



**VTC Inc.**  
Value the Customer™

# VM7120

2, 4, 6 OR 8-CHANNEL, 5-VOLT,  
THIN-FILM HEAD, READ/WRITE  
PREAMPLIFIER

**PRELIMINARY**

July, 1993

## FEATURES

- High Performance
  - Read Gain = 300 V/V Typical
  - Input Noise = 0.7nV/√Hz max
  - Head Inductance Range = 0.2 – 5 μH
  - Write Current Range 1 - 40 mA
- Low Input Capacitance Option Available, C<sub>IN</sub> = 16 pF max
- Very Low Power Dissipation = 3 mW Typical in Sleep Mode
- Power Up/Down Data Protect Circuitry
- Reduced Write-to-Read Recovery Time
- Single Power Supply = 5 V ± 10%
- Fault Detect Capability
- Designed for 2-Terminal Thin-Film or MIG Heads
- Standard Schottky - Isolated 400 Ω Damping Resistor (patent pending)
- Non-Damping Resistor Version Available
- Other Read Gain Options Available
- Available in 2, 4, 6 or 8-Channels

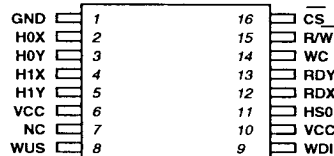
## DESCRIPTION

The VM7120 is a high-performance, very low-power read/write preamplifier designed for use with external 2-terminal, thin-film or MIG recording heads. This circuit will operate on a single 5-volt power supply and is ideally suited for use in battery powered disk drives.

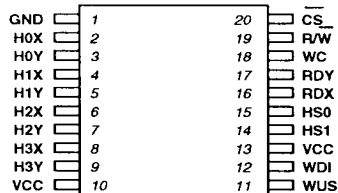
The VM7120 provides write current switching in the write mode and a low noise data path in the read mode for up to eight read/write recording heads. When deactivated, the device enters a **sleep mode** that reduces power dissipation to 3 mW. Data protection circuitry is provided to ensure that the write current source is totally disabled during power supply power up/power down conditions. Write-to-read recovery time is minimized by eliminating common mode output voltage swings when switching between modes.

The VM7120 is available in several different packages. Please consult VTC for package availability and additional read mode voltage gains.

