returns this result code upon connecting when the DTE speed is 28800 bps and the modem has been instructed to report the DTE speed upon connecting.

66- COMPRESSION: CLASS 5

This message is sent to the DTE when the modem has connected in MNP Class 5 and COMPRESSION message reporting has been enabled. (See S95 and Xn.)

67- COMPRESSION: V.42 bis

This message is sent to the DTE when the modem has connected in V.42 bis and COMPRESSION message reporting has been enabled. (See S95 and Xn.)

69- COMPRESSION: NONE

This message is sent to the DTE when the modem has connected without data compression and COMPRESSION message reporting has been enabled. (See S95 and Xn.)

70- PROTOCOL: NONE

This message is sent to the DTE when the modem has connected without any form of error correction, and the PROTOCOL message reporting has been enabled. (See S95 and Xn.)

77- PROTOCOL: LAPM

This message is sent to the DTE when the modem has connected in the V.42 LAPM mode of error correction, and PROTOCOL message reporting has been enabled. (See S95 and Xn.)

80- PROTOCOL: ALT

This message is sent to the DTE when the modem has connected in the MNP mode of error correction, and PROTOCOL message reporting has been enabled. (See S95 and Xn.)

81- PROTOCOL: ALT-CELLULAR

This message is sent to the DTE when the modem has connected in the MNP10 mode and cellular power level adjustment is enabled (")M1 or)M2").(See S95 and Xn.)

+F4- +FCERROR

This message is sent to the DTE when high speed fax data (V.27, V.29, V.33, or V.17) is expected and a V.21 signal is received.

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4. S-REGISTERS

The S-Registers are summarized in Table 4-1 along with their default values. Registers denoted with an '*' in Table 4-1 may be stored in one of the two user profiles by entering the &Wn command. One of these profiles may be loaded at any time by using the Zn command. Registers or register fields quoted as “reserved” are reserved for current or future use by the firmware, or are permanently overridden by PTT limitations. For the latter, control of the equivalent functionality is available with ConfigurACE Call Progress and Blacklisting options.

All bit-mapped registers are read-only. The appropriate AT command which controls the relevant bits in the S-Register should be used to change the value.

4.1. FACTORY DEFAULTS

The factory default values are stored in ROM and are loaded into the active configuration at power up or by the ATZn command. In addition, the designated default profile is subsequently loaded, and may change some of the factory default values. The designated default profile can be changed by entering the &Yn command where n is one of the two possible user profiles.

The defaults shown are those used by Rockwell in factory profiles zero and one. These may be overwritten by the OEM with ConfigurACE prior to placing the firmware in PROM. Minimum and maximum values may also be imposed by ConfigurACE in response to country PTT requirements.

The default values shown in Table 4-1 may vary by modem firmware configuration. Consult the MCU firmware release notes for exact configuration.

The factory default values may be loaded at any time by entering the &Fn command.

Table 4-1. S-Register Summary

Register	Function	Range	Units	Saved	Default**
S0	Rings to Auto-Answer	0-255	rings	*	0
S1	Ring Counter	0-255	rings		0
S2	Escape Character	0-255	ASCII	*	43
S3	Carriage Return Character	0-127	ASCII		13
S4	Line Feed Character	0-127	ASCII		10
S5	Backspace Character	0-255	ASCII		8
S6	Wait Time for Dial Tone	2-255	s	*	2
S7	Wait Time for Carrier	1-255	s	*	50
S8	Pause Time for Dial Delay Modifier	0-255	s	*	2
S9	Carrier Detect Response Time	1-255	0.1 s	*	6
S10	Carrier Loss Disconnect Time	1-255	0.1 s	*	14
S11	DTMF Tone Duration	50-255	0.001 s	*	95
S12	Escape Prompt Delay	0-255	0.02 s	*	50
S13	Reserved	-	-		-
S14	General Bit Mapped Options Status	-	-	*	138 (8Ah)
S15	Reserved	-	-		-
S16	Test Mode Bit Mapped Options Status (&T)	-	-		0
S17	Reserved	-	-		-
S18	Test Timer	0-255	s	*	0
S19	AutoSync Options	-	-		0
S20	AutoSync HDLC Address or BSC Sync Character	0-255	-	*	0
S21	V.24/General Bit Mapped Options Status	-	-	*	4 (04h)
S22	Speaker/Results Bit Mapped Options Status	-	-	*	117 (75h)
S23	General Bit Mapped Options Status		-	*	54 (36h)
S24	Sleep Inactivity Timer	0-255	s	*	0
S25	Delay to DTR Off	0-255	s or 0.01 s		5
S26	RTS-to-CTS Delay	0-255	0.01 s		1
S27	General Bit Mapped Options Status	-	-	*	9 (09h)
S28	General Bit-Mapped Options Status	-	-	*	0
S29	Flash Dial Modifier Time	0-255	10 ms		0
S30	Disconnect Inactivity Timer	0-255	10 s		0
S31	General Bit-Mapped Options Status	-	-	*	2
S32	XON Character	0-255	ASCII		17 (11h)
S33	XOFF Character	0-255	ASCII		19 (13h)
S34-S35	Reserved	-	-		-
S36	LAPM Failure Control	-	-	*	7
S37	Line Connection Speed	-	-	*	0
S38	Delay Before Forced Hangup	0-255	s		20
S39	Flow Control Bit Mapped Options Status	-	-	*	3

Table 4-1. S-Register Summary (Cont'd)

Register	Function	Range	Units	Saved	Default**
S40	General Bit-Mapped Options Status	-	-	*	105 (69h) (Non-MNP 10 models) 107(6Bh) (MNP 10 models)
S41	General Bit-Mapped Options Status	-	-	*	3
S42-S45	Reserved	-	-		-
S46	Data Compression Control	-	-	*	138
S48	V.42 Negotiation Control	-	-	*	7
S82	LAPM Break Control	-	-		128(40h)
S86	Call Failure Reason Code	0-255	-		-
S91	PSTN Transmit Attenuation Level	0-15	dBm		10 (Country dependent)
S92	Fax Transmit Attenuation Level	0-15	dBm		10 (Country dependent)
S95	Result Code Messages Control	-	-	*	0
S201	Cellular Transmit Level	0-63		*	58

* Register value may be stored in one of two user profiles with the &W command.

•• Default values may be modified using ConfigurACE.

4.2. S-REGISTER DEFINITIONS

S0 - Number of Rings to Auto-Answer

Sets the number of the rings required before the modem automatically answers a call. Setting this register to zero disables auto-answer mode.

Range: 0-255 rings

Default: 0

S1 - Ring Counter

S1 is incremented each time the modem detects a ring signal on the telephone line. S1 is cleared if no rings occur over an eight second interval.

Range: 0-255 rings

Default: 0

S2 - Escape Character

S2 holds the decimal value of the ASCII character used as the escape character. The default value corresponds to an ASCII '+'. A value over 127 disables the escape process, i.e., no escape character will be recognized.

Range: 0-255, ASCII decimal

Default: 43 (+)

S3 - Carriage Return Character

Sets the command line and result code terminator character. Pertains to asynchronous operation only.

Range: 0-127, ASCII decimal

Default: 13 (Carriage Return)

S4 - Line Feed Character

Sets the character recognized as a line feed. Pertains to asynchronous operation only. The Line Feed control character is output after the Carriage Return control character if verbose result codes are used

Range: 0-127, ASCII decimal

Default: 10 (Line Feed)

S5 - Backspace Character

Sets the character recognized as a backspace. Pertains to asynchronous operation only. The modem will not recognize the Backspace character if it is set to a value that is greater than 32 ASCII. This character can be used to edit a command line. When the echo command is enabled, the modem echoes back to the local DTE the Backspace character, an ASCII space character and a second Backspace character; this means a total of three characters are transmitted each time the modem processes the Backspace character.

Range: 0-32, ASCII decimal

Default: 8 (Backspace)

S6 - Wait Time for Dial Tone Before Blind Dialing, or After "W" Dial Modifier (W-Class Models)

1. Sets the length of time, in seconds, that the modem will wait before starting to dial after going off-hook when blind dialing. This operation, however, may be affected by some ATX options according to country restrictions. The "Wait for Dial Tone" call progress feature (W dial modifier in the dial string) will override the value in register S6.
2. For W-class models, S6 sets the length of time, in seconds, that the modem will wait for dial tone when encountering a "W" dial modifier before returning NO DIAL TONE result code.

The modem always pauses for a minimum of 2 seconds, even if the value of S6 is less than 2 seconds.

Range: 2-255 seconds

Default: 2

S7 - Wait Time For Carrier After Dial, For Silence, or For Dial Tone After "W" Dial Modifier (US Models)

1. Sets the length of time, in seconds, that the modem will wait for carrier before hanging up. The timer is started when the modem finishes dialing (originate), or 2 seconds after going off-hook (answer). In originate mode, the timer is reset upon detection of answer tone if allowed by country restrictions.
2. Sets the length of time, in seconds, that modem will wait for silence when encountering the @ dial modifier before continuing with the next dial string parameter.
3. For US models, S7 sets the length of time, in seconds, that the modem will wait for dial tone when encountering a "W" dial modifier before continuing with the next dial string parameter.

Range: 1-255 seconds

Default: 50

S8 - Pause Time For Dial Delay

Sets the time, in seconds, that the modem must pause when the "," dial modifier is encountered in the dial string.

Range: 0-255 seconds

Default: 2

S9 - Carrier Detect Response Time

Sets the time, in tenths of a second, that the carrier must be present before the modem considers it valid and turns on RLSD. As this time is increased, there is less chance to detect a false carrier due to noise from the telephone line.

Range: 1-255 tenths of a second

Default: 6 (0.6 second)

S10 - Lost Carrier To Hang Up Delay

Sets the length of time, in tenths of a second, that the modem waits before hanging up after a loss of carrier. This allows for a temporary carrier loss without causing the local modem to disconnect. When register S10 is set to 255, the modem functions as if a carrier is always present.

The actual interval the modem waits before disconnecting is the value in register S10 minus the value in register S9. Therefore, the S10 value must be greater than the S9 value or else the modem disconnects before it recognizes the carrier.

Range: 1-255 tenths of a second

Default: 14 (1.4 seconds)

S11 - DTMF Tone Duration

Sets the duration of tones in DTMF dialing (US models only). This value has no effect on pulse dialing.

For W-class models, this parameter is a country parameter loaded by ConfigurACE.

Range: 50-255 milliseconds

Default: 95 (95 milliseconds)

S12 - Escape Prompt Delay (EPD)

Defines the maximum period, in fiftieths of a second, allowed between receipt of the last character of the three escape character sequence from the DTE and sending of the OK result code to the DTE. If any characters are detected during this time, the OK will not be sent. Note that sending of the OK result code does not affect entry into command mode. (See 3.1.3.)

Range: 0-255 1/50 of a second

Default: 50 (1 second)

S13 - Reserved

S14 - General Bit Mapped Options Status

Indicates the status of command options.

Default: 138 (8Ah) (10001010b)

Bit 0 — This bit is ignored.

Bit 1 — Command echo (En)

- 0 = Disabled (E0)
- 1 = Enabled (E1) (Default.)

Bit 2 — Quiet mode (Qn)

- 0 = Send result codes (Q0) (Default.)
- 1 = Do not send result codes (Q1)

Bit 3 — Result codes (Vn)

- 0 = Numeric (V0)
- 1 = Verbose (V1) (Default.)

Bit 4 — Reserved

Bit 5 — Tone (T)/Pulse (P)

- 0 = Tone (T) (Default.)
- 1 = Pulse (P)

Bit 6 — Reserved

Bit 7 — Originate/Answer

- 0 = Answer
- 1 = Originate (Default.)

S15 - Reserved

S16 - General Bit Mapped Test Options Status

Indicates the test in progress status.

Default: 0

Bit 0 — Local analog loopback

0 = Disabled (Default.)

1 = Enabled (&T1)

Bit 1 — Not used

Bit 2 — Local digital loopback

0 = Disabled (Default.)

1 = Enabled (&T3)

Bit 3 — Remote digital loopback (RDL) status

0 = Modem not in RDL (Default.)

1 = RDL in progress

Bit 4 — RDL requested (AT&T6)

0 = RDL not requested (Default.)

1 = RDL requested (&T6)

Bit 5 — RDL with self test

0 = Disabled (Default.)

1 = Enabled (&T7)

Bit 6 — Local analog loopback (LAL) with self test

0 = Disabled (Default.)

1 = Enabled (&T8)

Bit 7 — Not used

S17 - Reserved

S18 - Test Timer

Sets the length of time, in seconds, that the modem conducts a test (commanded by &Tn) before returning to the command mode. If this register value is zero, the test will not automatically terminate; the test must be terminated from the command mode by issuing an &T0 or H command. When S18 is non-zero, the modem returns the OK message upon test termination.

Range: 0-255 seconds

Default: 0

S19 - AutoSync Bit Mapped Options

Defines the options for AutoSync operation (see &Q4 command). S19 must be set to the desired value before &Q4 is issued.

Default: 0

Bit 0 — Reserved

Bit 1 — BSC/HDLC format select

- 0 = BSC selected (Default.)
- 1 = HDLC selected

Bit 2 — Address detection enable/disable

- 0 = DIsabled (Default.)
- 1 = Enabled

Bit 3 — NRZI/NZI coding select

- 0 = NRZI (Default.)
- 1 = NZI

Bit 4 — Idle indicator select select

- 0 = Mark idle (Default.)
- 1 = Flag or sync idle

Bits 5 - 7 — Reserved

S20 - AutoSync HDLC Address or BSC Sync Character

Defines the HDLC address (S19 bit 1 = 1) or BSC Sync Character (S19 bit 1 = 0) for AutoSync operation (see &Q4 command). S20 must be set to the desired value before &Q4 is issued.

Range: 0-255

Default: 0

S21 - V.24/General Bit Mapped Options Status

Indicates the status of command options.

Default: 4 (00000100b)

Bit 0 — Set by &Jn command but ignored otherwise.

- 0 = &J0 (Default.)
- 1 = &J1

Bit 1 — Reserved

Bit 2 — CTS behavior (&Rn)

- 0 = CTS tracks RTS (&R0)
- 1 = CTS always on (&R1) (Default.)

Bits 3-4 — DTR behavior (&Dn)

- 0 = &D0 selected (Default.)
- 1 = &D1 selected
- 2 = &D2 selected
- 3 = &D3 selected

Bit 5 — RLSD (DCD) behavior (&Cn)

- 0 = &C0 selected (Default.)
- 1 = &C1 selected

Bit 6 — DSR behavior (&Sn)

- 0 = &S0 selected (Default.)
- 1 = &S1 selected

Bit 7 — Long space disconnect (Yn)

- 0 = Y0 (Default.)
- 1 = Y1

S22 - Speaker/Results Bit Mapped Options Status

Indicates the status of command options.

Default: 117 (75h) (01110101b)

Bits 0-1 — Speaker volume (Ln)

- 0 = Off (L0)
- 1 = Low (L1) (Default.)
- 2 = Medium (L2)
- 3 = High (L3)

Bits 2-3 — Speaker control (Mn)

- 0 = Disabled (M0)
- 1 = Off on carrier (M1) (Default.)
- 2 = Always on (M2)
- 3 = On during handshake (M3)

Bits 4-6 — Limit result codes (Xn)

- 0 = X0
- 4 = X1
- 5 = X2
- 6 = X3
- 7 = X4 (Default.)

Bit 7— Reserved

S23 - General Bit Mapped Options Status

Indicates the status of command options.

Default: 54 (36h) (00110110b)

Bit 0— Grant RDL

0 = RDL not allowed (&T5) (Default.)

1 = RDL allowed (&T4)

Bits 1-3 — DTE Rate

0 = 0 - 300 bps

1 = 600 bps

2 = 1200 bps

3 = 2400 bps (Default.)

4 = 4800 bps

5 = 9600 bps

6 = 19200 bps

7 = 38400 bps or higher

Bits 4-5 — Assumed DTE parity

0 = even

1 = not used

2 = odd

3 = none (Default.)

Bit 6-7 — Guard tone (&Gn)

0 = None (&G0) (Default)

1 = None (&G1)

2 = 1800 Hz (&G2)

S24 - Sleep Inactivity Timer

Sets the length of time, in seconds, that the modem will operate in normal mode with no detected telephone line or DTE line activity before entering low-power sleep mode. The timer is reset upon any DTE line or telephone line activity. If the S24 value is zero, neither DTE line nor telephone inactivity will cause the modem to enter the sleep mode.

Range: 0-255 seconds

Default: 0

S25 - Delay To DTR

Sets the length of time that the modem will ignore DTR for taking the action specified by &Dn. Its units are seconds for synchronous modes and one hundredths of a second for other modes.

Range: 0-255 (1 second for synchronous modes 1; 0.01 second otherwise)

Default: 5

S26 - RTS to CTS Delay

Sets the time delay, in hundredths of a second, before the modem turns CTS ON after detecting an OFF-to-ON transition on RTS when &R0 is commanded. Pertains to synchronous operation only.

Range: 0-255 hundredths of a second

Default: 1

S27 - Bit Mapped Options Status

Indicates the status of command options.

Default: 9 (09h) (00001001b)

Bits 0,1,3 — Synchronous/asynchronous selection (&Mn/&Qn)

3	**1**	**0**		
0	0	0	=	&M0 or &Q0
0	0	1	=	&M1 or &Q1
0	1	0	=	&M2 or &Q2
0	1	1	=	&M3 or &Q3
1	0	0	=	&Q4
1	0	1	=	&Q5 (Default.)
1	1	0	=	&Q6

Bit 2 — Leased line control (&Ln)

0 = Dial up line (&L0) (Default.)

1 = Leased line (&L1)

Bits 4,5 — Internal clock select (&Xn)

0 = Internal clock (&X0) (Default.)

1 = External clock (&X1)

2 = Slave clock (&X2)

Bit 6 — CCITT/Bell mode select (Bn)

0 = CCITT mode (B0) (Default.)

1 = Bell mode (B1)

Bit 7 - Reserved

S28 - Bit Mapped Options Status

Default: 0

Bits 0-1 — Reserved

Bit 2 — Reserved (always 0).

Bits3 -4 — Pulse dialing (&Pn)

- 0 = 39%-61% make/break ratio at 10 pulses per second (&P0) (Default.)
- 1 = 33%-67% make/break ratio at 10 pulses per second (&P1)
- 2 = 39%-61% make/break ratio at 20 pulses per second (&P2)
- 3 = 33%-67% make/break ratio at 20 pulses per second (&P3)

Bit 5 — Reserved

Bits 6-7 — MNP Link Negotiation Speed (*Hn)

- 0 = Link negotiation at highest speed (*H0) (Default.)
- 1 = Link negotiation at 1200 bps (*H1)
- 2= Link negotiation at 4800 bps (*H2)

S29 - Flash Dial Modifier Time

Sets the length of time, in units of 10 ms, that the modem will go on-hook when it encounters the flash (!) dial modifier in the dial string. The time can be limited as it is a country dependent parameter.

Range: 0-255 10 ms intervals

Default: 0 (disabled)

S30 - Disconnect Inactivity Timer

Sets the length of time, in tens of seconds, that the modem will stay online before disconnecting when no data is sent or received. In error-correction mode, any data transmitted or received will reset the timer. In other modes, any data transmitted will reset the timer. The timer is inoperative in synchronous mode.

Range: 0-255 tens of seconds (0-2550 seconds)

Default: 0 (disabled)

S31 - Bit Mapped Options Status

Default: 2 (00000010b)

Bit 0 — Reserved

Bit 1 — Controls auto line speed detection (Nn)

- 0 = Disabled (N0)
- 1 = Enabled (N1) (Default.)

Bits 2-3 — Controls error correction progress messages (Wn)

- 0 = DTE speed only (W0) (Default.)
- 1 = Full reporting (W1)
- 2 = DCE speed only (W2)

Bit 3 — Reserved

Bits 4-7 — Reserved

S32 - XON Character

Sets the value of the XON character.

Range: 0-255, ASCII decimal

Default: 17 (11h)

S33 - XOFF Character

Sets the value of the XOFF character.

Range: 0-255, ASCII decimal

Default: 19 (13h)

S34-S35 - Reserved

S36 - LAPM Failure Control

Default: 7 (00000111b)

Bits 0-2 — This value indicates what should happen upon a LAPM failure. These fallback options are initiated immediately upon connection if S48=128. If an invalid number is entered, the number is accepted into the register, but S36 will act as if the default value has been entered.

- 0 = Modem disconnects.
- 1 = Modem stays on-line and a Direct mode connection is established.
- 2 = Reserved.
- 3 = Modem stays on-line and a Normal mode connection is established.
- 4 = An MNP connection is attempted and if it fails, the modem disconnects.
- 5 = An MNP connection is attempted and if it fails, a Direct mode connection is established.
- 6 = Reserved.
- 7 = An MNP connection is attempted and if it fails, a Normal mode connection is established. (Default.)

Bits 3-7 — Reserved

S37 - Desired Line Connection Speed

This register specifies the desired line connection speed.

Notes:

1. When the Nn command is issued or the S37 register value is modified, the +MS command subparameters are updated to reflect the speed and modulation specified by the S37 value (see +MS command). For example:

   If N0 command is active, S37=10 updates the +MS command subparameters to reflect +MS=10,1,300,12000

   If N1 command is active, S37=10 updates the +MS command subparameters to reflect +MS=10,0,12000,12000

2. S37 is not updated by the +MS command.

3. Use of the +MS command is recommended instead of the Nn and S37=x commands. Nn and S37=x commands are supported for compatibility with existing communication software.

Default: 0

Bits 0-4 — Desired line connection speed. If an invalid number is entered, the number is accepted into the register, but S37 will act as if the default value has been entered.

- 0 = Attempt automode connection. If N0 is active, connection is attempted at the most recently sensed DTE speed (+MS command settings are updated to the appropriate values). If N1 is active, connection is attempted at the highest possible speed (+MS settings are updated to 11,1,300,2880 to reflect V.34, automode, 300 bps minimum speed, and 28800 bps maximum speed). (Default.)
- 1-3 = Attempt to connect at 300 bps.
- 4 = Reserved.
- 5 = Attempt to connect at V.22 1200 bps.
- 6 = Attempt to connect at V.22 bis 2400 bps.
- 7 = Attempt to connect at V.23.
- 8 = Attempt to connect at V.32 bis/V.32 4800 bps.
- 9 = Attempt to connect at V.32 bis/V.32 9600 bps.
- 10 = Attempt to connect at V.32 bis 12000 bps.
- 11 = Attempt to connect at V.32 bis 14400 bps.
- 12 = Attempt to connect at V.32 bis 7200 bps.

Bits 5-7 — Reserved

S38 - Delay Before Forced Hang Up

This register specifies the delay between the modem's receipt of the H command to disconnect (or ON-to-OFF transition of DTR if the modem is programmed to follow the signal), and the disconnect operation. Applicable to error-correction connection only. This register can be used to ensure that data in the modem buffer is sent before the modem disconnects.

