VTC Inc.
Value the Customer™

VM61214

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

950801

ADVANCE INFORMATION

August,1995

FEATURES

- High Performance
  - Read Voltage Gain = 200 V/V Typical
  - Input Noise = 0.65 nV/$\sqrt{Hz}$ Typical
  - Head Inductance Range = 100 nH to 500 nH
  - Write Current Range = 20 - 40 mA
  - Input Capacitance = 18pF Typical
  - Rise Time = 4ns Maximum (L_H = 250 nH, I_W = 30 mA)
- Operates from +5 and -3 Volt Power Supplies
- Up to 14 Channels Available
- Multi-channel Servo Write
- Fault Detect Capability
- Designed for Use With Four-Terminal MR Heads
- MR BIAS Current Range 6 - 20 mA
- Optional Write Data Flip-Flop
- Voltage Sense Configuration
- Optional series output resistors (0, 40Ω,80Ω) on RDP, RDN for enhanced stability into difficult loads

DESCRIPTION

The VM61214 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 VM61214 contains a thin-film head writer, an MR reader and associated fault circuitry to address up to 14 heads. It also provides bias current and control loops for setting the DC voltages on the MR element. The VM61214 also provides a 5-channel servo write feature, enabling the user to write servo information directly through the preamplifier.

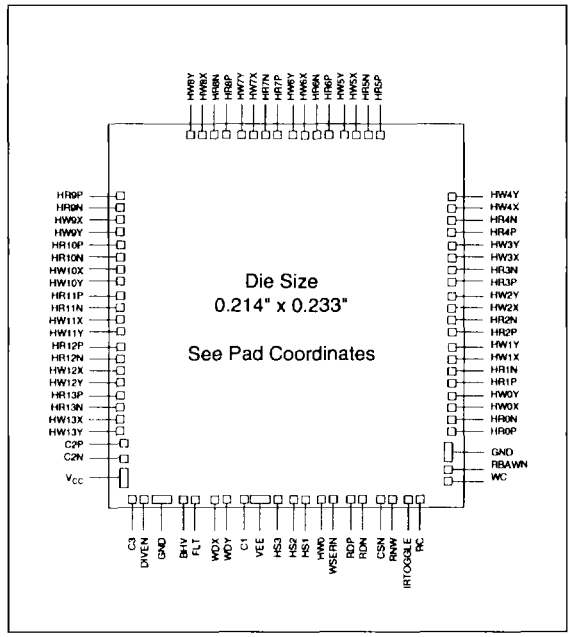
The VM61214 has two modes of operation. In read mode, the device operates as a low-noise differential preamplifier which senses resistance changes in the MR element that correspond to flux changes on the disk. The amplitude of the sense current is set either by an external resistor or by a current source and has a current gain of 20 mA/mA. In write mode, the circuit operates as a thin-film head write current switch, driving the thin-film write element of the MR head. The write current is externally programmed either by a resistor or an external current source and has a current gain of 20 mA/mA.

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.

