VTC Inc.
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VM3700 Series

6-CHANNEL, CENTER-TAPPED FERRITE and MIG HEAD, READ/WRITE PREAMPLIFIER with SERVO WRITE

970801

ADVANCE INFORMATION

August,1997

FEATURES

- *General*
  - Designed for Use With Three-Terminal MIG Heads
  - Operates from a Single +5 Volt Power Supply
  - Power Up/Down Data Protect Circuitry
  - Very Low Power Dissipation (10 mW Typical in Idle Mode)
  - Reduced Write-to-Read Recovery Time
  - Head Inductance Range = 0.2 – 3.0 µH
  - Fault Detect Capability
  - Multi-channel Servo Write
  - Up to 6 Channels Available
- *High Performance Reader*
  - Read Gain = 420 V/V Typical
  - Input Noise = 0.75 nV/√Hz Typical
  - Input Capacitance = 4 pF Typical
  - Bandwidth (-3dB) = 110MHz Typical
- *High Speed Writer*
  - Write Current Range 10 - 22 mA
  - Rise Time < 2 ns Typical (10-90%, L_{total} = 1 µH, R_H = 30 Ω, I_W = 16 mA)
  - Differential PECL Write Data Inputs

DESCRIPTION

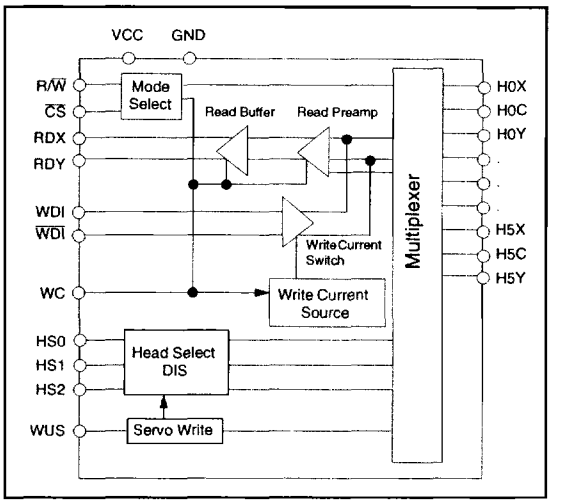
The VM3700 is a low-power, bipolar monolithic servo read/write preamplifier designed for use with three-terminal center-tapped ferrite or MIG recording heads.

It has PECL inputs for the write data. It provides write current control, data protection circuitry, and a low-noise read preamplifier. When unselected, the device enters a sleep mode, with power dissipation reduced to 10mW.

Fault protection is provided so that during power supply sequencing the write current generator is disabled. System write-to-read recovery time is minimized by maintaining the read channel common-mode output voltage in write mode.

In multi-channel servo write mode, three heads or all heads are written simultaneously. The servo mode is activated via the WUS line.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

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

Write Current I_W 30mA

Input Voltages:
- Digital Input Voltage V_{IN} ..... -0.3V to (V_{CC} + 0.3)VDC
- Head Port Voltage V_H ..... -0.3V to (V_{CC} + 0.3)VDC

Write Unsafe (WUS) ..... -0.3V to 6VDC

Output Current:
- RDX, RDY: I_O ..... -10mA
- WUS: I_{WUS} ..... +12mA

Storage Temperature Range ..... -65° to 150°C

RECOMMENDED OPERATING CONDITIONS

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

Write Current (I_W) ..... 10 to 22mA

Head Inductance (L_H) ..... 1 µH (typical)

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

3 - TERMINAL PREAMPS

CIRCUIT OPERATION

The VM3700 addresses up to six three-terminal heads, providing write drive or read amplification. The read function is done full coil (across HnX-HnY) and the write function is done half coil (across HnY-HnC).

Mode control and head selection are accomplished with pins $\overline{CS}$, R/$\overline{W}$ and WUS/SE, as shown in Tables 1 and 2. Internal pull-up resistors provided on pins $\overline{CS}$ and R/$\overline{W}$ will force the device into a non-writing condition if either control line is opened accidentally.

