VTC Inc.
Value the Customer™

VM6122

2-CHANNEL, MAGNETO-RESISTIVE HEAD, READ/WRITE PREAMPLIFIER WITH SERVO WRITE

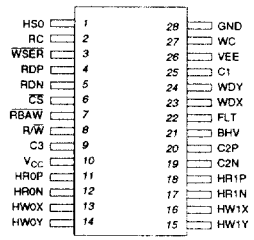
970801

August,1997

FEATURES

- High Performance
  - Read Voltage Gain = 150 or 350 V/V Typical
  - Input Noise = 0.70 nV/$\sqrt{Hz}$ Typical
  - Head Inductance Range = 100 nH to 500 nH
  - Write Current Range = 20 - 40 mA
  - Input Capacitance = 18 pF Typical
  - Rise Time = 4 ns Maximum (L_H = 220 nH, I_W = 30 mA)
- Operates from +5 and -3 Volt Power Supplies
- Dual-Channel Servo Write
- Fault Detect Capability
- Designed for Use With Four-Terminal MR Heads
- MR Bias Current Range 10 - 16 mA
- Write Data Flip-Flop Bondable Option
- Current Bias/Voltage Sense Configuration

CONNECTION DIAGRAM



2-Channel
28-lead NSSOP

DESCRIPTION

The VM6122 is an integrated bipolar read/write preamplifier designed for use in high-performance hard disk drive applications using 4-terminal magneto-resistive (MR) recording heads. The VM6122 contains a thin-film head writer, an MR reader and associated fault circuitry to address up to two heads. It also provides bias current and control loops for setting the DC voltages on the MR element. The VM6122 provides a two-channel servo write feature, enabling the user to write servo information directly through the preamplifier.

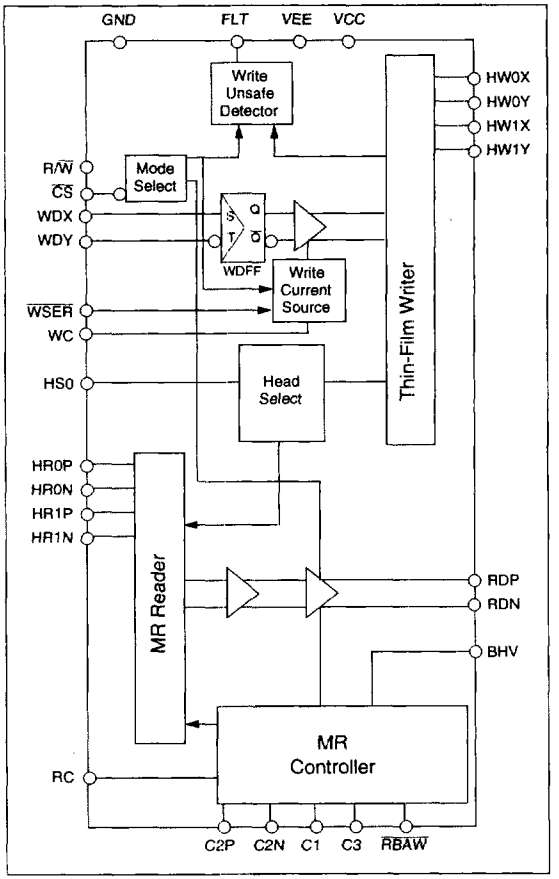
Fault protection is provided so during power sequencing, voltage faults or an invalid head select, the write current generator is disabled protecting the disk from potential transients. For added data protection, internal pull-up resistors are connected to the mode select lines ($\overline{CS}$ and R/$\overline{W}$) to prevent accidental writing due to open lines and to ensure the device will power-up in a non-writing condition.

The VM6122 operates from +5V, -3V power supplies. Low power dissipation is achieved through the use of high-speed bipolar processing and innovative circuit design techniques. When deselected, the device enters a idle mode which reduces the power dissipation.

The VM6122 is available in die form for chip-on-flex applications or in a 28-lead NSSOP. Please consult VTC for details.

