



**VTC Inc.**  
Value the Customer™

# VM7140

2, 4 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 = 0.65nV/√Hz max
  - Head Inductance Range = 0.2 – 5 μH
  - Write Current Range 1 - 40 mA
  - Input Capacitance = 33 pF max
- Differential Pseudo ECL Write Data Input
- 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 or 8-Channels

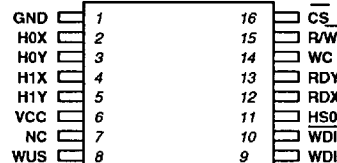
### DESCRIPTION

The VM7140 is a high-performance, very low-power read/write preamplifier designed for use with external 2-terminal, thin-film or MIG recording heads with differential pseudo ECL write data Input. This circuit will operate on a single 5-volt power supply and is ideally suited for use in battery powered disk drives.

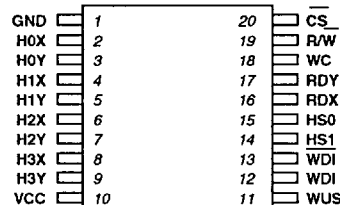
The VM7140 provides write current switching in the write mode and provides a low noise data path in the read mode for up to eight read/write recording heads. When deactivated, the device enters a *sleep mode* that reduces power dissipation to 3 mW. Data protection circuitry is provided to ensure that 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 VM7140 is available in several different packages. Please consult VTC for package availability and additional read mode voltage gains.

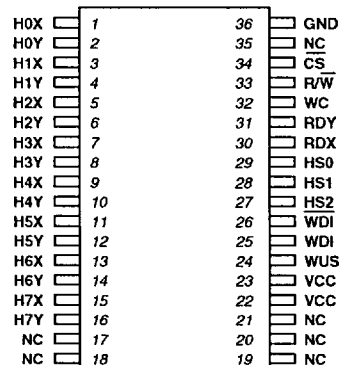
### CONNECTION DIAGRAMS



2-Channel  
16-lead SOIC

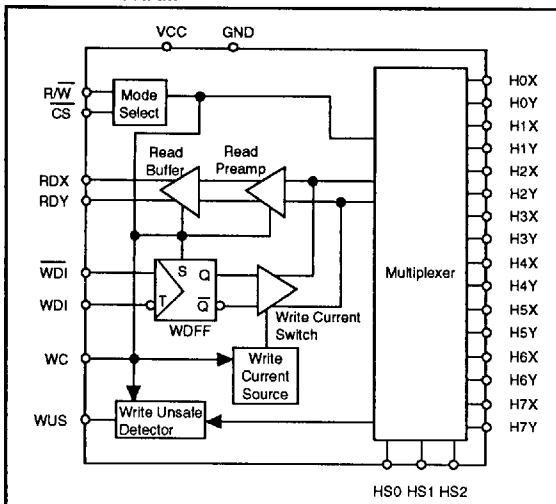


4-Channel  
20-lead SOIC, SSOP, VSOP



8-Channel  
36-lead SOIC

## BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

## Power Supply:

$V_{CC}$  ..... -0.3V to +7V

Write Current  $I_W$  ..... 60mA

## Input Voltages:

Digital Input Voltage  $V_{IN}$  ..... -0.3V to  $(V_{CC} + 0.3)V$

Head Port Voltage  $V_H$  ..... -0.3V to  $(V_{CC} + 0.3)V$

WUS Pin Voltage Range  $V_{WUS}$  ..... -0.3V to +6V

## Output Current:

RDX, RDY:  $I_O$  ..... -10mA

WUS:  $I_{WUS}$  ..... +12mA

Junction Temperature ..... 150°C

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

Thermal Characteristics,  $\theta_{JA}$ :

16-lead SOIC ..... 100°C/W

20-lead SOIC ..... 80°C/W

20-lead SSOP ..... TBD

## RECOMMENDED OPERATING CONDITIONS

## Power Supply Voltage:

$V_{CC}$  ..... +5V  $\pm$  10%

Write current ( $I_W$ ) ..... 1 to 40mA

Head Inductance ( $L_H$ ) ..... 0.2 to 10 $\mu$ H

Junction Temperature ( $T_J$ ) ..... 25°C to 125°C

## CIRCUIT OPERATION

The VM7140 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 VM7140 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 (WDFF) 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 ( $R_{WC}$ ) 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,  $\pm$  8%) is:

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

$$= 50/R_{WC} + 0.2mA$$

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 VM7140 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.

