

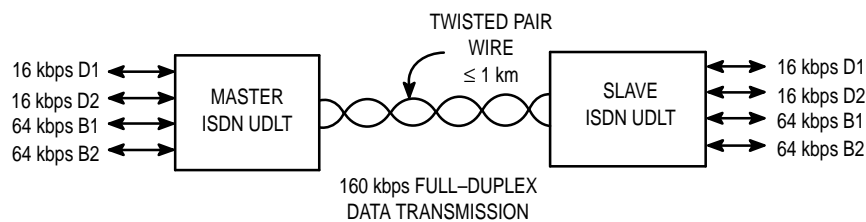
# ISDN Universal Digital Loop Transceivers II (UDLT II)

The MC145421 and MC145425 UDLTs are high-speed data transceivers capable of providing 160 kbps full-duplex data communication over 26 AWG and larger twisted-pair cable up to 1 km in length. These devices are primarily used in digital subscriber voice and data telephone systems. In addition, the devices meet and exceed the CCITT recommendations for data transfer rates of ISDNs on a single twisted pair. The devices utilize a 512 kbaud MDPSK burst modulation technique to supply the 160 kbps full-duplex data transfer rates. The 160 kbps rate is provided through four channels. There are two B channels, which are 64 kbps each. In addition, there are two D channels which are 16 kbps each.

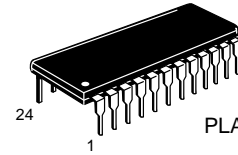
The MC145421 and MC145425 UDLTs are designed for upward compatibility with the existing MC145422 and MC145426 80 kbps UDLTs, as well as compatibility with existing and evolving telephone switching hardware and software architectures.

The MC145421 (Master) UDLT is designed for use at the telephone switch line card while the MC145425 (Slave) UDLT is designed for use at the remote digital telset or data terminal.

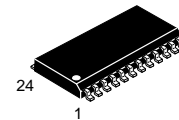
- Employs CMOS Technology in Order to Take Advantage of Its Proven Capability for Complex Analog and Digital LSI Functions
- Provides Synchronous Full-Duplex 160 kbps Voice and Data Communication in a 2B+2D Format for ISDN Compatibility
- Provides the CCITT Basic Access Data Transfer Rate (2B+D) for ISDNs on a Single Twisted Pair Up to 1 km
- Compatible with Existing and Evolving Telephone Switch Architectures and Call Signaling Schemes
- Protocol Independent
- Single + 5 V Power Supply
- MC145421EVK is Available



## MC145421 MC145425



**P SUFFIX**  
PLASTIC PACKAGE  
CASE 709



**DW SUFFIX**  
SOG PACKAGE  
CASE 751F

### ORDERING INFORMATION

MC145421P	Plastic Package
MC145425P	Plastic Package
MC145421DW	SOG Package
MC145425DW	SOG Package

## PIN ASSIGNMENTS

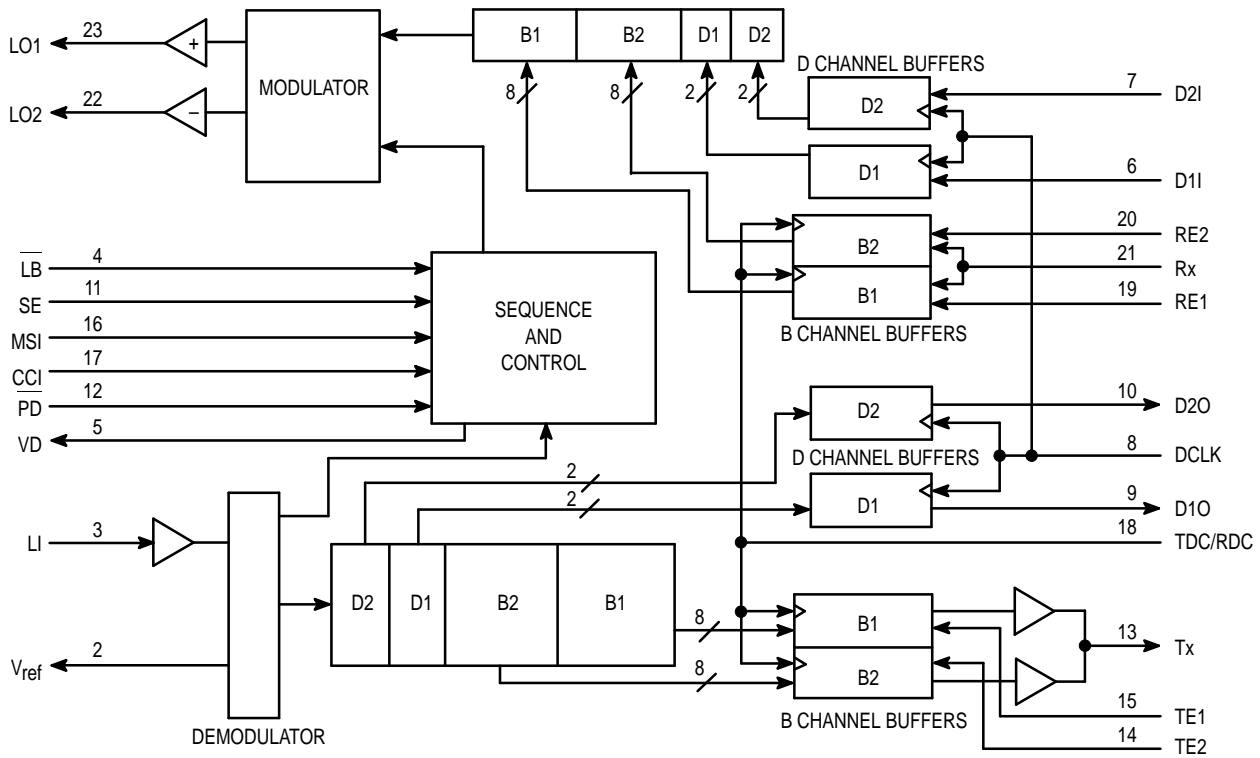
### MC145421 — MASTER (PLASTIC AND SOG PACKAGES)

V <sub>SS</sub>	□	1	●		24	□	V <sub>DD</sub>
V <sub>ref</sub>	□	2			23	□	LO1
LI	□	3			22	□	LO2
$\overline{\text{LB}}$	□	4			21	□	Rx
VD	□	5			20	□	RE2
D1I	□	6			19	□	RE1
D2I	□	7			18	□	TDC/RDC
DCLK	□	8			17	□	CCI
D1O	□	9			16	□	MSI
D2O	□	10			15	□	TE1
SE	□	11			14	□	TE2
$\overline{\text{PD}}$	□	12			13	□	Tx