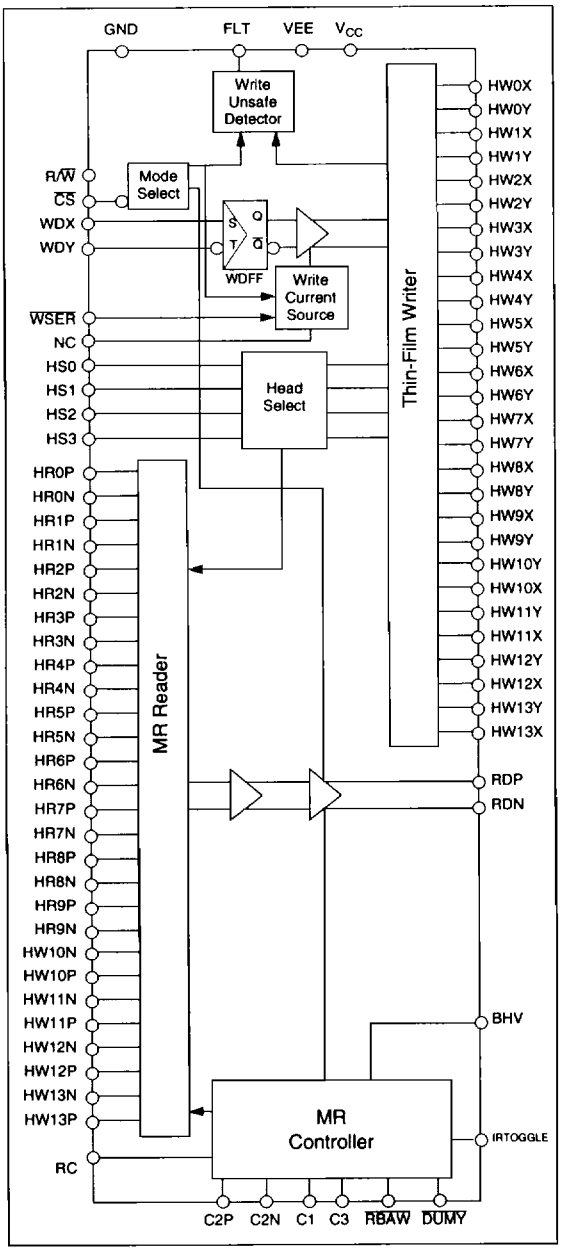
The VM61214 operates from +5V, -3V power supplies. Low power dissipation is achieved through the use of high-speed bipolar processing and innovative circuit design techniques. When deselected, the device enters a sleep mode which reduces the power dissipation to only 35mW.

The VM61214 is available in die form. Please consult VTC for details.

DIE PAD DIAGRAM



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}:
- 64-lead TQFP .....TBD

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.

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 VM61214 uses the current bias, voltage sensing, MR design. 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, five channels of the VM61214 are active at the same time. Pin $\overline{WSER}$ controls the servo mode and HS0 controls which five heads are simultaneously written. When $\overline{WSER}$, $\overline{CS}$ and R/$\overline{W}$ are low, the chip is in servo write mode: five channels are written at the same time dependent on the state of HS0 and HS1. When HS0 and HS1 = 0, heads 0, 1, 2, 3 and 4 are written and when HS0 = 5V and HS1 = 0, heads 5, 6, 7, 8 and 9 are written and when HS0 = 0 and HS1 = 5V, heads

10, 11, 12 and 13 are written (see Table 2). When $\overline{WSER}$ is high and R/$\overline{W}$ 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.
NOTE: The servo write function should not be used for DC erase or the maxmum power dissipation may be exceded.

Fault Detect

The VM61214 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
- Voltage drop below falt threshold's (see Static DC Characteristics)

Read Mode:
- I_{MR} exceeds 1.5 X it's net value
- Voltage drop below falt threshold's (see Static DC Characteristics)

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

- Low power supply voltage
- Invalid head select code
- Non write 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 3).

Table 1: Mode Select

MODE	*$\overline{CS}$*	*R/$\overline{W}$*	*$\overline{WSER}$*	*DESCRIPTION*
Read	0	1	1	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: Servo Mode Head Select

HS1	*HS0*	*$\overline{CS}$*	*R/$\overline{W}$*	*$\overline{WSER}$*	*DESCRIPTION*
0	0	0	0	0	Head 0, 1, 2, 3, and 4 are on for servo write
0	1	0	0	0	Head 5, 6, 7, 8, and 9 are on for servo write
1	0	0	0	0	Head 10, 11, 12 and 13 are on for servo write

Table 3: Read Bias Active During Write Mode

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

Table 4: Head Select

HS3	*HS2*	*HS1*	*HS0*	*HEAD*
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13

