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# 212A/V.22 Modem Filter With Equalizers & Analog Loopback

S35212A

Features

- Bell 212A/V.22/V.22BIS Compatible
- Usable for Bell 103/113 Applications
- High and Low Band Filters With Compromise Group Delay Equalizers and Smoothing Filters
- Guard Tone Notch Filters for CCITT V.22/V.22BIS Applications
- Originate/Answer Operating Modes
- Low Power CMOS: 75 mW Typ.
- Two Uncommitted Operational Amps
- Choice of Clocking Frequencies: 2.4576 MHz, 1.2288 MHz, or 153.6 kHz
- Call Progress Tone Filter Capability
- Analog Loopback Test Capability

General Description

The S35212A Modem Filter is a monolithic CMOS integrated circuit. It does the filter/equalizing functions of Bell 212A and CCITT V.22 (or V.22BIS) modems. The S35212A includes high band and low band filters. It features on-chip originate/answer mode selection. Included are compromise amplitude and group delay equalizers for full compromise equalization. There is a CCITT notch filter included. It provides rejection at 1800 Hz or 550 Hz. Two uncommitted operational amplifiers are available to use for gain control or anti-aliasing filters. A continuous low pass filter is also included on the RX(OUT) pin to act as a smoothing filter. SEL2 switches the S35212A between the normal data mode

Modems, Filters & PCM Products

Block Diagram

Pin Configuration

4.3

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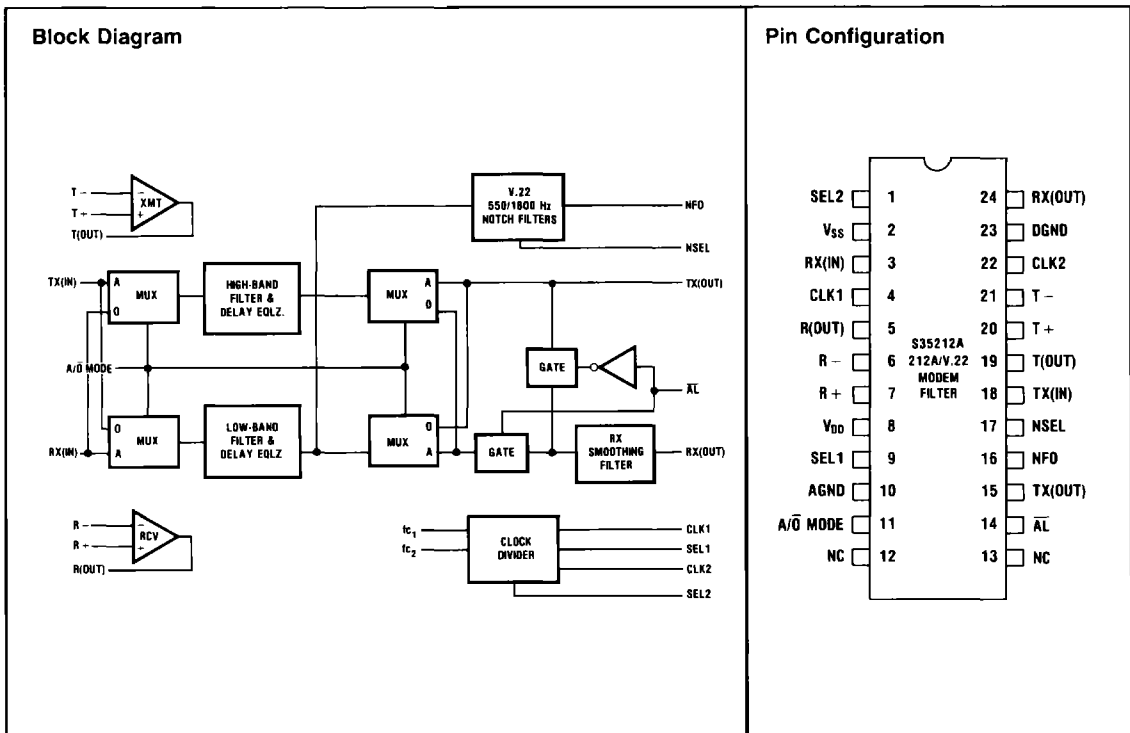
Analog Loopback capability to switch the transmit carrier output back through the receive output for testing.