1. If S38 is set to a value between 0 and 254, the modem will wait that number of seconds for the remote modem to acknowledge all data in the modem buffer before disconnecting. If time expires before all data is sent, the NO CARRIER result code will be issued to indicate that data has been lost. If all data is transmitted prior to time-out, the response to the H0 command will be OK.
2. If S38 is set to 255, the modem does not time-out and continues to attempt to deliver data in the buffer until the connection is lost or the data is delivered.

Range: 0-255 seconds

Default: 20

S39 - Flow Control Bit Mapped Options Status

Default: 3 (00000011b)

Bits 0-2 — Status of command options

0 = No flow control

3 = RTS/CTS (&K3) (Default.)

4 = XON/XOFF (&K4)

5 = Transparent XON (&K5)

6 = Both methods (&K6)

Bits 3-7 — Reserved

S40 - General Bit Mapped Options Status

Indicates the status of command options.

Default: 105 (69h) (01101001b)

Bit 0 - 1— MNP Extended Services (-Kn)

- 0 = Disable extended services (-K0) (Default for non-MNP 10 models.)
- 1 = Enable extended services (-K1) (Default for MNP 10 models.)
- 2 = Enable extended services (-K2)

Bit 2— Power Level Adjustment for Cellular Use ()Mn)

- 0 = Auto-adjustment ()M0) (Default.)
- 1 = Force adjustment ()M1)

Bits 3-5 — Break Handling (\Kn)

- 0 = \K0
- 1 = \K1
- 2 = \K2
- 3 = \K3
- 4 = \K4
- 5 = \K5 (Default.)

Bits 6-7 — MNP block size (\An)

- 0 = 64 chars (\A0)
- 1 = 128 chars (\A1) (Default.)
- 2 = 192 chars (\A2)
- 3 = 256 chars (\A3)

S41 - General Bit Mapped Options Status

Indicates the status of command options.

Default: 131 (10000011b)

Bits 0 -1 — Compression selection (%Cn)

- 0 = Disabled (%C0)
- 1 = MNP 5 (%C1)
- 2 = V.42 bis (%C2)
- 3 = MNP 5 and V.42 bis (%C3) (Default.)

Bit 2, 6— Auto retrain and fallback/fall forward (%En)

Bit 6	Bit 2		
0	0	=	Retrain and fallback/fall forward disabled (%E0) (Default.)
0	1	=	Retrain enabled (%E1)
1	0	=	Fallback/fall forward enabled (%E2)

Bit 3 — Reserved

Bit 4 — Block mode control (\Ln)

- 0 = Stream mode (\L0) (Default.)
- 1 = Block mode (\L1)

Bit 5 — Reserved

Bit 7 — Enable fallback to V.22bis/V.22 (-Qn)

- 0 = Disabled (-Q0)
- 1 = Enabled (-Q1) (Default.)

S46 - Data Compression Control

Controls selection of compression. The following actions are executed for the given values:

Range: 136 or 138

Default: 138

S46=136 Execute error correction protocol with no compression.

S46=138 Execute error correction protocol with compression. (Default.)

S48 - V.42 Negotiation Action

The V.42 negotiation process determines the capabilities of the remote modem. However, when the capabilities of the remote modem are known and negotiation is unnecessary, this process can be bypassed if so desired.

Range: 0, 7, or 128 If an invalid number is entered, it is accepted into the S-Register, but S48 will act as if 128 has been entered.

Default: 7

S48=0 Disable negotiation; bypass the detection and negotiation phases; and proceed with LAPM.

S48=7 Enable negotiation. (Default.)

S48=128 Disable negotiation; bypass the detection and negotiation phases; and proceed at once with the fallback action specified in S36. Can be used to force MNP.

S82 - Break Handling Options

S82 is for compatability purposes only, changing this register will not have any affect.

S86 - Call Failure Reason Code

When the modem issues a NO CARRIER result code, a value is written to this S-Register to help determine the reason for the failed connection. S86 records the first event that contributes to a NO CARRIER message. The cause codes are:

Range: 0, 4, 5, 9, 12, 13, or 14

Default:

S86=0	Normal disconnect, no error occurred.
S86=4	Loss of carrier.
S86=5	V.42 negotiation failed to detect an error-correction modem at the other end.
S86=9	The modems could not find a common protocol.
S86=12	Normal disconnect initiated by the remote modem.
S86=13	Remote modem does not respond after 10 re-transmissions of the same message.
S86=14	Protocol violation.

S91 - PSTN Transmit Attenuation Level

Sets the transmit attenuation level from 0 to 15 dBm for the PSTN mode, resulting in a transmit level from 0 to -15 dBm, In some countries, the transmit level may not be changed and there are checks to prevent transmit attenuation level change using ConfigurACE.

Range: 0 to 15 dBm (Corresponding to 0 to -15 dBm transmit level.)

Default: 10 (-10 dBm transmit level.)

S92 - Fax Transmit Attenuation Level

Sets the transmit attenuation level from 0 to 15 dBm for the fax mode, resulting in a transmit level from 0 to -15 dBm. In some countries, the transmit level may not be changed and there are checks to prevent transmit attenuation level change using ConfigurACE.

Range: 0 to 15 dBm (Corresponding to 0 to -15 dBm transmit level.)

Default: 10 (-10 dBm transmit level.)

S95 - Extended Result Codes

The bits in this register can be set to override some of the Wn command options. A bit set to a 1 in this register will enable the corresponding result code regardless of the Wn setting. Also, refer to Table 3-1.

Default: 0

Bit 0 —	CONNECT result code indicates DCE speed instead of DTE speed.
Bit 1 —	Append/ARQ to CONNECT XXXX result code in error-correction mode (XXXX = rate; see Table 3–1).
Bit 2 —	Enable CARRIER XXXX result code (XXXX = rate; see Table 3-1).
Bit 3 —	Enable PROTOCOL XXXX result code (XXXX = protocol identifier; see Table 3-1).
Bit 4 —	Reserved.
Bit 5 —	Enable COMPRESSION result code (XXXX = compression type; see Table 3-1).
Bit 6 —	Reserved.
Bit 7 —	Reserved.

S201 - Cellular Transmit Level

The bits in this register are set by the @Mn and :En commands to support cellular connections.

Default: 20h

Bits 0 - 4 —	Initial Cellular Power Level Setting (@Mn; default = @M0)
Bit 5 —	Compromise Equalizer Enable Command (:En; default = E1)
Bit 6 —	Reserved.
Bit 7 —	Reserved.

5. V.25 BIS COMMAND SET

V.25 bis commands are not supported.

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6. FAX CLASS 1 COMMANDS

6.1. FAX I/O PROCESSING

The fax I/O interface supports asynchronous serial and parallel interfaces. The interface rate is 19200 bps. The character format is 8 bits data, no parity, and 1 stop bit. Start and stop elements are removed from the transmit data and added to the receive data. Both transmit and receive data are buffered. Flow control using XON/XOFF (DC1/DC3) or RTS/CTS is provided.

Unique control character strings are identified, filtered, or reinserted into the I/O data stream. These control characters and their resultant action are described below.

6.1.1. DTE-to-Modem Transmit Data Stream

Characters Detected	Action Taken
<DLE><data>	Delete <DLE><data> characters.
<DLE><ETX>	Recognize as a string terminator and take appropriate action.
<DLE><DLE>	Replace with single <DLE> character.

6.1.2. Modem-to-DTE Receive Data Stream

Characters Detected	Action Taken
<DLE>	Insert extra <DLE> ahead of <DLE>.

The modem also identifies the end of a frame by inserting <DLE><ETX> into the data stream after the FCS bytes.

6.1.3. Fax Mode Selection

Fax class 1 commands are identified in Table 6-1. Fax modes and rates are determined by the AT+F commands as described in Section 6.2.

Table 6-1. Fax Class 1 Commands

Command	Function
Service Class ID	
+FCLASS=	Service Class
Fax Class 1 Commands	
+FAE=n	Data/Fax Auto Answer
+FTS=n	Stop Transmission and Wait
+FRS=n	Receive Silence
+FTM=n	Transmit Data
+FRM=n	Receive Data
+FTH=n	Transmit Data with HDLC Framing
+FRH=n	Receive Data with HDLC Framing

6.1.4. Fax Origination

Origination of fax calls is made using the ATD command. Upon completion of the dial function, a calling tone at 1100 Hz is transmitted, with a cadence of 0.5 seconds on and 3 seconds off. The modem automatically enters mode +FRH=3 and sends the CONNECT message to the DTE when FSK flags are detected from the remote.

6.1.5. Fax Answering

Answering of fax calls is identical to answering of data calls with the exception that the modem enters the fax handshaking mode instead of the data handshaking mode after going off-hook. If +FAE=0, the modem, after sending answer tone, automatically enters fax mode (+FTH=3), sends the CONNECT message to the DTE, and starts sending FSK flags. If +FAE=1, the modem determines whether the caller is a data modem or fax modem and sends the DATA or FAX result code, respectively, to the DTE.

6.1.6. Fax Control Transmission

Fax control transmission is initiated by the +FTH=n command. After this command is issued, the modem generates the CONNECT message and transmits carrier in the modulation scheme specified by the parameter n. The modem then transmits HDLC flags for a minimum of 1 second. The modem continues to transmit the HDLC flags until it receives a character from the DTE.

When characters are received from the DTE, the modem adds start and end flags, performs zero-bit insertion, generates FCS, and deletes <DLE><chr> character pairs before transmitting the characters to the remote fax machine. Each <DLE><DLE> sequence is transmitted as a single <DLE>. <DLE><ETX> is considered as the end of frame marker and is not transmitted. All data received from the DTE after <DLE><ETX> is ignored by the modem until the modem generates either the CONNECT, OK, or ERROR result code.

If no more data is in the transmit buffer and the final bit was a 1 (bit 4 of the second byte received from the DTE), the modem generates the OK result code and returns to the command mode. If the final bit was a 0, the modem generates the CONNECT message and waits for further data from the DTE while transmitting HDLC flags. If no more data is received before 5 seconds elapse, the modem drops carrier, goes on-hook, and generates the ERROR result code.

6.1.7. Fax Control Reception

Fax control reception is initiated using the AT+FRH=n command. After this command is issued, the modem looks for carrier in the modulation scheme specified by the parameter n. If no carrier is detected before the period of time specified by register S7 expires, the modem generates the NO CARRIER message and returns to command mode. If a V.21 carrier is detected when a high speed carrier is expected, the modem generates the +FCERROR message and returns to the command mode. If the specified carrier is detected, the modem generates the CONNECT message and enters the HDLC receive mode.

In HDLC receive mode, the modem receives HDLC frames from the remote fax machine, strips the flags, performs zero-bit deletion, performs error checking, and handles <DLE><chr> character pairs before passing the data to the DTE. The modem prefixes each <DLE> character with another <DLE> character before sending it to the DTE. After the last byte in the frame, the modem sends <DLE><ETX> to the DTE marking the end of the frame. The modem then generates either the OK message if no errors were detected or the ERROR message if errors were detected (FCS is incorrect), and returns to command mode.

While in command mode, the modem continues to receive data in the selected modulation scheme, and sends the data after sending the CONNECT message to the DTE when the DTE reissues the +FRH command with the same parameter. If the DTE issues the +FRH command with a different parameter, the modem clears all buffers and proceeds as described previously.

If carrier is lost while in command mode and the DTE reissues the +FRH command with the same parameter, and there is no data in the buffer, the modem sends the ERROR result code to the DTE and returns to the command mode. If there is data in the buffer, the modem sends the next frame of buffered data to the DTE, followed by <DLE><ETX>, and either the ERROR result code if errors were detected or the OK result code if no errors were detected. The modem then returns to command mode.

The modem concludes an error is detected if carrier is lost for any period of time during or before the reception of a frame. If carrier is lost for a time period longer than the time specified by the register S10, the modem finishes delivering the data in the receive buffer (if any) to the DTE, sends <DLE><ETX>, generates the ERROR message, and returns to command mode. All subsequent data received from the remote is discarded.

If the modem detects a frame abort sequence (seven consecutive ones with no zero insertion) while it is waiting for a frame beginning flag (it was receiving HDLC flags), it will wait for the HDLC flags again until either carrier is lost, or the DTE aborts the process by sending an abort character or by dropping DTR with &D2 in effect. If the frame abort sequence is detected while the modem is receiving a frame it finishes delivering the data in the receive buffer (if any) to the DTE, sends <DLE><ETX>, generates the ERROR message, and returns to command mode. The modem keeps looking for HDLC flags followed by more data from the remote, with the selected modulation scheme.

If the modem detects a receive buffer overflow condition, it concludes that there was an FCS error in that frame. The modem will receive more frames only if a starting flag is detected and there is room in the receive buffer. If a starting flag is detected and there is no room in the buffer, the modem discards all data in that frame.

If the modem receives any character from the DTE after the +FRH command (except flow control characters if software flow control is in effect), or if the modem detects a high-to-low transition of the DTR signal while &D1 is in effect, it sends <DLE><ETX> to the DTE, generates OK result code, and returns to command mode. The receive buffer is cleared and all data received from the remote is discarded. If the modem detects a DTR drop while &D2 is in effect, it goes on-hook, sends <DLE><ETX> to the DTE, generates OK result code, and returns to command mode. If the modem detects a DTR drop while &D3 is in effect, the modem performs a warm reset.

6.1.8. Fax Data Transmission

Fax data transmission is initiated by the AT+FTM=n command. After this command is issued, the modem generates the CONNECT message and transmits carrier in the modulation scheme specified by the parameter n. The modem then transmits constant 1 bits for a minimum of one second and continues to transmit constant 1 bits until it receives a character from the DTE.

When data is received from the DTE, the modem deletes start and stop bits and deletes all <DLE><chr> character pairs before transmitting the data to the remote. Each <DLE><DLE> sequence is transmitted as a single <DLE>. <DLE><ETX> is considered as the end of stream marker, and is not transmitted. All data received from the DTE after the <DLE><ETX> is ignored by the modem until the modem generates either the CONNECT, OK, or ERROR result code.

If no more data is in the transmit buffer, and the last transmitted character was not an ASCII NULL, the modem generates the OK result code and returns to the command mode. If the last character transmitted was an ASCII NULL, the modem generates the CONNECT message to the DTE and waits for further data from the DTE while transmitting NULLs to the remote. If more data is received before five seconds elapse, the modem continues to transmit the data as described in the previous paragraph. If five seconds elapse and no data is received from the DTE, the modem drops carrier, goes on-hook, and generates the ERROR result code.

6.1.9. Fax Data Reception

Fax data reception is initiated using the AT+FRM=n command. After this command is issued, the modem looks for carrier in the modulation scheme specified by the parameter n. If no carrier is detected before the period of time specified by register S7 expires, the modem generates the NO CARRIER message and returns to command mode. If a V.21 carrier is detected when a high speed carrier is expected, the modem generates the +FCERROR message and returns to the command mode. If the specified carrier is detected, the modem generates the CONNECT message and enters the data receive mode.

While in data receive mode, the modem receives data from the remote, adds start and stop bits, and handles <DLE><chr> character pairs before passing the data to the DTE. The modem prefixes each <DLE> character with another <DLE> character before sending it to the DTE.

If carrier is lost for a time period longer than the time specified by the register S10, the modem finishes delivering the data in the receive buffer (if any) to the DTE, sends <DLE><ETX>, generates the NO CARRIER result code, and returns to the command mode. All subsequent data received from the remote is discarded.

If the modem detects a receive buffer overflow condition, it stops receiving from the remote until there is room in the receive buffer. The modem informs the DTE of the buffer overflow after it sends to the DTE the last character that was stored in the buffer before the overflow occurred.

If the modem receives any character from the DTE after the +FRM command (except flow control characters if software flow control is in effect), or if the modem detects a high-to-low transition of the DTR signal while &D1 is in effect, it sends <DLE><ETX> to the DTE, generates the OK result code, and returns to command mode. The receive buffer is cleared and all data received from the remote is discarded. If loss of DTR is detected while &D2 is in effect, the modem goes on-hook, sends <DLE><ETX> followed by OK result code to the DTE, and returns to command mode. If the modem detects a DTR drop while &D3 is in effect, the modem performs a warm reset.

6.2. COMMANDS

+FCLASS=n - Select Service Class

+FCLASS=n command sets the active service class.

Parameters: 0-2

Command options:

+FCLASS=0	Select Data Mode (Default.)
+FCLASS=1	Select Facsimile Class 1
+FCLASS=2	Select Facsimile Class 2

+F<command>? - Report Active Configuration

+F<command>? interrogates the modem to determine the active configuration.

Typical responses are:

+FAE?	0 if auto answer is disabled; 1 if auto answer is enabled
+FCLASS?	0 if in data mode; 1 if in fax class 1; 2 if in fax class 2

+F<command>=? - Report Operating Capabilities

+F<command>=? can be used to determine the operating capabilities of the modem.

Typical responses are:

+FAE=?	0 or 1
+FCLASS=?	0, 1, or 2
+FTM=?	24, 48, 72, 73, 74, 96, 97, 98, 121, 122, 145, 146
+FRM=?	24, 48, 72, 73, 74, 96, 97, 98, 121, 122, 145, 146

+FAE=n - Data/Fax Auto Answer

+FAE=n allows the DTE to either restrict answering to class 1, or to automatically detect whether the calling station is a fax class 1 modem or data modem, and answer accordingly.

Parameters: n = 0 or 1

Command options:

n = 0	Disable data/fax auto answer mode. The modem answers as a fax modem only. (Default.).
n = 1	Enable data/fax auto answer mode. The modem answers as a fax or data modem.

After a data (not fax) connection is acheived (indicated by the DATA result code), the DTE must issue an ATO command to cause the modem to go on-line.

+FTS=n - Stop Transmission and Wait

+FTS=n causes the modem to terminate a transmission and wait for n 10-ms intervals before responding with the OK result code. An ERROR response code results if this command is issued while the modem is on-hook.

+FRS=n - Receive Silence

+FRS=n causes the modem to report back to the DTE with an OK result code after n 10 ms-intervals of silence have been detected on the line. This command is aborted if any character is received from the DTE. The modem discards the aborting character and issues an OK result code. An ERROR response code results if this command is issued while the modem is on-hook.

+FTM=n - Transmit Data

+FTM=n causes the modem to transmit data using the modulation defined below. An ERROR response code results if this command is issued while the modem is on-hook.

Parameters: See Command options

Command options:

+FTM=24	V.27 ter 2400 bps
+FTM=48	V.27 ter 4800 bps
+FTM=72	V.29 7200 bps
+FTM=73	V.17 7200 bps long
+FTM=74	V.17 7200 bps short
+FTM=96	V.29 9600 bps
+FTM=97	V.17 9600 bps long
+FTM=98	V.17 9600 bps short
+FTM=121	V.17 12000 bps long
+FTM=122	V.17 12000 bps short
+FTM=145	V.17 14400 bps long
+FTM=146	V.17 14400 bps short

+FRM=n - Receive Data

+FRM=n causes the modem to enter the receiver mode using the modulation defined below. An ERROR response code results if this command is issued while the modem is on-hook.

Parameters: See Command options

Command options:

+FRM=24	V.27 ter 2400 bps
+FRM=48	V.27 ter 4800 bps
+FRM=72	V.29 7200 bps
+FRM=73	V.17 7200 bps long
+FRM=74	V.17 7200 bps short
+FRM=96	V.29 9600 bps
+FRM=97	V.17 9600 bps long
+FRM=98	V.17 9600 bps short
+FRM=121	V.17 12000 bps long
+FRM=122	V.17 12000 bps short
+FRM=145	V.17 14400 bps long
+FRM=146	V.17 14400 bps short

+FTH=n - Transmit Data with HDLC Framing

+FTH=n causes the modem to transmit data using HDLC protocol and the modulation defined below. An ERROR response code results if this command is issued while the modem is on-hook.

Parameters: See Command options.

Command options:

+FTH=3	V.21 channel 2 300 bps
+FTH=24	V.27 ter 2400 bps
+FTH=48	V.27 ter 4800 bps
+FTH=72	V.29 7200 bps
+FTH=73	V.17 7200 bps long
+FTH=74	V.17 7200 bps short
+FTH=96	V.29 9600 bps
+FTH=97	V.17 9600 bps long
+FTH=98	V.17 9600 bps short
+FTH=121	V.17 12000 bps long
+FTH=122	V.17 12000 bps short
+FTH=145	V.17 14400 bps long
+FTH=146	V.17 14400 bps short

+FRH=n - Receive Data with HDLC Framing

+FRH=n causes the modem to receive frames using HDLC protocol and the modulation defined below. An ERROR response code results if this command is issued while the modem is on-hook.

Parameters: See Command options.

Command options:

+FTH=3	V.21 channel 2 300 bps
+FRH=24	V.27 ter 2400 bps
+FRH=48	V.27 ter 4800 bps
+FRH=72	V.29 7200 bps
+FRH=73	V.17 7200 bps long
+FRH=74	V.17 7200 bps short
+FRH=96	V.29 9600 bps
+FRH=97	V.17 9600 bps long
+FRH=98	V.17 9600 bps short
+FRH=121	V.17 12000 bps long
+FRH=122	V.17 12000 bps short
+FRH=145	V.17 14400 bps long
+FRH=146	V.17 14400 bps short

6.3. EXAMPLES

Examples of calling (transmitting) and answering (receiving) one page using fax class 1 commands are shown in Tables 6-2 and 6-3, respectively.

