Am7910

WORLD-CHIP™
FSK Modem

DISTINCTIVE CHARACTERISTICS

- Complete FSK Modem in a 28-pin package – just add line interface
- Compatible with Bell 103/113/108, Bell 202, CCITT V.21, CCITT V.23 specifications
  – 1200 bps full duplex on 4-wire line
- All digital signal processing, digital filters, and ADC/DAC included on-chip
  – No external filtering required
- Includes essential RS-232/CCITT V.24 handshake signals
  – Dial-up network response times
- Autoanswer capability
- Local copy/test modes

GENERAL DESCRIPTION

The Am7910 is a single-chip asynchronous Frequency Shift Keying (FSK) voiceband modem. It is pin-selectable for baud rates of 300, 600 or 1200 bits per second, and is compatible with the applicable Bell and CCITT-recommended standards for 103/113/108, 202, V.21 and V.23-type modems. Five mode control lines select a desired modem configuration.

Digital signal processing techniques are employed in the Am7910 FSK Modem to perform all major functions such as modulation, demodulation, and filtering. The Am7910 contains on-chip analog-to-digital and digital-to-analog converter circuits to minimize the external components in a system. This device includes the essential RS-232/CCITT V.24 terminal control signals with TTL levels.

Clocking can be generated by attaching a crystal to drive the internal crystal oscillator or by applying an external clock signal.

A Data Access Arrangement (DAA) or acoustic coupler must provide the phone line interface externally.

The Am7910 is fabricated using N-channel MOS technology in a 28-pin package. All the digital input and output signals (except the external clock and $\overline{\text{RESET}}$ signals) are TTL-compatible. Power supply requirements are ±5 volts.

BLOCK DIAGRAM

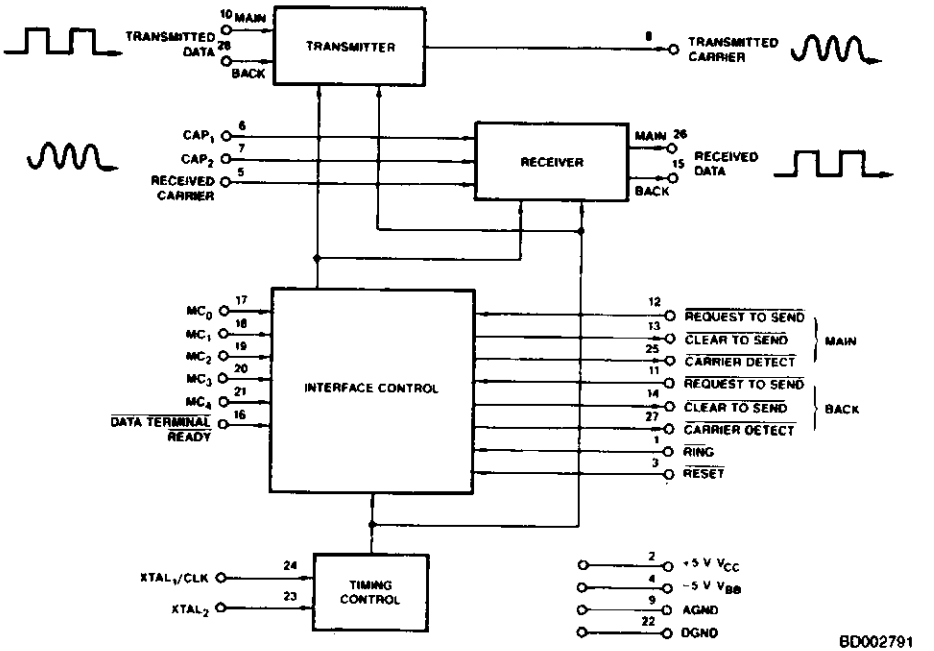

Table 3.1 Am79101 Nominal Transmit Levels

		FSK	DTMF (LOW)	DTMF (HIGH)
TC	dBm (600)	-3.0	-1.5	+0.5
	dBm (1200)	-6.0	-4.5	-2.5
	rms	0.548	0.652	0.820
	peak	0.776	0.922	1.160
RC	dBm (600)	-9.0	-7.5	-5.5
	dBm (1200)	-12.0	-10.5	-8.5
	rms	0.275	0.327	0.411
	peak	0.389	0.462	1.160
LINE	dBm (600)	-10.5	-9.0	-7.0
	dBm (1200)	-13.5	-12.0	-10.0
	rms	0.231	0.275	0.346
	peak	0.327	0.389	0.489

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3.3.3 Am79101 Transmit Levels

Since the Am79101 has a built-in hybrid, the resistor Z_L and the line transformer together give a 6 dB loss between TC and the transformer input (Figure 3.7). Table 3.1 provides levels at the TC pin, the transformer input (or RC) and levels on the line for FSK and DTMF.

