

TEST RESULT SUMMARY

FCC PART 15 SUBPART C Section 15.245

MANUFACTURER'S NAME	General Motors Corp - Electro-Motive Division
NAME OF EQUIPMENT	Transmitter for Locomotive Speed Sensor
MODEL NUMBER	40081692
MANUFACTURER'S ADDRESS	9301 W 55th Street La Grange IL 60525
TEST REPORT NUMBER	W8580
TEST DATE	05 January 1999

According to testing performed at TÜV Product Service Inc, the above-mentioned unit is in compliance with the electromagnetic compatibility requirements defined in FCC Part 15.

It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical characteristics. Any modifications necessary for compliance made during testing on the above mentioned date(s) must be implemented in all production units for compliance to be maintained.

TÜV Product Service Inc, as an independent testing laboratory, declares that the equipment tested as specified above conforms to the requirements of FCC Part 15.

Date: 11 February 1999

Location: Taylors Falls MN
USA

Greg S. Jakubowski
G. S. Jakubowski by TKS
Test Engineer

Joel T. Schneider
J.T. Schneider
Site Manager

Not Transferable

EMC EMISSION - TEST REPORT

Test Report File No. : **W011858001** Date of issue: 11 February 1999

Model / Serial No. : **40081692 / s/n Engineering 2**

Product Type : Transmitter for Locomotive Speed Sensor

Applicant : General Motors Corp - Electro-Motive Division

Manufacturer : General Motors Corp - Electro-Motive Division

License holder : General Motors Corp - Electro-Motive Division

Address : 9301 W 55th Street
: La Grange IL 60525

Test Result : ☒ **Positive** ☐ **Negative**

Test Project Number :
Reference(s) : **W8580**

Total pages including
Appendices : **21**

TÜV Product Service Inc is a subcontractor to TÜV Product Service, GmbH according to the principles outlined in ISO/IEC Guide 25 and EN 45001.

TÜV Product Service Inc reports apply only to the specific samples tested under stated test conditions. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. TÜV Product Service Inc shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV Product Service Inc issued reports.

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DIRECTORY - EMISSIONS

		Page(s)
A) Documentation		
Test report		<u>1 - 10</u>
Directory		<u>2</u>
Test Regulations		<u>3</u>
Deviation from standard / Summary		<u>10</u>
Test-setups (Photos)		<u>11 - 12</u>
Test-setup (drawing)		<u>Appendix A</u>
B) Test data		
Conducted emissions	10/150 kHz - 30 MHz	<u>5, 9</u>
Radiated emissions	10 kHz - 30 MHz	<u>5, 9</u>
Radiated emissions	30 MHz - 1000 MHz	<u>6, 9</u>
Interference power	30 MHz - 300 MHz	<u>6, 9</u>
Equivalent Radiated emissions	1 GHz - 18 GHz	<u>7, 9</u>
C) Appendix A		
Test Data Sheets and Test Setup Drawing(s)		<u>A2 -A5</u>
D) Appendix B		
Constructional Data Form		<u>B2</u>
Product Information Form(s)		<u>B3 - B4</u>
E) Appendix C		
Measurement Protocol		<u>C1 - C2</u>

EMISSIONS TEST REGULATIONS :

The emissions tests were performed according to following regulations:

- | | | |
|---|---|------------------------------------|
| ☐ - EN 50081-1 / 1991 | ☐ - Group 1 | ☐ - Group 2 |
| ☐ - EN 55011 / 1991 | ☐ - Class A | ☐ - Class B |
| ☐ - EN 55013 / 1990 | ☐ - Household appliances and similar | |
| ☐ - EN 55014 / 1987 | ☐ - Portable tools | |
| | ☐ - Semiconductor devices | |
| ☐ - EN 55014 / A2:1990 | ☐ - Household appliances and similar | |
| ☐ - EN 55014 / 1993 | ☐ - Portable tools | |
| | ☐ - Semiconductor devices | |
| ☐ - EN 55015 / 1987 | | |
| ☐ - EN 55015 / A1:1990 | | |
| ☐ - EN 55015 / 1993 | | |
| ☐ - EN 55022 / 1987 | ☐ - Class A | ☐ - Class B |
| ☐ - EN 55022 / 1994 | ☐ - Class A | ☐ - Class B |
| ☐ - BS | | |
| ☐ - VCCI | ☐ - Class A | ☐ - Class B |
| ■ - FCC Part 15 Subpart C Section 15.245 | | |
| ☐ - AS 3548 (1992) | ☐ - Class A | ☐ - Class B |
| ☐ - CISPR 11 (1990) | ☐ - Group 1 | ☐ - Group 2 |
| | ☐ - Class A | ☐ - Class B |
| ☐ - CISPR 22 (1993) | ☐ - Class A | ☐ - Class B |

