



VTC Inc.
Value the Customer™

VM7164S

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

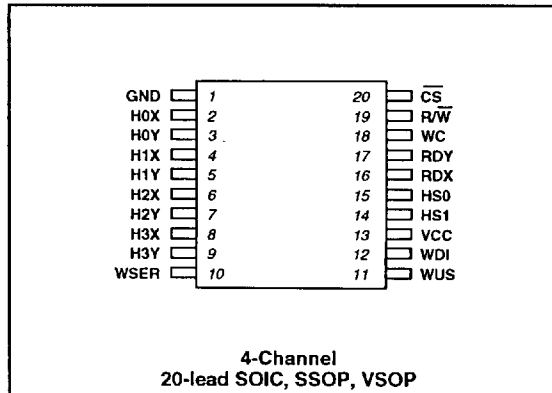
PRELIMINARY

July, 1993

FEATURES

- High Performance
 - Read Gain = 300 V/V Typical
 - Input Noise = 0.65nV/√Hz Maximum
 - Head Inductance Range = 0.7 – 5 μH (1.0 μH typical)
 - Write Current Range 5 - 35 mA
 - Low Input Capacitance = 16 pF Maximum (14 pF typical)
- TTL Write Data Input
- Servo Write Four Channels at the Same Time
- 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 4-Channels

CONNECTION DIAGRAM



TWO/THREE TERMINAL
& SERVO PREAMPLIFIERS

DESCRIPTION

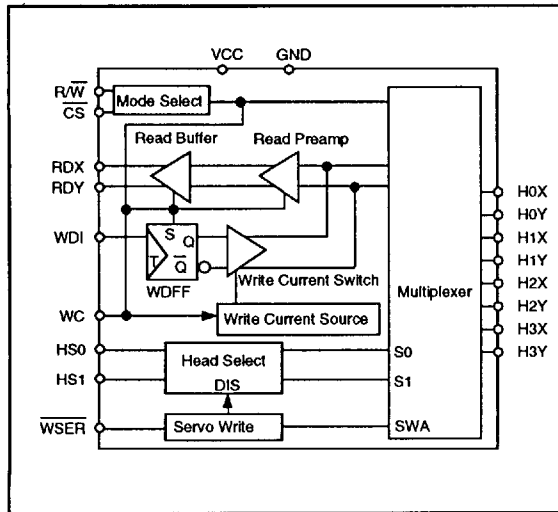
The VM7164S is a high-performance, very low-power read/write preamplifier designed for use with external 2-terminal, thin-film or MIG recording heads. This circuit will operate on a single 5-volt power supply and is ideally suited for use in battery powered disk drives. The VM7164S provides a four channel servo write feature, enabling the user to write servo information directly through the preamp.

The VM7164S provides write current switching in the write mode and a low noise data path in the read mode for up to four 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 VM7164S is available in several different packages. Please consult VTC for package availability and additional read mode voltage gains.

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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_{sig} -65° to 150°C

Thermal Characteristics, θ_{JA} :

20-lead SOIC 80°C/W

20-lead SSOP TBD

RECOMMENDED OPERATING CONDITIONS

Power Supply Voltage:

V_{CC} +5V \pm 10%

Write current (I_W) 5 to 35mA

Head Inductance (L_H) 0.7 to 5 μ H

Junction Temperature (T_J) 25°C to 125°C

CIRCUIT OPERATION

The VM7164S 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 1 and 2.

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 VM7164S 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 (Wdff) 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, \pm 8%) is:

$$I_W = K_W/R_{WC} + 0.2mA \\ = 50/R_{WC} + 0.2mA$$

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.

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

The WUS function is not operational and, therefore, not pinned out on the VM7164S.

Servo Write Mode

In servo write mode, four channels of the VM7164S are active at the same time. Pin WSER controls the servo mode. When WSER and R/W are low, the chip is in servo write mode: four channels are written at the same time, independent of the head select lines (see table 1). When WSER is high and R/W 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.

Internal pull-up 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 VM7164S 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.

