VTC Inc.
Value the Customer™

VM6130 Series

MAGNETO-RESISTIVE HEAD, HIGH PERFORMANCE, READ/WRITE PREAMPLIFIER

970801

August,1997

FEATURES

- *General*
  - Designed for Use With Four-Terminal MR Heads
  - Operates from +5V and -4.5V Power Supplies
  - Power Supply Fault Protection
  - Disk Voltage Monitor
  - Head-to-Disk Contact Monitor
  - Reduced Mode and Head Selection Delays in FAST Mode
  - Low Idle Power = 100 mW Typical
  - 12 or 14 Channels Available
- *High Performance Reader*
  - Current Bias / Current Sense Configuration
  - MR Bias Current Range 8 - 16 mA
  - Read Voltage Gain = 350 V/V Typical
  - Input Noise = 0.8 nV/$\sqrt{Hz}$ Typical
  - Input Capacitance = 10 pF Typical
  - Head Inductance Range = 0.1 - 0.4 µH
- *High Speed Writer*
  - Write Current Range = 20 - 40 mA
  - Rise Time = 3 ns Typical (L_H = 220 nH, R_H = 40Ω, I_W = 20 mA)
  - Differential PECL Write Data Inputs
  - Write Unsafe Detection
  - Mask-Selectable Write Damping Resistor

DESCRIPTION

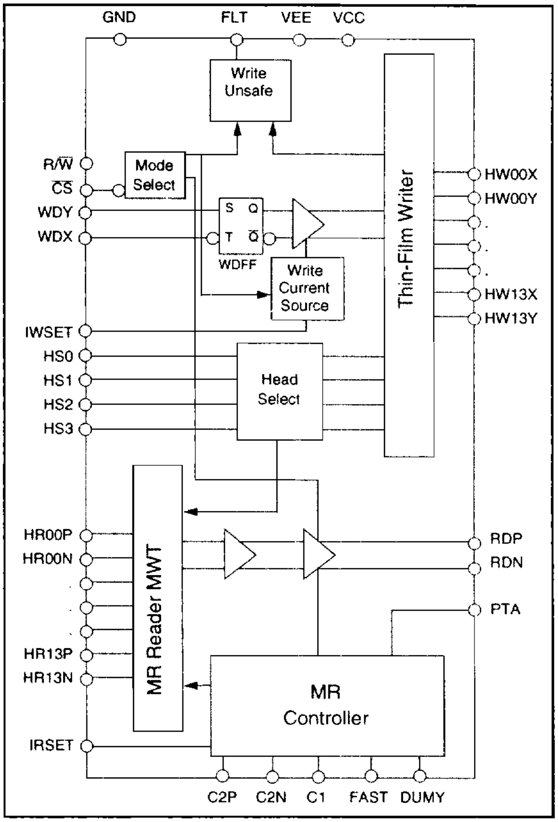
The VM6130 is an integrated bipolar read/write preamplifier designed for use in high-performance hard disk drive applications using 4-terminal magneto-resistive (MR) recording heads. The VM6130 contains a thin-film head writer, an MR reader and associated fault circuitry. It provides bias current and control loops for setting the DC voltages on the MR element.

Fault protection circuitry ensures that the write current generator is disabled during power sequencing, voltage faults or an invalid head select. This protects the disk from potential data loss. 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 VM6130 operates from +5V, -4.5V 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 an idle mode which reduces the power dissipation.

The VM6130 is available in die form for chip-on-flex applications. Please consult VTC for details.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

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

Input Voltages:
- Digital Input Voltage V_{IN} .... -0.3V to (VCC+ 0.3V)

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

Junction Temperature T_J .... 150°C

RECOMMENDED OPERATING CONDITIONS

Power Supply Voltage:
- V_{CC} .... +5V ± 10%
- V_{EE} .... -4.5V ± 10%

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

Head Voltage Control

In all modes of operation, the VM6130 controls the common mode potential of all MR elements. This is necessary because the MR element cannot be insulated, so that a small voltage differential will cause arcing to the disk and damage the heads.

Head voltages are held within ± 400 mV of the voltage on the VD pin, which monitors the disk potential of the drive. Thus, the disk may be grounded, as is done in disk drives having conventional thin film or ferrite recording heads, or isolated as the application may require.

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.

The appropriate TTL levels on the $\overline{CS}$ and R/$\overline{W}$ lines place the preamp in the read mode (see Table 1) and activate the bias generator, the read preamp and the read fault detection circuitry.

The VM6130 uses the current-bias/current-sensing MR architecture. An internally-generated 2.5 volt reference is present at the IRSET pin.The magnitude of the MR bias current is determined by an external resistor (connected between the IRSET pin and ground). The following equation governs the MR bias current magnitude:

$$I_{MR} = \frac{50}{(R_{RSET})} \qquad \text{(eq. 1)}$$

I_{MR} represents the bias current flowing to the MR element.
R_{RSET} represents the equivalent resistance between the IRSET pin and ground.

RDP and RDN outputs are emitter follower and are in phase with the HRnP and HRnN head ports. These outputs should be AC-coupled to the load.

The output common mode voltage is maintained in the write mode, thereby substantially reducing the write-to-read recovery delay in the subsequent pulse detection circuitry.

