VTC Inc.
Value The Customer™

V10615

10-CHANNEL, MAGNETO-RESISTIVE HEAD, READ/WRITE PREAMPLIFIER with SERVO WRITE CAPABILITY

980603 June 3, 1998

FEATURES

- *General*
  - Designed for Use With Four-Terminal MR Heads
  - Operates from +5 and -3 Volt Power Supplies
  - Fault Detect Capability
- *High Performance Reader*
  - Current Bias / Voltage Sense Configuration
  - MR Bias Current Range 8 - 15 mA
  - Read Voltage Gain = 200 V/V Typical
  - Input Noise = 0.60 nV/√Hz Typical
  - Input Capacitance = 16 pF Typical
  - Head Inductance Range = 100 nH to 600 nH
  - Fast Thermal Asperity Recovery Mode
- *High Speed Writer*
  - Write Current Range = 20 - 40 mA
  - Rise Time = 2.0 ns Typical (L_H = 220 nH, I_W = 30 mA)
  - Multi-Channel Servo Write
  - Optional WDFF as a bondable option

DESCRIPTION

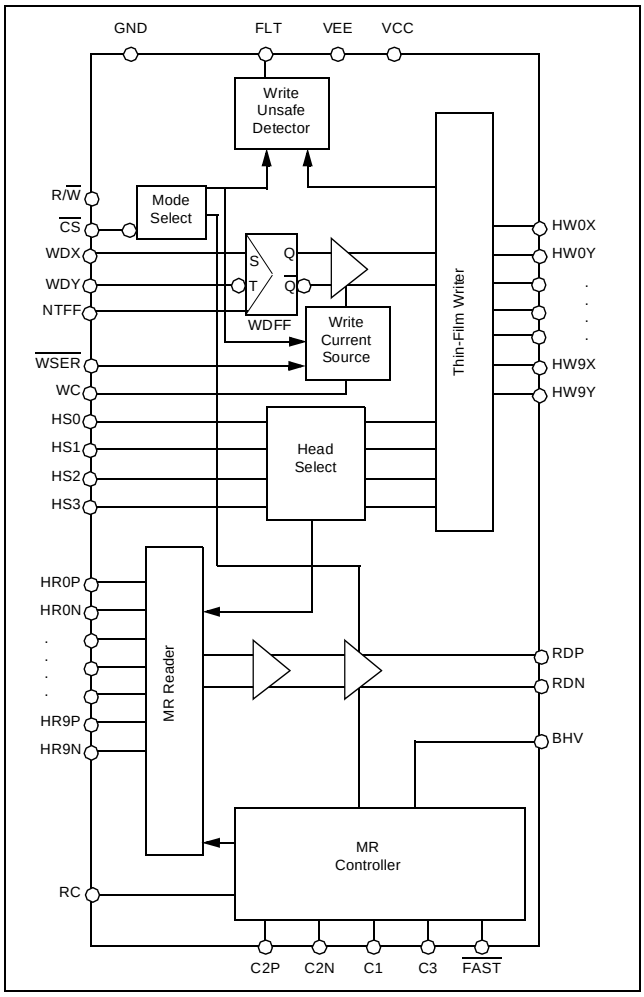
The V10615 is an integrated bipolar read/write preamplifier designed for use in high-performance hard disk drive applications using 4-terminal magneto-resistive (MR) recording heads. It provides bias current and control loops for setting the DC voltages on the MR element. The V10615 also provides a servo write feature, enabling the user to write servo information directly through the preamplifier.

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 transients. 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. Internal pull-up resistors are also provided on the $\overline{FAST}$ pin (to disable the fast thermal recovery mode) and the $\overline{WSER}$ pin (to ensure non-servo mode).

The V10615 operates from +5V, -3V 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 V10615 is available in die form for chip-on-flex applications. Please consult VTC for details.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Power Supply:
- V_{EE} ..... +0.3V to -5V
- V_{CC} ..... -0.3V to +7V

Write Current I_W 60mA

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

RECOMMENDED OPERATING CONDITIONS

Power Supply Voltage:
V_{EE} ..... -3V ± 10%
V_{CC} ..... +5V ± 10%
Junction Temperature (T_J) ..... 10°C to 125°C

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 bias generator, input multiplexer, read preamp and read fault detection circuitry is active.

