VTC Inc.
Value the Customer™

VM3500

4, 6 OR 8-CHANNEL, 5-VOLT, THIN-FILM HEAD, READ/WRITE PREAMPLIFIER WITH MULTIPLE SERVO WRITE CAPABILITY

950801

PRELIMINARY

August, 1995

FEATURES

- High Performance
  - Read Gain = 300 V/V Typical
  - Input Noise = 0.5nV/√Hz Typical
  - Head Inductance Range = 0.2 – 1 µH (0.54 µH Typical)
  - IW Rise/Fall Times = 3.0 ns (L_H = 0.54 µH, I_W = 10 mA b-p)
  - Write Current Range 5 - 25 mA
  - Write Current Servo Range 5 - 20 mA
  - Low Input Capacitance = 8 pF Typical
- PECL or TTL Write Data Inputs
- Multi-Channel Servo Write
- Very Low Power Dissipation = 3 mW Typical in Sleep Mode
- Power Up/Down Data Protect Circuitry
- Single Power Supply = 5 V ± 10%
- Write Unsafe Detection
- Reduced Write-to-Read Recovery Time
- Write Data Flip-Flop Optional
- Available in 4, 6 or 8-Channels

DESCRIPTION

The VM3500 is a high-performance read/write preamplifier designed for use in high-end disk drives. It provides write current control, data protection circuitry, and a low-noise read preamplifier for up to eight channels. When unselected, the device enters a sleep mode, with power dissipation reduced to less than 3mW.

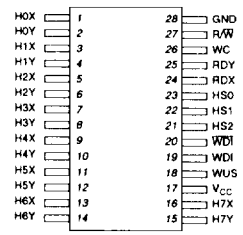
Fault protection is provided so that during power supply sequencing the write current generator is disabled. System write-to-read recovery time is minimized by maintaining the read channel common-mode output voltage in write mode.

Very low-power dissipation from the +5V supply is achieved through use of high-speed bipolar processing and innovative circuit design techniques.

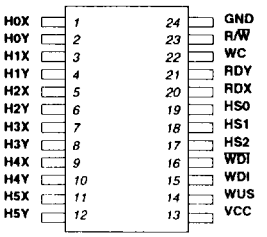
In multi-channel servo write mode, multiple heads can be written simultaneously. The VM3500 servo mode is activated via the WUS line or optional $\overline{\text{WSER}}$ pin and, when active, write all heads simultaneously.

The VM3500 is available in several different packages. Please contact VTC for package availability.

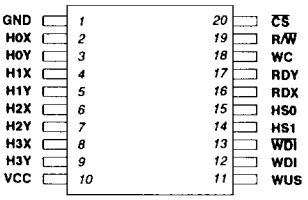
CONNECTION DIAGRAMS



8-Channel
28-lead SSOP

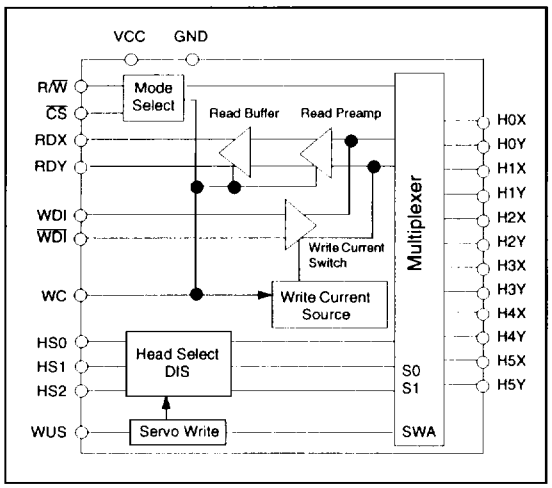


6-Channel
24-lead SSOP



4-Channel
20-lead SOIC, SSOP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Power Supply:
- V_{CC} ..... -0.3V to +7V

Write Current I_W 30mA

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 Tstg ..... -65° to 150°C

Thermal Characteristics, Θ_{JA}:
- 20-lead SOIC ..... 90°C/W
- 20-lead SSOP ..... 110°C/W
- 24-lead SSOP ..... 100°C/W