Environmental conditions in the lab:

	<u>Actual</u>
Temperature	: 21 °C
Relative Humidity	: 18 %
Atmospheric pressure	: 98.6 kPa
Power supply system	: 15 VDC

Sign Explanations:

- ☐ - not applicable
☒ - applicable

Emissions Test Conditions: CONDUCTED EMISSIONS (Interference Voltage)

The *CONDUCTED EMISSIONS (INTERFERENCE VOLTAGE)* measurements were performed at the following test location:

☒ - Test not applicable

- ☐ - Wild River Lab Large Test Site (Open Area Test Site)
- ☐ - Wild River Lab Small Test Site (Open Area Test Site)
- ☐ - Oakwood Lab (Open Area Test Site)
- ☐ - Wild River Lab Screen Room
- ☐ - New Brighton Lab Shielded Room

Test equipment used :

Model Number	Manufacturer	Description	Serial Number	Cal Date
--------------	--------------	-------------	---------------	----------

Use of the calibrated equipment on this list ensures traceability to national and international standards.

Emissions Test Conditions: RADIATED EMISSIONS (Magnetic Field)

The *RADIATED EMISSIONS (MAGNETIC FIELD)* measurements were performed at the following test location:

- ☐ - Wild River Lab Large Test Site (Open Area Test Site)
- ☐ - Wild River Lab Small Test Site (Open Area Test Site)
- ☐ - Oakwood Lab (Open Area Test Site)

at a test distance of :

- ☐ - 3 meters
- ☐ - 10 meters
- ☐ - 30 meters

☒ - Test not applicable

Test equipment used :

Model Number	Manufacturer	Description	Serial Number	Cal Date
--------------	--------------	-------------	---------------	----------

Emissions Test Conditions: RADIATED EMISSIONS (Electric Field)

The *RADIATED EMISSIONS (ELECTRIC FIELD)* measurements, in the frequency range of 30 MHz-1000 MHz, were tested in a horizontal and vertical polarization at the following test location :

☐ - Test not applicable

- - Wild River Lab Large Test Site (Open Area Test Site)
- ☐ - Wild River Lab Small Test Site (Open Area Test Site)
- ☐ - Oakwood Lab (Open Area Test Site)

at a test distance of :

- - 3 meters
- ☐ - 10 meters
- ☐ - 30 meters

Test equipment used :

	Model Number	Manufacturer	Description	Serial Number	Cal Date
■ -	SAS-200/512	A. H. Systems	Log Periodic Antenna	147	6-98
■ -	3108	Electro-Mechanics (EMCO)	Biconical Antenna	2429	6-98
■ -	8566B	Hewlett-Packard	Spectrum Analyzer	2221A01596	4-98
■ -	85662A	Hewlett-Packard	Analyzer Display	2152A03640	4-98
■ -	85650A	Hewlett-Packard	Quasi-Peak Adapter	2811A01127	4-98
■ -	ZHL-1042J	Mini-Circuits	Preamplifier	H072294-11	4-98

Use of the calibrated equipment on this list ensures traceability to national and international standards.

Emissions Test Conditions: INTERFERENCE POWER

The *INTERFERENCE POWER* measurements were performed by using the absorbing clamp on the mains and interface cables in the frequency range 30 MHz - 300 MHz at the following test location :

■ - Test not applicable

- ☐ - Wild River Lab Large Test Site (Open Area Test Site)
- ☐ - Wild River Lab Small Test Site (Open Area Test Site)
- ☐ - Oakwood Lab (Open Area Test Site)
- ☐ - Wild River Lab Screen Room
- ☐ - New Brighton Lab Shielded Room

Test equipment used :

	Model Number	Manufacturer	Description	Serial Number	Cal Date
--	--------------	--------------	-------------	---------------	----------

Emissions Test Conditions: RADIATED EMISSIONS (Electric Field)

The *EQUIVALENT RADIATED EMISSIONS* measurements in the frequency range 1 GHz - 100 GHz were performed in a horizontal and vertical polarization at the following test location :

