



# ML4532, ML4533, ML4536

## Servo Burst Area Detector

### GENERAL DESCRIPTION

The ML4532 and ML4533 Area Detectors are designed to minimize the pipeline transport delay while accurately quantizing the area of servo bursts in high-speed embedded servo systems. Combined with the ML2261 or ML2264 High Speed A/D Converters, the ML4532 and ML4533 are designed to capture back-to-back servo bursts in a 700ns or larger window. Power dissipation is minimized by the use of a digital power down pin which allows the area detector to be powered down between the servo sectors. The ML4536 is the ML4533 with different reference voltage levels.

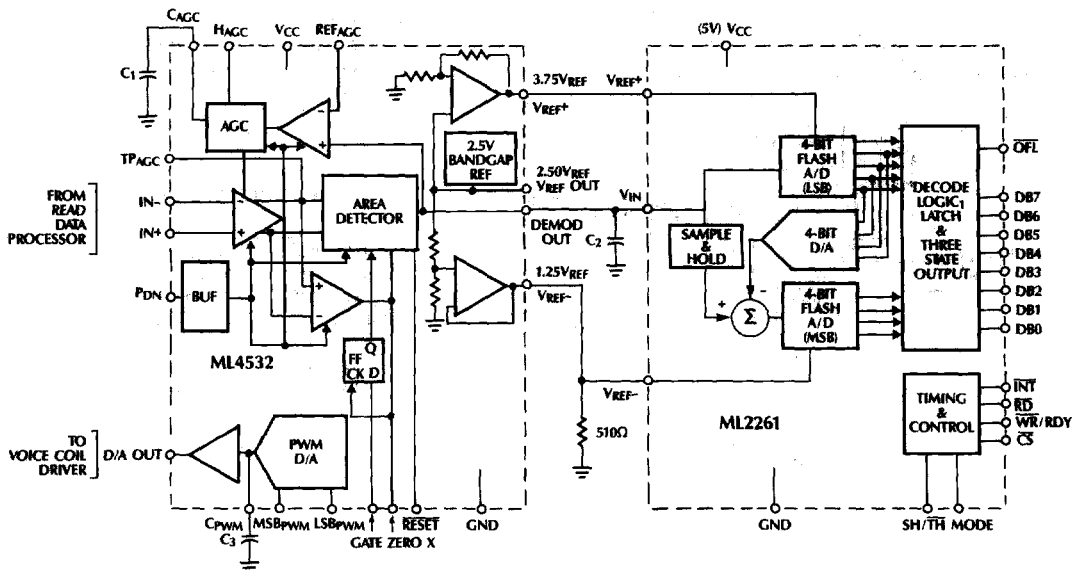
The ML4532 includes a PWM D/A for microprocessor control of the actuator driver, changing the REF<sub>AGC</sub> pin voltage during head change, or other system control functions.

FEATURES	ML4532	ML4533	ML4536
Package Options	20-Pin PCC or SSOP	16-Pin SOIC	16-Pin SOIC
Zero-Scale Ref. Output Voltage	1.25V	1.25V	1.0V
Full-Scale Ref. Output Voltage	3.75V	3.75V	3.4V
Reference Output Voltage	2.5V	2.5V	2.2V
PWM D/A Onboard	Yes	No	No

### FEATURES

- Allows for Area Detection of 1 $\mu$ s back-to-back bursts
- AGC amplifier for maintaining accuracy
- 0.2% nonlinearity between 25% and 75% of input signal range
- 2% nonlinearity over the input signal range
- Provides zero- and full-scale outputs for A/D converter
- 5V supply, at 29mA for ML4533/ML4536, 35mA for ML4532
- Digitally controlled power down for minimizing power between sectors
- Bandgap Reference output
- ML4532 includes PWM D/A for controlling voice coil driver or AGC during head change
- ML4533/ML4536 available in 16-pin SOIC package
- ML4532 available in 20-pin PCC or SSOP package
- Reference outputs defining the minimum and maximum demodulation output values

