SATURN
V.32bis / V.17 modem with V.42bis, FAX Class 1 & 2 and MNP

I - INTRODUCTION

This document describes the System Adaptable TURNkey (SATURN), a highly integrated High Speed modem built around the ST75C502 data pump from SGS-THOMSON microelectronics and the MC68302 software from Modem Manufacturers Associates.

The ST75C502 data pump includes all ITU-T modulation standards from V.32 bis to V.22, V.17 to V27 ter, and FSK V.23 & V.21.

With its powerful 68000-family core CPU, the SATURN integrates Automatic Call Unit (ACU), error correction / data compression (i.e. V.42 bis, MNP 5) and FAX functionality into a single processor and all with higher performance than was achievable with older 8-bit processor designs.

Designed for use in a variety of environments, the SATURN may be connected to asynchronous and synchronous microcomputers and / or terminals. It is compatible with both dial-up (GSTN) and leased lines.

Information contained herein serves as a development tool to instruct the modem manufacturer in both the SATURN's basic design as well as customizing its operation to meet specific requirements.

The SATURN has been designed to satisfy two vital needs within the data communications equipment manufacturing industry : The software design of the SATURN allows the manufacturer to make custom modifications to suit customer-specific needs. As well, the power inherent in the SATURN's software and hardware provide outstanding performance as well as a solid platform to accommodate recent technological innovations (e.g. V.FC, V.34, V.34bis).

The SATURN design is made up of different "communications modules". Each module performs specific tasks in the SATURN and all of them have been specified to conform with a clear and specific definition for all pin connections. The modules perform functions such as the controller (otherwise referred to as the automatic call unit or ACU), data pump, data access arrangement (DAA), hybrid and audio, and RS-232 interface.

Upgrades and new UCM's will be added to the SATURN in the form of Appendices. Because of the modular structure of the SATURN's basic design, any enhancements may be easily incorporated into any existing product.

I.1 - How this Manual is Organized

This document has been written to familiarize the customer with the operation, use and features of the SATURN. The manual is divided into five chapters and four appendices. The chapters describe the SATURN's operation as it is delivered to the customer.

The appendices provide basic information about SATURN design as well as electricals schematics for each UCM. The parts list supplied gives the comprehensive bill of materials required to populate the printed circuit board as specified.

Chapter I   is an introduction to this manual and the SATURN.

Chapter II   is an overview of the general features and functionality of the SATURN. Issues such as compatibility, front and back panel organization as well as jumper settings are among those discussed.

Chapter III   gives a complete description of the SATURN's AT Command set as well as the Facsimile and Autologon features.

Chapter IV   gives a complete description of the SATURN's V.25 bis command set.

Chapter V   gives a complete description of the SATURN's S-registers, including default values and bit mapped arrangements.

Appendix A   shows the basic block diagram of the SATURN, and gives the different possible adaptation of the basic design.

Appendix B   shows a simplified layout schematic of the stand alone modem as it is delivered.

Appendix C   supplies the electrical schematics of the SATURN stand alone modem.

Appendix D   supplies the complete part list of the SATURN stand alone application.

II.2 - Conventions

Please note the following conventions used throughout this document.

Signals

High = 1 bit = +5V

Low = 0 bit = 0V

Bit Order

The bits within a byte are always numbered 0 through 7 with 0 being the least significant bit (LSB).

II - GENERAL DESCRIPTION

The SATURN has been designed to transmit and receive data over standard telephone communications lines in accordance with the following standards/recommendations: ITU-T V.32 bis, V.32, V.23, V.22 bis, V.22, V.21, Bell 212A and Bell 103. For facsimile transmission, ITU-T V.17, V.29, V.27 ter, and V.21 channel 2 are supported. In addition, the SATURN supports MNP error correction and MNP Class 5 data compression as well as V.42 error correction and V.42 bis data compression. The latter can provide error-free full-duplex data transmission at data rates approaching 115.2 kbits/s. This is achieved through a combination of high speed modulation techniques (i.e. ITU-T V.32 bis which allows a basic rate of 14400 bits/s) coupled with the efficient data compression techniques provided by the error correction and data compression protocols.

In addition to the above features, the SATURN provides all of the standard features found on other commercially available modems including : Automatic dialing and call progress monitoring, autoanswer capabilities, storage of modem configurations and telephone numbers in non-volatile internal memory, industry-standard AT command set, lamps that give visual indication of some aspects of the SATURN's operating state and remote/internal test modes.

The AT command set deserves special mention. This feature allows the user to access or control the SATURN's behaviour through the use of data sent to it through the DTE interface. Whenever the user issues such a command, a response will be sent that may occur in two forms. The first form is referred to as "information text". This consists of information that the user has explicitly requested as a part of a specific command (e.g. the I command causes the SATURN to return information about its software version to the DTE as information text). The second form is referred to as a "result code" and gives information about either a change in operating state of the SATURN or the result of an AT command. For example, the result code "OK" will be sent after the completion of the I command while a "NO CARRIER" result code informs the user that a connection with a remote modem has been terminated.

While result codes may be generated by the SATURN asynchronously (i.e. as an indication of a change in operating state rather than as a response to an AT command), information text is always sent as a response to a command.

Facsimile transmission and reception is also managed through extensions to the AT command set. The SATURN supports both EIA/TIA Class 1 and Class 2 command sets.

II.1 - Compatibility

The SATURN supports the following ITU-T recommendations :

V.32bis Full duplex asynchronous at 14400, 12000, 9600, 7200 or 4800 bps with or without MNP, V.42 and V.42 bis.
Full duplex synchronous at 14400, 12000, 9600, 7200 or 4800 bps.

V.32 Full duplex asynchronous at 9600 or 4800 bps with or without MNP, V.42 and V.42 bis.
Full duplex synchronous at 9600 or 4800 bps.

V.17 Half duplex synchronous at 14400, 12000, 9600 or 7200 bps for fax tx & rx.

V.29 Half duplex synchronous at 9600, 7200 or 4800 bps for fax tx & rx.

V.27ter Half duplex synchronous at 4800 or 2400 bps for fax tx & rx.

V.23 Full duplex asynchronous at 1200 bps in forward channel and 75 bps in reverse channel.

V.22bis Full duplex asynchronous at 2400 bps with or without MNP, V.42 and V.42 bis.
Full duplex synchronous at 2400 bps.

V.22 Full duplex asynchronous at 1200 bps with or without MNP, V.42 and V.42 bis.
Full duplex synchronous at 1200 bps.

V.21 Full duplex asynchronous at 300 bps with or without MNP.
Full duplex synchronous at 300 bps for facsimile transmission and reception.

The SATURN also supports the following Bell standards :

212A Full duplex asynchronous at 1200 bps with or without MNP, V.42 and V.42 bis.
Full duplex synchronous at 1200 bps.

103 Full duplex asynchronous at 300 bps with or without MNP.

The SATURN supports facsimile transmission and reception through compliance with EIA/TIA standard 578 (Fax Class 1) and proposal EIA 2388 (Fax Class 2).

The SATURN incorporates V.42 and MNP levels 2 through 4 error correction as well as V.42 bis and MNP Class 5 data compression.

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II.2 - Front Panel

The SATURN offers a lot of front panel LEDs with the following meanings :

TX :   Data Transmit (V.24 103).
RX :   Data Receive (V.24 104)
DCD :   Data Carrier Detect (V24 109).
CTS :   Clear To Send (V.24 106).
DSR :   Data Set Ready (V.24 107).
DTR :   Data Terminal Ready (V.24 108).
OH :   Off Hook indicator.
TST :   Test indicator (V.24 142).
PWR :   Power supply indicator.

Two female 3.5 jack connector socket are available for the use of an external loudspeaker (HP) or an externel microphone (MIC). The internal electret microphone is located very close to the external microphone connector socket.

II.3 - Back Panel

The back panel of the SATURN stand alone modem consists of a DB25 female connector socket for the V.24 DTE interface (RS 232), a standard 2.5 jack connector socket for connection to the 7.5V power supply (PW 7.5V), two RJ11c style jacks (one for the GSTN line connection - LINE - and the other for a phone connection - PHONE -) and a reset pushbutton (RST).

II.4 - DB25 Pinout

Pin	V.24 Circuit	Function	Direction
1	101	Protective Ground	GND
2	103	Transmit Data	Input
3	104	Receive Data	Output
4	105	Request to Send	Input
5	106	Clear to Send	Output
6	107	Data Set Ready	Output
7	102	Signal Ground	GND
8	109	Receive Line Signal Detect	Output
15	114	Transmit clock	Output
17	115	Receive Clock	Output
18	141	Local Analog Loopback	Input
20	108	Data Terminal Ready	Input
21	140	Remote Digital Loopback	Input
22	125	Ring Indicator	Output
24	113	External Clock	Input
25	142	Test	Output

II.5 - Dumb Mode

The SATURN may be configured to ignore commands issued from the DTE. In order to do this, dumb mode must be enabled. When in dumb mode the SATURN ignores AT commands (including the escape sequence) and refrains from sending result codes to the DTE. This is especially useful in applications where the SATURN is permanently connected to a host that does not support the AT command set. In this case, the use of dumb mode ensures that only user data will flow between the SATURN and the host and that the SATURN cannot accidentally be placed in on-line command mode by user data.

II.6 - Functional Operation

This section describes the various operational modes that the SATURN may assume. Each of these modes exists so that a certain capability of the SATURN (e.g. command, data transfer) may be invoked.

Command Mode

For the SATURN to accept and process a command it must be in command mode. When powered up, it recalls the appropriate stored configuration (see the &V command) and then enters command mode from which you may place or receive calls, or alter any of its settings. If dumb mode has been selected, it is not possible to alter the settings of the SATURN because it does not response to AT commands. It is still possible to make or answer calls through other facilities provided by the SATURN (e.g. DTR dial, auto-answer) if an appropriate configuration was stored in its non-volatile memory previously.

Connect Mode

The SATURN is in this mode while the channel establishment procedures are occurring. The data pump handshake is performed at this time as well as any possible MNP or LAP-M link establishment. Note that the D command is used by the call originator and the A command (or auto-answer) is employed by the call answerer. The negotiation that occurs during the connect state will fail if the proper command is not given.

If the SATURN has been configured for facsimile operation, the appropriate data pump handshake is performed while in connect mode.

On-Line Mode

To transmit or receive data, the SATURN must be in the on-line mode. This occurs once a connection has been established. In this mode, data received from the DTE is transmitted to the remote modem (with appropriate MNP, LAP-M or facsimile proc-

essing, as necessary) while data received from the remote modem is, in turn, passed onto the DTE.

Time Independent Escape Sequence (TIES) and On-Line Command Mode

The following text relating to TIES was extracted from the VEN-TEL document Rev 1.06. When transferring into on-line command mode, in every instance an "AT" command will follow the three character escape sequence (ex. +++). All "AT" commands or command strings MUST be preceded by "AT" and terminated by the contents of S3 (typically a <CR>.

The TIES escape sequence, as in all AT command strings, must be terminated by the contents of <S3>. If <CR> characters are detected immediately before the <S3> terminating character, it is to be ignored. This is the same as any normal AT command line.

Note : TIES is an escape detection scheme - not an escape generation scheme.

A TIES escape sequence is comprised of the following :

a) A three character escape sequence user programmable case sensitive.
b) Followed by mandatory "AT" characters non user programmable case insensitive.
c) Followed by valid AT commands and settings case insensitive.
d) Followed by a mandatory terminating character terminating character is stored in S3 the default for <S3> is <CR>.

Note : Case insensitivity only pertains to alpha characters.

When a TIES modem detects a valid three character escape sequence, and only the three character escape sequence, it immediately enters in the command mode (no guard time is required). The modem stays in the command mode until one of the following occurs :

a) Detection of an invalid AT command string after the last character of the three character escape sequence.
b) ATO (return to data mode) is detected in the subsequent valid AT command string.
c) ATH (disconnect from telephone line) is detected in the subsequent valid AT command string.

"Valid" Three Character Escape Sequence

The TIES escape characters must be preceded by the standard three character escape sequence (typically +++).

TIES requires that the three character escape sequence be continuous and not repeated. That is, the character immediately preceding the first char-

acter of the three character escape sequence cannot be equal to the first character. For example, if the three character escape sequence is AAA, the character before the first A cannot be an A. If the three character escape sequence is +++, the character before the first + cannot be a +.

"Valid" AT Command Strings and Settings

The three character escape sequence is monitored to recognize the first three valid characters, then an A must be detected, then a T must be detected followed by valid AT string(s) and setting(s).

If the modem detects the valid three character escape sequence, followed by valid AT command string characters, and then is terminated by <S3>, the modem will execute the AT command and stay in the command mode.

Note : The acceptable length of the TIES valid AT command string detection is 40 characters.

"Invalid" TIES Command Strings

Up to the terminating <S3> any invalid character(s) will immediately return back to the data mode.

If invalid AT commands are detected, TIES immediately returns back into the data mode and any valid commands which may have been in the string will be ignored and not implemented.

Once the <S3> terminates a valid TIES escape sequence, any subsequent invalid AT command strings will not cause a return to the data mode. Only the normal return method is used (i.e. ATO or ATH).

TIES "Ignore" Characters

While detecting a valid TIES command string, it is possible that some characters may be detected which are not true AT commands. If TIES considers any AT commands as invalid, TIES will return the modem back to the data mode. This could give TIES the false reputation of not functioning with some software packages.

To avoid these instances we must generate a list of characters which may be found in some AT command strings which will be considered ignore characters. These characters are to be treated as non-existent to the TIES escape command string. Ignore characters may be found any time or place between the third + (or equivalent value in S2) and the terminating <S3> character.

III - AT COMMANDS, FACSIMILE AND AUTOLOGON FACILITY

This section discusses the operation of the AT command interpreter as well as describing all AT commands supported by the SATURN. Note that the SATURN includes the capability to have its command set modified as desired. Refer to chapter 5 for more information.

Also discussed here is the Autologon feature. With this, the user may implement a system where the SATURN provides a level of security designed to prevent unauthorized access to any data processing system.

III.1 - The AT Command Interpretor

The SATURN implements the industry-standard AT command set in a manner consistent with that of most commercial modem manufacturers. These commands are only available to the user when the SATURN is in command or on-line command mode and are realized in the form of asynchronous characters received from the DTE. Here is a basic description of its operation :

The AT Prefix

All command lines must begin with the two letters "A" and "T". Either upper case or lower case is acceptable but both letters should have the same case.

The SATURN attempts to determine the speed of the "A" by measuring the duration of its start bit. The "A" must be received at one of the speeds supported by the SATURN (i.e. 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200 bps) or this process will not succeed and the command process will fail.