- ☒ - Wild River Lab Large Test Site (Open Area Test Site)
- ☐ - Wild River Lab Small Test Site (Open Area Test Site)
- ☐ - Oakwood Lab (Open Area Test Site)
- ☐ - Wild River Lab Screen Room

at a test distance of:

- ☐ - 1 meters
- ☒ - 3 meters
- ☐ - 10 meters

☐ - Test not applicable

Test equipment used :

Model Number	Manufacturer	Description	Serial Number	Cal Date
■ - 3115	Electro-Mechanics (EMCO)	Horn Antenna	9001-3275	9-98
■ - 3116	Electro-Mechanics (EMCO)	Horn Antenna	2005	10-98
■ - 19-7025	Aerowave	Horn Antenna		7-97
■ - 15-7025	Aerowave	Horn Antenna		7-97
■ - 10-7025	Aerowave	Horn Antenna		7-97
■ - 8566B	Hewlett-Packard	Spectrum Analyzer	2221A01596	4-98
■ - 85662A	Hewlett-Packard	Analyzer Display	2152A03640	4-98
■ - 85650A	Hewlett-Packard	Quasi-Peak Adapter	2811A01127	4-98
■ - ZHL-1042J	Mini-Circuits	Preamplifier	H072294-11	4-98
■ - AFT-8434	Avantek	Preamplifier	9112 Z221	4-98
■ - AWT-18037	Avantek	Preamplifier	1001-9226	4-98
■ - 11975A	Hewlett-Packard	Preamplifier	2738A01200	7-98
■ - 11970K	Hewlett-Packard	Harmonic Mixer	2332A01170	11-98
■ - 11970A	Hewlett-Packard	Harmonic Mixer	2332A01861	11-98
■ - 11970U	Hewlett-Packard	Harmonic Mixer	3003A01395	11-98
■ - 11970V	Hewlett-Packard	Harmonic Mixer	2521A01172	11-98
■ - 11970W	Hewlett-Packard	Harmonic Mixer	2521A01336	11-98

Use of the calibrated equipment on this list ensures traceability to national and international standards.

Equipment Under Test (EUT) Test Operation Mode - Emission tests :

The device under test was operated under the following conditions during emissions testing:

- ☐ - Standby
- ☐ - Test program (H - Pattern)
- ☐ - Test program (color bar)
- ☐ - Test program (customer specific)
- ☐ - Practice operation
- ☐ - Normal Operating Mode
- ☒ - Transmitter on.

Configuration of the device under test:

- ☐ - See Constructional Data Form in Appendix B - Page B2
- ☒ - See Product Information Form in Appendix B - beginning on Page B3

The following peripheral devices and interface cables were connected during the measurement:

- | | |
|---|----------------|
| ☐ - _____ | Type : _____ |
| ☐ - _____ | Type : _____ |
| ☐ - _____ | Type : _____ |
| ☐ - _____ | Type : _____ |
| ☐ - _____ | Type : _____ |
| ☐ - _____ | Type : _____ |
| ☐ - _____ | Type : _____ |
| ☐ - _____ | Type : _____ |
| ☐ - _____ | Type : _____ |
| ☐ - unshielded power cable | |
| ☐ - unshielded cables | |
| ☒ - shielded cables | MPS.No.: _____ |
| ☐ - customer specific cables | |
| ☐ - _____ | |
| ☐ - _____ | |

Emission Test Results:
Conducted emissions 10/150 kHz - 30 MHz

The requirements are ☐ - MET ☐ - NOT MET
 Minimum limit margin _____ dB at _____ MHz
 Maximum limit exceeding _____ dB at _____ MHz
 Remarks: _____

Radiated emissions (magnetic field) 10 kHz - 30 MHz

The requirements are ☐ - MET ☐ - NOT MET
 Minimum limit margin _____ dB at _____ kHz
 Maximum limit exceeding _____ dB at _____ kHz
 Remarks: _____

Radiated emissions (electric field) 30 MHz - 1000 MHz

The requirements are ☒ - MET ☐ - NOT MET
 Minimum limit margin _____ >10 dB at _____ MHz
 Maximum limit exceeding _____ dB at _____ MHz
 Remarks: No signals detected within 10 dB of the limit.

