Bell 103/V.21 Single Chip Modem

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S3530H

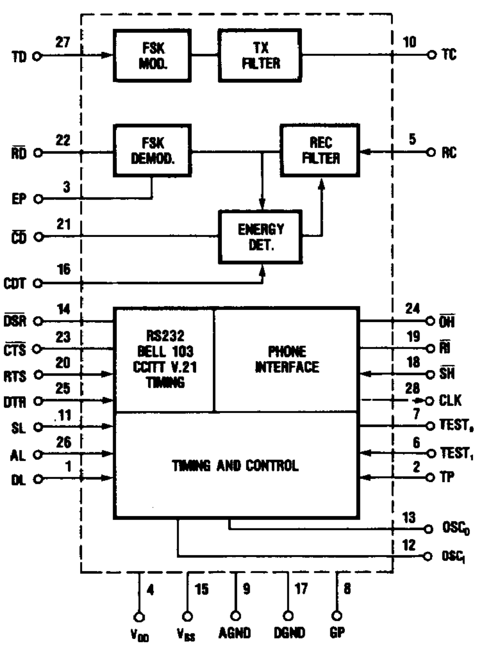
Features

- ☐ Single-Chip 300 bps, Full Duplex, FSK Modem
- ☐ Bell 103/113 and CCITT V.21 Operation (Pin Selectable)
- ☐ Auto Answer/Originate Operating Modes
- ☐ Manual Answer/Originate Modes
- ☐ No External Filtering Required
- ☐ Phase Continuous Transmit Carrier Frequency Switching
- ☐ RS-232 Control Interface
- ☐ Passthrough Mode for Protocol Independence
- ☐ Low Cost 3.58MHz (TV Crystal) Time Base
- ☐ Digital and Analog Loopback Modes
- ☐ UART Clock Output (4.8KHz)
- ☐ V.25 Tone Generation

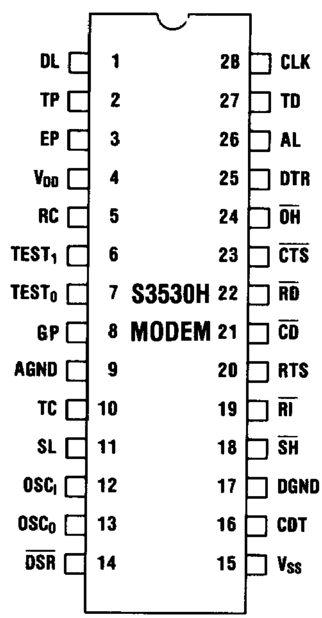
Typical Applications

- ☐ Stand Alone Modems for Home Computers
- ☐ Smart Modems for Personal Computers
- ☐ Board Modems for Office Automation Equipment
- ☐ Portable Lap Computers
- ☐ Encrypted Data Stream Modem
- ☐ Password Secure Modem
- ☐ Test Instrument Communications
- ☐ Phone and Modem Combination

Functional Block Diagram



Pin Configuration



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General Description

The S3530 is a Full Duplex FSK Modem integrated circuit which may be operated in Bell 103/113 or CCITT V.21 applications. The S3530 features transmit and receive filtering; answer/originate mode selections; RS-232 control interface; digital and analog loopback test modes; and generation of both the 4.8KHz UART clock and V.25 Answer Tone. The S3530 is designed for use in stand-alone modem applications and in applications in which the modem function is designed directly into the DTE.

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Pin/Function Descriptions

Pin #	Name	Function
1	DL (Digital Loopback)	A high level on this input causes the device to enter the digital loopback mode. In this mode the received data from the remote end is internally looped back to TD and $\overline{DSR}$ is forced high to signal to the DTE that the modem is not ready for transmission. The received data is not available on $\overline{RD}$ during the DL mode.
2	TP (Test Point)	Test Pin. Must be connected to either V_{SS} or V_{DD} for normal operations.
3	EP (Eye Pattern)	Output (analog) of the demodulator prior to slicing. Do not load.
4, 15	V_{DD}, V_{SS}	Positive and negative Power Pins, respectively ($\pm$5V).
5	RC (Receive Carrier)	This analog input is the data carrier received by the data access arrangement from the line. The modem demodulates this signal to generate the receive data bits.
6 7	Test 1 Test 0	These are test inputs and must be tied to V_{SS} for normal applications. See table under Passthru Mode.
8	GP	Ground this pin. (Analog GND).
9	AGND	Analog ground (0 Volts).
10	TC (Transmit Carrier)	This analog output is the modulated transmit data carrier. Its frequency depends upon whether the modem is in the answer or originate mode and if a mark or space condition is being sent (Table 1). Typically the output level is at −9dBm. (275mVRMS into 10KΩ.)
11	SL (Select)	A high level on this input selects the CCITT V.21 data transmission format. Applying a low level selects the Bell 103 data transmission format.
12 13	OSC_I OSC_O	These are terminals for connecting an external 3.579545MHz TV crystal. All internal clock signals are derived from this time base. Feedback resistor and capacitors are integrated on the chip but additional 20pF caps to V_{SS} from each pin are required.
14	$\overline{DSR}$ (Data Set Ready)	This output, when low, indicates to the data terminal that the modem is ready to transmit data.
16	CDT (Carrier Detect Threshold)	Applying a variable voltage level between 0 and −5V at this pin allows control of the recieve carrier detection threshold. This will override the internally determined threshold. If CDT is set to a voltage between +1.5 and +2.0V the AGC will be disabled during the test modes of pins 6 & 7.
17	DGND	Digital ground (0 Volts).
18	$\overline{SH}$ (Switch Hook)	This input is used to manually place the device in the originate mode. The device will make the $\overline{OH}$ output low and start the originate sequence if $\overline{SH}$ input is low (−5V) and DTR is on. This can be a level or a momentary low-going pulse input (min. 54msec). A pulse duration of less than 27 msec will not be detected. $\overline{RI}$ should be high if $\overline{SH}$ is to be exercised. Once $\overline{RI}$ has been activated RTS has no effect.