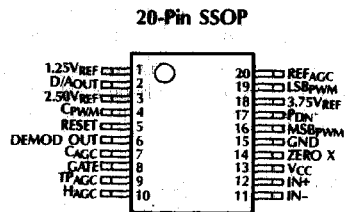
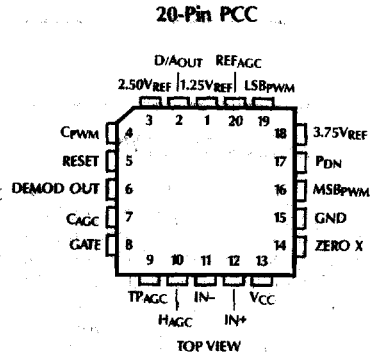
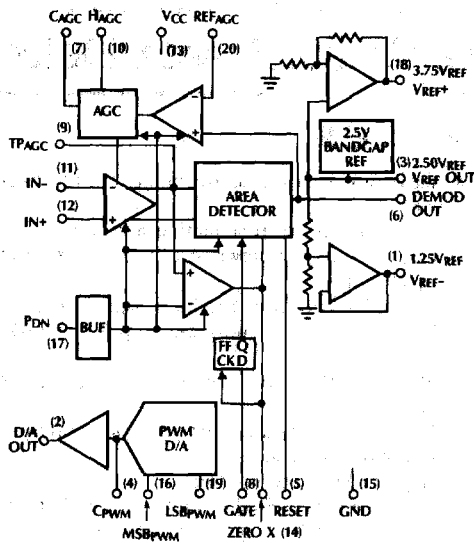
### TYPICAL APPLICATION



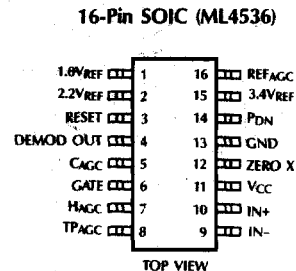
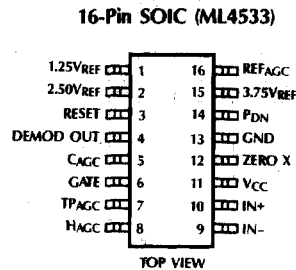
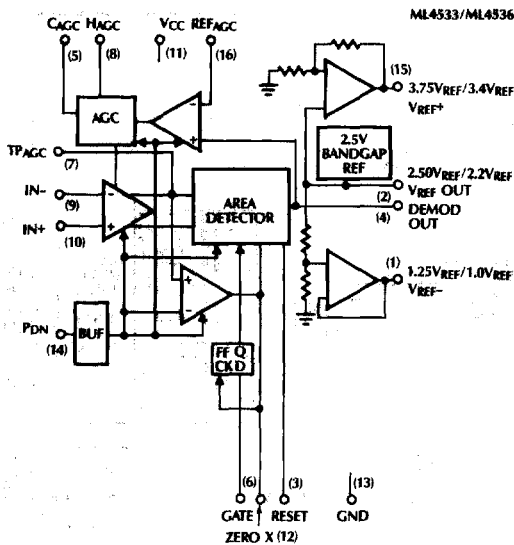
Typical HDD Digital Servo Application

# ML4532, ML4533, ML4536

## ML4532 BLOCK DIAGRAM AND PIN CONNECTION



## ML4533/ML4536 BLOCK DIAGRAM AND PIN CONNECTION



**PIN DESCRIPTION**

ML4533/ ML4532 ML4536			
PIN #	PIN #	NAME	DESCRIPTION
1	1	1.25V <sub>REF</sub> / 1.00V <sub>REF</sub>	Zero scale reference output.
2		D/A <sub>OUT</sub>	Analog output of PWM D/A.
3	2	2.50V <sub>REF</sub> / 2.20V <sub>REF</sub>	2.50 voltage reference output.
4		C <sub>PWM</sub>	PWM D/A smoothing capacitor.
5	3	RESET	Reset, active high.
6	4	DEM <sub>OD</sub> OUT	Area detector output.
7	5	C <sub>AGC</sub>	AGC capacitor.
8	6	GATE	Defines area detect window, active high.
9	7	TP <sub>AGC</sub>	Output test point for AGC.
10	8	H <sub>AGC</sub>	AGC hold input, AGC active when high; AGC constant when low.

ML4533/ ML4532 ML4536			
PIN #	PIN #	NAME	DESCRIPTION
11	9	IN-	Negative input.
12	10	IN+	Positive input.
13	11	V <sub>CC</sub>	5V power supply.
14	12	ZERO X	Zero detector crossing output.
15	13	GND	Ground.
16		MSB <sub>PWM</sub>	PWM D/A most significant bit input.
17	14	P <sub>DN</sub>	Power down control, reduces power if logic high.
18	15	3.75V <sub>REF</sub> / 3.40V <sub>REF</sub>	Full scale reference output.
19		LSB <sub>PWM</sub>	PWM D/A least significant bit input.
20	16	REF <sub>AGC</sub>	AGC voltage reference.