Interference Power at the mains and interface cables 30 MHz - 300 MHz

The requirements are ☐ - MET ☐ - NOT MET
 Minimum limit margin _____ dB at _____ MHz
 Maximum limit exceeding _____ dB at _____ MHz
 Remarks: _____

Equivalent Radiated emissions 1 GHz - 100 GHz

The requirements are ☒ - MET ☐ - NOT MET
 Minimum limit margin for fundamental _____ 6 dB at _____ 24.16 GHz
 Maximum limit exceeding _____ dB at _____ MHz

Remarks: The fundamental was measured to be 122 dBuV/m (1259 mV/m) in peak mode compared to a limit of 127.9 dBuV/m (2500 mV/m). No spurious or harmonics could be detected within 6 dB of the limit, even at a closer antenna-EUT distance.

DEVIATIONS FROM STANDARD:

None.

GENERAL REMARKS:

Page A5 of A5 is a plot showing that the fundamental is entirely contained in the allowed band of operation.

SUMMARY:

The requirements according to the technical regulations are

☒ - met

☐ - **not** met.

The device under test does

☒ - fulfill the general approval requirements mentioned on page 3.

☐ - **not** fulfill the general approval requirements mentioned on page 3.

Testing Start Date: 05 January 1999

Testing End Date: 05 January 1999

- TÜV PRODUCT SERVICE INC -

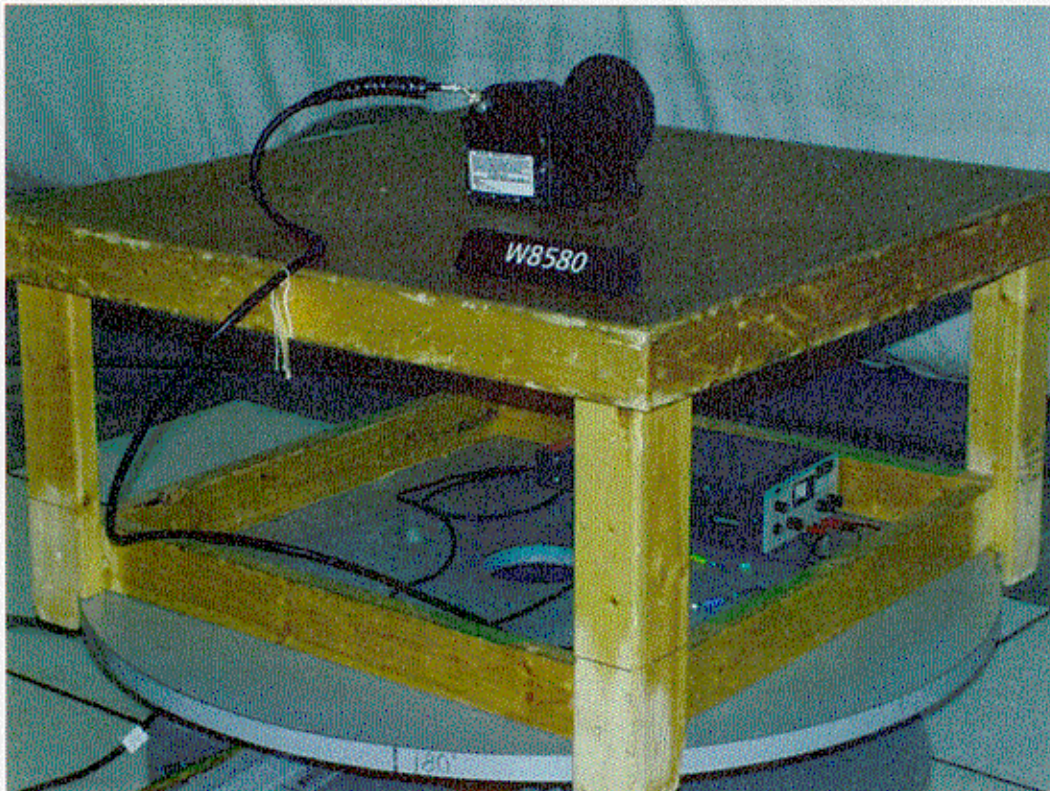
Joel T. Schneider
J. T. Schneider
Site Manager

Greg S. Jakubowski
Tested By: by x s
G. S. Jakubowski

Test-setup photo(s):
Conducted emission 10/150 kHz - 30 MHz

Not Applicable

Test-setup photo(s):
Radiated emission 30 MHz - 100 GHz



Appendix A

Test Data Sheets
and
Test Setup Drawing(s)