Pin/Function Descriptions (Continued)

Pin #	Name	Function
19	$\overline{RI}$ (Ring Indicator)	This input, when high, permits auto answer capability. The data access arrangements should apply a low level (−5V) to $\overline{RI}$ when a ringing signal is detected. The level should be low for at least 107msec. The input may remain low during data transmission, but must be reset before DTR. Similarly, in manual mode, the answer mode is entered by applying a low level to this input (unless RTS is high).
20	RTS (Request to Send)	A high level on this input with the DTR input in the on condition causes the device to enter the originate mode. $\overline{OH}$ will go low to seize the phone line. Auto dialing can be performed by turning the RTS input on and off to effect dial pulsing. This input must remain high for the duration of data transmission. (Auto answer will **not** function if RTS is high). RTS should follow DTR by no less than 1msec.
21	$\overline{CD}$ (Carrier Detect)	This output goes to a low level to indicate that the receive data carrier has been received at a level of −35dBm. It turns off if the received data carrier falls below the carrier detection threshold of −52dBm [Both values are ±2dB].
22	$\overline{RD}$ (Received Data)	The device presents data bits demodulated from the received data carrier at this output. This output is forced high if the DTR input or the carrier detect output is off.
23	$\overline{CTS}$ (Clear to Send)	This output goes to a low level at the completion of the handshaking sequence and turns off when the modem disconnects. It is always turned off if the device is in the digital loopback mode. Data to be transmitted should not be applied at the TD input until this output turns on.
24	$\overline{OH}$ (Off Hook)	This output goes to a low level when either the $\overline{SH}$ or the RTS input is on in the originate mode and when a valid ring signal is detected on the $\overline{RI}$ input in the answer mode. This output is off if DTR is off or if the disconnect sequence has been completed.
25	DTR (Data Terminal Ready)	A high level on this input enables all the other inputs and outputs and must be present before the device will enter the data mode either manually or automatically. The device will enter an irreversible disconnect sequence if the input is turned off (low level) for more than 14msec during a data call. A pulse duration of less than 6msec will not be detected. To reset the chip before each call, this pin should be held low for greater than 14msec.
26	AL (Analog Loopback)	This input allows the data terminal to make the telephone line busy (off hook) and implement the analog loopback mode. A high level on this input while DTR is high causes the device to make the $\overline{OH}$ output low and to enter the analog loopback mode. The receive filter center frequency is switched to correspond to the transmit filter center frequency and the transmit data carrier output is internally connected to the receive data carrier input as well as being available at TC.
27	TD (Transmit Data)	Data bits to be transmitted are presented to this input serially by the data terminal. A high level is considered a binary '1' or MARK and a low level is considered a binary '0' or SPACE. The data terminal should hold this input in the MARK state when data is not being transmitted. During handshaking this input is ignored.
28	CLK (Clock)	A 4.8KHz LSTTL compatible square wave output is provided for supplying the 16X clock signal required by a UART for 300 bits/sec. data rate. This output facilitates the integration of the modem function in the data terminal.

S3530H

Absolute Maximum Ratings

Supply Voltage ($V_{DD}-V_{SS}$)........................ +12.0V
Operating Temperature........................ 0°C to +70°C
Storage Temperature........................ −65°C to +150°C
Power Dissipation........................ V_{SS} − 0.3V ≤ V_{IN} ≤ V_{DD} + 0.3V

D.C. Electrical Operating Characteristics: T_A = 0°C to +70°C; ($V_{DD}-V_{SS}$) = 10V; (±5.0V)

Symbol	Parameter/Conditions	Min.	Typ.	Max.	Units
V_{DD}	Positive Supply Voltage (ref. to DGND, AGND; both at 0V)	+4.75	+5.0	+5.25	VDC
V_{SS}	Negative Supply Voltage (ref. to DGND, AGND)	−4.75	−5.0	−5.25	VDC
P_D	Power Dissipation, Operating (@±5V)		110	200	mW
R_{IN}	Input Resistance	8			MΩ
C_{IN}	Input Capacitance			15	pF

Analog Signal Parameters: T_A = 0°C to 70°C; ±5 VDC. f_{osc} = 3.58MHz

Symbol	Parameter/Conditions	Min.	Typ.	Max.	Units
f_{osc}	Oscillator Frequency		3.579545 ±0.02%		MHz
f_t	Transmit Frequency Tolerance		±1.2		Hz
t_D	Transmit 2nd Harmonic Attenuation with respect to Carrier Level		50		dB
T_{OUT}	Transmit Output Level into 10KΩ min., 25pF max.	245	275 (−9dBm)	308	mVRMS
	Carrier Input Range (CDT open)		−48 ±2	0	dBm
DNR	Dynamic Range (CDT open)		48		dB
	Bit Jitter (Input = −30dBm) Bit Bias Bias Distortion		100 1 3		µSec % %

Signal Input and Output Compatibility Table

Pin Name	No.	Input	Output	Voltage Level Low (Max.)	Voltage Level High (Min.)	Logic Family Compatibility	I_{OL} Milliamps	I_{OH} Milliamps
$\overline{SH}$	18	X		−3	+3	CMOS		
$\overline{RI}$	19	X		−3	+3	CMOS		
$TEST_0$	7	X		−3	+3	CMOS		
$TEST_1$	6	X		−3	+3	CMOS		
$\overline{OH}$	24		X	+0.4	+2.4	LSTTL	0.4	0.02
CLK	28		X	+0.4	+2.4	LSTTL	0.4	0.02
$\overline{CD}$	21		X	+0.4	+2.4	LSTTL	0.4	0.02
$\overline{RD}$	22		X	+0.4	+2.4	TTL	1.6	0.4
$\overline{CTS}$	23		X	+0.4	+2.4	TTL	1.6	0.4
$\overline{DSR}$	14		X	+0.4	+2.4	LSTTL	0.4	0.02
RTS	20	X		+0.8	+2.0	TTL*		
TD	27	X		+0.8	+2.0	TTL*		
DTR	25	X		+0.8	+2.0	TTL*		
AL	26	X		+0.8	+2.0	TTL*		
DL	1	X		+0.8	+2.0	TTL*		
SL	11	X		+0.8	+2.0	TTL*		

*These inputs are high impedance CMOS inputs that respond to TTL voltage levels.