VM6122

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Power Supply:
- V_{EE} ..... +0.3V to -5V
- V_{CC} ..... -0.3V to +7V

Write Current I_W 60mA

Input Voltages:
- Digital Input Voltage V_{IN} ..... V_{EE} -0.3V to (V_{CC} + 0.3)V
- Head Port Voltage V_H ..... V_{EE} -0.3V to (V_{CC} + 0.3)V

Output Current:
- RDP, RDN: I_O .....-10mA

Junction Temperature ..... 150°C

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

Thermal Characteristics, Θ_{JA}:

28-Lead Narrow SSOP ..... 100°C/W

RECOMMENDED OPERATING CONDITIONS

Power Supply Voltage:
- V_{EE} ..... -3V ± 10%
- V_{CC} ..... +5V ± 10%

Junction Temperature (T_J) ..... 0°C to 125°C

Write Mode

In the write mode, the circuit operates as a thin film head write current switch, driving the thin film write element of the MR head. The magnitude of the write current is externally programmed either by a resistor or a current source. The writer has a current gain of 20 mA/mA. The appropriate TTL level on $\overline{CS}$, R/$\overline{W}$ and $\overline{WSER}$ lines puts the preamp in the write mode and activates the write unsafe detect circuitry. In the write mode, the write data (PECL) signals on the WDX and WDY lines drive the internal flip-flop which drives the current switch to the thin film writer.The write data flip-flop internal to the chip is an option. The value of the write current is set by an external resistor connected between WC and ground. The following equation governs the write current magnitude:

$$I_W = \frac{36}{R_{WC}(1 + R_H/700)} + 3 \qquad \textit{(eq. 1)}$$

I_W represents the write current flowing to the selected head in mA.
R_{WC} represents the resistance between the ISET pin and ground in kΩ
R_H represents the series resistance of the write element in Ω.

Read Mode

In the read mode, the circuit operates as a low noise differential amplifier which senses resistance changes in the MR element which correspond to flux changes on the disk. In this mode, the bias generator, the input multiplexer, the read preamp and the read fault detection circuitry is turned on. The VM6122 uses the current bias/voltage sensing MR design. The following equation governs the MR bias current magnitude:

$$I_{MR} = \frac{38}{R_{RC}} \qquad \textit{(eq. 2)}$$

I_{MR} represents the bias current flowing to the MR element in mA.
R_{RC} represents the resistance between the ISET pin and ground in kΩ.

Due to the use of a negative supply, the MR head center voltage is at ground potential minimizing current spikes during disk contact.

Servo Write

In servo write mode, both channels of the VM6122 are active at the same time. Pin $\overline{WSER}$ controls the servo mode. When $\overline{WSER}$, $\overline{CS}$ and R/$\overline{W}$ are low, the chip is in servo write mode.

Note: When writing multiple heads, there is a limit to the write current duty cycle that can be used without approaching the maximum junction temperature. This maximum duty cycle is contingent on package type, number of heads selected, write current, heatsinking and airflow. DC erase using multiple heads will exceed the maximum allowable power dissipation.

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Fault Detect

The VM6122 is equipped with fault detect circuitry for both the read and write/servo modes. During the write and servo modes, a TTL high on the FLT line indicates a fault condition. In the read mode, a TTL low on the FLT line indicates a fault condition. A fault can be triggered by the following conditions:

Write/Servo Modes:
- WDI frequency too low
- Open head
- Head short to ground
- No write current
- Low power supply voltage
- Device in Read or Idle mode
- Invalid head selection

Read Mode
- I_{MR} exceeds 1.5 X its programmed value
- Low power suply voltage

The following fault conditions will also result in the shutdown of the write current source internal to the chip:

- Low power supply voltage
- Invalid head select code
- Device in Read or Idle mode

MR Bias Active During Write($\overline{RBAW}$)

Applying a TTL low level on $\overline{RBAW}$ during write mode turns on the MR bias prior to entering read mode to speed up the write to read transition time (see Table 2).

Table 1: Mode Select

MODE	*$\overline{CS}$*	*R/$\overline{W}$*	*$\overline{WSER}$*	*DESCRIPTION*
Read	0	1	X	Preamp in read mode
Write	0	0	1	Preamp in write mode
Servo	0	0	0	Preamp in servo bank mode
Idle	1	X	X	Preamp in idle mode

Table 2: Read Bias Active During Write Mode

MODE	*R/$\overline{W}$*	*$\overline{RBAW}$*	*MR BIAS CURRENT*
Read	1	0	On
Write	0	0	On
Write	0	1 or open	Off

