

Calling Line Identification (CLID) Receiver with Ring Detector

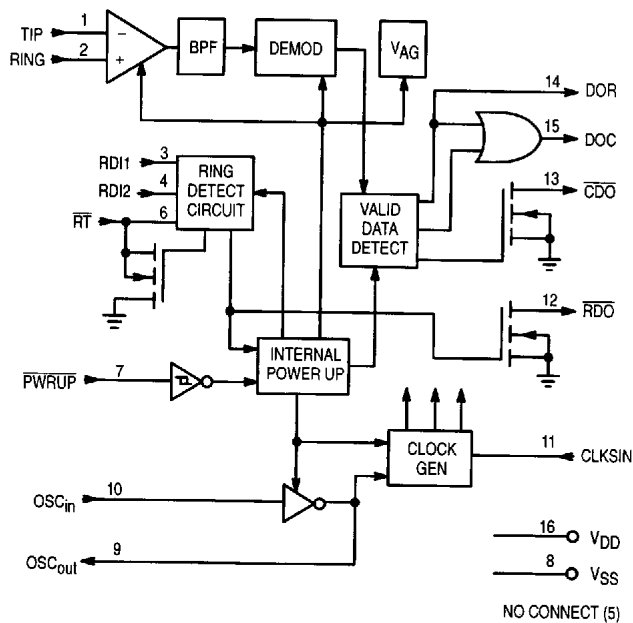
The MC145447 is a silicon gate HCMOS IC designed to demodulate Bell 202 and V.23 1200-baud FSK asynchronous data. The primary application for this device is in products that will be used to receive and display the calling number, or message waiting indicator sent to subscribers from participating central office facilities of the public switched network. The device also contains a carrier detect circuit and ring detector which may be used to power up the device.

Applications for this device include adjunct boxes, answering machines, feature phones, fax machines, and computer interface products.

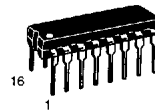
The MC145447 offers the following performance features.

- Ring Detector On-Chip
- Ring Detect Output for MCU Interrupt
- Power-Down Mode, Less than 1 μ A
- Single Supply: + 3.5 to + 6.0 V
- Pin Selectable Clock Frequencies: 3.68 MHz, 3.58 MHz, or 455 kHz
- Two Stage Power-Up for Power Management Control
- Demodulates Bell 202 and V.23

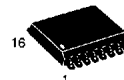
BLOCK DIAGRAM



MC145447



P SUFFIX
PLASTIC DIP
CASE 648



DW SUFFIX
SOG PACKAGE
CASE 751G

ORDERING INFORMATION

MC145447P Plastic DIP
MC145447DW SOG Package

PIN ASSIGNMENT

TI	1	16	VDD
RI	2	15	DOC
RD11	3	14	DOR
RD12	4	13	CDO
NC	5	12	RD0
RT	6	11	CLKSIN
PWRUP	7	10	OSC _{in}
VSS	8	9	OSC _{out}

NC = NO CONNECTION

ABSOLUTE MAXIMUM RATINGS

(Voltages referenced to GND, except where noted)

Rating	Symbol	Value	Unit
DC Supply Voltage	V _{DD}	- 0.5 to + 6.0	V
Input Voltage, All Pins	V _{in}	- 0.5 to V _{DD} + 0.5	V
DC Current Drain Per Pin	I	± 10	mA
Power Dissipation	P _D	20	mW
Operating Temperature Range	T _A	0 to + 70	°C
Storage Temperature Range	T _{stg}	- 40 to + 150	°C

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields. However, it is advised that normal precautions be taken to avoid applications of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range V_{SS} ≤ (V_{in} or V_{out}) ≤ V_{DD}.

Reliability of operation is enhanced if unused inputs are tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}).

ELECTRICAL CHARACTERISTICS

(All polarities referenced to V_{SS} = 0 V, V_{DD} = + 5 V ± 10%, unless otherwise noted, T_A = 0 to + 70°C)

Parameter	Symbol	Min	Typ	Max	Unit
DC Supply Voltage	V _{DD}	3.5	5	6	V
Supply Current (All Output Pins Unloaded) (See Figure 1) RT = 0, PWRUP = 1, XTAL = 3.58 MHz	I _{DD}	—	2.4	3	mA
Supply Current (All Output Pins Unloaded) (See Figure 1) PWRUP = 0, RT = Don't Care, XTAL = 3.58 MHz	I _{DD}	—	6.2	8	mA
Standby Current (All Output Pins Unloaded) (See Figure 1) RT = 1, PWRUP = 1	I _{STBY}	—	—	1	µA
Input Voltage 0 Level (CLKSIN, OSC _{in})	V _{IL}	—	—	V _{DD} × 0.3	V
Input Voltage 1 Level (CLKSIN, OSC _{in})	V _{IH}	V _{DD} × 0.7	—	—	V
Output Voltage High: V _{DD} = 5 V (DOR, DOC, OSC _{out}) I _{OH} = 40 µA I _{OH} ≤ 1 µA	V _{OH}	2.4 4.95	—	—	V
Output Voltage Low: V _{DD} = 5 V (DOR, DOC, OSC _{out}) I _{OL} = 1.6 mA I _{OL} ≤ 1 µA	V _{OL}	—	—	0.4 0.05	V
Input Leakage Current (OSC _{in} , CLKSIN, PWRUP, RT, RD11, and RD12)	I _{in}	—	—	±1	µA
Output Voltage Low: V _{DD} = 5 V (RD0, RT, CDO) I _{OL} = 2.0 mA	V _{OL}	—	—	0.4	V
Input Threshold Voltage Positive Going: V _{DD} = 5 V (RD11, RT, PWRUP) (See Figure 3)	V _{T+}	2.5	2.75	3.0	V
Input Threshold Voltage Negative Going: V _{DD} = 5 V (RD11, RT, PWRUP) (See Figure 3)	V _{T-}	2.0	2.3	2.6	V
RD12 Threshold	RD2VT	1.0	1.1	1.2	V
TIP/RING Input dc Resistance	R _{in}	—	500	—	kΩ

