

## DP501X/DP501XR/ $\mu$ A501X/ $\mu$ A501XR Series 6 or 8 Channel Read/Write Circuit

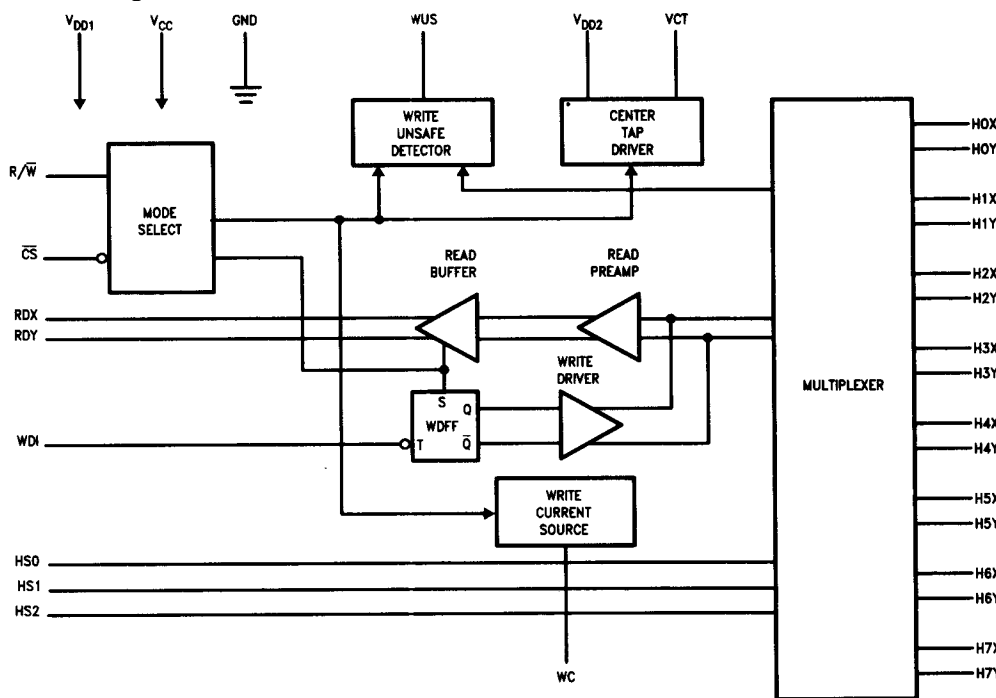
## General Description

The  $\mu$ A501X/ $\mu$ A501XR devices are bipolar monolithic integrated circuits designed for use with center-tapped ferrite recording heads. They provide a low noise read path, write current control, and data protection circuitry for eight channels. The  $\mu$ A501X/ $\mu$ A501XR requires +5.0V and +12V power supplies and is available in a variety of packages. The  $\mu$ A501XR differs from the  $\mu$ A501X by having internal damping resistors.

## Features

- +5.0V, +12V power supplies
- Single- or multi-platter Winchester drives
- Designed for center-tapped ferrite heads
- Programmable write current source
- Easily multiplexed for larger systems
- Includes write unsafe detection
- TTL compatible control signals

### Block Diagram



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**Note:** Caution: Use handling procedures necessary for a static sensitive component.

## Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Storage Temperature Range	
Ceramic DIP and Flatpak	-65°C to +175°C
Molded DIP and PLCC	-65°C to +150°C

Operating Temperature Range	0°C to +70°C
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Lead Temperature	
Ceramic DIP and Flatpak (Soldering, 60 seconds)	300°C
Molded DIP and PLCC (Soldering, 10 seconds)	265°C

Internal Power Dissipation (Notes 2 & 3)	
28L-Ceramic DIP	2.50W
28L-Plastic DIP	1.92W
32L-Brazed Flatpak	1.88W
40L-Ceramic DIP	2.65W
40L-Plastic DIP	2.5W
28L-Plastic LCC	1.39W
44L-Plastic LCC	1.92W

DC Supply Voltage	
$V_{DD1}$ and $V_{DD2}$	-0.3V to +14V
$V_{CC}$	-0.3V to +6.0V

Digital Input Voltage Range	-0.3V to $V_{CC} + 0.3V$
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Head Port Voltage Range	-0.3V to $V_{DD} + 0.3V$
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WUS Port Voltage Range	-0.3V to +14V
1 Write Current	60 mA
Output Current	
RDX and RDY	-10 mA
VCT	-60 mA
WUS	+12 mA