Write Mode

The write mode configures the VM3700 as a current switch. The write current polarity is defined by the levels of WDI/$\overline{WDI}$. For WDI > $\overline{WDI}$, current flows into the "C" port; for WDI < $\overline{WDI}$, current flows into the "Y" port.

The write current magnitude is determined by an external resistor connected between the WC pin and ground. An internally-generated 2.5V reference voltage is present at the WC pin. The magnitude of the write current is represented by the following equation:

$$I_W = \left(\frac{K_W}{R_{WC}}\right) + 0.2mA = \left(\frac{50}{R_{WC}}\right) + 0.2mA \qquad \textit{(eq. 1)}$$

(0-peak ±10%)

I_W represents the write current flowing to the selected head (in mA).
R_{WC} represents the equivalent resistance between the WC pin and ground (in kΩ).
K_W represents the product of the internally-generated reference voltage and the I_{WC}-to-head current gain of the preamp (2.5V and 20V/V respectively).

Power supply fault protection improves data security by disabling the write current generator during a voltage fault or power-up. Additionally, the write unsafe circuitry will flag any of the conditions below as a high level on the open collector output pin WUS:

- No write current
- WDI frequency too low
- Device in read, idle or servo write mode
- Open head (frequency < 10 MHz)
- Shorted head to ground (center-tap and channel Y)
- Low power supply voltage
- Invalid head selection

Two transitions on pin WDI, after the fault is corrected, may be required to clear the WUS flag.

Multi-Channel Servo Write Mode

In servo write mode, the operation is the same as described above except that three channels or all channels are written simultaneously. Servo mode is controlled using the WUS pin.

To initiate servo mode:

1. Bring R/$\overline{W}$ high (enter read mode).
2. Select the head bank (see Table 3).
3. Supply 10mA source current into the WUS pin (or bring V_{WUS} to V_{CC}+1.55).
4. Drop the R/$\overline{W}$ line low (enter servo mode).

To exit servo mode:

1. Bring R/$\overline{W}$ high (enter read mode).
2. Remove the 10mA source current into the WUS pin.

Read Mode

The read mode configures the VM3700 as a low-noise differential amplifier and deactivates the write current generator and write unsafe detection circuitry. The RDX and RDY outputs are emitter followers and are in phase with the "X" and "Y" head ports. These outputs should be AC-coupled to the load.

The RDX, RDY common-mode voltage is maintained in the write mode, minimizing the transient between the write mode and the read mode, thereby substantially reducing the recovery time delay to the subsequent pulse detection circuitry.

Idle Mode

When $\overline{CS}$ is high, virtually the entire circuit is shut down so that power dissipation is reduced to 10mW typical. In Idle mode, the reader outputs are high impedance. This allows multiple chip connection by simply wiring the reader outputs together.

Table 1: Mode Selection

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

** See "Multi-Channel Servo Write Mode" for additional detail.

Table 2: Head Selection

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	X	invalid

Table 3: Servo Mode Head Selection

HS2	HS1	HS0	HEADS
X	0	0	0,1,2
X	0	1	all
X	1	0	3,4,5
X	1	1	all

PIN DESCRIPTIONS

NAME	*I/O*	*DESCRIPTION*
HS0 - HS2	I*	Head Select: Selects one of six heads.
H0X - H5X H0Y - H5Y H0C - H5C	I/O	X, Y, and C Head Terminals
WDI, $\overline{WDI}$	I*	Write Data Inputs (PECL): Each transition on WDI toggles the direction of the head current.
$\overline{CS}$	I	Chip Select: High level signal puts chip in Idle mode; a low level awakens chip.
R/$\overline{W}$	I*	Read/Write select: A high level selects read mode. A low-level selects write mode.
WUS	O*	Write Unsafe: Open collector output. A high level indicates a write unsafe condition. **Note:** The WUS pin is also used to enter servo mode. See "Multi-Channel Servo Write Mode" on page 4.
WC		Write Current Adjust: A resistor adjusts the 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.

DC CHARACTERISTICS Recommended operating conditions apply unless otherwise specified.

