

# Hard Disk Read/Write

## GENERAL DESCRIPTION

The XR-117 is a high speed head interface integrated circuit for hard disk drives, performing both read and write functions. The XR-117 is compatible with 3½" to 14" single and multiple platter drives, and features high bandwidth, large dynamic range, and low noise. Several packaging options extend usefulness to applications requiring two, four, or six center-tapped read/write heads; multiple devices are easily cascaded for drives with more heads.

The XR-117R includes internal damping resistors, facilitating use in circuits requiring minimum external complexity and mass.

The XR-117, manufactured with a high speed bipolar process, operates on +5 V and +12 V.

## FEATURES

- Complete Head Interfacing Functions, Read and Write
- High Bandwidth and Dynamic Range
- Low Noise
- Available in Two, Four, and Six Head Versions
- Easily Cascaded for Larger Systems
- Power Monitor
- TTL Compatible Inputs

## APPLICATIONS

Single or Multiple Platter Hard Disk Drives

## ABSOLUTE MAXIMUM RATINGS

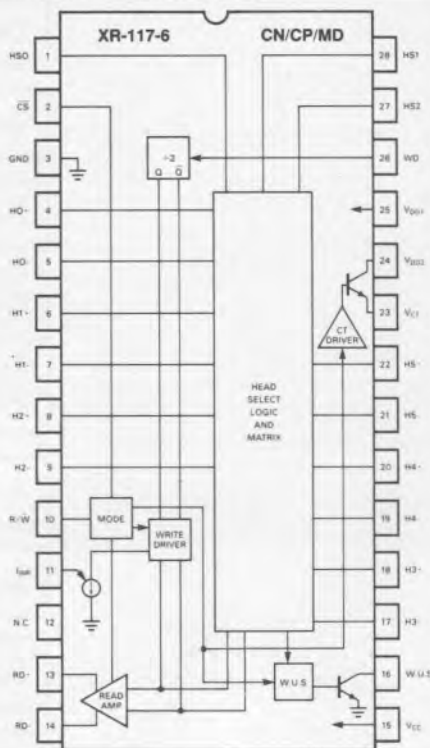
V <sub>DD1</sub> and V <sub>DD2</sub>	15 V
V <sub>CC</sub>	6 V
Digital Inputs	-0.3 V to V <sub>CC</sub> +0.3 V
Write Current	60 mA
Junction Temperature	150°C
Storage Temperature	-65°C to +150°C

## ORDERING INFORMATION

Part Number	Package	Operating Temperature
XR-117-2CP	18 Pin Plastic	0°C to 70°C
XR-117-4CP	22 Pin Plastic	0°C to 70°C
XR-117-6CP	28 Pin Plastic	0°C to 70°C
XR-117-xCN	Ceramic	0°C to 70°C
XR-117-xCQ*	Surface Mount Quad	0°C to 70°C
XR-117-xMD*	Surface Mount	0°C to 70°C
XR-117-6CJ	28 Pin PLCC	0°C to 70°C
XR-117R-xCP	Plastic	0°C to 70°C
XR-117R-xCQ*	Surface Mount Quad	0°C to 70°C
XR-117R-xMD*	Surface Mount	0°C to 70°C
XR-117R-6CJ	28 Pin PLCC	0°C to 70°C

x = 2, 4 or 6, depending on number of heads required  
 \* = contact factory for availability

## FUNCTIONAL BLOCK DIAGRAM



## SYSTEM DESCRIPTION

Four major blocks comprise the XR-117: a multiplexer for head selection, write data control circuitry, read signal amplifiers and buffers. Designed for six read/write heads, the XR-117 is also available in smaller packages for systems requiring only two or four heads. The 30 MHz minimum bandwidth facilitates data rates exceeding 25 Mbits per second.

Less than 1 nV/√Hz (nominal) noise allows error free operation with small input signals. Up to 50 mA of write current output means the disk signal can be large, further enhancing the readback signal-to-noise ratio for very low error rates.

Cascading multiple XR-117s is accomplished by alternately enabling and disabling devices via the chip select (CS) pin. Guaranteed write current tolerances allow close write matching between devices.