Table 6-2. Fax Class 1 Calling Sequence (One Page)

DTE Commands (Host)	DCE Responses (Modem)	Remote Fax	Notes
(1) AT+FCLASS=1	(2) OK		Set to Class 1
PHASE A			
(3) ATDT6163	(4) Dials	(5) Answers	+FRH=3 implied by Dialing
	(6) CONNECT	(7) Send HDLC flags	
PHASE B			
		(8)	Send NSF frame
	(9) <NSF>,OK		
(10) AT+FRH=3	(11) CONNECT		
		(12) Send CSI frame	
	(13) <CSI>,OK		
(14) AT+FRH=3	(15) CONNECT		
		(16) Send DIS frame	Last frame bit = 1
	(17) <DIS>,OK	(18) Drop carrier	
(19) AT+FTH=3	(20) Send HDLC flags	(21) Receive flags	
	(21) CONNECT		
(22) <TSI>	(23) Send TSI frame	(24) Receive TSI	Last frame bit = 0
	(25) CONNECT		
(26) <DCS>	(27) Send DCS frame	(28) Receive DCS	Last frame bit = 1
	(29) Detect last frame bit		
	(39) OK, drop carrier		
(31) AT+FTS=8	(32) OK, wait 80 ms		
(33) AT+FTM=96	(34) Send V.29		
	(35) CONNECT		
(36) <TCF>	(37) Send TCF data	(38) Receive & check	
	(39) OK		
(40) AT+FRH=3	(41) CONNECT		
	(42) Send CFR frame	Last frame bit = 1	
(43) <CFR>,OK	(44) Drop carrier		
	(45) OK		
PHASE C			
(46) AT+FTM=96	(47) Send V.29		
	(48) CONNECT		
(49) age data	(50) Send page data	(51) Receive data	
	(52) OK		
(53) AT+FTH=3	(54) Send HDLC flags	(55) Receive flags	
	(56) CONNECT		
PHASE D			
(57) <EOP>	(58) Send EOP frame	(59) Receive EOP	Last frame bit = 1
	(60) OK, drop carrier		
(61) AT+FRH=3	(62) CONNECT		
		(63) Send MCF frame	Last frame bit = 1
	(64) <MCF>, OK		
(65) AT+FTH=3	(66) Send HDLC flags	(67) Receive flags	
	(68) CONNECT		
(69) <DCN>	(70) Send DCN frame	(71) Receive DCN	Last frame bit = 1
	(72) OK, drop carrier		
PHASE E			
(73) ATH0	(74) OK, hang up	(75) Hang up	

Table 6-3. Fax Class 1 Answering Sequence (One Page)

DTE Commands (Host)	DCE Responses (Modem)	Remote Fax	Notes
(1) AT+FCLASS=1	(2) OK		Set to Class 1
PHASE A			
		(3) FAX machine dials	
	(4) RING		
(5) ATA	(6) Modem answers		
	(7) Send HDLC flags	(8) Receive flags	+FTH=3 implied by answering
	(9) CONNECT		
PHASE B			
(10) <NSF>	(11) Send NSF frame	(12) Receive NSF	Last frame bit = 0
	(13) CONNECT		
(14) <CSI>	(15) Send CSI frame	(16) Receive CSI	Last frame bit = 0
	(17) CONNECT		
(18) <DIS>	(19) Send DIS frame	(20) Receive DIS	Last frame bit = 1
	(21) OK, drop carrier		
(22) AT+FRH=3	(23) CONNECT		
		(24) Send TSI frame	Last frame bit = 0
	(25) <TSI>, OK		
(26) AT+FRH=3	(27) CONNECT		
		(28) Send DCS frame	Last frame bit = 1
	(29) <DCS>, OK	(30) Drop Carrier	
(31) AT+FRM=96			
		(32) Send V.29	
	(33) CONNECT	(34) Send TCF frame	
	(35) <TCF>	(36) Drop carrier	
	(37) NO CARRIER		
(38) AT+FTH=3	(39) CONNECT		
(40) <CFR>	(41) Send CFR frame	(42) Receive CFR	Last frame bit = 1
	(43) OK, drop carrier		
PHASE C			
(44) AT+FRM=96			
		(45) Send page data	
	(46) <page data>	(47) Drop carrier	
	(48) NO CARRIER		
PHASE D			
(49) AT+FRH=3	(50) CONNECT		
		(51) Send EOP frame	Last frame bit = 1
	(52) <EOP>, OK		
(53) AT+FTH=3	(54) CONNECT		
(55) <MCF>	(56) Send MCF frame	(57) Receive MCF	Last frame bit = 1
	(58) OK, drop carrier		
(59) AT+FRH=3	(60) CONNECT		
		(61) Send DCN frame	Last frame bit = 1
	(62) <DCN>, OK		
PHASE E			
(73) ATH0	(74) OK, hang up	(75) Hang up	

7. FAX CLASS 2 COMMANDS

The fax class 2 commands are summarized in Table 7-1.

7.1. COMMAND SYNTAX AND GUIDELINES

7.1.1. DTE Commands

The ISO 646 character set (CCITT T.50 International Alphabet 5, American Standard Code for Information Interchange) is used for the issuance of commands and responses. Only the low-order 7 bits of each character are used for commands or parameters; the high order bit is ignored. Upper case characters are equivalent to lower case characters.

For Phase C data transmission or reception, all 8 bits are needed.

DTE Command Lines

A command line is a string of characters sent from a DTE to the modem (DCE) while the modem is in a command state. A command line has a prefix, a body, and a terminator. Each command line (with the exception of the A/ command) must begin with the character sequence AT and must be terminated by a carriage return. Commands entered in upper case or lower case are accepted, but both the A and T must be of the same case, i.e., "AT" = ASCII 065, 084 or “at” = ASCII 097, 116. The body is a string of commands restricted to printable ASCII characters (032 - 126). Space characters (ASCII 032) and control characters other than CR (ASCII 013) and BS (ASCII 010) in the command string are ignored. The default terminator is the ASCII <CR> character. Characters that precede the AT prefix are ignored. The command line interpretation begins upon receipt of the carriage return character.

Facsimile Command Syntax

After the "AT" or "at" prefix, facsimile commands use extended syntax. Each command is preceded by the “+F” character and consists of single characters and a decimal parameter (if applicable) terminated by the semicolon “:” character (ASCII 059) or by the <CR> that terminated the command line. A missing decimal parameter is evaluated as 0.

For example, the command to instruct the modem to automatically answer a data or fax call and also enable reception is:

AT+FAE=0; +FCR 1 <CR>

Basic data mode and fax service class mode select commands are:

AT+FCLASS=0 <CR>	for Data Mode
AT+FCLASS=1 <CR>	for Service Class 1 Fax
AT+FCLASS=2 <CR>	for Service Class 2 Fax

In Class 2, the DCE makes and terminates calls, manages the communication session and negotiates (T.30 protocol) and transports the image date to DTE. The T.4 protocol management of image data, etc., is done by DTE.

The response to

AT+FCLASS= 0<CR>	in Data Mode

or

AT+FCLASS=2<CR>	in Service Class 2 Fax

is

OK

The service class may be set by the DTE from the choices available using the “+FCLASS=<VALUE>” command.

General Rules

1. +Fnnn commands must be entered completely, otherwise an ERROR response is sent.
2. All response messages are preceded and followed by <CR><LF>. Multiple response commands (e.g., +FDIS: +FCSI: and +FDCS:) will, therefore, appear to a have a blank line between them.

3. Fax Class 2 commands can be separated by the “:” character. The “;” character can be omitted if desired. Note that non-data commands cannot be separated by the “;” which is allowed as a dial modifier.

Table 7-1. Fax Class 2 Commands

Command	Function
Service Class ID	
+FCLASS=	Service Class
Class 2 Action Commands	
D	Originate a Call
A	Answer a Call
+FDT	Data Transmission
+FET=N	Transmit Page Punctuation
+FDR	Begin or Continue Phase C Receive Data
+FK	Session Termination
Class 2 DCE Responses	
+FCON	Facsimile Connection Response
+FDCS:	Report Current Session
+FDIS:	Report Remote Identification
+FCFR	Indicate Confirmation to Receive
+FTSI:	Report the Transmit Station ID
+FCSI:	Report the Called Station ID
+FPTS:	Page Transfer Status
+FET:	Post Page Message Response
+FHNG	Call Termination with Status
Class 2 Session Parameters	
+FMFR?	Identify Manufacturer
+FMDL?	Identify Model
+FREV?	Identify Revision
+FDCC=	DCE Capabilities Parameters
+FDIS=	Current Sessions Parameters
+FDCS=	Current Session Results
+FLID=	Local ID String
+FCR	Capability to Receive
+FPTS=	Page Transfer Status
+FCR=	Capability to Receive
+FAE	Adaptive Answer
+FBUF?	Buffer Size (Read Only)
+FPHCTO	Phase C Time Out
+FAXERR	Fax Error Value
+FBOR	Phase C Data Bit Order

4. All Class 2 commands are assumed to be the final command on a command line. Additional characters will be ignored.
5. An ERROR message will be generated if any of the following conditions occur:
    a. A Class 1 command is received while in Class 2.
    b. A Class 2 command is received while in Class 1.
    c. A Class 1 or Class 2 action command is received while in data modem mode.
    d. A Class 2 read-only parameter is given the “=” form of a +F command (e.g., AT+FAXERR=5).
    e. A Class 2 action command is given the inappropriate “=” or “=?” form (e.g., AT+FDR=?).

7.1.2. Serial Port Speed and Flow Control

During fax mode, the DTE-DCE port speed is 19200 bps.

The DCE provides a speed buffer of 1024 bytes and provides the DC1/DC3 (XON/XOFF) or RTS/CTS method of controlling the data into the buffer. This flow control is controlled by the &K3 or &K4 command.

This method of data flow control is available only for DTE to DCE direction of data. There is no provision for data flow control from DCE to DTE.

Data Stream Termination

The DCE exchanges streams of data with the DTE while executing data transfer commands. These data streams use the termination described in Section 3.2/ISO 2111.

The ASCII <DLE> character (016) is used as a special character to shield special characters. The <DLE><ETX> character pair (<106><003>) is used to mark the end of a stream. The following patterns are used:

any data...<DLE><ETX>	end of stream
any data...<DLE><DLE>	single <DLE> in data
any data...<DLE><any byte>	delete <DLE><any byte>

DTE to DCE Streams

The DCE filters the data stream from the DTE, and removes all character pairs beginning with <DLE>. The DCE recognizes <DLE><ETX> as the stream terminator. The DCE recognizes <DLE><DLE> and reinserts a single <DLE> in its place.

The DTE must filter stream data to the DCE, and insert extra <DLE> characters ahead of data.

DCE to DTE Streams

The DTE must filter the data stream from the DCE, and remove all character pairs beginning with <DLE>. The DTE must recognize <DLE><ETX> as the stream terminator. The DTE must recognize <DLE><DLE> and reinsert a single <DLE> in its place.

The DCE filters stream data to the DTE, and inserts extra <DLE> characters ahead of data.

7.1.3. Auto Answer

The DCE can answer as a data DCE or as a fax DCE. It can answer the call adaptively, i.e., it can determine whether the call is 'data' or 'fax'. The +FAA parameter controls this feature.

AT+FAA=1	; Auto answer as a facsimile or a data modem depending on the call
CONNECT XXXX	; DCE status response if data call
+FCON	; DCE status response if fax call

7.1.4. Identification of T.30 Options

Group 3 devices negotiate session parameters in DIS, DCS, and DTC frames. These parameters are defined in Table 7-2.

7.1.5. Session Status Reporting

The DCE provides reports to the DTE on the status of a session. The DCE provides the following status reports:

1. Connection and hang up status:

    +FCON

    +FHNG:<0-255>

2. Requested DIS session parameters +FDIS: <string> reports remote facsimile capabilities.

    Syntax: +FDIS: VR, BR, WD, LN, DF, EC, BF, ST

3. +FDCS: <string> reports the negotiated parameters

4. Phase C prompts:

    XON, XOFF, DC2

5. Phase C base status reports: depending upon copy quality and related end-of page status:

    +FPTS: <1-5>

7.1.6. Procedure Interrupt Negotiation

CCITT allows a station to request a procedure interruption at the end of a page. This request is passed between stations by the PIP, PIN, and PRI-Q messages.

7.2. SERVICE CLASS 2 IDENTIFICATION AND SELECTION

Three commands report identification and selection information. Each of these three commands cause the DCE to send a message to the DTE. The messages are programmable using ConfigurACE.

7.2.1. +FMFR?, Request Manufacturer Identification

The +FMFR? command causes the DCE to send a message identifying the DCE product manufacturer. The default message is:

ROCKWELL
OK

7.2.2. +FMDL?, Identify Product Model

The +FMDL? command causes the DCE to send a message identifying the DCE product model. The default message is similar to:

RC96XXXAC
OK

7.2.3. +FREV?, Identify Product Revision

The +FREV? command causes the DCE to send a message identifying the DCE product model revision number. The message format is the same as the ATI3 message, e.g:

VX.XXX-model number
OK

7.3. SERVICE CLASS 2 ACTION COMMANDS

These commands transfer data, and punctuate sessions. They also release specific T.30 messages. All action commands must be the last command on a command line as indicated by the terminating <CR>.

All action commands initiate processes. The modem will not accept other commands from the DTE until the modem issues a final result code (e.g., OK, CONNECT). The modem will abort the process if it receives any character before the final result code is issued.

7.3.1. ATD, Originate a Call

Syntax: ATD....<CR>

The DCE can support a DTE command to originate a call using the ATD command (see Section 3.2).

If this command is unsuccessful, the DCE reports an appropriate failure or error type result code such as NO CARRIER, NO DIALTONE, or BUSY (see Section 3.3).

If this call is successful, the typical DCE response is:

```
ATDnn..nn                    (go off-hook, dial, get CED)
+FCON                        (DCE detects flags)
[+FCSI:<remote ID string>]
+FDCS:<T.30 subparameter string>
OK
```

The DCE dials, detects call progress, and generates the CNG tone. It then waits for a DIS frame. On detection of the first Phase B preamble (V.21 ch. 2 modulated by 300 bps HDLC flags), it reports the "+FCON" message to the DTE. The DCE then switches to 19200 bps.

The DCE generates a DCS frame based on the received DIS frame and on the previously set +FDIS parameter. A +FDT command from the DTE releases the DCE to transmit that DCS frame.

The DCE reports the initial received T.30 negotiation messages, including the DIS frame and the optional CSI ID string. The +FDIS: report is followed by the OK final result code.

7.3.2. ATA, Answer a Call

The DCE can support a DTE command to answer an incoming call using the ATA command (see Section 3.2).

The DTE may issue an Answer command in response to an incoming ring.

If the Answer command is unsuccessful, the DCE will report an appropriate failure or error type result code, such as NO CARRIER (see Section 3.3).

Manual Call Answer

If this call is successful, the typical DCE response (answer and receive) is:

```
+FCON
[+FTSI:<remote ID string>]
+FDCS:<T.30 subparameter string>
OK
(DTE should issue +FDR command here)
```

Upon receipt of an Answer command from the DTE, the DCE answers and generates the CED tone. The DCE then generates a DIS frame (derived from the +FDIS parameter) and hunts for the first T.30 negotiation frames. Upon detection of the first Phase B preamble (V.21 ch 2 modulated by 300 bps HDLC flags), it reports the "+FCON" message to the DTE.

The DTE should report the initial received T.30 negotiation messages, including the DCS frame. The +FDCS: report will be followed by the OK final result code.

Automatic Answer

The modem provides for automatic answering of incoming calls. If configured for automatic answer, the modem answers an incoming call in compliance with T.30, and reports the same messages as described for manual answer.

Connection as a Data Modem

If configured to do so by the +FAA parameter, the DCE will adaptively answer as a facsimile DCE or as a data DCE. If the DCE answers as a data DCE, it resets the +FCLASS parameter to 0 and issues the appropriate final result code (e.g., CONNECT, or NO CARRIER) to the DTE.

7.3.3. +FDT, Data Transmission

Syntax: +FDT <CR>

The +FDT command prefixes Phase C data transmission. When the DCE is ready to accept Phase C data, it issues the negotiation responses and the CONNECT result code to the DTE.

In Phase B, the +FDT command releases the DCE to proceed with negotiation, and releases the DCS message to the remote station. In Phase C, the +FDT command resumes transmission after the end of a prior transmit data stream.

Initiate Page Transmission

Phase B DCE polled response:

```
[+FCSI:<remote ID string>]   - if new CSI received
[+FDIS:<subparameters from remote station>]
                             - if new DIS received
+FDCS:<T.30 subparameter string>
CONNECT
<XON>                        - when ready for data
```

After placing a call, or after finishing a document exchange, the DTE may command the DCE to re-enter T.30 Phase B to attempt to negotiate a document transmission.

Continue a Page

```
CONNECT
<XON>
```

The DTE may issue more than one +FDT command for a given page, so that different files may be concatenated together. These files must have the same format.

Phase C Data Framing

Phase C data must be presented to the DCE in stream mode. The DCE expects Phase C data to follow until it detects <DLE><ETX> termination characters. The DCE will filter the stream as described in Section 7.1.2.

The DCE will acknowledge the end of the data by returning the OK result code to the DTE.

If there is data underrun before the next +FDT or +FET= command, the DCE will zero-fill the pad as per T.4 until the Phase C timeout (+FPHCTO) is reached, or until more data is received. The DCE appends an RTC pattern to the transmit data after an +FET= command is received from the DTE.

Phase C Data Format

The Phase C data will be of the format specified by the negotiated T.30 DCS frame. The +FDCS:<string> response is defined in Section 7.4.2. The subparameter values are described in Table 7-2.

The DCE will use the negotiated minimum Scan Time parameter from the DCS frame, and insert sufficient fill bits to pad each line to the minimum scan time. This is reported in the +FDCS:ST subparameter.

If the DCE finds more than one consecutive EOL in Phase C data (e.g., RTC), it will send only one EOL.

1. Phase C data must conform to T.4 specifications.
2. The DTE need not include a final RTC, since the DCE will append an RTC in response to an FET= command.
3. Some facsimile machines may treat two EOLs as an RTC.

<CAN>, Escape from Transmission

The DCE may request the DTE to halt Phase C transmission, by sending a cancel <CAN> character (024) to the DTE. In this case, the DTE should terminate Phase C transmission, issue <CAN>, and wait for the OK response code from the DCE.

Table 7-2. T.30 Session Subparameter Codes

Label	Function	Value	Description	
VR	Vertical Resolution	0	Normal, 98 lpi	
		1	Fine, 196 lpi	
BR	Bit Rate (See Note 1)		+FDCS (originate)	+FDIS (answer)
		0	2400 bps/V.27 ter	V.27ter (2400 only)
		1	4800 bps/V.27 ter	V.27ter
		2	7200 bps/V.29	V.29, V.27ter
		3	9600 bps /V.29 or V.17	V.29, V.27ter
		4	12000 bps/V.33 or V.17	V.17, V.33, V.29, V.27ter
		5	14400 bps/V.33 or V.17	V.17, V.33, V.29, V.27ter
WD	Page Width	0	1728 pixels in 215 mm	
		1	2048 pixels in 255 mm	
		2	2432 pixels in 303 mm	
		3*	1216 pixels in 151 mm	
		4*	864 pixels in 107 mm	
LN	Page Length	0	A4, 297 mm	
		1	B4, 364 mm	
		2	unlimited length	
DF	Data Compression Format	0	1-D modified Huffman	
		1*	2-D modified Read	
		2*	2-D uncompressed mode	
		3*	2-D modified modified Read	
EC	Error Correction (Annex A/T.30)	0	Disable ECM	
		1*	Enable ECM, 64 bytes/frame	
		2*	Enable ECM, 256 bytes/frame	
BF	Binary File Transfer	0	Disable BFT	
		1*	Enable BFT	
ST	Scan Time/Line		VR = normal	VR = fine
		0	0 ms	0 ms
		1	5 ms	5 ms
		2	10 ms	5 ms
		3	10 ms	10 ms
		4	20 ms	10 ms
		5	20 ms	20 ms
		6	40 ms	20 ms
		7	40 ms	40 ms

Notes: 1. CCITT T.30 does not provide for the answering station to specify all speeds exactly using the DIS frame. Implementation of some BR codes (e.g., code 2) by an answering DCE is manufacturer specific.

* Not supported.

7.3.4. +FET, Transmit Page Punctuation

Syntax: +FET=<ppm>[,<pc>,<bc>,<fc>]

DCE response:

+FPTS:<ppr> - when receive from remote OK

This command is used to punctuate page and document transmission after one or more +FDT commands. This command generates T.30 Post Page Messages selected by the <ppm> code (Table 7-3).

The +FET=<ppm> command indicates that the current page is complete; no more data will be appended to it. The value indicates whether there are any additional pages are to be sent and, if so, whether there is a change in any of the document parameters.

The DTE can command the DCE to generate PRI-Q messages with the +FET=<ppm> command using ppm codes 4-6 (see Table 7-3).

This command must be sent within the time out specified by +FPHCTO after sending Phase C data, or else the DCE will end the page and document transmission. If the Phase C timeout is reached, the DCE sends an EOP post page message and terminates the session.

The remote facsimile station should respond to the post page message with a post page response. The DCE will report this using the +FPTS:<ppr> response (Table 7-4).

End a Page

The +FET= command causes the DCE to append an RTC (6 EOL) pattern as needed and enter Phase D by sending the selected T.30 Post Page message.

The +FET=1 (EOM) command signals the remote station that the next document will have a new DCS negotiated; this causes the session to re-enter Phase B.

Table 7-3. T.30 Post Page Message Codes

ppm Code	Mnemonic	Description
0	[PPS-]MPS	Another page next, same document
1	[PPS-]EOM	Another document next
2	[PPS-]EOP	No more pages or documents
3	PPS-NULL	Another partial page next
4	[PPS-]PRI-MPS	Another page, procedure interrupt
5	[PPS-]PRI-EOM	Another doc., procedure interrupt
6	[PPS-]PRI-EOP	All done, procedure interrupt
=8+ppm		Post Page Message (ppm code)

Table 7-4. T.30 Post Page Response Messages

ppr Code	Mnemonic	Description
1	MCF	Page good
2	RTN	Page bad; retrain requested
3	RTP	Page good; retrain requested
4	PIN	Page bad; interrupt requested
5	PIP	Page good; interrupt requested

7.3.5. +FDR, Begin or Continue Phase C Receive Data

Syntax: +FDR <CR>

Default value: 3 seconds in some places

The +FDR command initiates transition to Phase C data reception. This can occur after answering, dialing, a document is received, or a page is received.

The DCE reports the negotiated T.30 parameters, with the remote ID information if available. When the DCE is ready to commence data transfer, it issues a CONNECT response code. If the DCE cannot resume data transfer because there is no more data, it responds OK. When the DTE is ready to accept data, it issues an <DC2> character (018) to the DCE.

If the DTE issues an <XOFF> character to the DCE for flow control, the DCE signals the DTE when its buffers are empty by sending a <DLE><DC2> (<016><018>) character pair.

When the DCE delivers the last byte of a page, the DCE reports the Page Transfer Status via the +FPTS:<ppr> response (Table 7-4).

After a Page Transfer Status Report, the DCE reports the post page message from the remote facsimile station via the +FET:<ppm> response (Table 7-3) which signals the intentions of the remote station.

The DCE holds the post page response message to the remote facsimile station (MCF, etc.), represented in the +FPTS parameter until the next +FDR command. The DTE may modify the +FPTS parameter before issuing the +FDR command which releases that message. The DTE must issue a +FDR command to release Post Page Messages.

Initiate Document Reception

The +FDR command may be issued in Phase B after an answer command, or in Phase B after a previous document.

The DCE response in stream mode is:

+FCFR	when CFR sent
[+FTSI:<remote ID string>]	if new TSI received
+FDCS:<T.30 subparameter string>]	if new DCS

CONNECT
(<DC2> needed from DTE here)
<Phase C data stream>
<DLE><ETX>
+FPTS:<ppr>, <lc> [,<blc>, <cblc>]
+FET:<ppm>
OK
(DTE must issue +FDR command to release post page response)

Continue Document Reception

The DTE may issue a +FDR command in Phase D, which releases the post page message, and indicates readiness to receive another page after receipt of a Multipage (+FET:0) or PPS-NULL (+FET:3) message. The DCE response will be:

CONNECT
(<DC2> needed from DTE here)

<Phase C data stream)
<DLE><ETX>
+FPTS:<ppr>, <lc> [,<blc>, <cblc>]
+FET:<ppm>
OK
(DTE must issue +FDR command to release post page response)

If done receiving:

+FHNG: <hangup cause code>
OK

Continue page reception

Phase C Data Framing

Phase C data may be presented to the DTE in stream mode. The DCE will transfer a stream of data to the DTE, followed by the <DLE><ETX> stream termination characters. The DCE will filter the stream as described in 7.1.2.