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What Is a 300 Baud Modem and What Does It Do?

A modem acts like a translator between a computer and the telephone system. Computers work with data in the form of binary pulses but telephones were designed to transmit analog audio waveforms. The modem converts binary data from the computer into analog signals that the phone lines can carry. In the receive mode the modem demodulates the analog signals from the phone line, converting them back to binary form for the computer.

300 Baud modems are among the most common data communications devices in use today. Modems are used for exchanging information between home computers, personal computers, banks, offices and mainframes to name just a few posible applications. 300 Baud modems are used anywhere that a normal telephone line exists. Modems based on the S3530 have the advantages of full duplex operation using either BELL 103 or CCITT V.21 Protocols, a built-in interface to the industry standard RS232 serial data port, very low system part count, and low power CMOS single chip construction.

Both BELL 103 and CCITT V.21 modems use FSK modulation for data transmission over standard phone lines. FSK modulation simply means Frequency Shift Keying or the transmission of frequency "A" for binary "1" and frequency "B" for binary "0". Full duplex FSK occurs when two-way transmission happens simultaneously between two modems.

A simple protocol exists to prohibit both the originating modem and the answering modem from transmitting simultaneously on the same frequency. The protocol breaks the telephone frequency spectrum into two bands; a high band, and a low band. Each band has its own mark frequency corresponding to a binary 1 and its own space frequency corresponding to a binary 0, for a total of four transmitting frequencies. The protocol states that the originating modem must transmit on the low band and receive on the high band while the answering modem must transmit on the high band and receive on the low band.

Obviously the ability of a modem to separate the high band from the low band is important for correct decoding of the transmitted data. Figures 4, 5, 6, and 7 of the S3530 transmit and recieve filters shows a sharp 20 db cutoff within just a few hundred Hertz of the edges of the high and low bands.

Figure 1. Frequency Modulation (FSK)

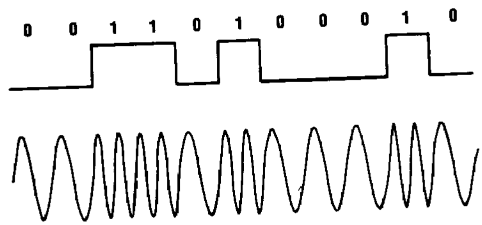
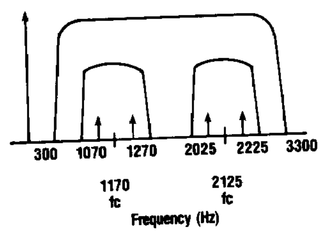


Figure 2. Full Duplex, 300 bps, Bell 103



Data: Serial, binary, asynchronous, full duplex
Data Transfer Rate: 0 to 300 bps
Modulation: Frequency shift-keyed (FSK) FM

Figure 3. Full Duplex, 300 bps, CCITT V.21

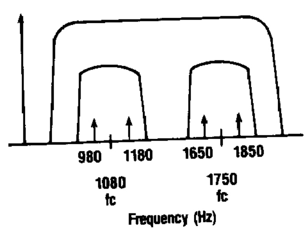


Figure 4. Transmit Filter Bell 103

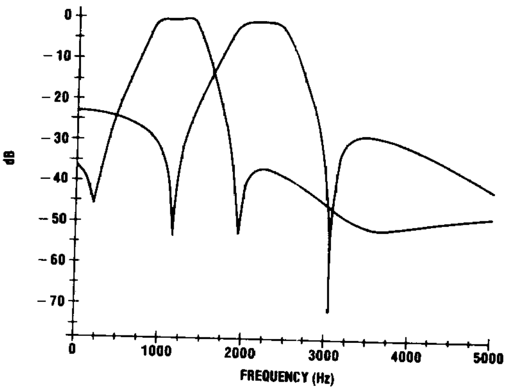


Figure 5. Transmit Filter V.21

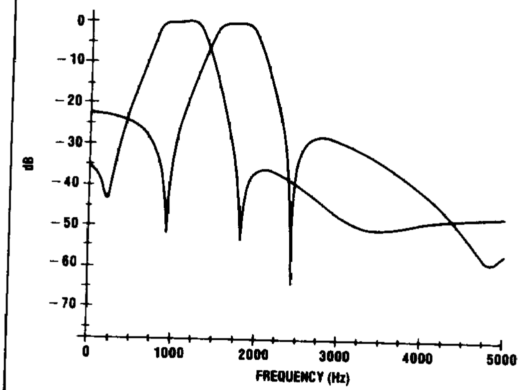


Figure 6. Receive Filter Bell 103

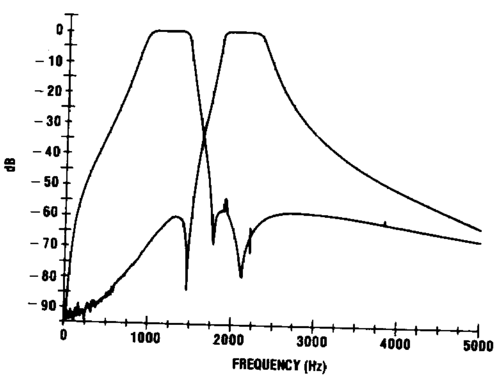
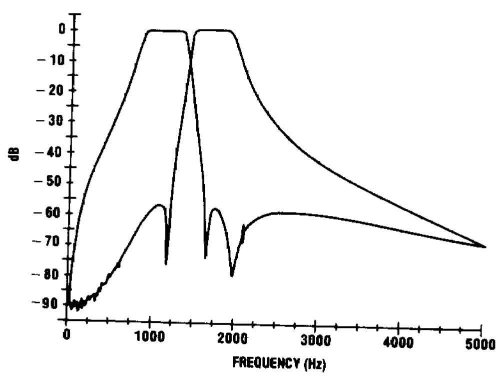


Figure 7. Receive Filter V.21



Block Description

The block diagram of the FSK Modem is shown on page 1. The input to the modulator is the TD (Transmit Data) signal, which is the digital data to be converted to analog form. This input would typically be provided by the RS-232 interface or a UART. The modulator generates a square wave whose frequency is shifted in response to the Transmit Data input.

