

# VM7160

## 2, 4 OR 8-CHANNEL, 5-VOLT, THIN-FILM HEAD, READ/WRITE PREAMPLIFIER WITH MULTIPLE SERVO WRITE CAPABILITY

**PRELIMINARY**

July, 1993

### FEATURES

- High Performance
  - Read Gain = 200 - 300 V/V Typical
  - Input Noise = 0.65nV/√Hz max
  - Head Inductance Range = 0.2 – 5 μH (0.5 μH typical)
  - Write Current Range 5 - 35 mA
  - Low Input Capacitance = 12 pF typical
- TTL Write Data Inputs
- Servo Write Two or Four Channels at the Same Time
  - VM7162 Two-Channel Servo Write
  - VM7164 Four-Channel Servo Write
  - VM7168 Two Banks of Four-Channel Servo Write
- Very Low Power Dissipation = 4.5 mW Typical in Sleep Mode
- Power Up/Down Data Protect Circuitry
- Fast Write-to-Read and Read-to-Write Recovery Time
- Single Power Supply = 5 V ± 10%
- Fault Detect Capability
- Designed for 2-Terminal Thin-Film or MIG Heads
- Other Read Gain Options Available
- Available in 2, 4 or 8-Channels

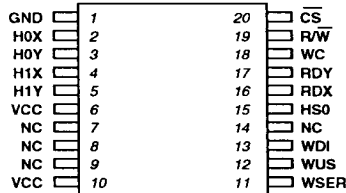
### DESCRIPTION

The VM7160 is a high-performance, very low-power read/write preamplifier designed for use with external 2-terminal, thin-film or MIG recording heads. This circuit will operate on a single 5-volt power supply and is ideally suited for use in battery powered disk drives. The VM7160 provides a two or four channel servo write feature, enabling the user to write servo information directly through the preamp.

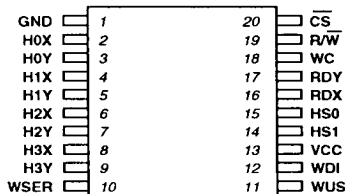
The VM7160 provides write current switching in the write mode and a low noise data path in the read mode for up to eight read/write recording heads. When deactivated, the device enters a *sleep mode* that reduces power dissipation to 4.5 mW. Data protection circuitry is provided to ensure that the write current source is totally disabled during power supply power up/power down conditions. Write-to-read recovery time is minimized by eliminating common mode output voltage swings when switching between modes.

The VM7160 is available in several different packages. Please consult VTC for package availability and additional read mode voltage gains.