**Note 1:** All voltages referenced to GND.

**Note 2:**  $T_J \text{ MAX} = 150^\circ\text{C}$  for the Plastic, and  $175^\circ\text{C}$  for the Ceramic.

**Note 3:** Ratings apply to ambient temperature at  $25^\circ\text{C}$ . Above this temperature, derate the 28L-Ceramic DIP at  $16.7 \text{ mW}/^\circ\text{C}$ , the 28L-Plastic DIP at  $15.3 \text{ mW}/^\circ\text{C}$ , the 32L-Brazed Flatpak at  $12.5 \text{ mW}/^\circ\text{C}$ , the 40L-Ceramic DIP at  $20.1 \text{ mW}/^\circ\text{C}$ , the 40L-Plastic DIP at  $20 \text{ mW}/^\circ\text{C}$ , the 28L-Plastic LCC at  $11.2 \text{ mW}/^\circ\text{C}$ , and the 44L-Plastic LCC at  $15.3 \text{ mW}/^\circ\text{C}$ .

## Recommended Operating Conditions

DC Supply Voltage	
$V_{DD1}$	$12V \pm 10\%$
$V_{CC}$	$5V \pm 10\%$
Head Inductance (Lh)	$5.0 \mu\text{H}$ to $15 \mu\text{H}$
Damping Resistor (External)	
RD (DP501X Only)	$500\Omega$ to $2000\Omega$
RCT Resistor	$90\Omega \pm 5.0\%$ ( $\frac{1}{2}W$ )
Write Current ( $I_W$ )	25 mA to 50 mA

## DC Electrical Characteristics

$V_{DD1} = 12V \pm 10\%$ ,  $V_{CC} = 5.0V \pm 10\%$ ,  $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$ , unless otherwise specified

Symbol	Parameter		Conditions	Min	Max	Units
$I_{CC}$	Supply Current		Read/Idle Mode		25	mA
			Write Mode		25	
$I_{DD}$	Supply Current		Idle Mode		20	mA
			Read Mode		40	
			Write Mode		$20 + I_W$	
$P_C$	Power Consumption		$25^\circ\text{C} \leq T_J \leq 135^\circ\text{C}$	Idle Mode	400	mW
				Read Mode	650	
				Write Mode, $I_W = 50 \text{ mA}$ , $RCT = 90\Omega$	880	
				Write Mode, $I_W = 50 \text{ mA}$ , $RCT = 0\Omega$	1060	
$V_{IL}$	Digital Inputs:	Input Voltage LOW		-0.3	0.8	V
$V_{IH}$		Input Voltage HIGH		2.0	$V_{CC} + 0.3$	V
$I_{IL}$		Input Current LOW	$V_{IL} = 0.8V$	-0.4		mA
$I_{IH}$		Input Current HIGH	$V_{IH} = 2.0V$		100	$\mu\text{A}$
$V_{OL}$	WUS Output		$I_{OL} = 8.0 \text{ mA}$		0.5	V
$I_{OH}$			$V_{OH} = 5.0V$		100	$\mu\text{A}$
$V_{CT}$	Center Tap Voltage		Read Mode	4.0 (typ)		V
			Write Mode	6.0 (typ)		V

**Write Characteristics**  $V_{DD1} = 12V \pm 10\%$ ,  $V_{CC} = 5.0V \pm 10\%$ ,  $0^\circ C \leq T_A \leq +70^\circ C$ ,  $I_W = 45 \text{ mA}$ ,  $L_h = 10 \mu\text{H}$ ,  $R_d = 750\Omega$  (DP501X only),  $f(\text{Data}) = 5.0 \text{ MHz}$ ,  $CL$  (RDX, RDY)  $\leq 20 \text{ pF}$ , unless otherwise specified

Parameter	Conditions	Min	Max	Units
Write Current Range		10	50	mA
Write Current Constant "K"		129	151	V
Differential Head Voltage Swing		7.5		V (pk)
Unselected Head Transient Current	$5.0 \mu\text{H} \leq L_h \leq 9.5 \mu\text{H}$		2.0	mA (pk)
Differential Output Capacitance			15	pF
Differential Output Resistance	Without Internal Resistors	10k		$\Omega$
	With Internal Resistors	560	940	
WDI Transition Frequency	WUS = LOW	250		kHz
Head Current Gain to $I_{WC}$ $\left(\frac{I_W}{I_{WC}}\right)$		20 (typ)		mA/mA
Unselected Head Leakage	Sum of X and Y Side Current		85	$\mu\text{A}$

