VM6150E Series

VTC Inc.
Value the Customer™

2, 4 or 8-CHANNEL, 5-VOLT, MAGNETO-RESISTIVE HEAD, READ/WRITE PREAMPLIFIER with SERVO WRITE

970801

PRELIMINARY

August,1997

FEATURES

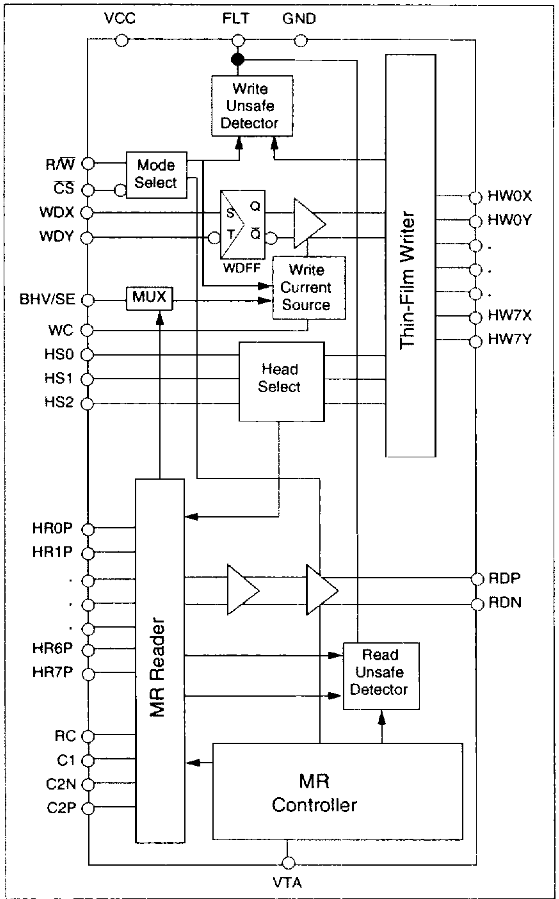
- *General*
  - Designed for Use With Four-Terminal MR Heads
  - Bandwidth = 160 MHz Typical
  - Operates from a Single +5 Volt Power Supply
  - Fault Detection Capability
  - Available in a Plastic TQFP Package
- *High Performance Reader*
  - Current Bias / Current Sense Architecture
  - MR Bias Current Range 6- 12 mA
  - Read Voltage Gain = 250 V/V Typical ($R_{MR} = 40\Omega$)
  - Input Noise = 0.75 nV/$\sqrt{Hz}$ Typical ($R_{MR} = 40\Omega$)
  - Thermal Asperity Detection and Fast Recovery Compensation
  - Dual Reader Input with One Side Grounded Externally
- *High Speed Writer*
  - Write Current Range = 10 - 40 mA
  - Rise Time = 2.2ns Typical (L_H = 150 nH, I_W = 35 mA)
  - Multi-Channel Servo Write
  - Optional WDFF

DESCRIPTION

The VM6150E is a high-performance read/write preamplifier designed for use with 4-terminal magneto-resistive recording heads. The VM6150E operates from +5V power supply. This device provides write current to the write current drivers, DC bias current for the MR head, read and write fault detect, and multi-channel servo write. This device also provides low voltage power supply detection, power saving idle mode, and an optional write data flip-flop for NRZ and NRZI data.

Please consult VTC for other channel-count availability.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

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

Write Current I_W 60mA

Input Voltages:
- Digital Input Voltage V_{IN} .... GND -0.3V to (V_{CC} + 0.3)V
- Head Port Voltage V_H .... GND -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:
- 48-lead TQFP, Θ_{JA} (Still Air) .... 75°C/W
- 48-lead TQFP, Θ_{JC} .... 35°C/W

RECOMMENDED OPERATING CONDITIONS

Power Supply Voltage:	
V_{CC}	+5V ± 10%
Junction Temperature (T_J)	25°C to 125°C

Read Mode

In the read mode, the circuit operates as a low noise, single-ended amplifier which senses resistance changes in the MR element which correspond to flux changes on the disk.

The magnitude of the MR bias current is programmed by an external resistor with an external current source. VTC recommends that the resistor (setting some nominal I_{MR}) be placed near the part to limit parasitics. The reader has a current gain of 20 mA/mA.

A "high" TTL level applied to R/$\overline{W}$ (along with the appropriate TTL level on the $\overline{CS}$ line) places the preamp in the read mode and activates the read unsafe detection circuitry (see Table 1).