<u>Fault Detection</u>

In the read mode, a TTL low on the FLT line indicates a fault condition. The fault condition can be triggered by any of the following conditions:

- Low power supply voltage
- Head to disk contact
  (the thermal asperity in the MR element will result in an abnormally high readback signal)

<u>Fast Mode</u>

Fast mode is utilized during head-to-head and idle-to-read transitions. When the FAST mode pin is high, the unity-gain frequency of the offset control loop is increased such that it is inside the passband of the reader, allowing the delay to be reduced to less than 5µs.

Note: This pin must be brought low before read data is valid.

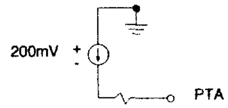
<u>Programmable Thermal Asperity</u>

The programmable thermal asperity pin (PTA), when left open, enables the TA circuitry with a nominal threshold of 3.25Vpp (referred to the input). This TA threshold may be changed and is governed by the following equation:

$$V_{TA} = 3.25\text{mVpp} - (16500 \times I_{PTA}) \qquad \text{(eq. 2)}$$

V_{TA} represents the Thermal Asperity threshold.
I_{PTA} represents the current sunk from pin PTA in Amperes.

The Thévenin equivalent of pin PTA (in read mode) is 2.2kΩ @ 200mV below ground. See the diagram below:



Note: To disable the Programmable Thermal Asperity function, *pin PTA should be connected directly to ground (GND).*

Write Mode

In the write mode, the circuit operates as a write current switch, driving the thin-film write element of the MR head.
(Note that MR bias current is maintained in order to minimize the write-to-read delay.)

The appropriate TTL levels on the $\overline{CS}$, R/$\overline{W}$ and $\overline{WSER}$ lines place the preamp in the write mode (see Table 1) and activates the write unsafe detect circuitry.

The magnitude of the write current is determined by an external resistor (connected between the IWSET pin and ground). An internally-generated 2.5 volt reference is present at the IWSET pin. The following three equations govern the write current magnitude:

If $I_W \cdot R_H < 450\text{mV}$:

$$I_W = \frac{49.2}{(R_{WSET})\left(1 + \frac{R_H}{R_D}\right)} \qquad \text{(eq. 3)}$$

If $450\text{mV} < I_W \cdot R_H < 615\text{mV}$:

$$I_W = \frac{(49.2/R_{WSET}) + 3\text{mA}}{1 + (0.008 \cdot R_H)} \qquad \text{(eq. 4)}$$

If $I_W \cdot R_H > 615\text{mV}$:

$$I_W = \frac{(49.2/R_{WSET}) + 4\text{mA}}{1 + (0.008 \cdot R_H)} \qquad \text{(eq. 5)}$$

I_W represents the write current flowing to the selected head.
R_{WSET} represents the equivalent resistance between the IWSET pin and ground.
R_H represents the series head resistance.
R_D represents an internal damping resistance of 692 Ω

The polarity of the current is initially into the HWnY port following a read-to-write transition. Write current polarity is reversed on low-to-high transitions of the write data input (WDX low-to-high).

<u>Fault Detection</u>

In the write mode, a TTL high on the FLT line indicates a fault condition. The fault condition can be triggered by any of the following conditions:

- Low power supply voltage
  (The writer is independent of VEE, so VEE faults do not generate a fault condition.)
- No write current
- Open write head
- Insufficient write data transition frequency
  (>2.5µs between transitions)
- Head short to ground

Two positive transitions of write data may be required to clear the fault after the safe condition is restored.

Idle Mode

In idle mode, the MR bias and write current sources are deactivated, and the device enters a low-power mode in which power dissipation is less than 100 mW. Write and read fault detection circuitry is disabled. MR common mode and offset control loops still receive power in order to reduce idle-to-read mode recovery.

Dummy Head

A TTL high level on the DUMY pin selects a dummy head in read or write mode. MR bias current is routed to an internal resistor, and the write current source is disabled to protect recorded data.

This mode is optionally used during power-up/down and following head-to-disk contacts.

An internal pull-up resistor ensures that the dummy head is selected in event of an accidental open.

Note: If this pin is not used it should be grounded for normal operation.

Table 1: Mode Select Logic

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

Table 2: Head Select Logic

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

Note: Invalid head select codes disable the writer and select head MR0.