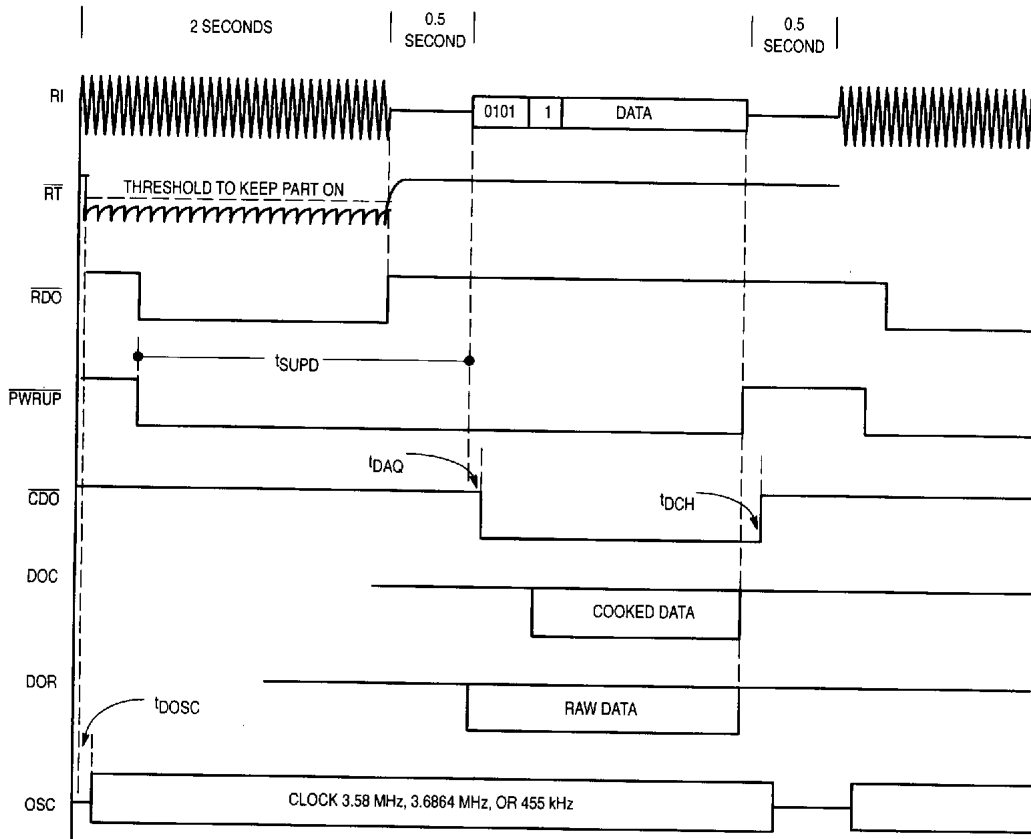
ANALOG CHARACTERISTICS (V_{DD} = + 5 V, T_A = + 25°C, unless otherwise noted, 0 dBm = 0.7746 Vrms @ 600 Ω)

Characteristic	Min	Typ	Max	Unit	
Input Sensitivity: TIP and RING (Pins 1 and 2, V _{DD} = + 5 V)	- 40	- 45	—	dBm	
Band-Pass Filter (BPF) Frequency Response (Relative to 1700 Hz @ 0 dBm)	60 Hz 500 Hz 2700 Hz ≥ 3300 Hz	— — — —	- 64 - 4 - 3 - 34	— — — —	dB
Carrier Detect Sensitivity	—	- 48	—	dBm	

SWITCHING CHARACTERISTICS ($V_{DD} = +5\text{ V}$, $C_L = 50\text{ pF}$, $T_A = +25^\circ\text{C}$)

Description	Symbol	Min	Typ	Max	Unit
OSC Startup	t_{DOSC}	—	2	—	ms
Power-Up Low to FSK (Setup Time)	t_{SUPD}	15	—	—	ms
Carrier Detect Acquisition Time	t_{DAQ}	—	14	—	ms
End of Data to Carrier Detect High	t_{DCH}	8	—	—	ms