The VM6150E uses a current bias, current sense architecture. The output of the read preamp is differential.

BHV (Buffered Head Voltage)

An amplified representation of the MR bias voltage is presented at the BHV/SE pin (in non-servo modes only). This voltage is defined by the equation:

$$V_{BHV} = 5(I_{MR} \times R_{MR}) \quad \text{(eq. 1)}$$

Thermal Asperity Detection and Compensation

A thermal asperity (caused by the collision of the MR element with the media) is characterized by a large amplitude disturbance in the readback signal followed by an exponential decay (See Figure 1).

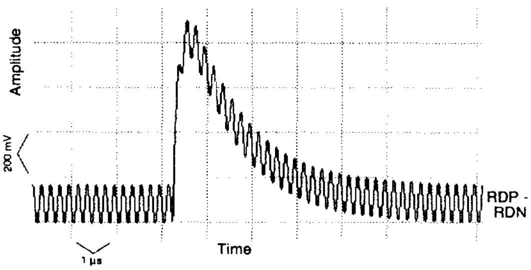


Figure 1: Thermal Asperity Event

Recovery from this large disturbance in the data path can take a relatively large amount of time (typically several microseconds) without detection and correction. The VM6150E implements both a programmable detection threshold and an automatic fast recovery for such disturbances.

Detection Threshold

The threshold for thermal asperity detection is programmable using the VTA pin (which sits at a nominal voltage of 2V) and is governed by the following equation:

$$V_{TADT} = k_{VTA} \times I_{VTA} \quad \text{(eq. 2)}$$

V_{TADT} represents the TA detection threshold at which the RDP/RDN output exceeds the baseline level (in mV).
k_{VTA} represents the VTA programming constant of 350 mV/mA.
I_{VTA} represents the programmed current flowing out of the VTA pin (in mA).

This threshold has a range from 100mV to 500mV (pk).

Fast Recovery Compensation

A Fast Recovery Compensation is automatically activated after a thermal asperity is detected (the programmed threshold is exceeded). This compensation raises the nominal 250 KHz lower -3dB corner frequency to approximately 1.5 MHz until the RDP-RDN output baseline is restored (see Figure 2).

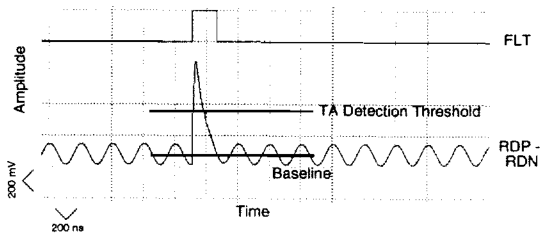


Figure 2: TA Detection and Compensation

This adjustment allows the preamp to reach its DC operating point rapidly after a thermal asperity occurrence (ensuring complete output recovery within nanoseconds rather than microseconds). After the RDP-RDN output baseline is restored, the preamp reinstates the lower -3dB corner frequency.

Fault Detection

In the read mode, a high on the FLT line indicates a thermal asperity fault condition. The thermal asperity fault condition takes the FLT line high when the detection threshold is reached and returns low when RDP-RDN returns to within 20mV of its DC operating point.

An MR open head fault condition is detected but not reported on the FLT line. The voltage on the loop-compensation capacitor (C1) is clamped to provide MR open head protection (until another head is selected or a mode change is initiated).

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 programmed by an external resistor with an external current source. VTC recommends that the resistor (setting some nominal I_W) be placed near the part to limit parasitics. The writer has a current gain of 20 mA/mA.

A "low" TTL level applied to R/$\overline{W}$ (along with the appropriate TTL level on the $\overline{CS}$ line) places the preamp in the write mode (see Table 1). The write data (PECL) signals on the WDX and WDY lines drive the optional internal flip-flop which drives the current switch to the thin film writer. Write current polarity is defined in Figures 3 and 4.

Fault Detection

In the write mode, a high on the FLT line indicates an open head write unsafe fault condition.

A low supply fault condition is detected but not reported on the FLT line. The write current source internal to the chip is shutdown and no current flows to any head.

Servo Write Mode

In the servo write mode, two channels of the VM6150E are written simultaneously.

Pulling the BHV/SE pin high to VCC (along with the appropriate TTL levels on the $\overline{CS}$, R/$\overline{W}$ and HS2 lines) places the preamp in servo write mode (see Table 1). The TTL levels applied to the HS0 - HS1 pins determine which heads are written (see Table 2).