Phase C Data Format

The received data format is negotiated under T.30 reported by the +FDCS:VR,BR,WD,LN,DF,EC,BF,ST response.

The DCE will delete the terminating RTC (6 EOLs) patterns.

<CAN>, Escape from Reception

From the +FDR command until the end of Phase D Date, the DCE is in a data transfer state, and will not respond to DTE command characters. The DCE will respond to three ASCII control characters: <DC1> (017) and <DC3> (019) flow control characters, and cancel <CAN> (024).

Upon receipt of the <CAN> character, the DCE will terminate the reporting of received data by sending trailing <DLE><ETX> characters to the DTE, and will then execute an implied +FK command in order to conduct an orderly disconnection.

7.3.6. +FK, Session Termination

Syntax: +FK

The +FK command causes the DCE to terminate the session in an orderly manner. In particular, the DCE will send a DCN message at the next opportunity and hang up. At the end of the termination process, the DCE will report the +FHNG response with result code (Table 7-5).

This operation can be invoked by using the cancel <CAN> character during Phase C data reception (see prior section)

The DCE will wait until the current page completes, unless the reception is of unlimited length; in that case, the DCE may halt reception and terminate the session at any time.

7.3.7. +FCIG, Set Polling ID

This command allows setting the Local Polling ID string used in a CIG frame. The syntax of this command is identical to +FLID.

Write syntax: +FCIG="<local ID string>"

Valid value: 20-character ASCII string

Default value: Empty

7.3.8. +FLPL, Indicate a Document for Polling

This command allows setting up an answering modem to know that it has a document available for polling. This allows a calling modem to receive this fax from the answerer. The syntax is:

```
AT+FLPL=?
0,1

OK
AT+FLPL=1

OK
AT+FLPL?
1
```

7.3.9. +FSPL, Enable Polling

This command allows setting up an originating modem to be able to request to receive a document from a polled station. The syntax is:

```
AT+FSPL=?
0,1

OK
AT+FSPL=1

OK
AT+FSPL?
1
```

Table 7-5. Hang Up Status Codes

Code	Cause Description
0-9	**Call Placement and Termination**
0	Normal and proper end of connection
1	Ring Detect without successful handshake
2	Call aborted, from +FK or AN
3	No Loop Current
10-19	**Transmit Phase A & Miscellaneous Errors**
10	Unspecified Phase A error
11	No Answer (T.30 T1 timeout)
20-39	**Transmit Phase B Hangup Codes**
20	Unspecified Transmit Phase B error
21	Remote cannot receive or send
22	COMREC error in transmit Phase B
23	COMREC invalid command received
24	RSPEC error
25	DCS sent three times without response
26	DIS/DTC received 3 times; DCS not recognized
27	Failure to train at 2400 bps or +FMINSP value
28	RSPREC invalid response received
40-49	**Transmit Phase C Hangup Codes**
40	Unspecified Transmit Phase C error
43	DTE to DCE data underflow
50-69	**Transmit Phase D Hangup Codes**
50	Unspecified Transmit Phase D error
51	RSPREC error
52	No response to MPS repeated 3 times
53	Invalid response to MPS
54	No response to EOP repeated 3 times
55	Invalid response to EOP
56	No response to EOM repeated 3 times
57	Invalid response to EOM
58	Unable to continue after PIN or PIP
70-89	**Receive Phase B Hangup Codes**
70	Unspecified Receive Phase B error
71	RSPREC error
72	COMREC error
73	T.30 T2 timeout, expected page not received
74	T.30 T1 timeout after EOM received
90-99	**Receive Phase C Hangup Codes**
90	Unspecified Receive Phase C error
91	Missing EOL after 5 seconds
92	Unused code
93	DCE to DTE buffer overflow
94	Bad CRC or frame (ECM or BFT modes)
100-119	**Receive Phase D Hangup Codes**
100	Unspecified Receive Phase D errors
101	RSPREC invalid response received
102	COMREC invalid response received
103	Unable to continue after PIN or PIP
120-255	**Reserved Codes**
Note: Some codes are not implemented.	

7.4. SERVICE CLASS 2 DCE RESPONSES

The DCE sends information responses to the DTE as a facsimile session proceeds. They indicate the state of the facsimile session and convey needed information. These messages are solicited messages generated in execution of DTE action commands described in Section 7.3.

The DCE precedes and follows the information responses with <CR><LF>.

The DCE provides the on-line status of several session parameters when they are available during T.30 handshaking. These include the remote ID string and the DIS/DCS parameters. These responses report the T.30 session parameter frames. The subparameters are described in Table 7-2.

7.4.1. +FCON, Facsimile Connection Response

+FCON indicates connection with a fax machine. It is released by detection of HDLC flags in the first received frame. +FCON is generated in response to an Originate or Answer command.

7.4.2. +FDCS:, Report Current Session Capabilities

Syntax: +FDCS:VR,BR,WD,LN,DF,EC,BF,ST

+FDCS:<string> reports the negotiated parameters. Phase C data will be formatted as described by the subparameters. This message may be generated in execution of +FDT or +FDR commands before the CONNECT result code if new DCS frames are generated or received. (See Table 7-2.)

7.4.3. +FDIS:, Report Remote Station Capabilities

Syntax: +FDIS:VR,BR,WD,LN,DF,EC,BF,ST

+FDIS:<string> reports remote facsimile station capabilities and intentions. The parameters are provided in ASCII notation. (See Table 7-2.)

This message is generated in execution of Originate, Answer, +FDT, or +FDR commands.

7.4.4. +FCFR, Indicate Confirmation to Receive

Syntax: +FCFR

The DCE sends a +FCFR response to the DTE upon reception of an acceptable TCF training burst and a valid DCS signal from the remote machine. This indicates that the DCE will receive Phase C data after the remote station receives the local DCE's CFR message. The +FCFR message is generated in execution of a +FDR command.

7.4.5. +FTSI:, Report the Transmit Station ID

Syntax: +FTSI: “<TSI ID string>” Transmit Station ID

This response reports the received transmit station ID string, if any. This message is generated in execution of Originate, Answer, +FDT, or +FDR commands.

7.4.6. +FCSI:, Report the Called Station ID

Syntax: +FCSI: “<CSI ID string>” Called Station ID

This response reports the received called station ID string, if any. This message is generated in execution of Originate, Answer, +FDT, or +FDR commands.

7.4.7. +FPTS:, Receive Page Transfer Status

Syntax: +FPTS:<ppr>, <lc> [,<blc>, <cblc>]

The +FPTS:<ppr> is generated by the DCE at the end of Phase C data reception in execution of a +FDR command.

The <ppr> is generated by the DCE; it depends on the DCE capabilities at T.4 error checking. See Table 7-4 for <ppr> values.

The receiving DCE will count the lines. These values are;

<lc> = line count

<blc = bad line count

<cblc> = <consecutive bad line count

A receiving DTE may inspect <ppr> and write a modified value into the +FPTS parameter. The DCE will hold the corresponding Post Page Response message until released by a +FDR command from the DTE.

7.4.8. +FET:, Post Page Message Response

Syntax: +FET:<ppm>

The +FET:<post page message> response is generated by a receiving DCE after the end of Phase C reception on receipt of the post-page message from the transmitting station. The +FET:<ppm> response is generated in execution of a +FDR command. The <ppm> codes respond to the T.30 post page messages (Table 7-3).

7.4.9. +FPTS:, Transmit Page Transfer Status

Syntax: +FPTS:<ppr>

The +FPTS: response reports a <ppr> number representing the copy quality and related post-page message responses received from the remote DCE. The valid <ppr> values are defined in Table 7-4.

The +FPTS:<ppr> response is generated in execution of a +FET=<ppm> command.

7.4.10. +FHNG:, Call Termination with Status

Syntax: +FHNG:<hangup status code>

+FHNG indicates that the call has been terminated. The hangup cause is reported and stored in the +FAXERR parameter for later inspection. The <hangup status code> values are described in Table 7-5.

+FHNG:<hsc> is a possible intermediate result code to any DTE action command described in Section 7.3. It is always followed by the OK final result code.

Upon termination of a call, the DCE determines the cause of termination and reports it as part of the FHNG:<hsc> response. It also stores this <hsc> code in the +FAXERR parameter for later inspection.

The hangup values are organized according to the phases of the facsimile transaction as defined by T.30. In the Figure A/T.30 flow charts, there are decision boxes labelled “Command Received?"; this is referred to as COMREC in the table. Similarly, decision boxes labelled `Response Received?' are referred to as RSPREC in the table. A COMREC error or RSPREC error indicates that one of two events occurred: 1) a DCN (disconnect) signal was received, or 2) an FCS error was detected and the incoming signal was still present after 3 seconds. (See Figure A/T.30).

The table values are in decimal notation. Leading zero characters are optional.

7.4.11. +FCIG:, Report the Polled Station ID

Syntax: +FCIG: “< ID string>” Polled Station ID

This response reports the received transmit station ID string, if any. This message is generated in execution of Originate, Answer, +FDT, or +FDR commands.

7.4.12. +FDTC:, Report the Polled Station Capabilities

Syntax: +FDTC: “< string>” Polled Station Capabilities

If the answerer has a document to poll, it would be communicated to the originator in bit 9 of the DIS frame. The originating station may elect to transmit a fax, and later, send SIG and DTC frames to pick up the polled document. The answering station would report the the incoming DTC frame via the +FDTC: response message after command mode is cancelled with the AT+FDR command.

7.4.13. +FPOLL, Indicate Polling Request

Syntax: +FPOLL:

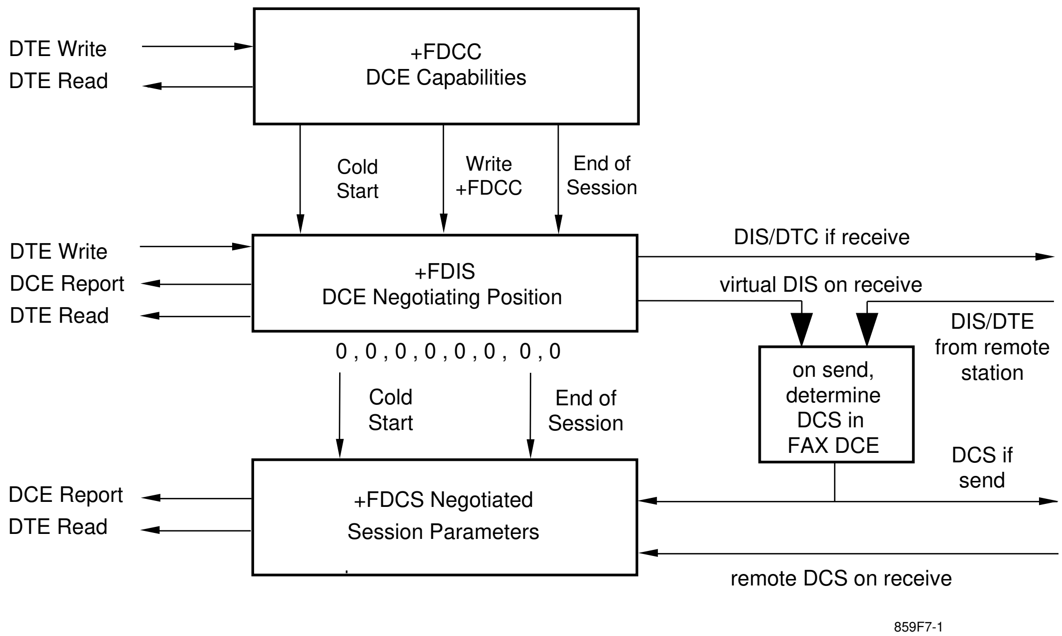
This message is sent to the DTE if the received DIS message indicates that the remote station has a document to poll (by bit 9 in the DIS) and polling has been enabled with the AT+FSPL command. The DTE may then decide to receive rather than transmit.

7.5. SERVICE CLASS 2 PARAMETERS

All Service Class 2 parameters can be read, written, and tested for range of legal values by the DCE. The general syntax is described in Section 7.1.

Group 3 FAX devices negotiate session parameters in DIS, DCS, and DTC frames. The following parameters are provided to condition the facsimile DCE for the capabilities it will offer and to report the session settings negotiated.

The three primary T.30 session parameters are +FDCC, +FDIS and +FDCS. They are compound parameters, using values listed in Table 7-2. Figure 7-1 illustrates their relationships.



7-1. T.30 Session Parameter Relationships

7.5.1. +FDCC, DCE Capabilities Parameters

Write syntax: +FDCC=VR,BR,WD,LN,DF,ED,BF,ST

Valid values: See Table 7-2

Default values: 0,5,0,2,0,0,0,0

+FDCC allows the DTE to sense and constrain the capabilities of the facsimile DCE from the choices defined in CCITT T.30 Table 2. When +FDCC is modified by the DTE, the DCE copies +FDCC into +FDIS.

7.5.2. +FDIS, Current Sessions Capabilities Parameters

Write syntax: +FDIS=VR,BR,WD,LN,DF,EC,BF,ST

Valid values: See Table 7-2

Default values: 0,5,0,2,0,0,0,0

The +FDIS parameter allows the DTE to sense and constrain the capabilities used for the current session. The DCE uses +FDIS to generate DIS or DTC messages directly, and uses +FDIS and received DIS messages to generate DCS messages.

The DCE initializes the +FDIS parameter from the +FDCC parameter on initialization, when +FDCC is written, and at the end of a session.

7.5.3. +FDCS, Current Session Results Parameters

Read syntax: +FDCS?

DCE response: +FDCS=VR,BR,WD,LN,DF,EC,BF,ST

or +FDCS=

Valid values: See Table 7-2.

Default values: 0,0,0,0,0,0,0,0

The +FDCS parameter is loaded with the negotiated T.30 parameters for the current session. A transmitting DCE generates DCS; a receiving DCE gets DCS from the remote station. The DTE may read this parameter.

The +FDCS parameter is initialized 0,0,0,0,0,0,0,0 upon initialization and at the beginning of a session. If the DTE issues a +FDCS? command in the initial state, the DCE reports:

<CR><LF>0,0,0,0,0,0,0,0<CR><LF>

The contents of +FDCS are spontaneously reported during execution of +FDR or +FDT commands by the +FDCS:VR,BR,WD,LN,BF,EC,BF,ST response using the same compound parameter format.

Several commands and responses reference T.30 session negotiated parameters. These are described by a set of common subparameters. These subparameters are described in Table 7-2 with notes. Optional parameter values are marked with an *. Unspecified parameter values are reserved for future use.

The +FDCC, +FDIS, and +FDCS compound parameters use these session parameters (On writes, unspecified subparameters are unchanged.)

The +FDIS:, +FDCS:, and +FDTC: session report responses use these subparameters.

For test response, ranges of values are reported for each subparameter enclosed in parentheses characters. For example, a DCE response to +FDCC=? could report:

<CRLF> (0,1), (0-5), (0-3), (0-2), (0-2), (0-2), (0), (0-7) <CRLF>

Example:

+FDIS=0,3,0,2,0,0,0,1 =

VR = 0	98 dpi vertical resolution,
BR = 5	14400 bit/s
WD = 0	1728 pixels,
LN = 2	unlimited length
DF = 0	1-D modified Huffman coding,
EC = 0	no ECM,
BF = 0	no BFT,
ST = 1	5 ms scan time.

7.5.4. +FLID=, Local ID String

Write syntax: +FLID="<local ID string>"

Valid value: 20-character ASCII string

Default value: Empty

If FLID is not a null string, it generates a TSI or CSI frame. Table 3/T.30 includes digits 0-9, “+” and space.

If the DCE supports use of Table 3/T.30 only, the response to a +FLID=? command is “(20) (32, 43, 48-57).” If the DCE supports printable ASCII <, the response is: “(20) (32-127)<CRLF>.” The first “(20)” represents string length: the second (character values) field reports supported string values.

1. The string is saved in RAM.
2. Non-numeric characters are not filtered out.
3. The string is right justified.

7.5.5. +FCR, Capability to Receive

Write syntax: +FCR=<value>

Valid values: 0 or 1

Default value: 0

+FCR=0 indicates that the DCE will not receive message data. This can be used when the DTE has insufficient storage. The DCE can send and can be polled for a file.

+FCR is sampled in CCITT T.30 Phase A and Phase D.

7.5.6. +FPTS=, Page Transfer Status

Write Syntax: +FPTS=<ppr>

Valid values: 1, 2, 3, 4, 5

Default value: 0

The +FPTS parameter contains a value representing the post page response, including copy quality and related end-of-page status. These values correspond to post page response messages defined in T.30. The receiving DCE sets this parameter after it receives a page of Phase C data. The transmitting DCE sets this parameter with the status reported by the receiving station. The DTE may inspect or modify this parameter.

The set of <ppr> values is defined in Table 7-4. These values are also reported in the +FPTS response to the +FDR command.

7.5.7. +FCQ, Copy Quality Checking

Write syntax: +FCQ=<value>

Valid values: 0

Default value: 0

This parameter controls Copy Quality checking by a receiving facsimile DCE.

The DCE returns +FCQ=0 which indicates the DCE does no quality checking. The DCE will generate Copy Quality OK (MCF) responses to complete pages, and set +FPTS=1.

7.5.8. +FPHCTO, DTE Phase C Response Time-out

Write syntax: +FPHCTO=<value>

Valid values: 0 - 255, 100 millisecond units.

Default value: 30

The +FPHCTO command determines how long the DCE will wait for a command after reaching the end of data when transmitting in Phase C. When this time-out is reached, the DCE assumes there are no more pages and no documents to send. It then sends the T.30 EOP response to the remote device.

7.5.9. +FAXERR, T.30 Session Error Report

Read syntax: +FAXERR= <table value>, read only

Valid values: 0 - 255, see Table 7-5 for meaning

This read-only parameter indicates the cause of the hangup. Table 7-5 shows the valid values for this parameter as well as the meaning of the each value. +FAXERR is set by the DCE at the conclusion of a fax session. The DCE resets +FAXERR to 0 at the beginning of Phase A off-hook time.

7.5.10. +FBOR, Data Bit Order

Write syntax: +FBOR=<value>

Valid values: 0, 1, 2, or 3

Default value: 0

This parameter controls the mapping between PSTN facsimile data and the DTE-DCE link. There are two choices:

Direct: The first bit transferred to each byte on the DTE-DCE link is the first bit transferred on the PSTN data carrier.

Reversed: The last bit transferred of each byte on the DTE-DCE link is the first bit transferred on the PSTN data carrier.

There are two data types to control:

This command controls Phase C data (T.4 encoded data) transferred during execution of +FDT or +FDR commands.

The following two codes are supported:

+FBOR=0 or 2 Selects direct bit order for Phase C data.

+FBOR=1 or 3 Selects reversed bit order for Phase C data.

Note that this parameter does not affect the bit order of control characters generated by the DCE.

7.5.11. +FAA, Answer Parameter

Write syntax: +FAA=<value>

Valid values: 0 or 1

Default value: 0

+FAA=0 Constrains the DCE to answer as set by +FCLASS.

+FAA=1 Indicates that the DCE can answer and automatically determine whether to answer as a Class 2 facsimile DCE or as a data modem. If the DCE automatically switches, it modifies FCLASS appropriately.

Class 2 adaptive answer is implemented as follows:

First, a data mode handshake is attempted. If the DCE has been configured for automode detection (using the +MS command), the DCE may try several protocols before terminating attempts to make a data mode connection. This can take as long as 6-8 seconds.

If the data mode connection attempt fails, a facsimile Class 2 connection is assumed. When a connection is made as a result of the adaptive answer, the DCE issues the DATA or FAX result code before the CONNECT or +FCON message to inform the DTE of the connection type. After making a Class 2 connection, the DCE stays on-line rather than going into the command mode as with a Class 1 connection.

7.5.12. +FBUF?, Buffer Size

Read syntax: +FBUF?

DCE response syntax: <bs>, <xoft>, <xont>, <bc>

where:

<bs> = total buffer size

<xoft> = XOFF threshold

<xcont> = XON threshold

<bc> = current buffer byte count

Example:

+FBUF?

512, 506, 500, 0

The +FBUF parameter allows the DTE to determine the characteristics of the DCE's data buffer. Data buffers are used for flow control. Use of the reported values allow the DTE to transfer data without provoking XOFF.

7.6. EXAMPLE SESSIONS

Tables 7-6 and 7-7 show the typical command and responses for sending and receiving two pages, respectively.

Table 7-6. Send Two Pages, 1-D, No Errors

DTE Command	DCE Response	Local DTE Action	Remote Station Action
AT+CLASS=2	OK	Set Class 2	x
AT+FLID="<local ID>"	OK	Set local ID	
AT<dial string>	 +FCON [+FCSI:"<csi>"] +FDIS: <dis codes> OK	Off hook, dial Send CNG Detect flags [Get CSI] Get DIS	Answer, Send [CED] V.21 flags [CSI] DIS
AT+FDT <1st page data> <DLE><ETX>	 +FDCS:<DCS codes> CONNECT <XON> OK	[Send TSI] Send DCS Send TCF Get CFR Send carrier Send page data	[Get TSI] Get DCS Get TCF Send CFR Receive carrier Receive page data
AT+FET=0	 +FPTS:1 OK	Send RTC Get MPS Get MCF	Get RTC Get MPS Send MCF
AT+FDT <2nd page data> <DLE><ETX>	CONNECT <XON> OK	Send carrier Send page data	Receive carrier Receive page data
AT+FET=2	 +FPTS:1 +FHNG:0 OK	Send RTC Send EOP Get MCF Send DCN Hang up	Get RTC Get EOP Send MCF Get DCN Hang up

Table 7-7. Receive Two Pages, 1-D Data, No Errors

DTE Command	DCE Response	Local DTE Action	Remote Station Action
AT+FCR=1	OK	Enable reception	
AT+FLID="<local ID>"	OK	Set local ID	
	RING	Detect ring	Dials[, Send CNG]
ATA	 +FCON [+FTSI:"<tsi>"] +FDCS:<dcs codes> OK	Off hook Send CED Send CSI Send DIS Detect flags [Get TSI] Get DCS Begin TCF receive	 Get CED Get CSI Get DIS Send V.21 flags [Send TSI] Send DCS Start TCF
AT+FDR <DC2>	 +FCFR [+FDCS:"<dcs codes>] CONNECT <page data stream> <DLE><ETX> +FPTS:1, <lc> +FET:0 OK	Accept TCF Send CFR Get page carrier Get page data Detect RTC Get MPS	Finish TCF Get CFR Send pager carrier Send page data Send RTC Drop carrier Send MPS
AT+FDR <DC2>	 CONNECT <page data stream> <DLE><ETX> +FPTS:1, <lc> +FET:2 OK	Send MCF Get page carrier Get page data Detect RTC Get EOP	Get MCF Send page carrier Send page data Send RTC Drop carrier Send EOP
AT+FDR	 +FHNG:0 OK	Send MCF Get DCN	Get MCF Send DCN

8. VOICE/AUDIO COMMANDS

The modem is configured into Voice Mode (modem models not supporting business audio) or Voice/Audio Mode (modem models supporting business audio) in response to the AT #CLS=8 command, and this mode is composed of the Voice and Audio sub-configurations as described in this section. Additional voice/audio AT commands are available to support selection of operational parameters from both inside and outside the Voice/Audio Mode.

a) **Voice Sub-Configuration**. Enhanced Adaptive Differential Pulse Code Modulation (ADPCM) coding and decoding of analog voice is accomplished with a 7.2 kHz sampling rate and 2 or 4 bits/sample quantization, and supports efficient compression and decompression of digitized voice. Optional coder silence deletion and decoder silence interpolation significantly increase compression rates. Additionally, the Voice Configuration supports concurrent tone generation/detection capabilities.

b) **Audio Sub-Configuration (Available Only for Modem Models Supporting Business Audio)** . Linear PCM coding and decoding of analog audio is accomplished with 7.2 kHz or 11.025 kHz sampling rates and 8 or 16 bits/sample quantization, and supports superior sound quality as compared to ADPCM. With a sampling rate of 7.2 kHz, the Audio Sub-configuration supports concurrent tone generation/detection capabilities. With a sampling rate of 7.2 kHz or 11.025 kHz, this sub-configuration can be used to record and playback monophonic data in 8-bit unsigned linear PCM or 16-bit signed linear PCM format.

