AM-542, AM-543
Programmable Gain Instrumentation Amplifiers

FEATURES

- 1 to 1024 Gains
- Digital gain selection
- 10^9 Ω Input impedance
- 6 Microseconds settling time, AM-543
- 1 Microvolt/°C offset drift, AM-542
- ±3 to ±18V dc Analog supply range, AM-542
- 6 mV Peak-to-peak output voltage noise, AM-543

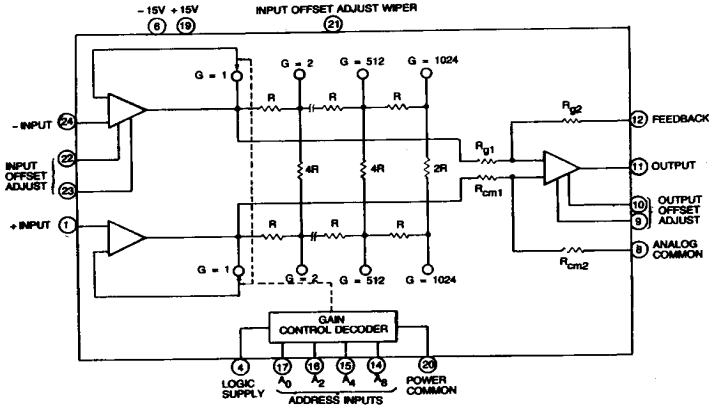
GENERAL DESCRIPTION

The AM-542 and AM-543 are high performance, digitally controlled, Progammable Gain Instrumentation Amplifiers. The AM-542 permits selection of gains from 1 to 1024 in 11 binary weighted steps, while the AM-543 permits selection of gains from 1 to 128 in 8 binary weighted steps. Gain selection is accomplished by the input of a 4-bit word. One version is optimized for low drift with extremely low noise and the other is optimized for fast settling. Use of these devices in data acquisition applications yields a system with wide dynamic range and high resolution.

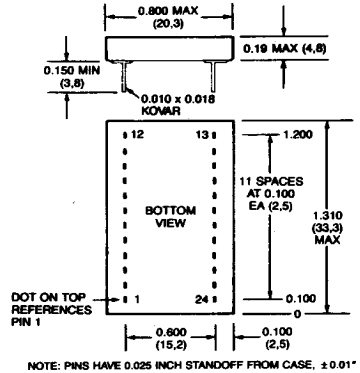
The AM-542 is optimized for low drift performance, having an input offset voltage drift specified at only 1 microvolt/°C, while the gain temperature coefficient is a maximum of only ±5 ppm/°C. Other specifications include an input impedance of 10^9 Ω, Common Mode Rejection of 90 dB minimum, and an output voltage range of ±10.5V dc minimum at 5 mA. The AM-542 operates from analog supply voltages from ±3V dc to ±18V dc with very low power dissipation.

The AM-543 is tailored for high speed applications; a 20V dc step settles to 0.01% in only 6 microseconds maximum at unity gain. These devices also feature a slew rate of 13V/microseconds, an input impedance of 10^{12}Ω, Common Mode Rejection of 80 dB minimum, and a gain temperature coefficient of ±10 ppm/°C maximum. The AM-543 operates with analog supply voltages from ±10V dc to ±16V dc.

Both devices are packaged in a compact, hermetically sealed 24-pin ceramic DIP and are available for operation over the 0°C to +70°C, −25°C to +85°C, and −55°C to +125°C temperature ranges.



MECHANICAL DIMENSIONS INCHES (MM)



NOTE: PINS HAVE 0.025 INCH STANDOFF FROM CASE, ±0.01"

INPUT/OUTPUT CONNECTIONS

PIN	FUNCTION
1	+INPUT
2	NC
3	NC
4	LOGIC SUPPLY
5	NC
6	−15V dc
7	NC
8	ANALOG COMMON
9	OUTPUT OFFSET ADJUST
10	OUTPUT OFFSET ADJUST
11	OUTPUT
12	FEEDBACK
13	NC
14	A_8
15	A_4
16	A_2
17	A_0
18	NC
19	+15V dc
20	POWER COMMON
21	INPUT OFF. ADJ. WIPER
22	INPUT OFFSET ADJUST
23	INPUT OFFSET ADJUST
24	−INPUT

ABSOLUTE MAXIMUM RATINGS	AM-542	AM-543
Positive Supply, Pin 10	+22V dc	+16V dc
Negative Supply, Pin 6	−22V dc	−16V dc
Input Voltage Range	±20V dc	±20V dc
No Damage	±VCC	±VCC

FUNCTIONAL SPECIFICATIONS

Typical at +25°C, ±15V dc and +5V dc supplies, unless otherwise noted.