Note: The servo write function cannot be used to do a DC erase or the maximum power dissipation will be exceeded.

Servo Verify Read Mode

In the servo verify read mode, the R/W pin is pulled high (read mode) to allow the VM6150E to read while still in servo mode (see Table 1). This allows verification of a servo write without leaving servo mode. Note that the standard (non-servo) head select table is used in this mode.

Table 1: Mode Select

$\overline{CS}$	R/$\overline{W}$	HS2	BHV/SE	DESCRIPTION
0	1	X	monitor	Read mode
0	0	X	monitor if desired	Write mode
0	0	1	pulled high (to VCC)	Servo mode
0	1	X	pulled high (to VCC)	Servo Verify Read mode (reference the non-servo head select table)
1	X	X	X	Idle mode

Table 2: Servo Mode Head Select

HS1	HS0	HEADS
0	0	0 and 1
0	1	2 and 3
1	0	4 and 5
1	1	6 and 7

Table 3: Head Select (non-servo)

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_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 mode).
3)	HS0-HS2	(I*)	Head Select: Selects one of the eight heads.
4)	BHV/SE	(I/O)	Buffered Head Voltage/Servo Enable: In non-servo mode, the preamp drives this pin to an analog voltage representing the buffered head voltage (BHV). When externally pulled to VCC, the preamp enters servo write mode.
5)	FLT	(O)	Fault/Thermal Asperity Detect: In Write mode, a high level indicates an open head write fault (write unsafe condition). In Read mode, a high level indicates a thermal asperity fault.
6)	VTA	(I)	Thermal Asperity programmable input.
7)	WDX, WDY	(I*)	Differential Pseudo-ECL write data inputs.
8)	HR0P-HR7P	(I)	MR head connections, positive end.
9)	HW0X-HW7X	(O)	Thin-Film write head connections, positive end.
10)	HW0Y-HW7Y	(O)	Thin-Film write head connections, negative end
11)	RDP, RDN	(O)	Read Data: Differential read signal outputs.
12)	WC	(*)	Write current reference pin: Sets the magnitude of write current.
13)	RC	(*)	MR bias current reference pin: Sets the magnitude of MR bias current.
14)	C2	-	Noise bypass capacitors.
15)	C1	-	Compensation capacitor for the MR head bias current loop.
16)	GND	-	Ground
17)	VCC	-	+5.0V supply

* 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.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC} Power Supply Current	I_{CC}	Read Mode, I_{MR} = 10mA		90	120	mA
		Write Mode, I_W = 20mA (read bias active)		105	160	
		Idle Mode		8	15	
		Servo Mode, I_W = 20mA, One bank of two heads		135	175	
Power Dissipation	P_d	Read Mode, I_{MR} = 10mA		450	660	mW
		Write Mode, I_W = 20mA		600	880	
		Idle Mode		40	83	
		Servo Mode, I_W = 20mA, One bank of two heads		675	965	
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_{IH} - 1.5		V_{IH} - 0.25	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 Voltage	V_{OH}	FLT: I_{OH} = -400µA	2			V
Output Low Voltage	V_{OL}	FLT: I_{OL} = 400µA			0.5	V
V_{CC} Fault Threshold	V_{DTH}	I_w < 200µA	3.5	3.9	4.2	V