## ELECTRICAL CHARACTERISTICS

Test Conditions:  $T_A = 25^\circ\text{C}$ ,  $V_{DD} = 12\text{ V}$ ,  $V_{CC} = 5\text{ V}$ ,  $R_W = 3.1\text{ k}\Omega$ ,  $L_h = 10\mu\text{H}$ ,  $R_d = 750\Omega$ ,  $C_L (R_{D+}, R_{D-}) \leq 20\text{ pF}$ , Data Rate = 5 MHz.

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT	CONDITIONS
DC CHARACTERISTICS						
$I_{CC}$	Supply Current			25 30	mA mA	$V_{CC} = 5.5\text{ V}$ , Read or Idle Mode $V_{CC} = 5.5\text{ V}$ , Write Mode
$I_{DD}$	Supply Current			25 50 30	mA mA mA	$V_{DD} = 13.2\text{ V}$ , Idle Mode $V_{DD} = 13.2\text{ V}$ , Read Mode $V_{DD} = 13.2\text{ V}$ , Write Mode, $I_W = 0\text{ mA}$
$P_D$	Power Dissipation			400 600 700 1050	mW mW mW mW	$V_{CC} = 5.5\text{ V}$ , $V_{DD} = 13.2\text{ V}$ , Idle Mode Read Mode Write Mode, $I_W = 50\text{ mA}$ , $R_{CT} = 130\Omega$ Write Mode, $I_W = 50\text{ mA}$ , $R_{CT} = 0\Omega$
$V_{CT}$	Center Tap Voltage		4.0 6.0		V V	Read Mode Write Mode
$I_{OL}$	Write Unsafe Output Saturation Voltage		.2	.5	V	$I_{OL} = 8\text{ mA}$
$I_{OH}$	Leakage Current			100	$\mu\text{A}$	$V_{OH} = 5\text{ V}$
DIGITAL INPUTS						
$V_{IL}$	Input "Low" Voltage			0.8	V	
$V_{IH}$	Input "High" Voltage	2.0			V	
$I_{IL}$	Input Current, Low	-0.4			mA	
$I_{IH}$	Input Current, High			100	$\mu\text{A}$	
WRITE CHARACTERISTICS						
	Write Current Accuracy	-5		+5	%	Note 1
$I_W$	Recommended Write Current Range	10	45	50	mA	
	Differential Head Voltage Swing	5.7			V <sub>peak</sub>	
	Unselected Differential Head Current			2	mA <sub>peak</sub>	
$C_O$	Differential Output Capacitance			15	pF	
$R_O$	Differential Output Resistance	10 635	750	865	k $\Omega$ $\Omega$	XR-117 XR-117R
	WD Rate (Transition Frequency)	125	500	625	kHz	
$K_1$	Current Source Factor		20			$K_1 = I_W / \text{Current Through Bus}$

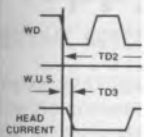
## READ CHARACTERISTICS

Parameter	Description	80	100	120	Units	Notes
$A_V$	Differential Voltage Gain	80	100	120	V/V	$V_{in} = 1 \text{ mVp-p} @ 300 \text{ kHz}$ $R_{L+} = R_{L-} = 1 \text{ k}\Omega$
	Dynamic Range	-2		2	mV	DC input voltage where gain drops 10%. $V_{in} = V_i + 0.5 \text{ mVp-p} @ 300 \text{ kHz}$ .
$R_{in}$	Differential Input Resistance	2 500	8 675	850	$\text{k}\Omega$ $\Omega$	XR-117 XR-117R
$C_{in}$	Differential Input Capacitance			23	pF	$f = 5 \text{ MHz}$
$e_{ni}$	Input Noise Voltage		1.0	2.1	$\text{nV}/\sqrt{\text{Hz}}$	$L_h = 0, R_h = 0, BW = 15 \text{ MHz}$
BW	Bandwidth	30	60		MHz	-3dB point $ Z_s  < 5\Omega, V_{in} = 1 \text{ mVp-p}$
$I_B$	Input Bias Current		10	45	$\mu\text{A}$	
CMRR	Common Mode Rejection Ratio	50	60		dB	$V_{CM} = V_{CT} + 100 \text{ mVp-p}$ at 5 MHz
PSRR	Power Supply Rejection Ratio	45	60		dB	100 mVp-p at 5 MHz Superimposed on $V_{DD1}, V_{DD2}$ or $V_{CC}$
	Channel Separation	45	60		dB	Unselected Channel: $V_{in} = 100 \text{ mVp-p}$ at 5 MHz. Selected Channel $V_{in} = 0 \text{ V}$
	Output Offset Voltage	-480	$\pm 50$	480	mV	
$V_{CM}$	Common Mode Output Voltage	5	6	7	V	

