

## 2 MBIT PCM SIGNALLING CIRCUIT

# MJ1440

### HDB3 ENCODER/DECODER

The 2.048 MBit PCM Signalling Circuits comprise a group of circuits which will perform the common signalling and error detection functions for a 2.048 MBit PCM transmission link operating to the appropriate CCITT recommendations. The circuits are fabricated in N-channel metal gate MOS and operate from a single 5 volt supply, relevant inputs and outputs are TTL compatible.

The MJ1440 is an encoder/decoder for the pseudoternary transmission code, HDB3 (CCITT Orange Book Vol III.2 Annex to Rec. G703). The device encodes and decodes simultaneously and asynchronously. Error monitoring functions are provided to detect violations of HDB3 coding, all ones detection and loss of input (all zeroes detection). In addition a loop back function is provided for terminal testing.

#### FEATURES

- 5v ± 5% Supply – 50mA Max
- HDB3 Encoding and Decoding to CCITT rec. G703.
- Asynchronous Operation.
- Simultaneous Encoding and Decoding.
- Clock Recovery Signal Generated from Incoming HDB3 Data.
- Loop Back Control.
- HDB3 Error Monitor
- 'All Ones' Error Monitor
- Loss of Input Alarm (All Zeros Detector).
- Decode Data in NRZ Form.

#### ABSOLUTE MAXIMUM RATINGS

The absolute maximum ratings are limiting values above which operating life may be shortened or specified parameters may be degraded.

##### Electrical Ratings

+V <sub>cc</sub>	7V
Inputs	V <sub>cc</sub> + 0.5V Gnd – 0.3V
Outputs	V <sub>cc</sub> , Gnd – 0.3V

##### Thermal Ratings

Max Junction Temperature	175°C
Thermal Resistance: Chip to Case	40°C/Watt
Chip to Amb.	120°C/Watt

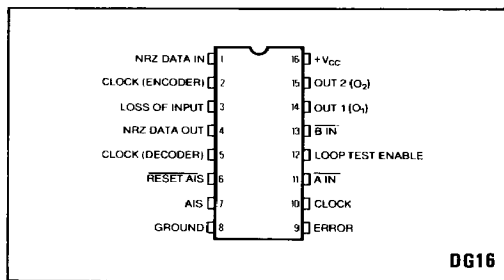


Fig. 1 Pin connections

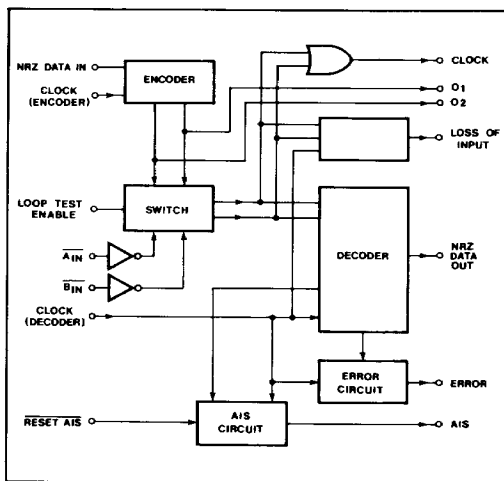


Fig. 2 Block diagram

## ELECTRICAL CHARACTERISTICS

## Test conditions (unless otherwise stated):

Supply voltage,  $V_{CC} = 5V \pm 0.25V$ Ambient temperature,  $T_{amb} = 0^{\circ}C$  to  $+70^{\circ}C$ 

## Static characteristics

Characteristic	Symbol	Pins	Value			Units	Conditions
			Min	Typ	Max		
Low level input voltage	$V_{IL}$	1,2,5,6 10,11,12,13	-0.3		0.8	V	$V_{IL} = 0V$
Low level input current	$I_{IL}$				50	$\mu A$	
High level input voltage	$V_{IH}$		2.5		$V_{CC}$	V	
High level input current	$I_{IH}$			50	$\mu A$	$V_{IH} = 5V$	
Low level output voltage	$V_{OL}$	10,14,15		0.5	V		$I_{sink} = 80\mu A$ $I_{sink} = 1.6mA$
		3,4,7,9		0.4	V		
High level output voltage	$V_{OH}$	3,4,7,9	2.7		V	$I_{source} = 60\mu A$	
		14,15	2.8		V	$I_{source} = 2mA$	
		10	2.8		V	$I_{source} = 1mA$	
Supply current	$I_{CC}$			20	50	mA	All inputs to 0V All outputs open circuit