PIN_FUNCTION LIST AND DESCRIPTION

1)	$\overline{CS}$	(I)	Chip Select: A TTL low level enables the device. Pin defaults high (disabled).
2)	$R/\overline{W}$	(I*)	Read/Write: A TTL low level enables write mode. Pin defaults high (read).
3)	HS0-HS3	(I*)	Head Select: Selects one of fourteen heads. Pins default low (head 0).
4)	DUMY	(I*)	Dummy Head: A TTL high level enables the dummy head. Pin defaults high (dummy head selected).
5)	FAST	(I*)	Fast Recovery in Read Mode: A TTL high level enables fast settling of the reader.
6)	FLT	(O*)	Write/Read Fault: A TTL high level indicates a fault in write mode. A TTL low level indicates a fault in read mode.
7)	WDX, WDY	(I*)	Differential Pseudo-ECL write data inputs: A positive edge on WDX toggles the direction of the head current.
8)	HR00P-HR13P	(I)	MR head connections, positive end.
9)	HR00N-HR13N	(I)	MR head connections, negative end.
10)	HW00X-HW13X	(O)	Write head connections, positive end.
11)	HW00Y-HW13Y	(O)	Write head connections, negative end.
12)	RDP, RDN	(O*)	Read Data: Differential read signal outputs.
13)	IWSET	(*)	Write current pin: Set the magnitude of write current.
14)	IRSET	(*)	MR bias reference pin: Sets the magnitude of MR bias current.
15)	C2P,C2N	(*)	Compensation capacitor for the MR head current loop.
16)	C1	(*)	Noise bypass capacitor for the MR bias current generator.
17)	VD	(I*)	Disk Voltage. Analog reference for the disk bias.
18)	PTA	(I)	Programmable Thermal Asperity input.
19)	VEE	-	-4.5V supply
20)	VCC	-	+5V 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.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC} Power Supply Current	I_{CC}	Read Mode, I_{MR} = 12mA		70	95	mA
		Write Mode, I_W = 30mA, I_{MR} = 12mA		125	145	mA
		Idle Mode		13	16	mA
V_{EE} Power Supply Current	I_{EE}	Read Mode, I_{MR} = 12mA		45	70	mA
		Write Mode, I_W = 30mA, I_{MR} = 12mA		100	125	mA
		Idle Mode		7	10	mA
Power Supply Dissipation	P_d	Read Mode, I_{MR} = 12mA		552	873	mW
		Write Mode, I_W = 30mA, I_{MR} = 12mA		1075	1420	mW
		Idle Mode		100	140	mW
Input High Voltage	V_{IH}	PECL	3.87		4.27	V
		CMOS	3.5			V
Input Low Voltage	V_{IL}	PECL	3.05		3.55	V
		CMOS			1.5	V
Disk Reference Voltage Range	V_D		-250		250	mV
Input High Current	I_{IH}	PECL			120	µA
		CMOS	-160		160	µA
Input Low Current	I_{IL}	PECL			120	µA
		CMOS	-160		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}		3.65		4.25	V
V_{EE} Fault Threshold	V_{ETH}		-3.75		-3.15	V

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READ CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified.

PARAMETER	***SYM***	***CONDITIONS***	***MIN***	***TYP***	***MAX***	***UNITS***
MR Head Current Range	I_{MR}		8		16	mA
MR Head Current Tolerance	I_{MR}	$8 < I_{MR} < 16$ mA	-5		+5	%
MR Bias Reference Voltage	V_{RSET}	$2775 < R_{RSET} < 6250\Omega$		2.5		V
IRSET to MR Bias Current Gain	A_{IMR}	$2775 < R_{RSET} < 6250\Omega$		20		mA/mA
Differential Voltage Gain	A_V	$V_{IN} = 1mV_{pp}$ @10MHz, R_L (RDP, RDN) = $1k\Omega$, $I_{MR} = 12mA$, $R_{MR} = 28\Omega$	260	350	440	V/V
Passband Upper Frequency Limit	f_{HR}	-1dB: $R_{MR} = 28\Omega$; $L_{MR} = 20nH$		50		MHz
		-3dB: $R_{MR} = 28\Omega$; $L_{MR} = 20nH$	60	80		
Passband Lower -3dB Frequency Limit	f_{LR}	$R_{MR} = 28\Omega$ $C_2 = 6nF$	0.1		0.5	MHz
Equivalent Input Noise	e_n	$I_{MR} = 12mA$; $1 < f < 80$ MHz $R_{MR} = 28\Omega$		.8		$nV/\sqrt{Hz}$
Differential Input Capacitance	C_{IN}	$I_{MR} = 12mA$			10	pF
Differential Input Resistance	R_{IN}	$I_{MR} = 12mA$			4	Ω
Dynamic Range	DR	AC input V where A_V falls to 90% of its value at $V_{IN} = 1mV_{pp}$ @ f = 10 MHz	4			mV_{pp}
Power Supply Rejection Ratio	PSRR	100mVp-p on V_{CC} or V_{EE}, $I_{MR} = 12mA$, $1 < f < 50$ MHz, $R_{MR} = 28\Omega$	30			dB
Common Mode Rejection Ratio	CMRR	V_{CM} = 100mVp-p	30			dB
Channel Separation	CS	Unselected Channels: V_{IN} = 100mVp-p, $1 < f < 50$ MHz	30			dB
Output Offset Voltage	V_{OS}	$I_{MR} = 12mA$, $R_{MR} = 28\Omega$			100	mV
Common Mode Output Voltage	V_{OCM}		V_{CC} - 2.4	V_{CC} -2.1	V_{CC}-1.8	V
Common Mode Output Voltage Difference	ΔV_{OCM}	V_{OCM} (READ) - V_{OCM} (WRITE)	- 250		250	mV
Single-Ended Output Resistance	R_{SEO}	(Includes 21Ω series resistor with RDP/RDN)			59	Ω
Output Current	I_O	AC Coupled Load, RDP to RDN	±1.5			mA
Total Harmonic Distortion	THD	$V_{in} = 4mV_{pp}$; ten harmonics			0.5	%
MR Head-to-Disk Contact Current	I_{DISK}	Extended contact, $R_{DISK} = 10M\Omega$			100	µA
		Maximum peak discharge, $C_{DISK} = 300pF$, $R_{DISK} = 10M\Omega$			20	mA
MR Head Potential	V_{MR}	$I_{MR} = 12mA$, $R_{MR} = 28\Omega$	V_D - 400		V_D + 400	mV
Thermal Asperity Detect Threshold	V_{PTA}	$R_{MR} = 28\Omega$, $I_{PTA} = 0$	2.44	3.25	4.06	mV_{pp}
		$R_{MR} = 28\Omega$, $V_{PTA} = 3.25 - (16500 \cdot I_{PTA})$	$.75 \cdot V_{PTA}$	V_{PTA}	$1.25 \cdot V_{PTA}$	