and the call progress monitoring mode. For maximum flexibility the S35212A will operate from a 2.4576 MHz, 1.2228 MHz or 153.6 kHz clock. The S35212A has

Pin Functional Description

Pin Name	Pin Number	Function
SEL2	1	Logic '0' for normal operation. Logic '1' scales down the frequency response by a factor of 6 for Call Progress Tone Detection through the high-band filter
V_{SS}	2	Negative Supply Voltage (-5 Volts).
RX(IN)	3	Receive Signal Input.
CLK1	4	2.4576 MHz or 1.2288 MHz Clock Input. This input is TTL and CMOS compatible. Leave open when using CLK2.
R(OUT)	5	Receive Uncommitted Op Amp Output (10 kΩ load maximum).
R−	6	Receive Uncommitted Op Amp Negative Input.
R+	7	Receive Uncommitted Op Amp Positive Input.
V_{DD}	8	Positive Supply Voltage (+5 Volts).
SEL1	9	Logic '0' selects 1 2288 MHz. Logic '1' selects 2.4576 MHz clock into Pin 4.
AGND	10	Analog Ground.
MODE (A/O)	11	Originate/Answer Mode Control Input. A logic '0' sets the device in Originate Mode with the transmit signal in the low-band and receive signal in the high-band. A logic '1' reverses the connections.
N/C	12	Do not connect to this pin.
N/C	13	Do not connect to this pin.
$\overline{AL}$	14	Analog Loopback Control Input. A logic '0' sets the device in Loopback Mode. A logic '1' sets the device in Normal Mode.
TX(OUT)	15	Transmit Signal Output. This output will drive a 20k load.
NFO	16	Notch Filter Output This output will drive a 20k load.
NSEL	17	A logic '0' on this input programs the notch filter to reject 500 Hz. A logic '1' programs it to reject 1800 Hz.
TX(IN)	18	Transmit Signal Input.
T(OUT)	19	Transmit Uncommitted Op Amp Output (10 kΩ load maximum).
T+	20	Transmit Uncommitted Op Amp Positive Input.
T−	21	Transmit Uncommitted Op Amp Negative Input.
CLK2	22	153.6 kHz Clock Input. This input is TTL and CMOS compatible Leave open when using CLK1
DGND	23	Digital Ground.
RX(OUT)	24	Receive Signal Output. This output will drive a 20k load.

Absolute Maximum Ratings

DC Supply Voltage ($V_{DD} - V_{SS}$) .... + 13.5V
Operating Temperature .... 0°C to + 70°C
Storage Temperature .... − 55°C to + 125°C
Analog Input .... $V_{SS} - 0.3V \leqslant V_{IN} \leqslant V_{DD} + 0.3V$

D.C. Electrical Operating Characteristics: $T_A = 0°C$ to + 70°C; $V_{DD} = + 5V \pm 10\%$; $V_{SS} = - 5V \pm 10\%$ unless otherwise specified

Symbol	Parameter/Conditions	Min.	Typ.	Max.	Units
V_{IH}	High Level Logic Input (Pins 1, 9, 11, 17, 14) SEL2, SEL1, MODE, NSEL, $\overline{AL}$	4		V_{DD}	V
V_{IH}	High Level Logic Input (Pins 4 and 22) CLK1, CLK2	2.0		V_{DD}	V
V_{IL}	Low Level Logic Input (Pins 1, 4, 9, 11, 17, 22, 14)	V_{SS}		0.8	V
R_{IN}	Input Resistance (Pins 3 and 18) RX(IN), TX(IN)		5		MΩ
C_{IN}	Input Capacitance (Pins 3 and 18) RX(IN), TX(IN)		10		pF
P_D	Power Dissipation @ ± 5.25V		75	150	mW