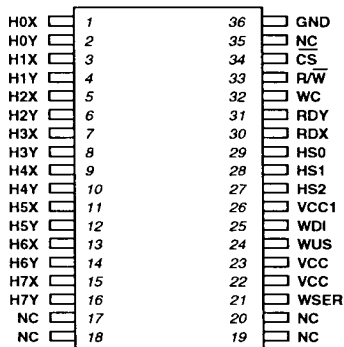
### CONNECTION DIAGRAMS



**2-Channel  
20-lead SSOP**



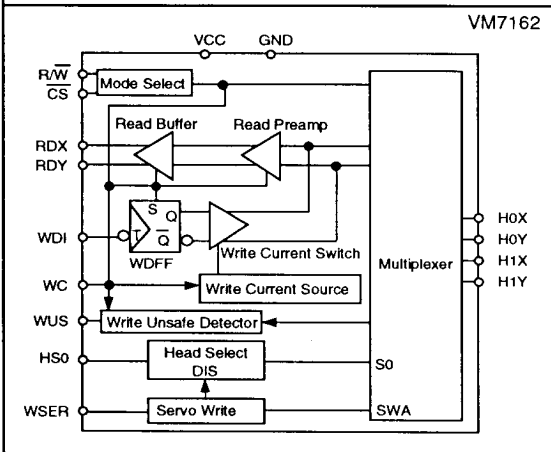
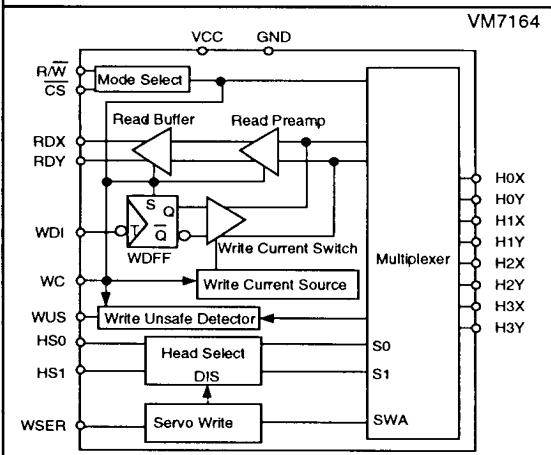
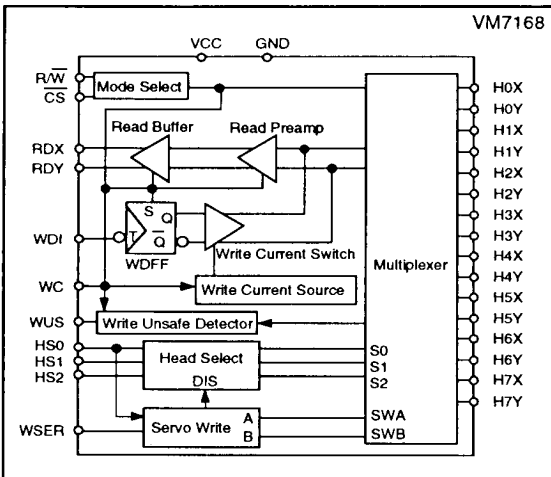
**4-Channel  
20-lead SOIC, SSOP**



**8-Channel  
36-lead SOIC**

TWO-THREE TERMINAL & SERVO PREAMPLIFIERS

**BLOCK DIAGRAMS**



**ABSOLUTE MAXIMUM RATINGS**

Power Supply:  
 $V_{CC}$  ..... -0.3V to +7V  
 Write Current  $I_W$  ..... 60mA

Input Voltages:  
 Digital Input Voltage  $V_{IN}$  ..... -0.3V to ( $V_{CC} + 0.3$ )V  
 Head Port Voltage  $V_H$  ..... -0.3V to ( $V_{CC} + 0.3$ )V  
 WUS Pin Voltage Range  $V_{WUS}$  ..... -0.3V to +6V

Output Current:  
 RDX, RDY:  $I_O$  ..... -10mA  
 WUS:  $I_{WUS}$  ..... +12mA

Junction Temperature ..... 150°C  
 Storage Temperature  $T_{stg}$  ..... -65° to 150°C

Thermal Characteristics,  $\Theta_{JA}$ :

16-lead SOIC	100°C/W
20-lead SOIC	80°C/W
20-lead SSOP	TBD
36-lead SOIC	65°C/W

**RECOMMENDED OPERATING CONDITIONS**

Power Supply Voltage:  
 $V_{CC}$  ..... +5V ± 10%  
 Write current ( $I_W$ ) ..... 1 to 40mA  
 Head Inductance ( $L_H$ ) ..... 0.2 to 10µH  
 Junction Temperature ( $T_J$ ) ..... 25°C to 125°C

**CIRCUIT OPERATION**

The VM7162 addresses two two-terminal thin-film heads, providing write drive or read amplification. Head selection and mode control are accomplished with pins WSER, HS0, CS and R/W, as shown in Tables 1a and 2a.

The VM7164 addresses four two-terminal thin-film heads, providing write drive or read amplification. Head selection and mode control are accomplished with pins WSER, HS0, HS1, CS and R/W, as shown in Tables 1b and 2b.

The VM7168 addresses eight two-terminal thin-film heads, providing write drive or read amplification. Head selection and mode control are accomplished with pins HS0, HS1, HS2, WSER, CS and R/W, as shown in Tables 1c and 2c.

On all versions, internal pull-up resistors on pins CS and R/W will force the device into a non-writing condition if either control line is opened accidentally.