WRITE CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified.
I_W = 30mA, L_H = 200nH, R_H = 15Ω, f_{DATA} = 5MHz.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
I_{WSET} Pin Voltage	V_{WSET}			2.5		V
I_{WSET} to Write Current Gain	A_I			20		mA/mA
Write Current Constant	K_W	$K_W = V_{WSET} \cdot A_I$	46	50	54	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	5	6		V_{pp}
Unselected Head Transition Current	I_{UH}	I_W = 30mA			50	μA_{pk}
Differential Output Capacitance	C_O				6	pF
Differential Output Resistance	R_O	Internal damping resistance	560	692	840	Ω
Time Between Write Data Transitions for Safe Condition	t_{SAFE}	FLT = Low			2.5	µs

SWITCHING CHARACTERISTICS
Recommended operating conditions apply unless otherwise specified.
I_W = 30mA, L_H = 200nH, R_H = 30Ω, f_{DATA} = 5MHz.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
R/$\overline{W}$ to Write Mode	t_{RW}	To 90% of write current			0.5	µs
R/$\overline{W}$ to Read Mode	t_{WR}	To 90% of envelope			1	µs
$\overline{CS}$ to Read Mode	t_{CS}	To 90% of envelope; FAST = low			50	µs
		FAST = high for 3.5µs †			15	µs
$\overline{CS}$ to Write Mode	t_{CS}	To 90% of write current			0.5	µs
HS0 - HS3 to Any Head	t_{HS}	To 90% of envelope; FAST = low			50	µs
		FAST = high for 3.5µs †			5	µs
DUMY Mode to Any Head	t_{DH}	To 90% of envelope; FAST = low			50	µs
		FAST = high for 3.5µs †			5	µs
$\overline{CS}$ to Unselect	t_{RI}	To 10% of read envelope or write current			0.6	µs
Safe to Unsafe*	t_{D1}	50% WDX to 50% FLT	0.6		3.6	µs
Unsafe to Safe*	t_{D2}	50% WDX to 50% FLT			1	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			0.2	ns
Rise/Fall Time	t_r / t_f	20-80%; I_W = 20mA; L_H = 220nH, R_H = 40Ω		3	4	ns
		L_H = 0, R_H = 0; I_W = 30mA			1.5	ns
Settling Time	T_{WSET}	I_{WC} = 30mA, L_H = 200nH, R_H = 15Ω; to ±10%			5	ns
Overshoot	W_{COV}	I_{WC} = 30mA; L_H = 200nH, R_H = 15Ω		10		%

* See Figure 1 for write mode timing diagram.
† See Figure 2 for read mode timing diagram.