READ CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
MR Head Current Range	I_{MR}		6	9	12	mA
MR Bias Reference Voltage	V_{RC}	$2k < R_{RC} < 4k\Omega$		2.0		V
IRC to MR Bias Current Gain	A_{IMR}	$6mA < I_{MR} < 12mA$	18.4	20	21.6	mA/mA
Unselected MR Head Current					100	µA
Differential Voltage Gain	A_V	$V_{IN} = 1mV_{pp}$ @10MHz, R_L(RDP, RDN) = 1kΩ, $I_{MR} = 9mA$, $R_{MR} = 40\Omega$		250		V/V
Passband Upper -3dB Frequency Limit	f_{HR}	$R_{MR} = 40\Omega$; $L_{MR} = 10nH$		160		MHz
Passband Lower -3dB Frequency Limit	f_{LR}	$R_{MR} = 40\Omega$; $C_1 = 0.022\mu F$		625		KHz
Equivalent Input Noise	e_n	$R_{MR} = 40\Omega$; $I_{MR} = 9mA$; 1 < f < 40 MHz		0.75		$nV/\sqrt{Hz}$
$I_{MR} \cdot R_{MR}$	V_{MR}		240		450	mV
Input Resistance	R_{IN}	$I_{MR} = 9mA$		3.2		Ω
Dynamic Range	DR	AC input V where A_V falls to 90% of its value at $V_{IN} = 1mV_{pp}$ @ f = 5 MHz	TBD	5		mV_{pp}
Power Supply Rejection Ratio	PSRR	$100mV_{pp}$ on V_{CC} or GND, $I_{MR} = 9mA$, $R_{MR} = 40\Omega$, 1 < f < 30 MHz		33		dB
Channel Separation	CS	Unselected Channels: $V_{IN} = 100mV_{pp}$, 1 < f < 40 MHz	40			dB
Output Offset Voltage	V_{OS}	$I_{MR} = 9mA$, $R_{MR} = 40\Omega$	-300		300	mV
Common Mode Output Voltage	V_{OCM}	Read Mode		V_{CC} - 2.7		V
Common Mode Output Voltage Difference	ΔV_{OCM}	V_{OCM} (READ) - V_{OCM} (WRITE)			300	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, $R_{DISK} = 10M\Omega$			TBD	µA
		Maximum Peak Discharge, $C_{DISK} = 300pF$, $R_{DISK} = 10M\Omega$			TBD	mA
Buffered Head Voltage Gain	A_{BHV}	Output range = $A_{BHV} I_{MR} R_{MR}$ = 500mV to 2.5V; BHV Source Current = 0-500µA	4.5	5.0	5.5	V/V
Thermal Asperity Reference Voltage	V_{VTA}	$0 < I_{VTA} < 1.5mA$		2		V
Thermal Asperity Programming Constant	k_{VTA}	Threshold of 100mV to 500mV over baseline level of RDP/RDN		350		mV/mA

WRITE CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified.
I_W = 35mA, L_H = 150nH, R_H = 25Ω, f_{DATA} = 5MHz.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
Write Current Range	I_W	(base to peak)	10		40	mA
WC Pin Voltage	V_{WC}			2.0		V
I_{WC} to Write Current Gain	A_I		18	20	22	mA/mA
Differential Head Voltage Swing	V_{DH}	Open Head, V_{CC} = 4.5V	6	7.5		V_{pp}
Unselected Head Transition Current	I_{UH}				50	μA_{pk}
Differential Output Resistance	R_O	Internal Damping*		450*		Ω

* An 800 Ohm damping resistor is a metal option.

SWITCHING CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified.
I_W = 35mA, L_H = 150nH, R_H = 25Ω, f_{DATA} = 5MHz.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
Read to Write Mode	t_{RW}	To 90% of write current		50		ns
Write to Read Mode	t_{WR}	RDP/RDN to within ± 30mV of final value			0.5	µs
$\overline{CS}$ to Read Mode	t_{CS}	RDP/RDN to within ± 30mV of final value			10	µs
HS0 - HS3 to Any Head	t_{HS}	RDP/RDN to within ± 30mV of final value; read mode		12	20	µs
$\overline{CS}$ to Unselect	t_{RI}	To 10% of read envelope or write current			0.5	µs
Head Current Propagation Delay	t_{D3}	From 50% points, WDX to I_W		20	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	I_W = 35mA; L_H = 150nH; 10 - 90%		2.2	3	ns

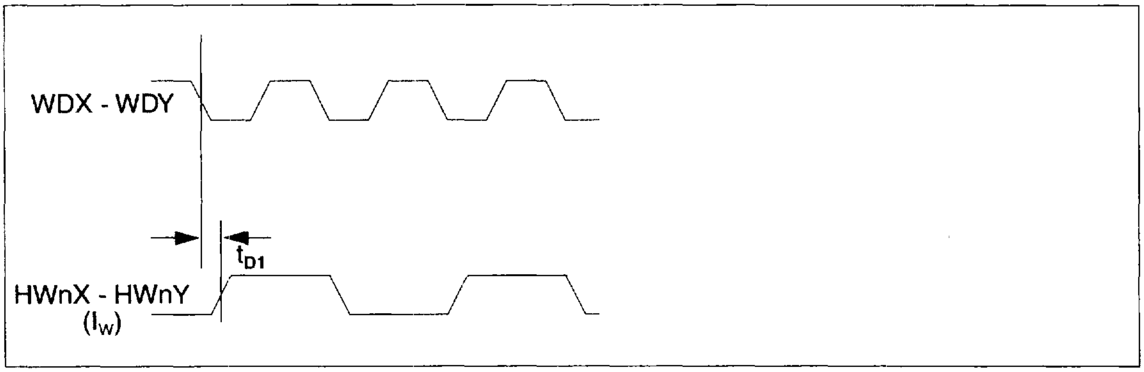

Figure 3: Write Mode Timing Diagram with Flip-Flop Active

Note: The write current polarity is toggled on each high to low transition of the expression (WDX - WDY).
A preceding read operation initializes the WDFF so that upon entering the write mode, current flows into the "X" port.