**Write Mode**

In write mode, the VM7160 acts as a write current switch with the write unsafe (WUS) detection circuitry activated. Write current is toggled between the X and Y side of the selected head on each high to low transition on the Write Data Flip-Flop (WDF) so that upon switching to the write mode, the write current flows into the "X" side of the head.

The write current magnitude is determined by an external resistor ( $R_{WC}$ ) connected between the WC pin and Ground. An internally generated reference voltage is present at the WC pin. The magnitude of the Write Current (0-PK, ± 8%) is:

$$I_W = K_W/R_{WC} + 0.2mA$$

$$= 50/R_{WC} + 0.2mA$$

THIN/FILM TERMINAL & SERVO PREAMPLIFIERS

## VM7160

Power supply fault protection ensures data security on the disk by disabling the write current source during a power supply voltage fault or by supply power up/down conditions. Additionally, the write unsafe (WUS) detection circuitry will flag any of the conditions listed below, as a high level on the WUS line. Two negative transitions on the WDI pin, after the fault is corrected, is required to clear the WUS line.

- No write current
- WDI frequency too low
- Read or sleep mode

### Servo Write Mode

In servo write mode, two channels of the VM7162 are active at the same time. Pin WSER controls the servo mode. When WSER and R/W are low, the chip is in normal write mode: one head is written at a time based on the state of the head select line. When WSER is high and R/W is low, the chip is in servo write mode, where the heads are written independent of the head select line (see table 1a).

In servo write mode, four channels of the VM7164 are active at the same time. Pin WSER controls the servo mode and HS0 controls which four heads are written independent of the head select lines (see table 1b).

In servo write mode, four channels of the VM7168 are active at the same time. Pin WSER controls the servo mode and HS0 controls which four heads are simultaneously written. When WSER is high and R/W is low, the chip is in servo write mode: four channels are written at the same time dependent on the state of HS0. When HS0 = 0, heads 0, 2, 4 and 6 are written, and when HS0 = 5V, heads 1, 3, 5 and 7 are written (see table 1c). When WSER is low, the chip is in normal write mode: one head is written at a time based on the state of the head select lines.

On all versions, an internal pull-down resistor on pin WSER will force the device into single head write mode if the control line is accidentally opened.

### Read Mode

In read mode, the VM7160 acts as a low noise differential amplifier for signals coming off the disk. The write current generator and write unsafe circuitry is deactivated. The RDX, RDY pins are emitter follower outputs and are in phase with "X" and "Y" head ports. These outputs should be AC coupled to the load. The RDX, RDY common mode output voltage is constant, minimizing the transient between read and write mode, thereby, substantially reducing the recovery time in the Pulse Detector circuit connected to these outputs.

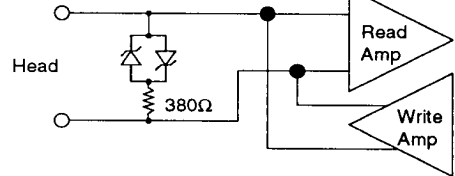
### Sleep Mode

When CS is high, initially all circuitry is shut down so that power dissipation is reduced to 4.5 mW in the **Sleep Mode**. Switching the CS line low *wakes up* the chip and the device will enter the read or write mode, depending on the status of the R/W line.

### Diode Connected Damping Resistor (patent pending)

The VM7162 has an optional damping resistors isolated by Schottky diodes. The diodes effectively remove the resistor from the circuit during the read mode, however during the write mode with the higher level input signal, the resistor provides damping for the write current waveform.

Input Structure:



Please consult factory for damping resistor options on other devices.

