Small Passenger Car Transmission Test—Mercury Lynx ATX Transmission

M. P. Bujold
Eaton Corporation
Engineering & Research Center

September 1981

Prepared for
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Lewis Research Center
Under Contract DEN 3-124

for
U.S. DEPARTMENT OF ENERGY
Conservation and Renewable Energy
Office of Vehicle and Engine R&D
NOTICE

This report was prepared to document work sponsored by the United States Government. Neither the United States nor its agent, the United States Department of Energy, nor any Federal employees, nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.
Small Passenger Car Transmission Test—Mercury Lynx ATX Transmission

M. P. Bujold
Eaton Corporation
Engineering & Research Center
Southfield, Michigan 48037

September 1981

Prepared for
National Aeronautics and Space Administration
Lewis Research Center
Cleveland, Ohio 44135
Under Contract DEN 3-124

for
U.S. DEPARTMENT OF ENERGY
Conservation and Renewable Energy
Office of Vehicle and Engine R&D
Washington, D.C. 20585
Under Interagency Agreement DE-AL01-77CS51044
PREFACE

The Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976 (Public Law 94-413) authorized a Federal program of research and development designed to promote electric and hybrid vehicle technologies. The Energy Research and Development Administration, now the Department of Energy (DOE), which was given the responsibility for implementing the Act, established the Electric and Hybrid Vehicle Research, Development, and Demonstration Project to manage the activities required by Public Law 94-413.

The National Aeronautics and Space Administration under an Interagency Agreement was requested by ERDA (DOE) to undertake research and development of propulsion systems for electric and hybrid vehicles. The Lewis Research Center was made the responsible NASA Center for this project. The work presented in this report is a part of that program.

The work described in this report was conducted under Contract DEN3-124 with the National Aeronautics and Space Administration (NASA) and sponsored by the Department of Energy through an agreement with NASA.
<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUMMARY</td>
<td>1</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>2</td>
</tr>
<tr>
<td>EQUIPMENT TESTED</td>
<td>3</td>
</tr>
<tr>
<td>TEST APPARATUS</td>
<td>4</td>
</tr>
<tr>
<td>TEST PROCEDURE</td>
<td>16</td>
</tr>
<tr>
<td>TEST RESULTS</td>
<td>26</td>
</tr>
<tr>
<td>DRIVE PERFORMANCE COVER SHEET</td>
<td>27</td>
</tr>
<tr>
<td>Drive Performance 1st Gear Input Torque = 10 lb-ft</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>64</td>
</tr>
<tr>
<td>DRIVE PERFORMANCE COVER SHEET</td>
<td>69</td>
</tr>
<tr>
<td>Drive Performance 2nd Gear Input Torque = 10 lb-ft</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>106</td>
</tr>
<tr>
<td>DRIVE PERFORMANCE COVER SHEET</td>
<td>111</td>
</tr>
<tr>
<td>Drive Performance 3rd Gear Input Torque = 10 lb-ft</td>
<td>113</td>
</tr>
<tr>
<td></td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>123</td>
</tr>
<tr>
<td></td>
<td>128</td>
</tr>
<tr>
<td></td>
<td>133</td>
</tr>
<tr>
<td></td>
<td>138</td>
</tr>
<tr>
<td></td>
<td>143</td>
</tr>
<tr>
<td></td>
<td>148</td>
</tr>
</tbody>
</table>
### TABLE OF CONTENTS (cont.)