PIN_FUNCTION LIST AND DESCRIPTION

1)	$\overline{CS}$	(I)	Chip select: a TTL low level enables the device.
2)	R/$\overline{W}$	(I*)	Read/Write: a TTL high level enables read mode.
3)	HS0	(I*)	Head Select.
4)	$\overline{RBAW}$	(I*)	A low level enables the Read Bias Active in Write mode.
5)	$\overline{WSER}$	(I*)	A low level enables servo mode.
6)	FLT	(O*)	Write/Read Fault: A high level indicates a fault in write mode. A low level indicates a fault in read mode.
7)	WDX, WDY	(I*)	Differential Pseudo-ECL write data in: a positive edge on WDX toggles the direction of the head current.
8)	HR0P-HR1P	(I)	MR head connections, positive end.
9)	HR0N-HR1N	(I)	MR head connections, negative end.
10)	HW0X-HW1X	(O)	Thin-Film write head connections, positive end.
11)	HW0Y-HW1Y	(O)	Thin-Film write head connections, negative end
12)	RDP, RDN	(O)	Read Data: Differential read signal outputs.
13)	WC	(*)	Write current reference pin: used to set the magnitude of write current.
14)	RC	(*)	MR biaspin: used to set the magnitude of MR bias current.
15)	C1		Noise bypass capacitor input for the MR bias current source.
16)	C2P, C2N		Reader AC coupling capacitor.
17)	C3		Compensation capacitor for the MR head current loop.
18)	BHV	(O)	Buffered MR Head Voltage output.
19)	VEE	-	-3.0V supply
20)	VCC	-	+5.0V supply
21)	GND	-	Ground

* When more than one device is used, these signals can be wire OR'ed together
I = Input pin
O = Output pin

STATIC (DC) CHARACTERISTICS Recommended operating conditions apply unless otherwise specified.
I_{MR} = 13mA, I_W = 30mA.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC} Power Supply Current	I_{CC}	Read Mode		65	90	mA
		Write Mode		105	140	
		Idle Mode		4	5	
		Read Bias Active in Write Mode		130	175	
		Servo Mode, I_W = 20mA		200	265	
V_{EE} Power Supply Current	I_{EE}	Read Mode		45	60	mA
		Write Mode		75	105	
		Idle Mode		2.5	3.5	
		Read Bias Active in Write Mode		95	125	
		Servo Mode, I_W = 20mA		180	240	
Power Supply Dissipation	P_d	Read Mode		460	630	mW
		Write Mode		750	995	
		Idle Mode		28	35	
		Read Bias Active in Write Mode		935	1250	
		Servo Mode, I_W = 20mA		790	1050	
Input High Voltage	V_{IH}	PECL	V_{CC} - 1.0		V_{CC} - 0.7	V
		TTL	2.0		V_{CC} + 0.3	V
Input Low Voltage	V_{IL}	PECL	V_{CC} - 1.9		V_{CC} - 1.6	V
		TTL	-0.3		0.8	V
Input High Current	I_{IH}	PECL			120	µA
		TTL, V_{IH} = 2.7V			80	µA
Input Low Current	I_{IL}	PECL			100	µA
		TTL, V_{IL} = 0.4V	-160			µA
Output High Current	I_{OH}	FLT: V_{OH} = 5.0V			50	µA
Output Low Voltage	V_{OL}	FLT: I_{OL} = 4mA			0.5	V
V_{CC} Fault Threshold	V_{CTH}	V_{EE} = -3.0V	3.5		4.2	V
V_{EE} Fault Threshold	V_{ETH}	V_{CC} = 5.0V	-2.5		-2.1	V

READER CHARACTERISTICS Recommended operating conditions apply unless otherwise specified.
I_{MR} = 13mA, R_{MR} = 22Ω, L_{MR} = 80nH.