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 V10615 uses the current bias / voltage sensing MR design. The MR bias current amplitude is determined by an external resistor or an external current source and is described by the following equation:

$$I_{MR} = \frac{40}{R_{RC}} \qquad \textit{(eq. 1)}$$

I_{MR} represents the magnitude of the bias current (in mA).
R_{RC} represents the equivalent resistance between the RC pin and ground (in kΩ).

Due to the use of a negative supply, the MR head center voltage is at ground potential minimizing current spikes during disk contact.

Fast Mode

Applying a TTL low level to the $\overline{FAST}$ pin enables the fast recovery mode. In fast mode, the first stage current is increased by a factor of three to reduce the recovery delay from a thermal asperity.

Fault Detection

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

- MR bias current too high (1.5 times its programmed value)
- Low power supply voltage

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 write unsafe detect circuitry is activated.

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 activate the write unsafe detect circuitry.

The write current magnitude is determined either by an external resistor or an external current source and is defined by the following equation:

$$I_W = \frac{39}{R_{WC} \times \left(1 + \frac{R_H}{R_D}\right)} \qquad \textit{(eq. 2)}$$

I_W represents the magnitude of the write current (in mA).
R_{WC} represents the equivalent resistance between the WC pin and ground (in kΩ).
R_H represents the series resistance of the head (in kΩ).
R_D represents the internal damping resistance (in kΩ).

Write data pseudo-ECL signals on the WDX and WDY lines drive the current switch of the thin film writer either directly or via the optional internal flip-flop.

Note: The flip-flop is enabled when the NTFF pad is connected to ground (a wire-bond option).

Fault Detection

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

- WDI frequency too low
- Open write head
- Write Head short to ground
- No write current programmed

In addition to triggering a fault the following conditions will result in the shutdown of the write current source internal to the chip:

- Low power supply voltage
- Invalid head select code
- Non-write mode

Servo Write Mode

Low TTL levels on $\overline{WSER}$, $\overline{CS}$ and R/$\overline{W}$ place the chip in servo write mode.

In servo mode, five channels of the V10615 are written simultaneously. Pin $\overline{WSER}$ controls the servo mode and pin HS0 controls which five heads are simultaneously written. See Table 2 for servo head selection description.

Note: When writing multiple heads, there is a limit to the write current duty cycle that can be used without approaching the maximum junction temperature. This maximum duty cycle is contingent on package type, number of heads selected, write current, heatsinking and airflow. DC erase using multiple heads will exceed the maximum allowable power dissipation.

Table 1 Mode Select

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

Table 2 Servo Mode Head Select

HS0	*DESCRIPTION*
0	Heads 0, 1, 2, 3, and 4
1	Heads 5, 6, 7, 8, and 9

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Table 3 Head Select

HS3	*HS2*	*HS1*	*HS0*	*HEAD*
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	X	DUMMY[1]
1	1	X	X	DUMMY[1]

1. All other HS combinations select an internal dummy head.

Table 4 Pin Function List and Description

Signal	*I/O*[1]	*Description*
BHV	O[2]	Buffered MR Head Voltage output.
C1		Noise bypass capacitor input for the MR bias current source.
C2P, C2N		Reader AC-coupling capacitor.
C3		Compensation capacitor for the MR head current loop.
$\overline{CS}$	I	Chip select: A TTL low level enables the device. The default is high (disabled).
$\overline{FAST}$	I[2]	Fast Mode: A TTL low level enables the fast thermal recovery mode. The default is high (disabled).
FLT	O[2]	Write/Read Fault: TTL high level indicates a fault in write mode. A low level indicates a fault in read mode.
GND	-	Ground
HR0N-HR9N	I	MR head connections, negative end.
HR0P-HR9P	I	MR head connections, positive end.
HS0-HS3	I[2]	Head Select: Selects one of the ten heads.
HW0X-HW9X	O	Thin-Film write head connections, positive end.
HW0Y-HW9Y	O	Thin-Film write head connections, negative end
NTFF		The write data flip-flop is enabled when this pad is connected to ground.
R/$\overline{W}$	I[2]	Read/Write: A TTL high level enables read mode. The default is high (read mode).
RC	[2]	MR bias current reference pin: Sets the magnitude of MR bias current.
RDP, RDN	O[2]	Read Data: Differential read signal outputs.
VCC	-	+5.0V supply
VEE	-	-3.0V supply
WC	[2]	Write current reference pin: Sets the magnitude of write current.
WDX, WDY	I[2]	Write Data Inputs: Differential Pseudo-ECL.
$\overline{WSER}$	I[2]	Write Servo: A TTL low level enables servo mode. The default is high (non-servo).