## SWITCHING CHARACTERISTICS

Parameter	Description	80	100	120	Units	Notes
R/W	Read to Write Write to Read		0.1 0.1	1 1	$\mu\text{S}$ $\mu\text{S}$	Note 2 Write to Read Note 3, Note 4
CS	Start-Up Delay		0.1	1	$\mu\text{S}$	Delay to 90% of $I_{W}$ or to 90% of 100 mV, 10 MHz read signal envelope
	Inhibit Delay		0.1	1	$\mu\text{S}$	Note 4
	Head Switching Delay		0.1	1	$\mu\text{S}$	Note 3, Switching between any heads
WUS	Write Unsafe Safe to Unsafe Unsafe to Safe	1.6	2.5 0.2	8.0 1	$\mu\text{S}$ $\mu\text{S}$	$I_W = 50 \text{ mA}$ , See Figure 1, TD1 $I_W = 20 \text{ mA}$ , See Figure 2, TD2
$I_W$	Head Current Propagation Delay Asymmetry Rise or Fall Time		4 9	25 20	nS nS nS	$L_h = 0 \mu\text{H}, R_h = 0\Omega$ , Note 5 Note 6. See Figure 1, TD3 10% to 90% or 90% to 10% points

- Note 1: Error from  $I_W = \frac{140}{R_W} \left( \frac{V}{\Omega} \right)$   
 Note 2: Delay to 90% of  $I_W$   
 Note 3: Delay to 90% of 100 mVp-p 10 MHz read single envelope  
 Note 4: Delay to 90% decay of  $I_W$   
 Note 5: From 50% points  
 Note 6: Input WD has 50% duty cycle and 1 nS rise and fall times.



CAUTION: *TD2* discharge, ESD

## PRINCIPLES

### Write Mode

Before writing Write (R/W) magnitude  $I_W$  ing edge trigger active side of th

Current is sou which is "high signals the disk tions exist and faults are: ope write data fre writing attempt

### Read Mode

Pulling R/W hi noise, high gai signal amplitude

## APPLICATION

As with all high tical. Lead leng be well bypass surface mount near the drive internal dampir aiding the goal ( for external re convenient whe cable connectin reduce layout c

The high freque certain degree bility, so static r

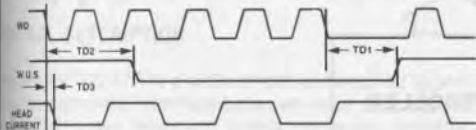


Figure 1. Write Mode Timing Diagram

**CAUTION:** This device may be damaged by electrostatic discharge. ESD precautions should be taken.

## PRINCIPLES OF OPERATION

### Write Mode

Before writing may begin, both chip select ( $\overline{CS}$ ) and Read/Write (R/W) must be pulled low. The desired head, selected by HS0 to HS2, is driven by a differential current sink of magnitude  $I_W$  set by  $R_{IW}$ . Input data is applied to a falling edge triggered toggle flip-flop, which in turn selects the active side of the center tapped write head.

Current is sourced through the center tap driver,  $V_{CT}$ , which is "high" in the write mode. Write unsafe (WUS) signals the disk controller whenever one of six error conditions exist and writing should be discontinued. The six faults are: open head, open center tap, no write current, write data frequency too low, device unselected, and writing attempted while the device is in the read mode.

### Read Mode

Pulling R/W high enables the data readback mode. A low noise, high gain differential amplifier increases the weak signal amplitude and provides low output impedance.

