M-976-2C2
MFC Transceiver

Features

- M-976-2C2 MFC Transceiver
- Designed for R2 MF signaling transmit and receive levels used in China
- Direct A-Law PCM digital input
- 2.048 Mb/s clocking
- Programmable forward/backward mode
- Programmable compelled/direct control
- Operates with standard codecs for analog interfacing
- Microprocessor read/write interface
- Binary or 2-of-6 data formats
- Dual-channel
- 5 volt power

Applications

- Test equipment
- Trunk adapters
- Paging terminals
- Traffic recorder
- PBX's

Description

The M-976-2C2 MFC Transceiver contains all the logic necessary to transmit and receive MF signaling used in China, both (forward) and (backward) multifrequency signals on one integrated circuit (IC). The M-976 provides two transceiver channels.

Operating with a 20.48 MHz crystal, the M-976 is capable of providing a direct digital interface to an A-law-encoded PCM digital input. Each channel can be connected to an analog source using a coder-decoder (codec) as shown in the Block Diagram below.

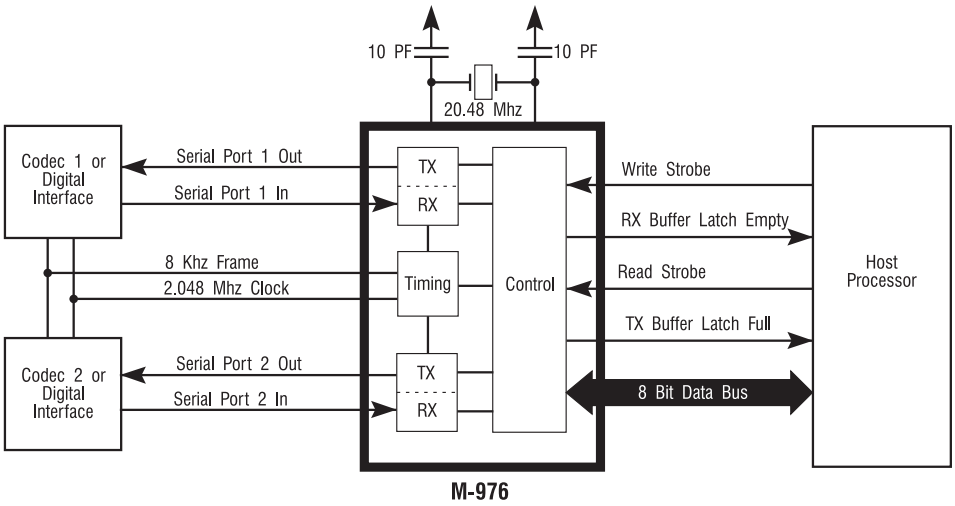
The M-976 can be configured by the customer to operate with the transmitter and receiver either coupled together or independent, allowing it to handle a compelled cycle automatically or via command from the host processor. The M-976 is configured and controlled through an integral coprocessor port.

The M-976-2C2X is available in two packaging options. The M-976-2C2P is a plastic 40-pin DIP and the M-976-2C2PL is a 44-pin plastic leaded chip carrier.

Ordering Information

Part #	Description
M-976-2C2P	40-pin plastic DIP
M-976-2C2PL	44-pin PLCC

Block Diagram



Functional Description

The M-976 can be set up for various operating modes by writing two configuration bytes to the coprocessor port. The format of the two configuration bytes is shown in the Configuration Bytes table on page 2 and the configuration options are described in the following paragraphs.

Configuration Options

External/Internal Codec Clock (ECLK): If external codec clocking is selected, an external clocking source provides an 8kHz transmit framing clock and an 8kHz receive framing clock. It also provides a serial bit clock with a frequency that is a multiple of 8 kHz between 2.496 MHz and 216 kHz for exchange of data via the serial ports. When internal codec clocking is selected, the M-976 provides an 8kHz framing clock and a 2.048 MHz serial bit clock.

Binary/2 of 6 Input/Output (IOM): When the 2-of-6 input/output is selected, the M-976 encodes the received R2 MF tone pair into a 6-bit format, where each bit represents one of the six possible frequencies. A logic high level indicates the presence of a frequency. The digital input to the M-976 that selects the transmitted R2 MF tone pair must also be coded in the 2-of-6 format.

When binary input/output is selected, the M-976 encodes the received MF tone pair into a 4 bit binary format. The digital input to the M-976 that selects the transmitted R2 MF tone pair must also be coded in a 4 bit binary format.

Enable/Disable Channel (ENC): When a channel is disabled, the receiver does not process its codec input for R2 MF tones, and the transmitter does not respond to transmit commands. If a transmit command is given while the channel is enabled, the tone off command must be given before the channel is disabled. Disabling the channel does not automatically shut off the transmitter. When a channel is enabled, the receiver and transmitter for that channel function normally.

End-of-Digit Indication (EOD): The end-of-digit indication option configures the M-976 to inform the host processor when the far end terminates transmission of the R2 MF tone it is sending. If this option is disabled, the host processor will not be notified when tone transmission terminates.

Automatic Compelled/Manual Sequence Signaling (CMP): When manual mode is selected, R2 MF tone transmission is turned on and off only via command from the host processor.

If the automatic mode is selected, the transmitter and receiver perform the compelled signaling handshake automatically. The specifics of operation are different for the forward and backward configurations.

In forward mode, the transceiver can exist in two states, STATE 1 and STATE 2:

- STATE 1: No backward signal detected.

Configuration Bytes

Configuration Byte 1							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
0	0	ECLK	IOM	ENC1	EOD1	CMP1	FB1

ECLK	Channels 1 & 2	1 = External codec clock; 0 = Internal codec clock
IOM	Channels 1 & 2	1 = Binary input/output; 0 = 2-of-6 input/output
ENC1	Channel 1	1 = Enable channel; 0 = Disable channel
EOD1	Channel 1	1 = Indicate end of digit; 0 = No end of digit indication
CMP1	Channel 1	1 = Automatic Compelled mode; 0 = Manual mode
FB1	Channel	1 = Forward mode (Tx backward frequencies and Rx forward frequencies)
		0 = Backward mode (Tx backward frequencies and Rx forward frequencies)

Configuration Byte 2							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
0	1	1	0	ENC2	EOD2	CMP2	FB2

ENC2	Channel 2	1 = Enable channel; 0 = Disable channel
EOD2	Channel 2	1 = Indicate end of digit; 0 = No end of digit indication
CMP2	Channel 2	1 = Automatic Compelled mode; 0 = Manual mode
FB2	Channel 2	1 = Forward mode (Tx forward frequencies and Rx backward frequencies)
		0 = Backward mode(Tx backward frequencies and Rx forward frequencies)

Transmitter under control of the host.

- STATE 2: Backward signal detected. Transmitter off unconditionally.

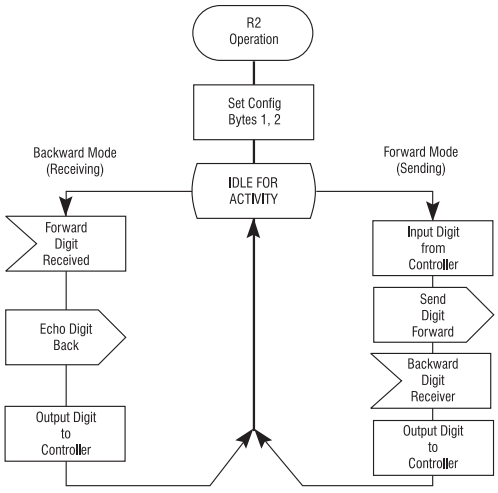
A Transmit Tone Command written while the transceiver is in STATE 1 will be acted upon immediately. The transmitter is unconditionally disabled upon entry into STATE 2. If a transmit command is written to the transceiver while in STATE 2, that command will become pending. Upon entry into STATE 1, a pending transmit command is acted upon.

In backward mode, the transceiver can exist in two states, STATE 1 and STATE 2:

- STATE 1: No forward signal detected. Transmitter off unconditionally.
- STATE 2: Forward signal detected. Transmitter transmits backward signal.

A transmit tone command written while the transceiver is in STATE 2 will be acted upon immediately. The transmitter is unconditionally disabled upon entry into STATE 1. If a transmit command is written to the transceiver while in STATE 1, that command will become pending. Upon entry into STATE 2, a pending transmit command is acted upon.

Automatic Compelled Mode Operation



EXAMPLE: Assume that the transceivers at both ends of a link are configured in automatic compelled mode. Both transceivers are in STATE 1. A compelled signaling sequence begins with the R2F host writing a transmit command byte to its transceiver via the coprocessor bus. The transceiver immediately begins transmitting the signal.

Binary Coding Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Transmit tone command	1	CHN	0	0	A	B	C	D
Receive tone return	0	CHN	0	0	A	B	C	D

CHN: 1 = channel 2; 0 = channel 1

R2 MF Frequencies:

ABCD	Forward (Hz)	Backward (Hz)	ABCD	Forward (Hz)	Backward (Hz)
0 0 0 0	Tone off	Tone off	1 0 0 0	1500 & 1860	1020 & 660
0 0 0 1	1380 & 1500	1140 & 1020	1 0 0 1	1620 & 1860	900 & 660
0 0 1 0	1380 & 1620	1140 & 900	1 0 1 0	1740 & 1860	780 & 660
0 0 1 1	1500 & 1620	1020 & 900	1 0 1 1	1380 & 1980	1140 & 540
0 1 0 0	1380 & 1740	1140 & 780	1 1 0 0	1500 & 1980	1020 & 540
0 1 0 1	1500 & 1740	1020 & 780	1 1 0 1	1620 & 1980	900 & 540
0 1 1 0	1620 & 1740	900 & 780	1 1 1 0	1740 & 1980	780 & 540
0 1 1 1	1380 & 1860	1140 & 660	1 1 1 1	1860 & 1980	660 & 540

2 of 6 Coding Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Transmit tone command	1	CHN	F6	F5	F4	F3	F2	F1
Receive tone return	0	CHN	F6	F5	F4	F3	F2	F1

CHN: 1 = channel 2; 0 = channel 1

R2 MF Frequencies:

Bit name	Forward (Hz)	Backward (Hz)	Bit name	Forward (Hz)	Backward (Hz)
F6	1980	540	F3	1620	900
F5	1860	660	F2	1500	1020
F4	1740	780	F1	1380	1140

The R2B transceiver detects the signal, enters STATE 2, and outputs the received tone code to its host via the coprocessor port. If the R2B host had determined the next tone to transmit and written a transmit command to the transceiver prior to entry into STATE 2, the state transition will cause this tone to be transmitted. Otherwise, the R2B transmitter waits for a transmit tone command from the host, and starts transmitting a tone once the transmit tone command is received.

The R2F transceiver detects the backward signal, enters STATE 2, and outputs the received tone code to its host. Entry into STATE 2 unconditionally disables the transmitter.

The R2B transceiver detects the absence of signal, enters STATE 1, and informs the host with the end-of-tone code if configured to do so. Entry into STATE 1 unconditionally disables the transmitter.

The R2F transceiver detects the absence of signal, enters STATE 1, and informs the host with the end-of-tone code if configured to do so. If the R2F host had determined the next signal to transmit and written a transmit command to the transceiver prior to entry into STATE 1, the state transition y20will cause this signal to be transmitted. Otherwise, the transmitter remains silent until the next transmit command by its host.

Forward/Backward Frequencies (FB): When forward mode is selected, the R2F (forward) frequencies are transmitted and R2B (backward) frequencies are received. When backward mode is selected, R2B frequencies are transmitted and R2F frequencies are received. The R2F frequencies are 1380, 1500, 1620, 1740, 1860, and 1980 Hertz. The R2B frequencies are 540, 660, 780, 900, 1020, and 1140 Hz.

Initial Configuration: The configuration of the M-976 immediately after a reset will be as follows:

- End-of-digit indication ON
- Forward mode ON
- Channel disabled
- 2-of-6 input/output
- External serial and serial frame clocks.

Also, the M-976 will place 00 hex on the coprocessor port to indicate to the host processor that it is working.

Transmit Tone Command

The transmit tone command allows the host processor to transmit any two of the 6 possible frequencies in the transmission mode the channel has been configured for (forward or backward). The format of the command depends on whether the M-976 is configured for binary format or 2-of-6 format.

Recieved Tone Detection

When a tone is detected by the M-976, the $\overline{\text{TBLF}}$ output goes low, indicating reception of the tone to the host processor. The host processor can determine which tone was detected and which channel the tone was detected on by reading data from the M-976 coprocessor port. The M-976 will return a single byte indicating the tone received and the channel that the tone was received on.The format of the returned byte depends on whether the M-976 is configured for binary or 2-of-6 coding. See Tables 2 and 3.

Coprocessor Port

Commands are written to the M-976 via the coprocessor port, and data indicating the received R2 MF tone is read from the coprocessor port.

Writing to the Coprocessor Port: The following sequence describes writing a command to the M-976.

(1) The $\overline{\text{WR}}$ signal is driven low by the host processor.

(2) The $\overline{\text{RBLE}}$ (receive buffer latch empty) signal transitions to a logic high level.

(3) Data is written from LD7-LD0 to the receive buffer latch (D7-D0) when the $\overline{\text{WR}}$ signal goes high.

(4) The $\overline{\text{RBLE}}$ signal transitions to a logic low level after the M-976 reads the data. This signals the host processor that the receive buffer is empty.

Note: The $\overline{\text{RBLE}}$ should be low before writing to the coprocessor.

Reading the Coprocessor Port: The following sequence describes reading received tone information from the coprocessor port.

(1) The $\overline{\text{TBLF}}$ (transmit buffer latch full) port pin on the M-976 goes low indicating the reception of a tone.

(2) The host processor detects the low logic level on the $\overline{\text{TBLF}}$ pin either by polling a connected port pin or by an interrupt.

(3) The host processor drives the RD signal low.

(4) The $\overline{\text{TBLF}}$ (transmit buffer latch full) signal transitions to a logic high level.

(5) Data is driven onto D7-D0 by the M-976 until the $\overline{\text{RD}}$ signal is driven high by the host processor.

Clock Characteristics and Timing

Internal Clock Option: The internal oscillator is enabled by connecting a crystal across X1 and X2/CLKIN. The crystal must be 20.48 MHz, fundamentalmode, and parallel resonant, with an effective series resistance of 30 ohms, a power dissipation of 1 mW, and be specified at a load capacitance of 20 pf.

External Clock Option: An external frequency source

can be used by injecting the frequency directly in X2/CLKIN, with X1 left unconnected. The external frequency injected must conform to the specifications Table on page 7.