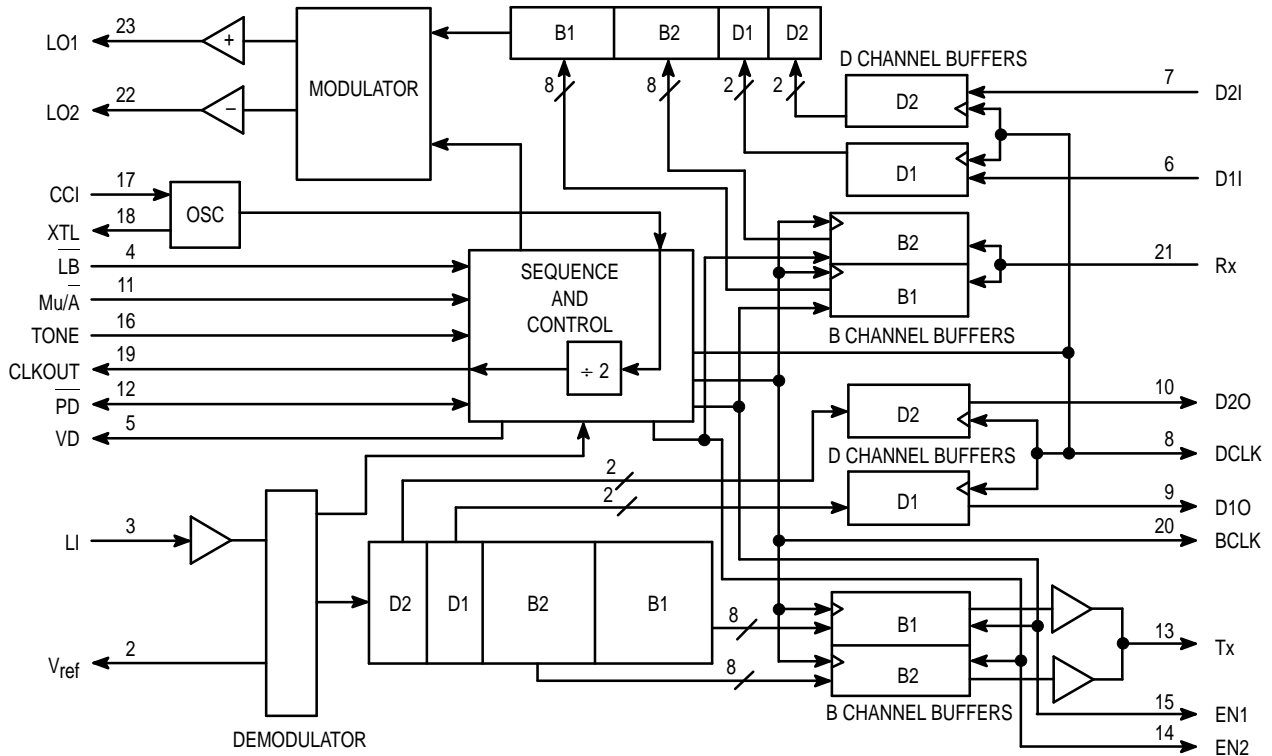
### MC145425 — SLAVE (PLASTIC AND SOG PACKAGES)

V <sub>SS</sub>	□	1	●		24	□	V <sub>DD</sub>
V <sub>ref</sub>	□	2			23	□	LO1
LI	□	3			22	□	LO2
$\overline{\text{LB}}$	□	4			21	□	Rx
VD	□	5			20	□	BCLK
D1I	□	6			19	□	CLKOUT
D2I	□	7			18	□	XTL
DCLK	□	8			17	□	CCI
D1O	□	9			16	□	TONE
D2O	□	10			15	□	EN1
$\overline{\text{Mu/A}}$	□	11			14	□	EN2
$\overline{\text{PD}}$	□	12			13	□	Tx

### MC145421 MASTER ISDN BLOCK DIAGRAM



### MC145425 SLAVE ISDN BLOCK DIAGRAM



**ABSOLUTE MAXIMUM RATINGS** (Voltage Referenced to  $V_{SS}$ )

Rating	Symbol	Value	Unit
DC Supply Voltage	$V_{DD} - V_{SS}$	- 0.5 to 6.5	V
Voltage Any Pin to $V_{SS}$	V	- 0.5 to $V_{DD} + 0.5$	V
DC Current, Any Pin (Excluding $V_{DD}$ , $V_{SS}$ )	I	$\pm 10$	mA
Operating Temperature	$T_A$	- 40 to + 85	$^{\circ}\text{C}$
Storage Temperature	$T_{stg}$	- 85 to + 150	$^{\circ}\text{C}$

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

**RECOMMENDED OPERATING CONDITIONS** ( $T_A = -40$  to  $+85^{\circ}\text{C}$ )

Parameter	Pins	Min	Typ	Max	Unit
DC Supply Voltage	$V_{DD}$	4.5	5.0	5.5	V
Frame Rate MC145421 (See Note)	MSI	—	8.0	—	kHz
MC145421/25 Frame Slip Rate (See Note)	—	—	—	0.25	%
CCI Clock Frequency	—	—	8.192	8.29	MHz
TDC/RDC Data Clocks (for Master)	—	0.128	—	4.1	MHz
DCLK	—	0.016	—	4.1	MHz
Modulation Baud Rate (CCI/16)	LO1, LO2	—	512	—	kHz

NOTE: The slave's crystal frequency divided by 1024 must equal the master's MSI frequency  $\pm 0.25\%$  for optimum operation. Also, the 8.192 MHz input at the master divided by 1024 must be within 0.048% of the master's 8 kHz MSI clock frequency.

**DIGITAL CHARACTERISTICS** ( $V_{DD} = 5$  V,  $T_A = -40$  to  $+85^{\circ}\text{C}$ )

Parameter		Min	Max	Unit
Input High Level		3.5	—	V
Input Low Level		—	1.5	V
Input Current, $V_{DD}$		—	15	mA
Input Current (Digital Pins)		—	5	$\mu\text{A}$
Input Capacitance		—	10	pF
Output High Current (Except Tx on Master and Slave, and PD on the Slave)	$V_{OH} = 2.5$ $V_{OH} = 4.6$	- 1.7 - 0.36	— —	mA
Tx Output High Current	$V_{OH} = 2.5$ $V_{OH} = 4.6$	- 3.4 - 0.7	— —	mA
PD (Slave) Output High Current (See Note)	$V_{OH} = 2.5$	—	- 90	$\mu\text{A}$
Output Low Current (Except Tx on Master and Slave, and PD on Slave)	$V_{OL} = 0.4$ $V_{OL} = 0.8$	0.36 0.8	— —	mA
Tx Output Low Current	$V_{OL} = 0.4$ $V_{OL} = 0.8$	1.7 3.5	— —	mA
PD (Slave) Output Low Current (See Note)	$V_{OL} = 0.4$	30	60	$\mu\text{A}$
Tx Three-State Impedance		100	—	k $\Omega$
XTL Output High Current	$V_{OH} = 4.6$	—	- 450	$\mu\text{A}$
XTL Output Low Current	$V_{OH} = 0.4$	450	—	$\mu\text{A}$

NOTE: To overdrive PD from a low level to 3.5 V, or a high level to 1.5 V requires a minimum of  $\pm 800$   $\mu\text{A}$  drive capability.

**ANALOG CHARACTERISTICS** ( $V_{DD} = 5$  V,  $T_A = 0$  to  $70^{\circ}\text{C}$ )

Parameter	Min	Max	Unit
Modulation Differential Amplitude $R_L = 880 \Omega$ (LO1 - LO2)	4.6	—	V <sub>peak</sub>
Modulation Differential DC Offset	—	40	mV
$V_{ref}$ Voltage (Typically $9/20 \cdot (V_{DD} - V_{SS})$ )	2.0	2.5	V
PCM Tone Level	- 22	- 18	dBm
Demodulator Input Amplitude	50	—	mV <sub>peak</sub>
Demodulator Input Impedance (LI to $V_{ref}$ )	75	300	k $\Omega$

## MC145421 MASTER PIN DESCRIPTIONS

### VDD

#### Positive Supply (Pin 24)

The most positive power supply pin, normally + 5 V with respect to VSS.

### VSS

#### Negative Supply (Pin 1)

The most negative supply pin and logic ground, normally 0 V.