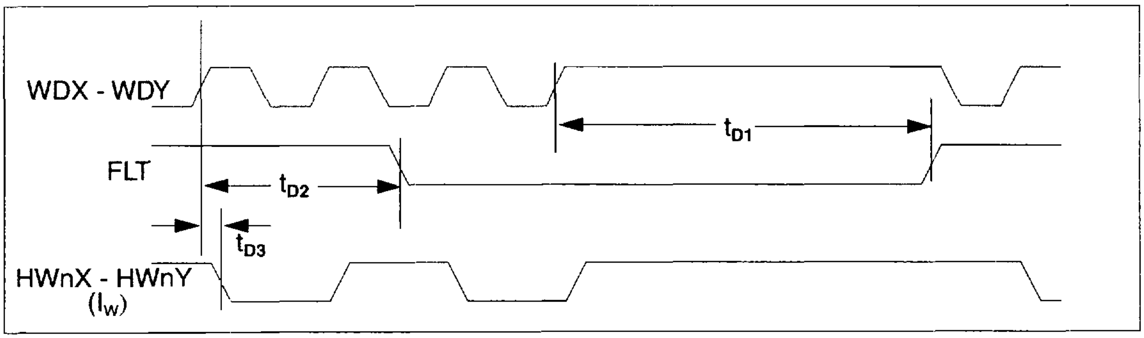

Figure 1: Write Mode Timing Diagram

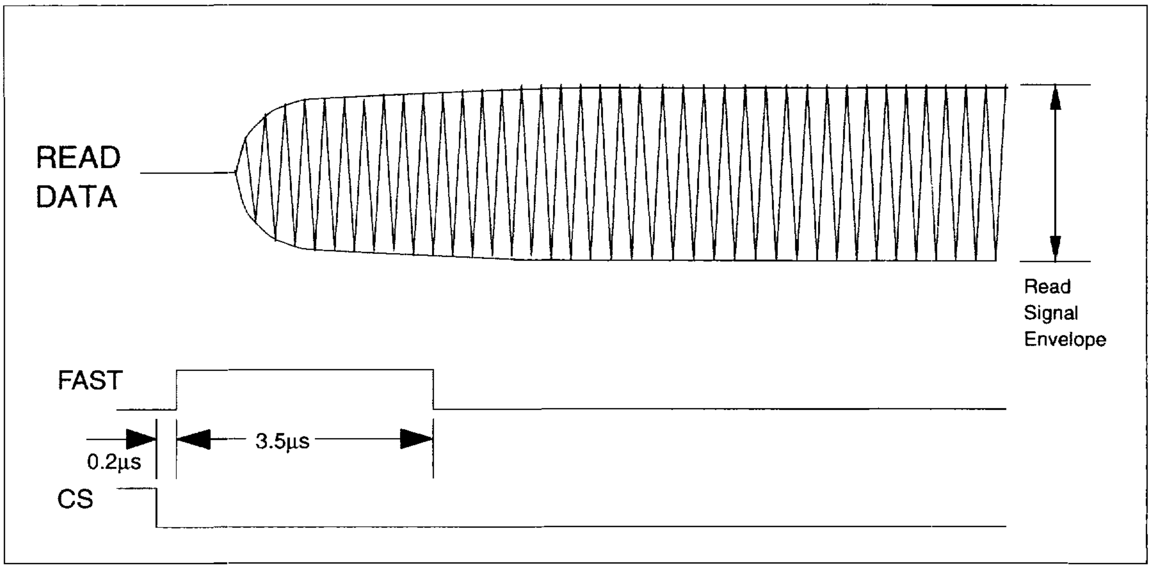

Figure 2: Read Mode Timing Diagram. Also applies to DUMY and HS0 - HS3.

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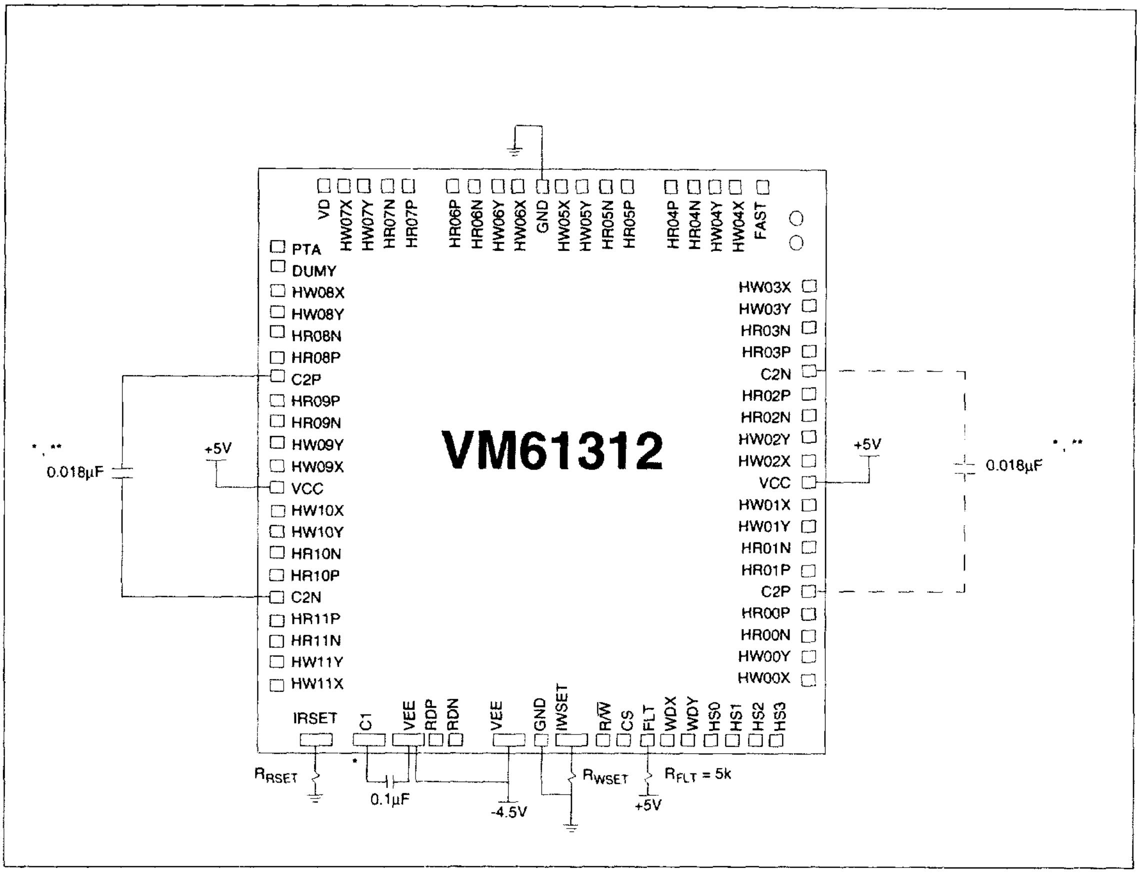
TYPICAL APPLICATION CONNECTIONS



Application Notes

- I_{MR} = MR Bias Current = $50/R_{RSET}$
- I_W = Write Current = $50/R_{WSET}(1+R_H/700)$, R_H = Head Series Resistance
- V_{CC} = +5V, GND = Ground, V_{EE} = -4.5V
- VTC recommends placing decoupling 0.1 µF and 0.01 µF capacitors in parallel between the following pins:
  VCC - GND
  VEE - GND

* Minimizing parasitics at this node is vital. Place a high quality (low resistance, low inductance) capacitor as close to the die as possible.

** VTC recommends using only one of the two sets of C2P/C2N pads included on the VM6130 die (and not externally connecting the two sets). The C2 capacitor sets the lower corner frequency of the preamplifier's bandpass filter.