Flammability/Reliability Specifications

Reliability: 480 FITS (failures/billion hours)
Flammability: Passes UL 94 V-0 tests

Signal Description

Signal	DIP Pinout	PLCC Pinout	I/O/Z	Description
Note: Please see the following definitions: DIP = Dual In-line Package PLCC = Plastic Leaded Chip Carrier				
D8-D15	11-18	13-17, 19-21	I/O/Z	Unused. Leave open.
D0-D7	19-26	22-28, 30	I/O/Z	8-bit coprocessor latch.
$\overline{TBLF}$	40	44	O	Transmit buffer latch full flag.
$\overline{RBLE}$	1	2	O	Receive buffer latch empty flag
HI/$\overline{LO}$	2	3	I	Latch byte select pin. Tie low.
$\overline{BIO}$	9	10	I	Unused. Leave open.
$\overline{RD}$	32	36	I/O	Used by the external processor to read from the coprocessor latch by driving the $\overline{RD}$ line active (low), thus enabling the output latch to drive the latched data. When the data has been read, the external device must bring the $\overline{RD}$ line high.
$\overline{EXINT}$	5	6	I	Unused. Leave open.
MC	3	4	I	Microcomputer mode select pin. Tie low.
MC/$\overline{PM}$	27	31	I	Coprocessor mode select pin. Tie low.
$\overline{RS}$	4	5	I	Reset input for initializing the device. When an active low is placed on $\overline{RS}$ pin for a minimum of five clock cycles, $\overline{RD}$ and $\overline{WR}$ are forced high, and the data bus (D7 through D0) goes to a high impedance state. The serial port clock and transmit outputs also go to the high impedance state.
$\overline{WR}$	31	35	I/O	Used by the external processor to write data to the coprocessor port. To write data the external processor drives the $\overline{WR}$ line low, places data on the data bus, and then drives the $\overline{WR}$ line high to clock the data into the on-chip latch.
XF	28	32	O	Watchdog signal. Toggles at least once every 15 milliseconds when the processor is functioning properly. If the pin is not toggled at least once every 15 ms, the processor is lost and should be reset.
CLKOUT	6	7	O	System clock output (one-fourth crystal/CLKIN frequency, nominally 5.12 MHz).
V_{CC}	30	34	I	5V supply pin.
V_{SS}	10	1, 12, 18, 29	I	Ground pin.
X1	7	8	O	Crystal output pin for internal oscillator. If an internal oscillator is not used, this pin should be left unconnected.
X2/CLKIN	8	9	I	Input pin to the internal oscillator (X2) from the crystal. Alternatively, an input pin for the external oscillator (CLKIN).
DR0 & DR1	29 & 33	33, 37	I	Serial-port receive-channel inputs. 2.048 MHz serial data is received in the receive registers via these pins. DR0 = channel 1; DR1 = channel 2
DX0 & DX1	35 & 36	39, 40	O	Serial-port transmit-channel outputs. 2.048 MHz serial data is transmitted from the transmit registers on these pins. These outputs are in the high-impedance state when not transmitting.

Signal Description (continued)

Signal	DIP Pinout	PLCC Pinout	I/O/Z	Description
FR	37	41	O	8 kHz internal serial-port framing output. If internal clocking is selected, serial-port transmit and receive operations occur simultaneously on an active (high) FR framing pulse.
$\overline{FSR}$	39	43	I	8 kHz external serial-port receive-framing input. If external clocking is selected, data is received via the receive pins (DR1 and DR0) on the active (low) FSR input. The falling edge of FSR initiates the receive process, and the rising edge causes the M-986 to process the data.
$\overline{FSX}$	38	42	I	8 kHz external serial-port transmit-framing input. If external clocking is enabled, data is transmitted on the transmit pins (DX1, DX0) on the active (low) input. The falling edge of FSX initiates the transmit process,and the rising edge causes the M-986 to internally load data for the next cycle.
SCLK	34	38	I/O/Z	2.048 MHz serial-port clock. Master clock for transmitting and receiving serial-port data. Configured as an input in external clocking mode or output in internal clocking mode. Reset ($\overline{RS}$) forces SCLK to the high-impedance state.

Absolute Maximum Ratings Over Specified Temperature Range

Supply voltage range, V_{CC}	-0.3 V to 7 V
Input voltage range	-0.3 V to 15 V
Output voltage range	-0.3 V to 15 V
Ambient air temperature range	0°C to 70°C
Storage temperature range	-45°C to 150°C

Absolute Maximum Ratings are stress ratings. Stresses in excess of these ratings can cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this data sheet is not implied. Exposure of the device to the absolute maximum ratings for an extended period may degrade the device and effect its reliability.

Serial Port Timing

Parameter		Min	Nom	Max	Units
t_d (CH-FR)	Internal framing delay from SCLK rising edge	-	-	70	ns
t_d (DX1-CL)	DX bit 1 valid before SCLK falling edge	20	-	-	ns
t_d (DX2-CL)	DX bit 2 valid before SCLK falling edge	20	-	-	ns
t_h (DX)	DX hold time after SCLK falling edge	244	-	-	ns
t_{su} (DR)	DR setup time before SCLK falling edge	20	-	-	ns
t_h (DR)	DR hold time after SCLK falling edge	20	-	-	ns
t_c (SCLK)	Serial port clock cycle time	399	488.28	4770	ns
t_f (SCLK)	Serial port clock fall time	-	-	30	ns
t_r (SCLK)	Serial port clock rise time	-	-	30	ns
t_w (SCLKL)	Serial port clock low-pulse duration*	220	244.14	2500	ns
t_w (SCLKH)	Serial port clock high-pulse duration*	220	244.14	2500	ns
t_{su} (FS)	$\overline{FSX}$/$\overline{FSR}$ setup time before SCLK falling edge	100	-	-	ns

* The duty cycle of the serial port clock must be within 45% to 55%.

Electrical Characteristics/Temperature Range

Parameter			Test Conditions		Min	Typ	Max	Unit
I_{CC}	Supply current f = 20.5 MHz,		V_{CC} = 5.5V, T_A = 0˚ to 70 ˚C		-	50	75	mA
V_{OH}	High-level output voltage		I_{OH} = MAX		2.4	3	-	V
			I_{OH} = 20 µ A		V_{CC} -0.4	-	-	V
V_{OL}	Low-level output voltage		I_{OL} = MAX		-	0.3	0.6	V
I_{OZ}	Off-state output current		V_{CC} = MAX	V_O = 2.4 V	-	-	20	µA
				V_O = 0.4 V	-	-	-20	µA
I_I	Input current		V_I = V_{SS} to V_{CC}	Except CLKIN	-	-	±20	µA
				CLKIN	-	-	±50	µA
C_I	Input capacitance	Data bus	f = 1 MHz, all other pins 0 V		-	25	-	pF
		All others			-	15	-	pF
C_O	Output capacitance	Data bus			-	25	-	pF
		All others			-	10	-	pF

External Frequency Specifications

Parameter		Min	Nom	Max	Unit
t_c(MC)	Master clock cycle time	48.818	48.828	48.838	ns
t_r(MC)	Rise time master clock input	-	5	10	ns
t_f(MC)	Pulse duration master clock	20	-	-	ns

Recommended Operating Conditions

Parameter			Min	Nom	Max	Unit
V_{CC}	Supply voltage		4.75	5	5.25	V
V_{SS}	Supply voltage		-	0	-	V
V_{IH}	High-level input voltage	All inputs except CLKIN	2	-	-	V
		CLKIN	3	-	-	V
V_{IL}	Low-level input voltage	All inputs except MC/$\overline{MP}$	-	-	0.8	V
		MC/$\overline{MP}$	-	-	0.6	V
I_{OH}	High-level output current (all outputs)		-	-	-300	µA
I_{OL}	Low-level output current (all outputs)		-	-	2	mA
T_A	Operating free-air temperature		0	-	70	˚C

Coprocessor Interface Timing

Parameter		Min	Nom	Max	Unit
$t_{d(R-A)}$	$\overline{RD}$ low to $\overline{TBLF}$ high	-	-	75	ns
$t_{d(W-A)}$	$\overline{WR}$ low to $\overline{RBLE}$ high	-	-	75	ns
$t_{a(RD)}$	$\overline{RD}$ low to data valid	-	-	80	ns
$t_{h(RD)}$	Data hold time after $\overline{RD}$ high	25	-	-	ns
$t_{su(WR)}$	Data setup time prior to $\overline{WR}$ high	30	-	-	ns
$t_{h(WR)}$	Data hold time after $\overline{WR}$ high	25	-	-	ns
$t_{w(RDL)}$	$\overline{RD}$ low-pulse duration	80	-	-	ns
$t_{w(WRL)}$	$\overline{WR}$ low-pulse duration	60	-	-	ns
$t_{wr(RBLE)}$	$\overline{RBLE}\uparrow$ to $\overline{RBLE}\downarrow$	-	-	1	ms

Reset (RS) Timing

Parameter		Test Conditions	Min	Max	Unit
$t_{dis}(R)$	Data bus disable time after $\overline{RS}$	R_L = 825 Ω	-	75	ns
t_{d12}	Delay time from $\overline{RS}\downarrow$ to high-impedance SCLK	C_L = 100 pF	-	200	ns
t_{d13}	Delay time from $\overline{RS}\downarrow$ to high-impedance DX1, DX0		-	200	ns
$t_{su}(R)$	Reset ($\overline{RS}$) setup time prior to CLKOUT		50	-	ns
$t_w(R)$	RS pulse duration		245	-	ns

CLKOUT Timing Parameters

Parameter		Test Conditions	Min	Nom	Max	Unit
$t_c(C)$	CLKOUT cycle time	195.27	195.31	195.35	ns	
$t_r(C)$	CLKOUT rise time	R_L = 825 Ω	-	10	-	ns
$t_f(C)$	CLKOUT fall time	C_L = 100 pF	-	8	-	ns
$t_d(MCC)$	Delay time CLKIN↑ to CLKOUT↓		25	-	60	ns

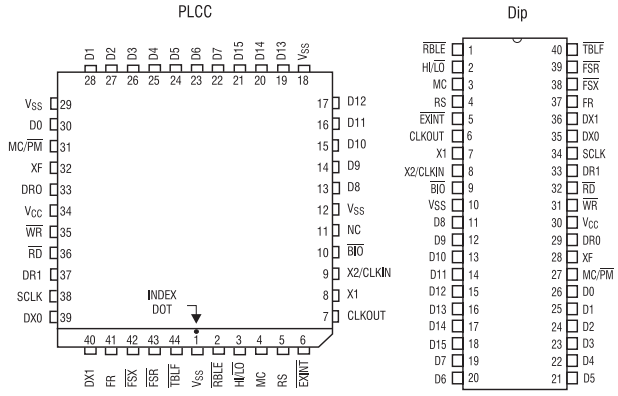
Transmitter Characteristics

Parameter		Test Conditions	Min	Typ	Max	Unit
F_{OS}	Frequency offset	From nominal	-	-	±4	Hz
TW	Twist	High/low	-	-	±0.6	dB
A_S	Signal amplitude	Per component	-9.00	-8.00	-7.00	dBm0
T_S	Time skew	Between components	-	-	0.5	ms
P_{hi}	Power due to harmonic distortion and intermodulation	300 to 400 Hz	-	-	-46.5	dBm0

Reciever Characteristics

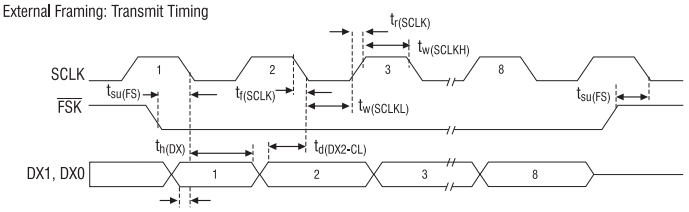
	Parameter	Test Conditions	Min	Max	Unit
A_d	Detect amplitude	Per frequency	-31	-1	dBm0
A_{nd}	No-detect amplitude	Per frequency	-38	-31	dBm0
F_d	Detect with frequency offset	From nominal	±10	-	Hz
TW_d	Detect with twist	Adjacent frequencies	±5	-	dB
		Nonadjacent frequencies	±7	-	dB
TW_{nd}	No detect with twist		±20	-	dB
$T3_r$	Third R2F tone reject Relative to highest level frequency		-20	-	dB
FF_d	Detect R2B with R2F disturbing	Above lowest level R2B tone (-12.5 dBm0 max.)	13.5	-	dB
FT_{nd}	No detect R2F with 2 out-of-band sine waves	Any frequencies from 330 - 1150 Hz and 2130 - 3400 Hz	-1	-	dBm0
RT_{nd}	No detect R2B with 2 out-of-band sine waves	Any frequencies from 1300-3400 Hz	-1	-	dBm0
T_{on}	Tone time	Reject	7	-	ms
T_{int}	Interrupted tone time	Reject	7	-	ms
T_{or}	Operate and release time		-	80	ms

Pin Assignments



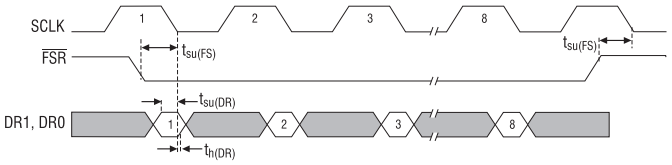
External Framing Timing Diagrams

External Framing: Transmit Timing



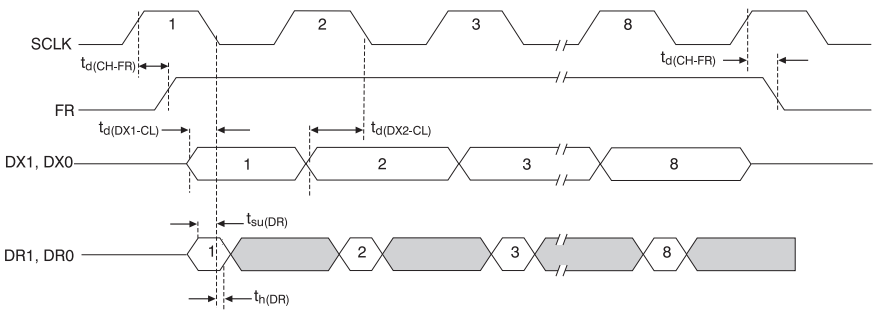
NOTES: Data valid on transmit outputs until SCLK rises.
The most significant bit is shifted first.

External Framing: Receive Timing



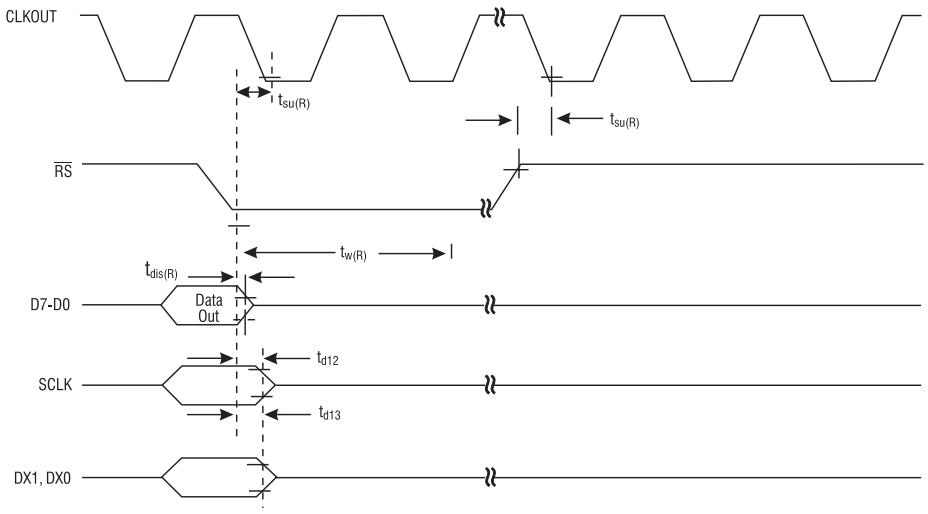
Internal Framing Timing

Internal Framing



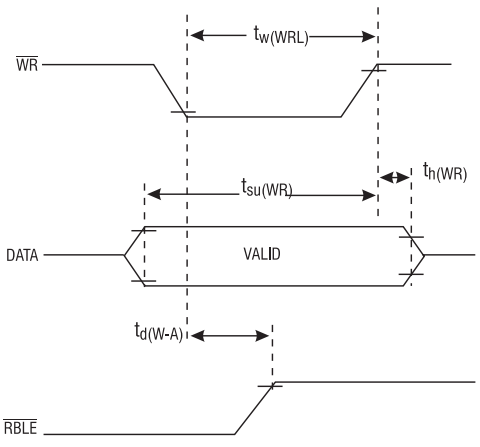
Note: The most significant bit is shifted first.