Once the "A" and "T" characters have been received, the SATURN determines the parity of the DTE by analyzing the parity bits of these two characters. All result codes and information text issued by the SATURN will be generated with this parity.

The following asynchronous character formats are supported :

Start Bit	Data Bits	Parity Bit	Stop Bits
1	7	Even or Odd	1
1	7	None	2
1	7	Mark or Space	1
1	8	None	1

If the SATURN receives a character but fails to detect it as an "A", it begins to search for another "A" character. If the SATURN receives an "A" but it is not followed by a "T", the SATURN begins searching for an "A" again.

The A/ Command

If the characters A/ (instead of AT) are received, the SATURN will re-execute the most recently received command line. In this case, the parity is assumed to be the same as that of the most recently received AT prefix.

Command Line Characters

All characters that follow the AT prefix are taken to be commands (these are described below).

The parity bit of all command characters is ignored.

Spaces (20 Hex) between command characters (and option characters) are ignored.

No more than 255 command line characters are allowed. If more than this is received, the command line will be ignored and the "ERROR" result code will be returned when the carriage return character is received. This behaviour applies even if an attempt to remove the excess characters is made using the backspace character.

The Carriage Return Character

The carriage return character is used to signify the end of the command line. When this character is received, the SATURN will begin to process the command characters previously received.

The default value for this character is Control-M (D Hex) but it may be changed through modification of the appropriate S-register.

The Backspace Character

The backspace character is used to edit the command line. If it is received, the SATURN will ignore the most recently received command character and issue a backspace-space-backspace sequence to the DTE (if echoing is enabled).

If an attempt is made to backspace onto the AT sequence, the SATURN will ignore the backspace character and take no action.

The default value for this character is Control-H (8 Hex) but it may be changed through modification of the appropriate S-register.

Characters Ignored by the SATURN

Other than the above characters, all ASCII control characters (value less than 20 Hex) are ignored.

Processing Command Characters

The SATURN processes each command character in the sequence that it was received. Any change in operational state required by a command occurs as soon as the command is processed.

If an error occurs in the processing of a command, the SATURN will stop processing the command line and output the "ERROR" result code.

The detection of an unimplemented command during processing causes a command processing error.

Some commands (e.g. E, I, Q, V) may be followed by numeric arguments which select a particular option for that command. If the argument is missing, a value of zero is assumed. If the value is outside the valid range of arguments for that command, a command processing error occurs.

If command line processing completes without error, the "OK" result code will be output.

III.2 - Basic AT Commands Supported by the SATURN

This section discusses the AT commands generally used to handle the transmission of asynchronous data.

A : Answer mode

Causes the SATURN to go off hook and attempt a handshake in answer mode.

B : Bell/ITU-T Mode

B0	ITU-T modulation schemes are used (at 1200 bps).
B1	Bell modulation schemes are used (at 1200 bps).

D : Dial Number

Instructs the SATURN to go off-hook and execute the dial string which follows the D. Commands which may be part of the dial string are listed below. Any unrecognized character in the dial string is ignored. Once dialing is complete, the SATURN attempts a handshake in originate mode (unless the R parameter is given).

0-9 (any numeric digit)	Causes the indicated symbol to be dialled.
A, B, C, D, # or * (tone dial only)	Causes the indicated symbol to be dialled.
P	Causes subsequent numbers to be pulse dialled.
T	Causes subsequent numbers to be tone dialled.
R	Forces the SATURN to dial a call in answer mode.
W	Causes the SATURN to wait for a dial tone using S7 as a time out.
,	Causes a delay, determined by S8, before the SATURN proceeds with the next command or digit.
!	Causes the SATURN to go on-hook for .5 sec and then off-hook for .5 seconds before continuing.

@	Causes the SATURN to wait until it detects 5 seconds of silence before continuing.
;	Causes the SATURN to go to the command mode when the number is dialled. In order to proceed with channel establishment mode ATO or ATD must be entered. Any characters that follow this parameter are treated as AT commands.
L	Causes the last telephone number that was dialled by the SATURN to be re-dialled.
S	Causes the SATURN to dial the number in stored position "n" [format is S = n or Sn].
^	Causes the SATURN to skip emitting calling tone after dialling.

Note : If S41 is set to a value other than 0, the SATURN will attempt a maximum of S41 redials upon call failure.

E : Echo Commands

Defines whether characters are echoed back from the SATURN to the DTE when in command mode.

E0	Command echo inhibited.
E1	Command echo enabled.

H : Hook Switch Control

Controls the hook switch relay of SATURN.

H0	Causes the SATURN to go on-hook.
H1	Causes the SATURN to go off-hook.

In error correction mode S38 dictates the delay before going on-hook.

I : Interrogate SATURN Status

I0	Requests SATURN product code.
I1	Requests that a checksum calculation be performed on the software ROM. The answer is displayed as three hexadecimal digits.
I2	The SATURN performs a ROM checksum, compares the result against a stored value, and returns an OK or ERROR message depending on the success of the comparison.
I3	The SATURN sends its firmware revision number.
I4	The SATURN sends its ASCII string test.
I5	The SATURN sends its data pump chipset revision.

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L : Speaker Volume

Sets the speaker volume when speaker is on.

L0   Low volume.
L1   Low volume.
L2   Medium volume.
L3   High volume.

M : Speaker Control

Controls how speaker behaves when off-hook.

M0   Speaker always off.
M1   Speaker on until handshake is complete.
M2   Speaker always on.
M3   Similar to M1 except speaker is off when dialing.

N : Handshaking

Selects whether a connection will be forced to a specific speed.

N0   Sets the required connection speed to that set under S37.
N1   If S-register S37 is not equal to 255 it allows handshaking at the highest speed supported by both modems. If S-register S37 equals 255 it allows handshaking at the highest speed supported by both modems and DTE.

O : Return to On-Line State

Applicable when a physical connection with a remote modem exists and the SATURN is in the on-line command state.

O0   Returns the SATURN to the on-line state.
O1   As O0 except that when a 2400 bps or higher connection is established an equalizer retrain sequence is transmitted.

P : Pulse Dialing

Causes subsequent dial digits to be executed as pulses.

Q : Return Result Codes

Defines whether or not the SATURN will issue result codes to the DTE.

Q0   Result codes returned.
Q1   Result codes not returned.
Q2   Result codes returned in originate mode only.

T : Tone Dialing

Causes subsequent dial digits to be executed as DTMF tones.

V : Verbose mode

Defines the form of result codes returned by the SATURN.

V0   Numeric form responses enabled.
V1   Verbose responses enabled (English responses).

W : Connection Result Codes

Defines the type of (extended) negotiation result codes to return.

W0   Negotiation codes not reported.
W1   Negotiation codes reported in 3 line format (Hayes format).
W2   Negotiation codes reported in 1 line format (Microcom format).

X : Extended Response Codes

Defines the GSTN network tones which are recognized by the SATURN.

X0   Causes the SATURN to ignore any network tones and omit the connection speed message.
X1   As above but enables the connection speed result codes.
X2   Causes the SATURN to detect dial tone.
X3   Causes the SATURN to detect busy tone.
X4   Causes the SATURN to detect busy and dial tones.
X5   Causes the SATURN to report ringing, but dial tone is ignored.
X6   Causes the SATURN to perform adaptive dialing (automatically determine if dialing can be performed using DTMF signalling).

Y : Long Space Disconnect

Y0   Disabled.
Y1   Enabled.

When set for Y1, on-line and not in error correction : The SATURN will disconnect if it receives a continuous "break" from the remote modem for a period of time greater than or equal to 1.6 seconds. As well, when the SATURN is instructed by the DTE to hang up it will send a 4 second break to the remote modem prior to going on-hook.

Z : Recall User Configuration

The user configuration stored in non-volatile memory is recalled to become the active configuration.

Z0   Resets SATURN and recalls user profile 0.
Z1   Resets SATURN and recalls user profile 1.
Z2   Resets SATURN and recalls user profile 2.
Z3   Resets SATURN and recalls user profile 3.

&A : ODP/ADP for V.42 Initiator

Defines whether the SATURN will send the ODP (Originating Detection Pattern) and detect the ADP (Answer Detection Pattern) when initiating a V.42

handshaking. This command is effective only when the SATURN is set for V.42 auto-reliable.

&A0 The SATURN will not transmit the ODP thus will not detect the ADP and will immediately beginning synchronous handshaking.

&A1 The SATURN will transmit the ODP and detect the ADP.

&B : Data Terminal Equipment Speed in Data Mode

&B0 DTE speed equals the line speed.

&B1 DTE speed equals the speed of the last AT command or the default value on power up.

&C : Data Carrier Detect Options

Defines what the SATURN outputs as the DCD signal on the DTE interface.

&C0 The interface control signal DCD is always ON.

&C1 In command and connect modes the DCD signal is OFF. When on-line without error-correction, the signal DCD remains OFF until the carrier is detected, for the period defined by S9, at which time DCD goes ON. When on-line with error correction, the signal DCD goes ON once error correction is established.

&D : Data Terminal Ready Options

Defines how the DTR signal is interpreted by the SATURN. If S25 is not zero the DTR signal is ignored for S25 seconds after a call is indicated (See S25 definition).

For asynchronous mode :

&D0 DTR is ignored.

&D1 If DTR drops for a period of S25 milliseconds while the SATURN is on-line, the effect is the same as if the escape sequence is received, forcing the SATURN into command mode without dropping the connection. At other times DTR is ignored.

&D2 DTR functions as ITU-T circuit 108.2. While DTR is OFF the SATURN will not answer a call. If DTR drops for a period of S25 milliseconds while the SATURN is on-line, the call is immediately terminated.

&D3 As for &D2 except that the transition of the DTR signal from ON to OFF has the same effect as entering the ATZ command except that the retrieved configuration profile will be as per the &Y command.

For synchronous mode :

If &Q1 is set, DTR is interpreted as for asynchronous mode when off-line and placing calls. When on-line and set for &D1, an ON to OFF transition of DTR will cause the SATURN to enter asynchronous on-line command mode. For all other &D settings an ON to OFF transition of DTR will cause the SATURN to hang up.

If &Q2 is set the &D command is ignored. A OFF to ON transition of DTR when off-line will cause the SATURN to initiate a call using the telephone number stored in location 0. An ON to OFF transition of DTR when on-line will cause the SATURN to hang up. No calls will be answered if DTR is low.

If &Q3 is set the &D command is ignored. A OFF to ON transition of DTR when off-line will cause the SATURN to initiate a call using the ATD command. An ON to OFF transition of DTR when on-line will cause the SATURN to hang up. No calls will be answered if DTR is low.

&E : Auto Retrain

Determines whether the SATURN will suspend transmission and send a retraining sequence if line conditions deteriorate.

&E0 Disable auto retrain & enable auto disconnect.

&E1 Enable auto retrain & auto disconnect.

&E2 Disable auto retrain & auto disconnect (for B.E.R. test, only when direct or normal modes).

&F : Recall Factory Configuration

The factory configuration contained in the ROM is loaded to become the SATURN's active configuration.

&F0 V.42 factory defaults.

&F1 MNP factory defaults.

&F2 Basic asynchronous operation defaults.

&G : Guard Tone

Defines what guard tone SATURN transmits when answering a call (1200, 2400 bps).

&G0 No guard tone.

&G1 550Hz guard tone.

&G2 1800Hz guard tone.

&I : Break Mode Control

Defines how the SATURN handles a break condition on the DTE interface.

&I0 The break is sent in sequence with the received data (non-expedited / non-destructive).

&I1 The break is immediately passed through without buffering by either modem (non-destructive / expedited).

&I2 The break is expedited and destructive. The break causes the data buffers at both ends to be cleared and the break is immediately passed through.

&K : Flow Control

Defines the flow control options

&K0   Flow control is off.

&K3   Hardware Flow Control [RTS/CTS].

&K4   Software Flow Control [Local XON/XOFF].
In this mode the SATURN recognizes and transmits the XON/XOFF characters from and to the DTE in order to start or stop data. The SATURN will not transmit the XON/XOFF characters received from the DTE to the remote modem.

&K8   Unidirectional Software Flow Control [Transparent XON/XOFF]. In this mode the SATURN recognizes the XON/XOFF characters from the DTE in order to start or stop data. The SATURN will also transmit the XON/XOFF characters received from the DTE to the remote modem. With this type of flow control, the SATURN does not use the XON/XOFF characters to flow control the DTE.

&K12   Software Flow Control [Local/Transparent XON/XOFF]. In this mode the SATURN recognizes and transmits the XON/XOFF characters from and to the DTE in order to start or stop data. The SATURN will also transmit the XON/XOFF characters received from the DTE to the remote modem.

&K16   Software Flow Control [Internal XON/XOFF - for non error correcting mode]. In this mode the SATURN recognizes and transmits the XON/XOFF characters from and to the remote modem in order to start or stop data. The SATURN will not transmit the XON/XOFF characters received from the remote modem to the DTE. There is no flow control on the DTE interface. This is also known as DCE to DCE software flow control.

&K20   Software Flow Control [Internal and Local XON/XOFF - for non error correcting mode]. In this mode the SATURN recognizes and transmits the XON/XOFF characters from and to the remote modem in order to start or stop data. The SATURN will not transmit the XON/XOFF characters received from the remote modem to the DTE. The SATURN also recognizes and transmits the XON/XOFF characters from and to the DTE in order to start or stop data. The SATURN will not transmit the XON/XOFF characters received from the DTE to the remote modem.

&L : Line Type Select

Selects if the SATURN operates in lease line mode or GSTN.

&L0   GSTN mode.

&L1   Leased line mode.

In lease line mode user has to set Bit 7 of S14 depending on whether he wants "answer" or "call" mode. Bit 7 of S14 is automatically set when entering the "D" command and automatically cleared when entering the "A" command. In this mode the SATURN will attempt a line connection at the same rate as the DTE speed (up to 14 400). It will attempt to handshake for 30 seconds. If it fails it will report NO CARRIER and will give the user 3 seconds to enter a command. If during this time no user commands were entered, the SATURN will again proceed with a 30s handshaking. This will go on until a connection succeeds or until a user command is entered between handshaking attempts. If lease line is configured in the stored profile to retrieve on power up, the SATURN will enter handshaking after power up at the DTE speed (S23) and mode (Bit 7 of S14) stored in this profile. The user can break this procedure by entering any AT command after the NO CARRIER message.

DTE Speed	Handshake Speed	DTE Speed	Handshake Speed
300	300	19200	14400
1200	1200	38400	14400
2400	2400	57600	14400
4800	4800	115200	14400
9600	9600	-	-

&N : Error Control Fallback Character

Selects if the fallback character is to be checked for during the error control mode negotiation sequence. This character will cause the SATURN to immediately fall back to regular asynchronous mode. This character is stored in S46.

&N0   Disable fallback control character.