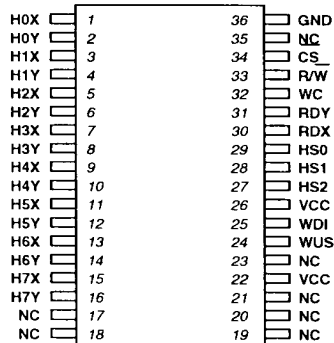
## CONNECTION DIAGRAMS



**2-Channel  
16-lead SOIC**

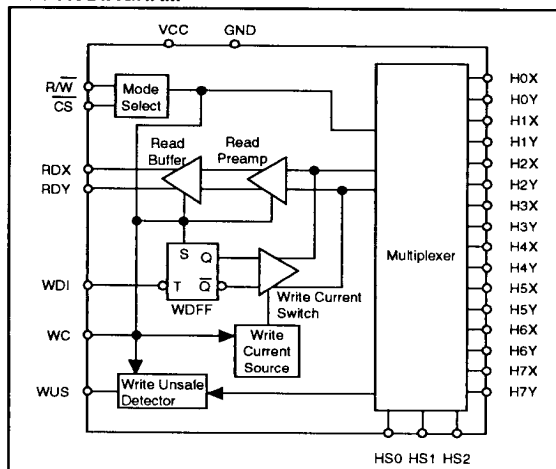


**4-Channel  
20-lead SOIC, SSOP, VSOP**



**8-Channel  
36-lead SOIC**

## BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

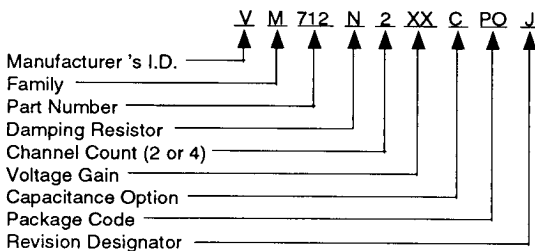
|                                                 |                                   |
|-------------------------------------------------|-----------------------------------|
| <b>Power Supply:</b>                            |                                   |
| V <sub>CC</sub>                                 | -0.3V to +7V                      |
| Write Current I <sub>W</sub>                    | 60mA                              |
| <b>Input Voltages:</b>                          |                                   |
| Digital Input Voltage V <sub>IN</sub>           | -0.3V to (V <sub>CC</sub> + 0.3)V |
| Head Port Voltage V <sub>H</sub>                | -0.3V to (V <sub>CC</sub> + 0.3)V |
| WUS Pin Voltage Range V <sub>WUS</sub>          | -0.3V to +6V                      |
| <b>Output Current:</b>                          |                                   |
| RDX, RDY: I <sub>O</sub>                        | -10mA                             |
| WUS: I <sub>WUS</sub>                           | +12mA                             |
| Junction Temperature                            | 150°C                             |
| Storage Temperature T <sub>stg</sub>            | -65° to 150°C                     |
| <b>Thermal Characteristics, Θ<sub>JA</sub>:</b> |                                   |
| 16-lead SOIC                                    | 100°C/W                           |
| 20-lead SOIC                                    | 80°C/W                            |
| 20-lead SSOP                                    | TBD                               |

## RECOMMENDED OPERATING CONDITIONS

|                                        |               |
|----------------------------------------|---------------|
| <b>Power Supply Voltage:</b>           |               |
| V <sub>CC</sub>                        | +5V ± 10%     |
| Write current (I <sub>W</sub> )        | 1 to 40mA     |
| Head Inductance (L <sub>H</sub> )      | 0.2 to 10μH   |
| Junction Temperature (T <sub>J</sub> ) | 25°C to 125°C |

## ORDERING INFORMATION

The VM7120 part type is available with a wide variety of possible options that allow the device to closely fit different applications. In order to simplify the task of defining the various possible options, ordering information is included here. Please note, not all possible combinations of options may actually have been built. Please consult the factory with any questions.



## DAMPING RESISTOR

Blank = Schottky Diode Connected Damping Resistor  
N = No Internal Damping Resistor

## VOLTAGE GAIN

15 = 150 Voltage Gain  
30 = 300 Voltage Gain

## CAPACITANCE OPTION (refer to Table 3)

C = Low Capacitance  
I = Intermediate Capacitance/Noise  
Blank = Low Noise

## PACKAGE CODES

PO = Small Outline Integrated Circuit (SOIC)  
SS = Shrink Small Outline Package (SSOP)  
VS = Very Small Outline Package (VSOP)

## CIRCUIT OPERATION

The VM7120 addresses up to four 2-terminal, thin-film recording heads, providing switched write current in the write mode, or data amplification in the read mode. Head selection and mode control is determined by the head select lines, HS1, HS2 and mode control lines, CS, R/W as shown in Tables 1 and 2. Internal resistor pullups, provided on the CS and R/W lines, will force the device into a non-write condition if either control line opens up. The part's operation over a wide range of inductive loads makes it suitable for 2-terminal MIG heads.

## Write Mode

In write mode, the VM7120 acts as a write current switch with the write unsafe (WUS) detection circuitry activated. Write current is toggled between the X and Y side of the selected head on each high to low transition on the Write Data Flip-Flop (WDF) so that upon switching to the write mode, the write current flows into the "X" side of the head.

The write current magnitude is determined by an external resistor (RWC) connected between the WC pin and Ground. An internally generated reference voltage is present at the WC pin. The magnitude of the Write Current (0-PK, ± 8%) is:

$$I_W = K_W/R_{WC} + 0.2mA \\ = 1.25/R_{WC} + 0.2mA$$

## VM7120

Power supply fault protection ensures data security on the disk by disabling the write current source during a power supply voltage fault or by supply power up/down conditions. Additionally, the write unsafe (WUS) detection circuitry will flag any of the conditions listed below, as a high level on the WUS line. Two negative transitions on the WDI pin, after the fault is corrected, is required to clear the WUS line.

- No write current
- WDI frequency too low
- Read or sleep mode

### Read Mode

In read mode, the VM7120 acts as a low noise differential amplifier for signals coming off the disk. The write current generator and write unsafe circuitry is deactivated. The RDX, RDY pins are emitter follower outputs and are in phase with "X" and "Y" head ports. These outputs should be AC coupled to the load. The RDX, RDY common mode output voltage is constant, minimizing the transient between read and write mode, thereby, substantially reducing the recovery time in the Pulse Detector circuit connected to these outputs.

### Sleep Mode

When CS is high, initially all circuitry is shut down so that power dissipation is reduced to 3 mW in the **Sleep Mode**. Switching the CS line low *wakes up* the chip and the device will enter the read or write mode, depending on the status of the R/W line.