Reset Timing

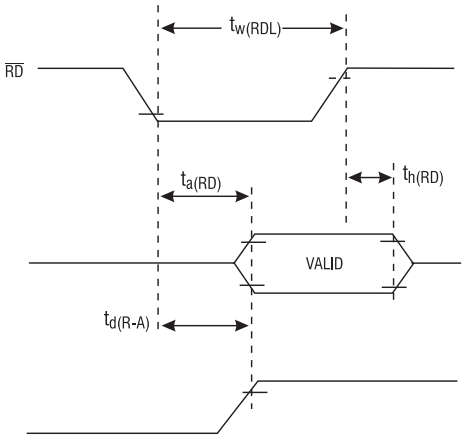


Coprocessor Timing

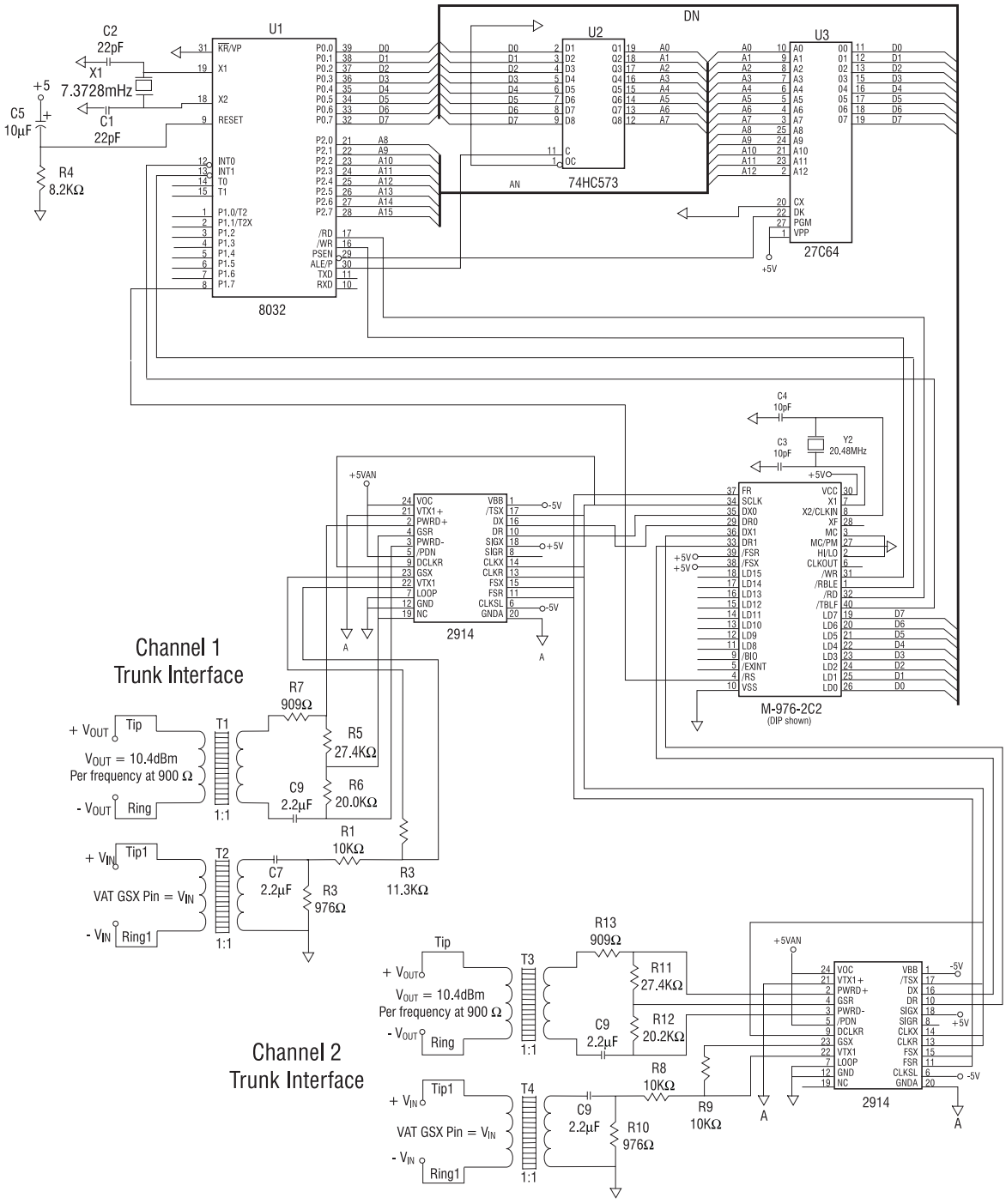
External Write to Coprocessor Port



External Read from Coprocessor Port

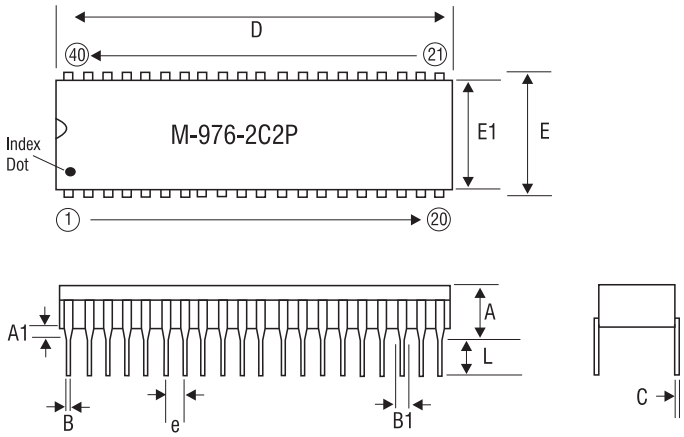


M-986 Dual Channel 4-Wire Interface Circuit



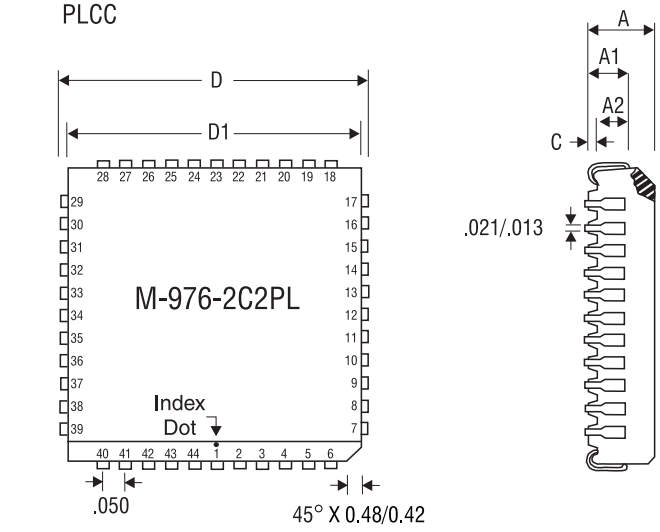
Mechanical Dimensions

DIP



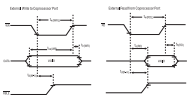
	Tolerances			
	(inches)		Metric (mm)	
	Min	Max	Min	Max
A	-	.250	-	6.35
A1	.015	-	.39	
B	.014	.022	.36	.56
B1	.030	.070	.77	1.78
C	.008	.015	.20	.38
D	1.98	2.095	50.30	53.20
E	.600	.625	15.24	15.87
E1	.485	.580	12.32	14.73
e	.100 BSC		2.54 BSC	
L	.115	.200	2.93	5.08

PLCC



	Tolerances			
	(inches)		Metric (mm)	
	Min	Max	Min	Max
A	.165	.180	4.19	4.57
A1	.090	.20	2.29	5.08
A2	.062	.083	1.58	2.11
C	.020 min		.51 min	
D	.685	.695	17.40	17.65
D1	.650	.653	16.51	16.66

Drawing not to scale.
Drawing does not reflect actual part marking.



Worldwide Sales Offices

CLARE LOCATIONS

Clare Headquarters
78 Cherry Hill Drive
Beverly, MA 01915
Tel: 1-978-524-6700
Fax: 1-978-524-4900
Toll Free: 1-800-27-CLARE

Clare Switch Division
4315 N. Earth City Expressway
Earth City, MO 63045
Tel: 1-314-770-1832
Fax: 1-314-770-1812

Clare Micronix Division
145 Columbia
Aliso Viejo, CA 92656-1490
Tel: 1-949-831-4622
Fax: 1-949-831-4628

SALES OFFICES

AMERICAS

Americas Headquarters
Clare
78 Cherry Hill Drive
Beverly, MA 01915
Tel: 1-978-524-6700
Fax: 1-978-524-4900
Toll Free: 1-800-27-CLARE

Eastern Region
Clare
603 Apache Court
Mahwah, NJ 07430
Tel: 1-201-236-0101
Fax: 1-201-236-8685
Toll Free: 1-800-27-CLARE

Central Region
Clare Canada Ltd.
3425 Harvester Road, Suite 202
Burlington, Ontario L7N 3N1
Tel: 1-905-333-9066
Fax: 1-905-333-1824

Western Region
Clare
1852 West 11th Street, #348
Tracy, CA 95376
Tel: 1-209-832-4367
Fax: 1-209-832-4732
Toll Free: 1-800-27-CLARE

Canada
Clare Canada Ltd.
3425 Harvester Road, Suite 202
Burlington, Ontario L7N 3N1
Tel: 1-905-333-9066
Fax: 1-905-333-1824

EUROPE

European Headquarters
CP Clare nv
Bampslaan 17
B-3500 Hasselt (Belgium)
Tel: 32-11-300868
Fax: 32-11-300890

France
Clare France Sales
Lead Rep
99 route de Versailles
91160 Champlan
France
Tel: 33 1 69 79 93 50
Fax: 33 1 69 79 93 59

Germany
Clare Germany Sales
ActiveComp Electronic GmbH
Mitterstrasse 12
85077 Manching
Germany
Tel: 49 8459 3214 10
Fax: 49 8459 3214 29

Italy
C.L.A.R.E.s.a.s.
Via C. Colombo 10/A
I-20066 Melzo (Milano)
Tel: 39-02-95737160
Fax: 39-02-95738829

Sweden
Clare Sales
Comptronic AB
Box 167
S-16329 Spånga
Tel: 46-862-10370
Fax: 46-862-10371

United Kingdom
Clare UK Sales
Marco Polo House
Cook Way
Bindon Road
Taunton
UK-Somerset TA2 6BG
Tel: 44-1-823 352541
Fax: 44-1-823 352797

ASIA/PACIFIC

Asian Headquarters
Clare
Room N1016, Chia-Hsin, Bldg II,
10F, No. 96, Sec. 2
Chung Shan North Road
Taipei, Taiwan R.O.C.
Tel: 886-2-2523-6368
Fax: 886-2-2523-6369

http://www.clare.com

Specification: DS-M976-2C2-R3

7/17/01

M-986-2A1
MF Transceiver

Features

- Direct A-Law or µ-Law PCM digital input
- 2.048 Mb/s clocking
- Operates with standard codecs for analog interfacing
- Microprocessor read/write interface
- Binary or 2-of-6 data formats
- Dual-channel
- 5 volt power

Applications

- Test equipment
- Trunk adapters
- Paging terminals
- Traffic recorders
- PBXs

Description

The M-986-2A1 dual channel MF Transceiver contains all the logic necessary to transmit and receive (North American) CCITT Region 1 multifrequency signals on one integrated circuit (IC).

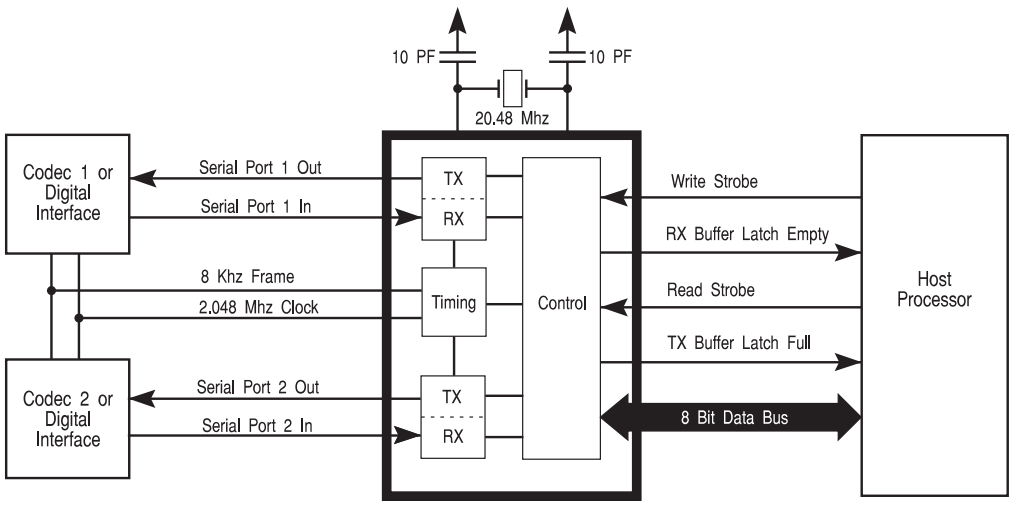
Operating with a 20.48 MHz crystal, the M-986 is capable of providing a direct digital interface to a m-law or A-law encoded PCM digital input. Each channel can be connected to an analog source using a coder-decoder (codec) as shown in the Block Diagram below.

The M-986 is configured and controlled through an integral coprocessor port.

Ordering Information

Part #	Description
M-986-2A1P	40-pin plastic DIP
M-986-2A1PL	44-pin PLCC

Block Diagram



M-986-2A1

Absolute Maximum Ratings Over Specified Temperature Range

Supply voltage range, V_{CC}	-0.3 V to 7 V
Input voltage range	-0.3 V to 15 V
Output voltage range	-0.3 V to 15 V
Ambient air temperature range	0˚ to 150˚C
Storage temperature range	-45˚C to 150˚C

Absolute Maximum Ratings are stress ratings. Stresses in excess of these ratings can cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this data sheet is not implied. Exposure of the device to the absolute maximum ratings for an extended period may degrade the device and effect its reliability.

Function Description

The M-986-2A1 can be set up for various modes of operation by writing two configuration bytes to the coprocessor port. The format of the two configuration bytes is shown in the Configuration Table on page 3 and the configuration options are described in the following paragraphs.

Configuration Options

External/Internal Codec Clock (ECLK): If external codec clocking is selected, an external clocking source provides an 8 kHz transmit framing clock and an 8 kHz receive framing clock. It also provides a serial bit clock with a frequency that is a multiple of 8 kHz between 216 kHz and 2.496 MHz for exchange of data via the serial ports. When internal codec clocking is selected, the M-986-2A1 provides an 8 kHz framing clock and a 2.048 MHz serial bit clock.

2 of 6/Binary Input/Output (IOM): When the 2-of-6 input/output is selected, the M-986-2A1 encodes the received R1 MF tone pair into a 6-bit format, where each bit represents one of the six possible frequencies. A logic high level indicates the presence of a frequency. The digital input to the M-986-2A1 that selects the transmitted R1 MF tone pair must also be coded in the 2-of-6 format.

When binary input/output is selected, the M-986-2A1 encodes the received R1 MF tone pair into a 4 bit binary format. The digital input to the M-986-2A1 that selects the transmitted R1 MF tone pair must also be coded in a 4 bit binary format.