&N1   Enable fallback control character.

Note : This command affects how data received from the DCE is processed.

&O : Error Control Buffer Control

Determines buffering to be performed during the error control negotiation period.

&O0   Discard data received during negotiation.

&O1   Buffer data received during negotiation. The buffered data will be sent to the DTE after the connect result code if error control negotiation fails.

Note : This command affects how data received from the DCE is processed.

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&P : Pulse Dial Make/Break Ratio

Sets the make/break ratio to be used when pulse dialing.

&P0　39% / 61% ratio for North American telephone networks.
&P1　33% / 67% ratio for United Kingdom telephone networks.

&Q : Communications Mode

Selects the operating mode of the SATURN. If the SATURN is in error control mode and S36 is not equal to 0, it will automatically fallback to asynchronous operation when communicating with a modem that does not support error control.

&Q0　Asynchronous mode.
&Q1　Synchronous mode 1.
&Q2　Synchronous mode 2.
&Q3　Synchronous mode 3.
&Q4　Asynchronous direct mode.
&Q5　MNP error control mode.
&Q6　V.42 error control mode.
&Q7　V.42 error control only (overrides S-register S36).

Synchronous Mode 1 : This mode is used for terminals which communicate both synchronously and asynchronously over the same port. The SATURN initiates a call in asynchronous mode using the standard dial commands and switches to synchronous operation once a connection has been established. Striking a key during dialing will abort the call and return the OK prompt. If the key is pressed after dialing but before the connect message, the NO CARRIER message is displayed.

Once a connection has been established, the SATURN ignores the state of DTR for a period set by the value of S25 in seconds. After the pause, if the SATURN identifies DTR as being ON, the SATURN enters the synchronous state and data transfer can start. If DTR is identified as being OFF for the period of time specified by S25 in milliseconds, the SATURN disconnects and returns to the asynchronous command state. It will disconnect if &D is set to either &D0, &D2 or &D3. When set to &D1 if DTR is OFF, the SATURN enters asynchronous on-line command mode.

Synchronous Mode 2 : This mode is for synchronous terminals or asynchronous computers with a synchronous card. In this mode, when DTR OFF-to-ON transition is detected, the SATURN automatically dials the number stored in position 0. When DTR ON-to-OFF is detected for a period longer than the value contained in S25, the SATURN hangs up and returns to asynchronous command

mode. If the carrier is lost for a period of time longer than the value contained in S10, the SATURN hangs up and returns to asynchronous command mode. In synchronous mode 2 the DTR setting selected with the &D command is ignored.

Synchronous Mode 3 : This mode is used with either synchronous terminals or asynchronous computers with a synchronous card. Mode 3 is used when there is a need for the call to be placed in "voice" mode and then switched to "data" mode. The operator manually dials the required number and then switches the SATURN to data mode by turning DTR ON. When carrier is lost for a period of time longer than the value contained in S10, the SATURN exits the synchronous on-line state and returns to asynchronous command state. When DTR ON-to-OFF is detected for a period longer than the value contained in S25, the SATURN hangs up and returns to asynchronous command mode. In synchronous mode 3 the DTR setting selected with the &D command is ignored.

&R : Clear to Send
(When in Synchronous On-Line State)

Defines the state of the CTS signal while the SATURN is on-line in synchronous mode.

&R0　CTS is OFF whenever RTS is OFF. When RTS goes ON, CTS goes ON after a delay defined by S26. This is the normal setting for full duplex synchronous operation.
&R1　CTS remains ON whenever the SATURN is on-line.

&S : Data Set Ready Options

Defines how the DSR signal is handled by the SATURN.

&S0　DSR is always ON.
&S1　DSR is compatible with ITU-T recommendations. In command mode DSR is OFF. When originating a call DSR is forced ON when the SATURN receives 2100Hz (or 2225Hz) answer tone, or (if this is absent) when valid carrier is detected. When answering a call DSR is forced ON during handshaking as defined by V.25.

&T : Test Commands

&T0　Test currently in progress is terminated.
&T1　Local analog loopback test is initiated (ITU-T V.54).
&T3　Local digital loopback test is initiated.
&T4　Allows SATURN to respond to a request (from remote modem) for a Remote Digital Loopback.

&T5 Prohibits the SATURN from granting a request from the remote modem for a Remote Digital Loopback.

&T6 Remote digital loopback test (ITU-T V.54) when on-line.

&T7 Not implemented.

&T8 Not implemented.

&T9 Enable test with 140 and 141 signals of the V.24 interface.

&T10 Disable test with 140 and 141 signals of the V.24 interface.

&U : Data Compression

&U0 Data compression disabled.

&U1 Data compression enabled. This command is only meaningful when the SATURN is set to &Q5, &Q6, &Q7, \N2, \N3, \N4, \N5, \N6 or \N7.

&V : Display Configuration

Causes the SATURN to display the its current configuration of AT commands.

&V0 Displays the active configuration, stored profiles 0 and 1 as well as the first 3 stored phone numbers.

&V1 Displays stored profiles 2 and 3 as well as the first 4 stored phone numbers.

&W : Write a Profile to Memory

The SATURN's active configuration is stored in the non-volatile memory as Profile 0, 1, 2 or 3.

&W0 User profile 0.
&W1 User profile 1.
&W2 User profile 2.
&W3 User profile 3.

&X : Synchronous Clock Source

Defines the source of the transmit clock when the SATURN is operating in synchronous mode.

&X0 Internal.
&X1 External (from RS-232 (V.24) interface).
&X2 Slave receive. The SATURN uses its receiver derived clock to drive the modulator.

&Y : Recall Preset Configuration on Power Up

The profile stored under &W0, &W1, &W2 or &W3 can be assigned as the default profile which is automatically installed on power up.

&Y0 Designate user profile 0.
&Y1 Designate user profile 1.
&Y2 Designate user profile 2.
&Y3 Designate user profile 3.

&Z : Store Number Command

Store the desired telephone number in location 0 through 9. The maximum length of each stored number is 36 digits. The format of the stored number is identical to that accepted by the D command.

&Zn = x stores telephone number "x" in position n.

&Zn? displays the telephone number stored in position n.

III.3 - "\" and "%" Style Commands

The "\" and "%" commands supported by the SATURN follow :

%A : Auto-Reliable Fallback Character

n = 0-127 ASCII (same effect as changing S46)

%C : Data Compression (same as &U command)

%C0 Compression Off (same as &U0).
%C1 Compression On (same as &U1).

%D : Disposition of Buffered Data upon Hang up

%D0 Hang up without clearing buffer.

%Dn Wait for receive buffer to be sent to DTE before hanging up. n = number of seconds to wait (same as S38).

%En : Fixed Compromise Equalizer

%E0 Fixed compromise equalizer disabled.
%E1 Enables fixed compromise equalizer 1 (3 dB).
%E2 Enables fixed compromise equalizer 2 (6 dB).

%H - PTT Testing Utilities

Facilities 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 %H, and the test is aborted when a ATH command is entered. The modem will continuously transmit the tone or carrier according to the parameter supplied and to S35 output level (except for DTMF tones).

%H0-%H9 DTMF tone dial digits 0 to 9.
%H10 DTMF digit *.
%H11 DTMF digit A.
%H12 DTMF digit B.
%H13 DTMF digit C.
%H14 DTMF digit #.
%H15 DTMF digit D.
%H16 V.21 channel 1 mark (originate) symbol.
%H17 V.21 channel 2 mark symbol.
%H18 V.23 backward channel mark symbol.
%H19 V.23 forward channel mark symbol.
%H20 Not used.

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%H21   V.22 originate (call mark) signalling at 1200 bps.

%H22   V.22 bis originate (call mark) signalling at 2400 bps.

%H23   V.22 answer signalling (guard tone if selected).

%H24   V.22 bis answer signalling (guard tone if selected).

%H25   V.21 channel 1 space symbol.

%H26   V.32 9600 bps.

%H27   V.32 bis 14400 bps.

%H28   V.21 channel 2 space symbol.

%H29   V.23 backward channel space symbol.

%H30   V.23 forward channel space symbol.

%H31   Silence (on-line), i.e., go off-hook.

%H32   V.25 answer tone.

%H33   1800 Hz guard tone.

%H34   V.25 calling tone (1300 Hz).

%H35   Fax calling tone (1100 Hz).

%H36   V.21 channel 2 half duplex (for Fax application).

%H37   V.27 ter 2400 bps.

%H38   V.27 ter 4800 bps.

%H39   V.29 7200 bps.

%H40   V.29 9600 bps.

%H41   V.17 7200 bps long train.

%H42   V.17 7200 bps short train.

%H43   V.17 9600 bps long train.

%H44   V.17 9600 bps short train.

%H45   V.17 12000 bps long train.

%H46   V.17 12000 bps short train.

%H47   V.17 14400 bps long train.

%H48   V.17 14400 bps short train.

%H49   V.32 - 4800.

%H50   V.32 - 9600.

%H51   V.32 bis - 4800.

%H52   V.32 bis - 7200.

%H53   V.32 bis - 9600.

%H54   V.32 bis - 12000.

%H55   V.32 bis - 14400.

%H56   V.21 channel 2 carrier detection.

%H57   V.27ter 2400 bps carrier detection.

%H58   V.27ter 4800 bps carrier detection.

%H59   V.29 7200 bps carrier detection.

%H60   V.29 9600 bps carrier detection.

%H61   V.17 7200 bps carrier detection.

%H62   V.22 originate carrier detection at 1200 bps.

%H63   V.17 9600 bps carrier detection.

%H64   V.22bis originate carrier detection at 2400 bps.

%H65   V.17 12000 bps carrier detection.

%H66   V.22 answer carrier detection at 1200 bps.

%H67   V.17 14400 bps carrier detection.

%H68   V.22bis answer carrier detection at 2400 bps.

Note : The short train V.17 commands generates first a long train followed by 2 seconds of data mode, then a short train after 1 second of idle state.

For carrier detection measurements, the connection must be done with a remote modem by typing the proper %H command as described in the following table, and then modifying the line attenuation. The 109 V.24 line follows the carrier detection status.

In FSK modes, mark and space signaling can be inverted in order to make exhaustive measurements. (see table 1)

Table 1

Local Modem			Remote Modem		
Mode	**Command**	**Measurement**	**Mode**	**Command**	**Measurement**
V.21 ch 1 mark	%H16	valid (ch 2)	V.21 ch 2 mark	%H17	valid (ch 1)
V.21 ch 1 space	%H25	valid (ch 2)	V.21 ch 2 space	%H28	valid (ch 1)
V.23 b. ch mark	%H18	valid (f. ch)	V.23 f. ch mark	%H 19	valid (b. ch)
V.23 b. ch space	%H29	valid (f. ch)	V.23 f ch space	%H30	valid (b. ch)
V.22 originate	%H62	valid (high ch)	V.22 answer	%H66	valid (low ch)
V.22bis originate	%H64	valid (high ch)	V.22bis answer	%H68	valid (low ch)
V.21 ch 2 hd (fax)	%H56	valid	V.21 ch 2 hd (fax)	%H36	invalid
V.27ter 2400 bps	%H57	valid	V.27ter 2400 bps	%H37	invalid
V.27ter 4800 bps	%H58	valid	V.27ter 4800 bps	%H38	invalid
V.29 7200 bps	%H59	valid	V.29 7200 bps	%H39	invalid
V.29 9600 bps	%H60	valid	V.29 9600 bps	%H40	invalid
V.17 7200 bps	%H61	valid	V.17 7200 bps	%H41	invalid
V.17 9600 bps	%H63	valid	V.17 9600 bps	%H43	invalid
V.17 12000 bps	%H65	valid	V.17 12000 bps	%H45	invalid
V.17 14400 bps	%H67	valid	V.17 14400 bps	%H47	invalid

%K : V42/MNP Window Size

%Kn Maximum window size. 1<n<15.

%L : Line Signal Level Options

%L0 Return received line signal level in dB.
%L1 Return data pump's line status report.

%P : Negative ADP Selected

%P0 Disabled.
%P1 Enabled (only when normal mode selected, &Q0, \N0).

%Qn : Ignore Keyboard Abort On Answer

%Q0 Disabled.
%Q1 Enabled.

%R : Attempt to use CRC-32 When in V42

%R0 Disabled.
%R1 Enabled.

%S : Attempt to use Selective Reject When in V42

%S0 Disabled.
%S1 Enabled.

%T : Attempt to Negotiate Ability to Send Loop-back Test Frames When in V42

%T0 Disabled.
%T1 Enabled.

When negotiation succeeds after a V42 connection, a user can enter the command AT & T6 to test the line integrity. The SATURN will report test passed or test failed.

%V : V25 bis Selection

Speed as per S23 bits 3, 2, 1 and S39 bits 3,2.

%V0 AT command set.
%V1 V25 bis command set asynchronous.
%V2 V25 bis command set synchronous BSC.
%V3 V25 bis command set synchronous HDLC (NRZ).
%V4 V25 bis command set synchronous HDLC (NRZI).

%W :Acknowledgment Timer (T401)

%Wn Wait to retransmit time out. 0<n<63
    T401 = 4 seconds + n x 100 ms.
    exception when in MNP mode :
    if n = 0 = use Microcom timers.
    if n = 63 = use ITU-T V42 Annex A timers.

%Y : MNP Synchronous/Asynchronous

%Y0 Use synchronous mode when possible.
%Y1 Always use asynchronous mode.

\A : Error Correction Maximum Block Size

\A0 Sets maximum block size for error correction to 64 characters.
\A1 Sets maximum block size for error correction to 128 characters.
\A2 Sets maximum block size for error correction to 192 characters.
\A3 Sets maximum block size for error correction to 256 characters.

\B : Send Break (In On-Line Command Mode Only)

Bn Causes a break to be sent to the remote modem. The parameter "n" (0-9) is the break duration in 100s of milliseconds. If n is 0 or omitted, a 300 millisecond break will be sent.

\C : Data Buffering During Error Corrected Link Negotiation

Determines how the SATURN will process incoming data from the remote modem while trying to negotiate an error corrected link.

\C0 Does not buffer data during error corrected link negotiation and does not recognize the fallback character specified by the %A command or S46.
\C1 Buffers all data until 128 characters are received but does not recognize the fallback character.
\C2 Buffered data until 128 characters are received or until it detects the fallback character.

\G : Modem-to-Modem Flow Control During a Normal Connection

\G0 No modem-to-modem flow control.
\G1 Use modem-to-modem software flow control (XON/XOFF).

\J : Automatic DTE Speed Adjust

\J0 Serial port rate is not adjusted to the connection rate (same as &B1).
\J1 Speed of the serial port is matched to the speed of connection (same as &B0).

\K : Break Handling

\K1   The break is expedited and destructive. The break causes the data buffers at both ends to be cleared and the break is immediately passed through.