## Dynamic Characteristics

Characteristic	Symbol	Value			Units	Conditions
		Min.	Typ.	Max.		
Max. Clock (Encoder) frequency	$f_{max_{enc}}$	4.0			MHz	Figs.10, 15
Max. Clock (Decoder) frequency	$f_{max_{dec}}$	2.2			MHz	Figs.11, 15
Propagation delay Clock (Encoder) to $O_1, O_2$	$tpd1A/B$			100	ns	Figs.10, 15. See Note 1
Rise and Fall times $O_1, O_2$				20	ns	Figs.10, 15
$tpd1A$ - $tpd1B$				20	ns	Figs.10, 15
Propagation delay Clock (Encoder) to Clock	$tpd3$			150	ns	Loop test enable = Figs.13, 15
Setup time of NRZ data in to Clock (Encoder)	$ts3$	30			ns	Figs.8, 10, 15
Hold time of NRZ data in	$th3$	55			ns	Figs.10, 15
Propagation delay $A_{in}, B_{in}$ to Clock	$tpd2$			150	ns	Loop test enable = '0' Figs.9, 13, 15
Propagation delay Clock (Decoder) to loss of input				150	ns	
Propagation delay Clock (Decoder) to error	$tpd4$			200	ns	Figs.12, 15
Propagation delay $\overline{\text{Reset AIS}}$ to AIS	$tpd5$			200	ns	Loop test enable = '0' Figs.14, 15
Propagation delay Clock (Decoder) to NRZ data out	$tpd6$			150	ns	Figs.9, 11, 15. See Note 2
Setup time of $A_{in}, B_{in}$ to Clock (Decoder)	$ts1$	75			ns	Figs.9, 11, 15
Hold time of $A_{in}, B_{in}$ to Clock (Decoder)	$th1$	5			ns	Figs.9, 11, 15
Hold time of $\overline{\text{Reset AIS}} = '0'$	$th2$	100			ns	Figs.9, 14, 15
Setup time Clock (Decoder) to $\overline{\text{Reset AIS}}$	$ts2$	200			ns	Figs.9, 14, 15
Setup time $\overline{\text{Reset AIS}} = 1$ to Clock (Decoder)	$ts2'$	0			ns	Figs.14, 15

## NOTES

1. Encoded HDB3 outputs ( $O_1, O_2$ ) are delayed by  $3/2$  clock periods from NRZ data in (Fig.3).
2. The decoded NRZ output is delayed by 3 clock periods from the HDB3 inputs ( $A_{in}, B_{in}$ ) (Fig.4).

**FUNCTIONAL DESCRIPTION**

**Functions Listed by Pin Number**

**1. NRZ data in**

Input data for encoding into ternary HDB3 form. The NRZ data is clocked by the negative edge of the Clock (Encoder).

**2. Clock (Encoder)**

Clock for encoding data on pin 1.

**3. Loss of input alarm**

This output goes to logic '1' if eleven consecutive zeroes are detected in the incoming HDB3 data. The output is set to logic '0' on receipt of a '1'.

**4. NRZ data out**

Decoded data in NRZ form from ternary HDB3 input data ( $A_{in}$ ,  $B_{in}$ ). data is clocked out by positive going edge of clock (Decoder).

**5. Clock (Decoder)**

Clock for decoding ternary data  $A_{in}$ ,  $B_{in}$ .

**6. Reset AIS, AIS**

Logic '0' on Reset AIS resets a decoded zero counter and either resets AIS outputs to zero provided 3 or more zeroes have been decoded in the preceding Reset AIS = 1 period or sets AIS to '1' if less than 3 zeroes have been decoded in the preceding two Reset AIS = 1 periods.