VM61312

12-CHANNEL DIE

Specific CHARACTERISTICS

Die size: 172 X 181 Mils

Pad Coordinates for the VM61312 (in Mils)

Pad Name	X Axis	Y Axis	Pad Size
C1	-53.484	-85.502	4x10
C2N	-81.230	-42.874	4x4
C2N:	81.230	27.992	4x4
C2P	-81.230	27.992	4x4
C2P:	81.230	-42.874	4x4
CSN	25.059	-85.502	4x4
DSBF	-81.230	71.457	4x4
DUMY	-81.230	64.793	4x4
FAST	72.323	85.512	4x4
FLT	32.146	-85.502	4x4
HS0	53.406	-85.502	4x4
HS1	60.492	-85.502	4x4
HS2	67.579	-85.502	4x4
HS3	74.665	-85.502	4x4
IRSET	-74.744	-85.502	4x10
IWSET	7.933	-85.502	4x10
HR00N	81.230	-57.047	4x4
HR01N	81.230	-28.701	4x4
HR02N	81.230	13.819	4x4
HR03N	81.230	42.165	4x4
HR04N	49.606	85.512	4x4
HR05N	21.260	85.512	4x4
HR06N	-21.260	85.512	4x4
HR07N	-49.606	85.512	4x4
HR08N	-81.230	42.165	4x4
HR09N	-81.230	13.819	4x4
HR10N	-81.230	-28.701	4x4
HR11N	-81.230	-57.047	4x4
HR00P	81.230	-49.961	4x4
HR01P	81.230	-35.787	4x4
HR02P	81.230	20.906	4x4
HR03P	81.230	35.079	4x4
HR04P	42.520	85.512	4x4
HR05P	28.346	85.512	4x4
HR06P	-28.346	85.512	4x4
HR07P	-42.520	85.512	4x4
HR08P	-81.230	35.079	4x4
HR09P	-81.230	20.906	4x4
HR10P	-81.230	-35.787	4x4
HR11P	-81.230	-49.961	4x4
RDN	-22.697	-85.502	4x4
RDP	-29.272	-85.502	4x4

Pad Name	X Axis	Y Axis	Pad Size
RNW	17.972	-85.502	4x4
VCC:	-2.106	-85.502	4x4
VCC:	81.230	73.661	4x4 oct
VCC:P	0.000	85.512	4x4
VD	-71.654	85.512	4x4
VDD:	81.230	-7.441	4x4
VDD:	81.230	80.748	4x4 oct
VDD:P	-81.230	-7.441	4x4
VEE:	-40.492	-85.502	4x10
VEE:G	-12.146	-85.502	4x10
HW00Y	81.230	-64.134	4x4
HW01Y	81.230	-21.614	4x4
HW02Y	81.230	6.732	4x4
HW03Y	81.230	49.252	4x4
HW04Y	56.693	85.512	4x4
HW05Y	14.173	85.512	4x4
HW06Y	-14.173	85.512	4x4
HW07Y	-56.693	85.512	4x4
HW08Y	-81.230	49.252	4x4
HW09Y	-81.230	6.732	4x4
HW10Y	-81.230	-21.614	4x4
HW11Y	-81.230	-64.134	4x4
HW00X	81.230	-71.220	4x4
HW01X	81.230	-14.528	4x4
HW02X	81.230	-0.354	4x4
HW03X	81.230	56.339	4x4
HW04X	63.780	85.512	4x4
HW05X	7.087	85.512	4x4
HW06X	-7.087	85.512	4x4
HW07X	-63.780	85.512	4x4
HW08X	-81.230	56.339	4x4
HW09X	-81.230	-0.354	4x4
HW10X	-81.230	-14.528	4x4
HW11X	-81.230	-71.220	4x4
WDY	46.319	-85.502	4x4
WDX	39.232	-85.502	4x4

1. Octagonal pins are for factory use only.

VTC Inc., 2800 East Old Shakopee Road, Bloomington, MN 55425, 612-853-5100

VM61312

12-CHANNEL DIE (Mirror)

Specific CHARACTERISTICS

Die size: 172 X 181 Mils

Pad Coordinates for the VM61312 Mirror (in Mils)

Pad Name	X Axis	Y Axis	Pad Size
C1	53.484	-85.502	4x10
C2N	81.230	-42.874	4x4
C2N:	-81.230	27.992	4x4
C2P	81.230	27.992	4x4
C2P:	-81.230	-42.874	4x4
CSN	-25.059	-85.502	4x4
DSBF	81.230	71.457	4x4
DUMY	81.230	64.793	4x4
FAST	-72.323	85.512	4x4
FLT	-32.146	-85.502	4x4
HS0	-53.406	-85.502	4x4
HS1	-60.492	-85.502	4x4
HS2	-67.579	-85.502	4x4
HS3	-74.665	-85.502	4x4
IRSET	74.744	-85.502	4x10
IWSET	-7.933	-85.502	4x10
HR00N	-81.230	-57.047	4x4
HR01N	-81.230	-28.701	4x4
HR02N	-81.230	13.819	4x4
HR03N	-81.230	42.165	4x4
HR04N	-49.606	85.512	4x4
HR05N	-21.260	85.512	4x4
HR06N	21.260	85.512	4x4
HR07N	49.606	85.512	4x4
HR08N	81.230	42.165	4x4
HR09N	81.230	13.819	4x4
HR10N	81.230	-28.701	4x4
HR11N	81.230	-57.047	4x4
HR00P	-81.230	-49.961	4x4
HR01P	-81.230	-35.787	4x4
HR02P	-81.230	20.906	4x4
HR03P	-81.230	35.079	4x4
HR04P	-42.520	85.512	4x4
HR05P	-28.346	85.512	4x4
HR06P	28.346	85.512	4x4
HR07P	42.520	85.512	4x4
HR08P	81.230	35.079	4x4
HR09P	81.230	20.906	4x4
HR10P	81.230	-35.787	4x4
HR11P	81.230	-49.961	4x4
RDN	22.697	-85.502	4x4
RDP	29.272	-85.502	4x4

