



Air Conditioning Compressor Component Level Noise and Vibration Evaluation Procedure

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. Define the method of quantifying Air Conditioning (A/C) compressor operating Noise and Vibration (N&V) related emission at a component level. This includes: radiated sound power, discharge line pressure pulsation, suction line pressure pulsation, compressor vibration level and clutch activation noise.

1.2 Applicability. This test procedure is appropriate for all engine belt driven A/C compressor devices used in vehicles to condition and cool air in the passenger compartment.

1.3 Remarks. These factors correlate to vehicle compressor noise in the passenger compartment.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ANSI S1.11	DIN 45652	ISO 3744	JIS Z8733
ANSI S12.34	IEC 61260	ISO 3745	
ANSI S12.35	IEC 651	JIS Z8732	

2.2 GM Standards/Specifications.

GMW14172	GMW14181
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2.3 Additional References.

- Isolators (optional): R2/RD2 (gray) series neoprene mountings produced by VMC-Korfund are typically used to isolate the compressor. Information for these isolators should be available online.
- Subsystem Technical Specification (SSTS)

3 Resources

3.1 Facilities. Semi-anechoic test cell meeting requirements defined in ISO 3745 or ISO 3744 standards.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Compressor Tachometer. An instrument grade tachometer signal probe, such as an optical tachometer pickup, capable of providing a 1 pulse per revolution signal is required.

3.2.2 Microphone Array. Microphone and array requirements are defined in ISO 3744 and ISO 3745 sound power standards. The preferred hemispherical array contains 19 microphones at a 1 m radius over a reflecting plane as defined in Figures 1 and 2.

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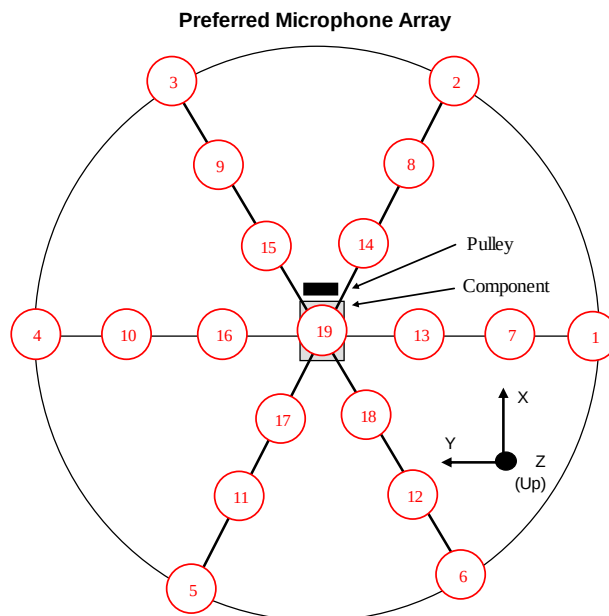


Figure 1: Preferred Test Stand Microphone Array

Microphone Position	X/r	Y/r	Z/r
1	0.00	-0.99	0.15
2	0.86	-0.50	0.15
3	0.86	0.50	0.15
4	0.00	0.99	0.15
5	-0.86	0.50	0.15
6	-0.86	-0.50	0.15
7	0.00	-0.89	0.45
8	0.77	-0.45	0.45
9	0.77	0.45	0.45
10	0.00	0.89	0.45
11	-0.77	0.45	0.45
12	-0.77	-0.45	0.45
13	0.00	-0.66	0.75
14	0.57	-0.33	0.75
15	0.57	0.33	0.75
16	0.00	0.66	0.75
17	-0.57	0.33	0.75
18	-0.57	-0.33	0.75
19	0.00	0.00	1.00

Figure 2: Preferred Microphone Array Coordinates

3.2.3 Accelerometers. Triaxial accelerometers with low sensitivity (1 mV/[m/s²] nominal), a flat frequency response between 2 Hz and 2000 Hz and a temperature range between 10 °C and 120 °C shall be used.

3.2.4 Pressure Transducers. Pressure transducers with a flat frequency response between 5 Hz and 1200 Hz, a measurement range exceeding 1500 kPa and a temperature range exceeding 0 °C to 135 °C shall be used.

3.2.5 Direct Current (DC) Power Supply and 12 V Battery. A variable DC power supply with sufficient power to provide 13.5 V to the Pulse Width Modulation (PWM) controller and compressor clutch when engaged is required. The suggested minimum output requirements are 15 V and 15 A.

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3.2.6 PWM Controller. A device capable of variable frequency and duty cycle of PWM signal to the compressor such as the Model 205 PWM Controller from Applied Processor and Measurement, Inc. is required for compressors that use PWM control, such as External Variable Displacement Compressors (EVDC).

3.2.7 Data Acquisition Equipment. Multi-channel data acquisition hardware capable of calculating frequency domain results between 0 Hz and 11.25 kHz, with a frequency resolution between 2 Hz and 4 Hz and a minimum dynamic range of 80 dB is required.

At a minimum, a single channel of data acquisition hardware with at least 16 bit quantization at a sample rate of 48 kHz is required for clutch engagement noise.