Logic '1' on Reset AIS enables the internal decoded zero counter.

**8. Ground**

Zero volts.

**9. Error**

A logic '1' indicates that a violation of the HDB3 coding has been received i.e. 3 '1's of the same polarity.

**10. Clock**

'OR' function of  $\overline{A_{in}}$ ,  $\overline{B_{in}}$  for clock regeneration when pin 12 = '0', 'OR' function of  $O_1$ ,  $O_2$  when pin 12 = '1'.

**11,13.  $\overline{A_{in}}$ ,  $\overline{B_{in}}$**

Inputs representing the received ternary HDB3 PCM signal.  $\overline{A_{in}}$  = '0' represents a positive going '1',  $\overline{B_{in}}$  = '0' represents a negative going '1'.  $\overline{A_{in}}$  and  $\overline{B_{in}}$  are sampled by the positive going edge of the Clock (Decoder).  $\overline{A_{in}}$  and  $\overline{B_{in}}$  may be interchanged.

**12. Loop test enable**

Input to select normal or loop back operation. Pin 12 = '0' selects normal operation, encode and decode are independent and asynchronous. When pin 12 = '1'  $O_1$  is connected internally to  $A_{in}$ .  $O_2$  is connected to  $B_{in}$ . Clock becomes the OR function  $O_1 + O_2$ . The delay from NRZ in to NRZ out is  $6\frac{1}{2}$  clock periods in the loop back condition.

**14,15.  $O_1$ ,  $O_2$**

Outputs representing the ternary encoded data for line transmission  $O_1$  = '1' representing a positive going '1',  $O_2$  = '1' represents a negative going '1'.  $O_1$  and  $O_2$  may be interchanged.

**16.  $V_{cc}$**

Positive supply, 5V  $\pm$  5%.