### Vref

#### Reference Output (Analog Ground) (Pin 2)

This pin is the output of the internal reference supply and should be bypassed to VDD and VSS with 0.1  $\mu$ F capacitors. This pin usually serves as an analog ground reference for transformer coupling of the device's incoming bursts from the line. No external dc load should be placed on this pin.

### LI

#### Line Input (Pin 3)

This pin is an input to the demodulator for the incoming bursts. The input has an internal 240 k $\Omega$  resistor tied to the Vref pin, so an external capacitor or line transformer may be used to couple the input signal to the device with no dc offset.

### LO1, LO2

#### Line Driver Outputs (Pins 23, 22)

These push-pull outputs drive the twisted pair transmission line with a 512 kHz modified DPSK (MDPSK) burst each 125  $\mu$ s, in other words at an 8 kHz rate. When not modulating the line, these pins are driven to the active high state — being the same potential, they create an ac short. When used in conjunction with feed resistors, proper line termination is maintained.

### SE

#### Signal Enable Input (Pin 11)

At the time of a negative transition on this pin, an internal latch stores the states of LB and PD for as long as SE is held low. During this time, the VD, DO1, and DO2 outputs are driven to the high-impedance state. When SE is high, all pins function normally.

### LB

#### Loopback Control (Pin 4)

A low level on this pin ties the internal modulator output to the internal demodulator input, which loops the entire burst for testing purposes. During the loopback operation, the LI input is ignored and the LO1 and LO2 drivers are driven to the active high level. The state of this pin is internally latched if the SE pin is held low. This feature is only active when the PD input is high.

### PD

#### Power-Down Input (Pin 12)

When held low the ISDN UDLT powers down, except the circuitry that is necessary to demodulate an incoming burst and to output VD, B, and D channel data bits. When PD is brought high, the ISDN UDLT powers up. Then, it begins

transmitting every MSI period to the slave device, shortly after the rising edge of MSI. The state of this pin is latched if the SE pin is held low.

### VD

#### Valid Data Output (Pin 5)

A high level on this pin indicates that a valid line transmission has been demodulated. A valid transmission burst is determined by proper synchronization and the absence of detected bit errors. VD changes state on the rising edge of MSI when PD is high. When PD is low, VD changes state at the end of demodulation of a transmission burst and does not change again until three MSI rising edges have occurred, at which time it goes low, or until the next demodulation of a burst. VD is a standard B-series CMOS output and is high impedance when SE is low.

### MSI

#### Master Sync Input (Pin 16)

This pin is the master, 8 kHz frame reference input. The rising edge of MSI loads B and D channel data which had been input during the previous frame into the modulator section of the device and initiates the outbound burst onto the twisted-pair cable. The rising edge of MSI also initiates the buffering of the B and D channel data demodulated during the previous frame. MSI should be approximately leading edge aligned with the TDC/RDC data clock input pin.

### CCI

#### High-Speed Clock Input (Pin 17)

An 8.192 MHz clock should be supplied to this input. The 8.192 MHz input should be 50% duty cycle. However, it may free-run with respect to all other clocks without performance degradation.

### D11, D2I

#### D Channel Signaling Bit Inputs (Pins 6, 7)

These inputs are 16 kbps serial data inputs. Two bits should be clocked into each of these inputs between the rising edges of the MSI frame reference clock. The first bit of each D channel is clocked into an intermediate buffer on the first falling edge of the DCLK following the rising edge of MSI. The second bit of each D channel is clocked in on the next negative transition of the DCLK. If further DCLK negative edges occur, new information is serially clocked into the buffer replacing the previous data one bit at a time. Buffered D channel data bits are burst to the slave device on the next rising edge of the MSI frame reference clock.

### D1O, D2O

#### D Channel Signal Outputs (Pins 9, 10)

These serial outputs provide the 16 kbps D channel signaling information from the incoming burst. Two data bits should be clocked out of each of these outputs between the rising edges of the MSI frame reference clock. The rising edge of MSI produces the first bit of each D channel on its respective pin. Circuitry then searches for a negative D channel clock edge. This tells the D channel data shift register to produce the second D channel bit on the next rising edge of the DCLK. Further positive edges of the DCLK recirculate the D channel output buffer information.

## DCLK

### D Channel Clock Input (Pin 8)

This input is the transmit and receive data clock for both D channels. D channel input and output operation is described in the D1O, D2O pin description.

## Tx

### Transmit Data Output (Pin 13)

This pin is high impedance when both TE1 and TE2 are low. This pin serves as an output for B channel information received from the slave device. The B channel data is under the control of TE1, TE2, and TDC/RDC. (See TE1, TE2 description.)

## Rx

### Receive Data Input (Pin 21)

B channel data is input on this pin and is controlled by the RE1, RE2, and TDC/RDC pins. (See RE1, RE2 description.)

## TE1, TE2

### Transmit Data Enable Input (Pins 14, 15)

These two pins control the output of data for their respective B channel on the Tx output pin. When both TE1 and TE2 are low, the Tx pin is high impedance. The rising edge of the respective enable produces the first bit of the selected B channel data on the Tx pin. Internal circuitry then scans for the next negative transition of the TDC/RDC clock. Following this event, the next seven bits of the selected B channel data are output on the next seven rising edges of the TDC/RDC data clock. When TE1 and TE2 are high simultaneously, data on the Tx pin is undefined. TE1 and TE2 should be approximately leading-edge aligned with the TDC/RDC data clock signal. In order to keep the Tx pin out of the high-impedance state, these enable lines should be high while the respective B channel data is being output.

## RE1, RE2

### Receive Data Enable Inputs (Pins 19, 20)

These inputs control the input of B channel data on the Rx pin of the device. The rising edge of the respective enable signal causes the device to load the selected receive data buffer with data from the Rx pin on the next eight falling edges of the TDC/RDC clock input. The RE1 and RE2 enables should be roughly leading-edge aligned with the TDC/RDC data clock input. These enables are rising edge sensitive and need not be high for the entire B channel input period.

## TDC/RDC

### Transmit/Receive Data Clock Input (Pin 18)

This input is the transmit and receive data clock for the B channel data. As described in the TE1/TE2 and the RE1/RE2 sections, output data changes state on the rising edge of this signal, and input data is read on the falling edges of this signal. TDC/RDC should be roughly leading-edge aligned with the TE1, TE2, RE1, and RE2 enables, as well as the MSI frame reference signal.

## MC145425 SLAVE PIN DESCRIPTIONS

## VDD

### Positive Supply (Pin 24)

The most positive power supply pin, normally + 5 V with respect to VSS.

## VSS

### Negative Supply (Pin 1)

The most negative supply pin and logic ground, normally 0 V.

## Vref

### Reference Output (Analog Ground) (Pin 2)

This pin is the output of the internal reference supply and should be bypassed to VDD and VSS with 0.1  $\mu$ F capacitors. This pin usually serves as an analog ground reference for transformer coupling of the device's incoming bursts from the line. No external dc load should be placed on this pin.

## LI

### Line Input (Pin 3)

This pin is an input to the demodulator for the incoming bursts. The input has an internal 240 k $\Omega$  resistor tied to the Vref pin, an external capacitor or line transformer may be used to couple the input signal to the device with no dc offset.

## LO1, LO2

### Line Driver Outputs (Pins 23, 22)

These push-pull outputs drive the twisted pair transmission line with a 512 kHz modified DPSK (MDPSK) burst each 125  $\mu$ s; in other words at an 8 kHz frame rate. When not modulating the line, these pins are driven to the active high state — being the same potential, they create an ac short. When used in conjunction with feed resistors, proper line termination is maintained.