The transmit filter outputs a Frequency Shift Keying signal at the TC (Transmit Carrier) output. The frequency of the FSK signal corresponds to the fundamental frequency of the square wave at the input of the filter.

On the receive side, the receive filter whose input is the Receive Carrier, rejects the adjacent channel energy and improves the Signal to Noise Ratio of the received signal.

The output of the receive filter is fed into the demodulator where the data is converted back into digital form.

The next block is the energy detect circuit. It detects energy levels at which reception and demodulation of data is considered reliable, controlling the $\overline{\text{CD}}$ signal.

The last block is the timing control and handshake logic, which besides controlling all the other blocks, also implements the RS-232 interface protocol and controls the BELL 103 and CCITT V.21 operations.

Transmit Filter

The function of the transmit filter is to produce an FSK signal from the phase continuous, frequency shifted, square wave input.

The prime objective of the transmit filter is to pass the square wave fundamental component while attenuating its harmonics. These harmonics could be located in the receive band. Unless attenuated by the transmit filter, they would be coupled back through the hybrid, unattenuated by the receive filter, thus causing degradation of bit error rate.

The transmit filter was designed to have a zero at the third harmonic of the square wave, to alleviate the above problem.

The second objective of the transmit filter is to attenuate the out of band energy. This is necessary since the modulation process produces energy over a broad spectrum and not just at the mark/space frequencies. The fundamental component is attenuated by 24 dB to produce a signal at −9 dBm at the TC (Transmit Carrier) output.

Receive Filter

The measured frequency response of the receive filter is shown in Figures 6 and 7. The receive filter rejects out-of-band noise so that the filtered signal can be demodulated with a resultant low bit error rate.

The filter was designed to reject the adjacent channel energy by 60dB. This is essential since that channel is used for carrier transmission which is coupled back, through the hybrid and into the receive section. Unless attenuated by the receive filter, this component would corrupt the demodulated data and result in excessive bit error rate. The filter was also designed to minimize group delay distortion between the mark and space frequencies. The band width of the filter is 500Hz and is centered around the center frequency of the received carrier.

The dynamic range of the receive signal is 50dB due to the automatic gain control circuit employed.

Timing Control

The chip also incorporates a 14 second abort timer. This is necessary for automatic operation. When a call is automatically originated, and the remote device is busy, then the originating device waits for 14 seconds and hangs up. On the other hand, if the modem is called by mistake it will hang up in 14 seconds, unless the appropriate carrier is received.

Clock Crystal

The S3530 uses the popular low-cost 3.58MHz crystal. This crystal is very popular because it is used in all NTSC color TVs and in many low cost personal computers (which require the 3.58MHz to interface with TV monitors). The S3530 can therefore use the same system clock as the display interface to reduce system costs.

Operation

A. Answer Mode

In the answer mode the S3530 stands idle waiting for an incoming call. With DTR high, a low from the ring detector to $\overline{\text{RI}}$ causes the S3530 to set $\overline{\text{OH}}$ and $\overline{\text{DSR}}$ low enabling the hookswitch relay and connecting the modem to the phone line. After 2.1 seconds the S3530 sends a carrier at 2225Hz (mark) to the Originate Modem. If 1270Hz (mark) is returned the S3530 carrier