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross Sectional Road Load Performance 3rd Gear</td>
<td>153</td>
</tr>
<tr>
<td>Output Torque</td>
<td></td>
</tr>
<tr>
<td>25 lb-ft</td>
<td>155</td>
</tr>
<tr>
<td>47 lb-ft</td>
<td>160</td>
</tr>
<tr>
<td>79 lb-ft</td>
<td>165</td>
</tr>
<tr>
<td>110 lb-ft</td>
<td>170</td>
</tr>
<tr>
<td>145 lb-ft</td>
<td>175</td>
</tr>
<tr>
<td>177 lb-ft</td>
<td>180</td>
</tr>
<tr>
<td>208 lb-ft</td>
<td>185</td>
</tr>
<tr>
<td>243 lb-ft</td>
<td>190</td>
</tr>
<tr>
<td>Coast Performance 1st Gear Engine Torque = 10 lb-ft</td>
<td>195</td>
</tr>
<tr>
<td>20 lb-ft</td>
<td>200</td>
</tr>
<tr>
<td>30 lb-ft</td>
<td>202</td>
</tr>
<tr>
<td>40 lb-ft</td>
<td>207</td>
</tr>
<tr>
<td>50 lb-ft</td>
<td>212</td>
</tr>
<tr>
<td>Coast Performance 2nd Gear Engine Torque = 10 lb-ft</td>
<td>222</td>
</tr>
<tr>
<td>20 lb-ft</td>
<td>224</td>
</tr>
<tr>
<td>30 lb-ft</td>
<td>229</td>
</tr>
<tr>
<td>40 lb-ft</td>
<td>234</td>
</tr>
<tr>
<td>50 lb-ft</td>
<td>239</td>
</tr>
<tr>
<td>60 lb-ft</td>
<td>244</td>
</tr>
<tr>
<td>70 lb-ft</td>
<td>249</td>
</tr>
<tr>
<td>80 lb-ft</td>
<td>254</td>
</tr>
<tr>
<td>Coast Performance 3rd Gear Engine Torque = 10 lb-ft</td>
<td>264</td>
</tr>
<tr>
<td>20 lb-ft</td>
<td>266</td>
</tr>
<tr>
<td>30 lb-ft</td>
<td>271</td>
</tr>
<tr>
<td>40 lb-ft</td>
<td>276</td>
</tr>
<tr>
<td>50 lb-ft</td>
<td>281</td>
</tr>
<tr>
<td>60 lb-ft</td>
<td>286</td>
</tr>
<tr>
<td>70 lb-ft</td>
<td>291</td>
</tr>
<tr>
<td>80 lb-ft</td>
<td>296</td>
</tr>
<tr>
<td>No Load Losses</td>
<td>306</td>
</tr>
<tr>
<td>1st Gear Closed Throttle</td>
<td>307</td>
</tr>
<tr>
<td>1st Gear Open Throttle</td>
<td>309</td>
</tr>
<tr>
<td>2nd Gear Closed Throttle</td>
<td>311</td>
</tr>
<tr>
<td>2nd Gear Open Throttle</td>
<td>313</td>
</tr>
<tr>
<td>3rd Gear Closed Throttle</td>
<td>315</td>
</tr>
<tr>
<td>3rd Gear Open Throttle</td>
<td>317</td>
</tr>
<tr>
<td>APPENDIX</td>
<td>319</td>
</tr>
</tbody>
</table>
SUMMARY

The small passenger car transmission test was initiated to supply electric vehicle manufacturers with technical information regarding the performance of commercially available transmissions. This information would enable EV manufacturers to design a more energy efficient vehicle. With this information the manufacturers would be able to estimate vehicle driving range as well as speed and torque requirements for specific road load performance characteristics.

This report covers the 1981 Mercury Lynx ATX transaxle. This transmission was tested per a passenger car automatic transmission test code (SAE J651b) which required drive performance, coast performance, and no load test conditions. Under these test conditions the transmission attained maximum efficiencies in the 93% range for drive performance tests. The major results of this test are the torque, speed and efficiency curves which are located in the data section of this report. These graphs map performance characteristics for the Mercury Lynx ATX transmission.
INTRODUCTION

The Mercury Lynx ATX is a commercially available automatic transmission which is suited for a small passenger car installation. The transmission is equipped with three forward driving ranges: a neutral, reverse and park. Very little technical information in the area of torque, speed and efficiency data is currently available on this transmission. This lack of available information was the principal reason for the initiation of this test.

The principal object of this test was to map torque, speed, and efficiency curves of the test transmission in each gear range and in both drive performance and coast performance conditions. The test was performed per the specifications of the Passenger Car Automatic Transmission Test Code - SAE J651b. The torque and speed limits of this test were governed by the torque and speed limits of an engine which would typically be supplied with this transmission. The test code specified that three basic tests were to be conducted which involved holding the torque constant and varying the transmission speed. The three specific tests were drive performance, coast performance, and no load losses which were conducted in first, second and third gear.

The test code required that the transmission should be held in gear over the complete range of the test. In order to accomplish this, it was necessary to block the valves. This kept the transmission locked in gear. The test code also specified an oil temperature requirement to ensure that a set viscosity level be attained throughout the tests. This temperature requirement was accomplished through the use of an immersion heater and oil cooler.

There were two main factors which determined the amount of load which could be applied to the system. These factors were the temperature of the transmission oil and the torque-speed characteristics of the absorber and dynamometer. The torque-speed characteristics of the absorber and dynamometer are contained in the Appendix.

The data that were obtained from the torque and speed sensors were placed directly onto tape. The tape was then fed into a computer which reduced the data and generated the necessary graphs and technical information. The main advantage to this method of data reduction is that any fluctuation that may occur due to system resonance is averaged by the computer. This method minimizes the operator error and allows the data to be viewed soon after the tests are completed.
This report involves the test conducted on a 1981 Mercury Lynx ATX (C1712PMA A2, 149228 E1EP AE). The automatic transaxle (ATX) combines an automatic transmission and differential into a single powertrain component designed for front wheel drive applications.