INPUT CHARACTERISTICS	AM-542	AM-543
Input Offset Voltage, adjust to zero	±200 μV dc, max.	±200 μV dc
Input Bias Current, max.		
MC models	±50 nA	±50 pA
MR/MM models	±14 nA	±50 pA
Input Offset Current, max.		
MC models	±50 nA	±50 pA
MR/MM models	±14 nA	±50 pA
Input Impedance, Diff. Mode	$10^9\Omega$	$10^{12}\Omega$
Com. Mode	2 x $10^9\Omega$	$10^{12}\Omega$
Common Mode Volt. Range min.[1]	±11V dc	±10.25V dc
Digital Inputs, Logic 1, min.[2]	+2.4V dc at 2 μA	+2.4V dc at 2 μA
Digital Inputs, Logic 0, max.	+0.8V dc at 50 μA	+0.8V dc at 50 μA
OUTPUT CHARACTERISTICS		
Output Voltage Range, min.[3]	±10.5V dc	±11V dc
Output Current, min.	±5 mA	±1 mA
Output Offset Voltage, max.[4]	±1 mV dc	±12 mV dc
Output Voltage Noise, dc to 1 MHz, max.[5]	6 mV dc (P-P)	7 mV (P-P)
PERFORMANCE		
Gain Range	1 to 1024	1 to 128
Gain Accuracy, max.	±0.02%	±0.05%
Gain Nonlinearity, max.	0.005%	0.01%
Gain Temp. Coefficient, max.	±5 ppm/°C	±10 ppm/°C
Input Offset Temp. Drift,		
0 to +70°C	1 μV dc/°C	30 μV dc/G +30 μV dc/°C
+70°C to +85°C	5 μV dc/°C	35 μV dc/G +30 μV dc/°C
+85°C to +125°C	10 μV dc/°C	40 μV dc/G +30 μV dc/°C
Power Supply Reject. Ratio, min.	80 dB	80 dB
Input Current Noise, max.[6]	90 pA (P-P)	270 pA (P-P)
Common Mode Rejection Ratio,		
60 Hz, min.[9]	86 dB	86 dB
DC, min.[9]	90 dB	80 dB
Small Signal Bandwidth, (−3 dB)		
G = 1	500 kHz	7 MHz
G = 1024	500 Hz	—
Slew Rate	0.14V dc/μsec.	13V dc/μsec.
Settling Time, 20V dc to 0.01%, max.		
G = 1	150 μsec.	6 μsec.
G = 16	200 μsec.	10 μsec.
G = 64	400 μsec.	40 μsec.
G = 128	400 μsec.	100 μsec.
G = 256	700 μsec.	—
G = 512	1.4 msec.	—
G = 1024	2.8 msec.	—
POWER REQUIREMENTS		
Analog Supply, Rated Value	±15V dc at 20 mA, max.	±15V dc at 40 mA, max.
Analog Supply Range	±3V dc to ±18V dc	±10V dc to ±16V dc
Logic Supply	+3V dc to +18V dc at 5 nA max.	+3V dc to +18V dc at 5 nA max.

PHYSICAL/ENVIRONMENTAL	
Operating Temperature Range	
MC	0 to +70°C
MM[10]	−55 to +125°C
Storage Temperature Range	−65 to +150°C
Package Type	Hermetically sealed 24-Pin DIP

FOOTNOTES:

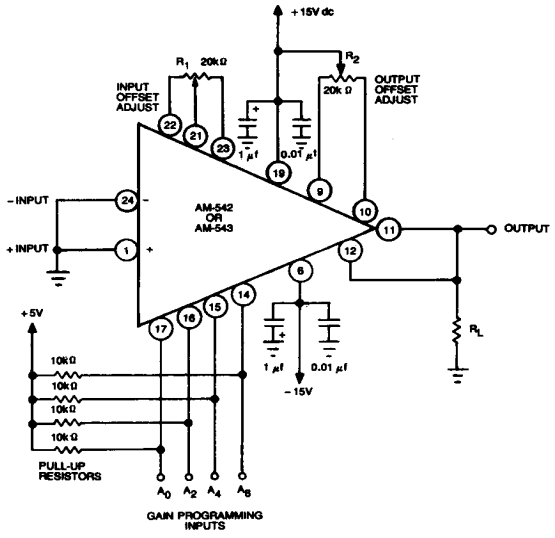
1. As with any three amplifier instrumentation amplifier configuration, the voltage at either input ± ½ the output voltage must not exceed ±12V dc (±11V dc — AM543) for linear operation.
2. Requires pull up resistor for TTL logic. Please refer to technical note 3.
3. AM-542, R_L = 2kΩ. AM-543, R_L = 10KΩ.
4. G = 1, adjustable to zero.
5. AM-542, R_S = 5kΩ, G = 1024. AM-543, R_S = 5kΩ, G = 128.
6. Maximum for AM-542MM/MR. Maximum for AM-542MC is ±0.05%.
7. Maximum for AM-542MM/MR. Maximum for AM-542MC is 0.01%.
8. DC to 1 kHz.
9. 1KΩ source imbalance, G = 2.
10. AM-542 only.