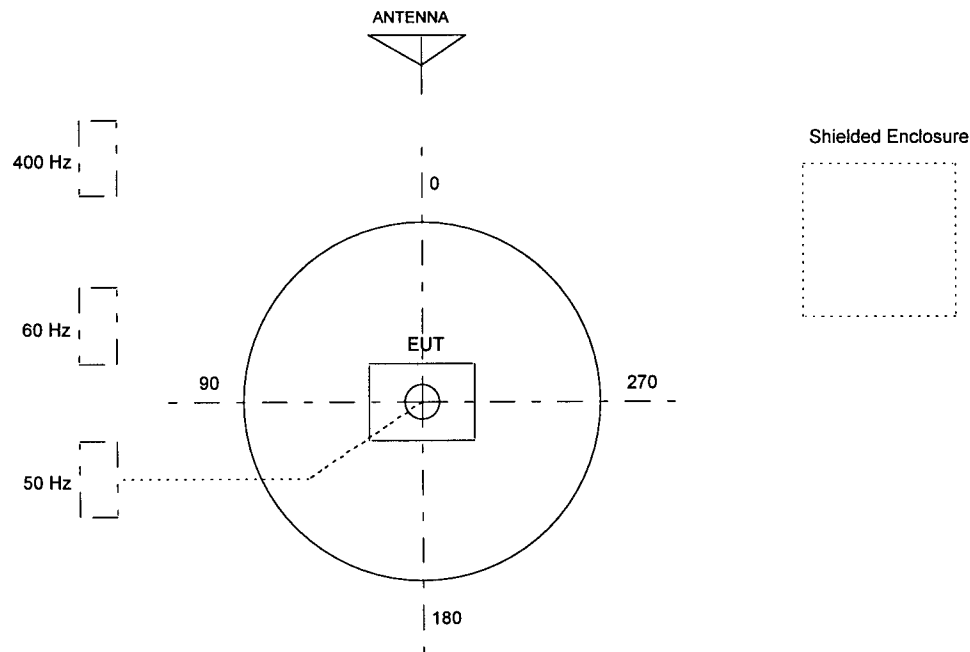
FCC ID: N5P003

TEST SETUP FOR EMISSIONS TESTING

WILD RIVER LAB
Large Test Site

Notes:

1. Items shown in dotted lines are located on the floor below the test area. It is 5 meters vertically from the ground floor to the test area.
2. 50 Hz, 60 Hz, and 400 Hz are power panels for alternating current.
3. The antenna may be positioned horizontally 3, 10 or 30 meters from the center of the turntable.
4. The circle is a 6.7 meter diameter turntable.
5. A ground plane is in the plane of this sheet.
6. The test sample is shown in the azimuthal position representing zero degrees.



T U V P R O D U C T S E R V I C E

RADIATED EMISSIONS

Large Test Site
3 Meter Antenna Distance
Equipment Under Test:
GM - ELECTRO-MOTIVE DIVISION
40081692 TRANSMITTER
Notes:

Report W8580 Run 1
Date 01-05-99 Page 1
Engineer _____
Tech: GSJ _____
Requester _____

Frequency MHz	Level dBuV	Factor dB	Cable dB	Peak dBuV/m	Ave dBuV/m	ANTENNA DISTANCE	Limit dBuV/m
24160	77	45	--	122		3 M	127.9

NO OTHER SIGNALS COULD BE DETECTED ABOVE SYSTEM NOISE LEVEL FROM 30 MHz TO 100 GHZ - ANTENNA MOVED CLOSE TO EUT AT 24.16 GHZ HARMONICS.

T U V P R O D U C T S E R V I C E

RADIATED EMISSIONS

Large Test Site
3 Meter Antenna Distance
Equipment Under Test:
GM - ELECTRO-MOTIVE DIVISION
40081692 TRANSMITTER
Notes:

Figure _____

Report W8580 Run 1
Date 01-05-99 Page 2

Engineer _____
Tech: GSJ _____
Requester _____

Measurement Summary

Frequency MHz	----- Final dBuV/m	----- uV/m	Azimuth deg	ANTENNA DISTANCE	Delta FCC 15.245	Delta
24160	122	1258925	--	3 M	-5.9	