3.4 INTERFACE DESCRIPTION

3.4.1 DA/$\overline{CA}$ (Am79101 only)

The Data/$\overline{Call}$ pin selects the Data mode (DA/$\overline{CA}$ = High) or Call mode (DA/$\overline{CA}$ = Low). In the Data mode, the Am79101 operates as a modem using the mode-control pins (MC4-MC0) to set the modem mode. In the Call mode, the mode control pins and $\overline{RTS}$ determine the generation of either DTMF or answer tones and the detection of call progress tones or answer tone.

The initial state and defaults of DA/$\overline{CA}$ should be the Data mode (DA/$\overline{CA}$ = High). To enter the Call mode, DA/$\overline{CA}$ and $\overline{DTR}$ must be High and a valid modem mode must be specified on the MC pins (i.e., no reserved modes). Then, when DA/$\overline{CA}$ is changed to a Low, the Am79101 will be in the Call mode. To return to the Data mode, DA/$\overline{CA}$ is taken High while there is a valid modem mode on the MC pins.

3.4.2 $\overline{Ring}$ (Am7910/11 Only)

This input signal permits autoanswer capability by responding to a ringing signal from a Data Access Arrangement. If a ringing signal is detected ($\overline{RING}$ = Low) and $\overline{DTR}$ is Low, the modem begins a sequence to generate an answer tone at the TC output.

Note: The Am79101 does not have a ring input pin. Rather, a ring indication output from the DAA interrupts the local microprocessor, which then initiates the autoanswer sequence in the Am79101, as described in section 3.8.

3.4.3 Mode Controls (MC0-MC4)

The FSK modem family has multiple built-in modem modes selectable by the user through a set of Mode Control Pins. Table 3.2 lists the modem modes, mode-control pin states and the product containing a particular mode.

The loopback modes set the receiver channel signal processing band to that of the transmit channel. No internal connection is made. The user must connect the TC pin to the RC pin if analog loopback is required (see Figure 3.9).

For digital loopback, external connection of the RD and TD pins is required.

With the Am7910/11, loopback modes can also be used to achieve full-duplex, 1200 bps communication. In CCITT V.23 or Bell 202 loopback modes, the modem can transmit and receive at 1200 bps using a 4-wire configuration (transmit over one channel and receive on another). See the System Configuration section for details.

3.4.4 $\overline{Data\ Terminal\ Ready}$ ($\overline{DTR}$)

A Low level on this input indicates the data terminal is ready to send and/or receive data via the modem. This signal is gated with all other TTL inputs and outputs so that a Low level enables these signals as well as the internal control logic. A High disables all TTL I/O pins and the internal logic.