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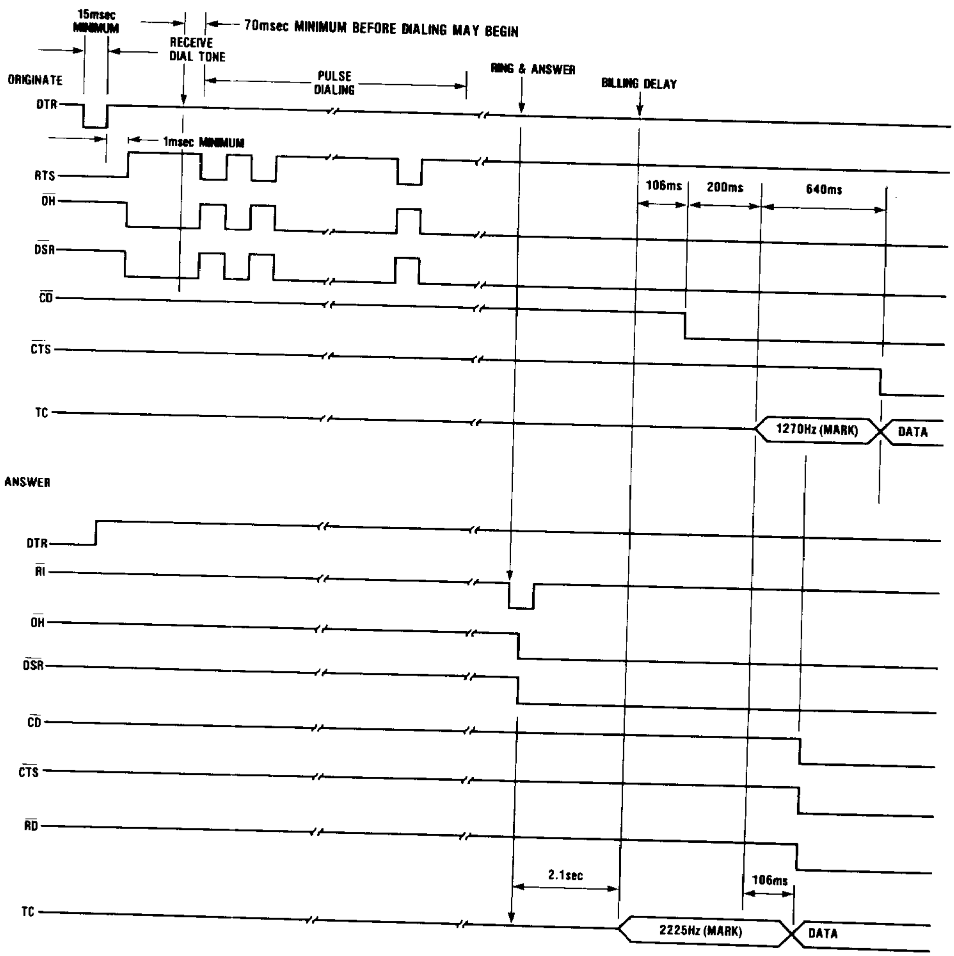
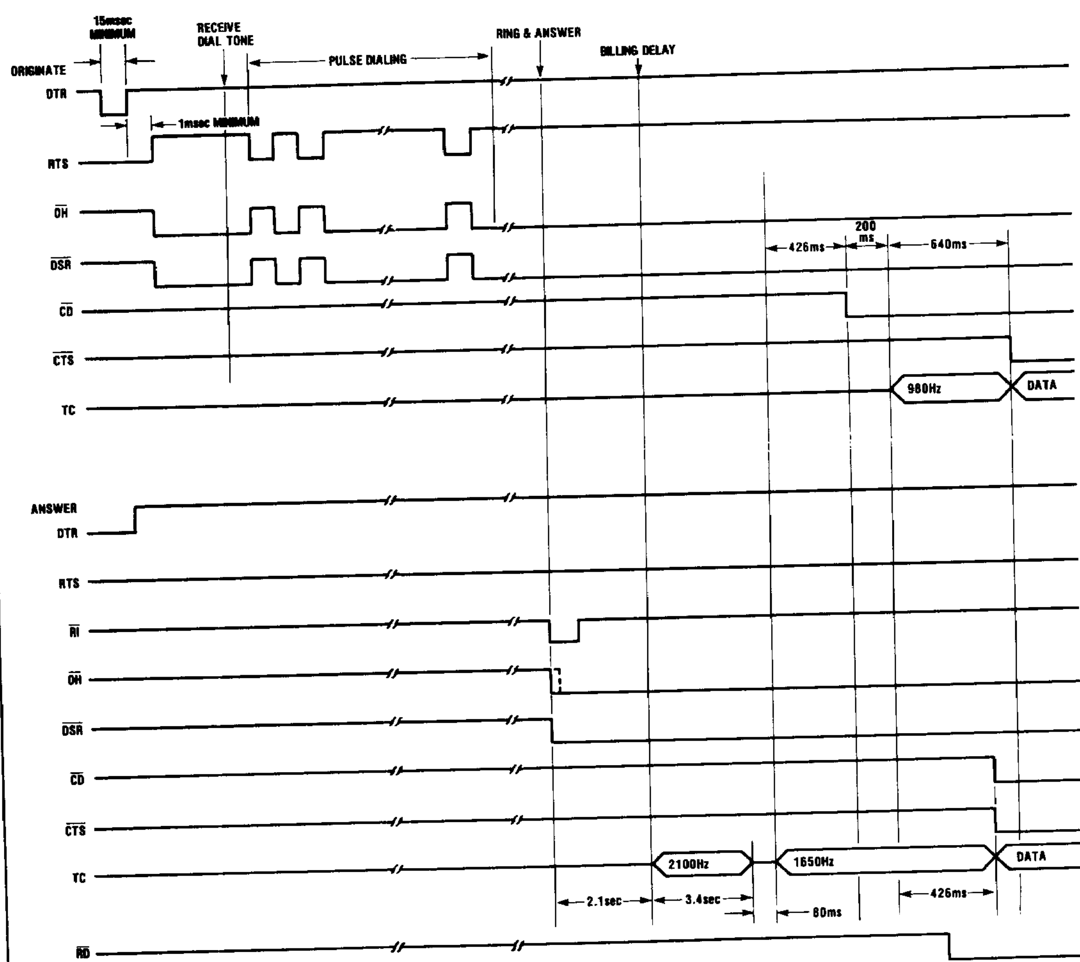
S3530 Modem Timing Chart for 103 Operating Mode



S3530 Modem Timing Chart for V.21 Operating Mode



detect circuit turns on within 106msec, setting $\overline{CD}$ and $\overline{CTS}$ low indicating completion of the handshaking sequence. Data can then be sent and received.

Originate Mode

In the originate mode with DTR high, a call is initiated by applying a high to the RTS input in auto mode or a negative or low pulse to $\overline{SH}$ in manual mode. This will cause $\overline{OH}$ to go low, enabling the hookswitch relay and connecting the phone line. When dial tone is detected, RTS can be pulsed off to provide dial pulses*. The $\overline{OH}$ will follow the RTS pulses, sending the desired digits over the line. When the answering modem comes on line it will wait 2.1 seconds ("billing delay") and then send the 2225Hz answer tone. 106msec later the $\overline{CD}$ pin will go low indicating carrier received. 190msec later the S3530 will respond with 640msec of 1270Hz. At the end of that time $\overline{CTS}$ will go low indicating to the terminal side that the communications link has been established.

Abort Mode

There is an automatic abort feature in the S3530 to avoid tying up a system when there is difficulty establishing a link. If no carrier is detected within 14 seconds of being put into the answer or originate mode it will abort the call by turning off $\overline{OH}$ and disconnecting the phone line. $\overline{DSR}$ will also go off (high). This abort time can be extended by pulsing RTS low for 1msec before the 14 seconds have elapsed. This will reset the abort timer. If time does run out DTR should be pulsed off to reset the S3530.

Shutdown Mode

Should the received carrier fall below −48 dBm (approx.) during data exchange for more than 213msec the S3530H will terminate the call and go on hook, disconnecting the phone line.

Reset Protocol

By insuring that all control inputs are in their inactive states a minimum of 2msec before the rising edge of DTR, the S3530 will be properly reset.

Manual Operation

The S3530 can be operated manually as well as automatically. With DTR enabled (high) a negative pulse (−5V) of >107msec on $\overline{RI}$ will put the device in the Answer Mode. Similarly (with DTR high) $\overline{SH}$ can be pulled low for >54msec to put the S3530 into the Originate Mode.

Passthru Mode

With the "Test 0" and "Test 1" lines the S3530 can be put into the Passthru Mode disabling the handshake protocol. The transmit and receive functions are enabled but become independent of timing and control. $\overline{CD}$ works as usual and the Answer and Originate Modes are selected manually with $\overline{RI}$ and $\overline{SH}$.