**ABSOLUTE MAXIMUM RATINGS**

(Note 1)

Power Supply Voltage, V <sub>CC</sub> .....	8V
Input Voltage .....	-0.3V to +8V
Storage Temperature .....	-65°C to +150°C
Package Dissipation at T <sub>A</sub> = 25°C (Board Mount)	
20-Pin PCC .....	875mW
20-Pin SSOP .....	750mW
16-Pin SOIC .....	750mW
Package Lead Temperature	
Soldering (10 sec) .....	260°C
Vapor Phase (60 sec) .....	215°C
Infrared (15 sec) .....	220°C

**OPERATING CONDITIONS**

Temperature Range .....	0 to +70°C
Supply Voltage (V <sub>CC</sub> ) .....	5V ± 5%
(I <sub>IN+</sub> ) - (I <sub>IN-</sub> ) .....	1V <sub>P-P</sub>
C <sub>AGC</sub> .....	100pF
REF <sub>AGC</sub> .....	2.5V
C <sub>PWM</sub> .....	.01μF
C <sub>H</sub> at DEMOD OUT .....	100pF

# ML4532, ML4533, ML4536

## ELECTRICAL CHARACTERISTICS

The following specifications apply over the recommended operating conditions of  $T_A = 0$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 4.75$  to  $5.25\text{V}$ , and external component values as recommended above, unless otherwise specified.

PARAMETER	NOTES	CONDITIONS	MIN	TYP (Note 2)	MAX	UNITS
<b>DEMODULATOR</b>						
Differential Input Range	3	For Full Scale Output	.25		2	$V_{P-P}$
Differential AGC Range	3		0.8		1.5	V/V
Differential Input Resistance				4		k $\Omega$
Differential Input Capacitance				5		pF
Common Mode Input Resistance				2		k $\Omega$
Power Supply RR				40		dB
Differential Nonlinearity	5, 3 5, 4	25% to 75% of Full Scale Zero to Full Scale		.2 2	2 5	% %
DEMODO OUT Offset Current		$V_{IN} = \pm 500\text{mV}$			20	$\mu\text{A}$
Maximum DEMODO OUT Charge Current	3	GATE = High	500			$\mu\text{A}$
DEMODO OUT Leakage Current	3	GATE = Low			+5	$\mu\text{A}$
DEMODO OUT Reset Voltage (ML4532/33) (ML4536)			1.15 0.9	1.25 1.0	1.35 1.1	V V
DEMODO OUT Reset Current		Discharge, RESET = High	2.0			mA
<b>AUTOMATIC GAIN CONTROL</b>						
AGC Dynamic Range	3		2.5			V/V
AGC Output Swing	3		1			V
$C_{ACC}$ Charging Current	3		150		250	$\mu\text{A}$
$C_{ACC}$ Discharging Current	3		150		250	$\mu\text{A}$
$C_{ACC}$ Leakage Current	3				5	$\mu\text{A}$
<b>VOLTAGE REFERENCES</b>						
1.25 $V_{REF}$ Output Voltage (ML4532/33)	3	$T_A = 25^\circ\text{C}$	1.20	1.25	1.30	V
3.75 $V_{REF}$ Output Voltage (ML4532/33)	3	$T_A = 25^\circ\text{C}$	3.60	3.75	3.90	V
2.50 $V_{REF}$ Output Voltage (ML4532/33)	3	$T_A = 25^\circ\text{C}$	2.40	2.50	2.60	V
1.0 $V_{REF}$ Output Voltage (ML4536)	3	$T_A = 25^\circ\text{C}$	0.95	1.0	1.05	V
3.4 $V_{REF}$ Output Voltage (ML4536)	3	$T_A = 25^\circ\text{C}$	3.2	3.4	3.6	V
2.2 $V_{REF}$ Output Voltage (ML4536)	3	$T_A = 25^\circ\text{C}$	2.05	2.2	2.35	V
Load Regulation	3	$0\text{mA} \leq I_{OUT} \leq 5\text{mA}$	-5		+5	mV/mA
Line Regulation			-30		+30	mV/V
<b>DIGITAL AND DC</b>						
Logical "0" Input Voltage	3				.8	V
Logical "1" Input Voltage	3		2.0			V
Logical "0" Input Current	3	$V_{IN} = 0.4\text{V}$			-1.5	mA
Logical "1" Input Current	3	$V_{IN} = 2.5\text{V}$			+100	$\mu\text{A}$
Logical "0" Output Voltage	3	ZERO X, $I_{OUT} = 1\text{mA}$			.5	V
Logical "1" Output Voltage	3	$I_{OUT} = -1\text{mA}$	3.0			V
Supply Current ML4532	3	$P_{DN} = \text{Low}$			45	mA
	3	$P_{DN} = \text{High}$		11	15	mA
ML4533/ML4536	3	$P_{DN} = \text{Low}$			38	mA
	3	$P_{DN} = \text{High}$		5	12	mA
Monotonicity	4		9	10		Bits
LSB to MSB Ratio	3		16.0	16.5	18.0	V/V