The ATX uses three friction clutches, one band and a single one way clutch. These components are applied as necessary to transmit engine torque through a compound planetary gear set. The planetary provides three forward gear ratios and one reverse. The ATX uses a standard torque converter with an internal splitter gear which provides mechanical connection between the engine and the transaxle. The splitter gear minimizes the converter slippage in second and third gear range. In first and reverse the engine torque is 100% hydraulically transmitted. In second and third gears the engine torque is split between the converter turbine and the splitter gear. This reduces torque converter losses and improves the efficiency of the transmission.

The transmission hydraulic system is pressurized by a gear type pump which provides the working pressure to operate the friction elements and automatic controls.
TEST APPARATUS

The test apparatus used in testing the Mercury Lynx ATX transmission consisted of the following basic items which are described and listed below. The set-up was basically the same for drive and coast performance tests except that the transmission was indexed 180° for coast performance tests.

The driving dynamometer was used to power the transmission. A torque sensor was placed on the dynamometer shaft to accurately monitor the torque into the transmission. A speed pickup was placed on the dyno shaft to measure the speed into the transmission.

The output shaft of the transmission was coupled to a torque sensor which accurately measured its torque. The torque sensor shaft was then coupled to a HY-VO chain drive (4:1 ratio) which was coupled to the absorber shaft. The purpose of the chain drive was to increase the slower output shaft speed into a range which would be acceptable to the absorber power requirements. The absorbing dynamometer was used to apply the system load. A speed pickup was mounted to the absorber shaft to measure output speed.

The transmission oil temperature was controlled through the use of a heat exchanger and circulation heater. When the transmission was operating at light load, the oil cooler was shut down and the circulation heater was engaged so that the oil could be kept up to temperature specification. When the transmission was operating under heavy load, the oil cooler was operating and the circulation heater was disengaged so that the temperature specification was not exceeded.

The transmission was held in first gear by placing the gear selector lever in its appropriate setting. The transmission was held in second gear by blocking the 1 to 2 shift valve in the second position. The transmission was held in third gear by placing stops in the 1 to 2 shift valve and the 2 to 3 shift valve so the valves were kept in the 2 and 3 position, respectively.

The transmission differential was locked for the entire test program. This was accomplished by welding the pinion gears to the differential carriers. This allowed the power to flow through one output shaft. This means that the output torques (drive performance) and input torques (coast performance) shown in the graphs are twice the values that each wheel would feel. However, the output speeds (drive performance) and input speeds (coast performance) are the actual speeds at each wheel.

The instrumentation for the setup consisted of the following basic items. The Lebow torque sensor was used in conjunction with a Daytronic signal conditioner (878). The Himmelstein torque sensor was matched with a Daytronic signal conditioner (878A). The magnetic speed pickup was used with an Airpax speed readout. These signals were then fed into a Sangamo 3500 tape recorder. The tape recorded data were then fed into a Hewlett Packard Analyzer which reduced the data.
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>PART NO.</th>
<th>MANUFACTURER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving Dynamometer</td>
<td>Model 26G308</td>
<td>General Electric</td>
</tr>
<tr>
<td>Flexible Coupling</td>
<td>226 SN</td>
<td>Thomas-Rexnord</td>
</tr>
<tr>
<td>Torque Sensor</td>
<td>MCRT6-02T(2-3)</td>
<td>Himmelstein</td>
</tr>
<tr>
<td>Pilot Bearing</td>
<td>SFT-15</td>
<td>Sealmaster</td>
</tr>
<tr>
<td>Transmission</td>
<td>Lynx ATX</td>
<td>Mercury</td>
</tr>
<tr>
<td>Rear Bearing</td>
<td>209-SFF</td>
<td>MRC</td>
</tr>
<tr>
<td>Flexible Coupling</td>
<td>226 SN</td>
<td>Thomas-Rexnord</td>
</tr>
<tr>
<td>Torque Sensor</td>
<td>1648-5K</td>
<td>Lebow</td>
</tr>
<tr>
<td>Absorber</td>
<td>1248-20K</td>
<td>Lebow</td>
</tr>
<tr>
<td>Heat Exchanger</td>
<td>1014DG</td>
<td>Dynamatic</td>
</tr>
<tr>
<td>Circulation Heater</td>
<td>F-301-ER-2P</td>
<td>Young</td>
</tr>
<tr>
<td>Pressure Gage</td>
<td>NWHO-2</td>
<td>Chromalox</td>
</tr>
<tr>
<td>HY VO Chain Drive (4:1)</td>
<td>1.25 WIDE</td>
<td>Morse</td>
</tr>
<tr>
<td><strong>INSTRUMENTATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torque Signal Conditioner</td>
<td>878A</td>
<td>Daytronic</td>
</tr>
<tr>
<td>Torque Signal Conditioner</td>
<td>878</td>
<td>Daytronic</td>
</tr>
<tr>
<td>Speed Readout</td>
<td>761400110</td>
<td>Airpax</td>
</tr>
<tr>
<td>Temperature Conditioner</td>
<td>810</td>
<td>Daytronic</td>
</tr>
<tr>
<td>Thermocouples</td>
<td>6610WBA2</td>
<td>Applied Instruments</td>
</tr>
<tr>
<td>FM Tape Recorder</td>
<td>3500</td>
<td>Sangamo</td>
</tr>
<tr>
<td>Speed Pickup</td>
<td>3030 AN</td>
<td>Electro</td>
</tr>
<tr>
<td>Speed Conditioner</td>
<td>840</td>
<td>Daytronic</td>
</tr>
<tr>
<td>Analyzer</td>
<td>5451B</td>
<td>Hewlett Packard</td>
</tr>
</tbody>
</table>
Drive Performance Test Setup