Enable/Disable Channel (ENC): When a channel is disabled, the receiver does not process its codec input for R1 MF tones, and the transmitter does not respond to transmit commands. If a transmit command is given while the channel is enabled, the “tone off” command must be given before the channel is disabled. Disabling the channel does not automatically shut off the transmitter. When a channel is enabled, the receiver and transmitter for that channel function normally.

Long/Short KP Tone Detection Time (KPL): When long KP tone detection is selected, the minimum on time for the KP tone to be detected is 55 milliseconds. When short KP tone detection is selected, the minimum on time for the KP tone to be detected is 30 milliseconds (the same as the minimum on time for the rest of the MF tones).

Enable MF Tone Detection After Reception of KP (KPEN): When this feature is enabled, MF tone detection is enabled after reception of the KP tone, and disabled after reception of ST, ST1, ST2, or ST3 tones. When this feature is disabled, MF tone detection is always enabled. Select A or µ-law input/output (AMU) for A-law encoding, this bit is set to a 1, for µ-law encoding it is set to 0.

Electrical Characteristics/Temperature Range

Parameter			Test ConditionsMin		Typ	Max	Unit	
I_{CC}	Supply current	f = 20.5 MHz,	V_{CC} = 5.5V, T_A = 0˚ to 70 ˚C		-	50	75	mA
V_{OH}	High-level output voltage		I_{OH} = MAX		2.4	3	-	V
			I_{OH} = 20 µ A		V_{CC} -0.4	-	-	V
V_{OL}	Low-level output voltage		I_{OL} = MAX		-	0.3	0.6	V
I_{OZ}	Off-state output current		V_{CC} = MAX	VO = 2.4 V	-	-	20	µA
				VO = 0.4 V	-	-	-20	µA
I_I	Input current		V_I = V_{SS} to V_{CC}	Except CLKIN	-	-	±20	µA
				CLKIN	-	-	±50	µA
C_I	Input capacitance	Data bus	f = 1 MHz, all other pins 0 V		-	25	-	pF
		All others			-	15	-	pF
C_O	Output capacitance	Data bus			-	25	-	pF
		All others			-	10	-	pF

Configuration

Configuration Byte 1							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
0	0	ECLK	IOM	ENCI	KPL1	KPEN1	0

ECLK	Channels 1 & 2	1 = External codec clock; 0 = Internal codec clock
IOM	Channels 1 & 2	1 = Binary input/output; 0 = 2-of-6 input/output
ENC1	Channel 1	1 = Enable channel; 0 = Disable channel
KPL1	Channel 1	1 = 55 ms detection time for KP; 0 = 30 ms detection time for KP
KPEN1	Channel 1	1 = Enable MF tone detection after KP detection; 0 = MF tone detection always on

Configuration Byte 2							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
0	1	0	AMU	ENC2	KPL2	KPEN2	0

AMU	Channels 1 & 2	1 = A-law Encoding, 0 = m-law Encoding
ENC2	Channel 2	1 = Enable channel; 0 = Disable channel
KPL2	Channel 2	1 = 55 ms detection time for KP; 0 = 30 ms detection time for KP
KPEN2	Channel 2	1 = Enable MF tone detection after KP detection; 0 = MF tone detection always

Initial Configuration: The configuration of the M-986-2A1 immediately after a reset will be as follows:

- channel disabled
- 2-of-6 input/output
- external serial and serial frame clocks.

Also, the M-986-2A1 will place a 00 hex on the coprocessor port to indicate to the host processor that it is working.

Transmit Tone Command

The transmit tone command allows the host processor to transmit any two of the 6 R1 MF frequencies. The format of the command depends on whether the M-986 is configured for binary format or 2-of-6 format.

Recieved Tone Detection

When a tone is detected by the M-986, the TBLF output goes low, indicating reception of the tone to the host processor. The host processor can determine which tone was detected and which channel the tone was detected on by reading data from the M-986 coprocessor port. The M-986 will return a single byte indicating the tone received and the channel that the tone was received on. The format of the returned byte depends on whether the M-986 is configured for binary or 2-of-6 coding.

Coprocessor Port

Commands are written to the M-986 via the coprocessor port, and data indicating the received R1 MF tone is read from the coprocessor port.

Writing to the Coprocessor Port: The following sequence describes writing a command to the M-986.

(1) The WR signal is driven low by the host processor.

(2) The RBLE (receive buffer latch empty) signal transitions to a logic high level.

(3) Data is written from D7-D0 to the receive buffer latch (D7-D0) when the WR signal goes high.

(4) The RBLE signal transitions to a logic low level after the M-986 reads the data. This signals the host processor that the receive buffer is empty.

Note: The RBLE should be low before writing to the coprocessor.

Reading the Coprocessor Port: The following sequence describes reading received tone information from the coprocessor port.

(1) The TBLF (transmit buffer latch full) port pin on the M-986 goes low indicating the reception of a tone.

(2) The host processor detects the low logic level on the TBLF pin either by polling a connected port pin or by an interrupt.

(3) The host processor drives the RD signal low.

(4) The TBLF (transmit buffer latch full) signal transition to a logic high level.

(5) Data is driven onto D7-D0 by the M-986 until the RD signal is driven high by the host processor.

Clock Characteristics and Timing

Internal Clock Option: The internal oscillator is enabled by connecting a crystal across X1 and X2/CLKIN. The frequency of CLKOUT is one-fourth the crystal fundamental frequency. The crystal should be 20.48 MHz, fundamental mode, and parallel resonant, with an effective series resistance of 30 ohms, a power dissipation of 1 mW, and be specified at a load capacitance of 20 pF.

External Clock Option: An external frequency source can be used by injecting the frequency directly in X2/CLKIN with X1 left unconnected. The external frequency injected must conform to the specifications listed in External Frequency Specifications table on page 6.

Flammability/Reliability Specifications

Reliability: 185 FITS failures/billion hours

Flammability: Passes UL 94 V-0 tests

2 of 6 Coding Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Transmit tone command	1	CHN	F6	F5	F4	F3F2	F1	
Receive tone return	0	CHN	F6	F5	F4	F3F2	F1	

CHN: 1 = channel 2; 0 = channel 1

R1 MF Frequencies:

Bit name	Frequency (Hz)	Bit name	Frequency (Hz)
F6	1700	F3	1100
F5	1500	F2	900
F4	1300	F1	700

Binary Coding Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Transmit tone command	1	CHN	0	0	A	B	C	D
Receive tone return	0	CHN	0	0	A	B	C	D

CHN: 1 = channel 2; 0 = channel 1

R1 MF Frequencies:

ABCD	Frequencies (Hz)	Name	ABCD	Frequencies (Hz)	Name
0 0 0 0	Tone off	-	1 0 0 0	900 & 1500	Digit 8
0 0 0 1	700 & 900	Digit 1	1 0 0 1	1100 & 1500	Digit 9
0 0 1 0	700 & 1100	Digit 2	1 0 1 0	1300 & 1500	Digit 0
0 0 1 1	900 & 1100	Digit 3	1 0 1 1	700 & 1700	ST3
0 1 0 0	700 & 1300	Digit 4	1 1 0 0	900 & 1700	ST1
0 1 0 1	900 & 1300	Digit 5	1 1 0 1	1100 & 1700	KP
0 1 1 0	1100 & 1300	Digit 6	1 1 1 0	1300 & 1700	ST2
0 1 1 1	700 & 1500	Digit 7	1 1 1 1	1500 & 1700	ST

Signal Description

Signal	Pin	I/O/Z	Description
D15-D8	18-11	I/O/Z	Unused. Leave open.
D7-D0	19-26	I/O/Z	8-bit coprocessor latch.
$\overline{TBLF}$	40	O	Transmit buffer latch full flag.
$\overline{RBLE}$	1	O	Receive buffer latch empty flag.
HI/$\overline{LO}$	2	I	Latch byte select pin. Tie low.
$\overline{BIO}$	9	I	Unused. Leave open.
$\overline{RD}$	32	I/O	Used by the external processor to read from the coprocessor latch by driving the RD line active (low), thus enabling the output latch to drive the latched data. When the data has been read, the external device must bring the RD line high.
$\overline{EXINT}$	5	I	Unused. Leave open.
MC	3	I	Microcomputer mode select pin. Tie low.
MC/$\overline{PM}$	27	I	Coprocessor mode select pin. Tie low.
$\overline{RS}$	4	I	Reset input for initializing the device. When an active low is placed on RS pin for a minimum of five clock cycles, RD and WR are forced high, and the data bus (LD7 through LD0) goes to a high impedance state. The serial port clock and transmit outputs also go to the high impedance state.
$\overline{WR}$	31	I/O	Used by the external processor to write data to the coprocessor port. To write data the external processor drives the WR line low, places data on the data bus, and then drives the WR line high to clock the data into the on-chip latch.
XF	28	O	Watchdog signal. Toggles at least once every 10 milliseconds when the processor is functioning properly. If the pin is not toggled at least once every 10 ms, the processor is lost and should be reset.
CLKOUT	6	O	System clock output (one-fourth crystal/CLKIN frequency, nominally 5.12 MHz).
V_{SS}	10	I	Ground pin.
V_{CC}	30	I	5V supply pin.
X1	7	O	Crystal output pin for internal oscillator. If the internal oscillator is not used, this pin should be left unconnected.
X2/CLKIN	8	I	Input pin to the internal oscillator (X2) from the crystal. Alternatively, an input pin for the external oscillator (CLKIN).
DR1 & DR0	33 & 29	I	Serial-port receive-channel inputs. 2.048 MHz serial data is received in the receive registers via these pins. DR0 = channel 1; DR1 = channel 2.
FR	37	O	8 kHz internal serial-port framing output. If internal clocking is selected, serial-port transmit and receive operations occur simultaneously on an active (high) FR framing pulse.
DX1 & DX0	36 & 35	O	Serial-port transmit-channel outputs. 2.048 MHz serial data is transmitted from the transmit registers on these pins. These outputs are in the high-impedance state when not transmitting. DX0 = channel 1; DX1 = channel 2.
$\overline{FSR}$	39	I	8 kHz external serial-port receive-framing input. If external clocking is selected, data is received via the receive pins (DR1 and DR0) on the active (low) FSR input. The falling edge of FSR initiates the receive process, and the rising edge causes the M-986 to process the data.
SCLK	34	I/O/Z	2.048 MHz serial-port clock. Master clock for transmitting and receiving serial-port data. Configured as an input in external clocking mode or output in internal clocking mode. Reset (RS) forces SCLK to the high-impedance state.
$\overline{FSX}$	38	I	8 kHz external serial-port transmit-framing input. If external clocking is enabled, data is transmitted on the transmit pins (DX1, DX0) on the active (low) input. The falling edge of FSX initiates the transmit process, and the rising edge causes the M-986 to internally load data for the next cycle.

Serial Port Timing

Parameter		Min	Nom	Max	Unit
t_d (CH-FR)	Internal framing delay from SCLK rising edge	-	-	70	ns
t_d (DX1-CL)	DX bit 1 valid before SCLK falling edge	20	-	-	ns
t_d (DX2-CL)	DX bit 2 valid before SCLK falling edge	20	-	-	ns
t_h (DX)	DX hold time after SCLK falling edge	244	-	-	ns
t_{su} (DR)	DR setup time before SCLK falling edge	20	-	-	ns
t_h (DR)	DR hold time after SCLK falling edge	20	-	-	ns
t_c (SCLK)	Serial port clock cycle time	399	488.28	4770	ns
t_f (SCLK)	Serial port clock fall time	-	-	30	ns
t_r (SCLK)	Serial port clock rise time	-	-	30	ns
t_w (SCLKL)	Serial port clock low-pulse duration*	220	244.14	2500	ns
t_w (SCLKH)	Serial port clock high-pulse duration*	220	244.14	2500	ns
t_{su} (FS)	$\overline{FSX}$/$\overline{FSR}$ setup time before SCLK falling edge	100	-	-	ns

* The duty cycle of the serial port clock must be within 45% to 55%.

External Frequency Specifications

Parameter		Min	Nom	Max	Unit
t_C(MC)	Master clock cycle time	48.818	48.828	48.838	ns
t_r(MC)	Rise time master clock input	-	5	10	ns
t_f(MC)	Pulse duration master clock	20	-	-	ns

Recommended Operating Conditions

Parameter			Min	Nom	Max	Unit
V_{CC}	Supply voltage		4.75	5	5.25	V
V_{SS}	Supply voltage		-	0	-	V
V_{IH}	High-level input voltage	All inputs except CLKIN	2	-	-	V
		CLKIN	3	-	-	V
		MC/PM	2.2	-	-	V
V_{IL}	Low-level input voltage	All inputs except MC/$\overline{MP}$	-	-	0.8	V
		MC/$\overline{MP}$	-	-	0.6	V
I_{OH}	High-level output current (all outputs)		-	-	-300	µA
I_{OL}	Low-level output current (all outputs)		-	-	2	mA
T_A	Operating free-air temperature		0	-	70	˚C

Coprocessor Interface Timing

Parameter		Min	Nom	Max	Unit
t_d(R-A)	RD low to $\overline{TBLF}$ high	-	-	75	ns
t_d(W-A)	$\overline{WR}$ low to $\overline{RBLE}$ high	-	-	75	ns
t_a(RD)	RD low to data valid	-	-	80	ns
t_h(RD)	Data hold time after $\overline{RD}$ high	25	-	-	ns
t_{su}(WR)	Data setup time prior to $\overline{WR}$ high	30	-	-	ns
t_h(WR)	Data hold time after $\overline{WR}$ high	25	-	-	ns
t_w(RDL)	$\overline{RD}$ low-pulse duration	80	-	-	ns
t_w(WRL)	$\overline{WR}$ low-pulse duration	60	-	-	ns
t_{wr}(RBLE)	$\overline{RBLE}\uparrow$ to $\overline{RBLE}\downarrow$	-	-	1	ms

Reset (RS) Timing

Parameter		Test Conditions	Min	Max	Unit
t_{dis}(R)	Data bus disable time after $\overline{RS}$	R_L = 825 Ω	-	75	ns
t_{d12}	Delay time from $\overline{RS}\downarrow$ to high-impedance SCLK	C_L = 100 pF	-	200	ns
t_{d13}	Delay time from $\overline{RS}\downarrow$ to high-impedance DX1, DX0		-	200	ns
t_{su}(R)	Reset ($\overline{RS}$) setup time prior to CLKOUT		50	-	ns
tw(R)	RS pulse duration		245	-	ns

CLKOUT Timing Parameters

Parameter		Test Conditions	Min	Nom	Max	Unit
$t_{c(C)}$	CLKOUT cycle time		195.27	195.31	195.35	ns
$t_{r(C)}$	CLKOUT rise time	R_L = 825 Ω	-	10	-	ns
$t_{f(C)}$	CLKOUT fall time	C_L = 100 pF	-	8	-	ns
$t_{d(MCC)}$	Delay time CLKIN$\uparrow$ to CLKOUT$\downarrow$		25	-	60	ns
$t_{d\ 8}$	Delay time CLKOUT $\downarrow$ to data bus OUT valid		-	-	1/4$t_{c(C)}$+75	ns