Note: The term "voice" is used to refer to both voice and audio functions, except where otherwise noted.

The Voice/Audio Mode (i.e., either sub-configuration) supports three submodes once a voice connection has been established (refer to the descriptions of the #CLS command): Online Voice Command Mode, Voice Receive Mode, and Voice Transmit Mode. Determination of whether operation takes place in the Voice sub-configuration or the Audio sub-configuration is made by use of the #VBS and #VSR commands (refer to the descriptions of these commands).

8.1. VOICE/AUDIO SUBMODES

8.1.1. Online Voice Command Mode

Online Voice Command Mode is the default Voice submode entered when the #CLS=8 command is issued, and may also be entered from Voice Receive Mode or Voice Transmit Mode. Entry into Online Voice Command Mode is indicated to the DTE via the VCON message, after which AT commands can be entered without aborting the telephone line connection.

If the modem is the answerer, it enters Online Voice Command Mode immediately after going off-hook, and can report instances of DTMF tones and calling tones to the DTE. If the modem is the originator, it enters Online Voice Command Mode based on detection of the ringback cadence going away, upon expiration of the ringback never came timer, or upon detection of answer tone, and the modem can report DTMF tones, answer tones, busy tone, and dial tone to the DTE. (Note that DTMF tone reporting is supported in this mode if DTMF reporting is enabled via the #VTD command.)

When this mode is entered as a result of going off-hook with the D or A command, VCON is always sent to the DTE, after which the modem accepts commands. If this mode is entered from Voice Transmit Mode, the DTE has issued the <DLE><ETX>, and the modem responds with VCON. If this mode is entered from the Voice Receive Mode because of a key abort, the modem issues the <DLE><ETX> followed by VCON.

If the #VLS command has switched in a handset or other device in place of the telephone line, Online Voice Command Mode is immediately entered, whereas if the telephone line is selected, a physical connection with another station must occur before entering this mode.

8.1.2. Voice Receive Mode

Voice Receive Mode is entered when the DTE issues the #VRX command in order to receive voice data. This typically occurs when either recording a greeting message, or when recording voice messages from a remote station.

In Voice Receive Mode, voice samples from the modem analog-to-digital converter (ADC) are sent either to the ADPCM codec for compression, or to the PCM coder for linear PCM coding, and can then be read by the host. AT commands control the voice sampling rate as well as codec bits-per-sample rates, and can also be used to select (optional) silence deletion including adjustment of the silence detection period and sensitivity level when ADPCM compression is selected.

In this mode, and when the sampling rate is 7.2 kHz, the modem detects and reports DTMF, dial tone, and busy tone cadence as enabled by the #VTD command. Additionally, the modem detects and reports inactivity (periods of silence) as enabled by the #VSS command. The modem can exit the Voice Receive Mode only via a DTE Key Abort, or via Disconnect Inactivity timer (S30) expiration.

8.1.3. Voice Transmit Mode

Voice Transmit Mode is entered when the DTE issues the #VTX command in order to transmit voice data. In this mode, when the sampling rate is 7.2 kHz, the modem continues to detect and report DTMF and calling tones if enabled by the #VTD command. This mode is typically used when playing back greeting messages or previously received/recorded messages.

In this mode:

a) If the Voice Sub-configuration is in operation, voice decompression is provided by the ADPCM codec, and the decompressed ADPCM voice data is then reconstituted into analog voice by the DAC at the original compression quantization sample-per-bits rate. Optional silence interpolation is enabled if silence deletion was selected for voice compression.

b) If the Audio Sub-configuration is in operation, PCM decoding is provided by the linear PCM decoder, and the decoded audio data is then reconstituted into analog voice by the DAC at the original 1 sample/8 bits or 1 sample/16 bits rate.

8.2. VOICE/AUDIO CAPABILITIES

8.2.1. Call Establishment - Originate

Directed Originate (Dial as a specific modem type)

For most call originations, it is known ahead of time what type of call is being attempted, and it is acceptable to disconnect if the remote side of the connection does not cooperate. In this case, the modem can be configured ahead of time with the existing +FCLASS (and +FAE=0 or +FAA=0) or the #CLS command to be a data, fax, or voice/audio modem. For Data and Fax Modes, the modem subsequently either succeeds with the desired type of connection, or eventually hangs up. For the Voice/Audio Mode, the DTE has the option of hanging up if there are indications that the remote station has not answered in voice, thus implementing a directed originate for voice. The following are the three connection type choices:

Voice/Audio

The modem dials and reports call progress to the DTE, which reduces to reporting “NO DIALTONE", "BUSY”, or "NO ANSWER".

The modem allows the DTE to program a time period, which if elapsed after any ringback is detected, forces the modem to assume the remote has gone off-hook. A secondary time period (safety valve) can define a maximum elapsed time after dialing for receiving no ringback before the modem assumes that the remote has gone off-hook. This safety valve is devised in case the remote picks up the telephone before any ringback is generated, and no other tones are detected. In this mode, the modem is attempting to make a voice connection only and therefore, while waiting for ringback to disappear, it is also feasible to disconnect upon detection something which is definitely not voice from the remote, such as any answer tone. The modem provides detection of “ringback went away or never came”.

Fax

The modem dials and reports call progress to the DTE as in all modes. A Fax Class 1 or Fax Class 2 handshake is pursued according to the current configuration.

Data

The modem dials and reports call progress to the DTE as in all modes. A data handshake is pursued according to the current configuration.

Adaptive Originate (Dial with Voice/Data/Fax Discrimination)

The DTE may wish to originate a call which adapts to the remote answerer. For instance, the user may wish to send a voice message if a human picks up the telephone, but a facsimile if a fax machine answers. The modem can facilitate this type of adaptive originate by extending what it does for the directed originate modes. After determining that the remote station has picked up the line, the modem goes back to Online Voice Command Mode, thus terminating the “connecting state.” Once in this mode, the modem reports what it receives from the answerer via specific result codes to the DTE. The DTE can then have the option of pursuing a data, fax, or voice/audio connection.

8.2.2. Call Establishment - Answer

Directed Answer (Answer as a specific modem type)

If the DTE wants to be only one kind of answerer (i.e., voice/audio, fax, or data), it can configure the modem to answer exclusively in the chosen mode.

Voice/Audio

The modem is configured to answer in Voice/Audio Mode only and assumes the caller will cooperate. After going off-hook, the voice VCON is issued, no answer tone is generated, and the modem is immediately placed in Online Voice Command Mode. The DTE typically responds by sending a greeting message of some type, and DTMF tone recognition/reporting can be enabled. Eventually, an incoming voice message can be recorded by the host. (Unpredictable results occur if the caller is not prepared for a voice call.)

Fax

The modem is configured to answer in Fax Class 1 or Fax Class 2 Mode only, and it assumes the caller is going to cooperate. This configuration has the effect of disabling Voice/Audio Mode, forcing +FCLASS to either 1 or 2, and forcing both +FAA and +FAE to 0.

Data

The modem is configured to answer in Data Mode only and assumes the caller is going to cooperate. This configuration has the effect of disabling Voice/Audio Mode, forcing +FCLASS = 0, and forcing both +FAA and +FAE to 0.

Adaptive Answer (Answer with Voice/Data/Fax Discrimination)

In normal operation, it is desirable for a modem supporting fax and voice to provide the ability to discriminate between the two when answering unsolicited or unattended calls. (It is most often the case that a fax is received or a voice message recorded when nobody is present.)

Data/Fax Discrimination

If the DTE wishes to allow for a data or fax call, the +FCLASS and +FAA or +FAE commands can be configured for adaptive answer between data and Class 1 or Class 2 fax.

Voice/Fax Discrimination

This is the most important discrimination capability needed from the user's standpoint. The modem must be configured for Voice/Audio (#CLS=8), causing the modem to enter Online Voice Command Mode immediately upon going off-hook. In Voice/Audio Mode, the DTE automatically receives indications of DTMF tones and Calling Tones. The DTE can now switch to Voice Transmit Mode in order to play a greeting message, perhaps one which instructs the caller how to enter specific DTMF sequences to switch modes. The DTE can then react to the response, or the lack thereof, to such a message. The modem supports switching to Class 1 or Class 2 answer mode by virtue of the #CLS=1 or #CLS=2 command, and if such a switch is made and fails, the modem reports the failure but does not hang up, allowing the DTE further experimentation time. If the user wishes to switch to Class 1 or Class 2, but also wants the DTE to indeed hang up the line if the fax fails, the +FCLASS command should be used instead of the #CLS command. The only difference between these commands is that issuing +FCLASS cancels the modem's memory of voice, whereas #CLS causes the modem to remain off-hook, even if a fax or data handshake fails, until it receives an H command.

Voice/Data/Fax Discrimination

The DTE can try data modem operation after an answer by changing the #CLS setting to 0. A data handshake attempt can be added based upon DTMF responses or lack thereof.

8.2.3. Voice/Audio Data Transfer

A significant area of concern when handling the transfer of voice/audio data is the data transfer rate on the modem/DTE interface. Data transfer rates can be expressed as the number of interrupts which must be serviced per time period to keep up. This is a function of the sampling rate and compression method (if any) used by the modem, and the DTE interface speed required to handle the data flow on the telephone line side.

Tables 8-1a and 8-1b demonstrate the relationship between the sampling rate, interrupt rate, and DTE speed necessary for the modem to support various compression ratios. The built-in 16C550A UART-compatible interface in the MCU hardware operating with RCV144ACi-BA firmware incorporating the Proprietary Rockwell High Speed Interface (RHSI) and an RHSI compatible communication software driver (RHSICOMM.DRV) in the host computer is required to support Voice/Audio Mode operation in the Microsoft Windows environment.

Table 8-1a. 7.2 kHz Sample Rate DTE Speeds

Modem Samples per 8-bit Byte	Required Asynchronous DTE Speed (8N1 Format)	Implied DTE Speed Supported
0.5 (16-bits)	144,000 bps	230.4 kbps
1 (8-bits)	72,000 bps	115.2 kbps
2 (4-bits)	36,000 bps	38.4 kbps
4 (2-bits)	18,000 bps	19.2 kbps

Table 8-1b. 11.025 kHz Sample Rate DTE Speed

Modem Samples per 8-bit Byte	Required Asynchronous DTE Speed (8N1 Format)	Implied DTE Speed Supported
0.5 (16-bits)	220,500 bps	230.4 kbps
1 (8-bits)	110,250 bps	115.2 kbps

8.2.4. Tone and Status Monitoring — Shielded <DLE> Statuses

The modem can detect specific tones and other status information, and report these to the DTE while in any of the three voice submodes. The modem simultaneously looks for 1300 and 1100 Hz calling tones when answering, and for CCITT and Bell answer tones when originating. The modem can also detect dial or busy tones in any of the three voice submodes. All detected tones, as well as certain other statuses addressed in Table 8-2 such as silence and “telset off-hook” (i.e., handset off-hook) are reported as shielded codes.

When in Online Voice Command Mode or Voice Transmit Mode, the codes in Table 8-2 are sent to the DTE immediately upon verification by the modem of the associated tone, status, or cadence. In this mode, the 2-character code is not buffered, nor does the DTE have the ability to stop the code with flow control. If the DTE has started (but not completed) sending any AT command, the Tone Monitoring function is disabled until the command has been received and processed.

The modem can discriminate between single and multiple DTMF tones received. If calling tone, dial tone, busy tone, or answer tone is detected, this detection is reported repeatedly (at reasonable intervals) if the DTE takes no action, and the tone continues to be detected.

Table 8-2. Shielded Codes Sent to the DTE

Code Sent to DTE	Meaning
<DLE>0 – <DLE>9, <DLE>*, <DLE>#, <DLE>A –<DLE>D	**DTMF**. Digits 0 through 9, *, #, or A through D detected by the modem, i.e., user has pressed a key on a local or remote telephone. The modem sends only one <DLE> code per DTMF button pushed.
<DLE>a	**Answer Tone (CCITT).** Send to the DTE when the V.25/T.30 2100 Hz Answer Tone (Data or Fax) is detected. If the DTE fails to react to the code, and the modem continues to detect Answer tone, the code is repeated as often as once every half second.
<DLE>b	**Busy.** Sent in Voice Receive Mode when the busy cadence is detected, after any remaining data in the voice receive buffer. The modem sends the busy <DLE>b code every 4 seconds if busy continues to be detected and the DTE does not react. This allows the DTE the flexibility of ignoring what could be a false busy detection.
<DLE>c	**Calling Tone.** Sent when the T.30 1100 Hz Calling Tone (Fax Modem) is detected in any of the voice operating modes. The modem assumes that the calling tone is valid and sends this code only after 4 seconds of proper cadence has been detected. If the DTE does not react to the <DLE>c, and calling tone continues, the code is sent again as often as once every 4 seconds.
<DLE>d	**Dialtone.** Sent in Voice Receive Mode when dial tone is detected after any remaining data in the voice receive buffer. The modem sends the <DLE>d code every 3 seconds if dial tone continues to be detected and the DTE does not react. This allows the DTE the flexibility of ignoring what could be a false dial tone detection.
<DLE>e	**European Data Modem Calling Tone.** Sent when the V.25 1300 Hz Calling Tone (Data Modem) is detected in a voice submode. The modem assumes that the calling tone is valid, and sends this code only after 4 seconds of proper cadence has been detected. If the DTE does not react to the <DLE>e and calling tone continues, the code is sent again as often as once every 4 seconds.
<DLE>f	**Bell Answer Tone.** Sent when Bell 2225 Hz Answer Tone (Data) is detected. If the DTE fails to react to the code and the modem continues to detect Answer tone, the code is repeated as often as every 1/2 second.
<DLE>h	**Hung Up Handset.** Sent immediately when the modem detects that the local handset has hung-up (i.e., has transitioned from off-hook to on-hook) while in any of the three voice submodes.
<DLE>o	**Overrun.** Sent in Voice Receive Mode if the voice receive data buffer overflows, in which case, the latest data is lost in favor of retaining the oldest data in the buffer. (The DTE may not have been reading data from the modem lately.) The modem inserts the <DLE>o at the end of the buffer, thus marking the location where data was lost by the DTE. The modem does not append <DLE>o codes to the buffer contiguously. If more than one data byte is lost before the DTE begins reading again, there is only on <DLE>o code in the data stream. However, if the DTE resumes reading, and then once again allows the buffer to overflow, a new <DLE>o is appended to the data by the modem. Thus, the <DLE>o does not indicate how many bytes of contiguous data has been lost, but may report multiple gaps of lost data in the data stream.
<DLE>q	**Quiet.** Sent in Voice Receive Mode following any remaining data in the receive voice buffer when the silence detection timer (#VSP) expires and there has been voice data passed to the DTE. Note that with #VSS=0, the Quiet message never occurs. But with silence deletion turned on, #VSS may not in itself be sufficient since “cracks and pops” for a short duration directly after a connection should not be considered voice. In general, <DLE>q is sent if first there was sound, and now there is no sound, and means that somebody has stopped talking, and according to the criteria selected in the #VSP and #VSS settings, is probably not going to start again. If the DTE ignores the <DLE>q code, the modem automatically resets its timer and sends the code again if the #VSP time period again expires. This allows the DTE time to react to what may be a false silence detection.

Table 8-2. Shielded Codes Sent to the DTE (Cont'd)

Code Sent to DTE	Meaning
<DLE>s	**Silence**. Sent in Voice Receive Mode after the silence detection timer (#VSP) expires and if valid voice has not been detected (#VSS). In general, <DLE>s is sent if no sound was detected at all. This differs slightly from Quiet (<DLE>q) in that it can be used by the DTE in its discrimination algorithms as a means of determining if anything at all is coming from the remote station. If the DTE ignores the <DLE>s code, the modem automatically resets its timer and sends the code again if the #VSP time period again expires. This allows the DTE time to react to what may be a false detection of silence.
<DLE>t	**Handset Off-Hook.** Sent one time when the local handset transition from on-hook to off-hook is detected in any of the three voice submodes.
<DLE>u	**Underrun.** Sent in Voice Transmit Mode when the voice transmit buffer becomes empty without receiving a <DLE><ETX> or <DLE><CAN> command first. The modem remains in transmit mode, but issues the <DLE>u to indicate that silence is being generated. When the DTE resumes sending bytes, the modem allows a small number of bytes to build up in the buffer before re-enabling the transmitter to avoid repeated underruns. However, with the underrun condition, the modem does not wait for the XOFF threshold (or timer) to be met before resuming, as it does on an initial transmit or resume operation because the remote listener may be unaware of the underrun, and keeping the silence short may serve to mask the underrun altogether.
<DLE>T	**Timing Mark.** Sent in Voice Receive Mode, and placed in the data stream at 1 second intervals, when enabled by #VTM = 10.
<DLE><ETX>	**End of Stream.** <DLE><ETX> is sent to denote the end of a voice data stream, similar to fax Class 1 and 2. This occurs in Voice Receive Mode only after the DTE issues the key abort.

8.2.5. Shielded <DLE> Commands from the DTE

Most commands issued for voice are implemented as extensions to the AT command set, and are accepted only if the modem is in a valid command mode, such as Online Voice Command Mode. However, there are some operations which are available to the DTE without necessitating a switch to Online Voice Command Mode. The most obvious of these is the <DLE><ETX> which the DTE issues during Voice Transmit Mode to terminate an output message. Table 8-3 lists shielded <DLE> commands recognized by the modem.

Table 8-3. Shielded DTE Codes

Code Sent to Modem	Meaning
<DLE>p	**Pause.** Sent during Voice Transmit Mode to force the modem to suspend sending voice data to the selected output device(s). Any data currently in the voice transmit buffer is saved until either a resume (<DLE>r), or cancel <DLE><CAN>, is received, in which case the data is lost. If a <DLE><ETX> is received during the paused state, the modem processes it normally, and also automatically resumes transmission of the data left in the buffer (appended with <DLE><ETX>). Any other data received from the DTE while in this paused state is placed in the transmit buffer according to available space, with flow control active. (This command is ignored in other voice submodes.)
<DLE>r	**Resume.** Sent during Voice Transmit Mode to force the modem to resume sending voice data to the selected output device(s). Any data currently in the voice transmit buffer is now played. (This command is ignored in other voice modes.) The pause and resume commands are different than a simple suspension of data; data in the buffer is “frozen” and not played when the DTE pauses.
<DLE>E	**Purge DCE Buffer.** Sent during the transmission or reception of voice/audio data, by embedding the command in the voice data stream, to purge the corresponding DCE buffer. (See the <DLE><EOT> code.)
<DLE>u	**Increment Playback Volume.** Sent during audio mode to increment the playback volume. The <DLE>u action command allows the application to increase the playback volume of the headphone and speaker outputs during playback while in the data state. Each <DLE>u will increment the transmit level by 1 unit. Adjustment by a value greater than 1 may be achieved by transmitting a string of <DLE>u codes. For example, a string consisting of "<DLE>u <DLE>u <DLE>u <DLE>u <DLE>u" increases the playback volume by a value of 5 units. The <DLE>u code can be used to adjust the volume within the range of 128-228. (See <DLE><u> and <DLE><d> in Section 8.3.2.)
<DLE>d	**Decrement Playback Volume.** Sent during audio mode to decrement the playback volume. The <DLE>d action command allows the application to decrease the playback volume of the headphone and speaker outputs during playback while in the data state. Each <DLE>d will decrement the transmit level by 1 unit. Adjustment by a value greater than 1 may be achieved by transmitting a string of <DLE>d codes. For example, a string consisting of "<DLE>d <DLE>d <DLE>d <DLE>d <DLE>d" decreases the playback volume by a value of 5 units. The <DLE>d code can be used to adjust the volume within the range of 128-228. (See <DLE><u> and <DLE><d> in Section 8.3.2.)
<DLE><CAN>	**Cancel.** Sent during Voice Transmit Mode to indicate that the DTE has finished transmitting a voice message and wants the modem to discard any remaining data in the voice transmit buffer. The modem immediately purges its buffer, and then responds with the VCON message entering Online Voice Command Mode. (This command is ignored by the modem when not in Voice Transmit Mode.)
<DLE><EOT>	**Voice Bytes Buffered Query.** Sent during the transmission or reception of voice/audio data, by embedding the command in the voice data stream, to learn the number of corresponding bytes buffered by the DCE at the moment the <DLE><EOT> command is received by the DCE. <DLE>XZBBC=n<DLE> is returned by the DCE, in which "n" represents the number of bytes buffered as a two byte hexadecimal value.
<DLE><ETX>	**Terminate.** Sent during Voice Transmit Mode to indicate that the DTE has finished transmitting a voice message. The modem completes transmission of any remaining data in the voice transmit buffer before responding with the VCON message and entering Online Voice Command Mode. (This command is ignored by the modem when not in Voice Transmit Mode.)