Table 1a: Mode Selection for VM7162

R/W	CS	WSER	Mode
0	0	0	Write Single
1	0	X	Read
X	1	X	Idle
0	0	1	Write Servo (head 0,1)

Table 1b: Mode Selection for VM7164

R/W	CS	WSER	Mode
0	0	0	Write Single
1	0	X	Read
X	1	X	Idle
0	0	1	Write Servo (head 0,1,2,3)

Table 1c: Mode Selection for VM7168

R/W	CS	WSER	HS0	Mode
0	0	0	X	Write Single
1	0	X	X	Read
X	1	X	X	Idle
0	0	1	0	Write Servo (head 0,2,4,6)
0	0	1	1	Write Servo (head 1,3,5,7)

**Table 2a: Head Selection in Single Write Mode (WSER = LOW) for VM716N2**

HS0	Head
0	0
1	1

**Table 2b: Head Selection in Single Write Mode (WSER = LOW) for VM716N4**

HS1	HS0	Head
0	0	0
0	1	1
1	0	2
1	1	3

**Table 2c: Head Selection in Single Write Mode (WSER = LOW) for VM716N8**

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

**PIN DESCRIPTIONS**

NAME	I/O	DESCRIPTION
HS0-HS2	I*	Head Select: selects one of up to 8 heads
H0X-H7X H0Y-H7Y	I/O	X, Y Head terminals
WDI	I*	Write Data Inputs: TTL input signal, negative transition toggles direction of head current.
$\overline{CS}$	I	Chip select: high level signal puts chip in sleep mode, low level wakes chip up
$\overline{R/W}$	I*	Read/Write select: High level selects read mode, low-level selects write mode
WUS	O*	Write unsafe: Open collector output: high level indicates writes unsafe condition
WC		Write current adjust: A resistor adjusts level of write current
RDX-RDY	O*	Read data output: differential output data
VCC		+5 volt supply**
GND		Ground
WSER	I*	Servo Write: A high level enables servo mode.

\* May be wire-OR'ed for multi-chip usage.

\*\* Although both VCC connections are recommended, only one connection is required as both are connected internally.

**WRITE CHARACTERISTICS** Recommended operating conditions apply unless otherwise specified;  $L_H = 1\mu H$ ,  $R_H = 30\Omega$ ,  $I_W = 20mA$ ,  $f_{DATA} = 5MHz$ .

PARAMETER	SYM	CONDITIONS	MIN	TYP (Note 1)	MAX	UNITS
WC Pin Voltage	V <sub>WC</sub>			2.5		V
I <sub>WC</sub> to Head Current Gain	A <sub>I</sub>			20		mA/mA
Write Current Constant	K <sub>W</sub>	$K_W = (V_{WC})(A_I)$	46	50	54	V
Write Current Range	I <sub>W</sub>	$1.44K < R_{WC} < 10.4K$	5		35	mA
Write Current Tolerance	$\Delta I_W$	$I_W = 5 - 35mA$	-8		+8	%
Differential Head Voltage Swing	V <sub>DH</sub>			5.4		V <sub>p-p</sub>
WDI Transition Frequency for Safe Condition	f <sub>DATA</sub>	WUS = low	1			MHz
Differential Output Capacitance	C <sub>O</sub>				15	pF
Differential Output Resistance	R <sub>O</sub>		3200			$\Omega$
Unselected Head Transient Current	I <sub>UH</sub>	$I_W = 15mA$		0.15	1	mA(pk)
RDX, RDY Common Mode Output Voltage	V <sub>CM</sub>			V <sub>CC</sub> -2.7		V

Note 1: Typical values are given at  $V_{CC} = 5V$  and  $T_A = 25^\circ C$ .