## ELECTRICAL CHARACTERISTICS (Continued)

The following specifications apply over the recommended operating conditions of  $T_A = 0$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 4.75$  to  $5.25\text{V}$ , and external component values as recommended above, unless otherwise specified.

PARAMETER	NOTES	CONDITIONS	MIN	TYP (Note 2)	MAX	UNITS
<b>D/A CONVERTER (ML4532 Only)</b>						
Output Voltage Swing	3	$R_L = 5\text{K}$	1.25		3.75	V
Logical "0" Input Voltage	3				.8	V
Logical "1" Input Voltage	3		2.0			V
Logical "0" Input Current	3	$V_{IL} = .4\text{V}$			-1	mA
Logical "1" Input Current	3	$V_{IH} = 2.5\text{V}$			300	$\mu\text{A}$
<b>DYNAMIC AND AC PARAMETERS (Figures 1 and 2)</b>						
$f_B$ , Burst Input Frequency	4		1		10	MHz
$t_{CS}$ , Gate Edge Setup Prior to Burst $\downarrow$ Zero Crossing	4, 6				30	ns
$t_{RESET}$ , Reset Pulse Width	4, 6	$C_H \leq 200\text{pF}$	300			ns
$t_{BZX}$ , Burst Zero Crossing to ZERO X Output	4, 6	$C_L = 50\text{pF}$			25	ns
$t_{PG}$ , Power Down $\downarrow$ to Gate $\uparrow$	4, 5			200	400	ns

**Note 1:** Absolute Maximum Ratings are limits beyond which the life of the integrated circuit may be impaired. All voltages unless otherwise specified are measured with respect to ground.