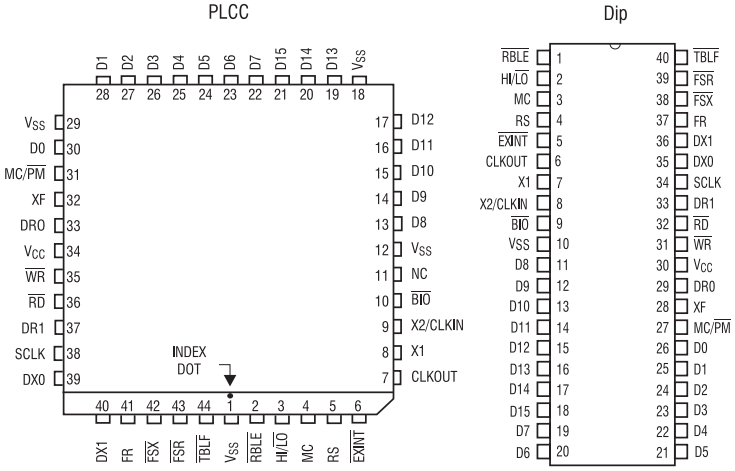
Transmitter Characteristics

Parameter		Test Conditions	Min	Typ	Max	Unit
F_{OS}	Frequency offset	From nominal	-	-	±1	Hz
TW	Twist	High/low	-	-	±0.5	dB
A_S	Signal amplitude	Per component	-7.40	-7.00	-6.60	dBm0
T_S	Time skew	Between components	-	-	0	ms
P_{hi}	Power due to extraneous components	-	-	-	-30	dB

Reciever Characteristics

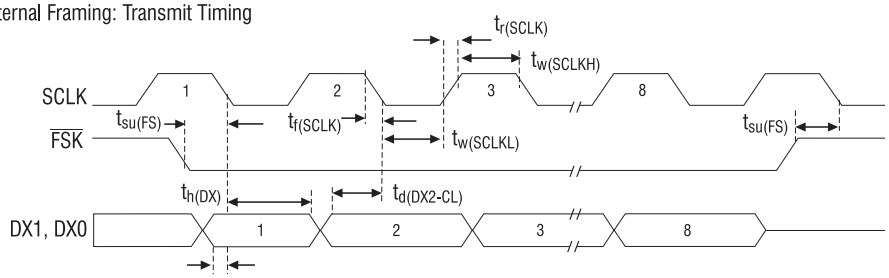
	Parameter	Test Conditions	Min	Max	Unit
A_d	Detect amplitude	Per frequency	-30	-5	dBm0
A_{nd}	No-detect amplitude	Per frequency	-40	-30	dBm0
F_d	Detect with frequency offset	From nominal	±1.5% +5Hz	-	Hz
TW_d	Detect with twist	High tone/low tone	±6	-	dB
T_{on}	Tone time	Reject	10	-	ms
T_{int}	Interrupted tone time	Reject	10	-	ms
T_i	Tone interpulse time	-	25	-	ms
KPL_d	KP long tone detect timeLong detect time	enabled	55	-	ms
KP_d	KP short tone detect timeLong detect time	disabled	30	-	ms
T_d	Tone detect time	-	30	-	ms
N_t	Noise tolerance	≤1 error in 25,000 digits	-	-20	dB
N_i	Impulse noise	≤1 error in 25,000 digits	-	-12	dB
P_{60}	60 Hz tolerance	≤1 error in 25,000 digits	-	81	dBrnc0
T_{180}	180 Hz tolerance	≤1 error in 25,000 digits	-	68	dBrnc0
M_t	Modulation products tolerance	2A-B and 2B-A products	-	-28	dB

Pin Assignments



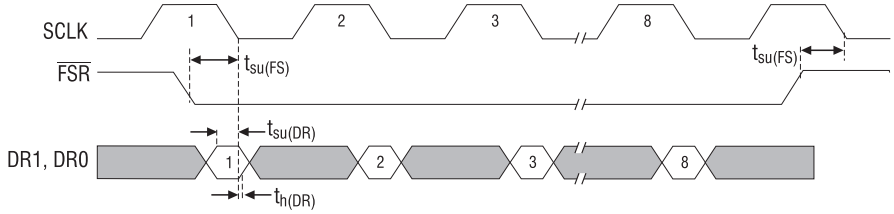
External Framing Timing Diagrams

External Framing: Transmit Timing



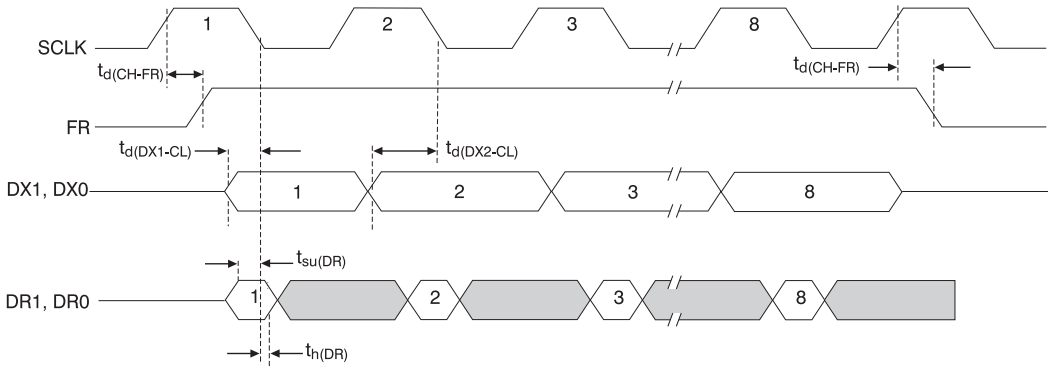
NOTES: Data valid on transmit outputs until SCLK rises.
The most significant bit is shifted first.

External Framing: Receive Timing



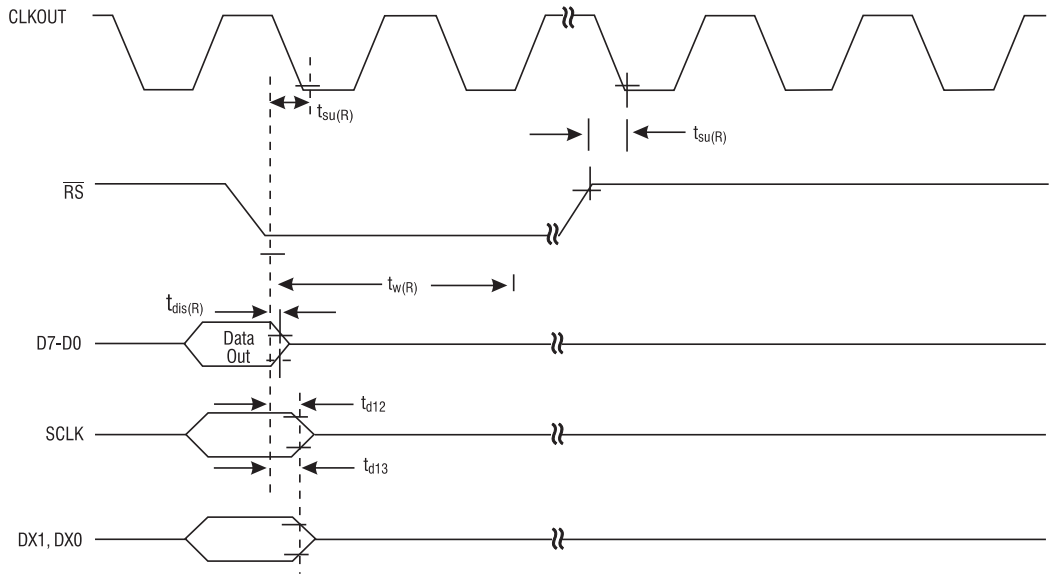
Internal Framing Timing

Internal Framing



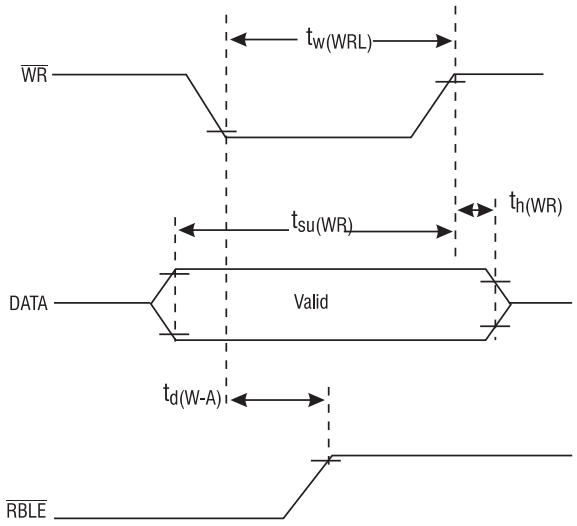
Note: The most significant bit is shifted first.

Reset Timing

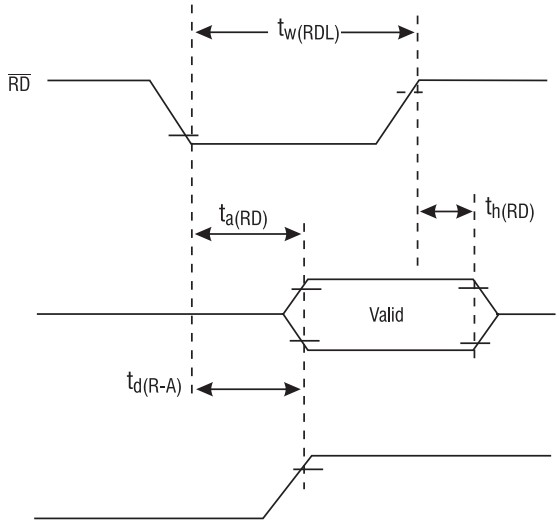


Coprocessor Timing

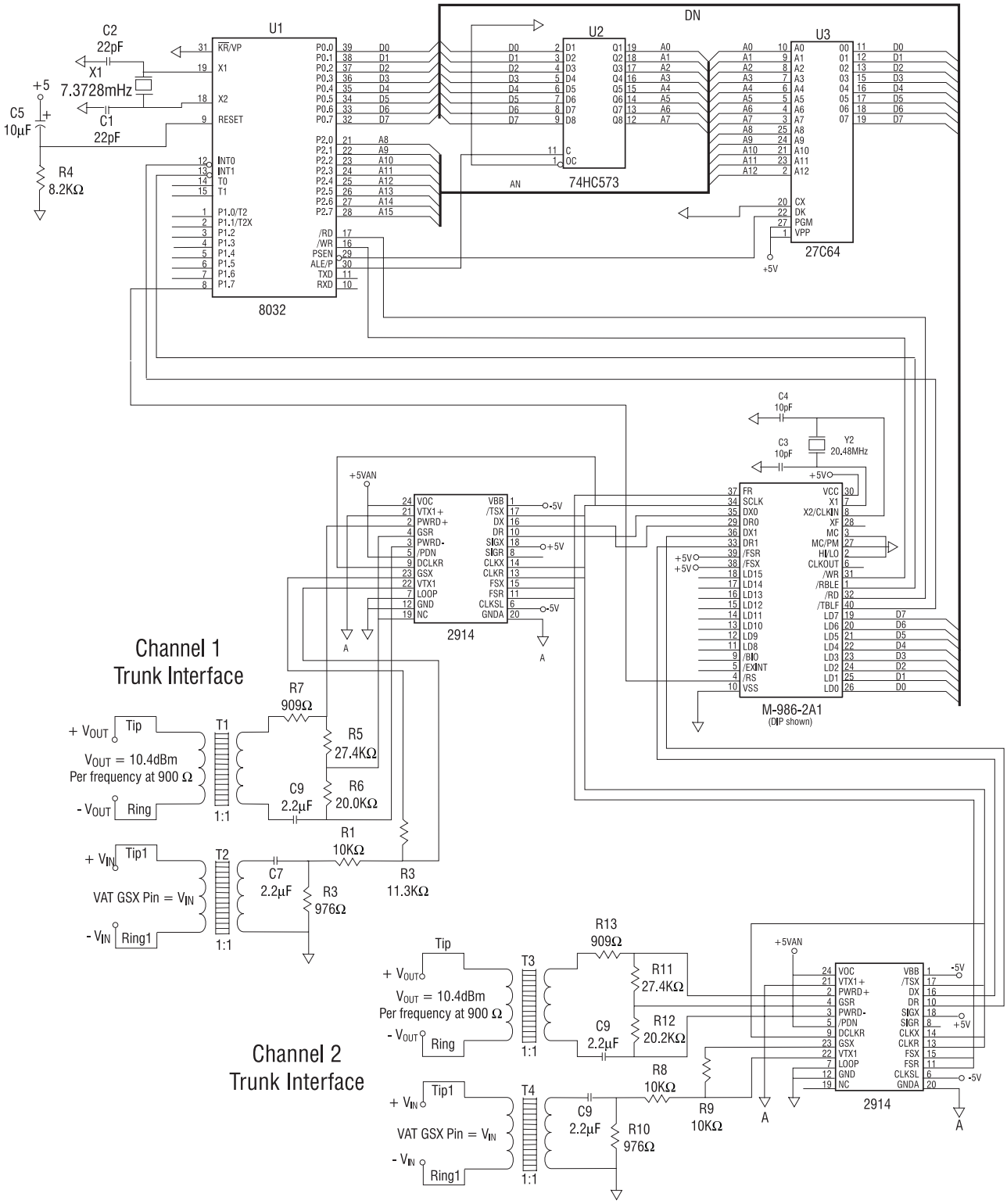
External Write to Coprocessor Port



External Read from Coprocessor Port

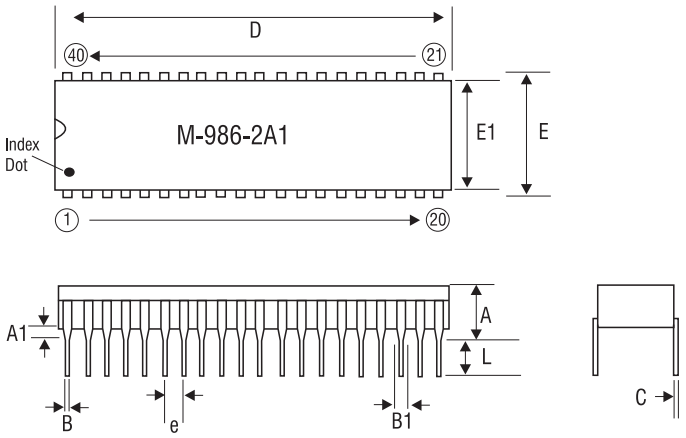


M-986 Dual Channel 4-Wire Interface Application Circuit



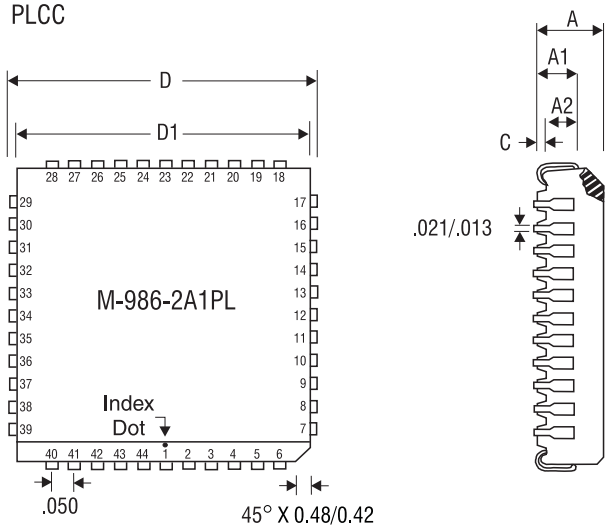
Mechanical Dimensions

DIP



	Tolerances			
	(inches)		Metric (mm)	
	Min	Max	Min	Max
A	-	.250	-	6.35
A1	.015	-	.39	
B	.014	.022	.36	.56
B1	.030	.070	.77	1.78
C	.008	.015	.20	.38
D	1.98	2.095	50.30	53.20
E	.600	.625	15.24	15.87
E1	.485	.580	12.32	14.73
e	.100 BSC		2.54 BSC	
L	.115	.200	2.93	5.08

PLCC



	Tolerances			
	(inches)		Metric (mm)	
	Min	Max	Min	Max
A	.165	.180	4.19	4.57
A1	.090	.20	2.29	5.08
A2	.062	.083	1.58	2.11
C	.020 min		.51 min	
D	.685	.695	17.40	17.65
D1	.650	.653	16.51	16.66

Drawing not to scale.
Drawing does not reflect actual part marking.