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP*	*MAX*	*UNITS*
Power Supply Voltage	V_{CC}		4.5	5.0	5.5	V
VCC Supply Current	I_{CC}	Read Mode		$28 + 0.2I_W$	TBD	mA
		Write Mode, I_W = 10mA		$22 + 1.2I_W$	TBD	
		Write Mode, Servo (bank of 6 heads), I_W = 10mA		$100 + 8.6I_W$	TBD	
		Idle Mode		0.5	3	
Power Supply Power Dissipation	PD	Read Mode		150	TBD	mW
		Write Mode, I_W = 10mA		200	TBD	
		Write Mode, Servo (bank of 6 heads), I_W = 10mA		1100	TBD	
		Idle Mode		2.5	16.5	
DIGITAL TTL INPUTS: $\overline{CS}$, R/$\overline{W}$, HS						
Input High Voltage	V_{IH}		2		V_{CC} +0.3	V
Input Low Voltage	V_{IL}		-0.3		0.8	V
Input High Current	I_{IH}	V_{IH} = 2.7V			80	µA
Input Low Current	I_{IL}	V_{IL} = 0.4V	-160			µA
WDI INPUT						
WDI, $\overline{WDI}$ Input High Voltage	V_{IH}	Pseudo ECL	V_{CC} - 2.0		V_{CC}	V
WDI, $\overline{WDI}$ Input Low Voltage	V_{IL}	Pseudo ECL	V_{IH} - 1.0		V_{IH} - 0.1	V
WDI, $\overline{WDI}$ Input High Current	I_{IH}	$V_{IH} = V_{CC}$			100	µA
WDI, $\overline{WDI}$ Input Low Current	I_{IL}	$V_{IL} = V_{IH}$ - 0.1V			80	µA
WUS OUTPUT						
Low Voltage	V_{OL}	I_{OL} = 4.0mA		0.35	0.5	V
High Current	I_{OH}	V_{OH} = 5.0V		13	100	µA
POWER SUPPLY FAULT VOLTAGE						
VCC Value for Write Current Turn Off		I_W < 0.2mA	3.3	3.6	4.0	V
SERVO ENABLE						
WUS Servo Enable	I_{SE}		10	*	20	mA

* The typical value for servo activation is 6 mA. The minimum value at which servo activation is guaranteed is 10 mA.

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WRITE CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified; L_H = 1µH, R_H = 30Ω, I_W = 16mA, f_{DATA} = 5MHz.

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP*	*MAX*	*UNITS*
I_{WC} to Head Current Gain	A_I			20		mA/mA
Write Current Constant	K_W		46	50	54	V
Write Current Range	I_W	10kΩ > R_{WC} > 2kΩ	10		22	mA
Write Current Tolerance	ΔI_W	10mA < I_W < 22mA	-10		10	%
Write Current Pin Voltage	V_{WC}			2.5		V
Differential Head Voltage Swing	V_{DH}	open head		8		Vp-p
WDI Transition Frequency for Safe Condition	f_{DATA}	WUS = low	1			MHz
Differential Output Capacitance	C_{OUT}			5		pF
Differential Output Resistance	R_{OUT}		4.8			kΩ
Unselected Head Current	I_{UH}				0.2	mA(pk)
RDX, RDY Common Mode Output Voltage	V_{CM}			V_{CC} - 2.7		V
SERVO						
Write Current Matching Between Channels	Δ_{IW}		-14		14	%

READ CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified; C_L (RDX, RDY) < 20pF, R_L (RDX, RDY) = 1kΩ.