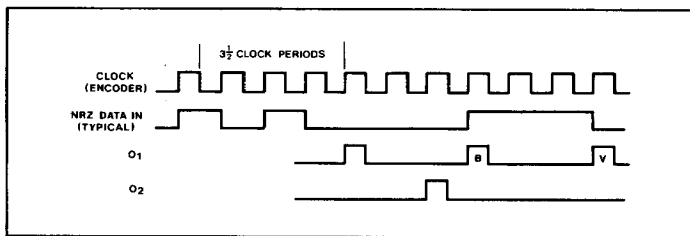


Fig. 3 Encode waveforms

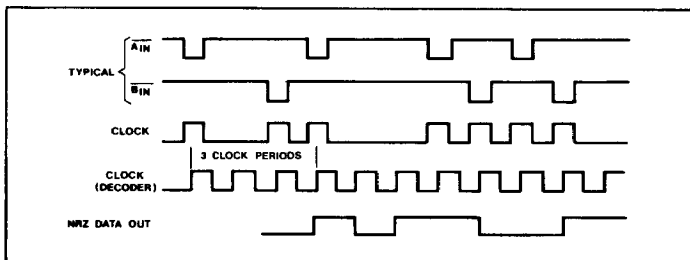


Fig. 4 Decode waveforms

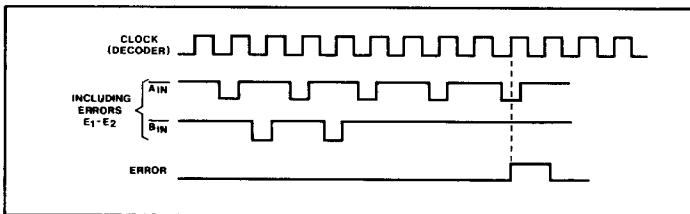


Fig. 5 HDB3 error output waveforms

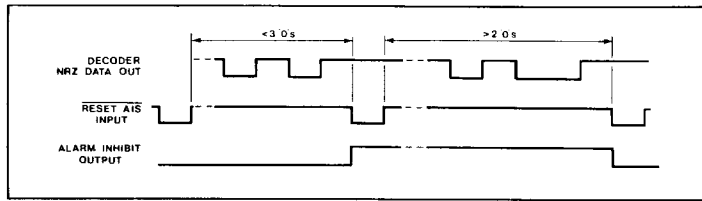


Fig. 6 AIS error and reset waveforms

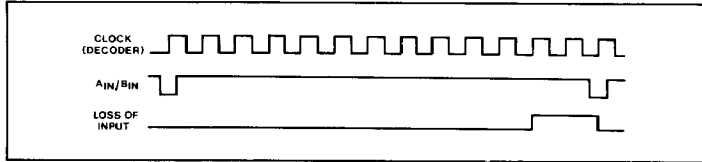


Fig. 7 Loss of input waveforms

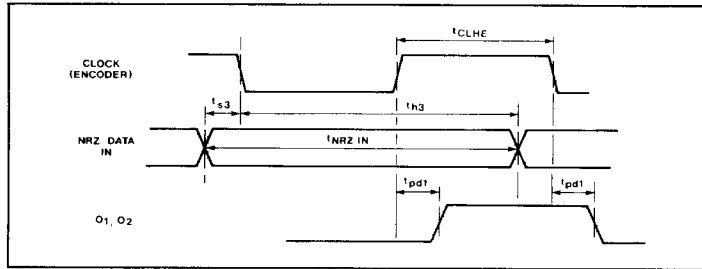


Fig. 8 Encoder timing relationship

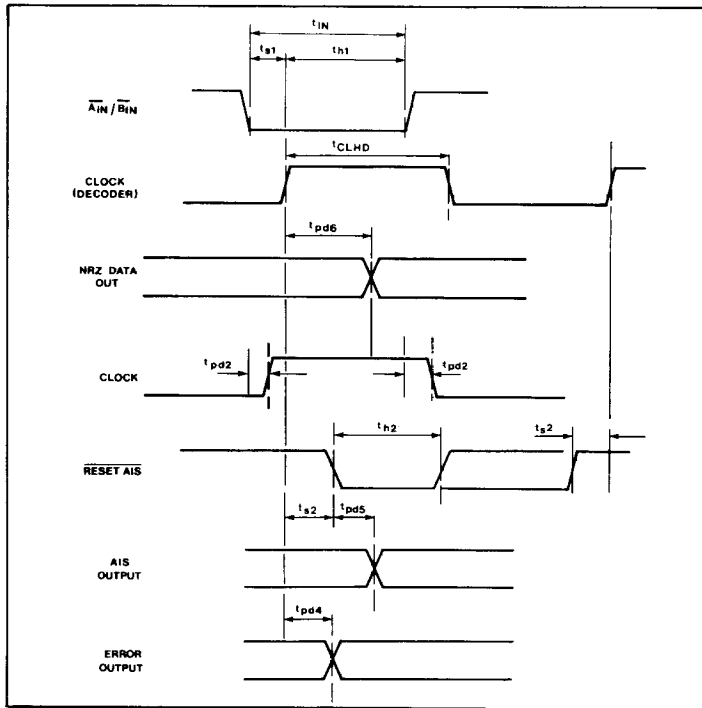


Fig. 9 Decoder timing relationship

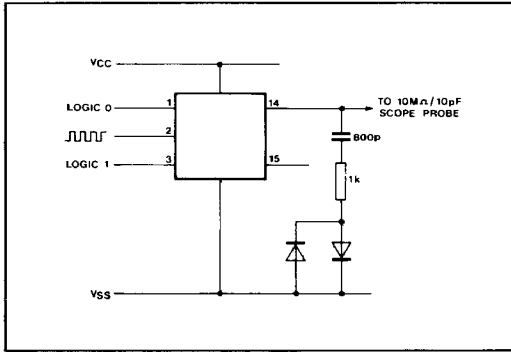


Fig. 10

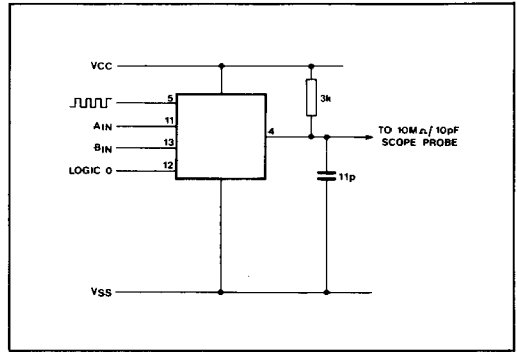


Fig. 11

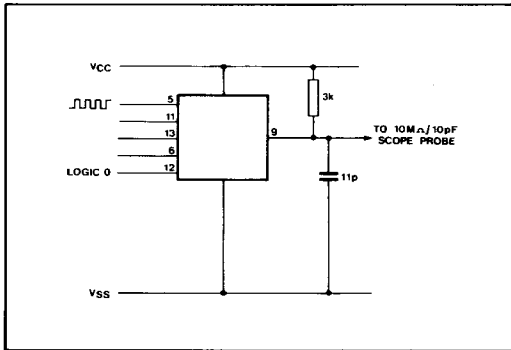


Fig. 12

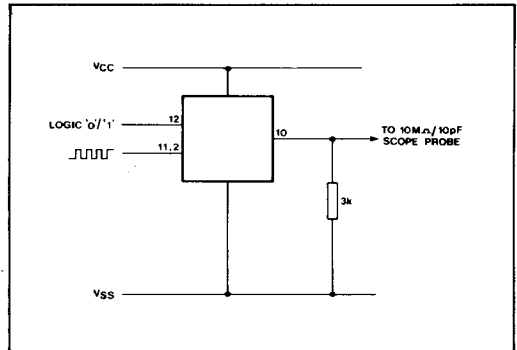


Fig. 13

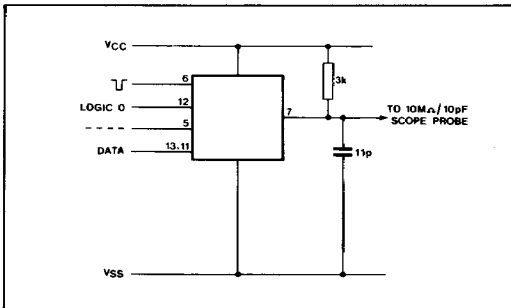


Fig. 14

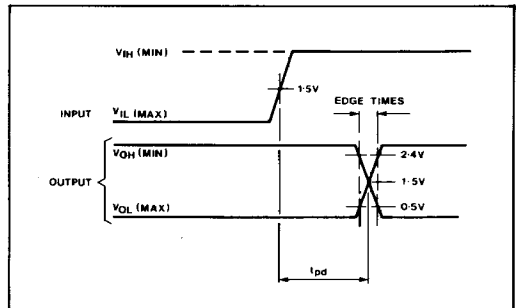


Fig. 15 Test timing definitions

**DEFINITION OF THE HDB3 CODE**

Coding of a binary signal into an HDB3 signal is done according to the following rules:

1. The HDB3 signal is pseudo-ternary, the three states are denoted B<sub>+</sub>, B<sub>-</sub> and O.
2. Spaces in the binary signal are coded as spaces in the HDB3 signal. For strings of four spaces however, special rules apply (see 4. below).
3. Marks in the binary signal are coded alternately as B<sub>+</sub> and B<sub>-</sub> in the HDB3 signal (alternate mark inversion). Violations of the rule of alternate mark inversion are introduced when coding strings of four spaces (see 4. below).
4. Strings of four spaces in the binary signal are coded according to the following rules:
  - a The first space of a string is coded as a space if the

preceding mark of the HDB3 signal has a polarity opposite to the polarity of the preceding violation and is not a violation by itself; it is coded as a mark, i.e. not a violation (i.e. B<sub>+</sub>, B<sub>-</sub>), if the preceding mark of the HDB3 signal has the same polarity as that of the preceding violation or is by itself a violation.

This rule ensures that successive violations are of alternate polarity so that no DC component is introduced.

b The second and third spaces of a string are always coded as spaces.

c The last space of a string of four is always coded as a mark, the polarity of which is such that it violates the rule of alternate mark inversion. Such violations are denoted V<sub>+</sub> or V<sub>-</sub> according to their polarity.