## CLK OUT

### Clock Output (Pin 19)

This pin serves as a buffered output of the crystal frequency divided by two. This clock is provided for systems using the MC145428 Data Set Interface asynchronous/synchronous terminal adaptor device.

## LB

### Loopback Control Input (Pin 4)

When this pin is low, the incoming B channels from the master are burst back to the master — instead of the Rx B channel input data. The B channel data from the master continues to be output at the slave's Tx pin during loopback. If the TONE and the loopback function are active simultaneously, the loopback function overrides the TONE function. D channel data is not affected by LB.

## VD

### Valid Data Output (Pin 5)

A high on this pin indicates that a valid transmission burst has been demodulated. A valid burst is determined by proper synchronization and the absence of detected bit errors. If no transmissions from the master have been received in the last 250  $\mu$ s, as determined by an internal oscillator, VD will go low.

## **Mu/A**

### **Tone Format Input (Pin 11)**

This pin determines the PCM code for the 500 Hz square wave tone generated when the TONE input is high — Mu-Law (Mu/A = 1) or CCITT A-Law (Mu/A = 0) format.

## **TONE**

### **Tone Enable Input (Pin 16)**

A high on this pin causes a 500 Hz square wave PCM tone to be inserted in place of the demodulated B channel data on B channel 1. This feature allows the designer to provide audio feedback for telset keyboard operations.

## **PD**

### **Power Down Input/Output (Pin 12)**

This is a bidirectional pin with a weak output driver so that it can be externally overdriven. When held low, the ISDN UDLT is powered down, and the only active circuitry is that which is necessary for demodulation, generation of EN1, EN2, BCLK, and DCLK, and outputting of the data bits and VD. When held high, the ISDN UDLT is powered up and transmits normally in response to received bursts from the master. If the ISDN UDLT is powered up for 250  $\mu$ s — which is derived from an internal oscillator and no bursts from the master have occurred — the ISDN slave UDLT generates a free-running set of EN1, EN2, BCLK, and DCLK signals and sends a burst to the master device every other 125  $\mu$ s frame. This is a wake-up signal to the master.

When PD is floating and a burst from the master is demodulated, the weak output drivers will try to force PD high. It will try to force PD low if 250  $\mu$ s have elapsed without a burst from the master being successfully demodulated. This allows the slave device to self power up and down in demand-powered loop systems.

## **CCI**

### **Crystal Input (Pin 17)**

Normally, an 8.192 MHz crystal is tied between this pin and the XTL pin. A 10 M $\Omega$  resistor between CCI and XTL and 25 pF capacitors from CCI and XTL to V<sub>SS</sub> are required to ensure stability and start-up. CCI may also be driven with an external 8.192 MHz signal if a crystal is not desired.

## **XTL**

### **Crystal Output (Pin 18)**

This pin is capable of driving one external CMOS input and 15 pF of additional load capacitance.

## **D11, D21**

### **D Channel Inputs (Pins 6, 7)**

These two pins are inputs for the 16 kbps D data channels. The D channel data bits are clocked in serially on the negative edge of the 16 kbps DCLK output pin.

## **D10, D20**

### **D Channel Outputs (Pins 9, 10)**

These two pins are outputs for the 16 kbps D data channels. These pins are updated on the rising edges of the slave DCLK output pin.

## **Tx**

### **Transmit Data Output (Pin 13)**

This line is an output for the B channel data received from the master. B channel 1 data is output on the first eight cycles of the BCLK output when EN1 is high. B channel 2 data is output on the next eight cycles of the BCLK, when EN2 is high. B channel data bits are clocked out on the rising edge of the BCLK output pin.

## **DCLK**

### **D Channel Clock Output (Pin 8)**

This output is the transmit and receive data clock for both D channels. It starts upon demodulation of a burst from the master device. This signal is rising edge aligned with the EN1 and BCLK signals. After the demodulation of a burst, the DCLK line completes two cycles and then remains low until another burst from the master is demodulated. In this manner synchronization with the master is established and any clock slip between master and slave is absorbed each frame.

## **Rx**

### **Receive Data Input (Pin 21)**

This pin is an input for the B channel data. B channel 1 data is clocked in on the first eight falling edges of the BCLK output following the rising edge of the EN1 output. B channel 2 data is clocked in on the next eight falling edges of the BCLK following the rising edge of the EN2 output.

## **EN1**

### **B Channel 1 Enable Output (Pin 15)**

This line is an 8 kHz enable signal for the input and output of the B channel 1 data. While EN1 is high, B channel 1 data is clocked out on the Tx pin on the first eight rising edges of the BCLK. During this same time, B channel 1 input data is clocked in on the Rx pin on the first eight falling edges of the BCLK. The VD pin is also updated on the rising edge of the EN1 signal. EN1 serves as the slave device's 8 kHz frame reference signal.

## **EN2**

### **B Channel 2 Enable Output (Pin 14)**

This pin is the logical inverse of the EN1 output and is used to signal the time slot for the input and output of data for the B channel 2 data.

## **BCLK**

### **B Channel Data Clock Output (Pin 20)**

This is a standard B series output which provides the data clock for the B channel data. This clock signal is 128 kHz and begins operating upon the successful demodulation of a burst from the master. At this time, EN1 goes high and BCLK starts toggling. BCLK remains active for 16 periods, at the end of which time it remains low until another burst is received from the master. In this manner synchronization between the master and slave is established and any clock slippage is absorbed each frame.

## BACKGROUND

The MC145421 and the MC145425 ISDN UDLTs provide an economical means of sending and receiving two B channels (64 kbps each) of voice/data and two D channels (16 kbps each) of signal data in a two-wire configuration at distances up to one kilometer. There are two ISDN UDLTs, master and slave. The master UDLT is compatible with existing and evolving PABX architectures. This device transmits 2B+2D channels of data to the remote slave. At the remote end, the slave device presents a replica of the PBX backplane to the terminal devices.

These devices permit existing digital PBX architectures to remain unchanged and provide enhanced voice/data communication services throughout the PBX service area by simply replacing a subscriber's line card and telset.

All operations occur within the boundaries of an 8 kHz frame (125  $\mu$ s). In the master, the frame sequence begins on the rising edge of MSI. In the slave, the frame begins after the demodulation of a burst from the master. The slave initializes its timing controls at this point to stay synchronized with the master.

During one 125  $\mu$ s frame four main activities are performed:

1. Previously buffered 2B+2D channel data is burst to the other end.
2. New 2B+2D channel data is accepted for the next frame's transmission.
3. An incoming burst is demodulated and stored.
4. 2B+2D channel data from the previous demodulated frame is output.

The bursts are 20 bits long, composed of two 8-bit B channels and two 2-bit D channels. Bursts are encoded using a modified DPSK method at 512 kHz. Since a single wire pair is used, half-duplex operation is used. A 512 kHz burst is sent from end to end in a ping-pong fashion. This method provides apparent full-duplex 160 kbps transmission of data at distances up to one kilometer.

## GENERAL

The ISDN UDLT consists of a modulator, a demodulator, intermediate data registers, receive and transmit data registers, and sequencing and control logic. The Rx and Tx buffers interface digitally to the line card backplane signals, while the modulator and demodulator interface to the twisted pair transmission media. Intermediate data registers buffer data between these main components. The ISDN UDLT is intended to operate with a 5 V power supply and can be driven by CMOS or TTL logic.