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP*	*MAX*	*UNITS*
Differential Voltage Gain	A_V	V_{IN} = 1mVp-p, @5MHz		420		V/V
Bandwidth (-3 dB)	BW	-3dB |Zs| < 5V, V_{IN} = 1mVp-p	90	110		MHz
Dynamic Range	DR	AC Input voltage where A_V falls to 90% of gain @ V_{IN} = 1Vp-p, f = 5MHz	2			mVrms
Input Voltage Noise	e_{in}	1 < f < 40 MHz, L_H = 0, R_H = 0		0.75		nV/√Hz
Input Current Noise	i_{in}			TBD		pA/√Hz
Differential Input Capacitance	C_{IN}	V_{IN} = 1mVp-p, 5 < f < 80 MHz		4		pF
Differential Input Resistance	R_{IN}	V_{IN} = 1mVp-p, 5 < f < 80 MHz		2000		Ω
Common Mode Rejection Ratio	CMRR	V_{IN} = 100mVp-p @ 5MHz	50			dB
Power Supply Rejection Ratio	PSRR	100mVp-p @ 5MHz on V_{CC}	65			dB
Channel Separation	CS	Unselected channels: V_{IN} = 100mVp-p @ 5MHz	45			dB
Output Offset Voltage	V_{OS}		-250		250	mV
RDX, RDY Common Mode Output Voltage	V_{OCM}	Read/Write Mode		V_{CC} - 2.7		
Read to Write Common Mode Output Voltage	ΔV_{OCM}	100mVp-p @ 5MHz on V_{CC}	-350		+350	mV
Single-Ended Output Resistance	R_{SEO}	f = 5 MHz			50	Ω
Output Load Current	I_{OUT}	AC coupled load, RDX to RDY		3.0		mA

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SWITCHING CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified; I_W = 16mA, f_{DATA} = 5MHz, L_H = 1µH, R_H = 30Ω.

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP*	*MAX*	*UNITS*
Read-to-Write Switching	t_{RW}	R/$\overline{W}$ to 90% of Write Output Envelope		30	100	ns
Write-to-Read Switching Delay	t_{WR}	R/$\overline{W}$ to 90% of 100mVp-p 10MHz RDX, RDY Envelope			200	ns
Idle-to-Write Switching	t_{IW}	$\overline{CS}$ to 90% of I_W			0.6	µs
Read-to-Idle Switching Delay	t_{RI}	$\overline{CS}$ to 10% of RDX, RDY Envelope			0.6	µs
Head Select Switching Delay	t_{HS}	HS Transition to 90% of 100mVp-p 10MHz RDX, RDY Envelope from Selected Head			0.6	µs
Write Unsafe Delay Safe-to Unsafe	t_{D1}		0.6		3.0	µs
Write Unsafe Delay Unsafe-to-Safe	t_{D2}				0.6	µs
Head Current Propagation Delay	t_{D3}	L_H = 0, R_H = 0 (from 50% points)		5		ns
Head Current Asymmetry	A_{SYM}	WDI has 50% duty cycle and 1ns rise/fall time; L_H = 0, R_H = 0			0.5	ns
Head Current Rise/Fall Time	t_r/t_f	10% to 90% points, L_H = 0, R_H = 0		1	3	ns
		10% to 90% points		2	TBD	

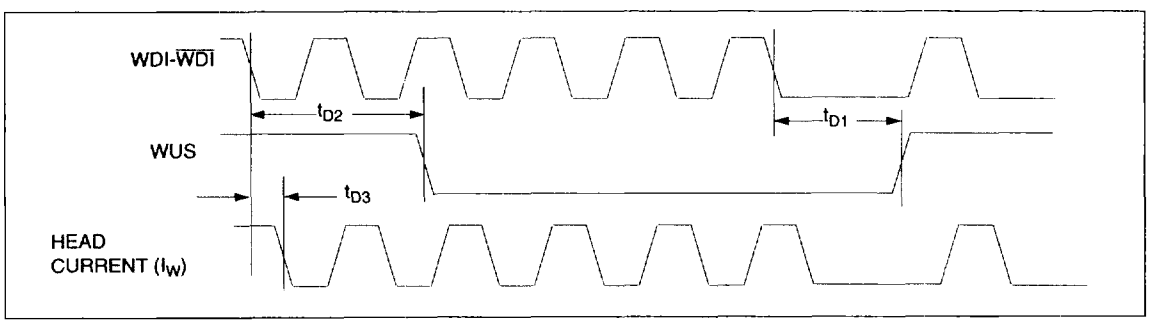

Figure 1: Write Mode Timing Diagram