\K3   The break is immediately passed through without buffering by either modem (non-destructive/expedited).

\K5   The break is sent in sequence with the received data (non-expedited, non-destructive).

\N : Operational Mode

\N0   Buffered or Normal asynchronous mode.
\N1   Direct mode.
\N2   Reliable MNP.
\N3   Auto-reliable MNP (fallback to non error correction).
\N4   Reliable V.42.
\N5   Auto-reliable V.42 (fallback to non error correction).
\N6   Reliable V.42/MNP.
\N7   Auto-reliable V.42/MNP (fallback to non error correction).

\S : Display Configuration

\S0   Same as &V0.
\S1   Same as &V1.

\V : Extended Result Codes

\V0   Suppress extended result codes (same as W0).

\V1   Enable extended result code (same as W2).

\Y : Attempt Error Corrected Link (On Line Command Mode Only)

The modem will attempt to establish an error corrected link when this command is issued if the modem has already made a connection in either normal or direct mode.

\Z : Terminate Error Corrected Link (On Line Command Mode Only)

The modem will attempt to switch to normal mode if a reliable link is currently active. This also will cause the remote modem to attempt this switch. Any data in the buffer at this time may be lost.

III.4 - Facsimile AT Commands Supported by the SATURN

This section describes the extended AT commands, implemented in the SATURN, that are used to support the transmission and reception of facsimile files. Commands discussed in EIA/TIA standard 578 (Fax Class 1) and the Class 2 Fax command set are given here.

General Comments on Fax AT Commands

All commands require the AT prefix and are generally entered in the same way as the data modem AT commands (see the discussion at the beginning of the previous section for a detailed description of how commands are entered).

All commands except "+FTS" and "+FRS" support a syntax of the form "+<COMMAND>X" where X may be any of three different strings. The string "=" is used to provide a value for execution by the command. The string "=?" is used to interrogate the command as to its range of acceptable values (i.e. the command returns a string of comma-separated values that are those that can be provided to the command via the "=" string). The string "?" is used determine the value for that command that is currently in use.

All commands except "+FCLASS" cause a command processing error if received when the SATURN is on hook.

The transmit and receive facsimile commands require a modulation parameter <MOD>. Below is a list of the possible values of <MOD>.

<MOD>	Modulation Type	Speed (bps)
3	V.21 ch.2	300
24	V.27 ter	2400
48	V.27 ter	4800
72	V.29	7200
73	V.17	7200
74	V.17w/st	7200
96	V.29	9600
97	V.17	9600
98	V.17w/st	9600
121	V.17	12000
122	V.17w/st	12000
145	V.17	14400
146	V.17 w/st	14400

III.5 - Fax Class 1 Commands

+FCLASS : Identify Service Class

This command selects whether the SATURN is configured as a data or fax modem.

+FCLASS=0   SATURN configured as data modem.

+FCLASS=1   SATURN configured as Class 1 fax modem.

+FCLASS= 2   SATURN configured as Class 2 fax modem.

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+FTS : Stop Transmission and Wait

Transmission is halted followed by a wait for the specified time.

+FTS=<TIME> Wait for the time (in increments of 10 ms) specified by <TIME> (0 - 2.55s).

+FRS : Receive Silence

This command completes execution when silence is detected from the remote modem for the specified amount of time. Processing of the command is aborted, without error, if a character is received from the DTE while attempting to detect the period of silence.

+FRS=<TIME> Wait for the time (in increments of 10 ms) specified by <TIME> (0 - 2.55s).

+FTM : Transmit Facsimile Data

A physical connection with the modulation type specified by <MOD> is first established. Data received from the DTE is then transmitted in facsimile format.

+FTM=<MOD> Transmit facsimile data using modulation <MOD>.

+FRM : Receive Facsimile Data

A physical connection with the modulation type specified by <MOD> is attempted with the remote modem. If this succeeds, data subsequently received from the remote modem is sent to the DTE in facsimile format. If the physical connection fails, the "+FCERROR" result code is returned.

+FRM=<MOD> Receive facsimile data using modulation <MOD>.

+FTH : Transmit Facsimile Data HDLC

A physical connection with the modulation type specified by <MOD> is first established. Data received from the DTE is then transmitted in facsimile format using HDLC framing.

+FTH=<MOD> Transmit facsimile data, HDLC format, using modulation <MOD>.

+FRH : Receive Facsimile Data HDLC

A physical connection with the modulation type specified by <MOD> is attempted with the remote modem. If this succeeds, data subsequently received from the remote modem, using HDLC framing, is sent to the DTE in facsimile format. If the physical connection fails, the "+FCERROR" result code is returned.

+FRH=<MOD> Receive facsimile data, HDLC format, using modulation <MOD>.

III.6 - Class 2 Commands

+FAA : Data/Fax Auto Answer

+FAA command configure the modem to automatically detect whether an incoming call is from a data modem or a fax modem.

+FBOR : Phase C Data Bit Order (Short form : +FBO)

This command controls the bit order for phase C.

+FBOR = 0 Select direct bit order for phase C.
+FBOR = 1 Select reversed bit order for phase C.

+FBUG : Debug Mode HDLC Frame (Short form : +FBU)

This command enables the DCE to report the content of the HDLC frames to the DTE.

+FBUG = 0 Disables HDLC frame reporting.
+FBUG = 1 Enables HDLC frame reporting.

+FDCC : Establish DCE Capabilities (Short form : +FCC)

This command allows the DTE to sense and constrain the capabilities of the facsimile DCE, from the choices defined in ITU-T T.30 Table 2. When the values of +FDCC are modified the DCE will copy +FDCC into +FDIS.

+FCQ : Copy Quality

This parameter controls copy quality checking by the DCE.

+FCQ = 0 The DCE does no copy quality checking.
+FCQ = 1 Copy Quality checking enable.

+FCR : Capability to Receive

Indicates if the DCE can receive a message.

+FCR = 0 The DCE can not receive a message. This option can be used when the DTE has insufficient storage.
+FCR = 1 The DCE can receive a message.

+FDCS : Current Session Parameters (Short form : +FCS)

The +FDCS is loaded with the negotiated T.30 parameters for the current session. A DCS is generated by the DCE every time that the unit is transmitting. This parameter is initialized to 0,0,0,0,0,0,0,0 at the beginning of a session. +FDCS is a read only command.

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

+FDR : Receive a Page

This command initiates transition to phase C data reception.

+FDT : Send a Page

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

+FET : End the Page or Document

The DCE uses this command in transmission mode to tell the DCE if any additional pages are to be sent.

+FET = 0   Another page is following, send MPS to the remote modem.
+FET = 2   No more pages are expected, send EOP to the remote modem.

+FHPS : Handshake Protocol

+FHPS = 0   Send "OK" to the DTE.
+FHPS = 1   Send "ERROR" to the DTE.

+FDIS : Current Session Negotiating Position (Short form : +FIS)

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 frames, and uses +FDIS and the received DIS frame to generate the DCS frame (transmission mode).

+FLID : Local FAX Station ID String (Short form : +FLI)

+FLID contains the local telephone number transmitted in the CSI frame to the remote modem.

+FMINSP : Minimum Phase C Speed (Short form : +FMS)

This parameter limits the lowest negotiable speed for a session. This parameter is useful for limiting the cost of a transmission. If the facsimile cannot negotiate to the minimum speed it will disconnect.

+FPTS : Page Transfer Status (Short form : +FPS)

The +FPTS parameter contains a value representing the post page response, including copy quality and related end-of-page status.

+FPTS = 1   An MCF frame has been received. (page good).
+FPTS = 2   An RTN frame has been received. (page bad).

III.7 - Class 2 Responses

+FCON : Connection Response (Short form : +FCO)

Indicates a connection with a fax machine. +FCON message is released when the unit receives the beginning of the first HDLC frame.

+FTSI : Report the Remote ID (Short form : +FTI)

The message +FTSI reports the received remote string sent in the TSI frame.

Syntax : +FTSI : "<TSI ID string>"

+FCSI : Report the Remote ID (Short form : +FCI)

The message +FCSI reports the received remote string sent in the CSI frame.

+FDCS : Report the Negotiated Parameters (Short form : +FCS)

This message will be generated during the execution of +FDT or +FDR commands, before the CONNECT result code, if new DCS frames are generated or received. The codes are given in the table 8.4 of the class 2 EIA standard proposal.

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

+FET : Post Message Response

This message is generated by the facsimile DCE after the end of Phase C reception. The +FET is generated during the execution of a +FDR command. The parameter received tell the DCE which post message command the unit had received.

+FET : 0   A MPS frame has been received.
+FET : 2   A EOP frame has been received.

+FDIS : Report Remote Facsimile Station Capabilities (Short form : +FIS)

This message will be generated during the execution of +FDT or +FDR commands. This message is sent when the unit is receiving a DIS frame, and contains the capabilities of the remote station. The codes are the same as the +FDCS response.

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

+FHT : Report Transmit HDLC Frames

This message is generated when +FBUG = 1 and when a HDLC frame is transmitted. This response shows the frame transmitted to the remote station.

Syntax : +FHT : <Address><control><fis><fif1><fif2>...

+FHR : Report Received HDLC Frame

This message is generated when +FBUG = 1 and when a HDLC frame has been received. This response shows the frame received by the DCE.

Syntax : +FHR : <Address><control><fis><fif1><fif2>...

+FPTS : Page Transfer Status Response (RX and TX) (Short form : +FPS)

The +FPTS message is generated by the DCE at the end of Phase C data reception, during the execution of a +FDR command. The first parameter <ppr> is generated by the DCE ; it depends on the DCE capability at T.4 error checking controlled by the +FCQ parameter. The second and the third parameters are generated only in the reception mode, and represent the total number of lines and the bad line count.

Syntax : +FPTS : <ppr>,<lc>,<blc>

+FNSF : Report Received Non Standard Negotiation Frame (Short form : +FNS)

This response indicates the reception of a NSF frame. The information of the frame is transmitted after the +FNSF response.

Syntax : +FNSF : <1><2><3><4>...

+FNSC : Report Received Non Standard Negotiation Frame (Short form : +FNC)

This response indicates the reception of a NSC frame. Same as the +FNSF frame.

III.8 - Description of the Autologon Facility

Autologon : Modem security

The SATURN has the ability to store Autologon sequences in conjunction with the numbers stored with the &Z = n command (n = 0 to 9). The SATURN can be instructed to execute this sequence when originating or auto-answering a call. The sequence consists of a number of Transmit and Receive fields, limited only by the size of the SATURN's dial input buffer (70 characters).

Inputting an Autologon Sequence

Storing an Autologon sequence should be done as follows :

Type : AT&Zn = xxx.

Where n is the Autologon number and xxx is a phone number if desired. Enter all desired Transmit, Receive, or Command fields.

Transmit fields are prefixed with "Control T".

Receive fields are prefixed with "Control R".

Command fields are prefixed with "Control C" (always last).

To complete the storing of the Autologon sequence, simply hit the "Enter" key. Investigation of the logon sequence stored in location n can be accomplished by typing : AT&Zn?<CR>

Autologon Operation

If the first logon field is a transmit field it will be transmitted and the SATURN will look for a response corresponding to the first receive field. When this is received the next transmit field (if any) is transmitted. This procedure can be repeated.

If the first logon field is a receive field, the SATURN waits for the message to be received from the remote before transmitting the first transmit field.

The SATURN starts a thirty second timeout when it enters the receive message state; if the expected message is not received within this period, the SATURN outputs :

AUTO-LOGON FAILED

and disconnects the call.

In originate mode the logon sequence is executed using ATDSn or ATDS = n where n is the desired stored sequence. When the number has been dialled and the call connected, the SATURN will enter the logon sequence.

To cause the SATURN to use a logon sequence when answering a call, register S34 must be set the required stored sequence with the command :

ATS34=n (n=0 to 9)

Typing ATS34 = 0 will disable the answer Autologon (Only 9 Autologon sequences are available in answer mode).

In answer mode the stored phone number associated with the chosen sequence is ignored.

Control Characters

A carriage return may be entered into any field by typing : ^A (Control A).

The SATURN's response is : (Return).

If the logon fields include control characters, they must be entered as Hex values. Any Hex value can be entered into a field by typing :

^Xnn (Control X)nn.

Where nn is a two digit hex code. The SATURN will echo : (HEX) nn.

A pause can be entered, anywhere in the Transmit fields, with : ^P (Control P).

The SATURN's response is : (PAUSE).

To allow the SATURN to execute an AT command, the character : ^C (Control C).

must be entered as the last control character in an Autologon sequence.

Example of Autologon as Call Back Security

Set up answer SATURN as follows :

Step	Typed by User	Echoed to Screen
1.	ATS0=1<CR>	ATS0=1<CR><CR><LF>
2.	ATS34=2<CR>	ATS34=2<CR><CR><LF>
3.	AT&Z2=^T	AT&Z2=<CR><LF> (Transmit)
4.	Password? ^R	Password? <CR><LF>(Receive)
5.	MONIQUE^C	MONIQUE<CR><LF> (Command)
6.	HDT7470254<CR>	ATHDT7470254<CR> <LF>OK

Step 1. Sets the SATURN to answer after 1 ring.

Step 2. Instructs the SATURN to use Autologon sequence #2 in answer mode.

Step 3. Entering of Auto logon sequence begins. Transmit field is requested.

Step 4. Desired transmit field is "Password? ". This is entered and Receive field is requested.

Step 5. Desired receive field is "MONIQUE". This is entered and Command field is requested.

Step 6. Desired command field is "HDT7470254". This is entered and Autologon configuration mode is ended.

Once one ring is detected and the SATURN has passed through the handshaking process and entered error correction mode if necessary, this Autologon sequence will perform the following task : when the SATURN is programmed with the above sequence, it will execute Autologon Sequence #2 and transmit the string "Password?". It then waits for the calling modem to reply with the string "MONIQUE". When this string is received the SATURN will perform the AT command requested in the command field, (i.e. HDT7470254<CR>). The effect of this command is to cause the SATURN to hang up and tone dial the line with the specified phone number. If any error occurs during the process of the receive field the SATURN will hang up and display AUTO-LOGON FAILED.

IV - V.25BIS COMMANDS

Modem operation may be controlled through the use of the V.25 bis command set. This is implemented by command, response and circuit signalling providing addressed call and/or answer via circuit 108/2 in accordance with V.25 bis. V.25 bis is a ITU-T recommendation that defines a method of exchanging commands and indications across a DTE interface (RS232/V.24). V25bis defines modem behaviour only while the modem is off-hook and is attempting to establish a connection. The following terms are used in the V.25bis description.

COMMAND : An instruction issued by the DTE to the modem as part of the automatic calling procedure.