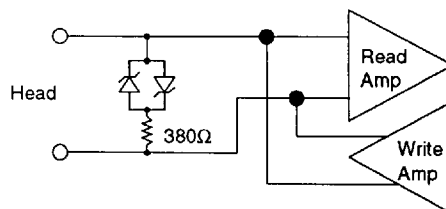
## Sleep Mode

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 VM7140 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:



## VM7140

Table 1: Head Select

| HS2 | HS1 | HS0 | HEAD |
|-----|-----|-----|------|
| 0   | 0   | 0   | 0    |
| 0   | 0   | 1   | 1    |
| 0   | 1   | 0   | 2    |
| 0   | 1   | 1   | 3    |

Table 2: Mode Select

| $\overline{CS}$ | $\overline{R/W}$ | 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, $\overline{WDI}$ | I*  | Write Data Input: PECL 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.

**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    |
|---------------------------------------------|--------------|-------------------------------|------|-----------------|-----|----------|
| WC Pin Voltage                              | $V_{WC}$     |                               |      | 2.5             |     | V        |
| $I_{WC}$ to Head Current Gain               | $A_I$        |                               |      | 20              |     | mA/mA    |
| Write Current Constant                      | $K_W$        | $K_W = (V_{WC})(A_I)$         | 46   | 50              | 54  | V        |
| Write Current Range                         | $I_W$        | $1.258K < R_{WC} < 60k\Omega$ | 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  $T_A = 25^\circ C$ .

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

| PARAMETER                                       | SYM      | CONDITIONS                      | MIN            | TYP<br>(Note 1) | MAX             | UNITS         |
|-------------------------------------------------|----------|---------------------------------|----------------|-----------------|-----------------|---------------|
| Supply Current                                  | $I_{CC}$ | Read Mode                       |                | $34 + .05 I_W$  | $51 + .05 I_W$  | mA            |
|                                                 |          | Write Mode                      |                | $44 + 1.05 I_W$ | $52 + 1.05 I_W$ |               |
|                                                 |          | Idle Mode                       |                | 0.6             | 3               |               |
| Power Dissipation                               | PD       | Read Mode, $I_W = 20\text{mA}$  |                | 165             | 286             | mW            |
|                                                 |          | Write Mode, $I_W = 20\text{mA}$ |                | 320             | 402             |               |
|                                                 |          | Idle Mode                       |                | 3               | 17              |               |
| Input High Voltage                              | $V_{IH}$ |                                 | 2              |                 | $V_{CC} + 0.3$  | V             |
| Input Low Voltage                               | $V_{IL}$ |                                 | -0.3           |                 | 0.8             | V             |
| WDI, $\overline{\text{WDI}}$ Input High Voltage | $V_{IH}$ | Psudeo ECL                      | $V_{CC} - 1.0$ |                 | $V_{CC} - 0.7$  | V             |
| WDI, $\overline{\text{WDI}}$ Input Low Voltage  | $V_{IL}$ | Psudeo ECL                      | $V_{CC} - 1.9$ |                 | $V_{CC} - 1.6$  | V             |
| Input High Current                              | $I_{IH}$ | $V_{IH} = 2.7\text{V}$          |                |                 | 80              | $\mu\text{A}$ |
| Input Low Current                               | $I_{IL}$ | $V_{IL} = 0.4\text{V}$          | -160           |                 |                 | $\mu\text{A}$ |
| WDI, $\overline{\text{WDI}}$ Input High Current | $I_{IH}$ |                                 |                |                 | 100             | $\mu\text{A}$ |
| WDI, $\overline{\text{WDI}}$ Input Low Current  | $I_{IL}$ |                                 |                |                 | 80              | $\mu\text{A}$ |
| WUS Output Low Voltage                          | $V_{OL}$ | $I_{OL} = 4.0\text{mA}$         |                | 0.35            | 0.5             | V             |
| WUS Output High Current                         | $I_{OH}$ | $V_{OH} = 5.0\text{V}$          |                | 13              | 100             | $\mu\text{A}$ |
| VCC Value for Write Current Turn Off            |          | $I_H < 0.2\text{mA}$            | 3.7            | 4.0             | 4.3             | V             |