PIN_FUNCTION LIST AND DESCRIPTION

VM61214

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-HS3	(I*)	Head Select: selects one of the ten heads.
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, when TFF is enabled. If not, IW is into HDX when WDX is low.
8)	HR0P-HR13P	(I)	MR head connections, positive end.
9)	HR0N-HR13N	(I)	MR head connections, negative end.
10)	HW0X-HW13X	(O)	Thin-Film write head connections, positive end.
11)	HW0Y-HW13Y	(O)	Thin-Film write head connections, negative end
12)	RDP, RDN	(O*)	Read Data: Differential read signal outputs.
13)	WC	(*)	Write current pin: used to set the magnitude of write current.
14)	RC	(*)	MR bias reference pin: 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)	V_{CC}	-	+5.0V supply
21)	GND	-	Ground
22)	IRTOGGLE	I*	Sets polarity of MR bias current

* When more than one device is used, these signals can be wire OR'ed together

I = Input pin

O = Output pin

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STATIC (DC) CHARACTERISTICS Recommended operating conditions apply unless otherwise specified. $0°C < T_A < 80°C$, $4.5V < V_{CC} < 5.5V$, $-3.3V < V_{EE} < -2.7V$

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP*	*MAX*	*UNITS*
V_{CC} Power Supply Current	I_{CC}	Read Mode, I_{MR} = 11mA		80	90	mA
		Write Mode, I_w = 30mA, I_{MR} = 11mA		110	140	
		Idle Mode		4	5	
		Read Bias Active in Write Mode, I_W = 30mA, I_{MR} = 11mA		135	175	
		Servo Mode, I_W = 30mA		200	265	
V_{EE} Power Supply Current	I_{EE}	Read Mode, I_{MR} = 11mA		45	60	mA
		Write Mode, I_w = 30mA, I_{MR} = 11mA		70	105	
		Idle Mode		2.5	3.5	
		Read Bias Active in Write Mode, I_W = 30mA, I_{MR} = 11mA		95	125	
		Servo Mode, I_W = 30mA		180	240	
Power Supply Dissipation	P_d	Read Mode, I_{MR} = 11mA		460	630	mW
		Write Mode, I_w = 30mA, I_{MR} = 11mA		750	995	
		Idle Mode		28	35	
		Read Bias Active in Write Mode, I_W = 30mA, I_{MR} = 11mA		935	1250	
		Servo Mode, I_W = 30mA		1540	2040	
Input High Voltage	V_{IH}	PECL	V_{CC} - 1.08		V_{CC} - 0.5	V
		TTL	2.0		V_{CC} + 0.3	V
Input Low Voltage	V_{IL}	PECL	V_{CC} - 2.2		V_{CC} - 1.1	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			0.6	V
V_{CC} Fault Threshold	V_{CTH}		3.5	3.8	4.2	V
V_{EE} Fault Threshold	V_{ETH}		-2.5	-2.2	-2.1	V

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READER CHARACTERISTICS Recommended operating conditions apply unless otherwise specified. $0°C < T_A < 80°C$, $4.5V < V_{CC} < 5.5V$, $-3.3V < V_{EE} < -2.7V$