## MASTER OPERATION

In the master, the rising edge of MSI initiates the 125  $\mu$ s frame. B channel data is clocked into the Rx registers under control of TDC/RDC, RE1, and RE2. This data is combined with the D channel data clocked in on pins D11 and D21 by the DCLK. The resulting 20-bit packet is stored for the next frame transmission to the slave UDLT.

The burst output to the slave consists of the 2B+2D data loaded during the previous frame. The burst received from the slave is demodulated and stored for outputting in the following frame.

B channel bits demodulated in the previous frame are output on the Tx pin under control of TDC/RDC, TE1, and TE2. Demodulated D channel bits are output on the D1O and D2O output pins. The indication of a valid burst demodulation is the VD output, which is updated at the start of every frame.

## SLAVE OPERATION

In normal slave operation, the main synchronizing event is completion of demodulating a burst from the master UDLT. This action initializes the 125  $\mu$ s frame boundary of the slave. During the slave frame, B channel data is loaded and stored under control of the BCLK, EN1, and EN2 outputs. D channel data is loaded at D11 and D21 under control of the DCLK output.

The demodulated burst from the master is separated into its D channel and B channel components and output on the D1O, D2O, and Tx pins. The return burst to the master consisting of previously loaded 2B+2D data is transmitted eight bauds after the completion of demodulation of the master's burst. This provides a period for line transients to diminish.

The start of the slave frame initiates two cycles of the 16 kHz DCLK, and one cycle each of the 8 kHz EN1 and EN2 enables. After completing their cycles, these outputs remain low until another demodulation signals the start of a new slave frame. In this manner, clock slip between the master and slave UDLTs is absorbed each frame.

## POWER-DOWN OPERATION

When PD is low in the master, the ISDN UDLT is powered down and only that circuitry necessary to demodulate incoming bursts is active. No transmissions to the slave occur during power down. If the master is receiving bursts from the slave, the VD pin will change state upon completion of the demodulation.

When the PD input pin is driven high, the master ISDN UDLT is powered up. In this mode, the master bursts to the slave every frame. B and D channel data can be loaded and unloaded and VD is updated on the MSI rising edge.

If no bursts are received by the master, whether powered up or not, the B channel data is unknown and the D channel bits will remain at their last known values.

The PD pin on the slave UDLT is bidirectional with a weak output driver that can be overdriven externally. When low, either externally or internally derived, the slave is powered down. No bursts to the master can be transmitted. EN1, EN2, BCLK, and DCLK outputs are inactive during power down except when TONE is high or a burst has been received from the master. B and D channel data can be loaded and unloaded, and VD is updated upon completion of demodulation of an incoming burst from the master. Input B and D channel data is not transmitted until the slave is powered up, in which case the first burst contains the most recently loaded data.

When the PD pin is high, the slave is powered up and transmits every frame, the data enables and clocks are output, and data can be loaded and unloaded.

## TIME-OUT OPERATION

Time-out is an operating state in both the UDLT master and slave devices. This state indicates that no incoming bursts have been demodulated, forcing the VD pin low. An internal counter is incremented for each frame that does not contain an incoming burst. The counter is reset upon demodulating a burst from the far end. Time-out can occur whether the device is powered up or down.



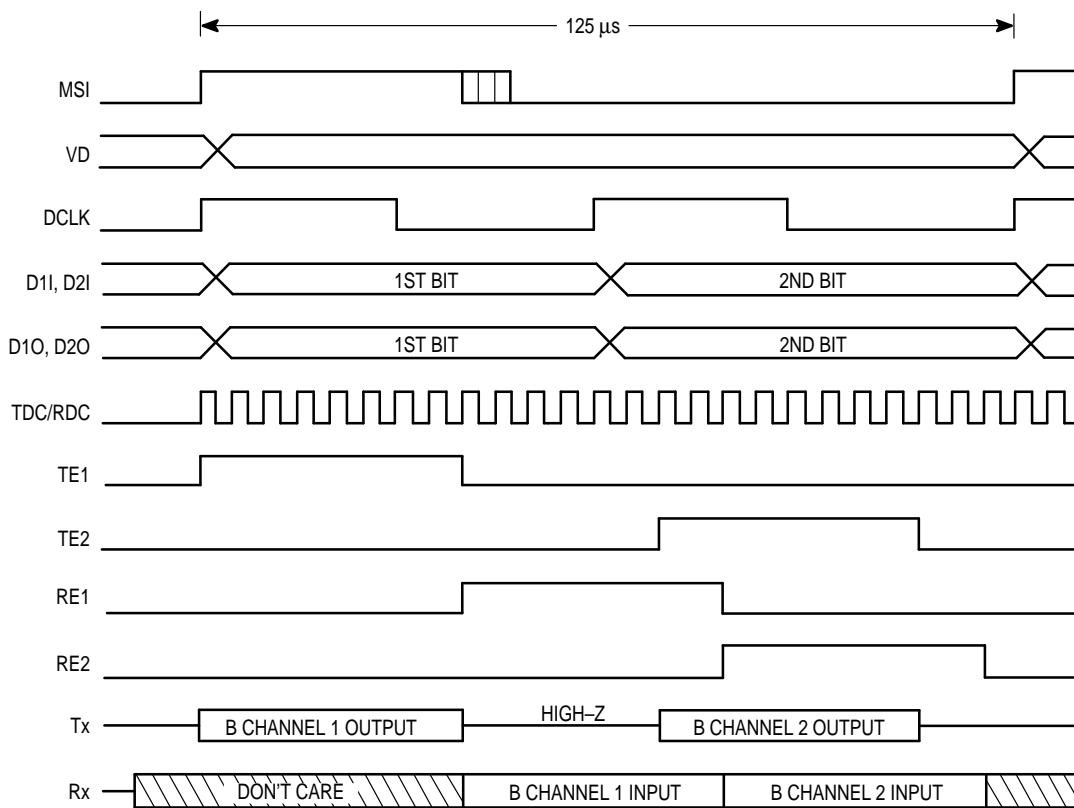
In the master, time-out begins on the rising edge of the third MSI following the last received burst. This is equivalent to two MSI frames. The VD output is forced low during time-out. The B channel output data will be unknown, but the D channel bits will remain at their last values. Successful demodulation of a burst from the slave will result in leaving the time-out state on the next rising MSI edge.

When the PD pin is used as an output on the slave UDLT, time-out controls the pin. Time-out forces the PD output low to indicate that the device has powered itself down. In this case, the slave will not transmit to the master. However,