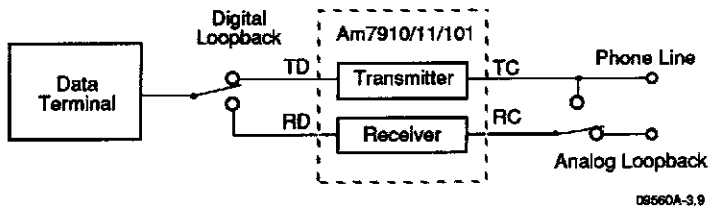

Figure 3.9 Analog Loopback

Table 3.2a Am7910/11/101 Mode Control Lines

7910	7911	79101	DA/$\overline{CA}$	MC4	MC3	MC2	MC1	MC0	DESCRIPTION
X	X	X	1	0	0	0	0	0	Bell 103 Originate 300 bps Full-Duplex
X	X	X	1	0	0	0	0	1	Bell 103 Answer 300 bps Full-Duplex
X	X	X	1	0	0	0	1	0	Bell 202 1200 bps Half-Duplex
X	X	X	1	0	0	0	1	1	Bell 202 with equalizer
X	X	X	1	0	0	1	0	0	CCITT V.21 Orig 300 bps Full-Duplex
X	X	X	1	0	0	1	0	1	CCITT V.21 Ans 300 bps Full-Duplex
X	X	X	1	0	0	1	1	0	CCITT V.23 M2 1200 bps Half-Duplex
X	X	X	1	0	0	1	1	1	CCITT V.23 M2 with Equalizer
X			1	0	1	0	0	0	CCITT V.23 M1 (1) 600 bps Half-Duplex
	X	X	1	0	1	0	0	0	CCITT V.23 M1 (2) 600 bps Half-Duplex
			1	0	1	0	0	1	Reserved
	X	X	1	0	1	0	1	0	Bell 202 with 150 bps Back Channel
	X	X	1	0	1	0	1	1	Bell 202 with 150 bps Back & Equalizer
	X	X	1	0	1	1	0	0	CCITT V.23 M1 (2) with Soft Turn-Off (STO)
			1	0	1	1	0	1	Reserved
	X	X	1	0	1	1	1	0	CCITT V.23 M2 (2) with STO
	X	X	1	0	1	1	1	1	CCITT V.23 M2 (2) with STO and Equalizer
X	X	X	1	1	0	0	0	0	Bell 103 Orig. Loopback
X	X	X	1	1	0	0	0	1	Bell 103 Answer Loopback
X	X	X	1	1	0	0	1	0	Bell 202 Main Loopback
X	X	X	1	1	0	0	1	1	Bell 202 with Equalizer Loopback
X	X	X	1	1	0	1	0	0	CCITT V.21 Orig. Loopback
X	X	X	1	1	0	1	0	1	CCITT V.21 Ans. Loopback
X	X	X	1	1	0	1	1	0	CCITT V.23 M2 Main Loopback
X	X	X	1	1	0	1	1	1	CCITT V.23 M2 with Equalizer Loopback
X	X	X	1	1	1	0	0	0	CCITT V.23 M1 Main Loopback
X			1	1	1	0	0	1	CCITT V.23 (1) Back Loopback
	X	X	1	1	1	0	0	1	CCITT V.23 (2) Back Loopback
	X	X	1	1	1	0	1	0	Bell 202 (2) Back Loopback

(1) Up to 75 Baud Back Channel
(2) Up to 150 Baud Back Channel

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Table 3.2b Am7910/11/101 Mode Control Lines (Continued)

7910	7911	79101	DA/$\overline{CA}$	MC4	MC3	MC2	MC1	MC0	DESCRIPTION
			1	1	1	0	1	1	Reserved
			1	1	1	1	0	0	Reserved
			1	1	1	1	0	1	Reserved
			1	1	1	1	1	0	Reserved
			1	1	1	1	1	1	Reserved
		X	0	0	0	0	0	0	DTMF 0 and Answer Tone Detection
		X	0	0	0	0	0	1	DTMF 1
		X	0	0	0	0	1	0	DTMF 2
		X	0	0	0	0	1	1	DTMF 3
		X	0	0	0	1	0	0	DTMF 4
		X	0	0	0	1	0	1	DTMF 5
		X	0	0	0	1	1	0	DTMF 6
		X	0	0	0	1	1	1	DTMF 7
		X	0	0	1	0	0	0	DTMF 8
		X	0	0	1	0	0	1	DTMF 9
		X	0	0	1	0	1	0	DTMF *
		X	0	0	1	0	1	1	DTMF #
		X	0	0	1	1	0	0	Bell 103 Answer Tone
		X	0	0	1	1	0	1	Bell 202 Answer Tone
		X	0	0	1	1	1	0	V.21 or V.23 Answer Tone
		X	0	0	1	1	1	1	Call Progress Tone Detection
		X	0	1	X	X	X	X	Reserved

NOTE: Reserved modes should not be entered.
DA/$\overline{CA}$ applies to the AM79101 only.

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When $\overline{DTR}$ is High, the modem handshake state machine is reset to initial conditions. This is the only way to reset the state machine and must be done after power-up. The state machine does not automatically power up to a known state. If $\overline{DTR}$ is permanently enabled (Low), the state machine will simply run from wherever it powers up. This can result in abnormal behavior such as an unusually short $\overline{RTS}$-$\overline{CTS}$ delay due to lack of $\overline{DTR}$ initialization.

In order to change the modem mode while the modem is powered up, use the following sequence:

1. Take $\overline{DTR}$ High
2. Change mode inputs to desired configuration
3. Wait at least 100 µs
4. Take $\overline{DTR}$ Low

The mode inputs perform some hardware functions, and they are also sampled periodically by the state machine. If the mode inputs are changed without the re-initialization using $\overline{DTR}$, the state machine will not completely change to the new mode.