**Note 2:** Typicals are parametric norm at  $25^\circ\text{C}$ .

**Note 3:** Parameter guaranteed and 100% production tested.

**Note 4:** Parameter guaranteed. Parameters not 100% tested are not in outgoing quality level calculation.

**Note 5:** Linearity measured as a percentage of the midpoint between 25% to 75% of full scale.

**Note 6:** Timing measured at 1.4V.

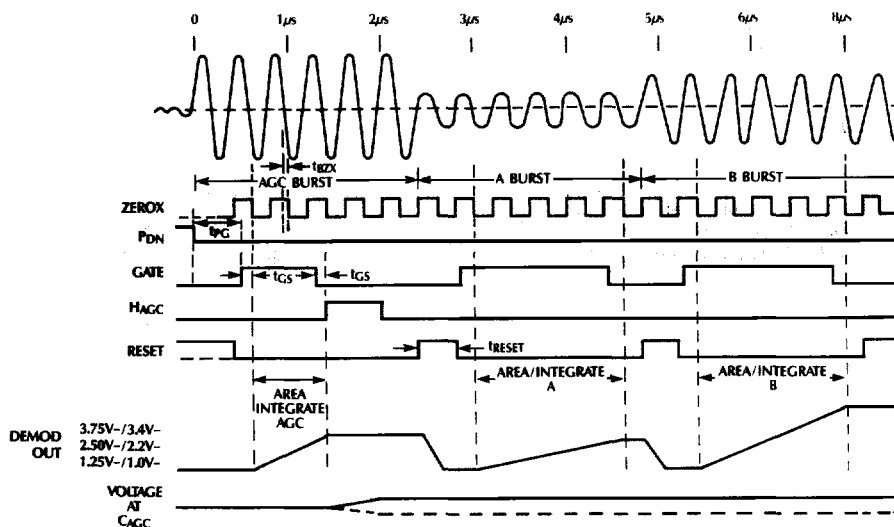


Figure 1. AGC Burst Timing

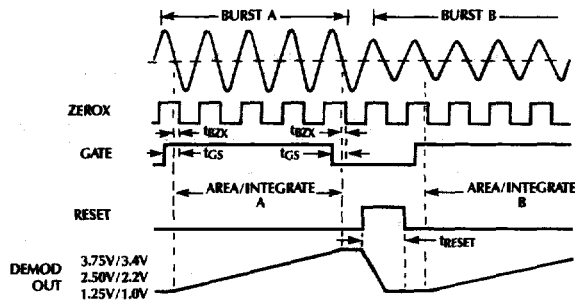


Figure 2. Burst Area Detect Timing

TYPICAL PERFORMANCE CURVES

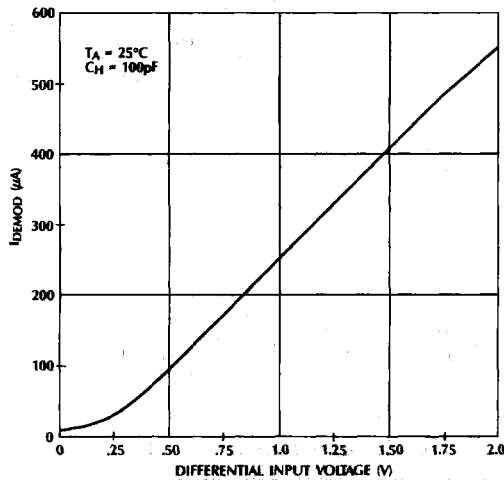


Figure 3. DEMOD Output Current vs. Input

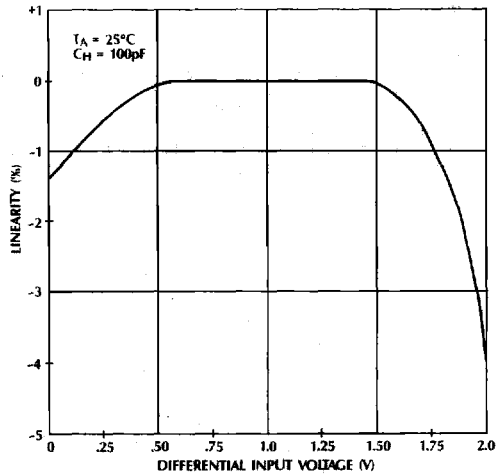


Figure 4. Linearity vs. Input

## 1.0 FUNCTIONAL DESCRIPTION

The ML4532, ML4533 and ML4536 are composed of an AGC amplifier, an area detector, and a band-gap reference with three buffered outputs. In addition the ML4532 (see Figure 5) includes a pulse width modulation D/A. The ML4536 is essentially the ML4533 with a different set of reference voltages.

### 1.1 INPUT AMPLIFIER AND AUTOMATIC GAIN CONTROL

The inputs of the ML4532, ML4533 and ML4536 are intended for use at the output of the read channel filter, accepting a  $0.25V_{P-P}$  to  $2V_{P-P}$  signal range. The input amplifier and AGC circuit of these area detectors operate in a differential signal mode to provide good common mode and power supply rejection. The purpose of the AGC loop is to maintain a constant area detect value that correlates to the zero scale ( $1.25V_{REF}/1.0V_{REF}$ ) and full scale ( $3.75V_{REF}/3.4V_{REF}$ ) output values based upon the minimum and maximum burst value. The sensing for the AGC is at the output of the area detector, allowing signal ranging based on the area of burst rather than the signal level of the burst. The AGC is intended to be updated at every sector of servo position bursts such that the signal variances due to platter radius and differences in read channel data frequencies can be corrected. The initial gain of the AGC circuit is established by the voltage applied to the  $REF_{AGC}$  input.

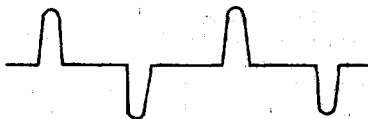
In this closed-loop system, the area detected output voltage is fed back and compared with the  $REF_{AGC}$  voltage in the  $G_M$  amplifier with a  $G_M$  of  $1/4000$  ohms, to provide a gain control current, charging and discharging  $C_{AGC}$ .