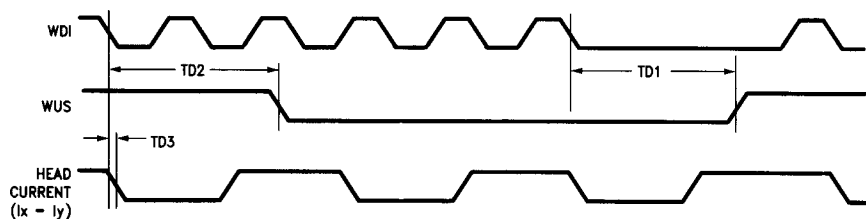
**Read Characteristics**  $V_{DD1} = 12V \pm 10\%$ ,  $V_{CC} = 5.0V \pm 10\%$ ,  $I_W = 45 \text{ mA}$ ,  $CL$  (RDX, RDY)  $\leq 20 \text{ pF}$ , ( $V_{IN}$  is referenced to  $V_{CT}$ ),  $0^\circ C \leq T_A \leq +70^\circ C$ ,  $L_h = 10 \mu\text{H}$ ,  $R_d = 750\Omega$ ,  $f(\text{Data}) = 5.0 \text{ MHz}$  unless otherwise specified

Characteristic	Condition		Min	Max	Unit
Differential Voltage Gain	$V_{IN} = 1.0 \text{ mV}_{PP}$ at 300 kHz $R_L \text{ (RDX), } R_L \text{ (RDY)} = 1.0 \text{ k}\Omega$ (AC coupled)		80	120	V/V
Dynamic Range	Input Voltage, $V_I$ , where Gain Falls by 10% $V_{IN} = V_I + 0.5 \text{ mV}_{PP}$ at 300 kHz		-3.0	3.0	mV
Bandwidth (-3 dB)	$ Z_S  < 5.0\Omega$ , $V_{IN} = 1.0 \text{ mV}_{PP}$		30		MHz
Input Noise Voltage	$BW = 15 \text{ MHz}$ , $L_h = 0$ , $R_h = 0$			1.5	nV/ $\sqrt{\text{Hz}}$
Differential Input Capacitance	$f = 5.0 \text{ MHz}$			23	pF
Differential Input Resistance	$f = 5.0 \text{ MHz}$ , $V_{IN} \leq 6 \text{ mV}_{PP}$	Without Internal Resistors	2k		$\Omega$
		With Internal Resistors	530	790	
Input Bias Current (per Side)				100	$\mu\text{A}$
Common Mode Rejection Ratio	$V_{CM} = V_{CT} + 100 \text{ mV}_{PP}$ at 5.0 MHz		50		dB
Power Supply Rejection Ratio	100 mV <sub>PP</sub> at 5.0 MHz on $V_{DD1}$ , $V_{DD2}$ , or $V_{CC}$		45		dB
Channel Separation	Unselected Channels: $V_{IN} = 100 \text{ mV}_{PP}$ at 5.0 MHz and Selected Channel: $V_{IN} = 0 \text{ mV}_{PP}$		45		dB
Output Offset Voltage			-480	480	mV
Common Mode Output Voltage		Read Mode	5.0	7.0	V
		Write/Idle Mode	4.3 (typ)		
Single Ended Output Resistance	$f = 5.0 \text{ MHz}$			30	$\Omega$
External Resistive Load (AC Coupled to Output)	Per Side to GND		100		$\Omega$
Leakage Current (RDX, RDY)	5.0 < RDX, RDY < 8.0V Write or Idle Mode		-50	50	$\mu\text{A}$
Center Tap Output Impedance	$0 \leq f \leq 5.0 \text{ MHz}$			150	$\Omega$
Output Current	AC Coupled Load RDX to RDY		2.0		mA

**Switching Characteristics**  $V_{DD1} = 12V \pm 10\%$ ,  $V_{CC} = 5.0V \pm 10\%$ ,  $0^\circ C \leq T_A \leq +70^\circ C$ ,  $I_W = 45\text{ mA}$ ,  $L_h = 10\text{ }\mu\text{H}$ ,  $R_d = 750\Omega$ ,  $f(\text{Data}) = 5.0\text{ MHz}$ , unless otherwise specified