1. I=Input pin, O=Output pin.
2. When more than one device is used, these signals can be wire-OR'ed together.

STATIC (DC) CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. I_{MR} = 13mA, I_w = 30mA.

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP*	*MAX*	*UNITS*
V_{CC} Power Supply Current	I_{CC}	Read Mode		75	88	mA
		Write Mode		133	150	
		Idle Mode		4.5	5	
		Fast Mode		98	118	
		Servo Mode, I_W = 20mA		290	325	
V_{EE} Power Supply Current	I_{EE}	Read Mode		51	61	mA
		Write Mode		101	115	
		Idle Mode		1.15	1.5	
		Fast Mode		71	86	
		Servo Mode, I_W = 20mA		230	265	
Power Supply Dissipation	P_d	Read Mode		528	686	mW
		Write Mode		1065	1205	
		Idle Mode		26	33	
		Fast Mode		703	933	
		Servo Mode, I_W = 20mA		2354	2662	
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_{CC} - 1.9		V_{CC} - 1.6	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 Current	I_{OH}	FLT: V_{OH} = 5.0V			50	µA
Output Low Voltage	V_{OL}	FLT: I_{OL} = 4mA			0.6	V
V_{CC} Fault Threshold	V_{CTH}	V_{EE} = -3.0V	3.6	3.8	4.0	V
V_{EE} Fault Threshold	V_{ETH}	V_{CC} = 5.0V	-2.3	-2.1	-1.9	V

READ CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. I_{MR} = 13mA, R_{MR} = 22Ω, L_{MR} = 80nH.

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP*	*MAX*	*UNITS*
MR Head Current Range	I_{MR}		8		15	mA
MR Head Current Tolerance	I_{MR}	8 < I_{MR} < 15 mA	-5		+5	%
Unselected MR Head Current					100	µA
MR Bias Reference Voltage	V_{RC}	2667 < R_{RC} < 4000 Ω	1.9	2.0	2.1	V
IRC to MR Bias Current Gain	A_{IMR}	2667 < R_{RC} < 4000 Ω		20		mA/mA
Differential Voltage Gain	A_V	V_{IN} = 2mV_{pp} @ 5 MHz, R_L(RDP, RDN) = 10kΩ	140	200	260	V/V
		Fast Mode	110	185	260	
Passband Upper Frequency Limit	f_{HR}	-1dB, Dependent on C2 parasitics	50	55		MHz
		Fast Mode	50	55		
		-3dB, Dependent on C2 parasitics	90	95		
		Fast Mode	80	85		
Passband Lower -3dB Frequency Limit	f_{LR}		0.1		0.8	MHz
Equivalent Input Noise	e_n	5 < f < 20 MHz		0.60	0.75	nV/$\sqrt{Hz}$
Differential Input Capacitance	C_{IN}			16	20	pF
		Fast Mode		20	25	
Differential Input Resistance	R_{IN}		1200	2100		Ω
		Fast Mode	600	1000		
Dynamic Range	DR	AC input V where A_V falls to 90% of its value at V_{IN} = 2mV_{pp} @ f = 5 MHz	8	20		mV_{pp}
Common Mode Rejection Ratio	CMRR	V_{CM} = 100mVpp, f=10MHz	45	60		dB
Power Supply Rejection Ratio	PSRR	100mV_{pp} on VCC or VEE, f=10MHz	40	45		dB
Channel Separation	CS	Unselected Channels: V_{IN} = 100mV_{pp}, f=10MHz	45	50		dB
Output Offset Voltage	V_{OS}		-150		150	mV
Common Mode Output Voltage	V_{OCM}	Read Mode	V_{CC} - 3.7	V_{CC} - 3.2	V_{CC} - 2.7	V
Common Mode Output Voltage Difference	ΔV_{OCM}	V_{OCM} (READ) - V_{OCM} (WRITE)	-250	50	250	mV
Single-Ended Output Resistance	R_{SEO}	Read Mode		30	50	Ω
Output Current	I_O	AC Coupled Load, RDP to RDN	-1.5		+1.5	mA