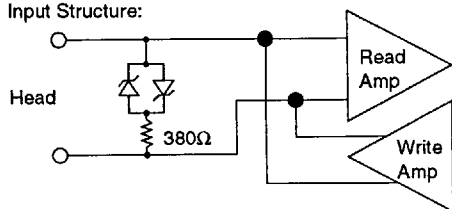
Sleep Mode

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 VM7164S has 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 1: Mode Selection for VM7164S

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

Table 2: Head Selection in Single Write Mode (WSER = HIGH) for VM7164S

HS1	HS0	HEAD
0	0	0
0	1	1
1	0	2
1	1	3

PIN DESCRIPTIONS

NAME	I/O	DESCRIPTION
HS0-HS1	I*	Head Select: selects one of up to 4 heads
H0X-H3X H0Y-H3Y	I/O	X, Y Head terminals
WDI	I*	Write Data Input: 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
$\overline{R/\overline{W}}$	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
\overline{WSER}	I*	Servo Write: A low 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.

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DC CHARACTERISTICS Recommended operating conditions apply unless otherwise specified.

PARAMETER	SYM	CONDITIONS	MIN	TYP (Note 1)	MAX	UNITS	
Supply Current	I _{CC}	Read Mode		44	54	mA	
		Write Mode, I _W = 35mA	Normal		54 + I _W		64 + I _W
			Servo		70 + 4 I _W		82 + 4 I _W
		Sleep Mode		0.6	3		
Power Dissipation	PD	Read Mode		220	297	mW	
		Write Mode, I _W = 35mA	Normal		445		545
			Servo		1050		1221
		Sleep Mode		3	17		
Input High Voltage	V _{IH}		2		V _{CC} + 0.3	V	
Input Low Voltage	V _{IL}		-0.3		0.8	V	
Input High Current	I _{IH}	V _{IH} = 2.7V			80	μA	
Input Low Current	I _{IL}	V _{IL} = 0.4V	-160			μA	
WUS Output Low Voltage	V _{OL}	I _{OL} = 4.0mA		0.35	0.5	V	
WUS Output High Current	I _{OH}	V _{OH} = 5.0V		13	100	μA	
VCC Value for Write Current Turn Off		I _H < 0.2mA	3.5	3.8	4.2	V	

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

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

PARAMETER	SYM	CONDITIONS	MIN	TYP (Note 1)	MAX	UNITS
WC Pin Voltage	V _{WC}			2.5		V
I _{WC} to Head Current Gain	A _I			20		mA/mA
Write Current Constant	K _W	$K_W = (V_{WC})(A_I); 10 - 30\text{mA}$	46	50	54	V
		$K_W = (V_{WC})(A_I); 5 - 35\text{mA}$	45	50	55	V
Write Current Range	I _W	$1.44\text{K} < R_{WC} < 10.4\text{K}$	5		35	mA
Write Current Tolerance	ΔI_W	$I_W = 10 - 30\text{mA}$	-8		+8	%
		$I_W = 5 - 35\text{mA}$	-10		+10	%
Differential Head Voltage Swing	V _{DH}		4	5.4		Vp-p
WDI Transition Frequency for Safe Condition	f _{DATA}	WUS = low	1			MHz
Differential Output Capacitance	C _O				15	pF
Differential Output Resistance	R _O		3200			Ω
Unselected Head Transient Current	I _{UH}	$I_W = 15\text{mA}$		0.15	1	mA(pk)
RDX, RDY Common Mode Output Voltage	V _{CM}			V _{CC} -2.7		V

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

VM7164S (Four Channels) Write

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
Write Current Matching Between Channels	ΔI_W	$5\text{mA} < I_W < 35\text{mA}$			10	%
Duty Cycle (25mA/head)					20	%