The AGC value is held constant by the hold function and is controlled by  $H_{AGC}$  pin. When  $H_{AGC}$  is at a logic high the level of gain can change up or down and is held at a constant gain with a logic low input.

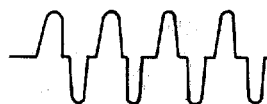
A capacitor from ground to the  $C_{AGC}$  pin holds the gain setting when  $H_{AGC}$  is at a logic low level and the area detector output does not affect the gain setting in this mode. See figure 1 for the AGC burst timing.

### 1.2 AREA DETECTOR

The area detector provides a measurement of servo burst area during a time window beginning at the first falling zero crossing edge after the GATE input is placed in a logic high state and ends at the first falling zero crossing edge after the GATE input is placed in a logic low state. The Zero crossing output enables the user to time the gate pulse by counting zero crossings. The analog input should be without open baseline by either keeping burst pulse spacing sufficiently close to avoid it or band limiting the signal. In most cases, both are necessary.



a. May clock anywhere and give multiple transitions, not acceptable.



b. Proper spacing.



c. Band limiting.

The value of the area measurement is held on the output hold capacitor ( $C_H$ ) until the RESET line is asserted. The RESET pin when placed in a logic high state for at least 300ns resets the area detector output to  $1.25V$  which is the zero scale reference point and equals the voltage value on the  $1.25V_{REF}$  pin. See Figure 2 for position area burst detection timing.

### ZERO X Detector Output

The output of the zero crossing detector (comparator) is provided for system synchronization. This signal is internally generated in ECL, but an internal ECL to TTL converter is provided to simplify external interfacing to this signal.

### 1.3 BANDGAP REFERENCE

A 2.5V bandgap reference is included on the ML4532 and ML4533 and a 2.2V one in the ML4536, to set up internal biasing and establish the on-track reference level. This is also a buffered output. Full-scale ( $V_{REF+}$ ) and zero scale ( $V_{REF-}$ ) outputs are derived and buffered from the bandgap to simplify the interface to A/D converters, such as the ML2261 or ML2264. The  $1.25V_{REF}$  pin is tied directly to the  $V_{REF-}$  pin of the A/D converter and with a  $510\Omega$  resistor to ground. The  $3.75V_{REF}$  pin is tied directly to the  $V_{REF+}$  pin of the high speed A/D converter. The ML4536 offers a  $1.0V_{REF}$  and  $3.4V_{REF}$  for interface with the A/D converter on the Zilog type microcontroller devices.



