VTC Inc.
Value the Customer™

VM7150

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/$\sqrt{Hz}$ Maximum
  - Head Inductance Range = 0.2 – 5 µH (0.5 µH typical)
  - Write Current Range 5 - 35 mA
  - Low Input Capacitance = 16 pF Maximum (14 pF typical)
- Pseudo ECL Write Data Inputs
- Servo Write Two or Four Channels at the Same Time
  - VM7152 Two-Channel Servo Write
  - VM7154 Four-Channel Servo Write
  - VM7158 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

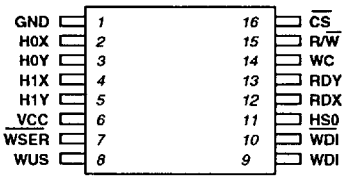
DESCRIPTION

The VM7150 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 VM7150 provides a two or four channel servo write feature, enabling the user to write servo information directly through the preamp.

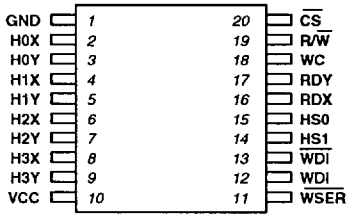
The VM7150 provides write current switching in the write mode and a low noise data path in the read mode for up to eight read/write recording heads. When deactivated, the device enters a ***sleep mode*** that reduces power dissipation to 4.5 mW. Data protection circuitry is provided to ensure that the 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 VM7150 is available in several different packages. Please consult VTC for package availability and additional read mode voltage gains.

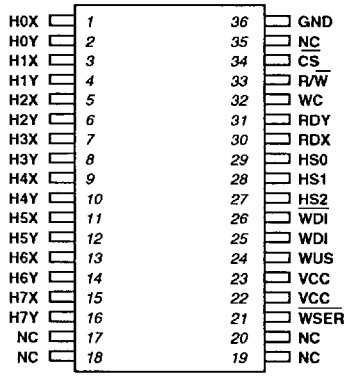
CONNECTION DIAGRAMS



2-Channel
16-lead SOIC
(narrow .150" wide body)



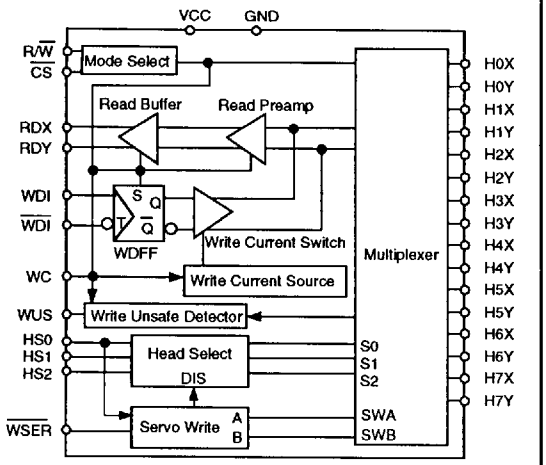
4-Channel
20-lead SOIC



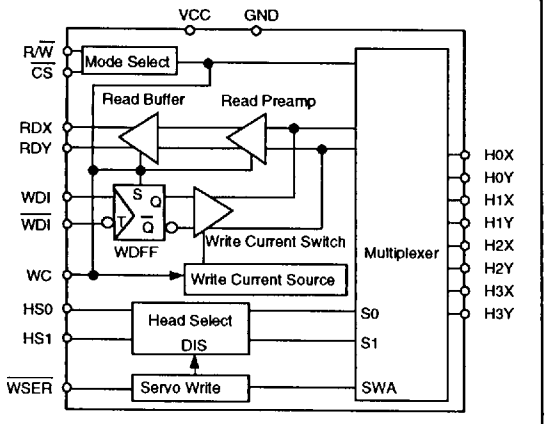
8-Channel
36-lead SOIC

BLOCK DIAGRAMS

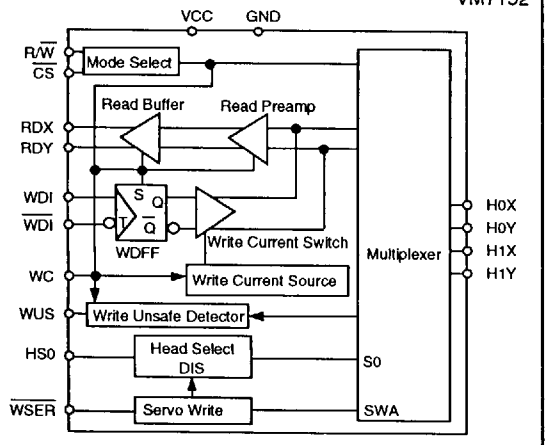
VM7158



VM7154



VM7152



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, Θ_{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) ..... 5 to 35mA