Test 0 PIN 7	Test 1 PIN 6	S3530 STATUS	
0	0	NORMAL	1 = +5V (V_{DD})
1	0	PASSTHRU	0 = −5V (V_{SS})

V.21 Mode, CCITT Operation

With the SL pin tied high the S3530 functions in the CCITT V.21 Mode but performs the same operations described above. The basic principle is the same but the frequencies and the timings are switched to V.21 specifications. When in V.21 Mode the V.25 answer tone of 2100Hz will be generated upon answering. See the timing charts and Table 1 for additional details.

Diagnostic Modes

The S3530 has two diagnostic modes for either local or remote testing. By putting the AL pin high while DTR is high, the device enters the Analog Loopback Mode. $\overline{OH}$ goes low to busy out the phone line. The receive filter center frequency is switched to the transmit

Table 1. 103/V.21 Mark and Space Frequencies

Mode	Transmit Frequency (Hz)		Receive Frequency (Hz)	
	Mark	Space	Mark	Space
Bell 103 Originate	1270	1070	2225	2025
Bell 103 Answer	2225	2025	1270	1070
CCITT V.21 Originate	980	1180	1650	1850
CCITT V.21 Answer	1650	1850	980	1180
CCITT V.25 Answer Tone	2100		N/A	

*(Note that OH only follows RTS. The proper timing for dialing must come from the terminal on the RTS line.)

center frequency and the TC signal is internally connected to the RC input. The transmit signal also remains available on the TC pin. Thus any digital data input at TD is coded and sent out via TC, and at the same time back through the analog input, decoded, and out on the $\overline{RD}$ pin.

By putting the DL pin high the S3530 enters the Digital Loopback mode. In this mode any data received from the remote end of the phone line is retransmitted back to its source and $\overline{DSR}$ is forced high. The digital or decoded data is not available at the $\overline{RD}$ output in this mode. See Table 2.

Table 2. Control Logic During Diagnostic Modes

Test Mode			Status Lines			
	DTR	RTS	$\overline{DSR}$	$\overline{OH}$	$\overline{CTS}$	$\overline{CD}$
AL	On	On	On	On	On	On
DL	On	On	Off	On	Off	Off

To establish diagnostic modes in either originate or answer, establish handshaking in the preferred mode (originate or answer), then enter diagnostic modes.

Oscillator Details

Quartz Crystal Specification (25°C ±2°C)	
Operating Temperature Range	0°C to +70°C
Frequency	3.579545MHz
Frequency Calibration Tolerance	.02±%
Load Capacitance	18pF
Effective Series Resistance	180 Ohms, max.
Drive Level-Correlation/Operating	2mW
Shunt Capacitance	7pF, max.
Oscillation Mode	Fundamental

External Drive Requirements

To use an external 3.58MHz clock a TTL level, 50% duty cycle, square wave can be applied to pin 12, OSC_O through a .1μF capacitor. It must have a 2V P-P amplitude and be AC coupled through the .1μF capacitor.

Applications Circuits

Three applications circuits are illustrated. The first circuit is for a stand-alone RS-232 interface modem to be used as a peripheral accessory to a terminal or computer. Plugging into an RS-232 serial port on one side and into a standard modular phone jack on the other side it is a stand-alone direct connect modem for operation at rates up to 300bps.

The second circuit is an add-on modem for building into a computer and connecting to the internal parallel buss structure. The ACIA or UART does the parallel-to-serial and serial-to-parallel conversion required. The edge connector is numbered for an Apple II application but the same interface applies to most μP systems.

Both circuits are intended for direct connection to the phone lines. This requires meeting FCC Part 68 requirements for network protection as well as protection of the modem. No suppression components are illustrated on these examples as the design of the interface will vary depending on the needs of the designer. After a design is completed it must be subjected to Part 68 certification before sale to the public.

If one wants to avoid the protection/certification details a certified DAA (Data Access Arrangement) such as the Cermetek CH1810 can be used instead. The DAA is designed to handle the phone line interface including the 4-wire to 2-wire function and is already registered with the FCC. See the third circuit.

Whether using a DAA or not, the S3530 requires very few external components.