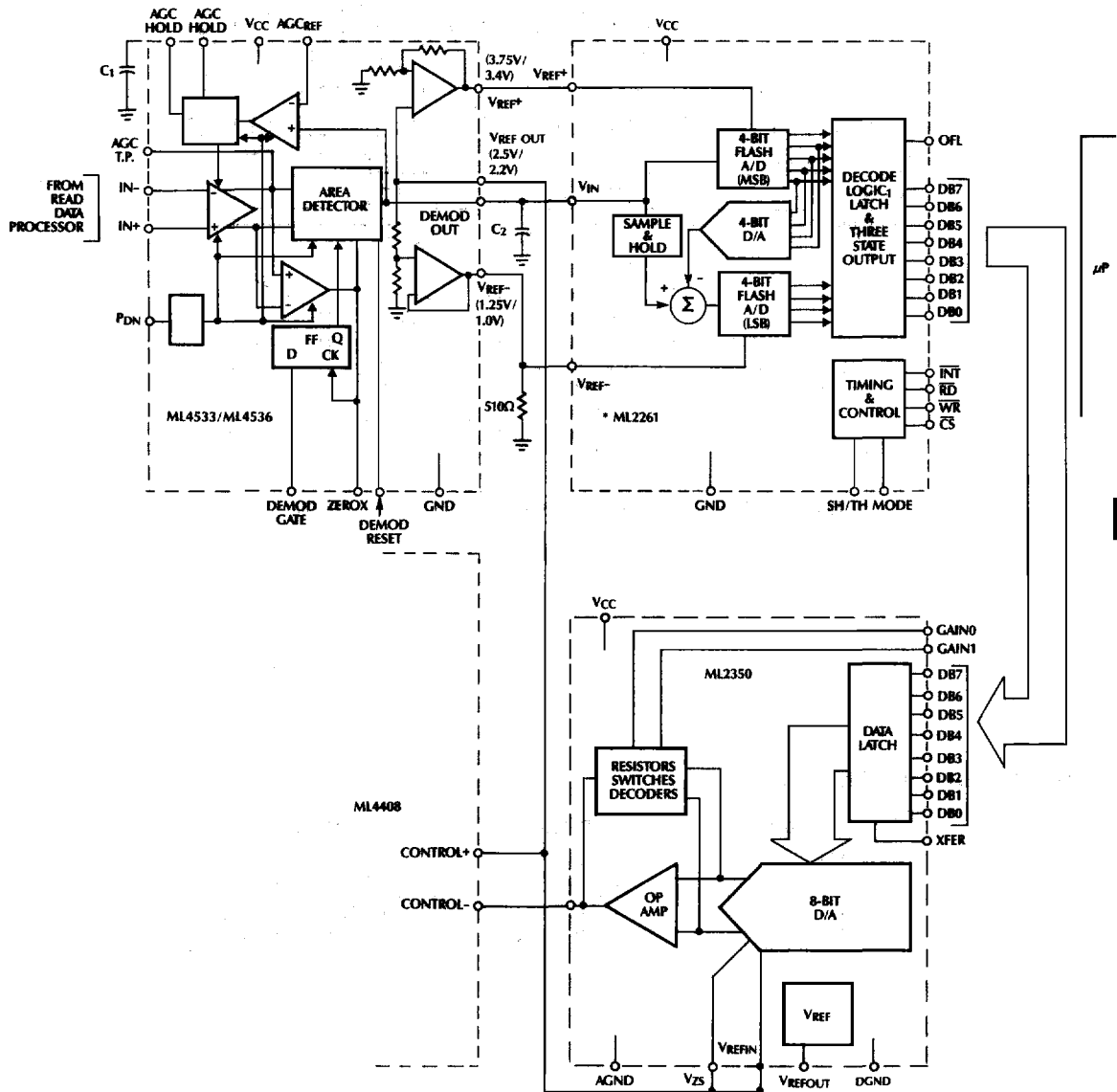


Figure 6. Typical Application ML4533/ML4536

# ML4532, ML4533, ML4536

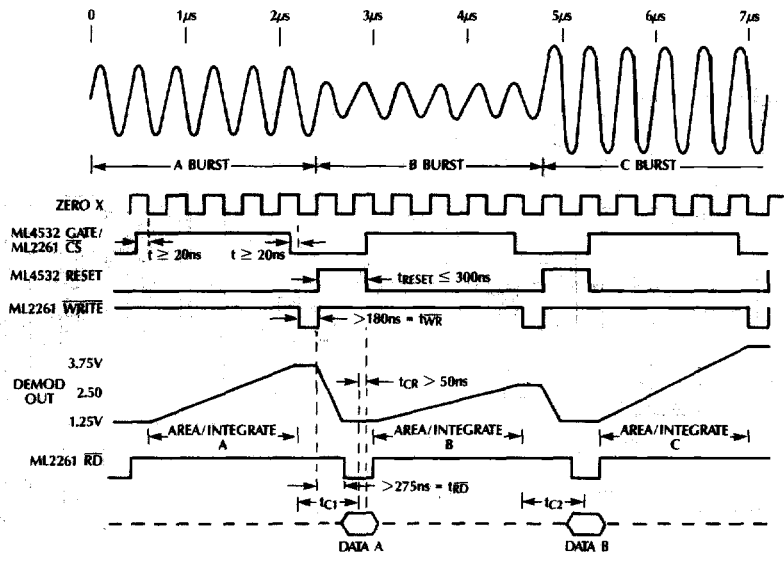


Figure 7. ML4532 Application Timing with ML2261 A/D Converter

## ORDERING INFORMATION

PART NUMBER	TEMP. RANGE	PACKAGE
ML4532CQ	0°C to +70°C	MOLDED PCC (Q20)
ML4532CR	0°C to +70°C	MOLDED SSOP (R20)
ML4533CS	0°C to +70°C	MOLDED SOIC (S16)
ML4536CS	0°C to +70°C	MOLDED SOIC (S16)