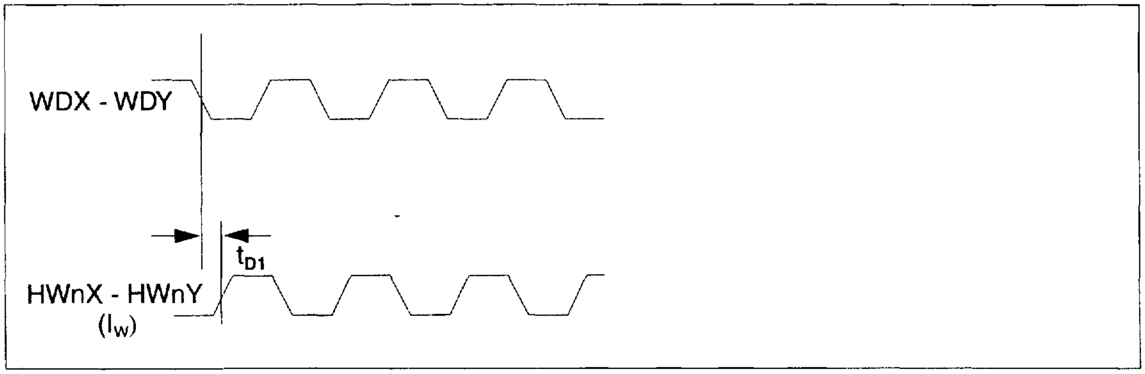

Figure 4: Write Mode Timing Diagram with Flip-Flop Inactive

Note: The write current polarity is defined by the levels of WDX and WDY (shown in the expression WDX - WDY).
For WDX>WDY current flows into the "X" port; for WDX<WDY current flows into the "Y" port.

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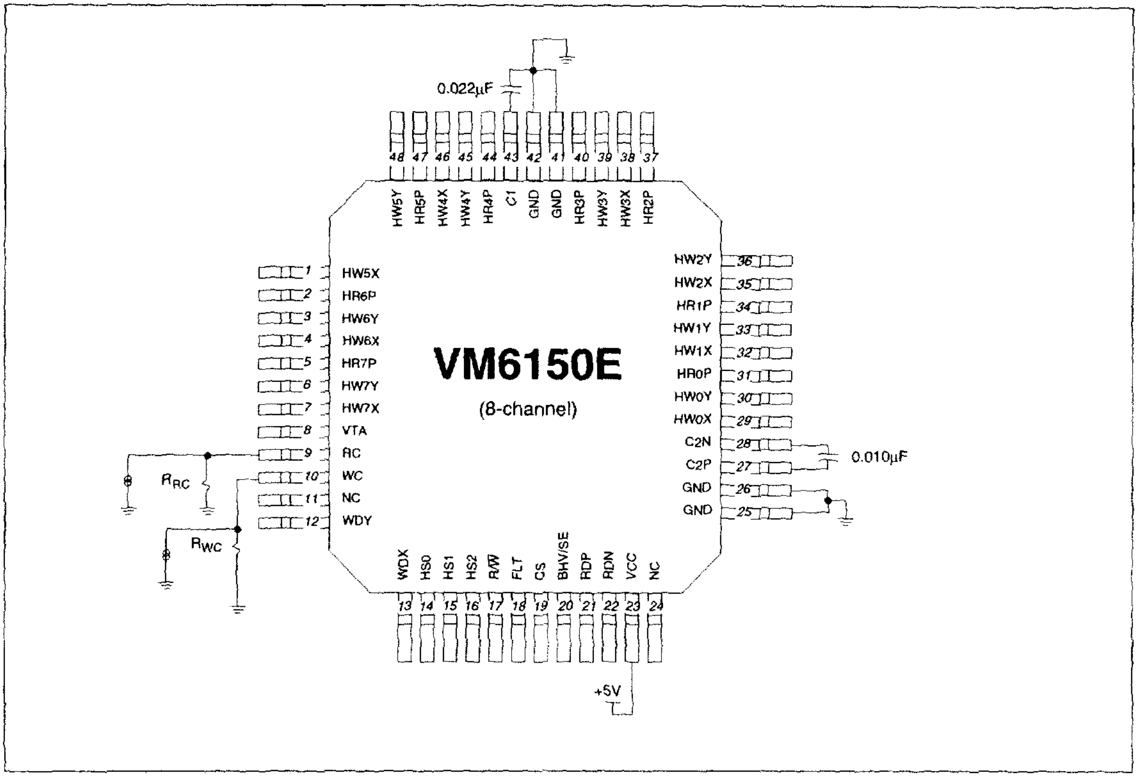
TYPICAL APPLICATION CONNECTIONS