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP*	*MAX*	*UNITS*
MR Head Current Range	I_{MR}		6		20	mA
MR Head Current Tolerance	I_{MR}	$6 < I_{MR} < 20$ mA	-5		+5	%
Unselected MR Head Current					15	µA
MR Bias Reference Voltage	V_{RC}	$2500 < R_{RC} < 6667\ \Omega$		2.0		V
IRC to MR Bias Current Gain	A_{IMR}	$2500 < R_{RC} < 6667\ \Omega$		20		mA/mA
Differential Voltage Gain	A_V	$V_{IN} = 1mV_{pp}$ @10MHz, R_L(RDP, RDN) = 10kΩ, I_{MR} = 11mA, $R_{MR} = 22\Omega$	150	200	250	V/V
Passband Upper Frequency Limit	f_{HR}	$R_{MR} = 22\Omega$; L_{MR} = 80nH; -1dB	70	100		MHz
		-3dB	90	120		
Passband Lower -3dB Frequency Limit	f_{LR}	$R_{MR} = 22\Omega$; L_{MR} = 80nH	0.1		0.2	MHz
Equivalent Input Noise	e_{IN}	$R_{MR} = 22\Omega$; I_{MR} = 11mA; $1 < f < 20$ MHz		0.65	0.80	nV/√Hz
Differential Input Capacitance	C_{IN}	$R_{MR} = 22\Omega$; I_{MR} = 11mA		18	30	pF
Differential Input Resistance	R_{IN}	I_{MR} = 11mA	600	1400		Ω
Dynamic Range	DR	AC input V where A_V falls to 90% of its value at $V_{IN} = 1mV_{pp}$ @ f = 5 MHz	8			mV_{pp}
Common Mode Rejection Ratio	CMRR	V_{CM} = 1mVpp, I_{MR} = 11mA, $R_{MR} = 22\Omega$, $1 < f < 60$ MHz	45			dB
Power Supply Rejection Ratio	PSRR	$1mV_{pp}$ on V_{CC} or V_{EE}, I_{MR} = 11mA, $R_{MR} = 22\Omega$, $1 < f < 60$ MHz	45			dB
Channel Separation	CS	Unselected Channels: $V_{IN} = 1mV_{pp}$, $1 < f < 60$ MHz	45			dB
Output Offset Voltage	V_{OS}	I_{MR} = 11mA, $R_{MR} = 22\Omega$	-100		100	mV
Common Mode Output Voltage	V_{OCM}	Read Mode	V_{CC} -3.2	V_{CC} -2.9	V_{CC} -2.6	V
Common Mode Output Voltage Difference	ΔV_{OCM}	V_{OCM} (READ) - V_{OCM} (WRITE) (Read mode only to Write with $\overline{RBAW}$ active)	-50		+50	mV
Single-Ended Output Resistance	R_{SEO}	Read Mode		50	200	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}	I_{MR} = 11mA, R_{MR} = 22Ω	-600		600	mV
Buffered Head Voltage	BHV		I_{MR}*R_{MR} - 10		I_{MR}*R_{MR} + 10	mV

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WRITER CHARACTERISTICS Recommended operating conditions apply unless otherwise specified. $0°C < T_A < 80°C$, $4.5V < V_{CC} < 5.5V$, $-3.3 < V_{EE} < -2.7$ $I_W = 30mA$, $L_H = 250nH$, $R_H = 25\Omega$, $f_{DATA} = 5MHz$.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
WC Pin Voltage	V_{WC}			2.0		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		15		40	mA
Write Current Tolerance	ΔI_W	$20 < I_W < 40$ mA	-8		+8	%
Differential Head Voltage Swing	V_{DH}	Open Head		7.8		V_{pp}
Unselected Head Trans. Current	I_{UH}	$I_W = 30mA$			50	μA_{pk}
Differential Output Capacitance	C_O				6	pF
Differential Output Resistance	R_O	Internal Damping Resistance	555	695	835	Ω
Write Data Freq. for Safe Condition	f_{DATA}	FLT low	1.0			MHz

SWITCHING CHARACTERISTICS Recommended operating conditions apply unless otherwise specified. $0°C < T_A < 80°C$, $4.5V < V_{CC} < 5.5V$, $-3.3 < V_{EE} < -2.7$, $I_W = 30mA$, $L_H = 250nH$, $R_H = 25\Omega$, $f_{DATA} = 5MHz$.

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 Write Mode	t_{WRI}	To 10% of write current			0.1	µs
R/$\overline{W}$ to Read Mode	t_{WR}	To 90% of envelope; $\overline{RBAW}$ low for 10µs		2.0		µs
$\overline{CS}$ to Read Mode	t_{CS}	To 90% of envelope			15	µs
HS0 - HS3 to Any Head	t_{HS}	To 90% of envelope			15	µs
$\overline{CS}$ to Unselect	t_{RI}	To 10% of read envelope or write current			0.5	µs
Safe to Unsafe*	t_{D1}	50% WDX to 50% FLT		0.7	1.5	µs
Unsafe to Safe*	t_{D2}	50% WDX to 50% FLT		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%; $I_W = 30mA$; $L_H = 250nH$, $R_H = 25\Omega$			4	ns

*See Figure 1 for write mode timing diagram.