### Diode Connected Damping Resistor (patent pending)

The VM7120 has damping resistors isolated by Schottky diodes as an option. The diodes effectively remove the resistor from the circuit during the read mode, however during the write mode with the higher level input signal, the resistor provides damping for the write current waveform.

Input Structure:

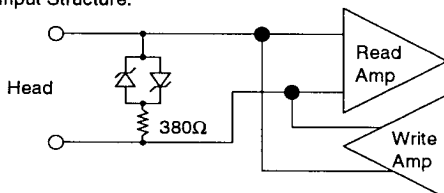


Table 1: Head Select

| 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    |

Table 2: Mode Select

| CS | R/W | MODE        |
|----|-----|-------------|
| 0  | 0   | Write/Awake |
| 0  | 1   | Read/Awake  |
| 1  | X   | Sleep       |

### PIN DESCRIPTIONS

| NAME               | I/O | DESCRIPTION                                                                               |
|--------------------|-----|-------------------------------------------------------------------------------------------|
| HS0-HS2            | I*  | Head Select: selects one of up to 8 heads                                                 |
| H0X-H7X<br>H0Y-H7Y | I/O | X, Y Head terminals                                                                       |
| WDI                | I*  | Write Data Input: TTL input signal, negative transition toggles direction of head current |
| CS                 | I   | Chip select: high level signal puts chip in sleep mode, low level wakes chip up           |
| R/W                | I*  | Read/Write select: High level selects read mode, low-level selects write mode             |
| WUS                | O*  | Write unsafe: Open collector output: high level indicates writes unsafe condition         |
| 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.

\*\* Although both VCC connections are recommended, only one connection is required as both are connected internally.

**DC CHARACTERISTICS** Recommended operating conditions apply unless otherwise specified.

| PARAMETER                            | SYM             | CONDITIONS                        | MIN  | TYP<br>(Note 1)          | MAX                      | UNITS |
|--------------------------------------|-----------------|-----------------------------------|------|--------------------------|--------------------------|-------|
| Supply Current                       | I <sub>CC</sub> | Read Mode                         |      | 34 + .05 I <sub>W</sub>  | 51 + .05 I <sub>W</sub>  | mA    |
|                                      |                 | Write Mode                        |      | 44 + 1.05 I <sub>W</sub> | 52 + 1.05 I <sub>W</sub> |       |
|                                      |                 | Idle Mode                         |      | 0.6                      | 3                        |       |
| Power Dissipation                    | PD              | Read Mode, I <sub>W</sub> = 20mA  |      | 165                      | 286                      | mW    |
|                                      |                 | Write Mode, I <sub>W</sub> = 20mA |      | 320                      | 402                      |       |
|                                      |                 | Idle Mode                         |      | 3                        | 17                       |       |
| Input High Voltage                   | V <sub>IH</sub> |                                   | 2    |                          | V <sub>CC</sub> +0.3     | V     |
| Input Low Voltage                    | V <sub>IL</sub> |                                   | -0.3 |                          | 0.8                      | V     |
| Input High Current                   | I <sub>IH</sub> | V <sub>IH</sub> = 2.7V            |      |                          | 80                       | μA    |
| Input Low Current                    | I <sub>IL</sub> | V <sub>IL</sub> = 0.4V            | -160 |                          |                          | μA    |
| WUS Output Low Voltage               | V <sub>OL</sub> | I <sub>OL</sub> = 4.0mA           |      | 0.35                     | 0.5                      | V     |
| WUS Output High Current              | I <sub>OH</sub> | V <sub>OH</sub> = 5.0V            |      | 13                       | 100                      | μA    |
| VCC Value for Write Current Turn Off |                 | I <sub>H</sub> < 0.2mA            | 3.7  | 4.0                      | 4.3                      | V     |

Note 1: Typical values are given at V<sub>CC</sub> = 5V and T<sub>A</sub> = 25°C.