This hardware shall meet class 1 accuracy corresponding to IEC 651 or be equivalent for the application (precision ± 0.7 dB or $\pm 8\%$).

3.2.8 A/C Load Cart. A device capable of controlling the A/C system load applied to the compressor.

3.2.9 Sound Quality Analysis Software. Artemis sound quality analysis program by Head Acoustics, or an equivalent analysis program is required. All equivalent programs must be correlated to Artemis results.

3.3 Test Vehicle/Test Piece. One (1) compressor representing the design under test is required.

3.4 Test Time.

Calendar time:	2 to 4 days
Test hours:	8 to 20 hours
Processing Time	6 to 10 hours
Coordination hours:	2 hours

3.5 Test Required Information. The compressor supplier must provide the maximum clutch air gap specification.

3.6 Personnel/Skills. One (1) qualified engineer or technician trained in the use of acoustic data acquisition and recording equipment, and having basic knowledge of digital signal processing.

In addition, knowledge of Heating, Ventilation, Air Conditioning (HVAC) charging systems and operation of the motor/controller used to drive the compressor is required.

4 Procedure

4.1 Preparation.

4.1.1 Compressor Mounting. Proper orientation of the A/C compressor is critical to its performance. Check with the customer, or manufacturer, prior to the installation of a new compressor.

Use GM qualified or approved dynamometer mounting bracket that has three (3) rubber isolators (see 2.3) to mount the compressor to the test stand, as shown in Figures 3 and 4. Install compressor to the bracket utilizing the component attachments bosses whenever possible. The mounting system must provide:

4.1.1.1 All compressor rigid body mounting frequencies below 300 Hz. Confirm resonant frequencies of the mounting system with an impact Frequency Response Function (FRF) test, referencing GMW14181.

4.1.1.2 Ability to level the component to achieve the correct angle and drive belt tension when driven. An angle of approximately 1 degree above horizontal when not rotating should result in a level component when driven.

The GM allowable pulley axial misalignment is $\frac{1}{2}$ degree total (looking at the plane of the belt between pulleys). This misalignment is the total allowed including all misalignment contributors. (Example: a 470 mm belt span using the $\frac{1}{2}$ degree specification allows a total of 4.1 mm misalignment.)

4.1.1.3 Ability to minimize belt noise and belt joint bump at all operating speeds.

4.1.1.4 Optionally, the compressor fixture may be mounted directly to the test stand without rubber isolators (see 2.3). However, this may cause additional unwanted noise to be introduced to the system.

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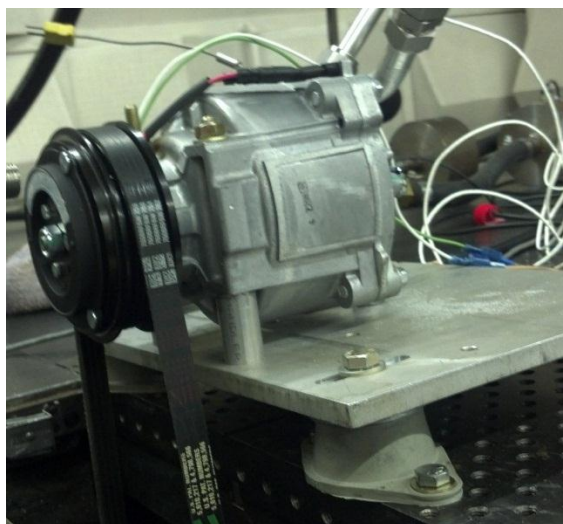


Figure 3: Example of Compressor Mounting

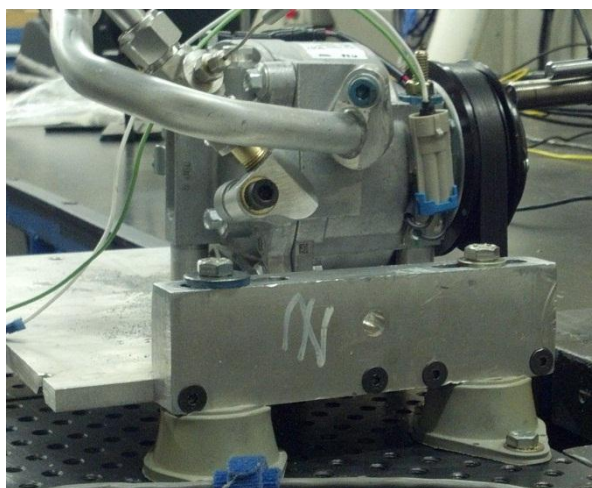


Figure 4: Example of Compressor Mounting

4.1.2 Compressor Control Setup. Set up the following devices to monitor and measure:

4.1.2.1 Pressure transducer to monitor compressor discharge pressure.

4.1.2.2 Pressure transducer to monitor compressor suction pressure.

4.1.2.3 Install an instrument grade tachometer signal probe, such as an optical tachometer pickup, providing a 1 pulse per revolution signal to measure compressor rotational speed.

4.1.2.4 For EVDC, connect PWM controller to DC power supply and to the compressor control valve as shown in Figure 5.

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