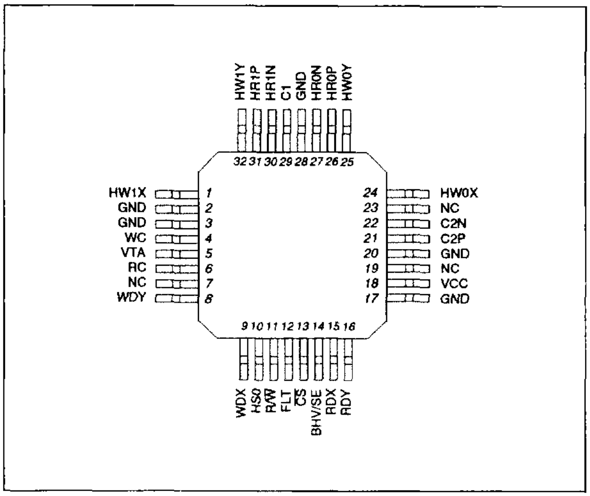


Application Notes:

- I_{MR} = MR Bias Current = $20 \cdot I_{RC}$
- I_W = Write Current = $20 \cdot I_{WC}(1+R_H/R_D)$
  R_H represents the Head Series Resistance, R_D represents the Damping Resistance
- V_{CC} = +5V, GND = Ground

VM6152E

2-CHANNEL CONNECTION DIAGRAM



2-Channel
32-lead TQFP (.8mm pitch)

Specific CHARACTERISTICS
See the general data sheet for common specification information.

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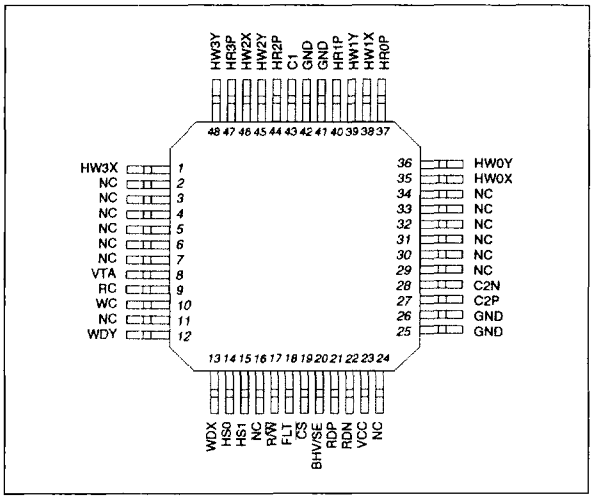
VM6154E

4-CHANNEL CONNECTION DIAGRAM

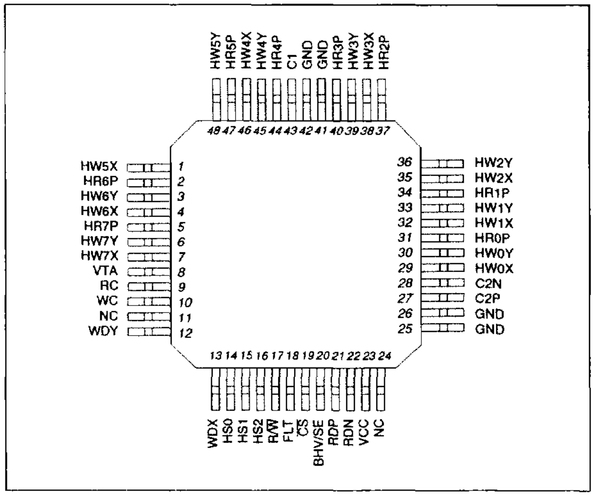


4-Channel
48-lead TQFP

Specific CHARACTERISTICS
See the general data sheet for common specification information.

VM6158E

8-CHANNEL CONNECTION DIAGRAM



8-Channel
48-lead TQFP

Specific CHARACTERISTICS

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