RECOMMENDED OPERATING CONDITIONS

Power Supply Voltage:
- V_{CC} .....+5V ± 10%

Write current (I_W) ..... 5 to 25mA

Head Inductance (L_H) ..... 0.2 to 1µH

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

CIRCUIT OPERATION

The VM3500 addresses up to eight two-terminal thin-film heads, providing write drive or read amplification. Mode control is accomplished with pins $\overline{CS}$ and R/$\overline{W}$, as shown in Table 1. Table 2 shows the head select during normal (single head) write mode. Internal resistor pull-high provided on pins $\overline{CS}$ and R/$\overline{W}$ will force the device into a non-writing condition if either control line is opened accidentally.

Write Mode

In write mode the VM3500 (F) acts as a write current switch with the write current toggled between the X and Y side of the selected head in response to transitions on the WDI (-WDI) PECL inputs. Also the write unsafe (WUS) detection circuitry is activated at this time to drive the outpiut to a low (Safe) condtion.

VM3500: Write current on the VM3500 product which has a WDI flip-flop (WDFF) is toggled on each low to high transtion of WDI (-WDI). A preceding read operation initializes the WDFF so that upon entering the write mode current flows into the "X" port.

VM3500F: For the VM3500F product (No WDFF), the write current polarity is defined by the levels of WDI (-WDI). For WDI > -WDI, the current flows into the "X" port and into the "Y" port for WDI < -WDI.

The write current magnitude is determined by an external resistor connected between the WC pin and ground. An internally-generated 2.5 V reference voltage is present at the WC pin. The magnitude of the write current (0-pk ±10%) is:

$$I_W = K_W/R_{WC} + 0.3mA = (50/R_{WC}) + 0.3mA \quad \textit{(eq. 1)}$$

Power supply fault protection improves data security by disabling the write current generator during a voltage fault or power-up. Additionally, the write unsafe circuitry will flag any of the conditions below as a high level on the open collector output pin WUS. Two transitions on pin WDI, after the fault is corrected,may be required to clear the WUS flag.

- No write current
- WDI frequency too low
- Device in read or sleep mode

Multi-Channel Servo Write Mode

In this mode, the operation is the same as described above except that multiple channels are written at the same time (see tables 1 - 3). Servo mode is controlled using the WUS pin. To initiate servo mode the following procedure is used:

1. Enter read mode via R/$\overline{W}$ high
2. Select Head 1
3. Supply 10mA source current into WUS pin
4. Drop the R/$\overline{W}$ line to low

The device is now in servo mode with all heads writing at the same time. If any other head is selected during servo the part will only write selected head. (i.e. part will fall out of servo.) To return to normal operations the following sequence is used:

1. Enter read mode
2. Drop the WUS pin (the device is in normal read mode)
3. Will also occur if any head except head 1 is selected, but will return to servo mode if HDI is reselected

Read Mode

The read mode configures the VM3500 as a low-noise differential amplifier and deactivates the write current generator and write unsafe detection circuitry. The RDX and RDY outputs are emitter followers and are in phase with the "X" and "Y" head ports. These outputs should be AC-coupled to the load. The RDX, RDY common-mode voltage is maintained in the write mode, minimizing the transient between the write mode and the read mode, thereby substantially reducing the recovery time delay to the subsequent pulse detection circuitry.

Idle Mode

When $\overline{CS}$ is high, virtually the entire circuit is shut down so that power dissipation is reduced to 3mW typical for sleep mode.

Table 3: Mode Select

R/$\overline{W}$	*$\overline{CS}$*	*MODE*
0	0	Write
0	0	Servo
1	0	Read
X	1	Idle

Table 4: Head Selection

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

PIN DESCRIPTIONS

NAME	*I/O*	*DESCRIPTION*
HS0 - HS2	I*	Head Select: selects one of up to six heads
H0X - H5X H0Y - H5Y	I/O	X, Y Head Terminals
WDI, $\overline{WDI}$	I*	Write Data Inputs: PECL input signal, rising edge toggles direction of head current. (every transition on "F" option)
$\overline{CS}$	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 indicates write mode
WUS	O*	Write unsafe: open collector output, high level indicates writes unsafe condition/also used during servo
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

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

DC CHARACTERISTICS Recommended operating conditions apply unless otherwise specified.