Head Inductance (L_H) ..... 0.2 to 10µH

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

CIRCUIT OPERATION

The VM7152 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 VM7154 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 VM7158 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 VM7150 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, ± 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 VM7154.

Servo Write Mode

In servo write mode, two channels of the VM7152 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, where both heads are written independent of the head select line (see table 1a). 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 line.

In servo write mode, four channels of the VM7154 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 1b). 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.

In servo write mode, four channels of the VM7158 are active at the same time. Pin WSER controls the servo mode and HS0 controls which four heads are simultaneously written. When WSER and R/W are 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 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.

On all versions, an 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

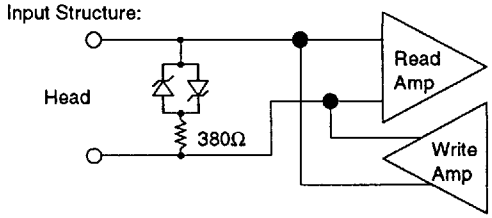
In read mode, the VM7150 acts as a low noise differential amplifier for signals coming off the disk. The write current generator and write unsafe circuitry is deactivated. The RDX, RDY pins are emitter follower outputs and are in phase with "X" and "Y" head ports. These outputs should be AC coupled to 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 VM7158 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.



Please consult factory for damping resistor options on other devices.

Table 1a: Mode Selection for VM715N2

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

Table 1b: Mode Selection for VM715N4

R/W	CS	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 1c: Mode Selection for VM7158

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

Table 2a: Head Selection in Single Write Mode (WSER = HIGH) for VM715N2

HS0	*HEAD*
0	0
1	1

Table 2b: Head Selection in Single Write Mode (WSER = HIGH) for VM715N4

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

Table 2c: Head Selection in Single Write Mode (WSER = HIGH) for VM7158

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, $\overline{WDI}$	I*	Write Data Inputs: PECL 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
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.

Table 3: Differential Read Voltage Gain

MIN	*TYP*	*MAX*	*UNIT*	Gain Option Designator
84	100	116	V/V	10
125	150	175		15
167	200	233		20
208	250	292		25
250	300	350		30

VM7150

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 VM7152		44 + I_W	52 + I_W	
		Normal VM7154 & VM7158		54 + I_W	64 + I_W	
		Servo VM7152		44 + 2 I_W	56 + 2 I_W	
		Servo VM7154 & VM7158		70 + 4 I_W	82 + 4 I_W	
		Sleep Mode		0.6	3	
VM7152 Power Dissipation	PD	Read Mode		220	297	mW
		Write Mode, I_W = 35mA				
		Normal		395	479	
		Servo		570	693	
		Sleep Mode		3	17	
VM7154, VM7158 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
WDI, $\overline{WDI}$ Input High Voltage	V_{IH}	Pseudo ECL	V_{CC} - 1.0		V_{CC} - 0.7	V
WDI, $\overline{WDI}$ Input Low Voltage	V_{IL}	Pseudo ECL	V_{CC} - 1.9		V_{CC} - 1.6	V
WDI, $\overline{WDI}$ Input High Current	I_{IH}	Pseudo ECL			100	µA
WDI, $\overline{WDI}$ Input Low Current	I_{IH}	Pseudo ECL			80	µA
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 VM7152	3.7	4.0	4.3	V
		I_H < 0.2mA VM7154 & VM7158	3.5	3.8	4.2	

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 = 1µH, R_H = 30Ω, I_W = 20mA, f_{DATA} = 5MHz.

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 - 30mA	46	50	54	V
		$K_W = (V_{WC})(A_I)$; 5 - 35mA	45	50	55	V
Write Current Range	I_W	1.44K < R_{WC}< 10.4K	5		35	mA
Write Current Tolerance	ΔI_W	I_W = 10 - 30mA	-8		+8	%
		I_W = 5 - 35mA	-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 = 15mA		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} = 5V and T_A = 25°C.