A.C. System Specifications: $T_A = 25°C$; $V_{DD} = + 5V \pm 10\%$; $V_{SS} = - 5V \pm 10\%$ unless otherwise specified

Symbol	Parameter/Conditions	Min.	Typ.	Max.	Units
V_0	Reference Signal Level Input		1		VRMS
V_{MAX}	Maximum Signal Level Input		1 4		VRMS
BW	Bandwidth (both bands; − 3dB)		960		Hz
A_{FO}	Gain at Center Frequencies	− 1	0	+ 1	dB
ICN_L	Idle Channel Noise-Low Band Filter		22	33	dBrnCO
ICN_H	Idle Channel Noise-High Band Filter		23	33	dBrnCO
N_{FT}	Clock Feedthrough with Respect to Signal Level	TX RX	− 23 − 60		dB dB

Frequency vs. Amplitude Performance of Low- and High- Band Filters

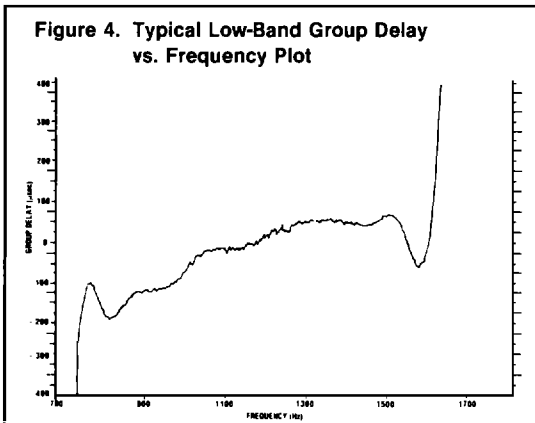| Frequency (Hz) Low-Band Filter	Relative Gain (dB)	
	Min.	Max.
400		− 35
800	− 1	+ 1
1200	0	
1600	− 1 5	+ 1
1800		− 18
2000		− 48
2400		− 55
2800		− 50

Frequency (Hz) High-Band Filter	Relative Gain (dB)	
	Min.	Max.
800		− 50
1200		− 53
1600		− 50
2000	− 2.5	+ 0.5
2400	0	
2800	0	+ 2 5
3200		− 10
3500		− 20

Notch Filter Response

Frequency (Hz)	Relative Gain (dB)	
	Min.	Max.
Low-Band Filter + 1800 Hz Notch Filter		
1200 Hz	− 1	+ 1
1800 Hz		−32
Low-Band Filter + 550 Hz Notch Filter		
1200 Hz	− 1	+ 1
550 Hz		−32

Frequency Response Characteristics

The curves on this page illustrate typical filter re-
sponses of the S35212A. Figure 1 shows the basic
band split function. This allows full duplex operation
within a voice channel. Figures 2 and 3 show the fre-
quency response of the two filters. These curves in-
clude the compromise equalizers. Figures 4 and 5 show
the typical group delay response of the filters and
equalizers.