CLARE

Worldwide Sales Offices

CLARE LOCATIONS

Clare Headquarters
78 Cherry Hill Drive
Beverly, MA 01915
Tel: 1-978-524-6700
Fax: 1-978-524-4900
Toll Free: 1-800-27-CLARE

Clare Switch Division
4315 N. Earth City Expressway
Earth City, MO 63045
Tel: 1-314-770-1832
Fax: 1-314-770-1812

Clare Micronix Division
145 Columbia
Aliso Viejo, CA 92656-1490
Tel: 1-949-831-4622
Fax: 1-949-831-4628

SALES OFFICES

AMERICAS

Americas Headquarters
Clare
78 Cherry Hill Drive
Beverly, MA 01915
Tel: 1-978-524-6700
Fax: 1-978-524-4900
Toll Free: 1-800-27-CLARE

Eastern Region
Clare
603 Apache Court
Mahwah, NJ 07430
Tel: 1-201-236-0101
Fax: 1-201-236-8685
Toll Free: 1-800-27-CLARE

Central Region
Clare Canada Ltd.
3425 Harvester Road, Suite 202
Burlington, Ontario L7N 3N1
Tel: 1-905-333-9066
Fax: 1-905-333-1824

Western Region
Clare
1852 West 11th Street, #348
Tracy, CA 95376
Tel: 1-209-832-4367
Fax: 1-209-832-4732
Toll Free: 1-800-27-CLARE

Canada
Clare Canada Ltd.
3425 Harvester Road, Suite 202
Burlington, Ontario L7N 3N1
Tel: 1-905-333-9066
Fax: 1-905-333-1824

EUROPE

European Headquarters
CP Clare nv
Bampslaan 17
B-3500 Hasselt (Belgium)
Tel: 32-11-300868
Fax: 32-11-300890

France
Clare France Sales
Lead Rep
99 route de Versailles
91160 Champlan
France
Tel: 33 1 69 79 93 50
Fax: 33 1 69 79 93 59

Germany
Clare Germany Sales
ActiveComp Electronic GmbH
Mitterstrasse 12
85077 Manching
Germany
Tel: 49 8459 3214 10
Fax: 49 8459 3214 29

Italy
C.L.A.R.E.s.a.s.
Via C. Colombo 10/A
I-20066 Melzo (Milano)
Tel: 39-02-95737160
Fax: 39-02-95738829

Sweden
Clare Sales
Comptronic AB
Box 167
S-16329 Spånga
Tel: 46-862-10370
Fax: 46-862-10371

United Kingdom
Clare UK Sales
Marco Polo House
Cook Way
Bindon Road
Taunton
UK-Somerset TA2 6BG
Tel: 44-1-823 352541
Fax: 44-1-823 352797

ASIA/PACIFIC

Asian Headquarters
Clare
Room N1016, Chia-Hsin, Bldg II,
10F, No. 96, Sec. 2
Chung Shan North Road
Taipei, Taiwan R.O.C.
Tel: 886-2-2523-6368
Fax: 886-2-2523-6369

http://www.clare.com

Specification: DS-M986-2A1-R3

7/26/01

M-986-2R2
MFC Transceivers

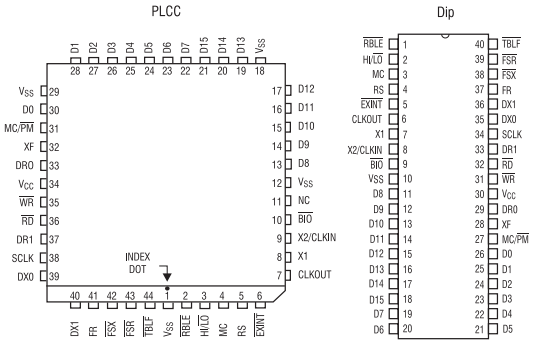
Features

- Direct A-Law PCM digital input
- 2.048 Mb/s clocking
- Programmable forward/backward mode
- Programmable compelled/direct control
- Operates with standard codecs for analog interfacing
- Microprocessor read/write interface
- Binary or 2-of-6 data formats
- Single- or dual-channel versions
- 5 volt power

Applications

- Test equipment
- Trunk adapters
- Paging terminals
- Traffic recorders
- PBXs

Pin Assignments



Description

The M-986-1R2 and -2R2 MFC Transceivers contain all the logic necessary to transmit and receive CCITT R2F (forward) and R2B (backward) multifrequency signals on one 40-pin integrated circuit (IC). M-986-1R2 is a single-channel version; M-986-2R2 provides two channels. R1 single and dual multifrequency transceivers are also available as M-986-1R1 and -2R1.

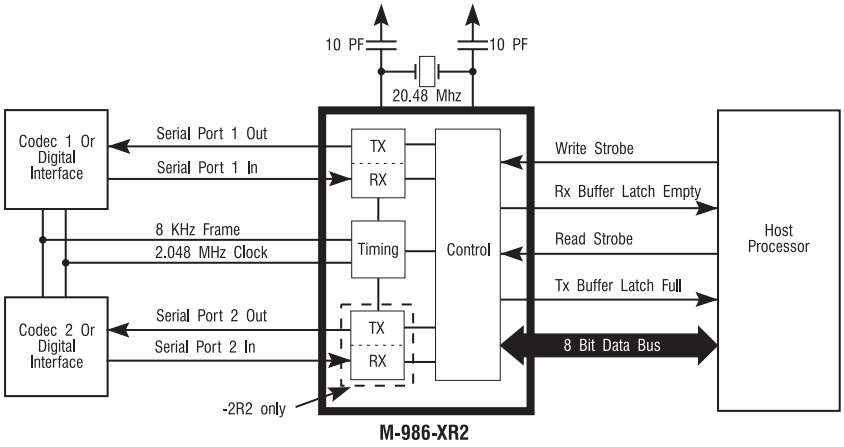
Operating with a 20.48 MHz crystal, the M-986 is capable of providing a direct digital interface to an A-law-encoded PCM digital input. Each channel can be connected to an analog source using a coder-decoder (codec) as shown in the Block Diagram below.

The M-986 can be configured by the customer to operate with the transmitter and receiver either coupled together or independently, allowing it to handle a compelled cycle automatically or via command from the host processor. For the R2 versions of the M-986, A-law is used for coding/decoding. The M-986 is configured and controlled through an integral coprocessor port.

Ordering Information

Part #	Description
M-986-1R2P	40-pin plastic DIP, Single Channel
M-986-1R2PL	44-pin PLCC, Single Channel
M-986-2R2P	40-pin plastic DIP, Dual Channel
M-986-2R2PL	44-pin PLCC, Dual Channel

Block Diagram



Function Description

The M-986 can be set up for various operating modes by writing two configuration bytes to the coprocessor port.

Configuration Options

External/Internal Codec Clock (ECLK): If external codec clocking is selected, an external clocking source provides an 8kHz transmit framing clock and an 8kHz receive framing clock. It also provides a serial bit clock with a frequency that is a multiple of 8 kHz between 2.496 MHz and 216 kHz for exchange of data via the serial ports. When internal codec clocking is selected, the M-986 provides an 8kHz framing clock and a 2.048 MHz serial bit clock.

Binary/2 of 6 Input/Output (IOM): When the 2-of-6 input/output is selected, the M-986 encodes the received R2 MF tone pair into in a 6-bit format, where each bit represents one of the six possible frequencies. A logic high level indicates the presence of a frequency. The digital input to the M-986 that selects the transmitted R2 MF tone pair must also be coded in the 2-of-6 format.

When binary input/output is selected, the M-986 encodes the received R2 MF tone pair into a 4 bit binary format. The digital input to the M-986 that selects the transmitted R2 MF tone pair must also be coded in a 4 bit binary format.

Enable/Disable Channel (ENC): When a channel is disabled, the receiver does not process its codec input for R2 MF tones, and the transmitter does not respond to transmit commands. If a transmit command is given while the channel is enabled, the “tone off” command must be given before the channel is disabled. Disabling the channel does not automatically shut off the transmitter. When a channel is enabled, the receiver and transmitter for that channel function normally.

End-of-Digit Indication (EOD): The end-of-digit indication option configures the M-986 to inform the host processor when the far end terminates transmission of the R2 MF tone it is sending. If this option is disabled, the host processor will not be notified when tone transmission terminates.

Automatic Compelled/Manual Sequence Signaling (CMP): When manual mode is selected, R2 MF tone transmission is turned on and off only via command from the host processor.

If the automatic mode is selected, the transmitter and receiver perform the compelled signaling handshake automatically. The specifics of operation are different for the forward and backward configurations.

In forward mode, the transceiver can exist in two states, STATE 1 and STATE 2:

- STATE 1: No backward signal detected. Transmitter under control of the host.
- STATE 2: Backward signal detected. Transmitter off unconditionally.

Configuration Bytes

Configuration Byte 1							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
0	0	ECLK	IOM	ENC1	EOD1	CMP1	FB1

ECLK	Channels 1 & 2	1 = External codec clock; 0 = Internal codec clock
IOM	Channels 1 & 2	1 = Binary input/output; 0 = 2-of-6 input/output
ENC1	Channel 1	1 = Enable channel; 0 = Disable channel
EOD1	Channel 1	1 = Indicate end of digit; 0 = No end of digit indication
CMP1	Channel 1	1 = Automatic Compelled mode; 0 = Manual mode
FB1	Channel 1	1 = Forward mode (Tx forward frequencies and Rx backward frequencies)
		0 = Backward mode (Tx backward frequencies and Rx forward frequencies)

Configuration Byte 2							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
0	1	0	0	ENC2	EOD2	CMP2	FB2

ENC2	Channel 2	1 = Enable channel; 0 = Disable channel
EOD2	Channel 2	1 = Indicate end of digit; 0 = No end of digit indication
CMP2	Channel 2	1 = Automatic Compelled mode; 0 = Manual mode
FB2	Channel 2	1 = Forward mode (Tx forward frequencies and Rx backward frequencies)
		0 = Backward mode(Tx backward frequencies and Rx forward frequencies)

A Transmit Tone Command written while the transceiver is in STATE 1 will be acted upon immediately. The transmitter is unconditionally disabled upon entry into STATE 2. If a transmit command is written to the transceiver while in STATE 2, that command will become pending. Upon entry into STATE 1, a pending transmit command is acted upon.

In backward mode, the transceiver can exist in two states, STATE 1 and STATE 2:

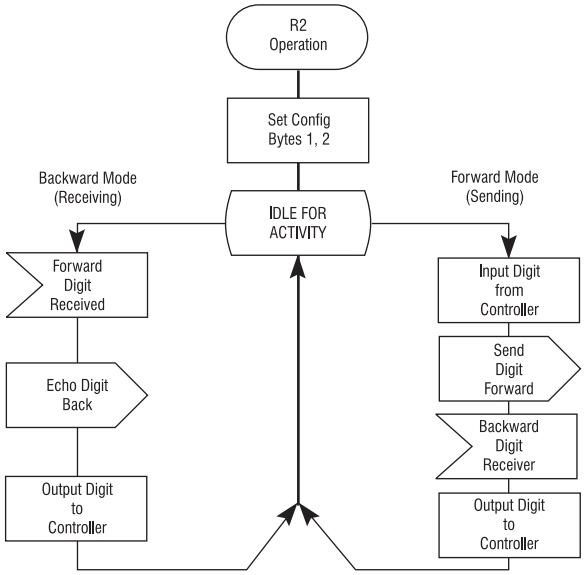
STATE 1: No forward signal detected.
Transmitter off unconditionally.

STATE 2: Forward signal detected.
Transmitter transmits backward signal.

A transmit tone command written while the transceiver is in STATE 2 will be acted upon immediately. The transmitter is unconditionally disabled upon entry into STATE 1. If a transmit command is written to the transceiver while in STATE 1, that command will become pending. Upon entry into STATE 2, a pending transmit command is acted upon.

EXAMPLE: Assume that the transceivers at both ends of a link are configured in automatic compelled mode. Both transceivers are in STATE 1. A compelled signaling sequence begins with the R2F host writing a transmit command byte to its transceiver via the coprocessor bus. The transceiver immediately begins transmitting the signal.

Automatic Compelled Mode Operation



2 of 6 Coding Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Transmit tone command	1	CHN	F6	F5	F4	F3	F2	F1
Receive tone return	0	CHN	F6	F5	F4	F3	F2	F1

CHN: 1 = channel 2; 0 = channel 1

R2 MF Frequencies:

Bit name	Forward (Hz)	Backward (Hz)	Bit name	Forward (Hz)	Backward (Hz)
F6	1980	540	F3	1620	900
F5	1860	660	F2	1500	1020
F4	1740	780	F1	1380	1140

Binary Coding Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Transmit tone command	1	CHN	0	0	A	B	C	D
Receive tone return	0	CHN	0	0	A	B	C	D

CHN: 1 = channel 2; 0 = channel 1

R2 MF Frequencies:

ABCD	Forward (Hz)	Backward (Hz)	ABCD	Forward (Hz)	Backward (Hz)
0 0 0 0	Tone off	Tone off	1 0 0 0	1500 & 1860	1020 & 660
0 0 0 1	1380 & 1500	1140 & 1020	1 0 0 1	1620 & 1860	900 & 660
0 0 1 0	1380 & 1620	1140 & 900	1 0 1 0	1740 & 1860	780 & 660
0 0 1 1	1500 & 1620	1020 & 900	1 0 1 1	1380 & 1980	1140 & 540
0 1 0 0	1380 & 1740	1140 & 780	1 1 0 0	1500 & 1980	1020 & 540
0 1 0 1	1500 & 1740	1020 & 780	1 1 0 1	1620 & 1980	900 & 540
0 1 1 0	1620 & 1740	900 & 780	1 1 1 0	1740 & 1980	780 & 540
0 1 1 1	1380 & 1860	1140 & 660	1 1 1 1	1860 & 1980	660 & 540

The R2B transceiver detects the signal, enters STATE 2, and outputs the received tone code to its host via the coprocessor port. If the R2B host had determined the next tone to transmit and written a transmit command to the transceiver prior to entry into STATE 2, the state transition will cause this tone to be transmitted. Otherwise, the R2B transmitter waits for a transmit tone command from the host, and starts transmitting a tone once the transmit tone command is received.

The R2F transceiver detects the backward signal, enters STATE 2, and outputs the received tone code to its host. Entry into STATE 2 unconditionally disables the transmitter.

The R2B transceiver detects the absence of signal, enters STATE 1, and informs the host with the end-of-tone code if configured to do so. Entry into STATE 1 unconditionally disables the transmitter.

The R2F transceiver detects the absence of signal, enters STATE 1, and informs the host with the end-of-tone code if configured to do so. If the R2F host had determined the next signal to transmit and written a transmit command to the transceiver prior to entry into STATE 1, the state transition will cause this signal to be transmitted. Otherwise, the transmitter remains silent until the next transmit command by its host.