INDICATION : A response message issued by the modem to the DTE as part of the automatic calling procedure.

PARAMETER : A variable which may accompany commands or indications. In general, more than one parameter may be used in a command or indication.

Formats for Commands and Indications

The modem will accept commands either in synchronous mode HDLC (NRZ or NRZI), BSC or in asynchronous mode (%Vn command).The command set conforms to the ITU-T recommendation with two extension for asynchronous mode.

Synchronous Signalling

HDLC Frames, Commands and indications are HDLC frames with data fields called messages.

FLAG   HEX "7E"

ADDRESS   HEX "FF"

CONTROL   HEX "13"

MESSAGE Data. Must be an integer number of 8 bit characters between 3 and 60.

FCS   Sixteen bit cyclic redundancy check based on the polynomial : $X16 + X12 + X5 + X1$

Synchronous Framing Rules

Framing may be preceded and followed by any data including additional flags.

A Frame with an address, control, or FCS field error is invalid. A frame with more than 125 characters in the message field is invalid. A frame with 3 or less characters in the message field is rejected with the INV indication.

Invalid frame frames are ignored.

For every valid command frame received, the modem responds with exactly one indication.

When the modem receives a valid command frame, it will ignore another command frame until it has completed sending its indication back to the attached DTE or until the connection is terminated whichever occurs last.

The modem can accept a valid command frame that follows an invalid frame if there is a pause of at least 2 bits time between the end of the invalid frame and the start of the valid frame.

Command and indication frames contain inserted zero bits as required by HDLC. The receiving entity (modem or DTE) must strip out these extra bits.

BSC Frames

The format for synchronous character oriented format shall be in accordance with ISO 1745.

SYN	HEX "16"
SYN	HEX "16"
STX	HEX "02"
MESSAGE	Data. Must be an integer number of 8 bit characters between 3 and 60. (ASCII 7 data bits, odd parity).
ETX	HEX "83"

BSC Framing Rules

Framing may be preceded and followed by any data including additional SYN characters.

A Frame with a parity error is invalid. A frame with more than 123 characters in the message field is invalid. A frame with 3 or less characters in the message field is rejected with the INV indication.

Invalid frame frames are ignored.

For every valid command frame received, the modem responds with exactly one indication if the connection is not completed and no indication if the connection is completed. The modem does not recognize or send any of the short "ack" type messages used in character oriented protocols.

When the modem receive a valid command frame, it will ignore another command frame until it has completed sending its indication back to the attached DTE or until the connection is terminated whichever occurs last.

The modem can accept a valid command frame that follows an invalid frame if there is a pause of at least 2 bit times between the end of the invalid frame and the start of the valid frame.

Asynchronous Signalling

The format for asynchronous character oriented format shall be the following:

MESSAGE <CR><LF>

The default data rate for commands and parameters will be the maximum data rate permitted by the modem recommendation.

The message field can contain between 3 and 60, 8 bit (as per the AT command format) which define the parameters. Each frame can contain only one command followed by as many parameters that will fill the limit.

Command/Indication Exchange Protocol

The modem will ignore a command issued from the DTE before it has completed execution of the previous command and given an appropriate re-sponse. The modem will ignore a command from the DTE while it is sending an indication to the DTE.

A command received with a message field of less than 3 characters or more than 60 characters is regarded as an error in the message and will result in the negative acknowledgment of the command by the return of the invalid message (INV).

DTE Adaptation

In asynchronous mode, the modem uses the speed stored in S23. The modem then accepts and sends characters according to this selection of speed, parity and length.

The following commands are implemented. Parameters applicable to each command are noted following the description of the command.

IV.1 - Standard V.25bis Commands

CIC : Connect Incoming Call

The modem will go on line in answer mode, canceling any DIC command previously issued. If no incoming call is present the modem will issue the INV message.

CRN : Call Request with Number

The modem will go on line, dial according to the dial string entered and attempt to establish a connection.

0-9	Digit 0 to 9.
A,B,C,D	Digit A, B, C and D : tone dialing only.
*	The "star" digit : tone dialing only.
#	the "gate" digit : tone dialing only.
T	Select tone dialing : affects current and subsequent dialing.
P	Select pulse dialing : affects current and subsequent dialing.
<	Short dial pause : period controlled by S8 : the modem will pause before dialing the digits following "<".
=	Long dial pause : period twice as long as the short dial pause.
:	Wait for dial tone : the modem will wait for dial tone before dialing the digits following ":".
&	Flash : causes the modem to go on-hook for .5 sec and then off-hook for .5 sec.
@	Wait for silence : the modem will wait for 5 sec of line silence before dialing the digits following "@".

CRS : Call Request with Memory Address

The modem will go on-line, dial according to the dial string entered in the dial string memory addressed and attempt to establish a connection.

0-9	Dial string memory address.

DIC : Disregard Incoming Call

The modem, though configured for auto-answer will disregard the incoming call. If there is no incoming call or auto-answer is not enabled the modem will issue the invalid message, the command not being applicable to the subsequent calls.

PRN : Program Normal

The modem will store the dial string specified into the dial string memory referenced.

0-9   Dial string memory address.
;   Separator : inserted between dial string memory address and dial string.
x..x   Dial string : a string of dial characters : 0-9AD* # T P< = &@ : characters accepted : an empty string clears the identification memory referenced.

RLN : List Request of Stored Numbers (Dial Strings)

The modem will return the dial string or the list of dial strings according to the parameter supplied.

0-9   Dial string memory address : if no address is supplied a full list of all stored dial string will be returned

The modem provides the indication/responses listed. Parameters applicable to each message are noted following the description of the response.

IV.2 - Standard V.25bis Indications

CFI : Call Failure Indication

The modem will send this message when a call fails to connect. A parameter is included to give the reason for the failure.

AB   No dial tone.
ET   Busy detected.
NT   Aborted; handshaking failure or loss of carrier.
RT   Ringback detected.
NS   Number requested not stored.

CNX : Connect Indication

This gives an indication of the line speed.

CNX   300
CNX   75TX/1200RX
CNX   1200TX/75RX
CNX   1200
CNX   2400
CNX   4800
CNX   7200
CNX   9600
CNX   12000
CNX   14400

INC : Incoming Call

The modem will send this message when incoming ringing is detected on the line.

INV : Invalid

The modem will send this message if the command line contain a syntax error or it is unable to execute the command.

LSN : List of Stored Numbers (Dial Strings)

The modem will use this message in response to the RLN command.

LSN 4;   19 : 1 = 7470336   response to RLN4

LSN 0;   response to RLN
LSN 1;
LSN 2;
LSN 3;
LSN 4;   19 : 1 =7470336
LSN 5;
LSN 6;
LSN 7;
LSN 8;
LSN 9;

VAL : Valid

The modem will send this message when it successfully executes the command issued and there is no other applicable response.

IV.3 - Extended V.25bis Command Set

There is one extension to the V.25bis command set.

CNL : Local Configuration

Any AT command string may be entered as a parameter of this command (e.g. CNLS0 = 2).

IV.4 - V.25bis Escape Sequence

An escape sequence function for V.25bis asynchronous operation is provided which operates exactly as the AT escape sequence.

V - S-REGISTERS

S-registers are byte-wide locations in SATURN memory that contain information about the configuration and operational status of the SATURN.

Many of the SATURN's options can be directly set via the S-registers and some extended features are only available through setting of these registers. Examples of this are S35 which is used to select the transmit level and S41 which selects the number of re-dial attempts.

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Some S-registers are bit-mapped, that is, the individual bits (or, sometimes, groups of bits) contain significant information as opposed to the contents of the register as a whole. When references to bit-mapped registers are made, the least significant bit is bit 0 while the most significant bit is bit 7.

V.1 - Reading an S-register

To display the value of an S-register in decimal format the command Sn? is used where "n" references the desired register. To display an S-register's value in hexadecimal format, use the Sn! command.

V.2 - Writing an S-register

An S-register's value may be altered by the Sn = X command where "n" is the register to be changed and "X" is the new decimal value to be assigned to it.

V.3 - Defaults

Entering AT! or AT? will display the content on the last register accessed while AT = n will alter the last accessed S register with the decimal value "n".

If the Sn = X command is used and the value "X" is not given, zero will be written to the appropriate S-register.

Any value of "n" or "X" is evaluated modulo 256 before any command processing takes place (i.e. the remainder of the expression [n or X] / 256 is the actual value of "n" or "X" used by the SATURN.

Unless otherwise specified, any value between 0 and 255 (decimal) may be written to an S-register. Out of range values are rejected and cause a command processing error.

Writing a value to an S-register designated as "reserved" (see below) will place that value in the register but has no effect on the SATURN's operation.

Reading an S-register "n" where "n" is 50 or greater will always return zero. Attempting to write such a register causes a command processing error.

V.4 - S-Register Descriptions

The complete set of S-registers is listed below with the corresponding bit maps where applicable.

All values are in decimal format. Default values indicated in bold type are those written after execution of the &F0 command. If the register TYPE is non-storable then this default value will also be written whenever the SATURN is reset. For storable register, however, the value after reset will be set to that stored in the appropriate stored profile.

Any register not specifically mentioned below is reserved.

S0 : Ring To Answer On
0 = No auto answer
Any other = SATURN answers after this number of rings
Default = 0
TYPE : Storable

S1 : Ring Count
This register is reset to 0 if 8 seconds elapse since receipt of the previous ring
Default = 0
TYPE : Non-Storable

S2 : Escape Sequence Character
If the value is greater than 127, escape sequence is disabled.
Default = 43 (+)
TYPE : Non-Storable

S3 : Carriage Return Character
Value : 0 - 127
Default = 13 (ASCII CR)
TYPE : Non-Storable

S4 : Line Feed Character
Value : 0 - 127
Default = 10 (ASCII LF)
TYPE : Non-Storable

S5 : Backspace Character
Value : 0 - 255
Default = 8 (ASCII BS)
TYPE : Non-Storable

S6 : Wait Time Before Dialing
Value : 2 - 255 s
Default = 2
TYPE : Storable

S7 : Wait Time For Carrier / Dial Tone
Value : 1 - 255 s
Default = 30
TYPE : Storable

S8 : Duration for Pause (,) Dial Modifier
Value : 0 - 255 s
Default = 2
TYPE : Storable

S9 : Carrier Detect Response Time
Value : 1 - 255 in .1 s increments (.1 - 25.5 s)
Default = 1
TYPE : Storable

S10 : Delay Between Lost Carrier And Hang Up

Value : 1 - 255 in .1 s increments (.1 - 25.5 s)

Default = 14

Note : S10 = 255 implies infinite delay

TYPE : Storable

S11 : DTMF Tone Duration and Silence Time Between Tones

Value : 50 - 255 in 1 ms increments (55 - 255 ms)

Default = 95

TYPE : Storable

S12 : Escape Sequence Prompt Time

Value : 0 - 255 in 20 ms increments (0 - 5.1 s)

0 = Do not check guard time

Default = 50

TYPE : Storable

S14 : Bit-mapped

Bit 0　　Reserved
Bit 1　　Echo command characters (E CMD)
　　　　　0 = No echo
　　　　　1 = Echo
Bit 4,2　Generate result codes (Q CMD)
　　　　　0 = Enable result codes
　　　　　1 = No result codes
　　　　　2 = Result codes enabled only when originate mode in effect
Bit 3　　Verbose / numeric result codes (V CMD)
　　　　　0 = Numeric result codes
　　　　　1 = Verbose result codes
Bit 5　　Tone / Dial (P and T CMD)
　　　　　0 = Tone dialing (T CMD)
　　　　　1 = Pulse dialing (P CMD)
Bit 6　　Reserved
Bit 7　　Answer / Originate
　　　　　0 = Answer mode
　　　　　1 = Originate mode
TYPE : Storable

S16 : Test Status (Bit-mapped)

ALB = Analog loopback, DLB = Local digital loopback, RDLB = Remote digital loopback.

Bit 0　　ALB (&T1 CMD)
　　　　　0 = No ALB
　　　　　1 = ALB active
Bit 1　　Reserved

Bit 2　　Digital loopback (&T3 CMD)
　　　　　0 = No DLB
　　　　　1 = DLB active
Bit 3　　Status of DLB initiated by remote mode
　　　　　0 = No DLB
　　　　　1 = DLB initiated by remote modem active
Bit 4　　Remote digital loopback (&T6 CMD)
　　　　　0 = No RDLB active
　　　　　1 = RDLB initiated and granted by remote
Bit 5　　RDLB with self test (&T7 CMD)
　　　　　0 = No RDLB active
　　　　　1 = RDLB with self test initiated and granted by remote
Bit 6　　ALB with self test (&T8 cmd)
　　　　　0 = No ALB
　　　　　1 = ALB with self test active
Bit 7　　Reserved
TYPE : Non-Storable

S18 : Test Timer

Value : 0 - 255 s

0 = Infinite test time

Any other = Test is terminated after specified time elapses

Default = 0

TYPE : Storable

S21 : Bit-mapped

Bit 0　　Reserved
Bit 1　　Reserved
Bit 2　　CTS control (&R CMD)
　　　　　0 = CTS follows RTS
　　　　　1 = CTS always on
Bit 4,3　DTR control (&D CMD)
　　　　　0 = Ignore
　　　　　1 = Command state
　　　　　2 = Hang up
　　　　　3 = Reset
Bit 5　　DCD control (&C CMD)
　　　　　0 = DCD always on
　　　　　1 = DCD controlled by SATURN
Bit 6　　DSR control (&S CMD)
　　　　　0 = DSR always on
　　　　　1 = DSR controlled by SATURN
Bit 7　　Long space disconnect (&Y CMD)
　　　　　0 = Disabled
　　　　　1 = Enabled
TYPE :　Storable

S22 : Bit-mapped

Bit 1,0   Speaker volume control (L CMD)
    0 = Low
    1 = Low
    2 = Medium
    3 = High

Bit 3,2   Speaker control (M CMD)
    0 = Always off
    1 = On until carrier detected
    2 = Always on when off hook
    3 = Off during dialing and after carrier detected

Bit 6,5,4 Extended response codes (X CMD)
    0 = Ignore GSTN status and do not report connection speed - (X0)
    1 = Detect busy and ringing tones and report connection speed - (X5)
    2 = As for X5 and also detect dial tone and perform adaptive dialing - (X6)
    3 = As for X6 - (X7)
    4 = As for X0 and also report connection speed - (X1)
    5 = Detect dial tone and report connection speed - (X2)
    6 = Detect busy tone and report connection speed - (X3)
    7 = Detect dial and busy tones and report connection speed - (X4)

Bit 7   Make / break ratio when pulse dialing (&P CMD)
    0 = U.S. (39%/61%)
    1 = U.K. (33%/67%)

TYPE :   Storable

S23 : Bit-mapped

Bit 0   Detect RDLB (&T4 and &T5 CMD)
    0 = Deny RDLB (&T5 CMD)
    1 = Accept RDLB (&T4 CMD)

Bit 3,2,1 DTE port communications speed (bps)
    0 = 300
    1 = 57600
    2 = 1200
    3 = 2400
    4 = 4800
    5 = 9600
    6 = 19200
    7 = 38400

Note : bits 3,2 and 1 of S23 are only valid if bit 3 of S39 = 0.