8.2.6. Voice Record

To effect recording of a message received via a handset or microphone, the DTE must configure the modem for Voice Mode (#CLS=8), and select the proper relay setup (#VLS) to instruct the modem whether to use the auxiliary device. The modem responds to the #VLS command by issuing a relay activate command to select the input device. When a device other than the telephone line is selected, the modem immediately enters Online Voice Command Mode (indicated by VCON). DTMF detection is therefore enabled as soon as the DTE selects the device, such as a handset, although the user still needs to physically pick up the telephone and “press buttons.” Even if the DTE has not entered Voice Receive or Transmit Modes (#VTX or #VRX), these DTMF tones are delivered via shielded codes identically to when a physical telephone connection exists but the DTE has not yet commanded receive or transmit.

When the DTE decides to record the message, it issues the #VRX command and upon command receipt, the modem immediately switches to Voice Receive Mode. Since the microphone or handset is switched in, the modem immediately issues the CONNECT message indicating that the modem has switched to Voice Receive Mode and is beginning the transfer of ADPCM voice or PCM audio data as well as shielded DTMF tones, and other tones and statuses.

In this recording state, the modem (if so configured) monitors for line silence. If the #VSP period expires, the modem sends the <DLE>q or <DLE>s code to the DTE.

Recording can be canceled only via two events:

1. The DTE sends any character to the modem. This is the key abort, and is the normal method of terminating the receive mode.
2. The S30 Disconnect Inactivity timer expires, which is generally an undesired event.

8.2.7. Voice Playback

To effect playback of a message recorded via a handset or microphone, or of a message recorded during a voice call, the DTE must configure the modem for Voice Mode (#CLS=8) and select the proper relay setup (#VLS) to instruct the modem whether to use the handset or speaker. The modem responds to the #VLS command by issuing a relay activate command to select the input device. The hardware must provide a means of selecting a handset and/or microphone instead of the telephone line, as this input device. When a device other that the telephone line is selected, the modem immediately enters Online Voice Command Mode (indicated by VCON). DTMF detection is thus enabled as soon as the DTE selects the device, such as a handset, although the user still needs to physically pick up the telephone before he can issue DTMF tones. Once selected, however, the user can indeed pick up the telephone and “press buttons.” Even if the DTE has not entered Voice Receive or Transmit Modes (#VTX or #VRX), these DTMF tones are delivered via shielded codes, identically to when a physical telephone connection exists but the DTE has not yet commanded receive nor transmit.

When the DTE decides to play the message, it issues the #VTX command, and the modem immediately switches to Voice Transmit Mode. Since the speaker or handset is already switched in, the modem immediately issues the CONNECT message indicating that the modem is in Voice Transmit Mode and is expecting voice data from the DTE.

A subsequent <DLE><ETX> has to be issued to switch back to Online Voice Command Mode.

Volume Adjustment During Record

The record volume is adjusted automatically by an automatic gain control (AGC) circuit.

Volume Adjustment During Playback

The playback volume of the headphone and speaker outputs can be adjusted during when a digital potentiometer is connected to the modem device set. The volume can be adjusted during the command state using the #VGT command and during the data state using the <DLE>u and <DLE>d commands (see the #VGT and the DLE>u and <DLE>d descriptions in Section 8.3.2). The handset playback level can be adjusted by the #TL command in Section 8.3.2).

8.2.8. Voice Call Termination

Local Disconnect

The DTE can disconnect from a telephone call by commanding a mode change to Online Voice Command Mode (if not already in it), and by issuing the H command.

Remote Disconnect Detection

When in Voice Receive Mode, the modem sends the proper shielded <DLE> code when dial tone or busy tone is detected. The modem stays in Voice Receive Mode, however, until the DTE issues a key abort to force Online Voice Command Mode. The DTE must issue the H command if it wishes to hang up.

8.2.9. Mode Switching

Voice to Fax

If the modem is in Online Voice Command Mode (i.e., it has gone off-hook with #CLS=8 in effect), the DTE can attempt a fax handshake by setting #CLS=1, followed by the A or D command corresponding to fax receive or send. This has the effect of beginning a fax Class 1 handshake (see #CLS command).

Unsuccessful Fax Connection Attempt to Voice

A fax handshake which does not succeed, attempted as the result of the DTE modifying the #CLS setting from voice (8) to fax (1), does not result in the modem hanging up, allowing the DTE the flexibility of commanding a switch back to Voice Mode with #CLS=8.

Voice to Data

If the modem is in the Online Voice Command Mode, the DTE can attempt a data handshake by setting #CLS=0 followed by the A or D command. This has the effect of beginning a Data Mode handshake according to the current Data Mode S-register and command settings.

Unsuccessful Data Connection Attempt to Voice

A data handshake which does not succeed, attempted as the result of the DTE modifying the #CLS setting from voice (8) to data (0), does not result in the modem hanging up, allowing the DTE the flexibility of commanding a switch back to Voice Mode with #CLS=8.

8.2.10. Caller ID

The modem supports Caller ID by passing the information received in Bell 202 FSK modulation to the DTE after the first RING detect. The modem supports both formatted and unformatted reporting of Caller ID information received in ICLID (Incoming Call Line ID) format as supported in certain areas of the U.S. and Canada. The DTE enables this feature via the #CID command.

8.3. AT VOICE COMMAND SUMMARY

Table 8-4 provides a complete summary of the AT voice commands described in detail in Sections 8.3.1 and 8.3.2.

Table 8-4. AT Voice Commands

Command	Function
A	Answering in Voice/Audio Mode.
D	Dial command in Voice/Audio Mode.
H	Hang up in Voice/Audio Mode.
Z	Reset from Voice/Audio Mode.
#BDR	Select baud rate (turn off autobaud).
#CID	Enable Caller ID detection and select reporting format.
#CLS	Select data, fax, or voice/audio.
#MDL?	Identify model.
#MFR?	Identify manufacturer.
#REV?	Identify revision level.
#TL	Audio output transmit level.
#VBQ?	Query buffer size.
#VBS	Bits per sample (ADPCM or PCM).
#VBT	Beep tone timer.
#VCI?	Identify compression method (ADPCM).
#VLS	Voice line select (ADPCM or PCM).
#VRA	Ringback goes away timer (originate).
#VRN	Ringback never came timer (originate).
#VRX	Voice Receive Mode (ADPCM or PCM).
#VSD	Silence deletion tuner (voice receive, ADPCM).
#VSK	Buffer skid setting.
#VSP	Silence detection period (voice receive, ADPCM).
#VSR	Sampling rate selection (ADPCM or PCM).
#VSS	Silence deletion tuner (voice receive, ADPCM).
#VTD	DTMF tone reporting capability.
#VTM	Enable timing mark placement.
#VTS	Generate tone signals.
#VTX	Voice transmit mode (ADPCM or PCM).

8.3.1. Global AT Command Set Extensions

The AT commands in the following section are global, meaning that they can be issued in any appropriate mode (i.e., any #CLS setting).

For consistency, the command set is divided into action commands and parameters (non-action commands). Those commands which are action commands (i.e., those which cause some change in the current operating behavior of the modem) are identified as such, and the remaining commands are parameters.

ATA - Answering in Voice/Audio

The answer action command works analogously to the way it works in Data and Fax Modes except for the following:

1. When configured for Voice/Audio Mode (#CLS=8), the modem enters Online Voice Command Mode immediately after going off-hook. When the #CLS=8 command is issued, the modem can be programmed to look for 1100 and 1300 Hz calling tones (see #VTD), thus eliminating the need to do so as part of A command processing. After the VCON message is issued, the modem re-enters Online Voice Command Mode while sending any incoming DTMF or Calling Tone indications to the DTE as described in Section 8.2.5.
2. After answering in Voice/Audio Mode (#CLS=8), the DTE, as part of its call discrimination processing, can decide to change the #CLS setting to attempt receiving a fax in Class 1, or to make a data connection. In such a case, the DTE commands the modem to proceed with the data or fax handshake via the A command even though the modem is already off-hook.

Result Code:

VCON	Issued in Voice Mode (#CLS=8) immediately after going off-hook.

ATD - Dial Command in Voice/Audio

The dial action command works analogously to the way it works in Data or Fax modes. When in Voice/Audio Mode (#CLS=8):

1. The modem attempts to determine when the remote has picked up the telephone line and once this determination has been made, the VCON message is sent to the DTE. This determination is initially made based upon ringback detection and disappearance. (See #VRA and #VRN commands.)
2. Once connected in Voice/Audio Mode, the modem immediately enters the command state and switches to Online Voice Command Mode which enables unsolicited reporting of DTMF and answer tones to the DTE.

Parameters: Same as Data and Fax modes.

Result Codes:

VCON	Issued in Voice/Audio Mode (#CLS=8) when the modem determines that the remote modem or handset has gone off-hook, or when returning to the Online Voice Command Mode. (See #VRA and #VRN.)
NO ANSWER	Issued in Voice/Audio Mode (#CLS=8) when the modem determines that the remote has not picked up the line before the S7 timer expires. Though the modem reports "NO ANSWER", the DTE has the responsibility of issuing an ATH (or ATZ) to disconnect the telephone line while #CLS=8.

ATH - Hang Up in Voice/Audio

This command works the same as in Data and Fax modes by hanging up (disconnecting) the telephone line. There are, however, some specific considerations when in Voice/Audio Mode:

1. The H command forces #CLS=0, but does not destroy any of the voice parameter settings such as #VBS, #VSP, etc. Therefore, if the DTE wishes to issue an H command and then pursue another voice call, it must issue a subsequent #CLS=8 command, but it need not re-establish the voice parameter settings again unless a change in the settings is desired.
2. The #BDR setting is forced back to 0, re-enabling autobaud.
3. If the #VLS setting is set to select a device which is not, or does not include the telephone line (such as a local handset or microphone), the H command deselects this device and reselects the normal default setting (#VLS =0). Normally, the DTE should not issue the H command while connected to a local device such as a handset, because merely selecting this device results in VCON. The normal sequence of terminating a session with such a device is to use the #VLS command to select the telephone line, which by definition makes sure it is on-hook.

Parameters: Same as Data and Fax modes.

Result Codes: Same as Data and Fax modes.

ATZ - Reset from Voice Mode

This command works the same as in Data and Fax modes. In addition, the Z command resets all voice related parameters to default states, forces the #BDR=0 condition (autobaud enabled), and forces the telephone line to be selected with the handset on-hook. No voice parameters are stored in NVRAM so the profile loaded does not affect the voice aspects of this command. (Note that when #CLS=8, ATZ causes a hang up if the telephone line is connected.)

Parameters: Same as Data and Fax modes.

Result Codes: Same as Data and Fax modes.

#BDR - Select Baud Rate (Turn off Autobaud)

This command forces the modem to select a specific DTE/modem baud rate without further speed sensing on the interface. When a valid #BDR=n command is entered, the OK result code is sent at the current assumed speed. After the OK has been sent, the modem switches to the speed indicated by the #BDR=n command it has just received.

When in Online Voice Command Mode and the #BDR setting is nonzero (no autobaud selected), the modem supports a full duplex DTE interface. This means that the DTE can enter commands at any time, even if the modem is in the process of sending a shielded code indicating DTMF detection to the DTE. [Note that when #BDR has been set nonzero, the modem employs the S30 Disconnect Inactivity timer, and this timer starts at the point where #BDR is set nonzero. If this period expires (nominally 60 seconds) with no activity on the DTE interface, the modem reverts to #BDR=0, #CLS=0, and #VLS=0.]

Parameters: n = 0 – 48 (New baud rate is n*2400 bps)

Default: 0

Result Codes:

OK	For the supported speeds.
ERROR	Otherwise.

Command options:

#BDR?	Returns the current setting of the #BDR command as an ASCII decimal value in result code format.
#BDR=?	Returns a message indicating the speeds that are supported.
#BDR=0	Enables autobaud detection on the DTE interface.
#BDR=n	Where 1<n<48. Sends OK message at current speed, then switches to the new speed defined by n*2400 bps unless and until another #BDR=n command is received. Autobaud is disabled, and the character format is maintained at the format most recently detected.

#CID - Enable Caller ID Detection and Select Reporting Format

This command selects or disables Caller ID recognition and reporting in any mode.

Parameters: n = 0, 1, or 2

Default: 0

Result Codes:

OK	n = 0, 1, or 2.
ERROR	Otherwise.

Command options:

#CID?	Returns the current setting (0,1 or 2) of the #CID command as an ASCII decimal value in result code format.
#CID=?	Returns the message, “0, 1, 2”.
#CID=0	Disables Caller ID.
#CID=1	Enables formatted Caller ID reporting of ICLID SDM (Single Data Message) and MDM (Multiple Data Message) packets.
#CID=2	Enables unformatted Caller ID reporting of any ICLID packet received after the first RING cycle including SDM, MDM, or call waiting packets.

#CLS - Select Data, Fax, or Voice/Audio

This command selects Data, Fax, or Voice/Audio Mode from operation in any mode.

Parameters: n = 0, 1, 2, or 8

Default: 0

Result Codes:

OK	If n = 0, 1, 2, or 8.
ERROR	Otherwise.

Command options:

#CLS?	Returns the current setting (0, 1, 2, or 8) of the #CLS command as an ASCII decimal value in result code format.
#CLS=?	Returns the message, “0, 1, 2, or 8”.
#CLS=0	Data. This is similar to setting +FCLASS=0, and instructs the modem to act like a data modem on subsequent answer or originate operations. When a disconnect or inactivity time out in the non-autobaud mode is detected, the modem automatically sets the #CLS setting to 0 and hangs up. This ensures that the modem is always in a known state despite disorderly DTE behavior.
#CLS=1	Class 1 fax. This is similar to setting +FCLASS=1, and instructs the modem to be a Class 1 fax modem. Once this is set, either the +FAA or the +FAE command can be used to force subsequent answers to be Class 1 adaptive answers.
#CLS=2	Class 2 fax. This is similar to setting +FCLASS=2, and instructs the modem to be a Class 2 fax modem. Once this is set, the +FAA command can be used to force subsequent answers to be Class 2 adaptive answers.
#CLS=8	Voice/Audio Mode. This is the main setting the DTE uses to effect directed or adaptive answer or originate sequences involving voice modes. All telephone calls initialized by #CLS=8 result (after answer or successful call progress) in the modem in Online Voice Command Mode.

#MDL? - Identify Model

This command requests the model number or name of the modem.

Command option:

#MDL? - RCV144ACi

#MFR? - Identify Manufacturer

This command requests the modem manufacturer.

Command option:

#MFR? - ROCKWELL

#REV? - Identify Revision Level

This command requests the revision level of the modem.

Command option:

#REV? - XXXX-XXXX-XXX YYY (Those places occupied by “X"'s represent the part number, while those places occupied by `Y"'s represent the revision number. The values are determined at time of production.)

8.3.2. AT#V Commands Enabled Only in Voice Mode (#CLS=8)

The commands described in the following subsection are extensions to the command set which the modem recognizes only when configured for Voice/Audio Mode with the #CLS=8 command.

#TL- Audio Output Transmit Level

This command provides adjustment of the transmit level of the data pump audio output, affecting both the playback level of the handset and speaker. An ERROR result code is returned if the #TL command is issued when the phone line is selected, however.

Parameters:	n=0000 to 7FFF if the handset or speaker is selected
Default:	7FFF, if local handset or speaker is selected
	3F44, if the phone line is selected

Result Codes:

OK	If n=0000 to 7FFF when the local handset or speaker is selected
ERROR	If the phone line is selected

#VBQ? - Query Buffer Size

This query-only command returns the size of the modem's voice transmit and voice receive buffers in ASCII decimal, followed by the OK result code.

Parameters: None

Command option:

#VBQ?	Returns the size of the modem voice transmit and voice receive buffers.

#VBS - Bits Per Sample

This command selects the degree of ADPCM voice compression or format of linear PCM to be used.

Parameters:	n = 2 or 4 (ADPCM Voice compression) bits/sample, or 8 or 16 (PCM) bits/sample
Default:	4

Result Codes:

OK	If n=2, 4, 8, or 16
ERROR	Otherwise.

Command options:

#VBS?	Returns the current setting of the #VBS command as an ASCII decimal value in result code format.
#VBS=?	Returns "2" or "4", which are the ADPCM compression bits/sample rates available, or "8" or "16", which is the PCM bits/sample rate. The 2 and 4 bits/sample rates are correlated with the #VCI query command response which provides the single compression method available. The "8" or "16" represents 8-bit or 16-bit unsigned linear PCM format, respectively.
#VBS=2	Selects 2 bits per sample ADPCM (valid for #VSR = 7200).
#VBS=4	Selects 4 bits per sample ADPCM (valid for #VSR = 7200).
#VBS=8	Selects 8 bits per sample PCM (valid for #VSR = 7200 or #VSR = 11025).
#VBS=16	Selects 16 bits per sample PCM (valid for #VSR = 7200 or #VSR = 11025).

#VBT - Beep Tone Timer

This command defines the time period, in 10ths of a second up to 4 seconds (40) which is used by the modem as the DTMF or fixed tone duration for generating tones via the D command while in Online Voice Command Mode.

Parameters:	n = 0 – 40 (0 – 4 seconds)
Default:	10

Result Codes:

OK	If n = 0 – 40.
ERROR	Otherwise.

Command options:

#VBT?	Returns the current setting of the #VBT command as an ASCII decimal value in result code format.
#VBT=?	Returns the message, “0-40”.
#VBT=0	Disables the tone generation capability.
#VBT=1 to 40	Sets tone duration time.

#VCI? - Identify Compression Method

This command provides a unique character string which may be used for identifying the proprietary compression method of Rockwell ADPCM.

Parameters:	No parameters supported
Default:	No parameters supported

Result Codes:

OK	Returned after the Compression Identifier string.
ERROR	Returned if attempting to assign a parameter value.

Command Options:

#VCI?	Returns the Compression Identifier string which may used to identify the proprietary voice data encoding of Rockwell ADPCM.

#VLS - Voice Line Select

This action command can be used to select which devices are routed through the modem.

Parameters: n = 0, 1, 2, 3, or 4. [This is the device position number (not device number) as reflected in response to #VLS=?]

Default: 0

Result Codes:

OK	If n = 0, 1, 2, 3, or 4.
VCON	If device selected does not connect to the telephone line. (A speaker is such a device, but a telephone line with speaker ON is not such a device, and generates OK.)
ERROR	If n does not equal 0, 1, 2, 3, or 4, or if telephone line or local handset is already off-hook.

Command options:

#VLS?	This query returns the current setting of the #VLS command as an ASCII decimal value in result code format.
#VLS=?	This query requests a report of the device types available for selection. The response is a number from 0 to 4 corresponding the device position number (see Table 8-5).
#VLS=0	The default option on the modem. This command instructs the modem that when entering any of the three voice operating submodes (Online Command, Transmit, or Receive), that the telephone line interface should be routed through the modem. The OK response is sent to the DTE, and any previous connection is lost (i.e., the modem ends up on-hook as a result of issuing this command to connect to the telephone line).
#VLS=1	This command instructs the modem to route only the handset through the modem. This setting can be chosen before recording a greeting message.
#VLS=2	This command instructs the modem to route only the speaker through the modem. This setting can be chosen before playing back any message. The modem immediately switches to Online Voice Command Mode, and the VCON response is generated for completeness. However, since this is an output only device, nothing of consequence can happen until the DTE sends the #VTX command.
#VLS=3	This command instructs the modem that only the auxiliary input device (microphone) should be routed through the modem. This setting can be chosen before recording a greeting message.
#VLS=4	This command is the same as #VLS =0, except that the modem enables the internal speaker as well as the telephone line/handset circuit.

Table 8-5. Device Types Supported by #VLS

ASCII Digit	Device Type and Considerations
0	**Telephone Line with Telephone handset.** This is the default device selected. In this configuration, the user can pick up a handset which is connected to the same telephone line as the modem, and * record both sides of a conversation with a remote station. The modem currently supports one telephone line/handset, which is in the first position of the #VLS =? response. (Note that the modem can interface to multiple telephone lines by having "0"'s in multiple positions in the #VLS ? response.) If a telephone line is selected, the modem must be on-hook or it hangs up. The OK message is generated.
1	**Transmit/Receive Device (other than telephone line).** This is a handset, headset, or speaker-phone powered directly by the modem. When such a device is selected, the modem immediately enters Online Voice Command Mode, DTMF monitoring is enabled if applicable, and the VCON response is sent. The modem supports one such device as the second device listed in the #VLS =? response.
2	**Transmit Only Device.** Normally, this is the onboard speaker. When this device is selected, the modem immediately enters Online Voice Command Mode, and the VCON response is sent. The modem supports selection of the internal speaker as the third device listed in #VLS =? response.
3	**Receive Only Device.** Normally, this is a microphone. When such a device is selected, the modem immediately enters Online Voice Command Mode, DTMF monitoring is enabled if applicable, and the VCON response is sent. The modem supports one microphone as the fourth element returned in the #VLS =? response.
4	**Telephone line with Speaker ON and handset.** This device type can be used to allow the DTE to select the telephone line/handset (if picked up) with the modem speaker also turned ON. This can be used by the DTE to allow the user to monitor an incoming message as it is recorded.

#VRA - Ringback Goes Away Timer (Originate)

This command can be used, when originating a voice/audio call (#CLS=8) to set the "Ringback Goes Away" timer value, i.e., an amount of time (in units of 100 ms) measured from when the ringback cadence stops once detected. If ringback is not detected within this period, the modem assumes that the remote has picked up the line and switches to Online Voice Command Mode. Every time a ringback cycle is detected, this timer is reset.

Parameters: n = 0 – 255 (0 – 2.55 seconds)

Default: 70

Result Code: OK

Result Code:

OK	If n = 0 – 255.
ERROR	Otherwise.

Command options:

#VRA?	Returns the current setting of the #VRA command as an ASCII decimal value in result code format.
#VRA=?	Returns the message, "0-255".
#VRA=0	Turns off the "ringback goes away timer." After one ringback, the dialing modem sends VCON and enters Online Voice Command Mode immediately.
#VRA=n	Where n defines the period without ringback (after at least one ringback has been detected) in 100 ms units.

#VRN - Ringback Never Came Timer (Originate)

This command can be used when originating a voice/audio call (#CLS=8) to set the “Ringback Never Came” timer value, i.e., an amount of time (in units of 100 ms) measured from completion of dialing. If ringback is not detected within this period, the modem assumes the remote has picked up the line and switches to Online Voice Command Mode.

Parameters: n = 0 – 255 (0 – 2.55 seconds)

Default: 100

Result Code:

OK	If n = 0 – 255.
ERROR	Otherwise.

Command options:

#VRN?	Returns the current setting of the #VRN command as an ASCII decimal value in result code format.
#VRN=?	Returns the message, “0-255”.
#VRN=0	Turns off the “ringback never came timer.” After dialing, the modem sends VCON and immediately enters Online Voice Command Mode.
#VRN=n	Where n defines the period without ringback after dialing in 100 ms units.

#VRX - Voice Receive

This action command is only valid if the modem is in the Online Voice Command Mode (indicated previously with the VCON message), and is the switch to the Voice Receive Mode. This command is used when a voice file is to be received from the line, microphone, or handset. The #VLS command should have been previously issued to select the input source.