Forward/Backward Frequencies (FB): When forward mode is selected, the R2F (forward) frequencies are transmitted and R2B (backward) frequencies are received. When backward mode is selected, R2B frequencies are transmitted and R2F frequencies are received. The R2F frequencies are 1380, 1500, 1620, 1740, 1860, and 1980 Hertz. The R2B frequencies are 540, 660, 780, 900, 1020, and 1140 Hz.

Initial Configuration: The configuration of the M-986 immediately after a reset will be as follows:

- End-of-digit indication ON
- Forward mode ON
- Channel disabled
- 2-of-6 input/output
- External serial and serial frame clocks.

Also, the M-986 will place 00 hex on the coprocessor port to indicate to the host processor that it is working.

Transmit Tone Command

The transmit tone command allows the host processor to transmit any two of the 6 possible frequencies in the transmission mode the channel has been configured for (forward or backward). The format of the command depends on whether the M-986 is configured for binary format or 2-of-6 format.

Recieved Tone Detection

When a tone is detected by the M-986, the $\overline{\text{TBLF}}$ output goes low, indicating reception of the tone to the host processor. The host processor can determine which tone was detected and which channel the tone was detected on by reading data from the M-986 coprocessor port. The M-986 will return a single byte indicating the tone received and the channel that the tone was received on.The format of the returned byte depends on whether the M-986 is configured for binary or 2-of-6 coding.

Coprocessor Port

Commands are written to the M-986 via the coprocessor port, and data indicating the received R2 MF tone is read from the coprocessor port.

Writing to the Coprocessor Port: The following sequence describes writing a command to the M-986.

(1) The $\overline{\text{WR}}$ signal is driven low by the host processor.

(2) The $\overline{\text{RBLE}}$ (receive buffer latch empty) signal transitions to a logic high level.

(3) Data is written from LD7-LD0 to the receive buffer latch (D7-D0) when the $\overline{\text{WR}}$ signal goes high.

(4) The $\overline{\text{RBLE}}$ signal transitions to a logic low level after the M-986 reads the data. This signals the host processor that the receive buffer is empty.

Note: The $\overline{\text{RBLE}}$ should be low before writing to the coprocessor.

Reading the Coprocessor Port: The following sequence describes reading received tone information from the coprocessor port.

(1) The $\overline{\text{TBLF}}$ (transmit buffer latch full) port pin on the M-986 goes low indicating the reception of a tone.

(2) The host processor detects the low logic level on the $\overline{\text{TBLF}}$ pin either by polling a connected port pin or by an interrupt.

(3) The host processor drives the $\overline{\text{RD}}$ signal low.

(4) The $\overline{\text{TBLF}}$ (transmit buffer latch full) signal transitions to a logic high level.

(5) Data is driven onto LD7-LD0 by the M-986 until the $\overline{\text{RD}}$ signal is driven high by the host processor.

Clock Characeristics and Timing

Internal Clock Option: The internal oscillator is enabled by connecting a crystal across X1 and X2/CLKIN. The crystal must be 20.48 MHz, fundamental mode, and parallel resonant, with an effective series resistance of 30 ohms, a power dissipation of 1 mW, and bespecified at a load capacitance of 20 pf.

External Clock Option: An external frequency source can be used by injecting the frequency directly in X2/CLKIN, with X1 left unconnected. The external frequency injected must conform to the specifications listed in the External Frequency specification Table on page 7.

Flammability/Reliability Specifications

Reliability: 185 FITS failures/billion hours
Flammability: Passes UL 94 V-0 tests

Signal Description

Signal	DIP Pinout	PLCC Pinout	I/O/Z	Description
Note: Please see the following definitions: DIP = Dual In-line Package PLCC = Plastic Leaded Chip Carrier				
D15-D8	18-11	13-17, 19-21	I/O/Z	Unused. Leave open.
D7-D0	19-26	22-28, 30	I/O/Z	8-bit coprocessor latch.
$\overline{TBLF}$	40	44	O	Transmit buffer latch full flag.
$\overline{RBLE}$	1	2	O	Receive buffer latch empty flag
HI/$\overline{LO}$	2	3	I	Latch byte select pin. Tie low.
$\overline{BIO}$	9	10	I	Unused. Leave open.
$\overline{RD}$	32	36	I/O	Used by the external processor to read from the coprocessor latch by driving the $\overline{RD}$ line active (low), thus enabling the output latch to drive the latched data. When the data has been read, the external device must bring the $\overline{RD}$ line high.
$\overline{EXINT}$	5	6	I	Unused. Leave open.
MC	3	4	I	Microcomputer mode select pin. Tie low.
MC/$\overline{PM}$	27	31	I	Coprocessor mode select pin. Tie low.
$\overline{RS}$	4	5	I	Reset input for initializing the device. When an active low is placed on $\overline{RS}$ pin for a minimum of five clock cycles, $\overline{RD}$ and $\overline{WR}$ are forced high, and the data bus (D7 through D0) goes to a high impedance state. The serial port clock and transmit outputs also go to the high impedance state.
$\overline{WR}$	31	35	I/O	Used by the external processor to write data to the coprocessor port. To write data the external processor drives the $\overline{WR}$ line low, places data on the data bus, and then drives the $\overline{WR}$ line high to clock the data into the on-chip latch.
XF	28	32	O	Watchdog signal. Toggles at least once every 15 milliseconds when the processor is functioning properly. If the pin is not toggled at least once every 15 ms, the processor is lost and should be reset.
CLKOUT	6	7	O	System clock output (one-fourth crystal/CLKIN frequency, nominally 5.12 MHz).
V_{CC}	30	34	I	5V supply pin.
V_{SS}	10	1, 12, 18, 29	I	Ground pin.
X1	7	8	O	Crystal output pin for internal oscillator. If an internal oscillator is not used, this pin should be left unconnected.
X2/CLKIN	8	9	I	Input pin to the internal oscillator (X2) from the crystal. Alternatively, an input pin for the external oscillator (CLKIN).
DR1 & DR0	33 & 29	37, 33	I	Serial-port receive-channel inputs. 2.048 MHz serial data is received in the receive registers via these pins. DR0 = channel 1; DR1 = channel 2
DX1 & DX0	36 & 35	40, 39	O	Serial-port transmit-channel outputs. 2.048 MHz serial data is transmitted from the transmit registers on these pins.These outputs are in the high-impedance state when not transmitting.

Signal Description (continued)

Signal	DIP Pinout	PLCC Pinout	I/O/Z	Description
FR	37	41	O	8 kHz internal serial-port framing output. If internal clocking is selected, serial-port transmit and receive operations occur simultaneously on an active (high) FR framing pulse.
$\overline{FSR}$	39	43	I	8 kHz external serial-port receive-framing input. If external clocking is selected, data is received via the receive pins (DR1 and DR0) on the active (low) FSR input. The falling edge of FSR initiates the receive process, and the rising edge causes the M-986 to process the data.
$\overline{FSX}$	38	42	I	8 kHz external serial-port transmit-framing input. If external clocking is enabled, data is transmitted on the transmit pins (DX1, DX0) on the active (low) input. The falling edge of FSX initiates the transmit process,and the rising edge causes the M-986 to internally load data for the next cycle.
SCLK	34	38	I/O/Z	2.048 MHz serial-port clock. Master clock for transmitting and receiving serial-port data. Configured as an input in external clocking mode or output in internal clocking mode. Reset ($\overline{RS}$) forces SCLK to the high-impedance state.

Absolute Maximum Ratings Over Specified Temperature

Supply voltage range, V_{CC}	-0.3 V to 7 V
Input voltage range	-0.3 V to 15 V
Output voltage range	-0.3 V to 15 V
Ambient air temperature range	0°C to 70°C
Storage temperature range	-45°C to 150°C

Absolute Maximum Ratings are stress ratings. Stresses in excess of these ratings can cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this data sheet is not implied. Exposure of the device to the absolute maximum ratings for an extended period may degrade the device and effect its reliability.

Serial Port Timing

Parameter		Min	Nom	Max	Units
t_d (CH-FR)	Internal framing delay from SCLK rising edge	-	-	70	ns
t_d (DX1-CL)	DX bit 1 valid before SCLK falling edge	20	-	-	ns
t_d (DX2-CL)	DX bit 2 valid before SCLK falling edge	20	-	-	ns
t_h (DX)	DX hold time after SCLK falling edge	244	-	-	ns
t_{su} (DR)	DR setup time before SCLK falling edge	20	-	-	ns
t_h (DR)	DR hold time after SCLK falling edge	20	-	-	ns
t_c (SCLK)	Serial port clock cycle time	399	488.28	4770	ns
t_f (SCLK)	Serial port clock fall time	-	-	30	ns
t_r (SCLK)	Serial port clock rise time	-	-	30	ns
t_w (SCLKL)	Serial port clock low-pulse duration*	220	244.14	2500	ns
t_w (SCLKH)	Serial port clock high-pulse duration*	220	244.14	2500	ns
t_{su} (FS)	FSX/FSR setup time before SCLK falling edge	100	-	-	ns

* The duty cycle of the serial port clock must be within 45% to 55%.

Electrical Characteristics/Temperature Range

Parameter			Test Conditions		Min	Typ	Max	Unit
I_{CC}	Supply current f = 20.5 MHz,		V_{CC} = 5.5V, - 50 T_A = 0˚ to 70 ˚C		75	mA		
V_{OH}	High-level output voltage		I_{OH} = MAX		2.4	3	-	V
			I_{OH} = 20 µ A		V_{CC} -0.4	-	-	V
V_{OL}	Low-level output voltage		I_{OL} = MAX		-	0.3	0.6	V
I_{OZ}	Off-state output current		V_{CC} = MAX	VO = 2.4 V	-	-	20	µA
				VO = 0.4 V	-	-	-20	µA
I_I	Input current		V_I = V_{SS} to V_{CC}	Except CLKIN	-	-	±20	µA
				CLKIN	-	-	±50	µA
C_I	Input capacitance	Data bus	f = 1 MHz, all other pins 0 V		-	25	-	pF
		All others			-	15	-	pF
C_O	Output capacitance	Data bus			-	25	-	pF
		All others			-	10	-	pF

External Frequency Specifications

Parameter		Min	Nom	Max	Unit
t_C(MC)	Master clock cycle time	48.818	48.828	48.838	ns
t_r(MC)	Rise time master clock input	-	5	10	ns
t_f(MC)	Pulse duration master clock	20	-	-	ns

Recommended Operating Conditions

Parameter			Min	Nom	Max	Unit
V_{CC}	Supply voltage		4.75	5	5.25	V
V_{SS}	Supply voltage		-	0	-	V
V_{IH}	High-level input voltage	All inputs except CLKIN	2	-	-	V
		CLKIN	3	-	-	V
		MC/$\overline{PM}$	2.2	-	-	V
V_{IL}	Low-level input voltage	All inputs except MC/$\overline{MP}$	-	-	0.8	V
		MC/$\overline{MP}$	-	-	0.6	V
I_{OH}	High-level output current (all outputs)		-	-	-300	µA
I_{OL}	Low-level output current (all outputs)		-	-	2	mA

Coprocessor Interface Timing

Parameter		Min	Nom	Max	Unit
$t_{d(R-A)}$	$\overline{RD}$ low to $\overline{TBLF}$ high	-	-	75	ns
$t_{d(W-A)}$	$\overline{WR}$ low to $\overline{RBLE}$ high	-	-	75	ns
$t_{a(RD)}$	$\overline{RD}$ low to data valid	-	-	80	ns
$t_{h(RD)}$	Data hold time after $\overline{RD}$ high	25	-	-	ns
$t_{su(WR)}$	Data setup time prior to $\overline{WR}$ high	30	-	-	ns
$t_{h(WR)}$	Data hold time after $\overline{WR}$ high	25	-	-	ns
$t_{w(RDL)}$	$\overline{RD}$ low-pulse duration	80	-	-	ns
$t_{w(WRL)}$	$\overline{WR}$ low-pulse duration	60	-	-	ns
$t_{wr(RBLE)}$	$\overline{RBLE}\uparrow$ to $\overline{RBLE}\downarrow$	-	-	1	ms

Reset (RS) Timing

Parameter		Test Conditions	Min	Max	Unit
$t_{dis}(R)$	Data bus disable time after $\overline{RS}$	R_L = 825	-	75	ns
t_{d12}	Delay time from $\overline{RS}\downarrow$ to high-impedance SCLK	C_L = 100 pFΩ	-	200	ns
t_{d13}	Delay time from $\overline{RS}\downarrow$ to high-impedance DX1, DX0		-	200	ns
$t_{su}(R)$	Reset ($\overline{RS}$) setup time prior to CLKOUT		50	-	ns
$t_{w(}R)$	RS pulse duration		977	-	ns

CLKOUT Timing Parameters

Parameter		Test Conditions	Min	Nom	Max	Unit
$t_{c(C)}$	CLKOUT cycle time	195.27	195.31	195.35	ns	
$t_{r(C)}$	CLKOUT rise time	R_L = 825	-	10	-	ns
$t_{f(C)}$	CLKOUT fall time	C_L = 100 pFΩ	-	8	-	ns
$t_{d(MCC)}$	Delay time CLKIN↑ to CLKOUT↓		25	-	60	ns

Transmitter Characteristics

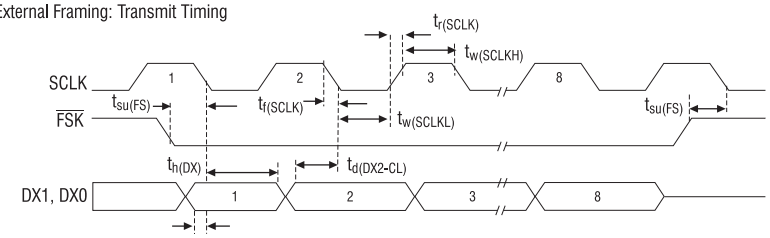
Parameter		Test Conditions	Min	Typ	Max	Unit
F_{OS}	Frequency offset	From nominal	-	-	±1	Hz
T_W	Twist	High/low	-	-	±0.5	dB
A_S	Signal amplitude	Per component	-9.26	-8.86	-8.46	dBm0
T_S	Time skew	Between components	-	-	0	ms
P_{hi}	Power due to harmonic distortion and intermodulation	300 to 3400 Hz	-	-	-46.5	dBm0

Reciever Characteristics

	Parameter	Test Conditions	Min	Max	Unit
A_d	Detect amplitude	Per frequency	-35	-5	dBm0
A_{nd}	No-detect amplitude	Per frequency	-42	-35	dBm0
F_d	Detect with frequency offset	From nominal	±10	-	Hz
TW_d	Detect with twist	Adjacent frequencies	±5	-	dB
		Nonadjacent frequencies	±7	-	dB
TW_{nd}	No detect with twist		±20	-	dB
$T3_r$	Third R2F tone reject Relative to highest level frequency		-20	-	dB
FF_d	Detect R2B with R2F disturbing	Above lowest level R2B tone (-12.5 dBm0 max.)	13.5	-	dB
FT_{nd}	No detect R2F with 2 out-of-band sine waves	Any frequencies from 330 - 1150 Hz and 2130 - 3400 Hz	-5	-	dBm0
RT_{nd}	No detect R2B with 2 out-of-band sine waves	Any frequencies from 1300-3400 Hz	-5	-	dBm0
T_{on}	Tone time	Reject	7	-	ms
T_{int}	Interrupted tone time	Reject	7	-	ms
T_{or}	Operate and release time			-	80

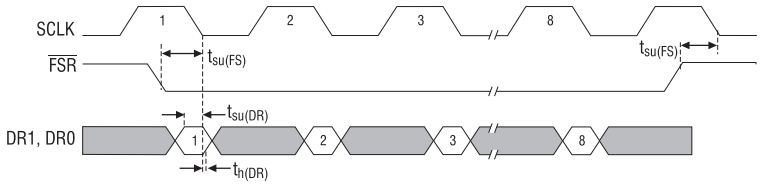
External Framing Timing Diagrams

External Framing: Transmit Timing

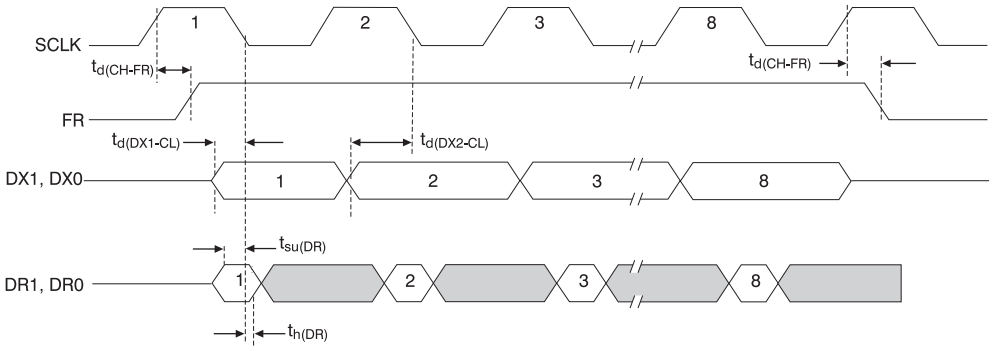


NOTES: Data valid on transmit outputs until SCLK rises.
The most significant bit is shifted first.