Bit 5,4   Parity
    0 = Even
    1 = Space / none
    2 = Odd
    3 = Mark

Bit 7,6   Guard Tone
    0 = None
    1 = 550Hz
    2 = 1800Hz
    3 = Not used

TYPE :   Storable

S24 : Bit-mapped

Bit 0   Error control fallback character (&N, \C CMD)
    0 = No fallback character
    1 = Enable fallback character in S46

Bit 1   Error control buffer control (&O, \C CMD)
    0 = Don't buffer incoming data during negotiation
    1 = Buffer data

Bit 2   Data compression control (&U, %C CMD)
    0 = Disable
    1 = Enable

Bit 3   Not used

Bit 4   DCE speed to be negotiated during handshake (N CMD)
    0 = S37 speed
    1 = Optimum speed if S37 ! = 255
    Optimum speed up to DTE if S37 = 255

Bit 6,5   Extended connection result code (W, \V CMD)
    0 = No extended result code
    1 = Hayes extended result code
    2 = Microcom extended result code
    3 = Not used

Bit 7   DTE speed after handshake completed (&B, \J CMD)
    0 = DTE set to DCE speed
    1 = DTE speed not changed by DCE

TYPE :   Storable

S25 : DTR Detection

Value : 0 - 255 in .01 s or in 1 s increments (0 - 2.55 s or 0 - 255 s) see &D command description

Default = 5

TYPE : Storable

S26 : RTS To CTS Delay

Value : 0 - 255 in .01 s increments (0 - 2.55 s)

Default = 1

TYPE : Storable

S27 : Bit-mapped

Bit 3,1,0 Communication mode (&Q, N CMD)
        0 = Normal asynchronous
        1 = Sync mode 1
        2 = Sync mode 2
        3 = Sync mode 3
        4 = Direct
        5 = MNP
        6 = MNP/V.42
        7 = V.42
Bit 2   Leased line (&L CMD)
        0 =GSTN
        1 = Lease line
Bit 5,4   Synchronous transmit clock source (&X CMD)
        0 = Internal
        1 = External
        2 = Derive from receiver (slave)
Bit 6   Bell / ITU-T (B CMD)
        0 = ITU-T
        1 = Bell
Bit 7   Reserved
TYPE : Storable

S28 : Bit-mapped

Bit 1,0   Error Correction Maximum Block Size (\A CMD)
        0 = 64 bytes
        1 = 128 bytes
        2 = 192 bytes
        3 = 256 bytes
Bit 6 to 2 V.42 detection period (T400) in 50 milliseconds increments
        0 = Infinite
        1 to 155 = (1 to 255) times .05 second
        Default = 16 for .8 seconds
Bit 7   ODP/ADP (&A CMD)
        0 = Do not use ODP/ADP when initiating a reliable V.42 handshake
        1 = Use ODP/ADP when initiating a reliable V.42 handshake
TYPE : Storable

S29 : Bit-mapped

Bits 5 to 0 V.42 acknowledgment timer (T401)(%W CMD) These six bits are interpreted as an integer that specifies the number of 100 millisecond increments which are added to the base value of four seconds in order to arrive at the T401 value. Because of he way it is specified here, the minimum value of T401 is 4 seconds and the maximum value of T401 is 10.3 seconds. The default value is zero which corresponds to a T401 value of 4 seconds.
        Default = 0 for 4 seconds

Bit 6   V.42 frame check sequence (%R CMD)
        0 = Always use CRC-16
        1 = Attempt use if CRC-32
Bit 7   V.42 selective reject (%S CMD)
        0 = Disabled
        1 = Enabled
TYPE : Stored

S30 : Bit-Mapped

Bits 4 to 0 V.42 windows size (k)(%K CMD) These 5 bits are interpreted as an integer that specifies the maximum number of unacknowledged packets that V.42 and MNP will allow at anytime. Although the bits may be set to any value between 0 and 31 a setting of zero is undefined and should not be used. The default value is 01111 (binary) = 15 (decimal).
        Default = 15 packets
Bit 5   Negative ADP (%V CMD)
        0 = Disabled
        1 = Enabled
Bit 6   Force asynchronous MNP (Class 2)(%Y CMD)
        0 = Do not force asynchronous MNP
        1 = Force asynchronous MNP
Bit 7   V.42 remote loopback test (%T CMD)
        0 = Ignore loopback frame received from remote
        1 = Process loopback frame received from remote
TYPE : Storable

S31 : Bit-mapped

Bits 1,0   V.25bis selection (%V CMD)
        0 = Asynchronous V.25 (%V1)
        1 = Bisync V.25bis NRZ(%V2)
        2 = HDLC V.25bis NRZ (%V3)
        3 = HDLC V.25bis NRZI (%V4)
Bit 2   Synchronous mode V.13 operation (&C CMD)
        0 = Disable
        1 = Enable
Bit 3   Ignore keyboard abort on answer (%Q CMD)
        0 = Disable
        1 = Enable
Bits 6 to 4 Reserved
Bit 7   V.25bis mode (%V CMD)
        0 = Disabled (AT commands %VO)
        1 = V.25bis enabled as per bits 1,0 (for other than %VO)
TYPE : Storable

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S32 : Bit-mapped

Bits 1,0   Encryption mode select (#S CMD)
           00 = No encryption (#S0)
           01 = Force V.42bis encryption(#S1)
           10 = Reserved for later use
           11 = Reserved for later use
Bits 3,2   MNP Extended Services (-K CMD)
           00 = Disabled (-K0)
           01 = Enabled (-K1)
           10 = Enabled without MNP indication during the answer detect phase. (-K2)
Bit 4   Power level adjustment setting (M CMD)
           0 = Disable (M0)
           1 = Enabled (M1)
Bits 6-5   Force an initial connection speed (*H CMD)
           00 = Highest supported (*H0)
           01 = 1200 bps (*H1)
           10 = 4800 bps (*H2)
Bit 7   Not used
TYPE :   Storable

S33 : Cellular Transmit Level

Value : 0 - 20

Default = 9

TYPE : Storable

S34 : Answer Logon Sequence

Value : 0 - 9 (If 0 then no logon in answer)

Default = 0

TYPE : Storable

S35 : Transmit Level (dBm)

Value : 0 - 20

Default = 9

TYPE : Storable

S36 : Error Correction Negotiation Failure Treatment

0 = Disconnect

1 = Normal asynchronous (no error control)

TYPE : Storable

S37 : Desired DCE Speed

• for N0 command :
0 = Last AT command speed
1 = 300 (Bell 103)
2 = 300 (Bell 103)
3 = 300 (Bell 103)
4 = Reserved
5 = 1200
6 = 2400

7 = V.32 4800
8 = Reserved
9 = V.32 9600 with Trellis Coded Modulation (TCM)
10 = V.32 9600 without TCM
11 = 300 (V.21)
12 = 1200 (V.23)
13 = reserved
14 = reserved
15 = V.32bis 4800
16 = V.32bis 7200
17 = V.32bis 9600
18 = V.32bis 12000
19 = V.32bis 14400
20 to 254 = Reserved
255 = Last AT command speed

• for N1 command :

0 to 19 = Connect at the highest possible speed regardless of the DTE speed.

255 = Connect at the highest possible speed up to the last AT command speed.

TYPE : Storable

S38 : Reliable Link Delay Before Forced Hang Up

Value : 0 - 254 s

Default = 20

TYPE : Storable

S39 : Bit-mapped

Bit 0   Not used
Bit 1   Auto disconnect (&E CMD, meanfull when direct or normal modes only.)
           0 = Enable
           1 = Disable
Bit 2   Reserved
Bit 3   DTE rate at 115200 bps
           0 = DTE rate is according to bits 1,2 and 3 of S23 or bit 2 of S39
           1 = DTE rate is at 115200 bps
Bit 5,4   Break handling (&I, K CMD)
           0 = Non-destructive / non-expedited
           1 = Non-destructive / expedited
           2 = Destructive / expedited
Bit 6   EIA loopback test control (&T9 , &T10 CMD)
           0 = Ignore EIA loopback test (&T10)
           1 = Process EIA loopback test (&T9)
Bit 7   Auto retrain (&E CMD)
           0 = Disable
           1 = Enable
TYPE :   Storable

S40 : Inactivity Timer

Value : 0 - 255 minutes (0 = Inactivity timer disabled)

Default = 0

TYPE : Storable

S41 : Dial Retry

Value : 0 - 10

Default = 0 (No retry)

TYPE : Non-Storable

S44 : Error Correction in Use

0 = No error correction
2 = MNP class 2
3 = MNP class 3
4 = MNP class 4
5 = MNP class 5
6 = V.42
7 = V.42bis
TYPE : Non-storable

S45 : Reason for Disconnection

0 = Lost carrier
1 = User interrupt
2 = Training failure
3 = Retrain failure
4 = Inactivity time out
5 = Long space disconnect
6 = Negotiation failure
TYPE : Non-storable

S46 : Fallback Character For Error Correction Negotiation

Value : 0 - 127

Default = 13 (ASCII CR)

TYPE : Storable

S47 : XON Character

Value : 0 - 127

Default = 17

TYPE : Storable

S48 : XOFF Character

Value : 0 - 127

Default = 19

TYPE : Storable

S49 : Bit-mapped

Bit 4 to 0 Flow Control (&K CMD)
    0 = No flow control
    3 = Hardware flow control
    4 = SATURN to DTE, bi-directional flow control
    8 = SATURN to DTE, unidirectional flow control
    12 = SATURN to DTE, bi-directional, transparent flow control
    16 = SATURN to remote modem, bi-directional flow control
    20 = DTE to SATURN to remote modem bi-directional flow control

Bit 5   Compromise equalizer
    (meanfull if bit 7 = 0)
    0 = Compromize equalizer 1 (3dB)
    1 = Compromize equalizer 2 (6dB)

Bit 6   Dumb mode
    0 = Smart mode
    1 = Dumb mode

Bit 7   Compromise equalizer
    0 = Compromise equalizer enabled
    1 = Compromise equalizer disabled

TYPE :   Storable

V.5 - S-Registers Factory defaults

Register	F0	F1	F2	Y0	Y1	Y2	Y3	Range	Status
S00	000	000	000	000	000	000	000	000 255	
S01	000	000	000	000	000	000	000	000 000	NS
S02	043	043	043	043	043	043	043	000 255	NS
S03	013	013	013	013	013	013	013	000 127	NS
S04	010	010	010	010	010	010	010	000 127	NS
S05	008	008	008	008	008	008	008	000 255	NS
S06	002	002	002	002	002	002	002	002 255	
S07	030	030	030	030	030	030	030	001 255	
S08	002	002	002	002	002	002	002	000 255	
S09	006	006	006	006	006	006	006	001 255	
S10	014	014	014	014	014	014	014	001 255	
S11	095	095	095	095	095	095	095	050 255	
S12	050	050	050	050	050	050	050	000 255	
S13	000	000	000	000	000	000	000	000 255	NS
S14	138	138	138	138	138	138	138	000 255	
S15	000	000	000	000	000	000	000	000 255	NS
S16	000	000	000	000	000	000	000	000 255	NS
S17	000	000	000	000	000	000	000	000 255	NS
S18	000	000	000	000	000	000	000	000 255	
S19	000	000	000	000	000	000	000	000 255	NS
S20	000	000	000	000	000	000	000	000 255	NS
S21	000	000	000	000	000	000	000	000 255	
S22	118	118	118	118	118	118	118	000 255	
S23	023	023	023	023	023	023	023	000 255	
S24	016	190	191	016	016	016	016	000 255	
S25	005	005	005	005	005	005	005	000 255	
S26	001	001	001	001	001	001	001	000 255	
S27	064	073	074	064	064	064	064	000 255	
S28	000	000	000	000	000	000	000	000 255	NS
S29	000	000	000	000	000	000	000	000 255	NS
S30	000	000	000	000	000	000	000	000 255	NS
S31	000	000	000	000	000	000	000	000 255	NS
S32	000	000	000	000	000	000	000	000 255	NS
S33	000	000	000	000	000	000	000	000 255	NS
S34	000	000	000	000	000	000	000	000 003	
S35	009	009	009	009	009	009	009	000 015	
S36	001	001	001	001	001	001	001	000 255	
S37	000	000	000	000	000	000	000	000 255	
S38	020	020	020	020	020	020	020	000 255	
S39	128	128	128	128	128	128	128	000 255	
S40	000	000	000	000	000	000	000	000 255	
S41	000	000	000	000	000	000	000	000 010	NS
S42	000	000	000	000	000	000	000	000 255	NS
S43	000	000	000	000	000	000	000	000 255	NS
S44	000	000	000	000	000	000	000	000 255	NS
S45	000	000	000	000	000	000	000	000 255	NS
S46	013	013	013	013	013	013	013	000 127	
S47	017	017	017	017	017	017	017	000 255	
S48	019	019	019	019	019	019	019	000 255	
S49	000	003	003	000	000	000	000	000 255	

Note : The STATUS column only applies to the Yn configurations. Those S-registers defined as Non Storable (NS) will be taken from the F0 configuration.

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VI - APPENDIX A : SATURN BLOCK DIAGRAM AND POSSIBLE EVOLUTIONS

Figure 1 : Block Diagram
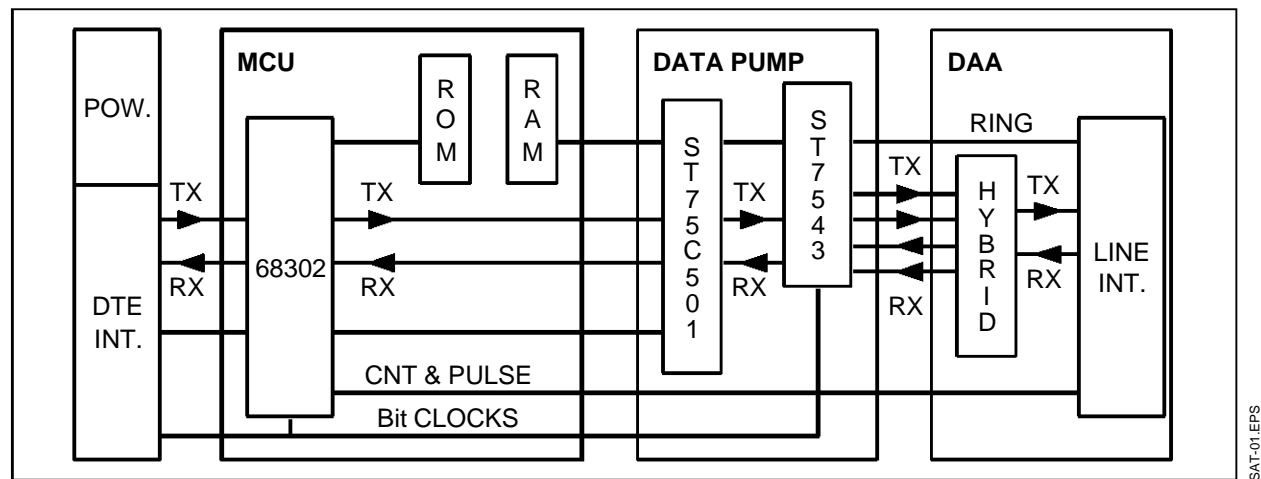
Stand Alone :

DTE interface = RS 232.