**Table 3: Input Noise and Differential Input Capacitance Options Available**

| Input Noise |      |        | Input Capacitance |     |      | Option Designator |
|-------------|------|--------|-------------------|-----|------|-------------------|
| TYP         | MAX  | UNIT   | TYP               | MAX | UNIT |                   |
| 0.50        | 0.70 | nV/√Hz | 32                | 45  | pF   | None / Standard   |
| 0.60        | 0.75 |        | 16                | 23  |      | I                 |
| 0.70        | 0.85 |        | 9                 | 16  |      | C                 |

**Table 4: Differential Read Voltage Gain**

| MIN | TYP | MAX | UNIT | Gain Option Designator |
|-----|-----|-----|------|------------------------|
| 125 | 150 | 175 | V/V  | 10                     |
| 250 | 300 | 350 |      | 30                     |

**READ CHARACTERISTICS** Recommended operating conditions apply unless otherwise specified;  $C_L$  (RDX, RDY) < 20pF,  $R_L$  (RDX, RDY) = 1k $\Omega$ .

| PARAMETER                                           | SYM              | CONDITIONS                                                    | MIN       | TYP<br>(Note 1) | MAX  | UNITS                  |
|-----------------------------------------------------|------------------|---------------------------------------------------------------|-----------|-----------------|------|------------------------|
| Differential Read Voltage Gain                      | $A_V$            | $V_{IN} = 1\text{mV}_{rms}$ , 1MHz; see Table 4               | —         | —               | —    | V/V                    |
| Bandwidth                                           | BW               | -1dB $ Z_s  < 5\Omega$ , $V_{IN} = 1\text{mV}_{p-p}$          | 40        | 55              |      | MHz                    |
|                                                     |                  | -3dB $ Z_s  < 5\Omega$ , $V_{IN} = 1\text{mV}_{p-p}$          | 65        | 85              |      |                        |
| Input Noise Voltage                                 | $e_{in}$         | BW = 17MHz, $L_H = 0$ , $R_H = 0$ , see Table 3               |           | 0.5             | 0.7  | nV/ $\sqrt{\text{Hz}}$ |
| Differential Input Capacitance                      | $C_{IN}$         | $V_{IN} = 1\text{mV}_{p-p}$ , $f = 5\text{MHz}$ , see Table 3 |           | 33              | 45   | pF                     |
| Differential Input Resistance                       | $R_{IN}$         | $V_{IN} = 1\text{mV}_{p-p}$ , $f = 5\text{MHz}$               | 380       | 1000            |      | $\Omega$               |
| Dynamic Range                                       | DR               | AC input where $A_V$ is 90% of gain at 0.2mV $_{rms}$ input   | 2         | 5               |      | mV $_{rms}$            |
| Common Mode Rejection Ratio                         | CMRR             | $V_{IN} = 100\text{mV}_{p-p}$ @ 5MHz                          | 50        | 70              |      | dB                     |
| Power Supply Rejection Ratio                        | PSRR             | 100mV $_{p-p}$ @ 5MHz on $V_{CC}$                             | 45        | 66              |      | dB                     |
| Channel Separation                                  | CS               | Unselected channel driven with 20mV $_{p-p}$ @ 5MHz           | 40        | 45              |      | dB                     |
| Output Offset Voltage                               | $V_{OS}$         |                                                               | -300      | 2               | +300 | mV                     |
| RDX,RDY Common Mode Output Voltage                  | $V_{OCM}$        | Read Mode                                                     |           | $V_{CC}-2.7$    |      | V                      |
| Read to Write Common Mode Output Voltage Difference | $\Delta V_{OCM}$ |                                                               | -350      | -45             | 350  | mV                     |
| Single-Ended Output Resistance                      | $R_{SEO}$        |                                                               |           | 22              | 35   | $\Omega$               |
| Output Current                                      | $I_O$            | AC Coupled Load, RDX to RDY                                   | $\pm 1.5$ |                 |      | mA                     |

Note 1: Typical values are given at  $V_{CC} = 5\text{V}$  and  $T_A = 25^\circ\text{C}$ .

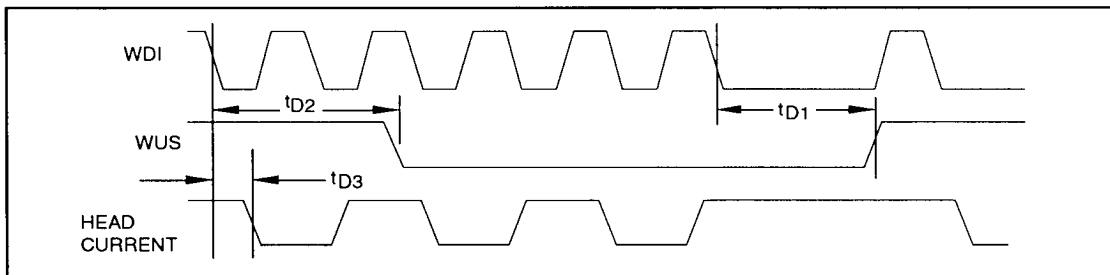


Figure 1: Write Mode Timing Diagram

**WRITE CHARACTERISTICS** Recommended operating conditions apply unless otherwise specified;  $L_H = 1\mu H$ ,  $R_H = 30\Omega$ ,  $I_W = 20mA$ ,  $f_{DATA} = 5MHz$ .