TECHNICAL NOTES

1. The AM-542 and AM-543 have an offset adjustment capability for each stage, input and output. The output trim should be sufficient to zero out offset errors on the lower gain ranges, adjustment should be made with a gain of 1 selected. For the higher gain ranges, the input offset zeroing circuit should be used to optimize accuracy. Adjustment of the input offset should be made with a gain of 1024 selected on the AM-542, and a gain of 128 selected for the AM-543.
2. Power supply inputs to the AM-542 and AM-543 are bypassed internally. However, for best performance both power supplies should be bypassed with 1 microfarad electrolytics in parallel with 0.01 microfarad ceramic capacitors as close as possible to the ± supply pins.
3. The digital inputs of the AM-542/543 are TTL/CMOS-compatible. However, when interfacing with TTL logic, it is recommended that 10 kΩ pull-up resistors be used. When interfacing with CMOS logic, the logic supply pin (pin 4) should be connected to the system logic supply.

CONNECTION AND APPLICATION

OFFSET ADJUSTMENT



The AM-542/543 are functionally laser trimmed to reduce initial offset voltage and offset voltage change due to gain change to a minimum level. However, for critical applications where zero offset is required, the following procedure can be followed to externally zero the offset.

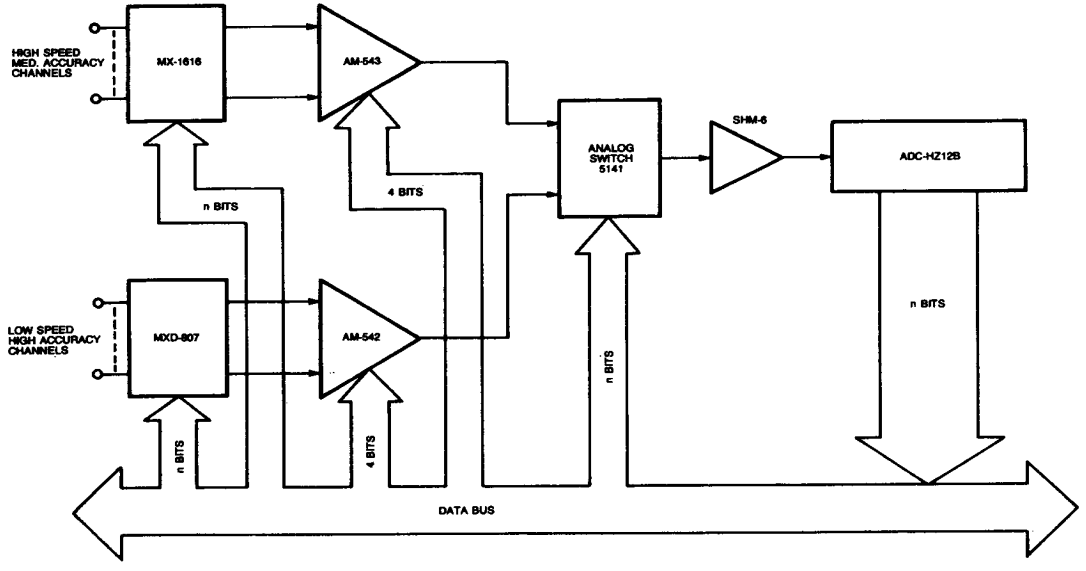
1. Allow the Amplifier to reach operating temperature.
2. Set R_1 and R_2 to mid-range.
3. Set gain to 1 V/V.
4. Adjust R_2 for zero output.
5. Set gain to 1024 (128-AM-543) V/V
6. Adjust R_1 for zero output.

This technique minimizes the offset voltage change over the maximum change in gain. Trimming may cause input offset temperature drift to increase slightly.

GAIN STATE TRUTH TABLE

DIGITAL INPUTS				GAIN	
A_1(PIN 14)	A_2(PIN 15)	A_4(PIN 16)	A_8(PIN 17)	AM-542	AM-543
0	0	0	0	1	1
0	0	0	1	2	2
0	0	1	0	4	4
0	0	1	1	8	8
0	1	0	0	16	16
0	1	0	1	32	32
0	1	1	0	64	64
0	1	1	1	128	128
1	0	0	0	256	—
1	0	0	1	512	—
1	0	1	0	1024	—