Pad Name	X Axis	Y Axis	Pad Size
RNW	-17.972	-85.502	4x4
VCC:	2.106	-85.502	4x4
VCC:	-81.230	73.661	4x4oct
VCC:P	0.000	85.512	4x4
VD	71.654	85.512	4x4
VDD:	-81.230	-7.441	4x4
VDD:	-81.230	80.748	4x4oct
VDD:P	81.230	-7.441	4x4
VEE:	40.492	-85.502	4x10
VEE:G	12.146	-85.502	4x10
HW00Y	-81.230	-64.134	4x4
HW01Y	-81.230	-21.614	4x4
HW02Y	-81.230	6.732	4x4
HW03Y	-81.230	49.252	4x4
HW04Y	-56.693	85.512	4x4
HW05Y	-14.173	85.512	4x4
HW06Y	14.173	85.512	4x4
HW07Y	56.693	85.512	4x4
HW08Y	81.230	49.252	4x4
HW09Y	81.230	6.732	4x4
HW10Y	81.230	-21.614	4x4
HW11Y	81.230	-64.134	4x4
HW00X	-81.230	-71.220	4x4
HW01X	-81.230	-14.528	4x4
HW02X	-81.230	-0.354	4x4
HW03X	-81.230	56.339	4x4
HW04X	-63.780	85.512	4x4
HW05X	-7.087	85.512	4x4
HW06X	7.087	85.512	4x4
HW07X	63.780	85.512	4x4
HW08X	81.230	56.339	4x4
HW09X	81.230	-0.354	4x4
HW10X	81.230	-14.528	4x4
HW11X	81.230	-71.220	4x4
WDY	-46.319	-85.502	4x4
WDX	-39.232	-85.502	4x

1. Octagonal pins are for factory use only.

VM61314

14-CHANNEL DIE

Specific CHARACTERISTICS

Die size: 244 X 181 Mils

Pad Coordinates for the VM61314 (in Mils)

Pad Name	X Axis	Y Axis	Pad Size
VEE:	-60.463	-85.502	4x4
VCC:	-14.301	-85.502	4x4
VDD:P	-116.663	-7.441	4x4
C2N	-116.663	-42.874	4x4
C2P:	116.663	-42.874	4x4
VDD:	116.663	-7.441	4x4
C2P	-116.663	27.992	4x4
VCC:P	0.000	85.512	4x4
C2N:	116.663	27.992	4x4
VEE:G	-26.762	-85.502	4x10
HR10P	-116.663	35.079	4x4
HR10N	-116.663	42.165	4x4
HW10X	-116.663	56.339	4x4
HW10Y	-116.663	49.252	4x4
HR09P	-77.953	85.512	4x4
HR09N	-85.039	85.512	4x4
HW09X	-99.213	85.512	4x4
HW09Y	-92.126	85.512	4x4
HR03P	116.663	35.079	4x4
HR03N	116.663	42.165	4x4
HW03X	116.663	56.339	4x4
HW03Y	116.663	49.252	4x4
HR04P	77.953	85.512	4x4
HR04N	85.039	85.512	4x4
HW04X	99.213	85.512	4x4
HW04Y	92.126	85.512	4x4
VDD:	116.663	80.748	4x4oct
VCC:	116.663	73.661	4x4oct
HR05P	63.780	85.512	4x4
HR05N	56.693	85.512	4x4
HW05X	42.520	85.512	4x4
HW05Y	49.606	85.512	4x4
HR08P	-63.780	85.512	4x4
HR08N	-56.693	85.512	4x4
HW08X	-42.520	85.512	4x4
HW08Y	-49.606	85.512	4x4
HR13P	-116.663	-49.961	4x4
HR13N	-116.663	-57.047	4x4
HW13X	-116.663	-71.220	4x4
HW13Y	-116.663	-64.134	4x4
HR12P	-116.663	-35.787	4x4
HR12N	-116.663	-28.701	4x4
HW12X	-116.663	-14.528	4x4