Symbol	Parameter	Conditions	Min	Max	Units
R/W	R/W to Write	Delay to 90% of Write Current		600	ns
	R/W to Read	Delay to 90% of 100 mV, 10 MHz Read Signal Envelope or to 90% Decay of Write Current		600	
$\overline{\text{CS}}$	$\overline{\text{CS}}$ to Select	Delay to 90% of Write Current or to 90% of 100 mV, 10 MHz Read Signal Envelope		600	ns
	$\overline{\text{CS}}$ to Unselect	Delay to 90% Decay of Write Current		600	
HS0 HS1 HS2	to Any Head	Delay to 90% of 100 mV, 10 MHz Read Signal Envelope		600	ns
WUS	Safe to Unsafe—TD1	$I_W = 50\text{ mA}$	1.6	8.0	$\mu\text{s}$
	Unsafe to Safe—TD2	$I_W = 20\text{ mA}$		1.0	
Head Current	Propagation Delay—TD3	$L_h = 0\text{ }\mu\text{H}$ , $R_h = 0\Omega$ from 50% Points		30	ns
	Asymmetry	WDI has 50% Duty Cycle and 1 ns Rise/Fall Time		2	
	Rise/Fall Time	10%–90% Points		20	

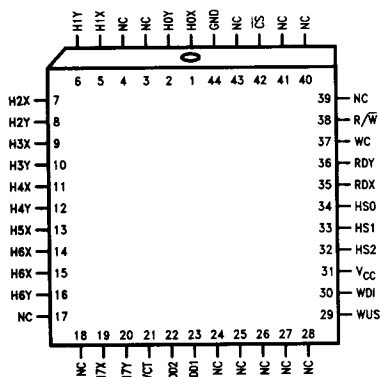
### Write Mode Timing Diagram



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## Connection Diagrams

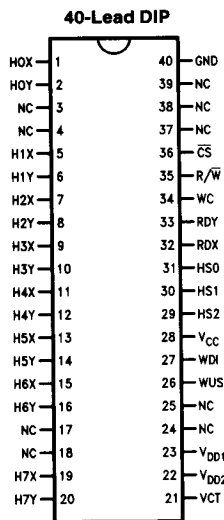
## 44-Lead PLCC



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### Top View

**Order Number  $\mu$ A5018QC or  $\mu$ A5018RQC**  
**See NS Package Number V44A**



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### Top View

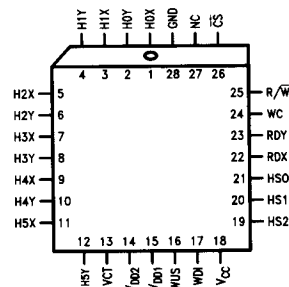
### Ceramic DIP

**\*Order Number  $\mu$ A5018DC or  $\mu$ A5018RDC**  
**\*\*See NS Package Number J40A**

**Molded DIP**

**\*Order Number  $\mu$ A5018PC or  $\mu$ A5018RPC**  
**\*\*See NS Package Number N40A**

## 28-Lead PLCC

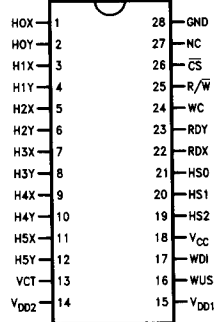


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### Top View

**Order Number  $\mu$ A5016QC or  $\mu$ A5016RQC**  
**See NS Package Number V28A**

**28-Lead DIP**



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### Top View

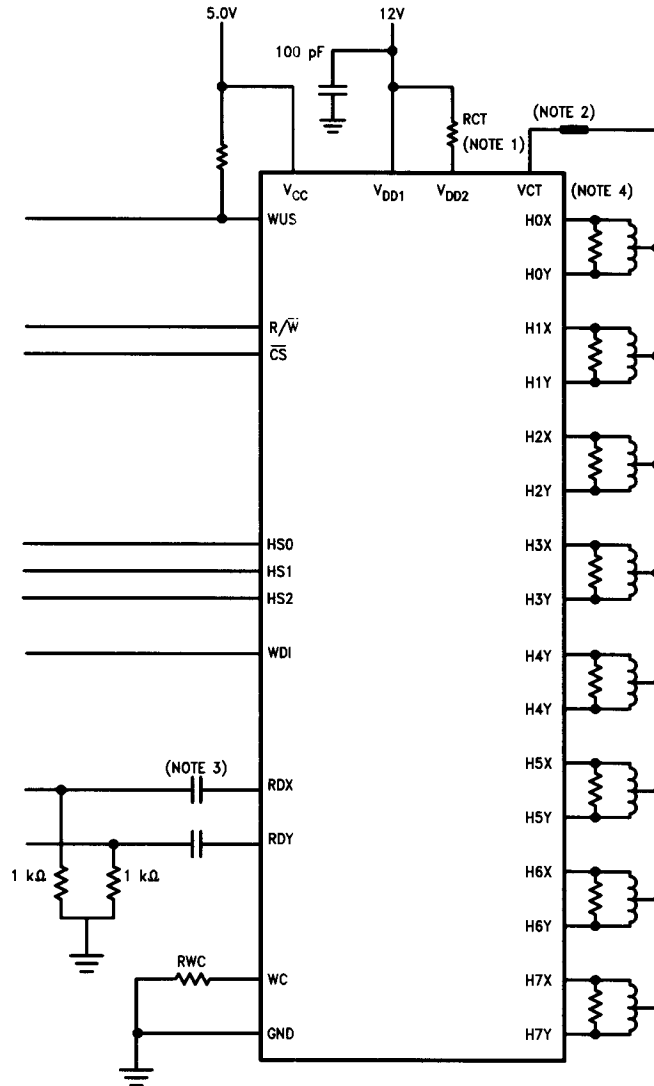
**Order Number  $\mu$ A5016DC or  $\mu$ A5016RDC**  
**See NS Package Number J28A**