TIMING DIAGRAM



2

\overline{RT}	\overline{PWRUP}	I_{DD}	OSC_{in}
1	1	1 μ A MAX	DISABLE
0	1	2.4 mA TYP	ENABLE
X	0	6.2 mA TYP	ENABLE

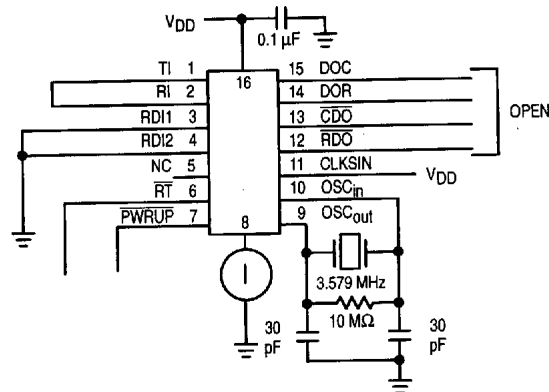


Figure 1. I_{DD} Test Circuit

PIN DESCRIPTIONS

TI

Tip Input (Pin 1)

This input pin is normally connected to the tip side of the twisted pair. It is internally biased to 1/2 supply voltage when the device is in the power-up mode. This pin must be dc isolated from the line.

RI

Ring Input (Pin 2)

This input is normally connected to the ring side of the twisted pair. It is internally biased to 1/2 supply voltage when the device is in the power-up mode. This pin must be dc isolated from the line.

RDI1

Ring Detect Input 1 (Pin 3)

This input is normally coupled to one of the twisted pair wires through an attenuating network. It detects energy on the line and enables the oscillator and precision ring detection circuitry.

RDI2

Ring Detect Input 2 (Pin 4)

This input to the precision ring detection circuit is normally coupled to one of the twisted pair wires through an attenuating network. A valid ring signal as determined from this input sends the \overline{RDO} (Pin 12) to a logic 0.

\overline{RT}

Ring Time (Pin 6)

An RC network may be connected to this pin. The RC time constant is chosen to hold this pin voltage below 2.2 V between the peaks of the ringing signal. \overline{RT} is an internal power-up control and activates only the circuitry necessary to determine if the incoming ring is valid.

\overline{PWRUP}

Power Up (Pin 7)

A logic 0 on the \overline{PWRUP} input causes the device to be in the active mode ready to demodulate incoming data. A

logic 1 on this pin causes the device to be in the standby mode, if the \overline{RT} input pin is at a logic 1. This pin may be controlled by \overline{RDO} and \overline{CDO} for auto power-up operation. For other applications, this pin may be controlled externally.

VSS

Ground (Pin 8)

Ground return pin is typically connected to the system ground.

OSC_{out}

Oscillator Output (Pin 9)

This pin will have either a crystal or a ceramic resonator tied to it with the other end connected to OSC_{in} .

OSC_{in}

Oscillator Input (Pin 10)

This pin will have either a crystal or a ceramic resonator tied to it with the other end connected to OSC_{out} . OSC_{in} may also be driven directly from an appropriate external source.

CLKSIN

Clock Select Input (Pin 11)

A logic 1 on this input configures the device to accept either a 3.579 MHz or 3.6864 MHz crystal. A logic 0 on this pin configures the part to operate with a 455 kHz resonator.

For crystal and resonator specifications see Table 1.

\overline{RDO}

Ring Detect Out (Pin 12)

This open-drain output goes low when a valid ringing signal is detected. \overline{RDO} remains low as long as the ringing signal remains valid. This signal can be used for auto power-up, when connected to Pin 7.

\overline{CDO}

Carrier Detect Output (Pin 13)

When low, this open drain output indicates that a valid carrier is present on the line. \overline{CDO} remains low as long as the carrier remains valid. An 8 ms hysteresis is built in to allow for a momentary drop out of the carrier. \overline{CDO} may be used in the auto power-up configuration when connected to \overline{PWRUP} .

DOR

Data Out Raw (Pin 14)

This pin presents the output of the demodulator whenever \overline{CDO} is low. This data stream includes the alternate 1 and 0 pattern, and the 150 ms of marking, which precedes the data. At all other times, DOR is held high.

DOC

Data Out Cooked (Pin 15)

This output presents the output of the demodulator whenever \overline{CDO} is low, and when an internal validation sequence has been successfully passed. The output does not include the alternate 1 and 0 pattern. At all other times, DOC is held high.

VDD

Positive Power Supply (Pin 16)

The digital supply pin, which is connected to the positive side of the power supply.

APPLICATIONS INFORMATION

The MC145447 has been designed to be one of the main functional blocks in products targeted for the CLASS (Custom Local Area Signaling Service) market. CLASS is a set of subscriber features now being presented to the consumer by the RBOCs (Regional Bell Operating Companies) and independent TELCOs. Among CLASS features, such as distinctive ringing and selective call forwarding, the subscriber will also have available a service known as Calling Number Delivery (CND) and message waiting. With these services, a subscriber will have the ability to display at a minimum, a message containing the phone number of the calling party, the date, and the time. A message containing only this information is known as a single format message, as shown in Figure 9. An extended message, known as multiple format message, can contain additional information as shown in Figure 10.