Parameters: None

Result Codes:

CONNECT	When voice/audio transfer from modem to DTE can begin.
ERROR	If #VLS=0 and not connected to any input device.

#VSD - Enable Silence Deletion (Voice Receive) [ADPCM]

This command is used to enable or disable Voice Receive Mode silence deletion (ADPCM).

Parameters: n = 0 or 1

Default: 0

Result Code:

OK	If n = 0 or 1.
ERROR	Otherwise.

Command options:

#VSD?	Returns the current setting of the #VSD command as an ASCII decimal value in result code format.
#VSD=?	Returns the message, “0,1”.
#VSD=0	Turns off the silence deletion.
#VSD=1	Turns on the silence deletion if the silence sensitivity setting #VSS is nonzero. The aggressiveness of the silence deletion is controlled by #VSS.

#VSK - Buffer Skid Setting

This command queries and sets the number of bytes of spare space, after the XOFF threshold is reached, in the modem's buffer during Voice Transmit Mode. This equates to the “skid” spare buffer space, or the amount of data the DTE can continue to send after being told to stop sending data by the modem, before the modem voice transmit buffer overflows.

Parameter: n = 255 (Number of bytes of “skid spare buffer space)

Default: 255

Result Code:

OK	If n = 255.
ERROR	Otherwise.

Command options:

#VSK?	Returns the current setting of the #VSK command as an ASCII decimal value in result code format.
#VSK=?	Returns the message, “255”.

#VSP - Silence Detection Period (Voice Receive) [ADPCM]

This command sets the Voice Receive Mode silence detection period (inactivity timer) value. The parameter, in units of 100 ms, can be used when receiving voice data. This is an amount of time, which if elapsed without receiving any ADPCM data, causes the modem to send the <DLE>s or <DLE>q codes after insuring that the buffer is empty. There are two cases:

1. With the modem's silence deletion feature enabled, the #VSP setting is in effect an inactivity timer. The modem must reset this timer on every byte of voice data received.
2. With the modem's silence deletion feature disabled, the modem determines what constitutes silence. This involves monitoring and debouncing the modem value for average energy. If this debounced value is less than an arbitrary threshold constituting the modem's definition of silence for a period greater than that defined by the #VSP setting, the modem sends the <DLE>q or <DLE>s shielded code to the DTE.

Parameters: n = 0 – 255 (0 – 25.5 seconds)

Default: 55

Result Code:

OK	If n = 0 – 255.
ERROR	Otherwise.

Command options:

#VSP?	Returns the current setting of the #VSP command as an ASCII decimal value in result code format.
#VSP=?	Returns the message, “0-255”.
#VSP=0	Turns off the silence period detection timer.
#VSP=n	Where n defines the period without received voice data in 100 ms units.

#VSR - Sampling Rate Selection

This parameter, along with the bits per sample (#VBS) command, determines the necessary DTE interface speed to transmit and receive in Voice/Audio Mode.

Parameters:	n=7200 (7200 Hz sampling rate for ADPCM or PCM), or n=11025 (11.025 kHz sampling rate for PCM only)
Default:	7200

Result Codes:

OK	If n=7200, or if n=11025 and #VBS=8, or #VBS = 16
ERROR	Otherwise

Command options:

#VSR?	Returns the current setting of the #VSR command as an ASCII decimal value in result code format.
#VSR=?	Returns the message "7200, 11025"
#VSR=7200	Selects 7200 Hz sampling rate
#VSR=11025	Selects 11.025 kHz sampling rate

#VSS - Silence Detection Tuner (Voice Receive) [ADPCM]

This command enables or disables the Voice Receive mode silence detection, and controls the sensitivity employed by the modem in ADPCM compressing periods of silence.

Parameters:	n = 0 – 3
Default:	0

Result Codes:

OK	If n = 0 – 3.
ERROR	Otherwise.

Command options:

#VSS?	Returns the current setting of the #VSS command as an ASCII decimal value in result code format.
#VSS=?	Returns the message “0,1,2,3".
#VSS =0	Disables silence detection by the modem when in Voice Receive Mode.
#VSS =1	Least sensitive setting. When this command is received by the modem, the system is configured to a state which is least likely to detect and compress periods of silence, but still able to do so if the line is really quiet.
#VSS =2	Midrange setting (default). When this command is received by the modem, the system is configured to a state which is likely to be the best overall compromise on normal telephone lines.
#VSS =3	Most sensitive setting. When this command is received by the modem, the system is configured to a state which is most likely to detect and compress periods of silence.

#VTD - DTMF Tone Reporting

This command queries and controls which types of tones can be detected and reported to the DTE via shielded codes in Voice Transmit, Voice Receive, and Online Voice Command Modes.

Parameters: i, j, k (three ASCII hexadecimal bit maps)

Default: 3F, 3F, 3F

Result Codes:

- OK — If bits supported with #VTD=? are selected.
- ERROR — Otherwise.

Command options:

- #VTD? — Returns the current setting of the #VTD command as an ASCII decimal value in result code format.
- #VTD=? — Returns the tone reporting capabilities of the modem.
- #VTD=i,j,k — Where i,j,k corresponds (in ASCII hexadecimal) to the desired capabilities, as shown in Table 8-6, for Voice Transmit, Voice Receive, and Online Voice Command Modes, respectively.

Table 8-6. #VTD Tone Detection/Reporting Bit Settings

Bit	Description
0	0 = Disable DTMF tone capability; 1 = Enable DTMF tone capability [1].
1	0 = Disable V.25 1300 Hz Calling tone capability; 1 = Enable V.25 1300 Hz Calling tone capability [1].
2	0 = Disable T.30 1100 Hz Facsimile Calling tone capability; 1 = Enable T.30 1100 Hz Facsimile Calling tone capability [1].
3	0 = Disable V.25/T.30 2100 Hz Answer tone capability; 1 = Enable V.25/T.30 2100 Hz Answer tone capability [1].
4	0 = Disable Bell 2225 Hz Answer tone capability; 1 = Enable Bell 2225 Hz Answer tone capability [1].
5	0 = Disable call progress tone and cadence (e.g., busy and dial tone) capability; 1 = Enable call progress tone and cadence (e.g., busy and dial tone) capability [1].
6-7	Reserved.

Notes:
1. The modem detects this tone/cadence, and reports it via a shielded code to the DTE.
2. Tone detection is only performed when the sampling rate is 7.2 kHz (see the #VSR command).

#VTM - Enable Timing Mark Placement

This command controls the placement of <DLE><T> timing marks by the DCE in the data stream during ADPCM recording.

Parameters: n=0 (disabled) or 10 (1 second interval)

Default: n=0 (disabled)

Result Codes:

- OK — If n=0 or 10
- ERROR — Otherwise

Command Options:

- #VTM? — Returns the current setting of the #VTM command as an ASCII decimal value in result code format.
- #VTM=? — Returns "0, 10"

#VTS - Generate Tone Signals (Online Voice Command)

This action command can be issued to play one of more DTMF or other tones (such as a “beep") if and only if the modem is in the Online Voice Command Mode and the sampling rate (see the #VSR command) is set to 7.2 kHz. The modem parses and plays the tones defined in the parameter in the order listed, and no key abort is accepted. The parameter can have three types of elements separated by commas, and following "#VTS=":

Dual or Single Tones with Variable Duration: These are represented by the substring [x,y,z] (enclosed in square brackets, "[ ]", as shown) in the parameter field. Each such substring consists of three sub-elements corresponding to the two frequencies (i.e., x and y), and the duration (i.e., z).

[x,y,z]	x represents the first frequency (0 or 200-3000 Hz) y represents second frequency (0 or 200-3000 Hz) z represents the duration (which is ASCII decimal in units of 100 ms)

DTMF Digits with Variable Duration. This is represented by a substring {x,z} (enclosed in curly braces, "{}", as shown) in the parameter field. Each such substring consists of two sub-elements corresponding to a DTMF digit (i.e., x) and the duration (i.e., z).

{x,z}	x represents the DTMF digit (0-9,A-D,*,#) z represents the duration (which is ASCII decimal in units of 100 ms)

DTMF Digits, with duration defined by #VBT. This is represented by a value x (non-bracketed) corresponding to a DTMF digit (i.e., x) in the parameter field.

x	x represents the DTMF digit (0-9,A-D,*,#), with the duration defined by #VBT

Command options:

#VTS=[x,y,z], {x,z}, and/or x, as described above.

Parameters: The tone generation consists of elements in a list with each element separated by commas.

Result Codes:

OK	Command to play tones on currently selected device is accepted.
ERROR	Command was not issued during Online Voice Command Mode or string is grammatically incorrect.

#VTX - Voice Transmit

This action command can be issued if and only if the modem is in the Online Voice Command Mode (indicated previously with the VCON message), and is the switch to Voice Transmit Mode. #VTX is used when a voice file is to be transmitted to the line, speaker, or handset. The #VLS command should have been previously issued to select the output source.

Parameters: None

Result Codes:

CONNECT	When voice transmission by DTE can begin.
ERROR	If #VLS =0 and output device not connected.

#VGT - Set Playback Volume in the Command State

The #VGT command allows the DTE to set the playback volume of the headphone and speaker outputs via the on-board digital potentiometer while in the command state. The application can use #VGT=? command to determine the range of valid values. The lowest value in the range means the lowest transmit level while the highest in the range means the highest transmit level.

Parameters: n=128 to 228

Default: 153

Result Codes:

OK	if n=128 to 228
ERROR	Otherwise

Command Options:

#VGT=?	Returns "128-228" if the external volume control is present, otherwise "128".
VGT?	153 (default).

<DLE><u> and <DLE><d> - Set Playback Volume in the Data State

The <DLE>u and <DLE>d action commands allow the DTE to adjust the playback volume of the headphone and speaker outputs via the on-board digital potentiometer while in the data state. The application may embed the <DLE>u and <DLE>d codes into the playback data to adjust the volume during playback. Each <DLE>u or <DLE>d will increment or decrement the transmit level by 1 unit, respectively. Adjustment by a value greater than 1 may be achieved by transmitting a string of the appropriate <DLE> codes. A string consisting of "<DLE>u<DLE>u<DLE>u<DLE>u<DLE>u", for example, would increase the playback volume by a value of 5 units. The <DLE>u and <DLE>d codes can be used to adjust the volume within the range of 128-228.

Command Options:

<DLE><u>	Increment volume (transmit level) by 1 unit in data state.
<DLE><d>	Decrement volume (transmit level) by 1 unit in data state.

8.4. S-REGISTERS

The following S-Register is global, meaning that it can be set in any appropriate mode (i.e., any #CLS setting).

S30 - Disconnect Inactivity Timer

Range: n = 0 – 255

Default: 0 (OFF, which means DTE should usually set it to some value for Voice)

Command options:

S30=0 Disconnect Inactivity timer off. No matter how long it might continue, the modem never spontaneously hangs up the telephone line or switches to autobaud mode as a result of inactivity.

S30=1 to 255 This is the period of time (in seconds), which if expired causes the modem to hang up the telephone line if it is off-hook and no data has passed during the period. The timer is also active whenever the #BDR setting is non-zero. In order to avoid a state where speed sense is disabled (even though the PC can crash, come back up, and try to issue commands at what should be a supported speed), the inactivity time-out occurs if there is no data passed on the DTE interface within the S30 period, even if the modem is on-hook. DTE software must not select a nonzero setting for #BDR until it is ready to establish a telephone call or virtual connection to a speaker or microphone. When there is an inactivity time out with #CLS=8, the modem always forces #CLS=0 and #BDR=0.

8.5. RESULT CODES FOR VOICE OPERATION

VCON VCON is sent when the modem is configured for voice/audio (#CLS=8), or when after answering or originating a call, the modem enters the Online Voice Command Mode for the first time. Typically, this is immediately after an off-hook in answer mode, and after ringback ceases in originate mode. VCON is also sent when the DTE requests a switch from Voice Transmit Mode to Online Voice Command Mode by issuing a <DLE><ETX> to the modem, or when the DTE requests a switch from Voice Receive Mode to Online Voice Command Mode via the key abort.

CONNECT CONNECT is sent when switching from the Online Voice Command Mode to either Voice Receive Mode via the #VRX command, or to Voice Transmit Mode via the #VTX command. This message is sent to the DTE to inform it that it may begin receiving or sending ADPCM or PCM data.

8.6. EXAMPLES OF VOICE OPERATION

See Tables 8-7 through 8-13.

Table 8-7. Record a Greeting Message

DTE to Modem	Modem to DTE	Description and Interpretation
#CLS=8		Configure the modem for Voice Mode.
	OK	The modem confirms command implemented, and is now set up for voice.
#VBS=4		The DTE asks for 4-bit compression (ADPCM). The DTE needs to work at 38,400 bps since after start and stop bits are added, the speed increases to 36,000 bps.
	OK	The modem is configured for 4-bit compression.
S30=60		DTE wants to insure that the modem can recover even if DTE dies with the baud rate set to a speed which cannot be speed sensed.
	OK	Modem now has Disconnect Inactivity timer set to 1 minute. If no activity takes place after a connection, or no DTE activity takes place after #BDR is changed, the modem reverts to #CLS=0, #BDR=0.
#BDR=16		The DTE knows that compression requires a 38,400 bps speed, so it forces this as the new speed. (For this example, lets say that the DTE was sending all commands, including this one, at 2400 bps.)
	OK	This OK message is sent at 2400 bps, but the modem then switches to 38,400 bps. All subsequent commands are assumed to be sent at 38,400 bps. If the DTE does not switch to 38,400 bps after the OK<CR><LF>, it will not recognize the data stream coming from the modem. The S30 timer is now active.
#VSP=20		The DTE changes its own speed to 38,400 bps and sends this command to set up the silence detection period for 2 seconds.
	OK	The modem agrees. When receiving voice data, 2 seconds of silence terminates the Receive Mode. For handset operation, this amounts to a hang up.
#VSD=1		This enables silence deletion.
	OK	The modem confirms command reception.
#VSS =1		The DTE has decided to use level "1" silence detection sensitivity, meaning it is making it somewhat more difficult to delete and compress silence for the modem, but expects that when the user has hung up the handset, the silence is indeed detected. The DTE has tried to improve the quality of the message because it knows this is a handset operation. Also, since silence deletion has been enabled, the #VSP setting for silence detection now becomes basically an inactivity timer. If silence deletion is turned off here instead of enabled, the #VSP timer is based upon average energy readings from the modem.
	OK	The modem confirms command reception.
#VLS=?		Find out what type of devices are supported by the product.
	0,1,2,3,4 OK	The modem tells the DTE that is has a telephone line with handset (#VLS=0), an input/output device such as a handset or speaker-phone (#VLS=1), and an output only device such as a speaker.
#VLS=1		Select the handset as the input device to be used by the modem.
	VCON	The modem agrees, switches out the telephone line, switches in the handset, and the modem enters Online Voice Command Mode. Since this is a handset, and since the baud rate has been preselected with #BDR, this also means that DTMF detection and reporting is now enabled. The user can pick up the telephone and send tones at this point, which are delivered as shielded codes to the DTE, although the voice data is not yet being passed.

Table 8-7. Record a Greeting Message [Cont'd]

DTE to Modem	Modem to DTE	Description and Interpretation
#VRX		This tells the modem that the DTE is ready to receive a voice message at the current compression/sampling settings.
	CONNECT	The modem tells the DTE that it can now expect data. The modem enters Voice Receive Mode. DTMF monitoring is still enabled as well as ADPCM data flow.
	<Data>	User says: "Hello, this is me, press * to skip this message. I'm happy that you have called, so press 5 to send your fax, or you can leave your message at the beep." User then hangs up, the message is buffered to the DTE, and the DTE waits for the message to end. The DTE should have some kind of maximum timer running to ensure that the user won't speak longer than some predetermined limit. Alternatively, the DTE can require the user to enter a DTMF tone to terminate transmission of the message to the DTE.
	<DLE>q	The modem has noticed (#VSP time out) that the user has finished. The modem reports this while staying in Voice Receive Mode. DTMF detection and reporting is still active. The DTE now has the entire greeting message on disk.
	<DLE>*	The user has inadvertently pressed the "*" button, but the DTE is not interested in this presently.
!		The DTE issues a key abort to switch to Online Voice Command Mode.
	<DLE><ETX> VCON	The modem exits Voice Receive Mode and switches to Online Voice Command Mode.
#VLS=0		The DTE did not really have to do this, but wants to make sure that it gets no more DTMF codes from the handset. Selection of the telephone line here forces the modem out of Online Voice Command Mode, which is equivalent to hanging up.
	OK	

Table 8-8. Playback a Greeting Message

DTE to Modem	Modem to DTE	Description and Interpretation
#CLS=8		Configure the modem for Voice Mode.
	OK	The modem confirms command reception, and is now set up for voice.
#VBS=4		The DTE asks for 4-bit compression. The data from the DTE needs to travel at 38,400 bps since after start and stop bits are added, the speed increases to 36,000 bps.
	OK	The modem is configured for 4-bit compression (ADPCM).
#BDR=16		The DTE knows that compression requires a 38,400 bps speed, so it forces this as the new speed. (For this example, lets say that the DTE was sending all commands, including this one, at 4800 bps.)
	OK	This OK message is sent at 4800 bps, but the modem switches to 38,400 bps. All subsequent commands are assumed to be sent at 38,400 bps. The DTE should switch after the <CR><LF> following the OK. The S30 timer is now active.
#VSD=1		This enables silence insertion.
	OK	The modem confirms command reception.(#VSS is unnecessary for playback.)
#VLS=2		Select the speaker as the output device to be used by the modem.
	VCON	The modem confirms command reception, and enters Online Voice Command Mode. Since this is an output only device, nothing more can happen yet.
#VTX		This tells the modem that the DTE is ready to send voice per the current compression/sampling settings.
	CONNECT	The modem tells the DTE that it can now send data. The modem enters Voice Transmit Mode and ADPCM data flow begins.
<Data>		The DTE sends data. The modem waits 1 second before starting to transmit to the speaker to ensure uninterrupted data flow. If the voice transmit buffer runs empty, the transmitter is disabled.
<DLE><ETX>		The DTE has finished its transmission and now instructs the modem to enter Online Voice Command Mode after emptying the voice transmit buffer.
	VCON	The modem tells the DTE it is done. If the DTE sends the <DLE><ETX> before the modem has finished transmitting all the data in its buffer, the DTE must wait for this response. (VCON indicates that the DTE can send more data at any time with #VTX.)

Table 8-9. Answer Call/Play Greeting/Record Message

DTE to Modem	Modem to DTE	Description and Interpretation
#CLS=8		Configure the modem for Voice Mode. Note that the #BDR setting is assumed to be zero here, meaning that no time-out occurs forcing #CLS=0.
	OK	The modem agrees, and is now set up for voice.
#VBS=4		The DTE asks for 4-bit compression for greeting message playback (ADPCM). The DTE needs to work at 38,400 bps since after start and stop bits are added, the speed increases to 36,000 bps.
	OK	The modem is configured for 4-bit compression.
#VSD=1		This enables silence deletion.
	OK	The modem confirms command reception.
#VSS =2		Set silence detection sensitivity.
	OK	The modem confirms command reception.
#VLS=0		Select the telephone line as the source, ensuring that the modem is now on-hook. DTMF detection is now off regardless of the previous setting of #VLS.
	OK	The modem confirms command reception, and it switches in the telephone line.
	RING	Some time later, we receive the first call. (Note that the modem also processes Caller ID information at this time.)
#CLS=8		Configure the modem for Voice Mode again. Although the modem has already been so configured, it is a good idea to select #CLS=8 directly following a RING because in normal use, any S30 time-out or hang up during Voice Mode forces #CLS=0.
	OK	The modem agrees, and is now definitely set up for voice.
#BDR=16		The DTE knows that compression requires a 38,400 bps speed, so it forces this as the new speed. (For this example, lets say that the DTE was sending all commands, including this one, at 9600 bps.)
	OK	This OK message is sent at 9600 bps, but the modem then switches to 38,400 bps. All subsequent commands are assumed to be sent at 38,400 bps until either another #BDR command is received or until the S30 timer expires. The S30 timer is now activated, and the default is 60 seconds.
A		The DTE tells the modem to answer.
	VCON	The modem is now in Online Voice Command Mode. DTMF and calling tone detection is enabled.

Table 8-9. Answer Call/Play Greeting/Record Message [Cont'd]

DTE to Modem	Modem to DTE	Description and Interpretation
#VTX		The DTE does not wait for any tones, and tells the modem that it is ready to send a voice greeting at the current compression and sampling settings (4-bit/7200).
	CONNECT	The modem tells the DTE that it can now send data. The modem enters Voice Transmit Mode and DTMF monitoring is still enabled as well as the ADPCM data flow.
<Data>		The DTE sends greeting message data. The modem waits up to 1 second or until XOFF threshold is reached before starting to transmit to ensure uninterrupted data flow. If the voice transmit buffer runs empty, the transmission is disabled.
<DLE><ETX>		The DTE has finished with its transmission, and now instructs the modem to enter Online Voice Command Mode since this is the telephone line.
	VCON	The modem tells the DTE it is done. If the DTE sends the <DLE><ETX> before the modem has finished transmitting all the data in its voice transmit buffer, the DTE must wait for this response.
#VBT=12		The DTE requests that DTMF digits be sent as "beeps" with the #VTS command while in Online Voice Command Mode, with each "beep" having a duration of 1.2 seconds.
	OK	The modem confirms command reception
#VTS=#		The DTE sends a "BEEP" to annotate its greeting message. This beep is a 1.2 second long DTMF #. During this period, the no abort is possible from the DTE, and should not be necessary.
	OK	After the modem sends the "BEEP", it sends OK to inform the DTE that it is ready to move on. DTMF pass through is re-enabled.
#VBS=4		The DTE asks for 4-bit compression to recorded message. The DTE needs to work at 38,400 bps since after start and stop bits are added the speed increases to 36,000 bps.
	OK	The modem is configured for 4-bit compression.
#VRX		The DTE instructs the modem to turn the line around and begin recording a message from the remote.
	CONNECT	The modem sets things up and enables ADPCM data transfer to the DTE with the current silence deletion setting.
	<Data>	ADPCM data is shipped to the DTE with shielded DTMF tones folded in. The modem is looking for silence, busy, dial tone, and loop break. The DTE records everything in its storage media.
	<DLE>b	The caller has finished, hung up, and in this case, a busy cadence was detected before anything else such as expiration of the #VSP silence detection period.
X		The DTE uses a key abort to respond to a busy detection.
	<DLE><ETX> VCON	The modem is now in Online Voice Command Mode.
H		DTE sends modem to #CLS=0 with #BDR=0.