# VM7160

**DC CHARACTERISTICS** Recommended operating conditions apply unless otherwise specified.

PARAMETER	SYM	CONDITIONS	MIN	TYP <i>(Note 1)</i>	MAX	UNITS
Supply Current	I <sub>CC</sub>	Read Mode		44	54	mA
		Write Mode, I <sub>W</sub> = 35mA				
		Normal VM7162		44 + I <sub>W</sub>	52 + I <sub>W</sub>	
		Normal VM7164 & VM7168		54 + I <sub>W</sub>	64 + I <sub>W</sub>	
		Servo VM7162		44 + 2 I <sub>W</sub>	56 + 2 I <sub>W</sub>	
Servo VM7164 & VM7168		70 + 4 I <sub>W</sub>	82 + 4 I <sub>W</sub>			
VM7162 Power Dissipation	PD	Sleep Mode		0.6	3	mW
		Read Mode		220	297	
		Write Mode, I <sub>W</sub> = 35mA				
		Normal		395	479	
Servo		570	693			
VM7164, VM7168 Power Dissipation	PD	Sleep Mode		3	17	mW
		Read Mode		220	297	
		Write Mode, I <sub>W</sub> = 35mA				
		Normal		445	545	
		Servo		1050	1221	
Sleep Mode		3	17			
Input High Voltage	V <sub>IH</sub>		2		V <sub>CC</sub> + 0.3	V
Input Low Voltage	V <sub>IL</sub>		-0.3		0.8	V
Input High Current	I <sub>IH</sub>	V <sub>IH</sub> = 2.7V			80	μA
Input Low Current	I <sub>IL</sub>	V <sub>IL</sub> = 0.4V	-160			μA
WUS Output Low Voltage	V <sub>OL</sub>	I <sub>OL</sub> = 4.0mA		0.35	0.5	V
WUS Output High Current	I <sub>OH</sub>	V <sub>OH</sub> = 5.0V		13	100	μA
VCC Value for Write Current Turn Off		I <sub>H</sub> < 0.2mA	3.7	4.0	4.3	V

Note 1: Typical values are given at V<sub>CC</sub> = 5V and T<sub>A</sub> = 25°C.

TWO/THREE TERMINAL & SERVO PREAMPLIFIERS

**READ CHARACTERISTICS** Recommended operating conditions apply unless otherwise specified;  $C_L$  (RDX, RDY) < 20pF,  $R_L$  (RDX, RDY) = 1k $\Omega$ .

PARAMETER	SYM	CONDITIONS	MIN	TYP (Note 1)	MAX	UNITS	
Differential Voltage Gain	A <sub>V</sub>	V <sub>IN</sub> = 1mVrms, 1MHz	VM7162	250	300	350	V/V
			VM7164	250	300	350	
			VM7168	210	250	290	
Bandwidth	BW	-1dB  Z <sub>s</sub>   < 5 $\Omega$ , V <sub>IN</sub> = 1mVp-p	30	40		MHz	
		-3dB  Z <sub>s</sub>   < 5 $\Omega$ , V <sub>IN</sub> = 1mVp-p	55	75			
Input Noise Voltage	e <sub>in</sub>	BW = 17MHz, L <sub>H</sub> = 0, R <sub>H</sub> = 0		0.5	0.65	nV/ $\sqrt{Hz}$	
Differential Input Capacitance	C <sub>IN</sub>	V <sub>IN</sub> = 1mVp-p, f = 5MHz		12	TBD	pF	
Differential Input Resistance	R <sub>IN</sub>	V <sub>IN</sub> = 1mVp-p, f = 5MHz	380	1000		$\Omega$	
Dynamic Range	DR	AC input where A <sub>V</sub> is 90% of gain at 0.2mVrms input	2	5		mVrms	
Common Mode Rejection Ratio	CMRR	V <sub>IN</sub> = 100mVp-p @5MHz	50			dB	
Power Supply Rejection Ratio	PSRR	100mVp-p @5MHz on V <sub>CC</sub>	45			dB	
Channel Separation	CS	Unselected channels driven with 20mVp-p @5MHz	45			dB	
Output Offset Voltage	V <sub>OS</sub>		-400		+400	mV	
RDX,RDY Common Mode Output Voltage	V <sub>OCM</sub>	Read Mode		V <sub>CC</sub> -2.7		V	
Read to Write Common Mode Output Voltage Difference	$\Delta$ V <sub>OCM</sub>		-350		350	mV	
Single-Ended Output Resistance	R <sub>SEO</sub>				35	$\Omega$	
Output Current	I <sub>O</sub>	AC Coupled Load, RDX to RDY	$\pm$ 1.5			mA	

Note 1: Typical values are given at V<sub>CC</sub> = 5V and T<sub>A</sub> = 25°C.