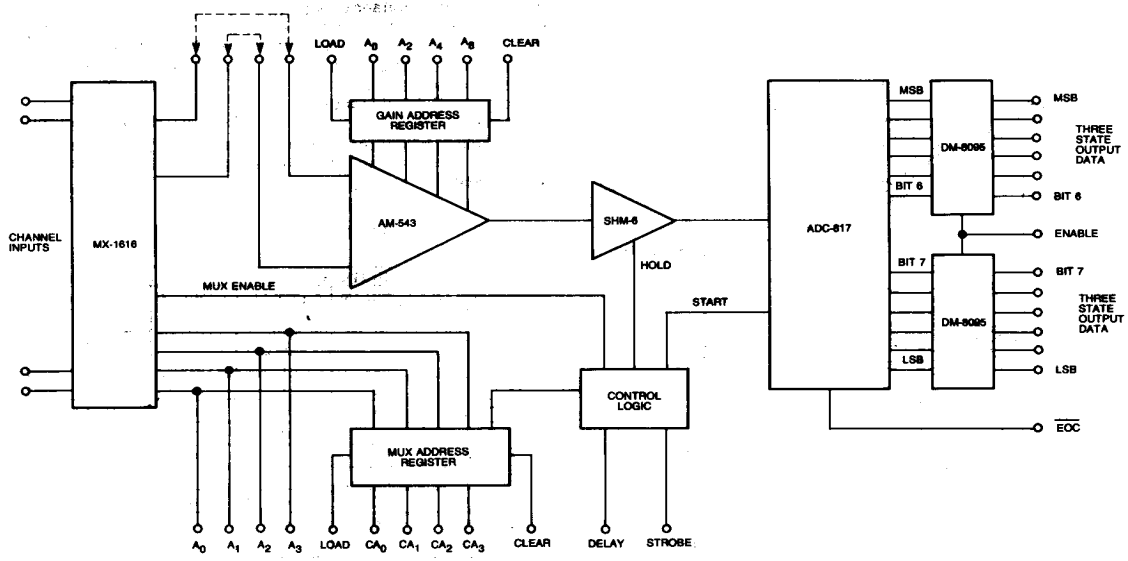
HIGH ACCURACY/HIGH SPEED DATA ACQUISITION SYSTEM



This diagram shows a system that uses the AM-542 with high gain, high accuracy, low-to-moderate speed transducers and the AM-543 with moderate gain, moderate-to-high speed transducers.

TYPICAL APPLICATIONS

HIGH SPEED DATA ACQUISITION SYSTEM

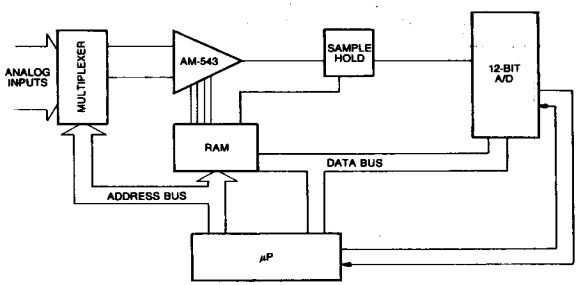


This diagram shows a high-speed data acquisition system with 8 differential inputs and 12-bit resolution using the AM-543. If the control logic is timed so that the Sample-Hold-ADC section is converting one analog value while the mux-amplifier section is allowed to settle to the next input value, throughput rates greater than 156 KHz can be achieved. The AM-543 is used with Datel's ADC-817, a 12-bit hybrid A/D with a 2 μsec conversion rate, the SHM-6, a 0.01%, 1 μsec hybrid Sample-Hold, and the MX-1616, a low cost, high-speed, monolithic analog multiplexer.

The system works as follows:

The μP selects a channel and initiates a conversion at G = 1 and then looks at the MSB of the conversion result. If the MSB = 1, the μP will store the value. If the MSB = 0, the μP will select G = 2. The μP will repeat the cycle of gain incrementing, comparison, and analog-to-digital conversion until the MSB = 1. The μP will then test for an output of all 1's, as this is the full-scale output of the A/D. If the output is all 1's, the μP will decrement the gain by 1 step and perform the final conversion.

MICROPROCESSOR BASED DATA ACQUISITION SYSTEM



A typical application of the AM-542/543 is in a microprocessor controlled data acquisition system. The microprocessor loads the RAM with the desired gain coding. This coding relates the selected gain ranges to a specific address. When the processor instructs the multiplexer to multiplex a particular analog input channel, this instruction is also received by the RAM, which puts out the appropriate gain code to the AM-542/543. This system allows acquisition of signals over a wide dynamic range at high resolution.

ORDERING INFORMATION

MODEL NO.	OPERATING TEMP. RANGE
AM-542MC	0°C to +70°C
AM-542MM	−55°C to +125°C
AM-543MC	0°C to +70°C

For military devices compliant to MIL-STD-883, consult DATEL.