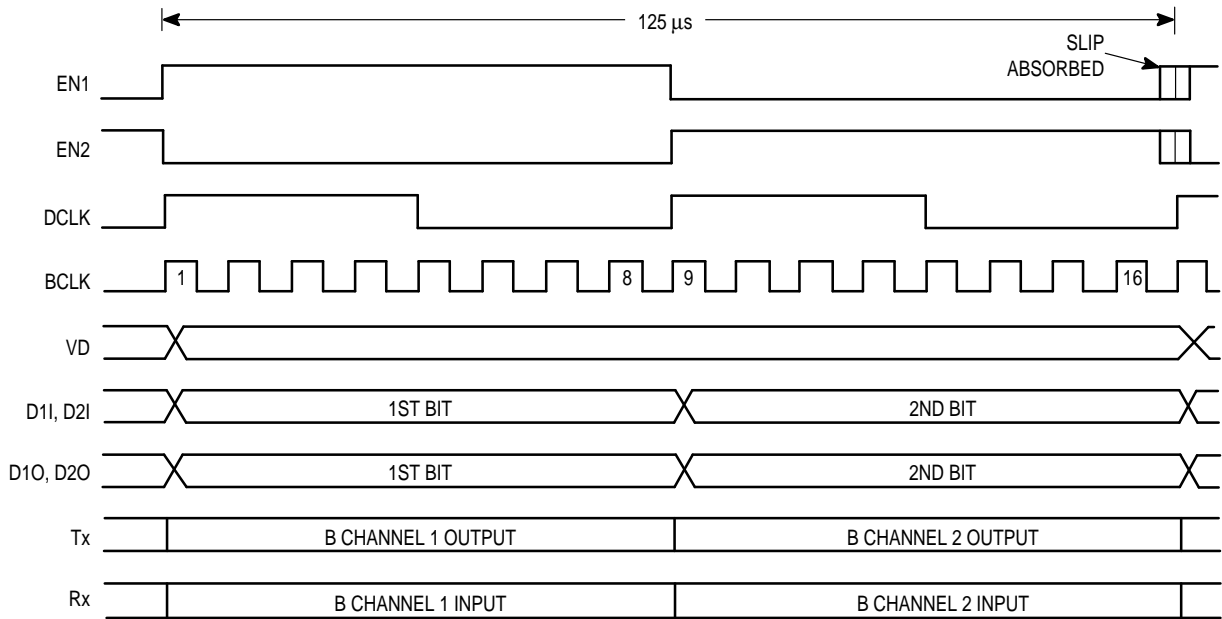
when a valid burst is received, time-out ends and the  $\overline{\text{PD}}$  pin is driven high to indicate power up. This feature allows the slave UDLT to self-power-up and down in demand-powered loop systems.

**NOTE**

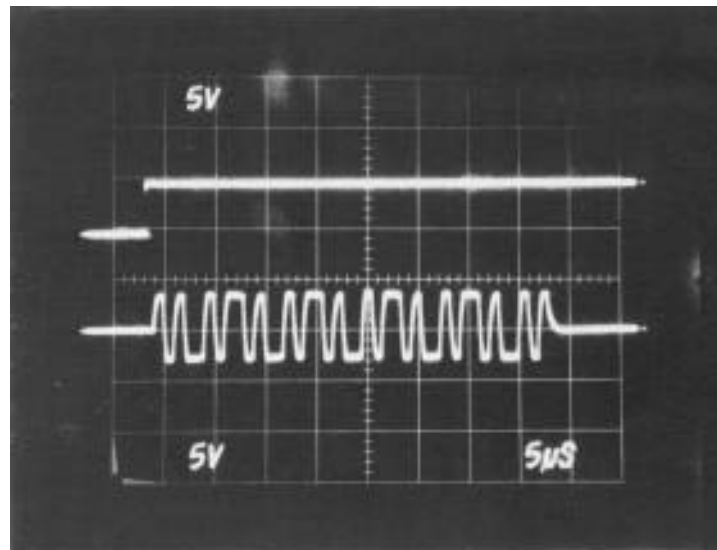
The slave uses a free running clock during time-out. After a long period without a burst from the master, the timing between master and slave could be such that more than one burst will be needed to resync the two devices.



**Figure 1. Typical MC145421 Master ISDN UDLT Timing**

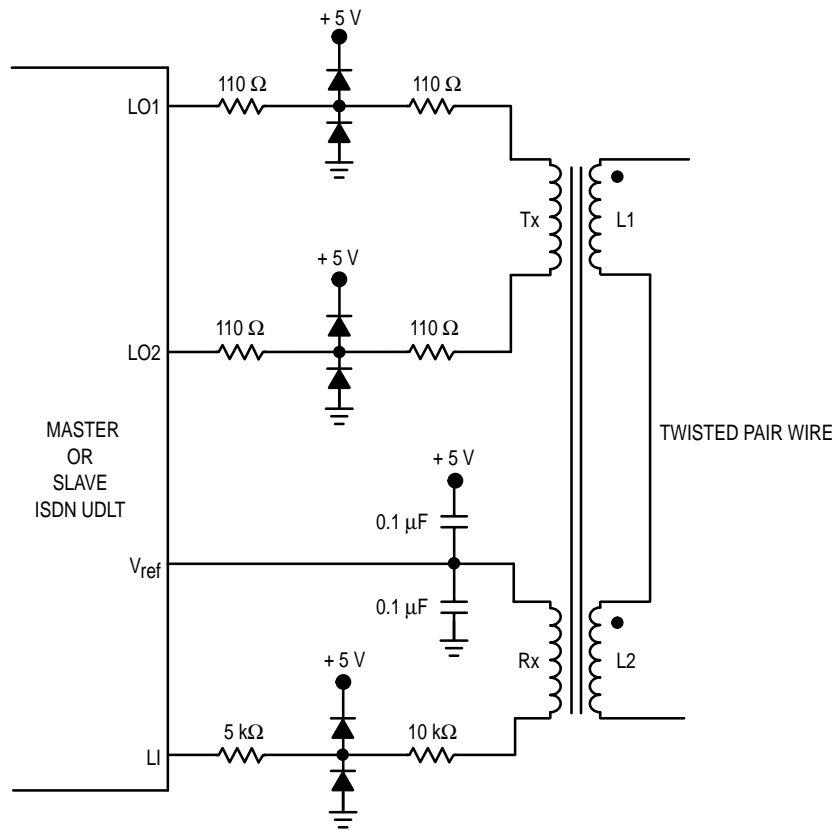


**Figure 2. MC145425 Slave ISDN UDLT Timing**



Top Trace: MSI  
Bottom Trace: Outgoing burst measured at LI (with respect to  $V_{ref}$ )

**Figure 3. Master Burst**



TRANSFORMER PARAMETERS  
 INDUCTANCE OF Tx: WINDING: 1.75 mH  
 TURNS RATIO: Tx L1 + L2 2:1  
 TURNS RATIO: Rx L1 + L2 4:1  
 DIODES: 1N4148 OR EQUIVALENT

**Figure 4. Interface to Twisted Pair Wire**

**SWITCHING CHARACTERISTICS** ( $V_{DD} = 5\text{ V}$ ,  $T_A = 0\text{ to }70^\circ\text{C}$ ;  $C_{Load} = 50\text{ pF}$ )

No.*	Parameter	Min	Max	Unit
<b>Master Timing</b>				
1	TDC/RDC Pulse Width High	110	—	ns
2	TDC/RDC Pulse Width Low	110	—	ns
3	MSI Rising Edge to TDC/RDC Falling Edge	90	—	ns
4	MSI Pulse Width	200	—	ns
5	MSI Rising Edge to First DCLK Falling Edge	90	—	ns
6	MSI Rising Edge to First D1O, D2O Bit Valid	—	100	ns
7	TE1, TE2 Rising Edge to TDC/RDC Falling Edge	110	—	ns
8	TDC/RDC Falling Edge to TE1, TE2 Rising Edge	20	—	ns
9	TE1, TE2 Rising Edge to First Tx Data Bit Valid	—	50	ns
10	TDC/RDC Rising Edge to Tx Data Bits 2 Through 8 Valid	—	50	ns
11	TE1, TE2 Falling Edge to Tx High-Impedance	—	70	ns
12	RE1, RE2 Rising Edge to TDC/RDC Falling Edge	110	—	ns
13	TDC/RDC Falling Edge to RE1, RE2 Rising Edge	20	—	ns
14	Rx Data Setup (Data Valid Before TDC/RDC Falling Edge)	50	—	ns
15	Rx Data Hold (Data Valid After TDC/RDC Falling Edge)	20	—	ns
16	RE1, RE2 Pulse Width	220	—	ns
17	DCLK Rising Edge to D1O, D2O Bit Valid	—	135	ns
18	D1I, D2I Data Setup (Data Valid Before DCLK Falling Edge)	50	—	ns
19	D1I, D2I Data Hold (Data Valid After DCLK Falling Edge)	20	—	ns
20	DCLK Pulse Width Low	110	—	ns
21	DCLK Pulse Width High	110	—	ns
22	MSI Rising Edge to VD Valid	—	150	ns
23	PD, LB Setup (PD, LB Valid Before MSI Rising Edge)	50	—	ns
24	PD, LB Hold (PD, LB Valid After MSI Rising Edge)	20	—	ns