READ CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. I_{MR} = 13mA, R_{MR} = 22Ω, L_{MR} = 80nH.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
MR Head-to-Disk Contact Current	I_{DISK}	Extended Contact, R_{DISK}=10MΩ			100	µA
		Maximum Peak Discharge, C_{DISK}=300pF, R_{DISK}=10MΩ			1	mA
MR Head Potential, Selected Head	V_{MR}		-350		350	mV
Buffered Head Voltage Error	BHV	$(I_{MR} \bullet R_{MR})$ - BHV	-10		+10	mV

WRITE CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. I_W = 30mA, L_H = 220nH, R_H = 15Ω, f_{DATA} = 5MHz.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
WC Pin Voltage	V_{WC}		1.9	2.0	2.1	V
I_{WC} to Write Current Gain	A_I			20		mA/mA
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, I_W = 40mA, V_{CC} = 4.5V, V_{EE} = -2.7V	7.0	8.0		V_{pp}
Unselected Head Transition Current	I_{UH}				50	μA_{pk}
Differential Output Capacitance	C_O				6	pF
Differential Output Resistance	R_O	(with internal damping resistor)	3760	4700	5640	Ω
Open Head Detect Frequency	f_{OHD}	Open Head		[1]	17	MHz
Open Head Detect Resistance	R_{OHD}	I_W = 40mA, V_{CC} = 4.6V		[2]	26	Ω
Write Data Freq. for Safe Condition	f_{DATA}	FLT low, < 5kΩ pullup	1.4			MHz

1. Open Head Detection is guaranteed up to a frequency of 17MHz and typically operates to 20MHz.
2. Open Head Detection is guaranteed up to a head resistance of 26Ω and typically operates to 35Ω.

SWITCHING CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. I_W = 30mA, L_H = 220nH, R_H = 15Ω, f_{DATA} = 5MHz.

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
Read to Write Mode	t_{RW}	To 90% of write current		0.1	0.15	µs
Write to Read Mode	t_{WR}	To 90% of envelope and ±20mV of steady-state offset		1.4	2.0	µs
Idle to Read Mode	t_{CS}	To 90% of envelope and ±20mV of steady-state offset		13	20	µs
HS0-3 to Any Head	t_{HS}	To 90% of envelope and ±20mV of steady-state offset		3	5	µs
Read to Idle	t_{RI}	To 10% of read envelope or write current		0.1	0.5	µs
Safe to Unsafe*	t_{D1}	50% WDX to 50% FLT, < 5kΩ pullup		0.7	1.5	µs

SWITCHING CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. I_W = 30mA, L_H = 220nH, R_H = 15Ω, f_{DATA} = 5MHz.

PARAMETER	*SYM*	*CONDITIONS*	*MIN*	*TYP*	*MAX*	*UNITS*
Unsafe to Safe[1]	t_{D2}	50% WDX to 50% FLT, < 5kΩ pullup		0.1	0.3	µs
Head Current Propagation Delay*	t_{D3}	From 50% points		12	15	ns
Asymmetry	A_{SYM}	Write Data has 50% duty cycle & 1ns rise/fall time, L_H=0, R_H=0		0.05	0.1	ns
Rise/Fall Time	t_r / t_f	20-80%		1.8	2.5	ns
		10-90%		2.5	3.5	