External Framing: Receive Timing

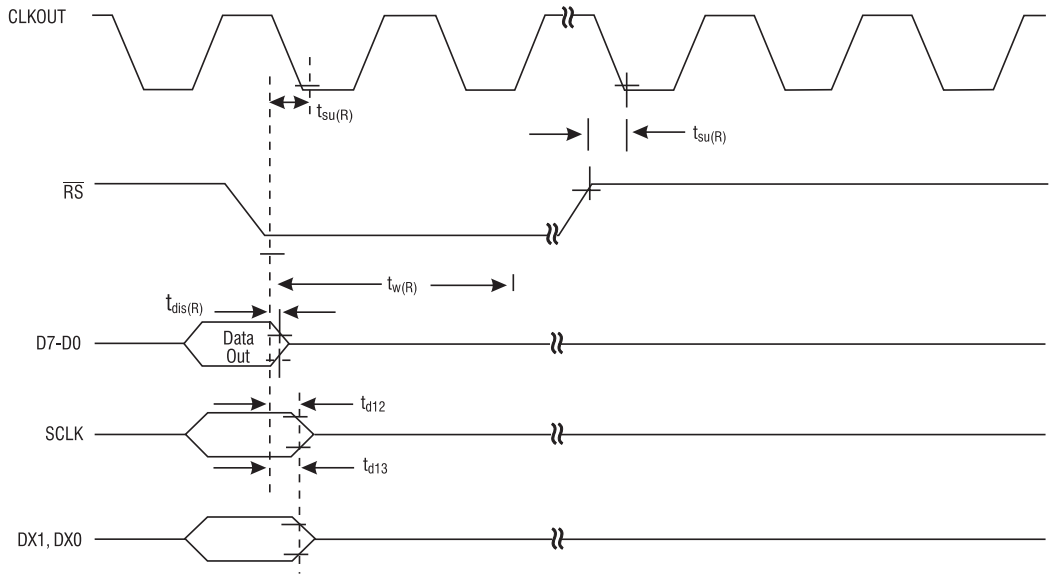


Internal Framing Timing



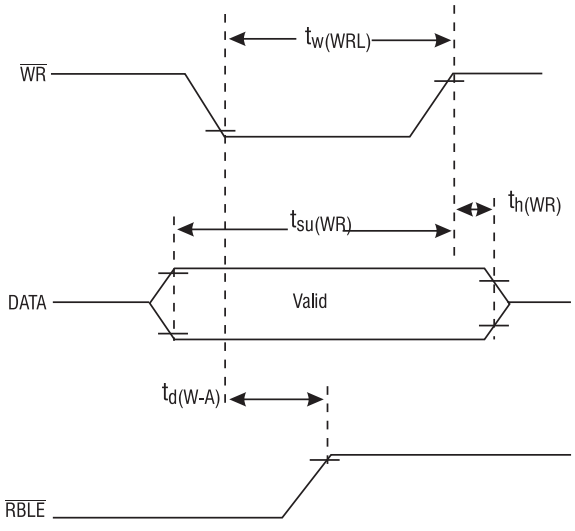
Note: The most significant bit is shifted first.

Reset Timing

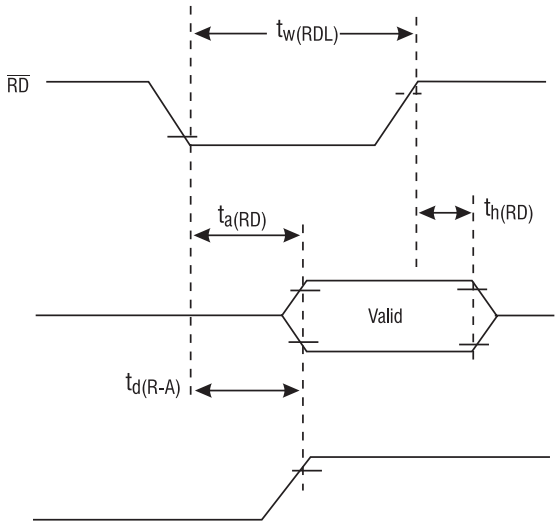


Coprocessor Timing

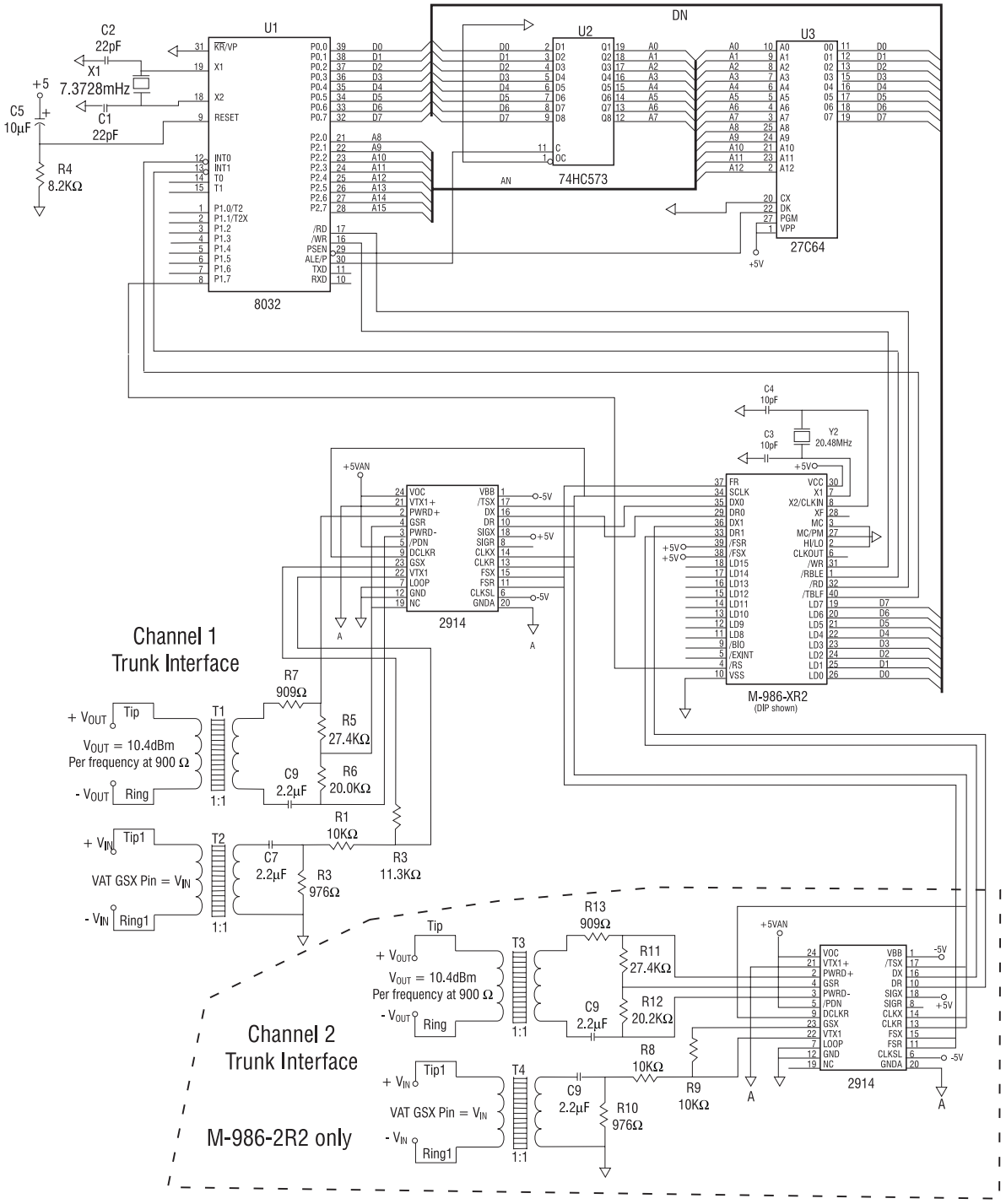
External Write to Coprocessor Port



External Read from Coprocessor Port



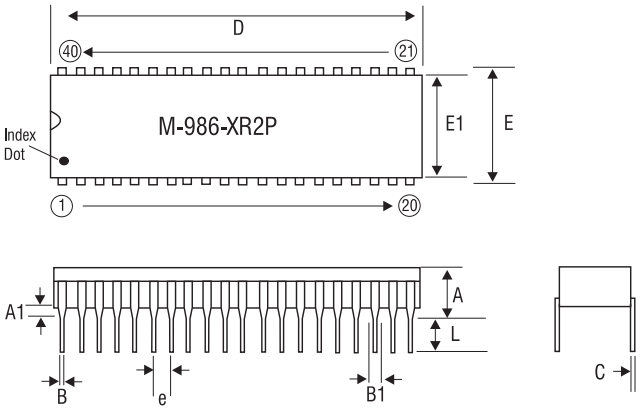
M-986 Dual Channel 4-Wire Interface Circuit



Mechanical Dimensions

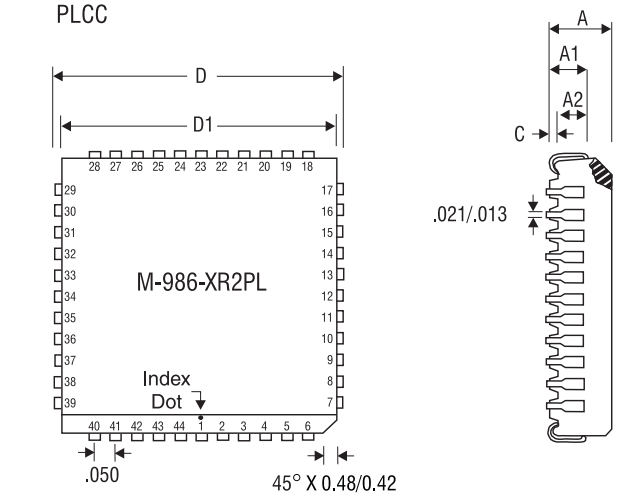
Drawing not to scale.
Drawing does not reflect actual part marking.

DIP



	Tolerances			
	(inches)		Metric (mm)	
	Min	Max	Min	Max
A	-	.250	-	6.35
A1	.015	-	.39	
B	.014	.022	.356	.558
B1	.030	.070	.77	1.78
C	.008	.015	.204	.38
D	1.98	2.095	50.30	53.20
E	.600	.625	15.24	15.87
E1	.485	.580	12.32	14.73
e	.100 BSC		2.54 BSC	
L	.115	.200	2.93	5.08

PLCC



	Tolerances			
	(inches)		Metric (mm)	
	Min	Max	Min	Max
A	.165	.180	4.191	4.572
A1	.090	.20	2.286	5.08
A2	.062	.083	1.575	2.108
C	.020 min		.508 min	
D	.685	.695	17.399	17.653
D1	.650	.653	16.510	16.662

Dimensions
mm
(inches)

CLARE

Worldwide Sales Offices

CLARE LOCATIONS

Clare Headquarters
78 Cherry Hill Drive
Beverly, MA 01915
Tel: 1-978-524-6700
Fax: 1-978-524-4900
Toll Free: 1-800-27-CLARE

Clare Switch Division
4315 N. Earth City Expressway
Earth City, MO 63045
Tel: 1-314-770-1832
Fax: 1-314-770-1812

Clare Micronix Division
145 Columbia
Aliso Viejo, CA 92656-1490
Tel: 1-949-831-4622
Fax: 1-949-831-4628

SALES OFFICES

AMERICAS

Americas Headquarters
Clare
78 Cherry Hill Drive
Beverly, MA 01915
Tel: 1-978-524-6700
Fax: 1-978-524-4900
Toll Free: 1-800-27-CLARE

Eastern Region
Clare
603 Apache Court
Mahwah, NJ 07430
Tel: 1-201-236-0101
Fax: 1-201-236-8685
Toll Free: 1-800-27-CLARE

Central Region
Clare Canada Ltd.
3425 Harvester Road, Suite 202
Burlington, Ontario L7N 3N1
Tel: 1-905-333-9066
Fax: 1-905-333-1824

Western Region
Clare
1852 West 11th Street, #348
Tracy, CA 95376
Tel: 1-209-832-4367
Fax: 1-209-832-4732
Toll Free: 1-800-27-CLARE

Canada
Clare Canada Ltd.
3425 Harvester Road, Suite 202
Burlington, Ontario L7N 3N1
Tel: 1-905-333-9066
Fax: 1-905-333-1824

EUROPE

European Headquarters
CP Clare nv
Bampslaan 17
B-3500 Hasselt (Belgium)
Tel: 32-11-300868
Fax: 32-11-300890

France
Clare France Sales
Lead Rep
99 route de Versailles
91160 Champlan
France
Tel: 33 1 69 79 93 50
Fax: 33 1 69 79 93 59

Germany
Clare Germany Sales
ActiveComp Electronic GmbH
Mitterstrasse 12
85077 Manching
Germany
Tel: 49 8459 3214 10
Fax: 49 8459 3214 29

Italy
C.L.A.R.E.s.a.s.
Via C. Colombo 10/A
I-20066 Melzo (Milano)
Tel: 39-02-95737160
Fax: 39-02-95738829

Sweden
Clare Sales
Comptronic AB
Box 167
S-16329 Spånga
Tel: 46-862-10370
Fax: 46-862-10371

United Kingdom
Clare UK Sales
Marco Polo House
Cook Way
Bindon Road
Taunton
UK-Somerset TA2 6BG
Tel: 44-1-823 352541
Fax: 44-1-823 352797

ASIA/PACIFIC

Asian Headquarters
Clare
Room N1016, Chia-Hsin, Bldg II,
10F, No. 96, Sec. 2
Chung Shan North Road
Taipei, Taiwan R.O.C.
Tel: 886-2-2523-6368
Fax: 886-2-2523-6369

http://www.clare.com

Specification: DS-M986-2R2-R3

7/20/01