Figure 1. Typical Amplitude vs. Frequency Plot

Figure 2. Typical Low-Band Amplitude vs. Frequency Plot

Figure 3. Typical High-Band Amplitude vs. Frequency Plot

Figure 4. Typical Low-Band Group Delay vs. Frequency Plot

Figure 5. Typical High-Band Group Delay vs. Frequency Plot
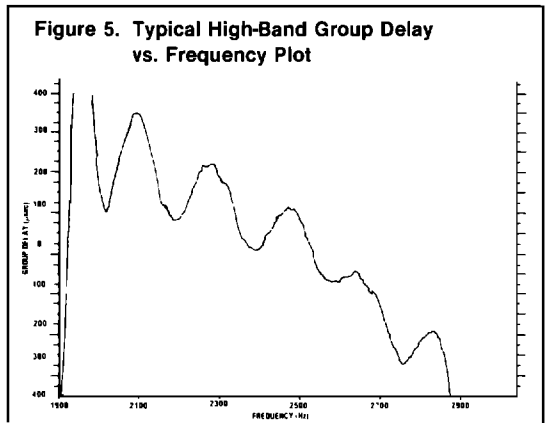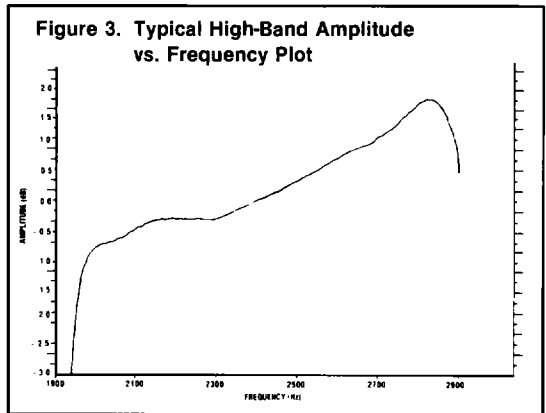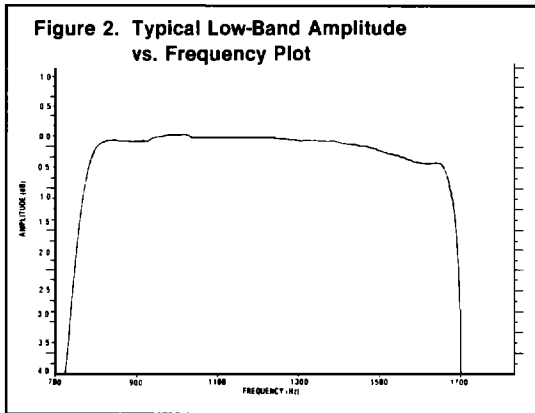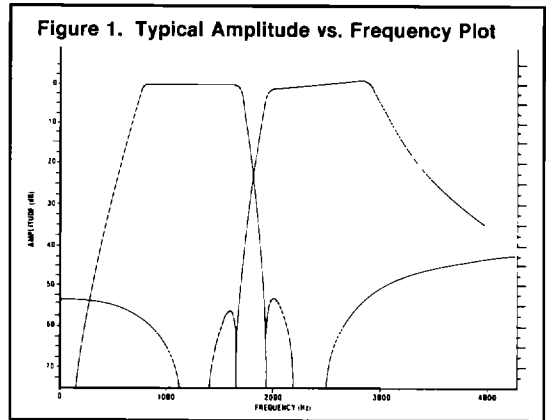
Call Progress Monitoring (Pin 1)

The center frequencies of the two filters shift down to one-sixth of their original values when pin 1 goes high. The high-band 2400 Hz filter centers around 400 Hz. Its passband is approximately 300 to 480 Hz. Precision dial tone (350/440 Hz) will pass. Ringback (440/480 Hz) and half of busy/reorder (480/620 Hz) will also pass.

The modem's energy detector software can determine the cadence or timing of the information to identify the proper status of the call.

V.22 Notch Filter (Pins 16, 17)

The S35212A includes a notch filter for CCITT V.22 modem operation. This filter notches out the guard tone required in V.22 operation. When a V.22 modem answers, it sends the 2100 Hz answer tone, and then the 2400 Hz data carrier. It is also required to send along with the data carrier a guard tone of 1800 Hz. (Some administrations require 550 Hz.) The purpose of this tone is to prevent the network from disconnecting. It provides energy at another point in the spectrum other than 2400 Hz. This simulates speech and will not trigger signaling receivers. The tone is only 3 dB below the data carrier. It is 600 Hz closer to the desired receive frequency of 1200 Hz, requiring additional filtering to maintain performance.