1. See Figures 1 and 2 for write mode timing diagrams.

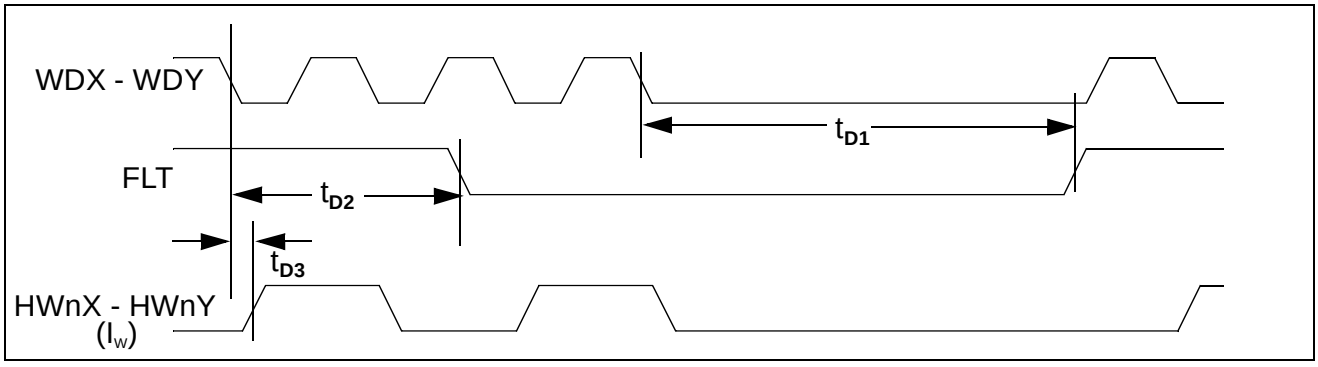


Figure 1 Write Mode Timing Diagram (with flip-flop active)

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.

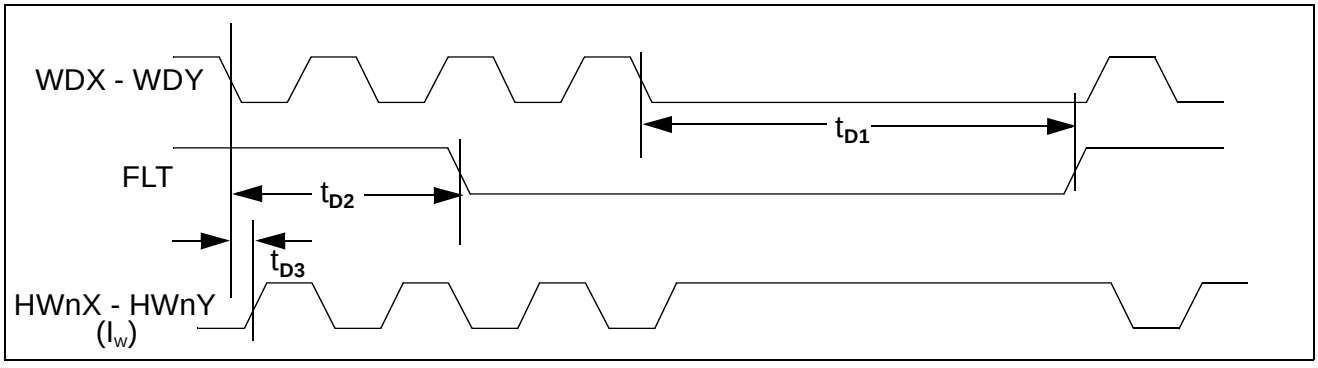
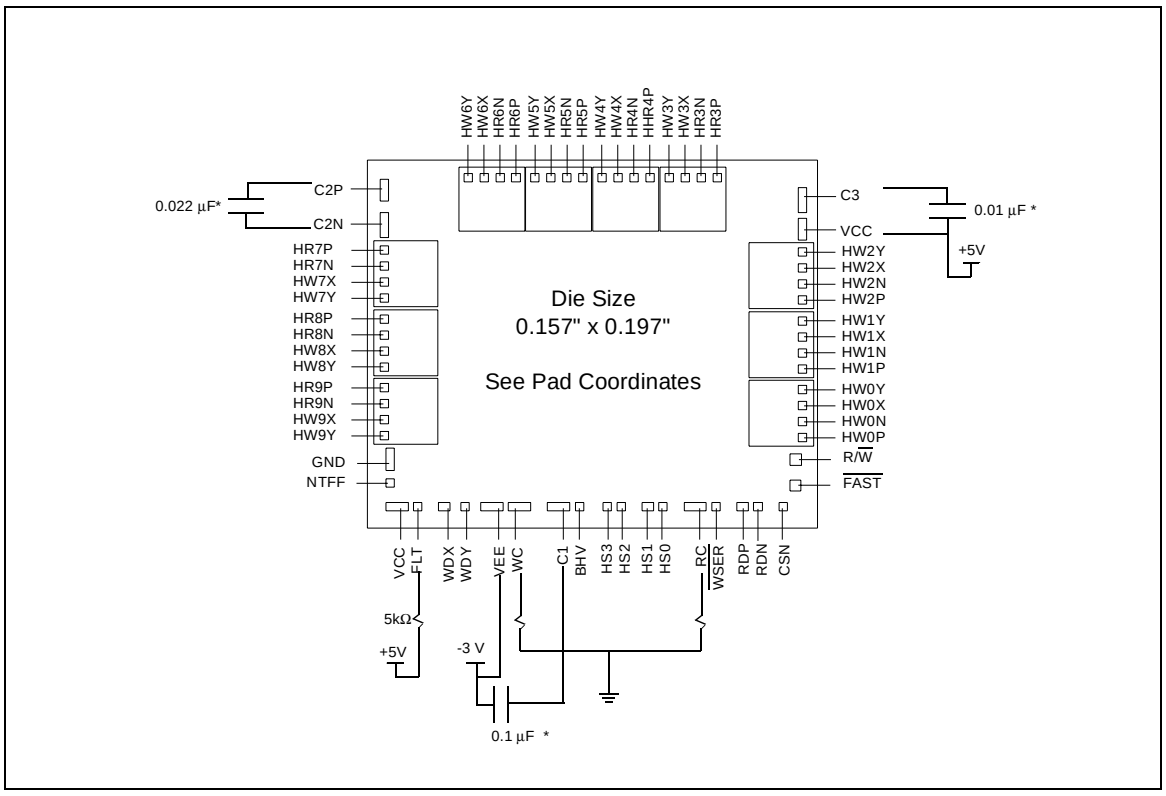