Hybrid Function

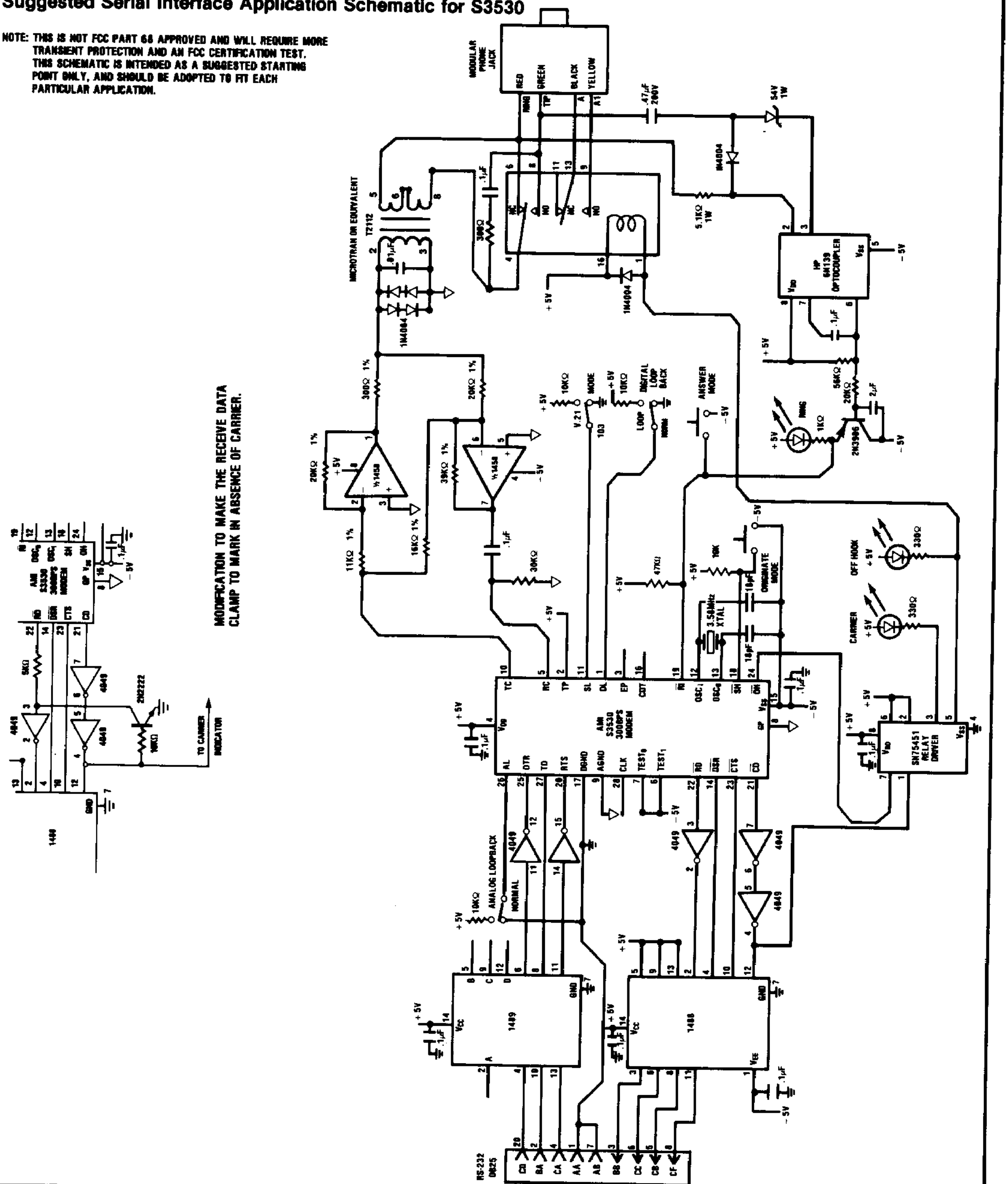
In the stand-alone circuit the hybrid 4-wire to 2-wire converter utilizing the dual op amp was configured to provide 1:1 conversion in each direction. A −9dBm voltage level from the Transmit Carrier pin on the S3530 is amplified by the op amp to compensate for the losses in the 300Ω matching resistor and the coupling transformer. The transmit carrier is delivered to the line at −9dBm. (For CCITT applications this should be reduced to −13dBm.)

In the receive direction the loss in the coupling transformer is compensated for by the other half of the op amp. If there is a −20dBm signal across Tip and Ring then a −20dBm signal is delivered to the Receive Carrier pin on the S3530.

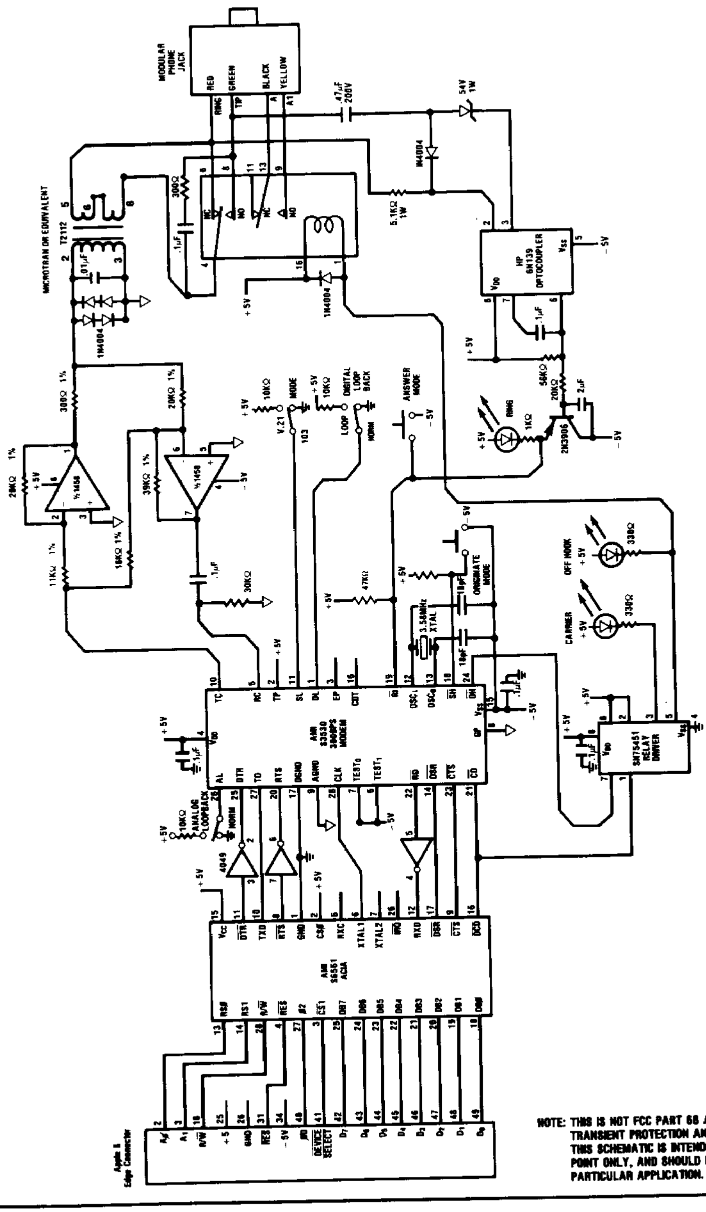
The 300Ω resistor is to provide the proper termination so that Tip and Ring look like a 600Ω AC impedance to the line. The 16KΩ resistor from the Transmit Carrier pin to the inverting input of the receive op amp is to provide sidetone suppression. The transmit carrier is provided through the 16KΩ resistor 180° out of phase from the transmit carrier presented to the line. Thus, the transmit carrier is cancelled and presented to the Recieve Carrier pin on the S3530 at a reduced level.

Suggested Serial Interface Application Schematic for S3530

NOTE: THIS IS NOT FCC PART 68 APPROVED AND WILL REQUIRE MORE TRANSIENT PROTECTION AND AN FCC CERTIFICATION TEST. THIS SCHEMATIC IS INTENDED AS A SUGGESTED STARTING POINT ONLY, AND SHOULD BE ADOPTED TO FIT EACH PARTICULAR APPLICATION.