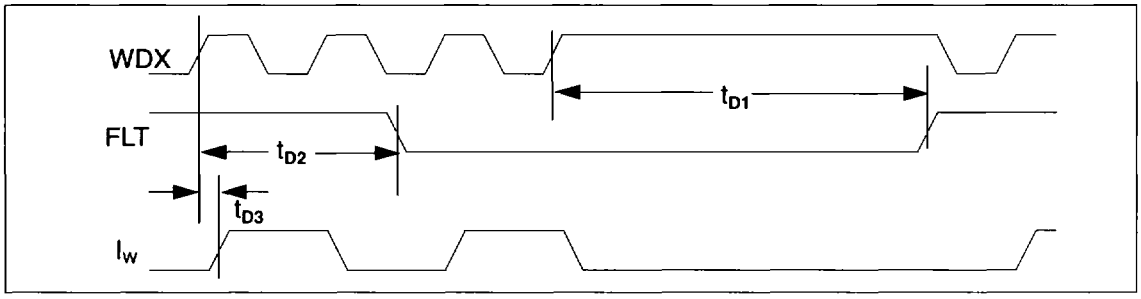
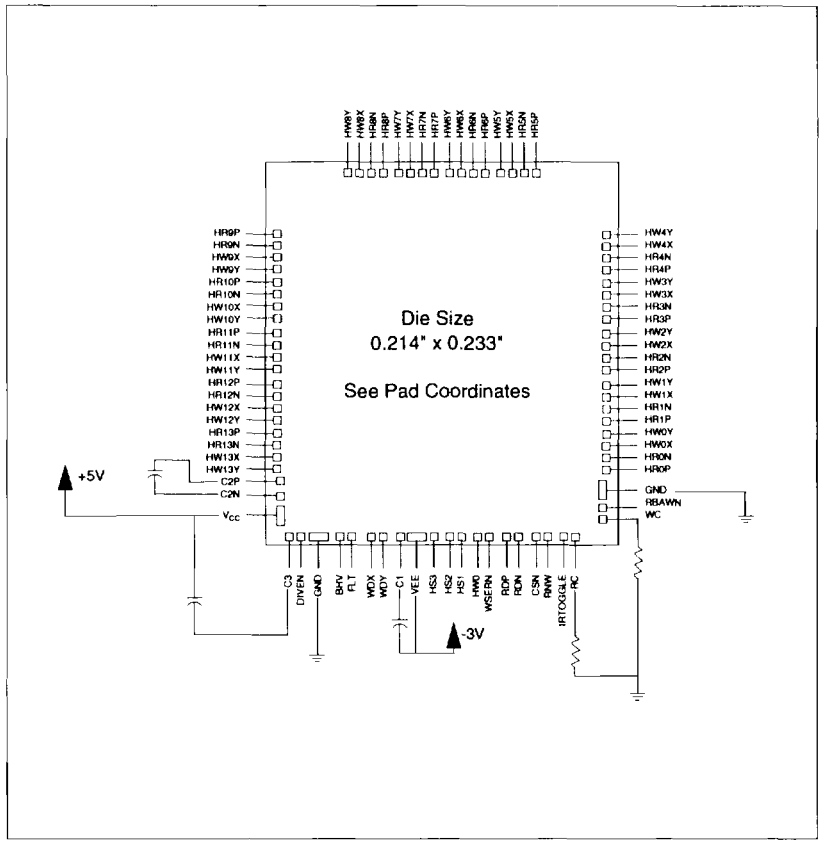