Figure 2 Write Mode Timing Diagram (without flip-flop)

Note: Without the flip-flop, 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.

TYPICAL APPLICATION CONNECTIONS



Application Notes

- V_{CC} = +5V, GND = Ground, V_{EE} = -3V
- Both VCC pads are electrically-connected on the die, but external connection is preferred for noise immunity.

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

V10615

10-CHANNEL DIE

Specific Characteristics

Die size: 192 X 191 Mils

Pad Coordinates for the V10615 (in Mils)

Pad Name	*X Axis*	*Y Axis*
BHV	- 140.0	-1727.75
C1	- 381.0	-1727.75
C2N	-2357.5	1341.75
C2P	-2357.5	1707.75
C3	2357.5	1607.75
$\overline{CS}$	2156.0	-1727.75
$\overline{FAST}$	2288.5	-1511.75
FLT	-1972.5	-1727.75
GND	-2288.0	-1210.25
GND	-1143.5	-1727.75
HR0N	2357.5	- 839.25
HR0P	2357.5	-1019.25
HR1N	2357.5	- 74.25
HR1P	2357.5	- 254.25
HR2N	2357.5	690.75
HR2P	2357.5	510.75
HR3N	1237.0	1852.75
HR3P	1417.0	1852.75
HR4N	472.0	1852.75
HR4P	652.0	1852.75
HR5N	- 292.0	1852.75
HR5P	- 112.0	1852.75
HR6N	-1057.0	1852.75
HR6P	- 877.0	1852.75
HR7N	-2357.5	920.75
HR7P	-2357.5	1100.75
HR8N	-2357.5	155.75
HR8P	-2357.5	335.75
HR9N	-2357.5	- 609.25
HR9P	-2357.5	- 429.25
HS0	785.0	-1727.75
HS1	619.0	-1727.75
HS2	322.5	-1727.75
HS3	156.5	-1727.75
HW0X	2357.5	- 659.25
HW0Y	2357.5	- 479.25
HW1X	2357.5	105.75
HW1Y	2357.5	285.75

Pad Name	*X Axis*	*Y Axis*
HW2X	2357.5	870.75
HW2Y	2357.5	1050.75
HW3X	1057.0	1852.75
HW3Y	877.0	1852.75
HW4X	292.0	1852.75
HW4Y	112.0	1852.75
HW5X	- 472.0	1852.75
HW5Y	- 652.0	1852.75
HW6X	-1237.0	1852.75
HW6Y	-1417.0	1852.75
HW7X	-2357.5	740.75
HW7Y	-2357.5	560.75
HW8X	-2357.5	- 24.25
HW8Y	-2357.5	- 204.25
HW9X	-2357.5	- 789.25
HW9Y	-2357.5	- 969.25
NTFF	-2288.5	-1451.25
$\overline{R/W}$	2288.5	-1215.25
RC	1156.5	-1727.75
RDN	1860.0	-1727.75
RDP	1694.0	-1727.75
VCC	-2213.5	-1727.75
VCC	2357.5	1291.75
WC	- 827.0	-1727.75
WDX	-1617.0	-1727.75
WDY	-1437.0	-1727.75
$\overline{WSER}$	1397.5	-1727.75

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