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

PARAMETER	SYM	CONDITIONS	MIN	TYP (Note 1)	MAX	UNITS
Differential Voltage Gain	AV	$V_{IN} = 1\text{mV}_{\text{rms}}, 1\text{MHz}$	250	300	350	V/V
Bandwidth	BW	-1dB $ Z_s < 5\Omega, V_{IN} = 1\text{mV}_{\text{p-p}}$	30	40		MHz
		-3dB $ Z_s < 5\Omega, V_{IN} = 1\text{mV}_{\text{p-p}}$	55	75		
Input Noise Voltage	e_{in}	BW = 17MHz, $L_H = 0, R_H = 0$		0.50	0.65	nV/ $\sqrt{\text{Hz}}$
Differential Input Capacitance	C_{IN}	$V_{IN} = 1\text{mV}_{\text{p-p}}, f = 5\text{MHz}$		14	16	pF
Differential Input Resistance	R_{IN}	$V_{IN} = 1\text{mV}_{\text{p-p}}, f = 5\text{MHz}$	350	800		Ω
Dynamic Range	DR	AC input where AV is 90% of gain at 0.2mVrms input	2	5		mVrms
Common Mode Rejection Ratio	CMRR	$V_{IN} = 100\text{mV}_{\text{p-p}} @ 5\text{MHz}$	50			dB
Power Supply Rejection Ratio	PSRR	100mVp-p @ 5MHz on VCC	45			dB
Channel Separation	CS	Unselected channels driven with 20mVp-p @ 5MHz	45			dB
Output Offset Voltage	VOS		-400		+400	mV
RDX,RDY Common Mode Output Voltage	VOCM	Read Mode		$V_{CC}-2.7$		V
Read to Write Common Mode Output Voltage Difference	ΔVOCM		-350		350	mV
Single-Ended Output Resistance	RSEO				35	Ω
Output Current	I_O	AC Coupled Load, RDX to RDY	± 1.5			mA

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

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 (RDX, RDY) $\leq 20\text{pF}$ (see Figure 1).

PARAMETER	SYM	CONDITIONS	MIN	TYP (Note 1)	MAX	UNITS
R/W Read to Write Delay	t_{RW}	R/W to 90% I_W		0.04	0.2	μs
R/W Write to Read Delay	t_{WR}	R/W to 90% of 100mV, 10MHz read signal envelope		0.4	1	μs
WSER to Read Delay	t_{SR}	R/W to 90% of 100mV, 10MHz read signal envelope. (WSER and R/W coincident switching)		0.4	1	μs
CS Unselect to Select Delay	t_{IR}	$\overline{\text{CS}}$ to 90% I_W or 90% of 100mV, 10MHz read signal envelope			0.6	μs
CS Select to Unselect Delay	t_{RI}	$\overline{\text{CS}}$ to 10% of I_W			0.6	μs
HS0, 1, any Head Delay	t_{HS}	HS0, 1 to 90% of 100mV, 10MHz read signal envelope			0.6	μs
WUS Safe to Unsafe Delay	t_{D1}		0.6		3.6	μs
WUS Unsafe to Safe Delay	t_{D2}				1.0	μs
Head Current Propagation Delay (TD3)	t_{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		4	6	ns
			$L_H = 0$, $R_H = 0$			
				12	16	

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

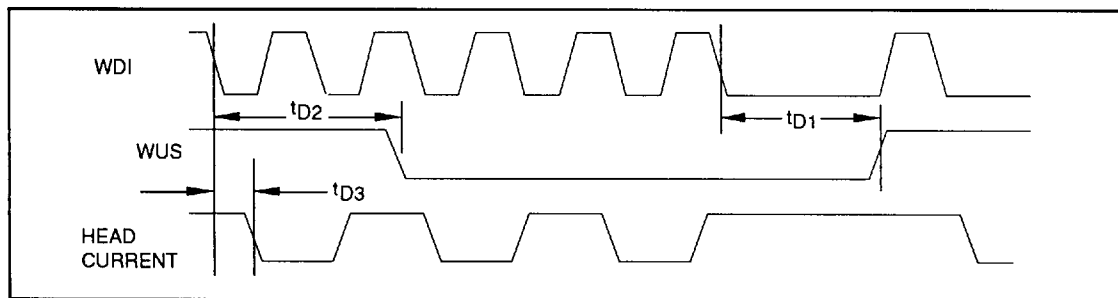


Figure 1: Write Mode Timing Diagram

TWO/THREE TERMINAL
& SERVO PREAMPLIFIERS