The interface should be arranged to allow simplex data transmission from the terminating central office, to the CPE (Customer Premises Equipment), only when the CPE is in an on-hook state. The data will be transmitted in the silent period between the first and second power ring after a voice path has been established.

The data signaling interface should conform to Bell 202, which is described as follows:

- Analog, phase coherent, frequency shift keying
- Logical 1 (Mark) = 1200 ± 12 Hz
- Logical 0 (Space) = 2200 ± 22 Hz
- Transmission rate = 1200 bps
- Application of data = serial, binary, asynchronous

The transmission level from the terminating C.O. will be -13.5 dBm ± 1.0 . The expected worst case attenuation through the loop is expected to be -20 dB. The receiver therefore, should have a sensitivity of approximately -34.5 dBm to handle the worst case installations.

Additional information on CLASS services can be obtained from:

BELLCORE CUSTOMER SVS.
1-800-521-2673
201-699-5800 FOREIGN CALLS
201-699-0936 FAX

The document number is: TA-NWT-000030

Title: "Voice Band Data Transmission Interface Generic Requirements"

Figure 7 is a conceptual design of how the MC145447 can be implemented into a product which will retrieve the incoming message and convert it to EIA-232 levels for transmission to the serial port of a PC. With this message and appropriate software, the PC can be used to look up the name and any additional information associated with the caller that had been previously stored.

Figure 8 is a conceptual design of an adjunct unit in parallel with an existing phone. This arrangement gives the subscriber CND service without having to replace existing equipment.

Table 1. Oscillator Specifications

Clock Select Pin 11 = 1	
Crystal Mode	Parallel
Frequency	3.579 MHz or 3.6864 MHz
R _f	10 M Ω
C1 and C2	30 pF
Source: Fox Electronics 5570 Enterprise Pkwy. Ft. Myers, FL 33905 Tel. 813-693-0099	
Clock Select Pin 11 = 0	
Resonator	#CSB455J
Frequency	455 kHz $\pm 0.5\%$
R _f	1.0 M Ω
C1 and C2	100 pF
Source: Murata Manufacturing Co. Ltd. 2200 Lake Park Dr. Smyrna, GA 30080 Tel. 404-436-1300	

NOTE: Motorola cannot recommend one supplier over another and in no way suggests that this is a complete listing.

FULL-TIME POWER-UP APPLICATION WITH RING DETECTOR CIRCUIT DISABLED

Some MC145447 applications require that the Calling Line Identification Receiver be constantly powered. To ensure that the device is properly reset, a Logic 1 must be applied to \overline{PWRUP} (Pin 7) for a minimum of 10 μ s after V_{DD} has reached its full value. It is also necessary that the \overline{RT} pin (Pin 6) be high while \overline{PWRUP} is high. This may be accomplished with an external ring detect signal or MCU generated signal applied to \overline{PWRUP} . Alternatively, a power on reset RC network may be used as shown in Figure 6. Rpu and Cpu must be chosen such that the voltage at \overline{PWRUP} meets the logic 1 input threshold requirements for 10 μ s after V_{DD} has reached its full value. The power supply rise time on V_{DD} (Pin 16) must also be taken into account when determining Rpu and Cpu. See Figure 3 for a description of the change in input thresholds (V_{T+} and V_{T-}) with respect to V_{DD} for \overline{PWRUP} . Also, some applications may not require the ring detect function. In this case, RD11 (Pin 3) and RD12 (Pin 4) should be tied to V_{SS} and \overline{RT} tied to V_{DD} as shown in Figure 6.

DESIGN INFORMATION

The circuit in Figure 2 illustrates in greater detail the relationship between Pins 3, 4, 6, and 7.

The external component values shown in Figure 2 are the same as those shown in Figures 7 and 8. When V_{DD} is applied to the circuit in these two figures, the RC network will charge cap C1 to V_{DD} holding \overline{RT} (Pin 6) off. If the \overline{PWRUP} (Pin 7) is also held at V_{DD} , the MC145447 will be in a power-down mode, and will consume 1 μA of supply current (max).

The resistor network (R2 - R4) attenuates the incoming power ring applied to the top of R2. The values given have been chosen to provide a sufficient voltage at RDI1 (Pin 3) to turn on the Schmitt-trigger input with approximately a 40 Vrms or greater power ring input from tip and ring. When V_{T+} of the Schmitt is exceeded, Q1 will be driven to saturation discharging cap C1 on \overline{RT} . This will initialize a partial power-up, with only the portions of the part involved with the ring signal analysis enabled, including RDI2 (Pin 4). At this time the MC145447 power consumption is increased to approximately 2.4 mA (typ).