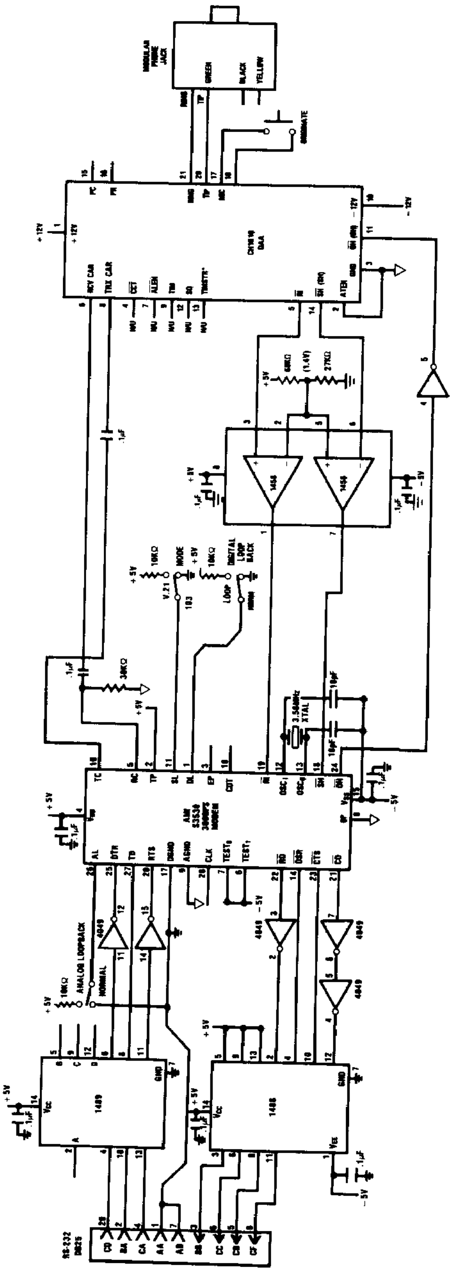


Suggested Parallel Interface Application Schematic for S3530 and Apple II



NOTE: THIS IS NOT FCC PART 68 APPROVED AND WILL REQUIRE MORE TRANSIENT PROTECTION AND AN FCC CERTIFICATION TEST. THIS SCHEMATIC IS INTENDED AS A SUGGESTED STARTING POINT ONLY, AND SHOULD BE ADOPTED TO FIT EACH PARTICULAR APPLICATION.

Suggested Application Schematic
Using Part 68 Certified DAA



Under ideal conditions 20dB or more of cancellation might be achieved, but because telephone lines vary considerably, a cancellation of around 10dB is a more realistic number.

Also, the transformer listed is rated to 75mA loop current. To go to the maximum loop current the Microtran number would be T5115 for 120mA loop current capability. The DC resistance may be slightly different and various components may need to be adjusted to retain the necessary AC and DC specifications. Another transformer is the T2112 which is much smaller and lighter because the low end frequency response is not needed.

Application Hint

An important point to remember is that if the chip is in the answer mode and an originating modem, **not** following Bell or CCITT protocol, sends carrier before the S3530 has finished the auto answer sequence there will be carrier detect but handshaking will not be completed and data will not be transfered. This is of particular importance in V.21 because the longer answer sequence with the answer tone is almost 6 seconds.

NOTE once again, that only minimal transient protection is illustrated in these examples, This must be added to meet the needs of the application and the FCC Part 68 requirements.

Modem Glossary

Analog Loopback — A diagnostic test for the entire internal signal path of the modem chip. The transmitted analog output is internally connected to the analog input.

Asynchronous — A scheme for transmitting data on a character-by-character basis without a synchronizing clock signal. In general the asynchronous protocol includes a start bit to identify the beginning of a character, the data bits, and stop bit(s).

Bandwidth — The frequency range of a communications channel. Normal phone lines have a bandwidth of 3000Hz for voice, from 300Hz to 3300Hz.

BPS — The speed at which a modem can transmit or receive data, measured in bits per second. 300 bps is roughly equal to 300 words per minute.

Bias Distortion — Distortion such that the actual mark and space bits are not of equal time duration, thus causing a deviation from the expected 50% duty cycle.

CCITT — International Telegraph and Telephone Consultative Committee. An organization for developing communication system standards. The European equivalent of BELL standards.

Data Distortion — Bit bias distortion occurs when the width of bits received are not equivalent for both a logic one and a logic zero. Bit bias is easily measured as it shows up as a deviation in average voltage. In a normal data stream of alternating ones and zeros the average voltage is zero. However when bit bias destortion is present the duty cycle is not exactly 50% and hence the average voltage is not zero. Excessive bit bias will lead to quality degradation as system UARTs deserialize data correctly only when bit bias distortion is low.

Bit jitter distortion is also important for proper operation of all modems. Bit jitter occurs when the actual center of the data bit drifts around the theoretical center. Again, this is important to the proper operation of a modem because UARTs only deserialize data correctly when bit jitter distortion is low. Jitter distortion is important in all asynchronous serial data systems because the edges of the data bits are used to reconstruct all timing information.

DAA — Data Access Arrangement. An FCC registered device necessary for correctly connecting a device to the switched telephone network. Refer to Part 68 of the FCC's regulations.

DCE — Data Communication Equipment. Modem or any other equipment necessary for the transmission and reception of data between computers and terminals.

Digital Loopback — A diagnostic test for the entire phone line and remote modem. The remote modem's digital output to the DTE is connected to the digital input from the DTE and fed back to the transmitting modem.

Direct Connect Modems — Modems that contain a DAA rather than requiring an acoustic coupler or a tie-in to a phone handset mouthpiece.

DTE — Data Terminal Equipment. The digital equipment that attaches to a modem as the end of the data path. Usually a terminal or a computer.

FSK — Frequency Shift Keying. A modulation method which varies the carrier frequency to correspond with the binary signals to be transmitted.

Full Duplex — Simultaneous two-way communication (transmission and reception) between two computers or modems.

Off-Hook — Connected to the telephone line.

RS232C — A serial communications interface defined by the Electronic Industries Association. Frequently used to connect stand-alone modems to personal computers.