VM7152 (Two Channels), VM7154, VM7158 (Four Channels) Write

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

VM7150

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

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP (Note 1)*	*MAX*	*UNITS*
Differential Voltage Gain	A_V	V_{IN} = 1mVrms, 1MHz (see table 3)	250	300	350	V/V
Bandwidth	BW	-1dB |Zs| < 5Ω, V_{IN} = 1mVp-p	30	40		MHz
		-3dB |Zs| < 5Ω, V_{IN} = 1mVp-p	55	75		
Input Noise Voltage	e_{in}	BW = 17MHz, L_H = 0, R_H = 0		0.50	0.65	nV/√Hz
Differential Input Capacitance	C_{IN}	V_{IN} = 1mVp-p, f = 5MHz		14	18	pF
Differential Input Resistance	R_{IN}	V_{IN} = 1mVp-p, f = 5MHz	350	800		Ω
Dynamic Range	DR	AC input where A_V is 90% of gain at 0.2mVrms input	2	5		mVrms
Common Mode Rejection Ratio	CMRR	V_{IN} = 100mVp-p @5MHz	50			dB
Power Supply Rejection Ratio	PSRR	100mVp-p @5MHz on V_{CC}	45			dB
Channel Separation	CS	Unselected channels driven with 20mVp-p @5MHz	45			dB
Output Offset Voltage	V_{OS}		-400		+400	mV
RDX,RDY Common Mode Output Voltage	V_{OCM}	Read Mode		V_{CC}-2.7		V
Read to Write Common Mode Output Voltage Difference	ΔV_{OCM}		-350		350	mV
Single-Ended Output Resistance	R_{SEO}				35	Ω
Output Current	I_O	AC Coupled Load, RDX to RDY	±1.5			mA

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

SWITCHING CHARACTERISTICS Recommended operating conditions apply unless otherwise specified; I_W = 20mA, f_{DATA} = 5MHz, L_H = 1µH, R_H = 30Ω, C_L (RDX, RDY) ≤ 20pF (see Figure 1).

PARAMETER	SYM	CONDITIONS	MIN	TYP (Note 1)	MAX	UNITS
R/$\overline{W}$ Read to Write Delay	t_{RW}	R/$\overline{W}$ to 90% I_W		0.04	0.2	µs
R/$\overline{W}$ Write to Read Delay	t_{WR}	R/$\overline{W}$ to 90% of 100mV, 10MHz read signal envelope		0.4	1	µs
$\overline{WSER}$ to Read Delay	t_{SR}	R/$\overline{W}$ to 90% of 100mV, 10MHz read signal envelope. ($\overline{WSER}$ and R/$\overline{W}$ coincident switching)		0.4	1	µs
$\overline{CS}$ Unselect to Select Delay	t_{IR}	$\overline{CS}$ to 90% I_W or 90% of 100mV, 10MHz read signal envelope			0.6	µs
$\overline{CS}$ Select to Unselect Delay	t_{RI}	$\overline{CS}$ 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	A_{SYM}	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
		10% to 90% points, L_H = 1µH, R_H = 30Ω		12	16	

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

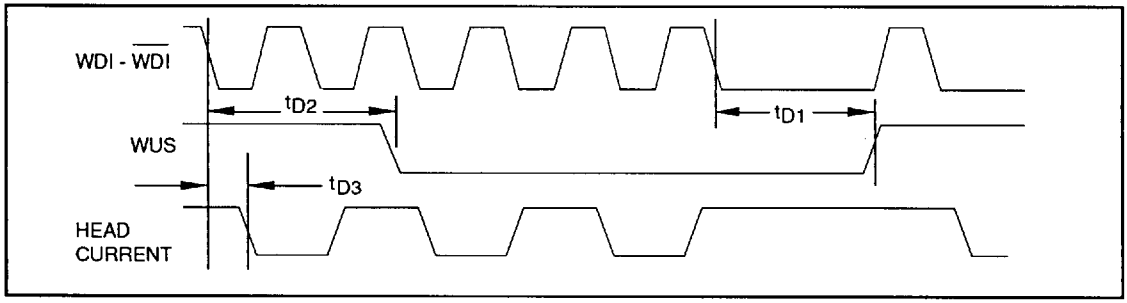


Figure 1: Write Mode Timing Diagram