Power suply = 7.5V rectified & filtered AC adapter and TDA8137 double 5V linear regulator.

PC board :

DTE interface = 16C550 or ST7548.

Power supply = from PC with low power 5V linear regulator for analog.

PCMCIA board :

DTE interface = ST7548.

Power supply = from PCMCIA bus.

SATURN possible evolutions

VII - APPENDIX B : SATURN STAND ALONE BOARD LAYOUT SCHEMATICS

Figure 2

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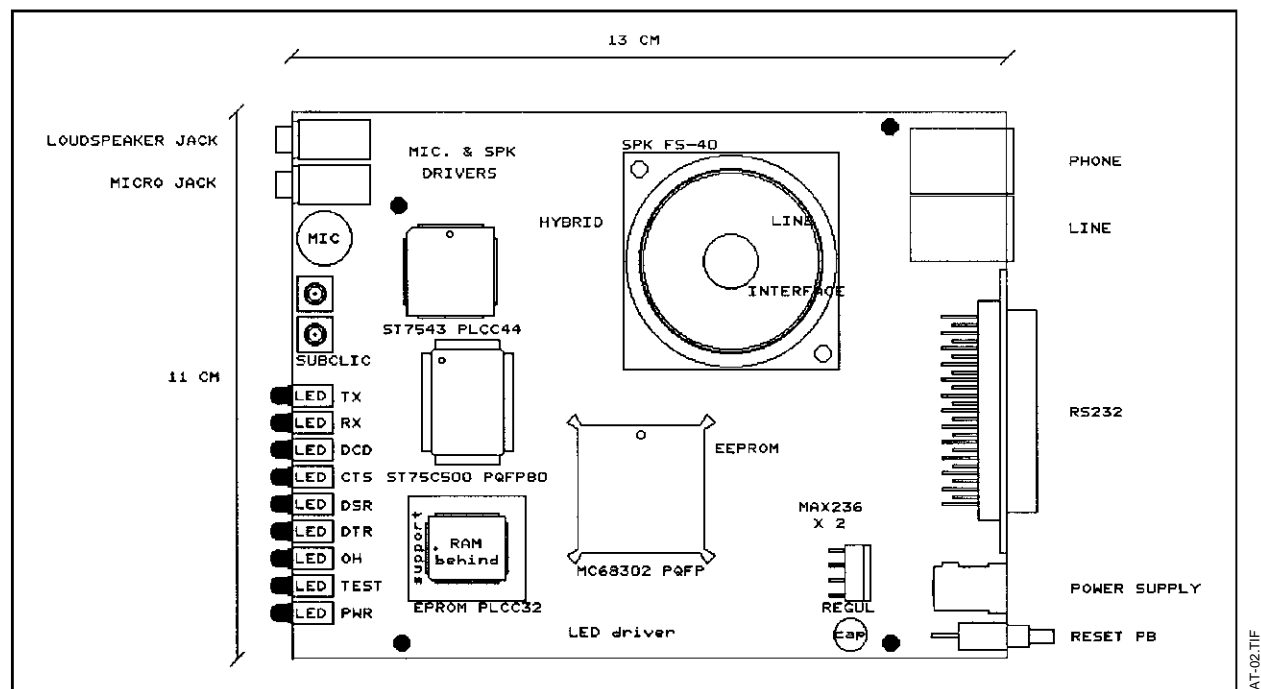
VIII - APPENDIX C : SATURN STAND ALONE BOARD ELECTRICAL SCHEMATICS

Figure 3 : Main Sheet
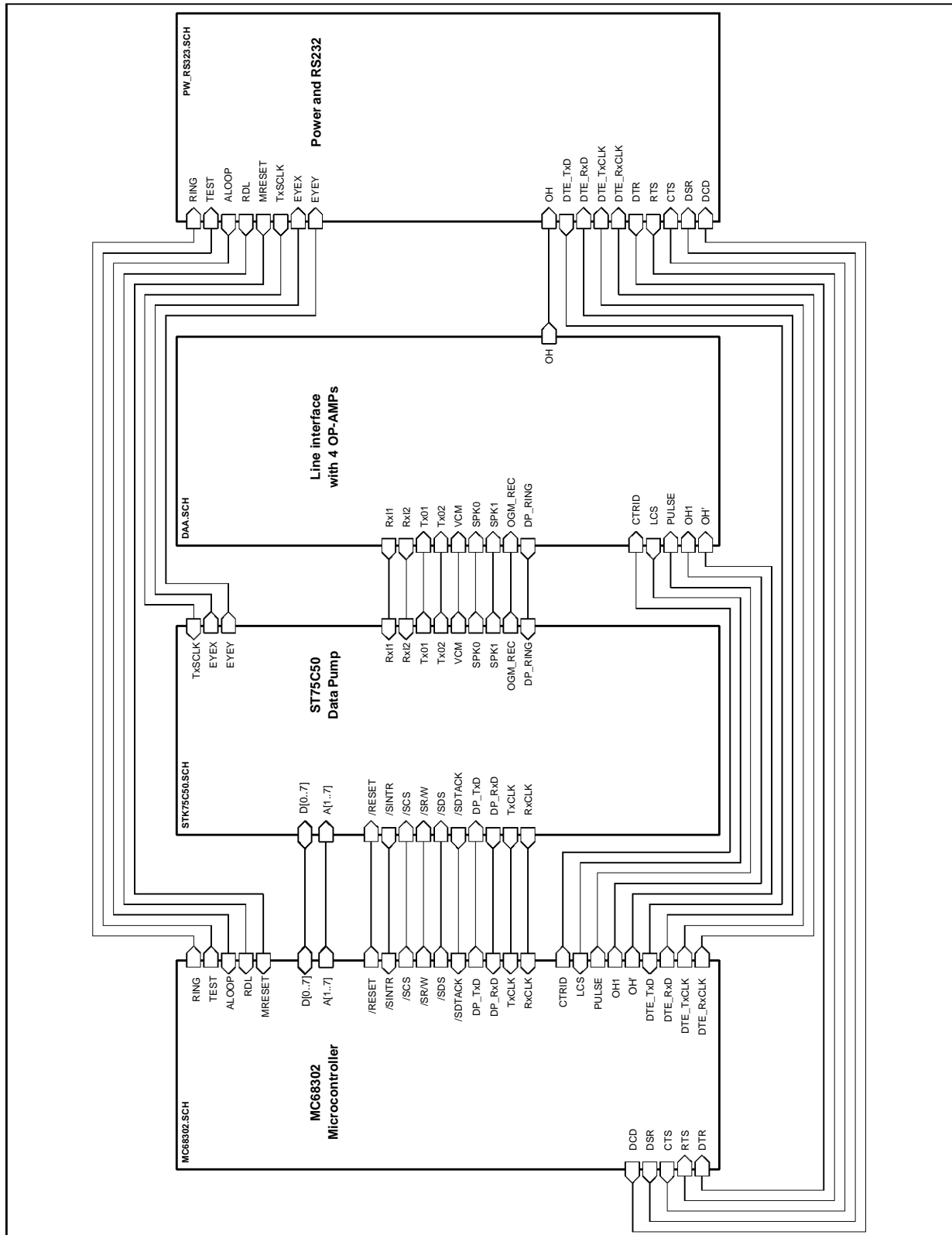
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Figure 4 : Microcontroller and Memories
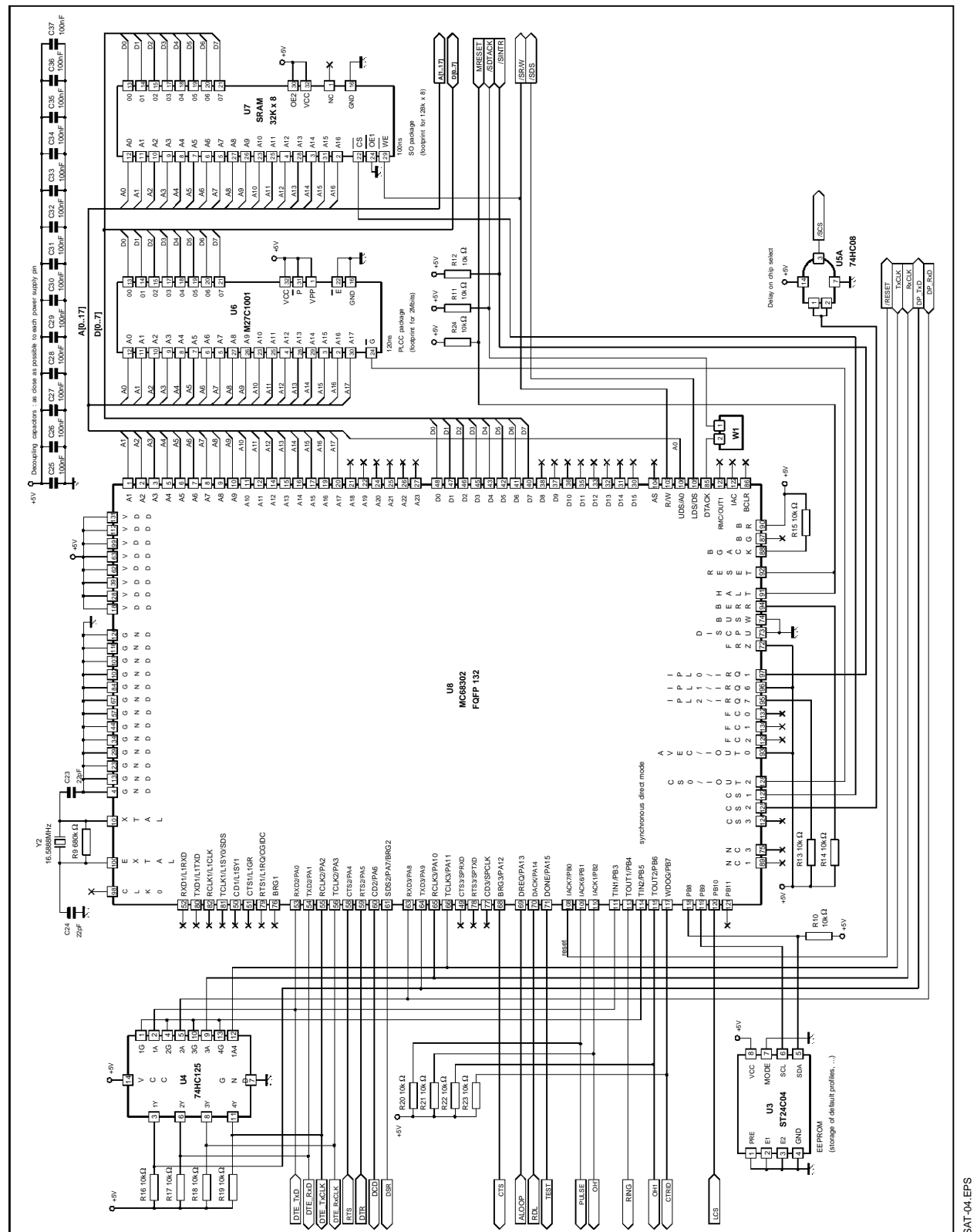
SAT-04.EPS