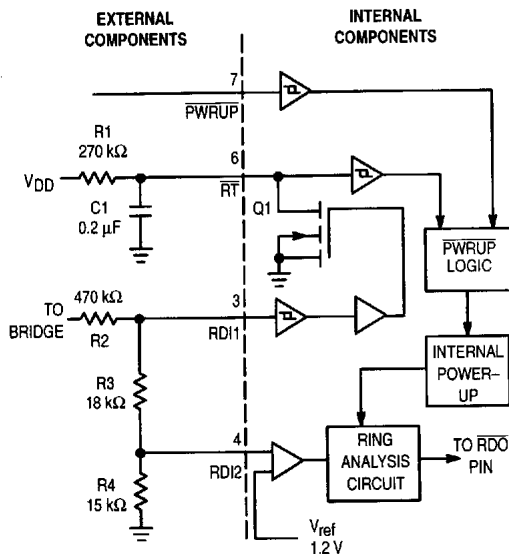


Figure 2.

The value of R1 and C1 must be chosen to hold the \overline{RT} pin voltage below the V_{T+} of the \overline{RT} Schmitt between the individual cycles of the power ring. The values shown will work for ring frequencies of 15.3 Hz (min).

With RDI2 now enabled, a portion of the power ring above 1.2 V is fed to the ring analysis circuit. This circuit is a digital integrator which looks at the duty cycle of the incoming signal. When the input to RDI2 is above 1.2 V, the integrator is counting up at an 800 Hz rate. When the input to RDI2 falls below 1.2 V, the integrator counts down at a 400 Hz rate.

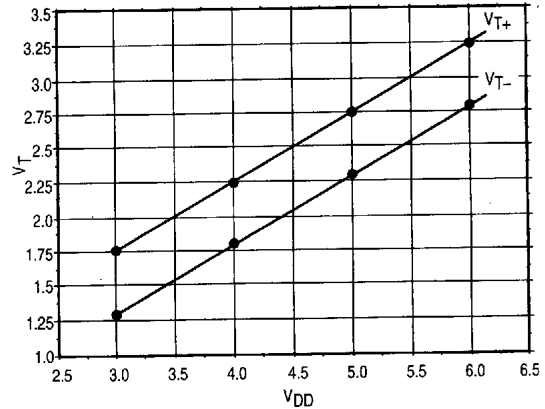


Figure 3. V_{DD} versus V_{T+} and V_{T-}

A ring is qualified when an internal count of binary 48 is reached. The ring is disqualified when the count drops to a binary 32. The number of ring cycles required to qualify the signal will depend on the amplitude of the voltage presented to RDI2. The shortest amount of time needed to do the qualification is approximately 60 ms. The shortest amount of time required for dequalification will be approximately 40 ms.

Once the ring signal is qualified, the RDO pin will be sent low. This can be fed back to \overline{PWRUP} as shown in Figure 7, or with a pull-up resistor, can be used as an interrupt to an MCU as shown in Figure 8. In either case, once the \overline{PWRUP} pin is below V_{T-} , the part will be fully powered up, and ready to receive FSK. During this mode, the device current will increase to approximately 6.2 mA (typ). The state of the \overline{RT} pin is now a "don't care" as far as the part is concerned. Normally, however, this pin will be allowed to return to V_{DD} .

After the FSK message has been received, the \overline{PWRUP} pin can be allowed to return to V_{DD} and the part will return to the standby mode, consuming less than 1 μA of supply current. The part is now ready to repeat the same sequence for the next incoming message.

TYPICAL DEMODULATOR PERFORMANCE

The following describes the performance of the MC145447 demodulator in the presence of noise over a simulated Bell 3002 telephone loop.

The Bell 3002 loop represents a worst case local telephone loop in North America. The characteristics of this loop, which affect performance, are high frequency attenuation and Envelope Delay Distortion (EDD) or group delay.

The minimum receiver sensitivity of the MC145447 under these conditions is typically -45 dBm.

The MC145447 achieves a Bit Error Rate (BER) of 1×10^{-5} at a Signal-to-Noise Ratio (SNR) of 15 dB in V.23 operation and at an SNR of 18 dB in Bell 202 operation (see Figures 4 and 5).

All measurements in dBm are referenced to 600 Ω : 0 dBm = 0.7746 Vrms.

All measurements were taken using the MC145460EVK evaluation board.

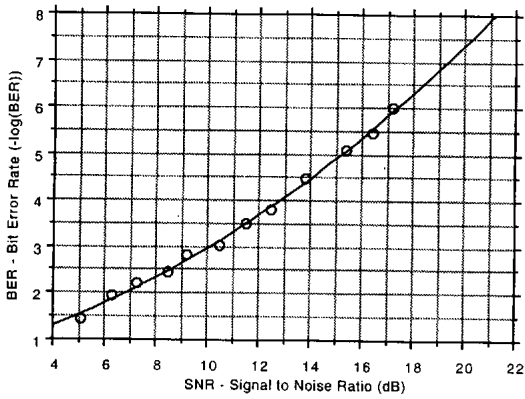


Figure 4. MC145447 V.23 Operation
(Typical BER vs SNR)

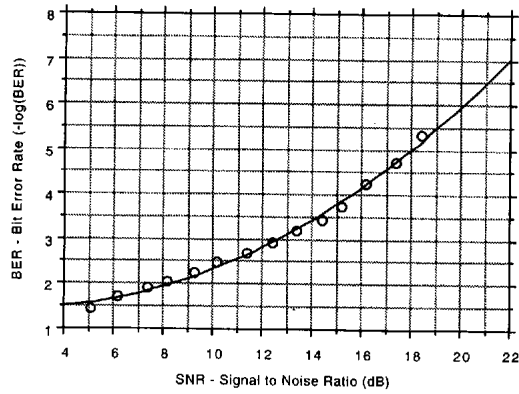


Figure 5. MC145447 Bell 202 Operation
(Typical BER vs SNR)