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP*	*MAX*	*UNITS*
MR Head Current Range	I_{MR}		10		16	mA
MR Head Current Tolerance	I_{MR}	10 < I_{MR} < 16 mA	-5		+5	%
Unselected MR Head Current					100	µA
MR Bias Reference Voltage	V_{RC}	2375 < R_{RC} < 3800 Ω	1.9	2.0	2.1	V
IRC to MR Bias Current Gain	A_{IMR}	2375 < R_{RC} < 3800 Ω		20		mA/mA
Differential Voltage Gain	A_V	V_{IN} = 2mV_{pp} @ 5MHz, R_L(RDP, RDN) = 10kΩ	280	350	420	V/V
Passband Upper Frequency Limit	f_{HR}	-1dB; Dependent on C2 parasitics	70	100		MHz
		-3dB; Dependent on C2 parasitics	90	120		
Passband Lower -3dB Frequency Limit	f_{LR}	Determined by C2	0.1		0.8	MHz
Equivalent Input Noise	e_{IN}	5 MHz < f < 20 MHz		0.70	1.00	nV/√Hz
Differential Input Capacitance	C_{IN}			18	30	pF
Differential Input Resistance	R_{IN}		600	1000		Ω
Dynamic Range	DR	AC input V where A_V falls to 90% of its value at V_{IN} = 2mV_{pp} @ f = 5 MHz	8			mV_{pp}
Common Mode Rejection Ratio	CMRR	V_{CM} = 100mV_{pp}, f = 10 MHz	45			dB
Power Supply Rejection Ratio	PSRR	100mV_{pp} on V_{CC} or V_{EE}, f = 10 MHz	45			dB
Channel Separation	CS	Unselected Channels: V_{IN} = 100mV_{pp}, f = 10 MHz	45			dB
Output Offset Voltage	V_{OS}		-100		100	mV
Common Mode Output Voltage	V_{OCM}	Read Mode	V_{CC} - 3.25	V_{CC} - 2.75	V_{CC} - 2.25	V
Common Mode Output Voltage Difference	ΔV_{OCM}	V_{OCM} (READ) - V_{OCM} (WRITE) (Read mode only to write with $\overline{RBAW}$ active)	-250		50	mV
Single-Ended Output Resistance	R_{SEO}	Read Mode			50	Ω
Output Current	I_O	AC Coupled Load, RDP to RDN	1.5			mA
MR Head-to-Disk Contact Current	I_{DISK}	Extended Contact, R_{DISK} = 10MΩ			100	µA
		Maximum Peak Discharge, C_{DISK} = 300pF, R_{DISK} = 10MΩ			1	mA
MR Head Potential, Selected Head	V_{MR}		-400		400	mV
Buffered Head Voltage	BHV	T_A = 25°C, V_{CC} = 5.0V, V_{EE} = -3.0V	I_{MR}*R_{MR} - 10		I_{MR}*R_{MR} + 10	mV

WRITER CHARACTERISTICS Recommended operating conditions apply unless otherwise specified.
I_W = 30mA, L_H = 220nH, R_H = 25Ω, f_{DATA} = 5MHz.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
WC Pin Voltage	V_{WC}		1.9	2.0	2.1	V
I_{WC} to Write Current Gain	A_I			20		mA/mA
Write Current Constant	K_W	$K_W = V_{WC} * A_I$	36	40	44	V
Write Current Range	I_W		20		40	mA
Write Current Tolerance	ΔI_W	20 < I_W < 40 mA	-8		+8	%
Differential Head Voltage Swing	V_{DH}	Open Head, I_W = 40mA, V_{EE} = -2.7, V_{CC} = 4.5V		7.8		V_{pp}
Unselected Head Transition Current	I_{UH}				50	μA_{pk}
Differential Output Capacitance	C_O				6	pF
Differential Output Resistance	R_O	Internal Damping Resistance	560	700	840	Ω
Write Data Frequency for Safe Condition	f_{DATA}	FLT low, < 5kΩ pullup resistor	1.0			MHz

SWITCHING CHARACTERISTICS Recommended operating conditions apply unless otherwise specified.
I_W = 30mA, L_H = 220nH, R_H = 25Ω, f_{DATA} = 5MHz.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
R/$\overline{W}$ to Write Mode	t_{RW}	To 90% of write current			0.1	µs
R/$\overline{W}$ to Read Mode	t_{WR}	To 90% of envelope and ±20mV of DC offset, $\overline{RBAW}$ low for 10 µs			2.0	µs
$\overline{CS}$ to Read Mode	t_{CS}	To 90% of envelope and ±20mV of DC offset,			60	µs
HS0 - HS3 to Any Head	t_{HS}	To 90% of envelope and ±20mV of DC offset,			30	µs
$\overline{CS}$ to Unselect	t_{RI}				0.5	µs
Safe to Unsafe*	t_{D1}	50% WDX to 50% FLT, < 5kΩ pullup resistor		0.7	1.5	µs
Unsafe to Safe*	t_{D2}	50% WDX to 50% FLT, < 5kΩ pullup resistor		0.1	0.3	µs
Head Current Propagation Delay*	t_{D3}	From 50% points			30	ns
Asymmetry	A_{SYM}	Write Data has 50% duty cycle & 1ns rise/fall time, L_H = 0, R_H = 0			0.5	ns
Rise/Fall Time	t_r / t_f	20-80%; I_W = 30mA; L_H = 220nH, R_H = 25Ω			4	ns

*See Figure 1 for write mode timing diagram.