**Slave Timing**

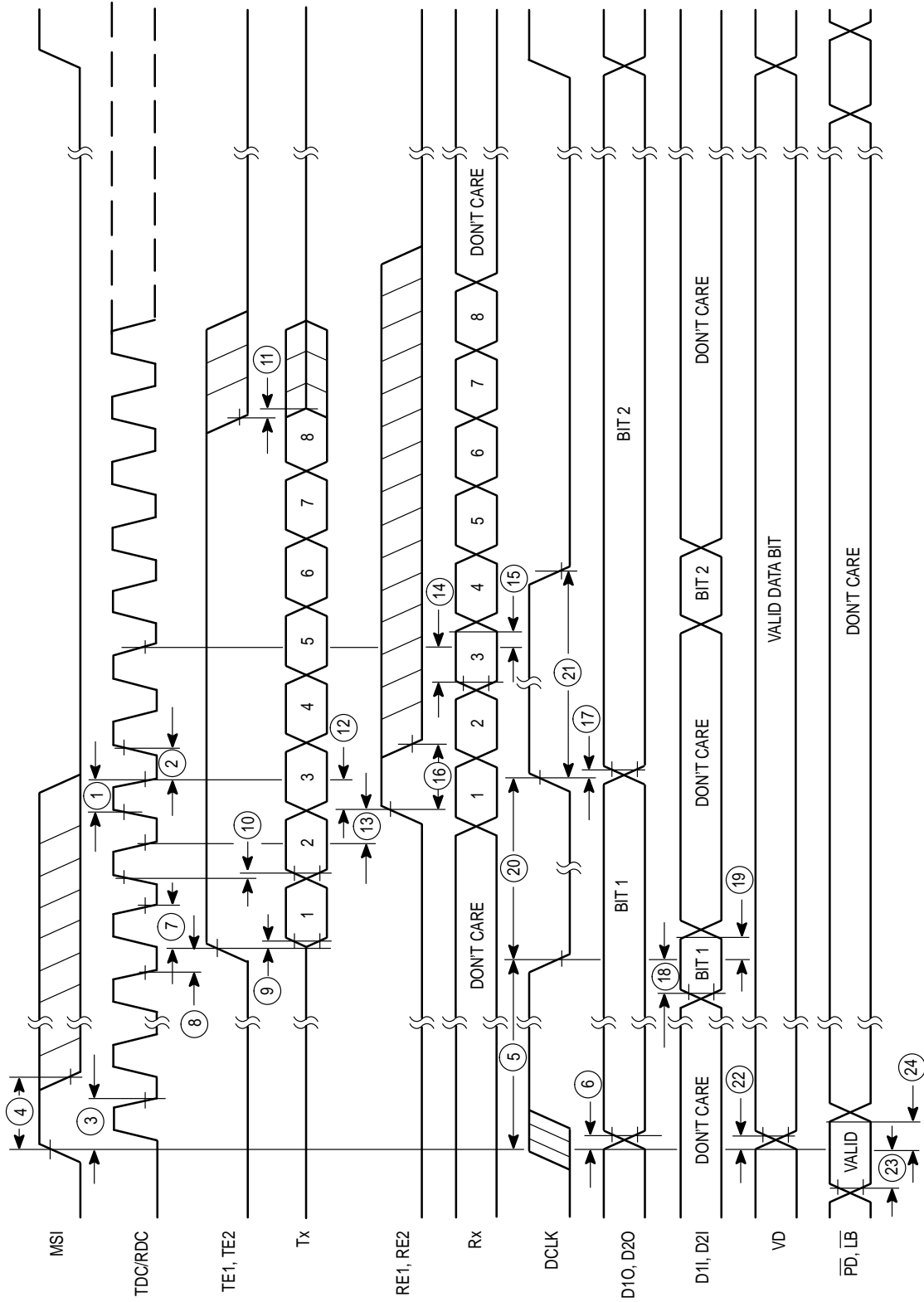
25	BCLK Pulse Width High (CCI = 8.192 MHz)	3.66	4.15	$\mu\text{s}$
26	BCLK Pulse Width Low (CCI = 8.192 MHz)	3.66	4.15	$\mu\text{s}$
27	EN1 or EN2 Rising Edge to BCLK Rising Edge	75	175	ns
28	EN1 or EN2 Rising Edge to DCLK Rising Edge	—	$\pm 50$	ns
29	EN1 or EN2 Rising Edge to First Tx Data Bit Valid	—	50	ns
30	BCLK Rising Edge to Tx Data Bits 2 Through 8 Valid	—	-75	ns
31	DCLK Pulse Width High (CCI = 8.192 MHz)	31.0	31.5	$\mu\text{s}$
32	DCLK Pulse Width Low (CCI = 8.192 MHz)	31.0	31.5	$\mu\text{s}$
33	DCLK Rising Edge to D1O, D2O Bits Valid	—	50	ns
34	Rx Setup (Rx Data Valid Before BCLK Falling Edge)	175	—	ns
35	Rx Hold (Rx Data Valid After BCLK Falling Edge)	20	—	ns
36	D1I, D2I Setup (D1I, D2I Valid Before DCLK Falling Edge)	50	—	ns
37	D1I, D2I Hold (D1I, D2I Valid After DCLK Falling Edge)	20	—	ns
38	EN1 Rising Edge to VD Valid	—	50	ns

**SE Pin Timing**

39	LB, PD Hold (LB, PD Valid After SE Falling Edge)	20	—	ns
40	D1O, D2O, VD High Impedance After SE Falling Edge	—	70	ns
41	D1O, D2O, VD Valid After SE Rising Edge	60	—	ns
42	LB, PD Setup (LB, PD Valid Before SE Rising Edge)	50	—	ns