## APPLICATIONS INFORMATION

As with all high frequency, high gain systems, layout is critical. Lead lengths should be minimized and supplies should be well bypassed. The XR-117 is available in small outline surface mount and PLCC packages, facilitating installation near the drive heads. The XR-117R option has 750 $\Omega$  internal damping resistors across each head input, further aiding the goal of short lead lengths by eliminating the need for external resistors. The XR-117R option is especially convenient when the device is mounted on the flexible cable connecting the heads, as internal damping resistors reduce layout complexity, parts counts, and mass.

The high frequency characteristics of the XR-117 lead to a certain degree of electrostatic discharge (ESD) susceptibility, so static reducing precautions should be taken.

### Write Mode Design Considerations

Write current,  $I_W$ , typically between 20 mA and 50 mA, is determined by a single resistor,  $R_{IW}$ .

$$R_{IW} = \frac{140,000}{I_W}$$

where  $I_W$  is in mA and  $R_{IW}$  is in ohms.

The  $V_{CC}$  supply monitor disables writing when  $V_{CC}$  drops below about 4 V.

Device power dissipation is reduced by a resistor,  $R_{CT}$ , connecting  $V_{DD2}$  to the +12 V supply. Some of the center tap driver voltage drop then is across the resistor.

With the nominal 12 V supply,  $R_{CT}$  is calculated as

$$R_{CT} = 130 \left( \frac{55}{I_W} \right)$$

where  $R_{CT}$  is in ohms and  $I_W$  is in milliamperes.

Internal dissipation reduction is primarily a consideration with high write current levels and small outline packages. For low write currents,  $R_{CT}$  may be deleted, with  $V_{DD2}$  directly connected to the supply.

Write center tap circuitry is designed for higher stability than similar devices from other manufacturers. If extreme conditions exist, a ferrite bead around the  $V_{CT}$  line to the heads will reduce or eliminate overshoot and ringing.

Write unsafe (WUS) pulls high whenever one or more of six write error conditions exist. Four conditions; open head, open center tap, no write current and write data transition rate too low, are detected with a differential capacitor charge/discharge circuit. Device unselected and read mode digital conditions also force WUS high.

After removal of the fault condition, two negative write data transitions are required to clear WUS. This output is for indication only, intended for signaling a controller, and does not directly impede device operation. A pull-up resistor of about 2 k $\Omega$  to 10 k $\Omega$  is necessary for operation of this open collector output.

### Read Mode Design Considerations

The read amp has a fully differential input and output and provides approximately 100 V/V gain. Its 60 MHz bandwidth and low noise characteristics (1.0nV/  $\sqrt{Hz}$  typical) provide substantial margins in most drives. The output should be AC coupled to delete the approximately 6 V output common mode voltage. Best results are obtained by limiting load capacitance to 20 pF and load current to 100  $\mu$ A.