Table 8-10. Answer Call/Record Message/Receive Fax

DTE to Modem	Modem to DTE	Description and Interpretation
#CLS=8		Configure the modem for Voice Mode.
	OK	The modem agrees, and is now set up for voice.
#VBS=4		The DTE asks for 4-bit compression (ADPCM). The DTE needs to work at 38,400 bps since after start and stop bits are added the speed increases to 36,000 bps.
	OK	The modem is configured for 4-bit compression.
#VSS=2		Set silence sensitivity. (We assume #VSD=1.)
	OK	The modem confirms command reception.
#VLS=0		This selects the telephone line, and ensures that it is on-hook.
	OK	The modem confirms command reception, and switches in the telephone line.
#CLS=8		This ensure things are set up for voice.
	OK	The modem confirms command reception, and is now set up for voice.
	RING	Sometime later, the next call is received. The modem answers.
#BDR=16		The DTE knows that compression requires a 38,400 bps speed, so it forces this as the new speed. (For this example, lets say that the DTE was sending all commands, including this one, at 9600 bps.)
	OK	This OK message is sent at 9600 bps, but the modem then switches to 38,400 bps. All subsequent commands are assumed to be sent at 38,400 bps. The S30 timer is now active.
A		The DTE answers.
	VCON	The modem is now in Online Voice Command Mode. DTMF and calling tone detection is enabled.
#VTX		The DTE does not wait for any tones, and tells the modem that it is ready to send a voice greeting at the current compression and sampling settings.
	CONNECT	The modem tells the DTE that it can now send data. The modem enters Voice Transmit Mode and DTMF monitoring is still enabled as well as ADPCM data flow.
<Data>		The DTE sends greeting message data. The modem waits 1 second before starting to transmit to ensure uninterrupted data flow. If the voice transmit buffer runs empty, the transmission is disabled.
<DLE><ETX>		The DTE has finished its transmission and now instructs the modem to enter Online Voice Command Mode.
	VCON	The modem tells the DTE it is done. If the DTE sends the <DLE><ETX> before the modem has finished transmitting all the data in its voice transmit buffer, this response is delayed until the buffer is empty.
#VBT=13		The DTE requests that DTMF digits be dialed as “beeps” while in Online Voice Command Mode, with each “beep” having a duration of 1.3 seconds.
	OK	The modem agrees.
#VTS= [1000,0,20],9,		The DTE sends a “BEEP” to annotate its greeting message. This beep is a 2 second long 1000 Hz tone, followed by a 1.3 second long DTMF 9. During this period, the DTE is locked out.
	OK	After the modem sends the “BEEP”, it sends OK to inform the DTE that it is ready to move on. DTMF pass through is re-enabled.

Table 8-10. Answer Call/Record Message/Receive Fax (Cont'd)

DTE to Modem	Modem to DTE	Description and Interpretation
#VRX		The DTE instructs the modem to turn the line around and begin recording a message from the remote.
	CONNECT	The modem sets things up and enables ADPCM data transfer to the DTE with the current silence deletion setting.
	<Data>	ADPCM data is shipped to the DTE with shielded DTMF tones folded in. The modem is looking for silence, busy, dial tone, and loop break. The DTE records everything in its storage media.
	<DLE>5	The caller has finished his voice message, but is now insisting that he be able to send us a facsimile.
X		DTE sends `X' as key abort. If the user tried to keep talking after he hit the DTMF 5, anything said was lost. Whatever he said before the 5 is on disk.
	<DLE><ETX> VCON	The modem obeys key abort. Receive Mode is canceled, and the modem is now in Online Voice Command Mode. DTMF is still passed through.
#CLS=1		The DTE instructs the modem to pretend no voice activity has taken place, although the modem does not hang up if the fax fails.
	OK	The modem now thinks its a Class 1 Fax modem. The DTE can now tailor the +F settings which were not accessible until +FCLASS became 1.
A		Answer tone is generated and prompts the user on the telephone to press the button on his fax machine to send his fax. After the successful fax is received, the modem hangs up.

Table 8-11. Answer Call, Determine It's a Fax

DTE to Modem	Modem to DTE	Description and Interpretation
	RING	Sometime later, the next beta-site calls.
#CLS=8		Configure the modem for Voice Mode.
	OK	The modem agrees, and is now set up for voice.
#VBS=4		The DTE asks for 4-bit compression (ADPCM). The DTE needs to work at 38,400 bps since after start and stop bits are added the speed increases to 36,000 bps.
	OK	The modem is configured for 4-bit compression.
#BDR=16		The DTE knows that compression requires a 38,400 bps speed, so it forces this as the new speed.
	OK	This OK message is sent at 9600 bps, but the modem then switches to 38,400 bps. All subsequent commands are assumed to be sent at 38,400 bps. The S30 timer is now active.
#VSS =2		Set sensitivity to normal setting.
	OK	The modem confirms command reception.
#VSD=1		This enables silence deletion.
	OK	The modem confirms command reception.
A		Finally, the modem answers.
	VCON	The modem is now in Online Voice Command Mode. DTMF and calling tone detection is enabled. (Note that alternatively, the DTE can go into the Transmit or Receive mode and look for either calling tone or silence as a means of discrimination.) The DTE waits a few seconds to give a possible fax machine or remote data/fax modem a chance to send calling tone without being disturbed by a voice greeting. (In this example only calling tone is considered, which excludes a person sending a fax when he hears answer tone.)
	<DLE>c	The modem has detected T.30 Calling tone and presents this information to the DTE.
#CLS=1		The DTE decides to receive the fax, and tells the modem to pretend that it just went off-hook as a Class 1 Facsimile modem. The DTE must be able to handle Class 1 commands from here on. Note
	OK	The modem is now a Class 1 fax modem.
A		The modem pretends that it just got the incoming RING, and modem handles the fact that it is already off-hook.

Table 8-12. Adaptive Fax/Data/Voice; Determine Data

DTE to Modem	Modem to DTE	Description and Interpretation
	RING	Sometime later, we receive a call.
#CLS=8		Configure the modem for Voice Mode (still ADPCM).
	OK	The modem agrees, and is now set up for voice, but the DTE can change things during the discrimination phase.
#BDR=16		The DTE knows that the compression requires a 38,400 bps speed, so it forces this as the new speed.
	OK	This OK message is sent at 9600 bps, but the modem then switches to 38,400 bps. The S30 timer is now active.
#VSS=2		This enables default silence deletion.
	OK	The modem confirms command reception.
A		The DTE answers. (Note that this is where the DTE can let another RING go by to process Caller ID.)
	VCON	The modem is now in Online Voice Command Mode. DTMF and calling tone detection is enabled. If fax or data calling tones are detected, the DTE can change to Fax or Data Mode.
#VTX		The DTE immediately switches to Voice Transmit Mode to send out a short greeting.
	CONNECT	The modem says, “Send me the ADPCM data.”
<Data>		The DTE sends a previously recorded message from a very fast talking person: “Hello, this is Dave. Press * to send a fax, # for help, or leave your message at the beep.” Note that the caller can enter DTMF tones at any time, which the DTE can take into account, or calling tone can still be detected.
<DLE><ETX>		This ends the greeting message.
	VCON	The modem switches back to Online Voice Command Mode.
#VTS=#		The DTE sends # as the beep.
	VCON	The modem is still able to receive DTMF or Calling tone here.
#VRX		Enter Receive Mode. Now the modem is clocking silence, as well as DTMF, and recording whatever the caller says.
	<DLE>s	#VSP must have been set to 35, since 3.5 seconds later the modem sends this indication of silence period expiration. No ADPCM data was sent to the DTE, because the data pump deleted all 3.5 seconds of silence. This tells the DTE that nobody is talking.
!		The DTE issues a key abort to switch to Online Voice Command Mode.
	<DLE><ETX> VCON	The modem exits Voice Receive Mode and switches to Online Voice Command Mode.
#CLS=0		The DTE received no voice data, just the silence indicator after a 3.5 second wait. Since there was no calling tone and the user never entered any DTMF tones, the DTE assumes it must be a calling data modem. If the data handshake fails, the modem does not hang up the line thus giving the DTE another chance to try the fax again (in this case).
	OK	The modem is now a data modem.
A		The modem pretends that it just got RING, try V.22 bis/V.42 bis, etc.

Table 8-13. Originate a Call, Send Answerer a Message

DTE to Modem	Modem to DTE	Description and Interpretation
#CLS=8		Configure the modem for Voice Mode (still ADPCM).
	OK	The modem agrees, and is now set up for voice.
#BDR=16		The DTE knows that compression requires a 38,400 bps speed, so it forces this as the new speed.
	OK	This OK message is sent at 2400 bps, but the modem then switches to 38,400 bps.
#VLS=0		This ensures that the telephone line is selected.
	OK	The modem agrees.
#VRA=45		The DTE allows 4.5 seconds for ringback to stop before assuming that the modem thinks that the remote has answered.
	OK	The modem agrees with the DTE's assumption.
DT6807		The DTE makes a telephone call, and the modem dials and goes through call progress. BUSY or NO DIALTONE can be detected, but in this example, the modem gets ringback.
	VCON	This message is sent 4.5 seconds after the third ringback cadence is detected by the modem. The modem is in effect assuming that the remote telephone was answered on the third ring because no fourth ringback was detected before the #VRA time-out. The modem enters Online Voice Command Mode, and DTMF and answer tone detection is enabled. (Note that during this period, the modem might have detected answer tone from a data modem. In this case, the appropriate <DLE> shielded code has to be sent prompting the DTE to pursue a data handshake.)
#VTX		The DTE has a message to send.
	CONNECT	The modem says: “send it.”
<Data>		The DTE sends the message: “Hi Dave. Your mother called.”
<DLE><ETX>		Procedure complete.
	VCON	DTMF still active.
H		The DTE has completed its forwarding task.

A. AT COMMAND SET SUMMARY

A.1. BASIC AT COMMANDS

Command	Function
A/	Re-execute command.
A	Go off-hook and attempt to answer a call.
B0	Select V.22 connection at 1200 bps.
B1	Select Bell 212A connection at 1200 bps.
C1	Return OK message.
Dn	Dial modifier.
E0	Turn off command echo.
E1	Turn on command echo.
H0	Initiate a hang-up sequence.
H1	If on-hook, go off-hook and enter command mode.
I0	Report product code.
I1	Report pre-computed checksum.
I2	Report OK.
I3	Report firmware revision, model, and interface type.
I4	Report response programmed by an OEM.
I5	Report the country code parameter.
I6	Report modem data pump model and code revision.
I7	Reports the DAA code (W-class models only).
L0	Set low speaker volume.
L1	Set low speaker volume.
L2	Set medium speaker volume.
L3	Set high speaker volume.
M0	Turn speaker off.
M1	Turn speaker on during handshaking and turn speaker off while receiving carrier.
M2	Turn speaker on during handshaking and while receiving carrier.
M3	Turn speaker off during dialing and receiving carrier and turn speaker on during answering.
N0	Turn off automode detection.
N1	Turn on automode detection.
O0	Go on-line.
O1	Go on-line and initiate a retrain sequence.
P	Force pulse dialing.
Q0	Allow result codes to DTE.
Q1	Inhibit result codes to DTE.
Sn	Select S-Register as default.
Sn?	Return the value of S-Register n.
=v	Set default S-Register to value v.
?	Return the value of default S-Register.
T	Force DTMF dialing.

V0	Report short form (terse) result codes.	
V1	Report long form (verbose) result codes.	
W0	Report DTE speed in EC mode.	
W1	Report line speed, EC protocol and DTE speed.	
W2	Report DCE speed in EC mode.	
X0	Report basic call progress result codes, i.e., OK, CONNECT, RING, NO CARRIER (also, for busy, if enabled, and dial tone not detected), NO ANSWER and ERROR.	
X1	Report basic call progress result codes and connections speeds (OK, CONNECT, RING, NO CARRIER (also, for busy, if enabled, and dial tone not detected), NO ANSWER, CONNECT XXXX, and ERROR.	
X2	Report basic call progress result codes and connections speeds, i.e., OK, CONNECT, RING, NO CARRIER (also, for busy, if enabled, and dial tone not detected), NO ANSWER, CONNECT XXXX, and ERROR.	
X3	Report basic call progress result codes and connection rate, i.e., OK, CONNECT, RING, NO CARRIER, NO ANSWER, CONNECT XXXX, BUSY, and ERROR.	
X4	Report all call progress result codes and connection rate, i.e., OK, CONNECT, RING, NO CARRIER, NO ANSWER, CONNECT XXXX, BUSY, NO DIAL TONE and ERROR.	
Y0	Disable long space disconnect before on-hook.	
Y1	Enable long space disconnect before on-hook.	
Z0	Restore stored profile 0 after warm reset.	
Z1	Restore stored profile 1 after warm reset.	
&C0	Force RLSD active regardless of the carrier state.	
&C1	Allow RLSD to follow the carrier state.	
&D0	Interpret DTR ON-to-OFF transition per &Qn:	
	&Q0, &Q5, &Q6	The modem ignors DTR.
	&Q1, &Q4	The modem hangs up.
	&Q2, &Q3	The modem hangs up.
&D1	Interpret DTR ON-to-OFF transition per &Qn:	
	&Q0, &Q1, &Q4,.	
	&Q5, &Q6	Asynchronous escape.
	&Q2, &Q3	The modem hangs up.
&D2	Interpret DTR ON-to-OFF transition per &Qn:	
	&Q0 thru &Q6	The modem hangs up.
&D3	Interpret DTR ON-to-OFF transition per &Qn:.	
	&Q0, &Q1, &Q4,.	
	&Q5, &Q6	The modem performs soft reset.
	&Q2, &Q3	The modem hangs up.
&F0	Restore factory configuration 0.	
&F1	Restore factory configuration1.	
&G0	Disable guard tone.	
&G1	Disable guard tone.	
&G2	Enable 1800 Hz guard tone.	
&J0	Set S-Register response only for compatibility.	
&J1	Set S-Register response only for compatibility.	
&K0	Disable DTE/DCE flow control.	
&K3	Enable RTS/CTS DTE/DCE flow control.	
&K4	Enable XON/XOFF DTE/DCE flow control.	
&K5	Enable transparent XON/XOFF flow control.	
&K6	Enable both RTS/CTS and XON/XOFF flow control.	
&L0	Select dial up line operation.	
&L1	Select leased line operation.	

* Serial interface operation only.

&M0	Select direct asynchronous mode.
&M1	Select sync connect with async off-line command mode.*
&M2	Select sync connect with async off-line command mode and enable DTR dialing of directory zero.*
&M3	Select sync connect with async off-line command mode and enable DTR to act as Talk/Data switch.*
&P0	Set 10 pps pulse dial with 39%/61% make/break.
&P1	Set 10 pps pulse dial with 33%/67% make/break.
&P2	Set 20 pps pulse dial with 39%/61% make/break.
&P3	Set 20 pps pulse dial with 33%/67% make/break.
&Q0	Select direct asynchronous mode.
&Q1	Select sync connect with async off-line command mode.*
&Q2	Select sync connect with async off-line command mode and enable DTR dialing of directory zero.*
&Q3	Select sync connect with async off-line command mode and enable DTR to act as Talk/Data switch.*
&Q4	Select Hayes AutoSync mode.
&Q5	Modem negotiates an error corrected link.
&Q6	Select asynchronous operation in normal mode.
&R0	CTS tracks RTS (async) or acts per V.25 (sync).
&R1	CTS is always active.
&S0	DSR is always active.
&S1	DSR acts per V.25.
&T0	Terminate any test in progress.
&T1	Initiate local analog loopback.
&T2	Returns ERROR result code.
&T3	Initiate local digital loopback.
&T4	Allow remote digital loopback.
&T5	Disallow remote digital loopback request.
&T6	Request an RDL without self-test.
&T7	Request an RDL with self-test.
&T8	Initiate local analog loop with self-test.
&V	Display current configurations.
&W0	Store the active profile in NVRAM profile 0.
&W1	Store the active profile in NVRAM profile 1.
&X0	Select internal timing for the transmit clock.
&X1	Select external timing for the transmit clock.
&X2	Select slave receive timing for the transmit clock.
&Y0	Recall stored profile 0 upon power up.
&Y1	Recall stored profile 1 upon power up.
&Zn=x	Store dial string x (to 35) to location n (0 to 3).
%E0	Disable line quality monitor and auto retrain.
%E1	Enable line quality monitor and auto retrain.
%E2	Enable line quality monitor and fallback/fall forward.
%L	Return received line signal level.
%Q	Report the line signal quality.
%TTn	PTT certification test signals.

* Serial interface operation only.

\Kn	Controls break handling during three states:
When modem receives a break from the DTE:	
\K0,2,4	Enter on-line command mode, no break sent to the remote modem.
\K1	Clear buffers and send break to remote modem.
\K3	Send break to remote modem immediately.
\K5	Send break to remote modem in sequence with transmitted data.
When modem receives \B in on-line command state:	
\K0,1	Clear buffers and send break to remote modem.
\K2,3	Send break to remote modem immediately.
\K4,5	Send break to remote modem in sequence with transmitted data.
When modem receives break from the remote modem:	
\K0,1	Clear data buffers and send break to DTE.
\K2,3	Send a break immediately to DTE.
\K4,5	Send a break with received data to the DTE.
\N0	Select normal speed buffered mode.
\N1	Select direct mode.
\N2	Select reliable link mode.
\N3	Select auto reliable mode.
\N4	Force LAPM mode.
\N5	Force MNP mode.
+MS	Select modulation
**0	Download to flash memory at last sensed speed.
**1	Download to flash memory at 38.4 kbps.
**2	Download to flash memory at 57.6 kbps.

A.2. ECC COMMANDS

%C0	Disable data compression.
%C1	Enable MNP 5 data compression.
%C2	Enable V.42 bis data compression.
%C3	Enable both V.42 bis and MNP 5 compression.
\A0	Set maximum block size in MNP to 64.
\A1	Set maximum block size in MNP to 128.
\A2	Set maximum block size in MNP to 192.
\A3	Set maximum block size in MNP to 256.
\Bn	Send break of n x 100 ms.

A.3. MNP 10 COMMANDS

)M0	Disable MNP 10 link negotiation power adjustment.
)M1	Enable MNP 10 link negotiation power adjustment.
*H0	Select MNP 10 link negotiation at highest rate.
*H1	Select MNP 10 link negotiation at 1200 bps.
*H2	Select MNP 10 link negotiation at 4800 bps.
-K0	Disable MNP 10 extended services.
-K1	Enable MNP 10 extended services.
-K2	Enable MNP 10 extended services detection only.
-Q0	Disable MNP 10 fallback to 2400 bps (V.22 bis)/1200 bps (V.22).
-Q1	Enable MNP 10 fallback to 2400 bps (V.22 bis)/1200 bps (V.22).

@M0	Select initial transmit level of -26 dBm.
@M1	Select initial transmit level of -30 dBm.
@M2	Select initial transmit level of -10 dBm.
@M3 - @M10	Select initial transmit level of -10 dBm.
@M11	Select initial transmit level of -11 dBm.
@M12	-Select initial transmit level of -12 dBm.
.	
.	
.	
@M30	Select initial transmit level of -30 dBm.
@M31	Select initial transmit level of -31 dBm.

:E0	Disable the compromise equalizer.
:E1	Enable the compromise equalizer.

A.4. W-CLASS COMMANDS

*B	Display list of permanently blacklisted numbers.
*D	Display list of delayed numbers.
*NCnn	Change country to one of eight in NVRAM.

A.5. CALLER ID COMMANDS

#CID=0	Disable Caller ID.
#CID=1	Enable Caller ID with formatted presentation.
#CID=2	Enable Caller ID with unformatted presentation.

A.6. V.25 BIS COMMANDS

Not supported.

A.7. FAX CLASS 1

+FCLASS=n	Service class.
+FAE=n	Data/fax auto answer
+FRH=n	Receive data with HDLC framing.
+FRM=n	Receive data.
+FRS=n	Receive silence.
+FTH=n	Transmit data with HDLC framing.
+FTM=n	Transmit data.
+FTS=n	Stop transmission and wait.

A.8. FAX CLASS 2

+FCLASS=n	Service class.
+FAA=n	Adaptive answer.
+FAXERR	Fax error value.
+FBOR	Phase C data bit order.
+FBUF?	Buffer size (read only).
+FCFR	Indicate confirmation to receive.
+FCLASS=	Service class.
+FCON	Facsimile connection response.
+FCIG	Set the polled station identification.
+FCIG:	Report the polled station identification.
+FCR	Capability to receive.
+FCR=	Capability to receive.
+FCSI:	Report the called station ID.
+FDCC=	DCE capabilities parameters.
+FDCS:	Report current session.
+FDCS=	Current session results.
+FDIS:	Report remote capabilities.
+FDIS=	Current sessions parameters.
+FDR	Begin or continue phase C receive data.
+FDT=	Data transmission.
+FDTC:	Report the polled station capabilities.
+FET:	Post page message response.
+FET=N	Transmit page punctuation.
+FHNG	Call termination with status.
+FK	Session termination.
+FLID=	Local ID string.
+FLPL	Document for polling.
+FMDL?	Identify model.
+FMFR?	Identify manufacturer.
+FPHCTO	Phase C time out.
+FPOLL	Indicates polling request.
+FPTS:	Page transfer status.
+FPTS=	Page transfer status.
+FREV?	Identify revision.
+FSPL	Enable polling
+FTSI:	Report the transmit station ID.

A.9. VOICE COMMANDS

#BDR	Select baud rate (turn off autobaud).
#CLS	Select data, fax, or voice.
#MDL?	Identify model.
#MFR?	Identify manufacturer.
#REV?	Identify revision level.
#TL	Audio output transmit level.
#VBQ?	Query buffer size.
#VBS	Bits per sample.
#VBT	Beep tone timer.
#VCI?	Identify compression method.
#VGT	Set playback volume in the command state.
#VLS	Voice line select.
#VRA	Ringback goes away timer (originate).
#VRN	Ringback never came timer (originate).
#VRX	Voice receive mode.
#VSD	Enable silence deletion.
#VSK	Buffer skid setting.
#VSP	Silence detection period (voice receive).
#VSR	Sampling rate selection.
#VSS	Silence deletion tuner (voice receive).
#VTD	DTMF/tone reporting.
#VTM	Enable timing mark placement.
#VTS	Generate tone signals.
#VTX	Voice transmit mode.

A.10. CELLULAR COMMANDS

^C2	Download cellular phone driver.
^I	Identify cellular phone driver.
^T6	Indicate status of cellular phone.

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B. COMMON CONFIGURATION SETUP STRINGS

This appendix describes setup strings to establish commonly used configurations.

1. Force V.42 bis data compression with LAP-M error correction.

   AT\N4%C2-K0

2. Force V.42 bis data compression with MNP error correction.

   AT\N5%C2

3. Force MNP 5 data compression with MNP error correction.

   AT\N5%C1

   Note: With the setup strings in examples 1-3, if the remote is unable to negotiate the desire rate mode, the modem will disconnect and respond with NO CARRIER.

4. Auto negotiate data compression and error correction.

   AT&F (factory defaults) or

   AT\N3%C3.

   In this mode, the modem prefers MNP 10 over LAP-M, LAP-M over MNP 4, and V.42 bis over MNP 5. If error correction is not negotiated, the modem will connect in normal mode.

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