Figure 5 : Data Pump

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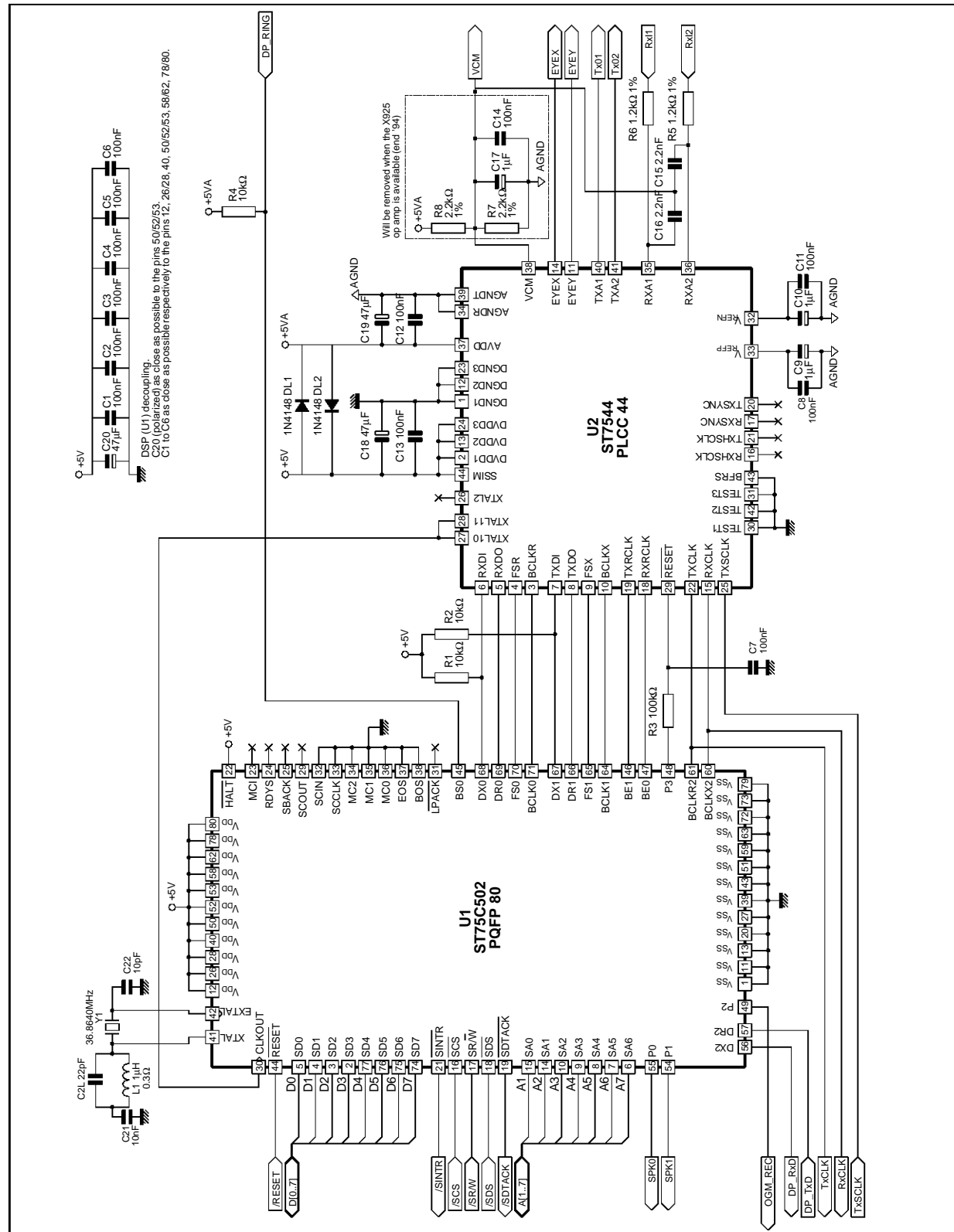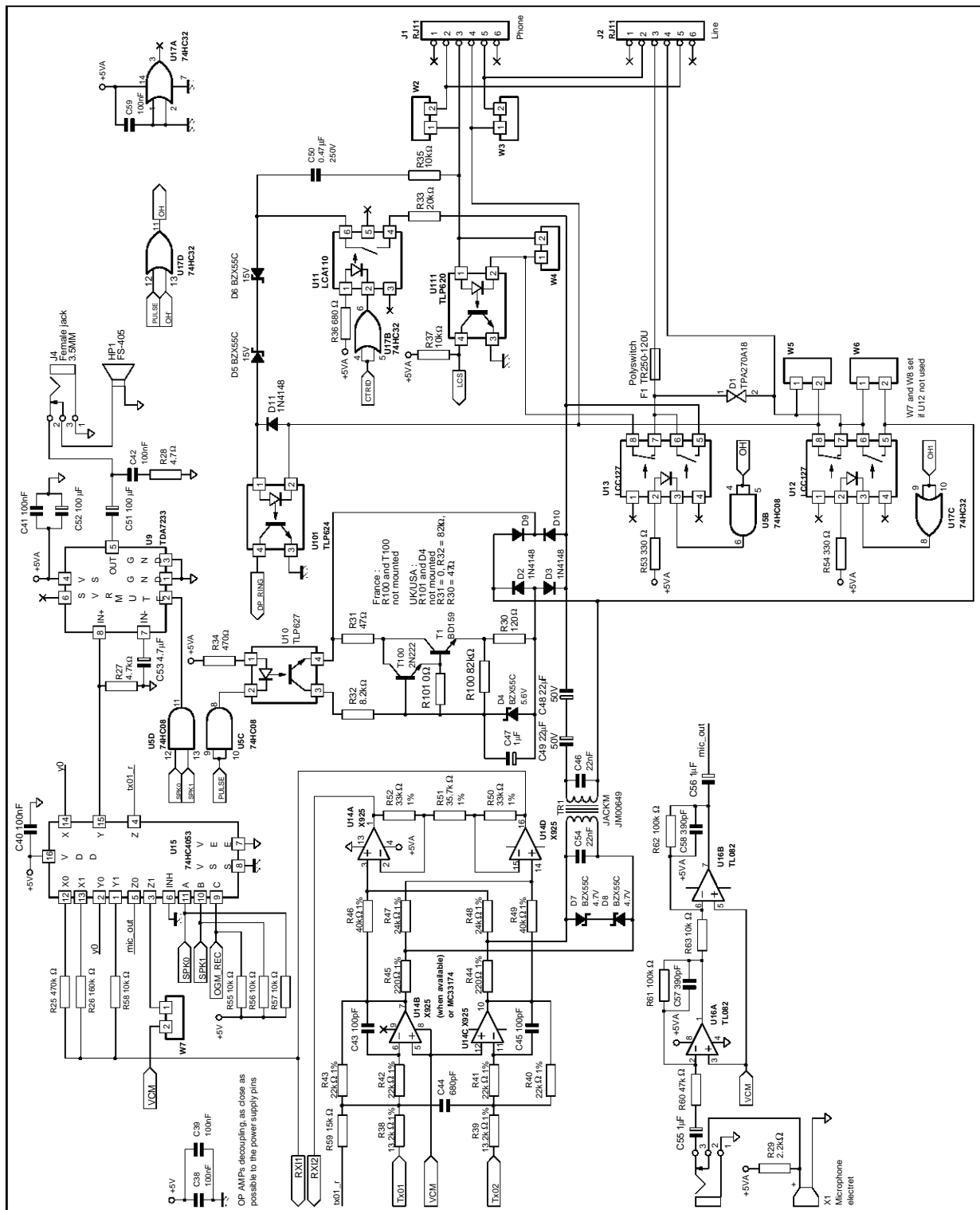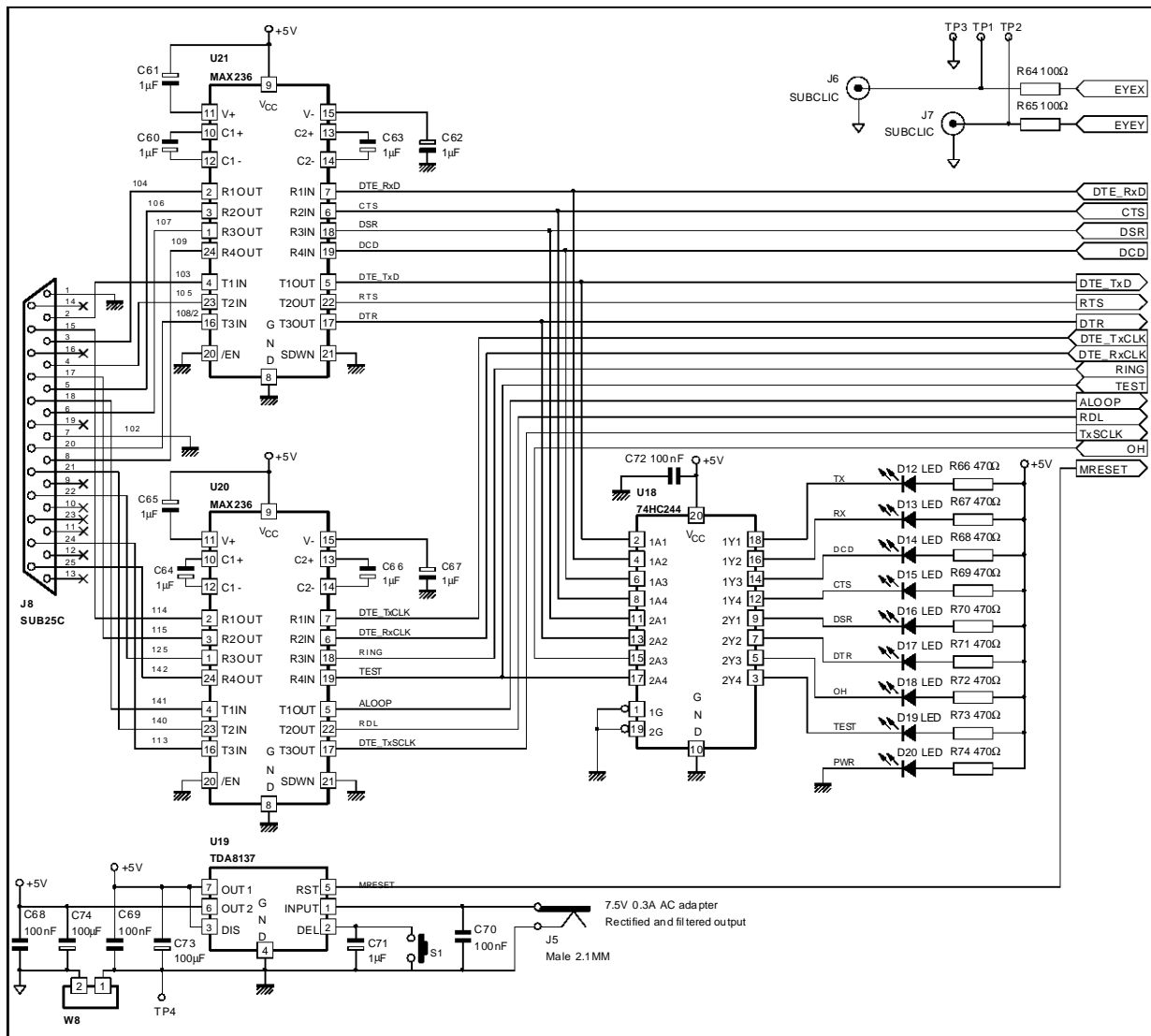
Figure 6 : Hybrid and Line Interface

Note : The op amp X925 package is a SO16. The MC33174 (SO14) used as long as the X925 is not available must be mounted Pin1 on Pin1.

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Figure 7 : RS232 Interface and Power Supply

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IX - APPENDIX D : SATURN STAND ALONE BOARD PART LIST

Item	Quantity	Reference	Part
1	35	C1,C2,C3,C4,C5,C6,C7,C8,C11,C12,C13,C14,C25,C26, C27,C28,C29,C30,C31,C32,C33,C34,C35,C36,C37,C38, C39,C40,C41,C42,C59,C68,C69,C70,C72	100nF CERAMIC
2	3	C2L,C23,C24	22pF CERAMIC
3	14	C9,C10,C17,C47,C55,C56,C60,C61,C62,C63,C64,C65, C66,C67	1μF 16V TANTALUM
4	2	C15,C16	2.2nF CERAMIC
5	3	C18,C19,C20	47μF 16V TANTALUM
6	1	C21	10nF CERAMIC
7	1	C22	10pF CERAMIC
8	2	C43,C45	100pF CERAMIC
9	1	C44	680pF CERAMIC
10	2	C46,C54	22nF CERAMIC
11	2	C48,C49	22μF 50V CHEMICAL
12	1	C50	0.47μF 250V
13	4	C51,C52,C73,C74	100μF 16V CHEMICAL
14	1	C53	4.7μF 16V TANTALUM
15	2	C57,C58	390pF CERAMIC
16	1	C71	1μF 16V TANTALUM
17	7	DL1,DL2,D2,D3,D9,D10,D11	1N4148
18	1	D1	TPA270A18
19	1	D4	BZX55C 5.6V
20	2	D5,D6	BZX55C 15V
21	2	D7,D8	BZX55C 4.7V
22	2	D12,D13	LED GREEN
23	7	D14,D15,D16,D17,D18,D19,D20	LED RED
24	1	F1	TR250-120U POLYSWITCH
25	1	HP1	FS-40S 8Ω
26	2	J1,J2	RJ11 MOLEX 95001-2661 LOW PROFILE
27	2	J3,J4	FEMALE JACK 3.5MM
28	1	J5	MALE 2.1MM POWER SUPPLY
29	2	J6,J7	SUBCLIC EYE MONITORING (OPTIONAL)
30	1	J8	SUBD25C FEMALE
31	1	L1	1μH O.3Ω
32	25	R1,R2,R4,R10,R11,R12,R13,R14,R15,R16,R17,R18,R19, R20,R21,R22,R23,R24,R35,R37,R55,R56,R57,R58,R63	10kΩ 1/4W 5%
33	3	R3,R61,R62	100kΩ 1/4W 5%
34	2	R5,R6	1.2kΩ 1/4W 1%
35	2	R7,R8	2.2kΩ 1/4W 1%
36	1	R9	680kΩ 1/4W 5%
37	1	R25	470kΩ 1/4W 5%
38	2	R26,R60	47kΩ 1/4W 5%
39	1	R27	4.7kΩ 1/4W 5%
40	1	R28	4.7Ω 1/4W 5%
41	1	R29	2.2kΩ 1/4W 5%
42	1	R30	120Ω 1/2W 5%
43	1	R31	47Ω 1/4W 5%
44	1	R32	8.2kΩ 1/4W 5%

Item	Quantity	Reference	Part
45	1	R33	20kΩ 1/4W 5%
46	10	R34,R66,R67,R68,R69,R70,R71,R72,R73,R74	470Ω 1/4W 5%
47	1	R36	680Ω 1/4W 5%
48	2	R38,R39	13.2kΩ 1/4W 1%
49	4	R40,R41,R42,R43	22kΩ 1/4W 1%
50	2	R44,R45	220Ω 1/4W 1%
51	2	R46,R49	40kΩ 1/4W 1%
52	2	R47,R48	24kΩ 1/4W 1%
53	2	R50,R52	33kΩ 1/4W 1%
54	1	R51	35.7kΩ 1/4W 1%
55	2	R53,R54	330Ω 1/4W 5%
56	1	R59	15kΩ 1/4W 5%
57	2	R64,R65	100Ω 1/4W 5%
58	1	R100	82kΩ
59	1	R101	0Ω
60	1	S1	PUSH BUTTON
61	4	TP1,TP2,TP3,TP4	TEST POINT SINGLE PIN
62	1	TR1	JACK'M JM00649 TRANSFORMER
63	1	T1	BD159
64	1	T100	2N2222
65	1	U1	ST75C502 PQFP 80
66	1	U2	ST7544 PLCC 44
67	1	U3	ST24C04
68	1	U4	74HC125
69	1	U5	74HC08
70	1	U6	M27C1001 120 NS - PLCC PACKAGE (FOOTPRINT FOR 2 MBITS)
71	1	U7	SRAM 128K X 8 100 NS - SO PACKAGE (FOOTPRINT FOR 128K X 8)
72	1	U8	MC68302 PQFP 132
73	1	U9	TDA7233
74	1	U10	TLP627 TOSHIBA
75	1	U11	LCA110 CLARE (OPTIONAL)
76	1	U12	LCC127 OR LCC 110 CLARE (OPTIONAL)
77	1	U13	LCC127 OR LCC 110 CLARE
78	1	U14	X925 (WHEN AVAILABLE) OR MC33174
79	1	U15	74HC4053
80	1	U16	TL082
81	1	U17	74HC32
82	1	U18	74HC244
83	1	U19	TDA8137
84	2	U20,U21	MAX236
85	1	U101	TLP624 TOSHIBA
86	1	U111	TLP620 TOSHIBA (OPTIONAL)
87	8	W1,W2,W3,W4,W5,W6,W7,W8	JP2 SOLDERED STRAP
88	1	X1	MICROPHONE ELECTRET
89	1	Y1	36.8640MHz THIRD OVERTONE CRYSTAL 50 PPM LOW PROFILE (ATS 49)
90	1	Y2	16.5888MHz CRYSTAL LOW PROFILE (ATS 49)