Figure 1: Write Mode Timing Diagram

VM61214 PAD COORDINATES

PIN NAME	X AXIS	Y AXIS
C2P	-2507.5	-1980.0
C2N	-2507.5	-2263.5
V_{CC}	-2507.5	-2504.5
C3	-2345.75	-2743.5
DIVEN	-2179.75	-2743.5
GND	-1884.0	-2743.5
BHV	-1588.25	-2743.5
FLT	-1422.25	-2743.5
WDX	-1059.75	-2743.5
WDY	-893.75	-2743.5
C1	-610.25	-2743.5
VEE	-369.25	-2743.5
HS3	-128.25	-2743.5
HS2	155.25	-2743.5
HS1	321.25	-2743.5
HS0	604.75	-2743.5
WSERN	770.75	-2743.5
RDP	1054.25	-2743.5
RDN	1220.25	-2743.5
CSN	1503.75	-2743.5
RNW	1669.75	-2743.5
IRTOGGLE	1953.25	-2743.5
RC	2119.25	-2743.5
WC	2507.0	-2552.0
RBAWN	2507.0	-2386.0
GND	2507.0	-2091.25
HR0P	2566.5	-1779.0
HR0N	2566.5	-1597.0
HW0X	2566.5	-1414.5
HW0Y	2566.5	-1232.5
HR1P	2566.5	-1014.5
HR1N	2566.5	-832.5
HW1X	2566.5	-650.0
HW1Y	2566.5	-468.0
HR2P	2566.5	-250.0
HR2N	2566.5	-68.0
HW2X	2566.5	114.5
HW2Y	2566.5	296.5
HR3P	2566.5	514.5
HR3N	2566.5	696.5
HW3X	2566.5	879.0
HW3Y	2566.5	1061.0
HR4P	2566.5	1279.0
HR4N	2566.5	1461.0
HW4X	2566.5	1643.5
HW4Y	2566.5	1825.5
HR5P	1420.0	2811.25
HR5N	1238.0	2811.25
HW5X	1055.5	2811.25
HW5Y	837.5	2811.25
HR6P	655.5	2811.25
HR6N	473.5	2811.25
HW6X	291.0	2811.25
HW6Y	109.0	2811.25
HR7P	-109.0	2811.25
HR7N	-291.0	2811.25
HW7X	-473.5	2811.25
HW7Y	-655.5	2811.25
HR8P	-873.5	2811.25
HR8N	-1055.5	2811.25
HW8X	-1238.0	2811.25
HW8Y	-1420.0	2811.25
HR9P	-2566.5	1825.5
HR9N	-2566.5	1643.5
HW9X	-2566.5	1461.0
HW9Y	-2566.5	1279.0
HR10P	-2566.5	1061.0
HR10N	-2566.5	879.0
HW10X	-2566.5	696.5
HW10Y	-2566.5	514.5
HR11P	-2566.5	296.5
HR11N	-2566.5	114.5
HW11X	-2566.5	-68.0
HW11Y	-2566.5	-250.0
HR12P	-2566.5	-468.0
HR12N	-2566.5	-650.0
HW12X	-2566.5	-832.5
HW12Y	-2566.5	-1014.5
HR13P	-2566.5	-1232.5
HR13N	-2566.5	-1414.5
HW13X	-2566.5	-1597.0
HW13Y	-2566.5	-1779.0

TYPICAL CONNECTION DIAGRAM



Note 1: IRC = MR Bias Current = $38/R_{RSET}$

Note 2: I_{WC} = Write Current = $40/R_{WC}(1+R_H/700)$, R_H = Head Series Resistance

Note 3: V_{CC} = +5V, GND = Ground, V_{EE} = -3.0V

Note 4: Pins C3 is connected to pin 32 internally, but external connection is preferred for noise immunity

Note 5: Bandwidth is extremely dependent on parastic inductance presented at C2 pins. Traces to C2 should be as wide and as short as possible for optimum bandwidth.