| PARAMETER                                   | SYM          | CONDITIONS                 | MIN  | TYP<br>(Note 1) | MAX | UNITS    |
|---------------------------------------------|--------------|----------------------------|------|-----------------|-----|----------|
| $I_{WC}$ to Head Current Gain               | $A_I$        |                            |      | 1               |     | mA/mA    |
| Write Current Constant                      | $K_W$        | $K_W = (V_{WC})(A_I)$      |      | 1.25            |     | V        |
| Write Current Range                         | $I_W$        | $32 < R_{WC} < 1560\Omega$ | 1    |                 | 40  | mA       |
| Write Current Tolerance                     | $\Delta I_W$ | $I_W = 10 - 40mA$          | -8   | -1              | +8  | %        |
| Differential Head Voltage Swing             | $V_{DH}$     |                            | 4.5  | 5.4             |     | Vp-p     |
| WDI Transition Frequency for Safe Condition | $f_{DATA}$   | WUS = low                  | 1    |                 |     | MHz      |
| Differential Output Capacitance             | $C_O$        |                            |      |                 | 15  | pF       |
| Differential Output Resistance              | $R_O$        |                            | 3200 |                 |     | $\Omega$ |
| Unselected Head Transient Current           | $I_{UH}$     | $I_W = 15mA$               |      | 0.15            | 1   | 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  $T_A = 25^\circ C$ .

**SWITCHING CHARACTERISTICS** Recommended operating conditions apply unless otherwise specified;  $I_W = 20mA$ ,  $f_{DATA} = 5MHz$ ,  $L_H = 1\mu H$ ,  $R_H = 30\Omega$ ,  $C_L$  (RDX, RDY)  $\leq 20pF$  (see Figure 1).

| PARAMETER                                | SYM         | CONDITIONS                                                               | MIN                               | TYP<br>(Note 1) | MAX | UNITS   |
|------------------------------------------|-------------|--------------------------------------------------------------------------|-----------------------------------|-----------------|-----|---------|
| $\overline{R/W}$ Read to Write Delay     | $t_{RW}$    | $\overline{R/W}$ to 90% $I_W$                                            |                                   | 0.06            | 1.0 | $\mu s$ |
| $\overline{R/W}$ Write to Read Delay     | $t_{WR}$    | $\overline{R/W}$ to 90% of 100mV, 10MHz read signal envelope             |                                   | 0.15            | 1.0 | $\mu s$ |
| $\overline{CS}$ Unselect to Select Delay | $t_{IR}$    | $\overline{CS}$ to 90% $I_W$ or 90% of 100mV, 10MHz read signal envelope |                                   | 0.23            | 0.6 | $\mu s$ |
| $\overline{CS}$ Select to Unselect Delay | $t_{RI}$    | $\overline{CS}$ to 10% of $I_W$                                          |                                   | 0.02            | 0.6 | $\mu s$ |
| HS0, 1, any Head Delay                   | $t_{HS}$    | HS0, 1 to 90% of 100mV, 10MHz read signal envelope                       |                                   | 0.23            | 0.6 | $\mu s$ |
| WUS Safe to Unsafe Delay                 | $t_{D1}$    |                                                                          | 0.6                               | 2.1             | 3.6 | $\mu s$ |
| WUS Unsafe to Safe Delay                 | $t_{D2}$    |                                                                          |                                   |                 | 1.0 | $\mu s$ |
| Head Current Propagation Delay (TD3)     | $t_{D3}$    | $L_H = 0$ , $R_H = 0$ , from 50% points                                  |                                   | 12              | 30  | ns      |
| Head Current Asymmetry                   | $A_{SYM}$   | 50% duty cycle on WDI, 1ns rise/fall time; $L_H = 0$ , $R_H = 0$         |                                   | 0.04            | 0.5 | ns      |
| Head Current Rise/Fall Time              | $t_r / t_f$ | 10% to 90% points                                                        | $L_H = 0$ , $R_H = 0$             | 2               | 5   | ns      |
|                                          |             |                                                                          | $L_H = 1\mu H$ , $R_H = 30\Omega$ | 12              | 16  |         |

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