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

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**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 Voltage Gain                           | AV               | $V_{IN} = 1\text{mVrms}$ , 1MHz; Note 2                | 120       | 150             | 180  | V/V                    |
| Bandwidth                                           | BW               | -1dB   $Z_s$   < 5 $\Omega$ , $V_{IN} = 1\text{mVp-p}$ | 40        | 55              |      | MHz                    |
|                                                     |                  | -3dB   $Z_s$   < 5 $\Omega$ , $V_{IN} = 1\text{mVp-p}$ | 65        | 85              |      |                        |
| Input Noise Voltage                                 | $e_{in}$         | BW = 17MHz, $L_H = 0$ , $R_H = 0$                      |           | 0.5             | 0.7  | nV/ $\sqrt{\text{Hz}}$ |
| Differential Input Capacitance                      | $C_{IN}$         | $V_{IN} = 1\text{mVp-p}$ , $f = 5\text{MHz}$           |           | 33              | 45   | pF                     |
| Differential Input Resistance                       | $R_{IN}$         | $V_{IN} = 1\text{mVp-p}$ , $f = 5\text{MHz}$           | 380       | 1000            |      | $\Omega$               |
| Dynamic Range                                       | DR               | AC input where $A_V$ is 90% of gain at 0.2mVrms input  | 2         | 5               |      | mVrms                  |
| Common Mode Rejection Ratio                         | CMRR             | $V_{IN} = 100\text{mVp-p}$ @ 5MHz                      | 50        | 70              |      | dB                     |
| Power Supply Rejection Ratio                        | PSRR             | 100mVp-p @ 5MHz on $V_{CC}$                            | 45        | 66              |      | dB                     |
| Channel Separation                                  | CS               | Unselected channel driven with 20mVp-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  $T_A = 25^\circ\text{C}$ .

Note 2:  $A_V$  is mask programmable for nominal values of: 150 and 300V/V.

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

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

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

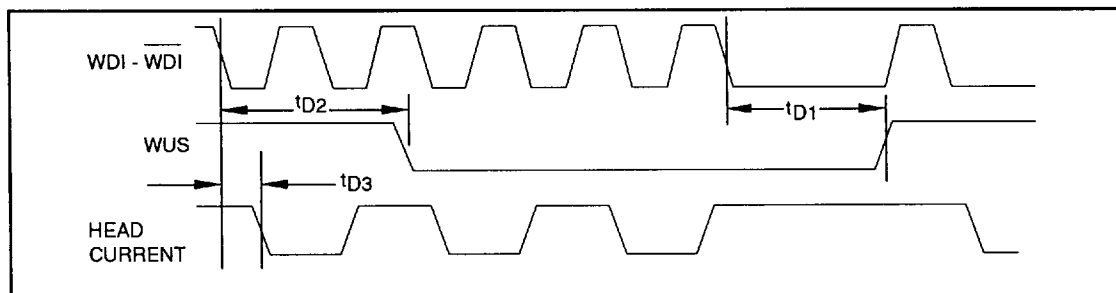


Figure 1: Write Mode Timing Diagram