Pin 17, NSEL, when high, provides 1800 Hz notching. When low, it provides 550 Hz notching.

The output of the low-band filter, through the notch filter, is always available at pin 16, Notch Filter Out.

Analog Loopback (ALB) (Pin 14)

When pin 14, $\overline{AL}$, is low, the signal at pin 18, TX(IN), passes through the filter selected by pin 11, A/$\overline{O}$, and out through pin 5, RX(OUT).

Analog Loopback tests the local modem and terminal/computer hardware and software. Any character sent from the keyboard echoes back to the screen after being sent to the modem. It is modulated by the modem and sent out to the filter. If pin 14 is low, the

Call Progress Tones

Frequencies	Timing/Cadence	Condition Indicated
350 + 440 Hz	Constant Tone	Dial Tone
440 + 480 Hz	2sec on, 4sec off	Audible Ringing
480 + 620 Hz	0.5sec on, 0.5sec off (60 ppm)	Line Busy (Station Busy)
480 + 620 Hz	0.25sec on, 0.25sec off (120 ppm)	Trunk Busy (Reorder)

analog signal passes back through the RX(OUT) pin to the modem. It is demodulated and returned to the terminal/computer as received data.

Clock Input Selection (Pins 4, 9, 22)

The filter uses one of three possible clock frequencies. Either 2.4576 MHz or 1.2288 MHz can be applied to pin 4, CLK1. Pin 9, SEL1, when high, selects the divider for 2.4576 MHz. When low, it selects the divider for 1.2288 MHz. When using the S35212A with the S35213 modem chip, or if a 153.6 kHz clock is available, the clock is applied to pin 22, CLK2. Leave pins 4 and 9 open.

Compatibility with Previous Filters (Pins 12, 13, 14)

The S35212A plugs directly into any socket that previously held an S35212. It functions exactly as the S35212 as long as pin 14 is high. Pins 12 and 13 should be left open.

Answer/Originate Mode Selection (Pin 11)

Pin 11 selects the filters for the particular mode of operation. When it is low for the originate mode, the transmit path is through the low-band filter. Receive is through the high-band filter. When this pin is high for the answer mode, the transmit path is through the high-band filter. Receive is through the low-band filter. An internal pull-down resistor keeps the chip in the originate mode when this pin is not connected.

Modems, Filters & PCM Products

Uncommitted Operational Amplifiers

The two operational amplifiers are available to use as gain stages or anti-aliasing filters for the complete modem circuit. These are CMOS op amps. They do not have low impedance drive capability. Do not load by less than 10 kΩ. The open loop voltage gain is typically about 86 dB and the unity gain frequency is about 1.5 MHz with < 5 pF loading. Input offset voltages will be 10 mV or less.

Using one of the op amps for anti-aliasing is a good idea. The receive input to the filters must be band limited to avoid aliasing. The telephone network band limits the incoming signals from distant modems. Nevertheless, local noise or noise on the modem board itself can create problems. Figure 6 shows a second-order

Figure 6. Anti-Aliasing Low-Pass Filter for S35212A
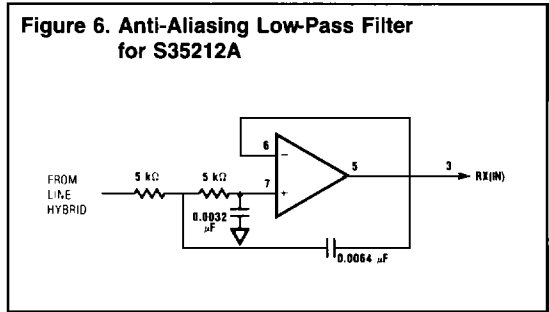
low-pass filter constructed around the receive op amp. It is a critically-damped, unity-gain, Sallen-Key filter with a cutoff frequency of 6 kHz.

Figure 7. RS-232 Serial Modem for 1200/300bps Asynchronous Operation/Auto-Answer/Auto-Dial Capability