Pad Name	X Axis	Y Axis	Pad Size
HW12Y	-116.663	-21.614	4x4
HR00P	116.663	-49.961	4x4
HR00N	116.663	-57.047	4x4
HW00X	116.663	-71.220	4x4
HW00Y	116.663	-64.134	4x4
HR01P	116.663	-35.787	4x4
HR01N	116.663	-28.701	4x4
HW01X	116.663	-14.528	4x4
HW01Y	116.663	-21.614	4x4
HR11P	-116.663	20.906	4x4
HR11N	-116.663	13.819	4x4
HW11X	-116.663	-0.354	4x4
HW11Y	-116.663	6.732	4x4
HR07P	-7.087	85.512	4x4
HR07N	-14.173	85.512	4x4
HW07X	-28.346	85.512	4x4
HW07Y	-21.260	85.512	4x4
HR02P	116.663	20.906	4x4
HR02N	116.663	13.819	4x4
HW02X	116.663	-0.354	4x4
HW02Y	116.663	6.732	4x4
HR06P	7.087	85.512	4x4
HR06N	14.173	85.512	4x4
HW06X	28.346	85.512	4x4
HW06Y	21.260	85.512	4x4
RDN	-38.888	-85.502	4x4
RDP	-51.053	-85.502	4x4
FLT	40.000	-85.502	4x4
CSN	28.346	-85.502	4x4
WDX	51.654	-85.502	4x4
WDY	63.307	-85.502	4x4
HS0	74.961	-85.502	4x4
HS1	86.614	-85.502	4x4
RNW	16.693	-85.502	4x4
HS2	98.268	-85.502	4x4
HS3	109.921	-85.502	4x4
DUMY	-116.663	63.701	4x4
FAST	108.386	85.512	4x4
DSBF	-116.663	71.447	4x4
IWSET	2.087	-85.502	4x10
IRSET	-90.896	-85.502	4x10
C1	-72.825	-85.502	4x10
VD	-107.087	85.512	4x4

VTC Inc., 2800 East Old Shakopee Road, Bloomington, MN 55425, 612-853-5100

VM61314

14-CHANNEL DIE (Mirror)

Specific CHARACTERISTICS

Die size: 244 X 181 Mils

Pad Coordinates for the VM61314 Mirror (in Mils)

Pad Name	X Axis	Y Axis	Pad Size
VEE:	60.463	-85.502	4x4
VCC:	14.301	-85.502	4x4
VDD:P	116.663	-7.441	4x4
C2N	116.663	-42.874	4x4
C2P:	-116.663	-42.874	4x4
VDD:	-116.663	-7.441	4x4
C2P	116.663	27.992	4x4
VCC:P	0.000	85.512	4x4
C2N:	-116.663	27.992	4x4
VEE:G	26.762	-85.502	4x10
HR10P	116.663	35.079	4x4
HR10N	116.663	42.165	4x4
HW10X	116.663	56.339	4x4
HW10Y	116.663	49.252	4x4
HR09P	77.953	85.512	4x4
HR09N	85.039	85.512	4x4
HW09X	99.213	85.512	4x4
HW09Y	92.126	85.512	4x4
HR03P	-116.663	35.079	4x4
HR03N	-116.663	42.165	4x4
HW03X	-116.663	56.339	4x4
HW03Y	-116.663	49.252	4x4
HR04P	-77.953	85.512	4x4
HR04N	-85.039	85.512	4x4
HW04X	-99.213	85.512	4x4
HW04Y	-92.126	85.512	4x4
VDD:	-116.663	80.748	4x4oct
VCC:	-116.663	73.661	4x4oct
HR05P	-63.780	85.512	4x4
HR05N	-56.693	85.512	4x4
HW05X	-42.520	85.512	4x4
HW05Y	-49.606	85.512	4x4
HR08P	63.780	85.512	4x4
HR08N	56.693	85.512	4x4
HW08X	42.520	85.512	4x4
HW08Y	49.606	85.512	4x4
HR13P	116.663	-49.961	4x4
HR13N	116.663	-57.047	4x4
HW13X	116.663	-71.220	4x4
HW13Y	116.663	-64.134	4x4
HR12P	116.663	-35.787	4x4
HR12N	116.663	-28.701	4x4
HW12X	116.663	-14.528	4x4

Pad Name	X Axis	Y Axis	Pad Size
HW12Y	116.663	-21.614	4x4
HR00P	-116.663	-49.961	4x4
HR00N	-116.663	-57.047	4x4
HW00X	-116.663	-71.220	4x4
HW00Y	-116.663	-64.134	4x4
HR01P	-116.663	-35.787	4x4
HR01N	-116.663	-28.701	4x4
HW01X	-116.663	-14.528	4x4
HW01Y	-116.663	-21.614	4x4
HR11P	116.663	20.906	4x4
HR11N	116.663	13.819	4x4
HW11X	116.663	-0.354	4x4
HW11Y	116.663	6.732	4x4
HR07P	7.087	85.512	4x4
HR07N	14.173	85.512	4x4
HW07X	28.346	85.512	4x4
HW07Y	21.260	85.512	4x4
HR02P	-116.663	20.906	4x4
HR02N	-116.663	13.819	4x4
HW02X	-116.663	-0.354	4x4
HW02Y	-116.663	6.732	4x4
HR06P	-7.087	85.512	4x4
HR06N	-14.173	85.512	4x4
HW06X	-28.346	85.512	4x4
HW06Y	-21.260	85.512	4x4
RDN	38.888	-85.502	4x4
RDP	51.053	-85.502	4x4
FLT	-40.000	-85.502	4x4
CSN	-28.346	-85.502	4x4
WDX	-51.654	-85.502	4x4
WDY	-63.307	-85.502	4x4
HS0	-74.961	-85.502	4x4
HS1	-86.614	-85.502	4x4
RNW	-16.693	-85.502	4x4
HS2	-98.268	-85.502	4x4
HS3	-109.921	-85.502	4x4
DUMY	116.663	63.701	4x4
FAST	-108.386	85.512	4x4
DSBF	116.663	71.447	4x4
IWSET	-2.087	-85.502	4x10
IRSET	90.896	-85.502	4x10
C1	72.825	-85.502	4x10
VD	107.087	85.512	4x4