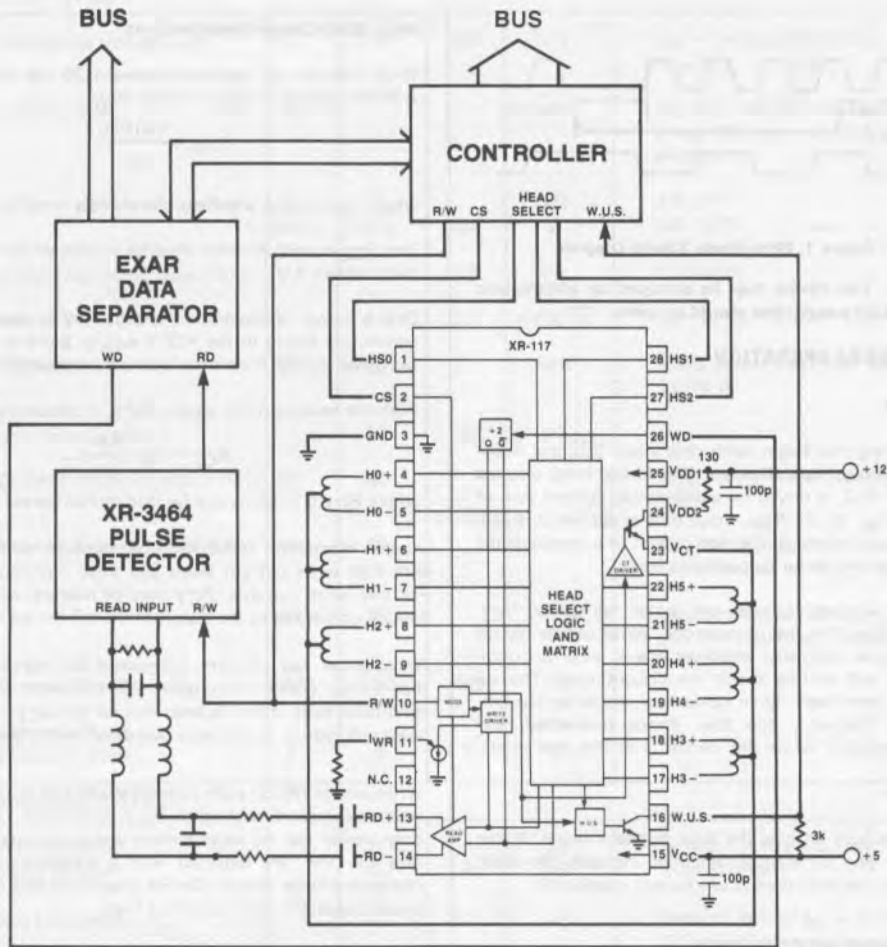


Figure 2. Hard Disk Read/Write Applications Circuit

Note: Circuit shown for XR-117R. Non-R versions require damping resistors across each head.

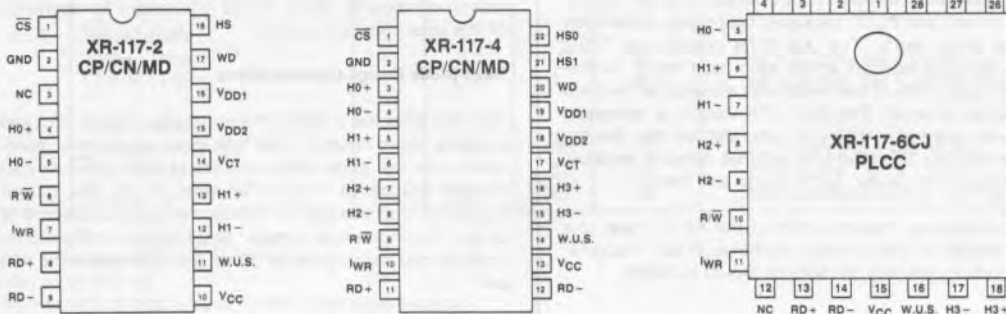


Figure 3. Additional Packages for XR-117 (Six head DIP shown in Functional Block Diagram, page 1)

## Copy Disk V

### DESCRIPTION

247/2247A is a write amplifier providing a complete interface between a microprocessor and dual-head magnetic heads. It is suitable for floppy disk drive systems and can also be used in other applications such as tape drives. To minimize current in dual head systems, compatible with emitter-coupled logic (ECL) 2247 and diodes (which correct for non-linear characteristics) in the output stage. Currents are each externally programmable. Also included are write current compensation and current outputs during power-up. Erase turn-on is internally programmable.

2247/2247A, available in a single power supply and is suitable for...

### FEATURES

- Programmable Write and Erase Turn-on
- Programmable Erase Turn-on
- Head Switching for Dual Head Operation
- Back Write Current Compensation
- Compatible Inputs
- Internal Parts Count

### APPLICATIONS

- Disk Drives
- Dual Head Systems
- Magnetic Tape Write Amplifier

### ABSOLUTE MAXIMUM RATINGS

- Supply Voltage (Pin 1)
- Voltage (all digital inputs)
- Quiescent Current (Pin 4)
- Operating Current (Pins 2, 10)
- Storage Temperature
- Operating Junction Temperature
- Power Dissipation
- Operating Temperature Above 25°C