#### VM7162 (Two Channels), VM7164, VM7168 (Four Channels) Write

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
Write Current Matching Between Channels	$\Delta$ I <sub>W</sub>	5mA < I <sub>W</sub> < 35mA			10	%
Duty Cycle (25mA/head)					20	%

**SWITCHING CHARACTERISTICS** Recommended operating conditions apply unless otherwise specified;  $I_W = 20\text{mA}$ ,  $f_{\text{DATA}} = 5\text{MHz}$ ,  $L_H = 1\mu\text{H}$ ,  $R_H = 30\Omega$ ,  $C_L (\text{RDX, RDY}) \leq 20\text{pF}$  (see Figure 1).

PARAMETER	SYM	CONDITIONS	MIN	TYP (Note 1)	MAX	UNITS
R $\bar{W}$ Read to Write Delay	$t_{\text{RW}}$	R $\bar{W}$ to 90% $I_W$		0.04	0.2	$\mu\text{s}$
R $\bar{W}$ Write to Read Delay	$t_{\text{WR}}$	R $\bar{W}$ to 90% of 100mV, 10MHz read signal envelope		0.4	1	$\mu\text{s}$
WSER to Read Delay	$t_{\text{SR}}$	R $\bar{W}$ to 90% of 100mV, 10MHz read signal envelope. (WSER and R $\bar{W}$ coincident switching)		0.4	1	$\mu\text{s}$
$\bar{\text{CS}}$ Unselect to Select Delay	$t_{\text{IR}}$	$\bar{\text{CS}}$ to 90% $I_W$ or 90% of 100mV, 10MHz read signal envelope			0.6	$\mu\text{s}$
$\bar{\text{CS}}$ Select to Unselect Delay	$t_{\text{RI}}$	$\bar{\text{CS}}$ to 10% of $I_W$			0.6	$\mu\text{s}$
HS0, 1, any Head Delay	$t_{\text{HS}}$	HS0, 1 to 90% of 100mV, 10MHz read signal envelope			0.6	$\mu\text{s}$
WUS Safe to Unsafe Delay	$t_{\text{D1}}$		0.6		3.6	$\mu\text{s}$
WUS Unsafe to Safe Delay	$t_{\text{D2}}$				1.0	$\mu\text{s}$
Head Current Propagation Delay (TD3)	$t_{\text{D3}}$	$L_H = 0$ , $R_H = 0$ , from 50% points			30	ns
Head Current Asymmetry	ASYM	50% duty cycle on WDI, 1ns rise/fall time; $L_H = 0$ , $R_H = 0$			0.5	ns
Head Current Rise/Fall Time	$t_r/t_f$	10% to 90% points	$L_H = 0$ , $R_H = 0$	4	6	ns
			$L_H = 1\mu\text{H}$ , $R_H = 30\Omega$	12	16	

Note 1: Typical values are given at  $V_{\text{CC}} = 5\text{V}$  and  $T_A = 25^\circ\text{C}$ .

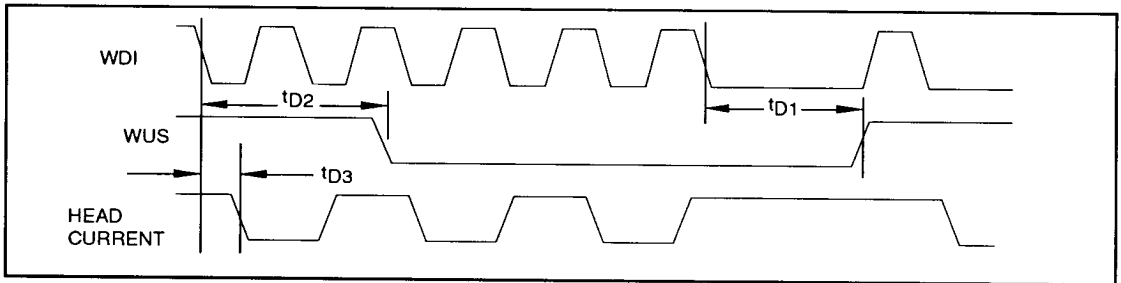


Figure 1: Write Mode Timing Diagram

TWO/THREE TERMINAL & SERVO PREAMPLIFIERS