2

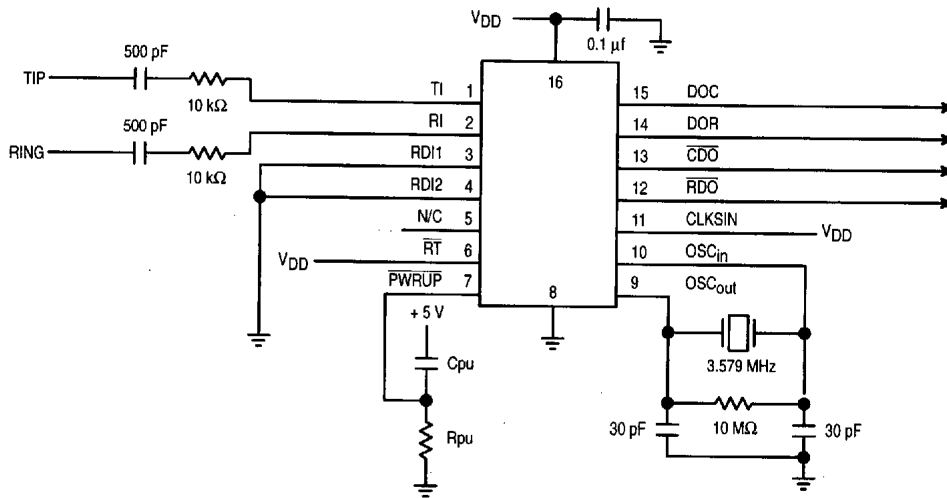


Figure 6.

APPLICATION CIRCUIT

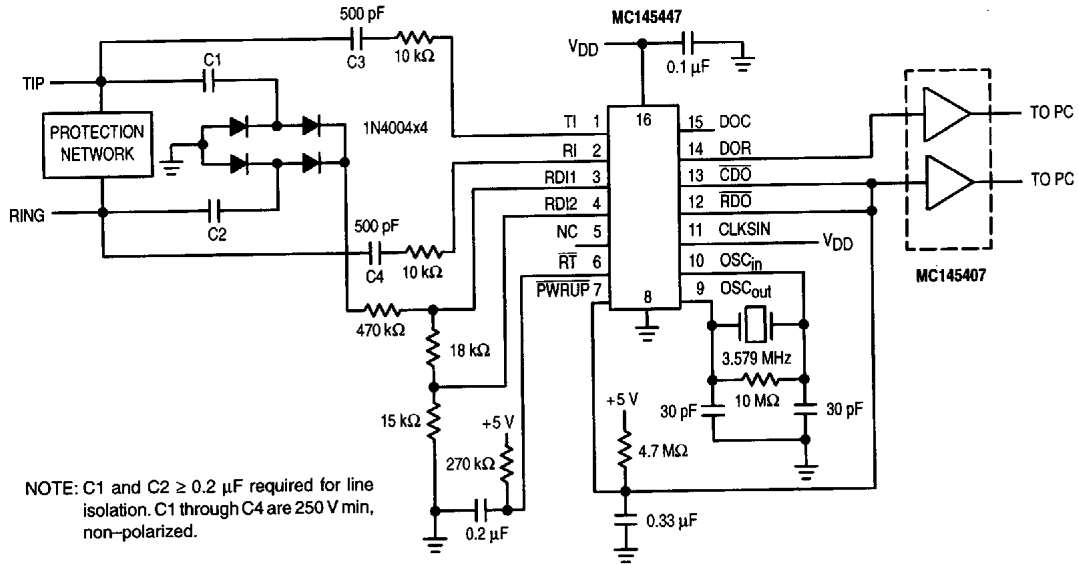
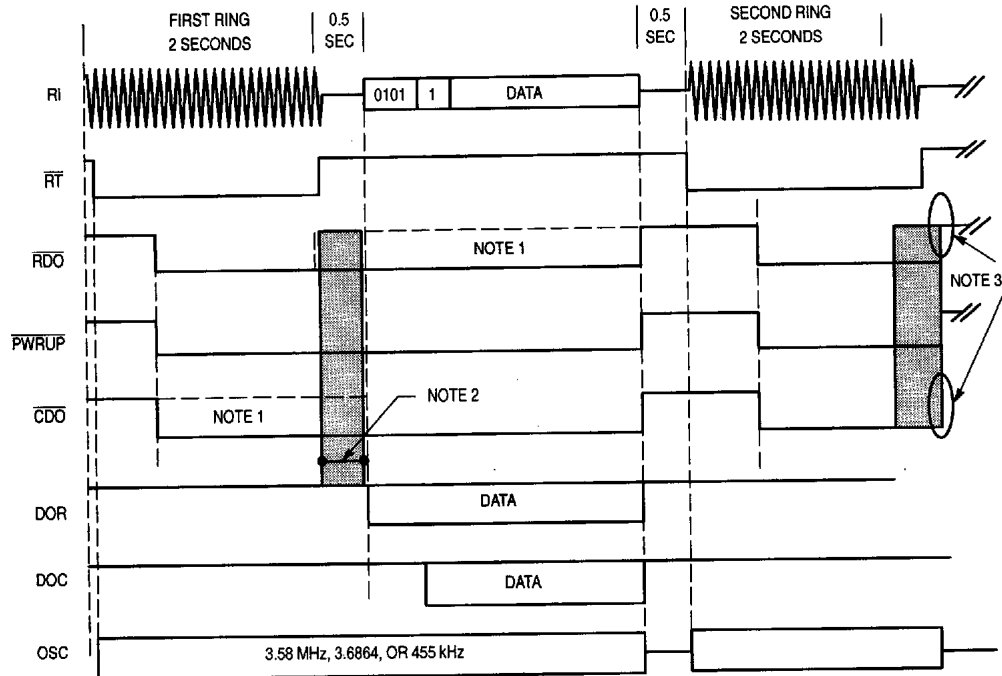