MKR 24.160 0 GHz
82.70 dBμV

HARMONIC 6L

REF 90.0 dBμV

hp

10 dB/

CNVLOSS

21.0
dB

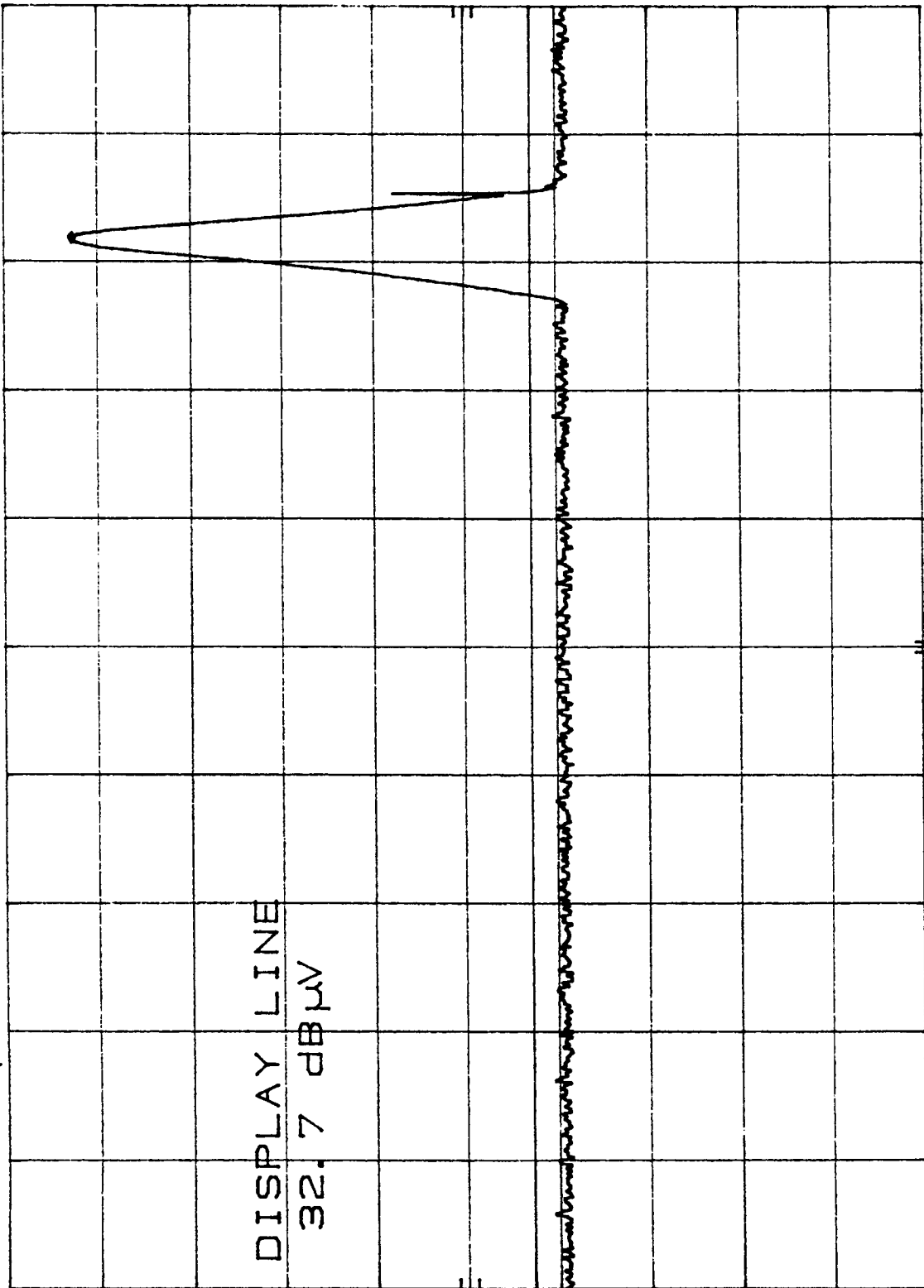
DISPLAY LINE

32.7 dBμV

DL

32.7
dBμV

fundamental
in allowed
band



STOP 24.180 GHz
SWP 20.0 msec

VBW 300 kHz

START 24.070 GHz
RES BW 1 MHz

FCC ID: N5P003



Appendix B

Constructional Data Form
and
Product Information Form(s)

Constructional Data Form

Not Applicable

PRODUCT INFORMATION FORM

NOTE: It is required to complete both 1) a Product Information Form for each unit under test and 2) a Constructional Data Form for each system tested as outlined in the enclosed instructions.