NOTE for the Am79101: In call mode, $\overline{DTR}$ does not have to be changed when going from one DTMF digit to another.

3.4.5 Request To Send ($\overline{RTS}$)

A Low on this input instructs the modem to enter the transmit mode. This input must remain Low for the duration of data transmission. This signal has no effect if $\overline{DTR}$ is set High (disabled). A High level on this input turns off the transmitter.

For the Am79101 in the Call mode, $\overline{RTS}$ also controls the transmitter. When $\overline{RTS}$ is Low, the DMTF or answer tone specified by the MC pins will be transmitted. A High level will turn off the tone. During answer tone detection and call progress tone detection, $\overline{RTS}$ should be High.

3.4.6 Back Request To Send ($\overline{BRTS}$)

Since the 1200 bps modem configurations (Bell 202 and CCITT V.23) permit only half-duplex operation over 2-wire lines, a low baud rate backward/back channel is provided for simultaneous transmission in the reverse direction. $\overline{BRTS}$ is equivalent to $\overline{REQUEST\ TO\ SEND}$ for the main channel, except that it belongs to the back channel. Since the modem contains a single transmitter, $\overline{RTS}$ and $\overline{BRTS}$ should not be asserted simultaneously. $\overline{BRTS}$ is meaningful only when a 202 or V.23 mode is selected by MC0-MC4. In all other modes, it is ignored.

For the V.23 modes and the 202 150 bps (or 75 bps) back channel mode, the frequency appearing at the transmitted carrier (TC) output pin is determined by a mark or space at the Back Transmitted Data (BTD) input.

For the 202 5 bps Back Channel Mode, a frequency of 387 Hz appears at TC when $\overline{BRTS}$ is Low and BTD is High. No energy (0.0 volts) appears at TC when $\overline{BRTS}$ is High. BTD should be fixed High for 202 back channel transmission. $\overline{BRTS}$ then, is equivalent to the transmitted data. $\overline{BRTS}$ is the Secondary Request-to-Send for 202 S/T modems, or the Supervisory Transmitted Data for 202 C/D modems.

3.4.7 Clear To Send ($\overline{CTS}$)

This output goes Low at the end of a delay (t_{RCON}) initiated when $\overline{RTS}$ goes Low. Actual data to be transmitted should not be presented to the Transmit Data input until a Low is indicated on the $\overline{CTS}$ output. This gives the receiving modem (on the other end of the phone line) enough time to recognize a valid carrier signal before data is transmitted. Normally the user should force the TD input High whenever $\overline{CTS}$ is High so a mark will be sent during the t_{RCON} time. $\overline{CTS}$ goes High at the end of a delay initiated when $\overline{RTS}$ goes High (t_{RCOFF}). $\overline{CTS}$ will never be Low when $\overline{DTR}$ is High.

3.4.8 Back Clear To Send ($\overline{BCTS}$)

This line is equivalent to $\overline{CLEAR\ TO\ SEND}$ for the main channel, except it belongs to the back channel. $\overline{BCTS}$ is meaningful only when a V.23 mode or 202 150 bps (or 75 bps) back channel mode is selected by MC0-MC4. This signal is not used in the 202 5 bps back channel mode.

3.4.9 Transmitted Data (TD)

Data bits to be transmitted are presented to this input serially; High (mark) corresponds to logic 1 and Low (space) corresponds to logic 0. This data determines which frequency appears at any instant at the TRANSMITTED CARRIER output pin (Table 3.3). No signal appears at the TRANSMITTED CARRIER output unless $\overline{DTR}$ is Low and $\overline{RTS}$ is Low.

3.4.10 Back Transmitted Data (BTD)

This line is equivalent to TRANSMITTED DATA for the main channel, except it belongs to the back channel. BTD is meaningful only when a 202 or V.23 mode is selected by MC0-MC4. For 202 5 bps back channel transmission of on/off keying, BTD should be fixed at a High level.

3.4.11 Carrier Detect ($\overline{CD}$)

A Low on this output indicates that a valid carrier signal is present at the receiver and has been present for at least a time t_{CDON}. A High on this output signifies that no valid carrier is being received and has not been received for a time t_{CDOFF}. Carrier Detect looks for energy in the receive bandwidth. $\overline{CD}$ is Low when the receive signal is above a threshold limit V_{CDON} and High when the level of the received signal is below V_{CDOFF}.