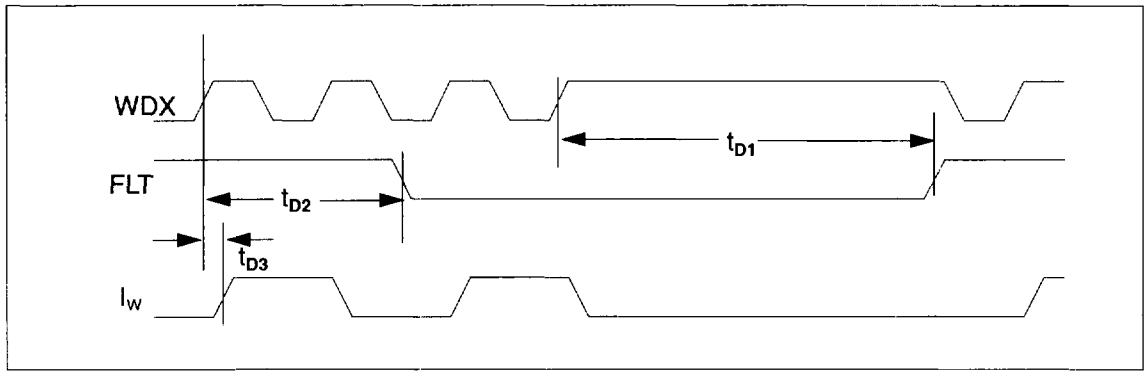
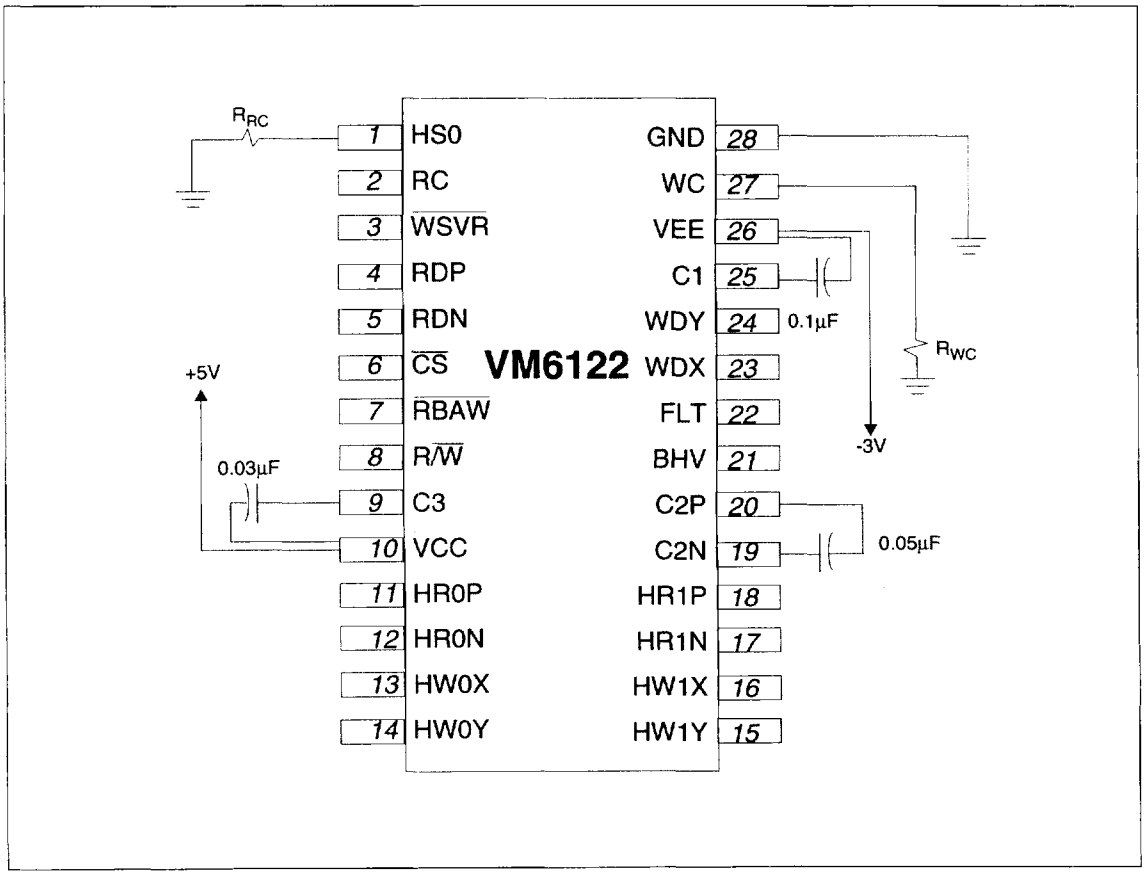


Figure 1: Write Mode Timing Diagram

TYPICAL CONNECTION DIAGRAM



Note 1: V_{CC} = +5V, Ground = GND, V_{EE} = -3V