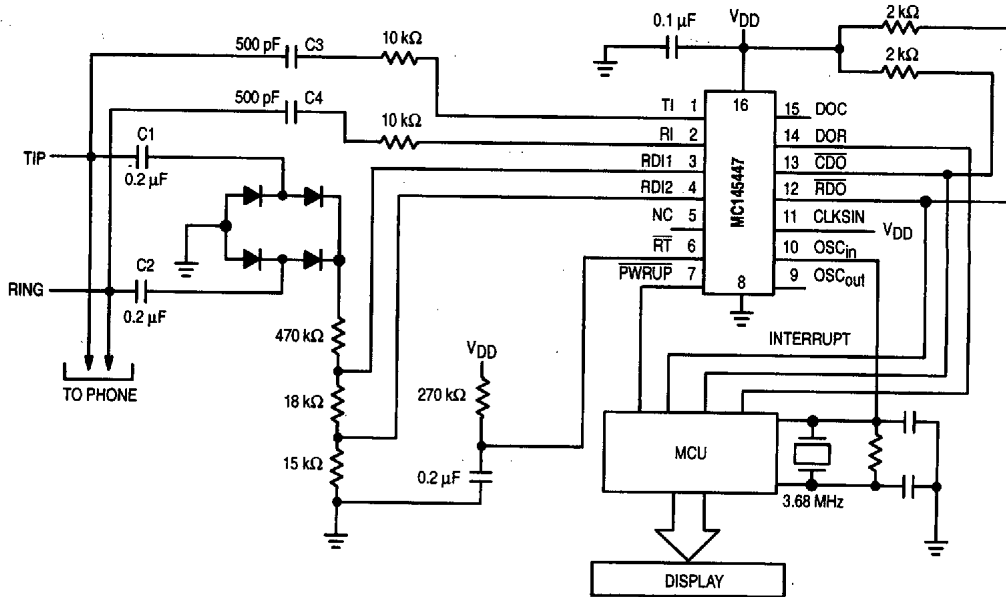
Figure 7. Partial Implementation of PC Interface to Tip and Ring



- NOTES:
1. Wired 'OR' $\overline{\text{RDO}}$ with $\overline{\text{CDO}}$.
 2. Overlap of $\overline{\text{RDO}}$ edge with $\overline{\text{CDO}}$ edge to ensure part stays in $\overline{\text{PWRUP}}$ determined by RC time constant on $\overline{\text{RDO}}$, $\overline{\text{PWRUP}}$, and $\overline{\text{CDO}}$ pin.
 3. Part reverts to $\overline{\text{PWR ON}}$, on rising edge of $\overline{\text{RDO}}$ since there is no $\overline{\text{CDO}}$.