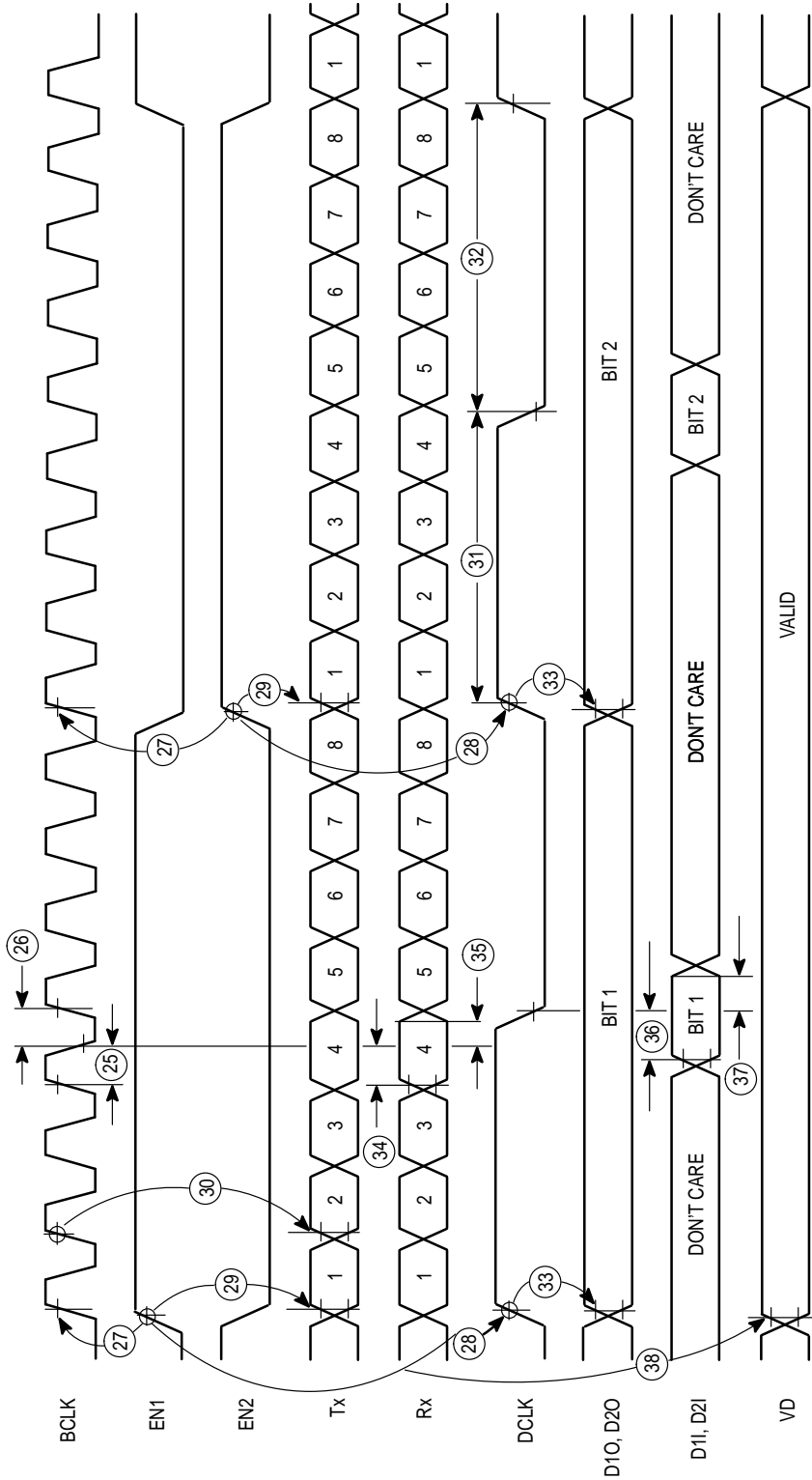
\* See Switching Characteristics waveforms.

### MASTER SWITCHING CHARACTERISTICS

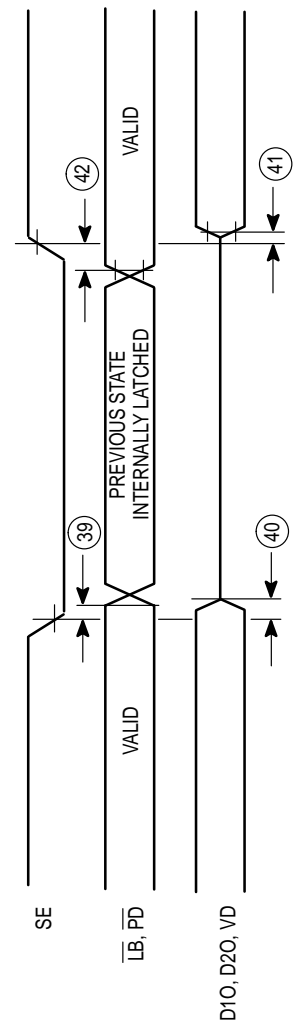


NOTE: All measurement thresholds are 30% or 70% of  $V_{DD}$ .

### SLAVE SWITCHING CHARACTERISTICS



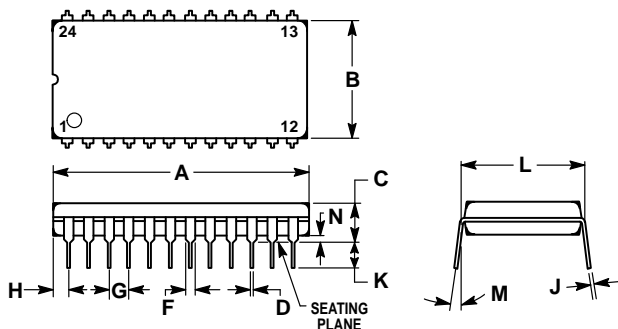
### MASTER SE PIN TIMING



Note: All measurement thresholds are 30% or 70% of  $V_{DD}$ .

# PACKAGE DIMENSIONS

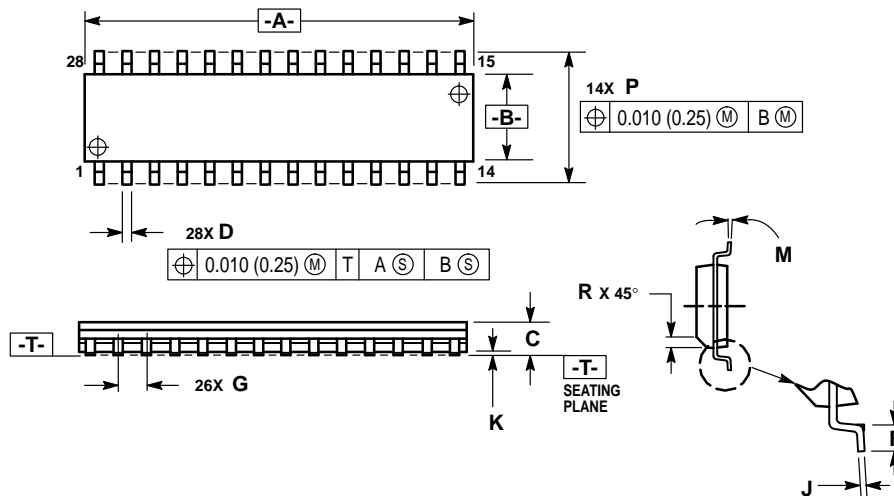
## P SUFFIX PLASTIC PACKAGE CASE 709-02



- NOTES:
1. POSITIONAL TOLERANCE OF LEADS (D), SHALL BE WITHIN 0.25 (0.010) AT MAXIMUM MATERIAL CONDITION, IN RELATION TO SEATING PLANE AND EACH OTHER.
  2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
  3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	31.37	32.13	1.235	1.265
B	13.72	14.22	0.540	0.560
C	3.94	5.08	0.155	0.200
D	0.36	0.56	0.014	0.022
F	1.02	1.52	0.040	0.060
G	2.54 BSC		0.100 BSC	
H	1.65	2.03	0.065	0.080
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	15.24 BSC		0.600 BSC	
M	0°	15°	0°	15°
N	0.51	1.02	0.020	0.040

## DW SUFFIX SOG PACKAGE CASE 751F-04



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
  5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.13 (0.005) TOTAL IN EXCESS OF D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	17.80	18.05	0.701	0.711
B	7.40	7.60	0.292	0.299
C	2.35	2.65	0.093	0.104
D	0.35	0.49	0.014	0.019
F	0.41	0.90	0.016	0.035
G	1.27 BSC		0.050 BSC	
J	0.23	0.32	0.009	0.013
K	0.13	0.29	0.005	0.011
M	0°	8°	0°	8°
P	10.05	10.55	0.395	0.415
R	0.25	0.75	0.010	0.029

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MC145421/D