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP*	*MAX*	*UNITS*
Power Supply Voltage	V_{CC}	Servo Mode	4.5	5.0	5.5	mA
VCC Supply Current	I_{CC}	Read Mode		$34 + 0.05I_W$	TBD	mA
		Write Mode, I_W = 10mA, Normal		$25 + 1.2\ I_W$	TBD	
		Write Mode, Servo (4-Channel)		$55 + 4.3I_W$	TBD	
		Write Mode, Servo (6-Channel)		$70 + 6.5I_W$	TBD	
		Sleep Mode		0.5	3	
Power Supply Power Dissipation	PD	Read Mode				mW
		Write Mode, I_W = 10mA, Normal				
		Write Mode, Servo, I_W = 10mA (4-Channel)				
		Write Mode, Servo, I_W = 10mA (6-Channel)				
		Sleep Mode		3	16.5	
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
WDI, $\overline{WDI}$ Input High Voltage	V_{IH}	Pseudo ECL	V_{CC} - 1.5		V_{CC} - 0.7	V
WDI, $\overline{WDI}$ Input Low Voltage	V_{IL}	Pseudo ECL	V_{IH} - 1.5		V_{IH} - 0.7	V
WDI, $\overline{WDI}$ Input High Current	I_{IH}	$V_{IH} = V_{CC}$ - 0.7V			100	µA
WDI, $\overline{WDI}$ Input Low Current	I_{IL}	$V_{IH} = V_{CC}$ - 1.6V			80	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	3.3	3.6	4.0	V
WUS Servo Enable	I_{SE}		10	6 *	20	mA

* The typical value for servo activation = 6mA.

WRITE CHARACTERISTICS Recommended operating conditions apply unless otherwise specified; L_H = 0.54µH, R_H = 20Ω, I_W = 10mA, 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	V_{CC} = 5V ±10%	45	50	55	V
Write Current Range	I_W	10.64ΩK > R_{WC} > 2.54KΩ	5		25	mA
Write Current Tolerance	ΔI_W	V_{CC} ±10%	-10		+10	%
Write Current Tolerance Servo	ΔI_W	V_{CC} ±10%	-14		+14	
Differential Head Voltage Swing	V_{DH}	Open head	5.4	6.0		Vp-p
WDI Transition Frequency for Safe Condition	f_{DATA}	WUS = low	1			MHz
Differential Output Capacitance	C_{OUT}				10	pF
Differential Output Resistance	R_{OUT}		3.2			kΩ
Unselected Head Current	I_{UH}	I_W = 25mA		0.15	0.5	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.

Servo Write

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP*	*MAX*	*UNITS*
Write Current Matching Between Channels	ΔI_W	5mA < I_W < 20mA			10	%
Duty Cycle (15mA/head) * 4 Channel					20	%

* Duty Cycle must take into account Iw and the # of channels in servo mode.

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	250	300	350	V/V
Bandwidth	BW	-1dB |Zsl < 5Ω, V_{IN} = 1mVp-p	50			MHz
		-3dB |Zsl < 5Ω, V_{IN} = 1mVp-p	100	120		
Input Noise Voltage	e_{in}	BW = 20MHz, L_H = 0, R_H = 0		0.5	0.65	nV/√Hz
Differential Input Capacitance	C_{IN}	V_{IN} = 1mVp-p, f = 5MHz		8	10	pF
Differential Input Resistance	R_{IN}	V_{IN} = 1mVp-p, f = 5MHz	300	750		Ω
Dynamic Range	DR	AC input where A_V is 90% of gain at 0.2mVrms input	2			mV P-P
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: V_{IN} = 20mVp-p @ 5MHz V_{IN} = 0 on selected head	45			dB
Output Offset Voltage	V_{OS}	Steady state read	-300		300	mV
RDX, RDY Common Mode Output Voltage	V_{OCM}	Read/Write Mode		V_{CC} - 2.7		
RDX, RDY Common Mode Output Voltage Difference Between Modes	ΔV_{OCM}		-350		+350	mV
Single-Ended Output Resistance	R_{SEO}	f = MHz			35	Ω
Output Current	I_O	AC coupled load, RDX to RDY	±1			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 = 10mA, f_{DATA} = 5MHz, L_H = 0.54µH, R_H = 20Ω, 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		0.06	0.15	µs
R/$\overline{W}$ Write to Read Delay	t_{WR}	R/$\overline{W}$ to 90% of 100mV, 10 MHz read signal envelope		0.2	0.4	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 - HS3 any Head Delay	t_{HS}	HS0 - HS3 to 90% of 100mV, 10MHz read signal envelope			0.6	µs