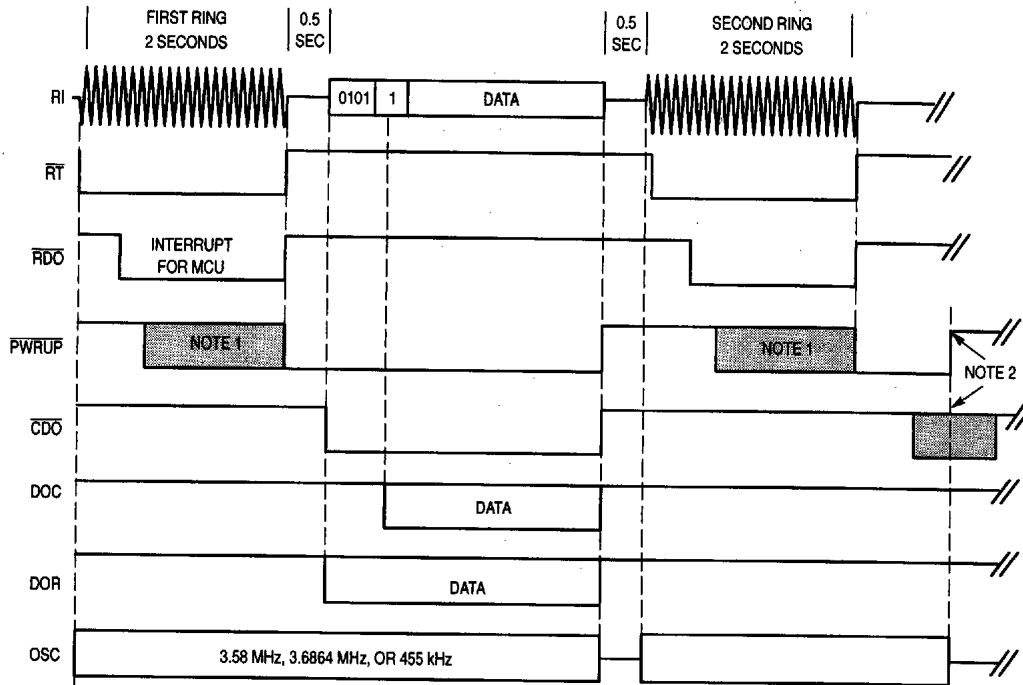
Timing Diagram for Figure 7

APPLICATION CIRCUIT



2

Figure 8. Adjunct Box Concept for Calling Number Display



- NOTES:
1. MCU must assert $\overline{\text{PWRUP}}$ to MC145447.
 2. No data detected, MCU powers down the MC145447.

Timing Diagram for Figure 8

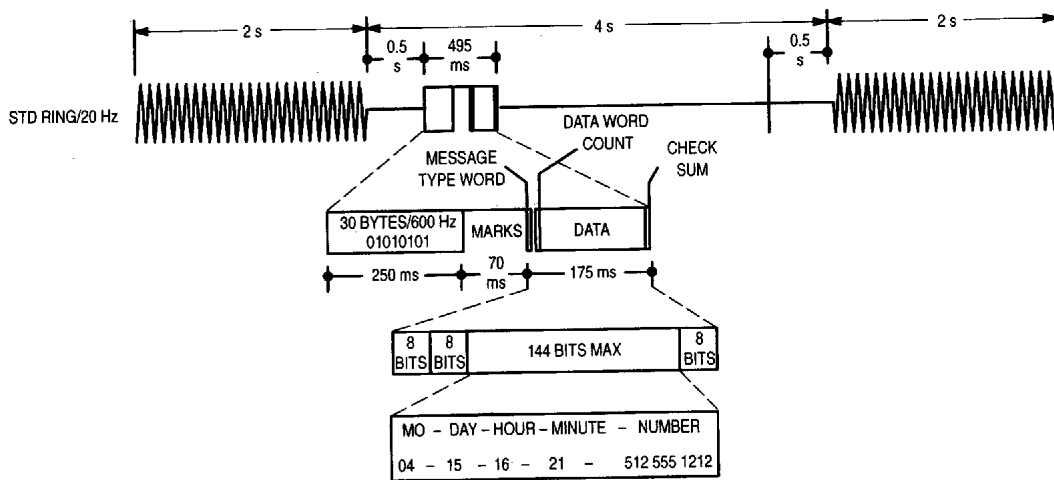


Figure 9. Single Message Format

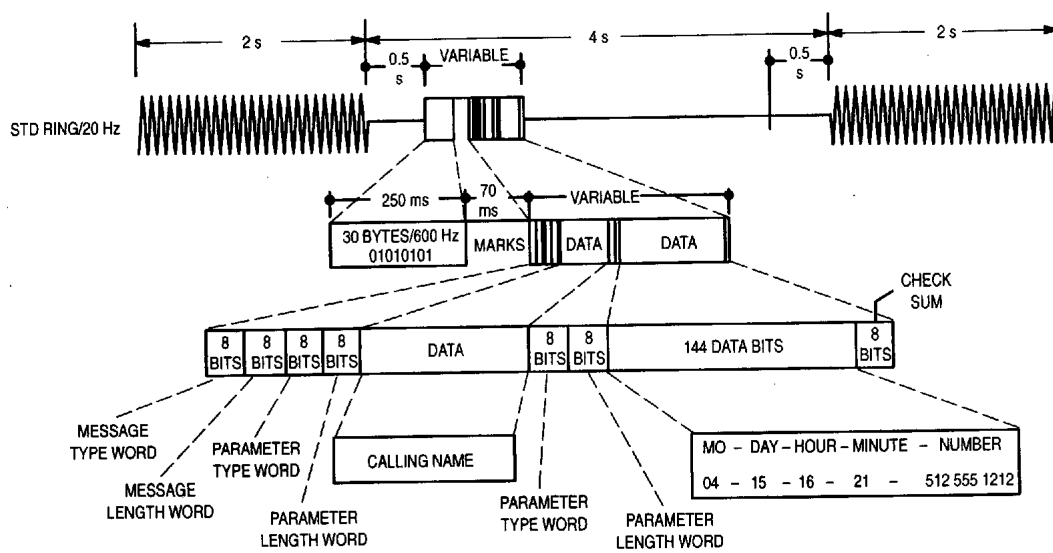


Figure 10. Multiple Message Format