For the Am79101 in the Call mode, $\overline{CD}$=Low indicates a valid answer tone or call progress tone has been detected above the V_{CDON} level. $\overline{CD}$=High indicates there is no energy above the V_{CDOFF} limit.

3.4.12 Back Carrier Detect ($\overline{BCD}$)

This line is equivalent to $\overline{CARRIER\ DETECT}$ for the main channel, except it belongs to the back channel. $\overline{BCD}$ is meaningful only when a 202 or V.23 mode is selected by MC0-MC4. For the V.23 back channel mode or the 202 150 bps (or 75 bps) back channel mode, $\overline{BCD}$ activates when either the mark or space frequency appears with sufficient level at the received carrier (RC) input.

For the 202 5 bps back channel mode, $\overline{BCD}$ turns on in response to a 387 Hz tone of sufficient level at the RC input. In this case $\overline{BCD}$ is equivalent to the Secondary Received Line Signal Detector for 202 S/T modems, or Supervisory Received Data for 202 C/D modems.

3.4.13 Received Data (RD)

Data bits demodulated from the RECEIVED CARRIER input are available serially at this output; High (mark) indicates logic 1 and Low (space) indicates logic 0.

Under the following conditions, this output is forced to logic 1, because the data may be invalid:

1. When $\overline{CD}$ is High
2. During the internal squelch delay at half-duplex line turn-around (202 and V.23 modes only)
3. During soft carrier turnoff at half-duplex line turn-around (202 and V.23 soft turn-off modes only)
4. When $\overline{DTR}$ is HIGH
5. When $\overline{RTS}$ is Low and $\overline{BRTS}$ is High in 202 and V.23 modes only
6. During the autoanswer sequence

Table 3.3a Frequency Parameters

Modem	Baud Rate (BPS)	Duplex	Transmit Frequency		Receive Frequency		Answer Tone Freq Hz	Soft Turn Off Tone Hz
			Space Hz	Mark Hz	Space Hz	Mark Hz		
Bell 103 Orig	300	Full	1070	1270	2025	2225	–	–
Bell 103 Ans	300	Full	2025	2225	1070	1270	2225	–
CCITT V.21 Orig	300	Full	1180	980	1850	1650	–	–
CCITT V.21 Ans	300	Full	1850	1650	1180	980	2100	–
CCITT V.23 Mode 1	600	Half	1700	1300	1700	1300	2100	900***
CCITT V.23 Mode 2	1200	Half	2100	1300	2100	1300	2100	900***
CCITT V.23 Mode 2 Equalized	1200	Half	2100	1300	2100	1300	2100	900***
Bell 202	1200	Half	2200	1200	2200	1200	2025	900
Bell 202 Equalized	1200	Half	2200	1200	2200	1200	2025	900
CCITT V.23 Back	75/150	–	450	390	450	390	–	–
Bell 202 5bps Back	5	–	*	*	**	**	–	–
Bell 202 150bps Back	150	–	487	387	487	387	–	–

* ($\overline{BRTS}$ Low) and (BTD High): 387 Hz at TC
* ($\overline{BRTS}$ High) or (BTD Low): 0 volts at TC
* Meets CCITT R.20 frequency tolerance.

** 387 Hz at RC: $\overline{BCD}$ Low
** No 387 Hz at RC: $\overline{BCD}$ High
*** For V.23 soft turn off modes only

Frequency tolerance is less than ±0.4 Hz with 2.4576 MHz Crystal. Except Bell 202 which is +1.0 Hz (1200 Hz, mark).

Table 3.3b Timing Parameters

		Am7910/101			
Symbol	Description	Bell 103	CCITT V.21	Call Mode	Units
t_{RCON}	Request-to-Send to Clear-to-Send ON Delay	208.3	400	-	ms ±0.3%
t_{RCOFF}	Request-to-Send to Clear-to-Send OFF Delay	0.4	0.4	-	ms ±40%
t_{CDON}	Carrier Detect ON Delay	92-106	300-312	-	ms
t_{CDOFF}	Carrier Detect OFF Delay	21-40	21-40	-	ms
t_{CDONF}	Carrier Detect Call ON Delay	-	-	92-106	ms
$t_{CDOFF'}$	Carrier Detect Call OFF Delay	-	-	21-40	ms
t_{RING}	Ring Delay	25	25	-	µs