**Order Number  $\mu$ A5016PC or  $\mu$ A5016RPC**  
**See NS Package Number N28B**

\*For most current order information, contact your local sales office.

**\*\*For current package information, contact product marketing.**

## Application Information



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**Note 1:** An external  $\frac{1}{2}W$  resistor, RCT, given by  $RCT = 90 (50/I_W)\Omega$ , where  $I_W$  is in mA can be used to limit internal power dissipation. Otherwise connect V<sub>DD2</sub> to V<sub>DD1</sub>.

**Note 2:** A ferrite bead (Ferroxcube 5659065/4A6) can be used to suppress write current overshoot and ringing induced by flex cable parasitics.

**Note 3:** Limit DC current from RDX and RDY to 100  $\mu$ A and load capacitance to 20 pF.

**Note 4:** Damping resistors required on DP501X only.

## Pin Descriptions

TABLE I. Description of Lead Functions

Name	Functions
HS0–HS2	Head Select
$\overline{CS}$	Chip Select: a low level enables device.
R/ $\overline{W}$	Read/ $\overline{Write}$ : a high level selects read mode.
WUS	Write Unsafe: a high level indicates an unsafe writing position.
WDI	Write Data In: a negative transition toggles the direction of the head current.
H0X–H7X H0Y–H7Y	X, Y Head Connections
RDX, RDY	X,Y Read Data: differential read signal out.
WC	Write Current: used to set the magnitude of the write current.
VCT	Voltage Center Tap: voltage source for head center tap.
V <sub>CC</sub>	+ 5.0V
V <sub>DD1</sub>	+ 12V
V <sub>DD2</sub>	Positive power supply for the center tap voltage source.
GND	Ground

## Circuit Operation

The  $\mu$ A510X/ $\mu$ A501XR functions as a write driver or as a read amplifier for the selected head. Head selection and mode control are described in Tables II and III. Both R/ $\overline{W}$  and  $\overline{CS}$  have internal pull-up resistors to prevent an accidental write condition.

### WRITE MODE

The Write mode configures the  $\mu$ A510X/ $\mu$ A501XR as a current switch and activates the Write Unsafe Detector. Head current is toggled between the X- and Y-side of the recording head on the falling edges of WDI, Write Data Input. Note that a preceding read operation initializes the Write Data Flip-Flop, WDFF, to pass current through the X-side of the head. The magnitude of the write current, given by

$$I_W = K/R_{wc}, \text{ where } K = \text{Write Current Constant}$$

is set by the external resistor,  $R_{wc}$ , connected from lead WC to GND.

TABLE II. Mode Select

$\overline{CS}$	R/ $\overline{W}$	Mode
0	0	Write
0	1	Read
1	X	Idle

TABLE III. Head Select

HS2	HS1	HS0	Head
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

0 = Low Level

1 = High Level

Any of the following conditions will be indicated as a high level on the Write Unsafe, WUS, open collector output.

- Head open
- Head center tap open
- WDI frequency too low
- Device in Read mode
- Device not selected
- No write current

After the fault condition is removed, two negative transitions on WDI are required to clear WUS.

### READ MODE

In the Read mode the  $\mu$ A510X/ $\mu$ A501XR is configured as a low noise differential amplifier, the write current source and the write unsafe detector are deactivated, and the write data flip-flop is set. The RDX and RDY outputs are driven by emitter followers and are in phase with the "X" and "Y" head ports. They should be AC coupled to the load.

Note that the internal write current source is deactivated for both the Read and the chip deselect mode. This eliminates the need for external gating of the write current source.