*** Please show the exact spelling [including spacing, capitalization, etc] as you want shown on the After Test Documentation.**

***Company Name** ELECTRO-MOTIVE DIVISION

***Company Address** GENERAL MOTORS CORPORATION

9301 W 55TH STREET

LA GRANGE IL 60525

Customer Representatives THOMAS OPEKA

***Equipment Description** LOCOMOTIVE SPEED SENSOR

***Model Number** 40081692 ***Serial Number** ENGINEERING 2

Type of Test

☐ Development

☒ Initial Design Verification

☐ Design Change (Please describe exact changes below)

☐ Production Sample (Audit Test)

☐ _____

Changes Made

Oscillator Frequencies

24.160 GHZ

Power Interface

Frequency DC

Voltage 15

of Phases _____

Current 0.500 AMP

Power Supply

Description _____

Manufacturer _____

Model Number _____

Switching Freq _____

Power Cable

☐ Hardwired ☐ Flexible

☐ Shielded ☐ Unshielded

☐ Attached ☒ Removable

Power Line Filter

Manufacturer N/A Model Number _____

Cabinet Shielding Provision**BUILT IN ALUMINUM HOUSING WITH INTEGRAL ANTENNA.****Software and/or Operating Modes****SOFTWARE DOES NOT CONTROL RF SECTION. SOFTWARE IS FOR PROCESSING DOPPLER OUTPUT.****Interfacing Equipment or Simulators**

Description	Model Number	Serial Number	FCC ID#
N/A			

I/O Cables

Function	Length (meters)	Shielded	Analog/Digital	Active During Test
1 CABLE (SUPPLIED WITH TEST UNIT)		Y	D	Y
ANTENNA CABLE				
		Y N	A D	Y N

Block Diagram

Appendix C

MEASUREMENT PROTOCOL

GENERAL INFORMATION

Measurement Uncertainty

The test system for conducted emissions is defined as the LISN, tuned receiver or spectrum analyzer, and coaxial cable. The test system for radiated emissions is defined as the antenna, the pre-amplifier, the spectrum analyzer and the coaxial cable. These test systems have a measurement uncertainty of ± 4.5 dB. The equipment comprising the test systems are calibrated on an annual basis.

Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral into it's characteristic impedance or left unterminated. When appropriate, the cables are manually manipulated with respect to each other to obtain maximum emissions from the unit.

CONDUCTED EMISSIONS

The final level, expressed in dB μ V, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the FCC limit.

To convert between dB μ V and μ V, the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

RADIATED EMISSIONS

The final level, expressed in dB μ V/m, is arrived at by taking the reading from the spectrum analyzer (Level dB μ V) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has the FCC limit subtracted from it to provide the Delta which gives the tabular data as shown in the data sheets in Attachment B. The amplifier gain is automatically accounted for by using an analyzer offset.

Example:

Frequency (MHz)	Level (dB μ V)	+	Factor & Cable (dB)	=	Final (dB μ V/m)	-	FCC B Limit (dB μ V/m)	=	Delta FCC B (dB)
32.21	13.9	+	16.3	=	30.2	-	40.0	=	-9.8

DETAILS OF TEST PROCEDURES**General Standard Information**

The test methods used comply with ANSI C63.4-1992 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."

Conducted Emissions

Conducted emissions on the 60 Hz power interface of the EUT are measured in the frequency range of 450 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection, and a Line Impedance Stabilization Network (LISN), with 50 Ω /50 μ H (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimeters above the floor and is positioned 40 centimeters from the vertical ground plane (wall) of the screen room. In some cases, a pre-scan using a spectrum analyzer is initially performed on the units comprising the system under test to locate the highest emissions. If the minimum passing margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver or spectrum analyzer with quasi-peak and average detection and recorded on the data sheets.

Radiated Emissions

Radiated emissions from the EUT are measured in the frequency range of 30 to 1000 MHz using a spectrum analyzer and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection and measurements above 1000 MHz are made with a 1 MHz/6 dB bandwidth and peak detection. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimeters above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Interface cables that are closer than 40 centimeters to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimeters from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna is positioned 3, 10 or 30 meters horizontally from the EUT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 meters, measurement scans are made with both horizontal and vertical antenna polarizations and the EUT are rotated 360 degrees.