SWITCHING CHARACTERISTICS Recommended operating conditions apply unless otherwise specified; I_W = 10mA, f_{DATA} = 5MHz, L_H = 0.54µH, R_H = 20Ω, C_L (RDX, RDY) ≤ 20pF (see Figure 1).

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP* *(Note 1)*	*MAX*	*UNITS*
WUS Safe to Unsafe Delay	t_{D1}		0.6		3.6	µs
WUS Unsafe to Safe Delay	t_{D2}	I_W = 10mA			1.0	µs
Head Current Propagation	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, I_W = 10mA		1.0	2.0	ns
		10% to 90% points, L_H = 540nH, I_W = 10mA, R_H = 20Ω		3.0	5.0	

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

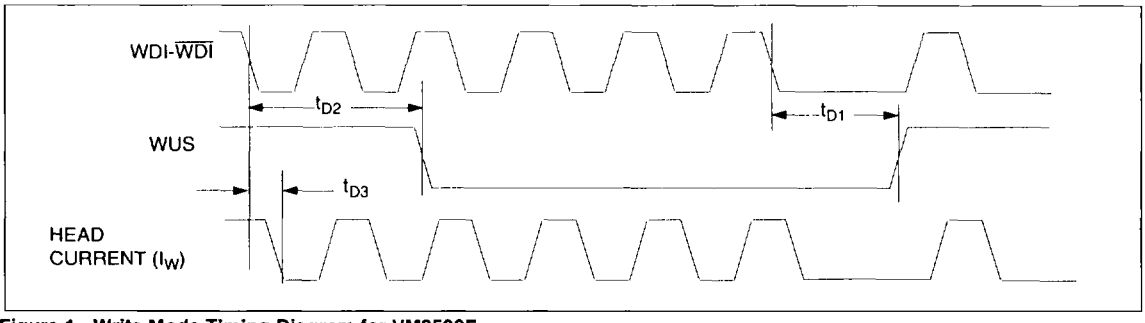


Figure 1: Write Mode Timing Diagram for VM3500F

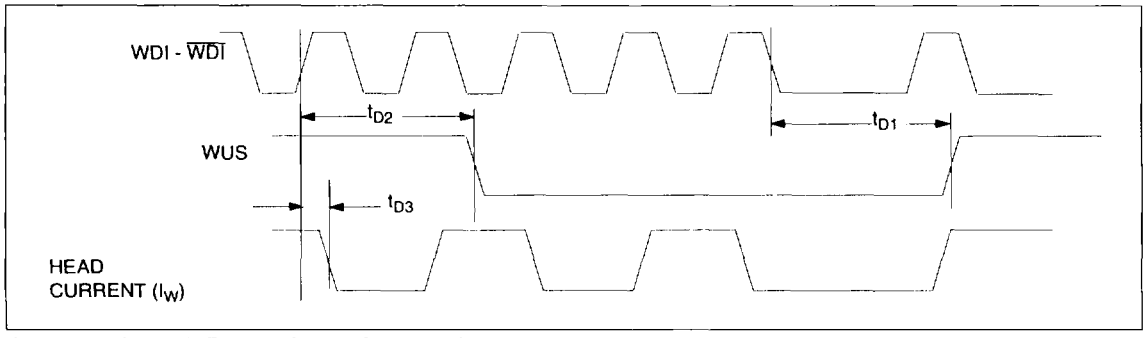


Figure 2: Write Mode Timing Diagram for VM3500