- Dynamometer
- Pilot Bearing
- Mercury Lynx Transmission
- Torque Sensor-Himmelstein
- Immersion Heater
- Torque Sensor-Lebow
- Hy Vo Chain Drive (4:1 Ratio)
- Absorber
- Speed Pickup
- Sump
- Oil Cooler
Coast Performance Test Setup
1981 Mercury Lynx Drive Performance Test Setup
Back View
1981 Mercury Lynx Coast Performance Test Setup
Front View
1981 Mercury Lynx Coast Performance Test Setup
Side View
Control Console
with Data Reduction Equipment
TEST PROCEDURE

The test was conducted per the Passenger Car Automatic Transmission Test Code-SAE J651b. The code states that three basic tests should be performed on the transmission. These tests are Drive Performance, Coast Performance and No Load Losses. Each test was performed to the accuracies stated in the code. The throttle valve was modulated throughout the test to its normal operating positions. The table on page 18 indicates the engine torque and its related throttle valve setting.

The limits of the test were determined by the normal operating conditions of an engine typically supplied with this transmission. The transmission was tested at a torque which ranged from 10-80 lb-ft on the input shaft of the transmission. The torque was incremented by 10 lb-ft for each test. The speed limits of the test ranged from 700 to 3800 rpm on the input shaft of the transmission.

The first test conducted was the Drive Performance - Constant Input Torque test. The input torque was held at 10 lb-ft, and the speed was incremented from 750-3800 rpm. The torque was then set to 20 lb-ft, and the transmission was run through the same speed range. This procedure was followed for input torques of 10, 20, 30, 40, 50, 60, 70, and 80 lb-ft. The throttle valve was modulated to match the appropriate input torque for these test ranges. The starting speed was dependent on when the torque could be attained, which was characteristic of the torque converter. The data recorded in this test were input and output speed, input and output torque, line pressure, sump temperature, outlet temperature, case hotspot temperature and ambient temperature.

This procedure was performed on the transmission in first, second and third gear range. The transmission was held in each gear through the entire torque and speed range per the explanation given in the Test Apparatus section of this report.

The next portion of the Drive Performance test to be conducted was the Cross Sectional Road Load Performance test. This test was conducted in third gear and involved holding the transmission output shaft at a constant torque while varying the input speed. The output torques selected were 25, 47, 79, 110, 145, 177, 208, and 243 lb-ft. The speed range was from 750 to 3800 rpm on this input shaft. The starting speed was dependent on when the torque could be attained. The throttle valve was modulated throughout this test to match the appropriate engine torque. The data recorded in this test were input and output torques, input and output speeds, line pressure, sump temperatures, outlet temperatures, case hotspot temperature and ambient temperatures.
The No Load Losses portion of the test was performed next. This test was run with the output shaft turning freely. The input torque and speed were recorded for an entire speed range which ran from 700 rpm to 3700 rpm. This test was performed in each gear range by disconnecting the output shaft and allowing it to turn freely.

The parameters recorded in this test were input torque and speed, line pressure, sump temperature, outlet temperature, case hotspot temperature, and ambient temperature.

The final test performed was the Coast Performance test. For this test the transmission was oriented in the reverse direction so that the dynamometer drove through the output shaft of the transmission and the power was taken up in the absorber. The test was conducted by setting the converter impeller torque at a constant level and varying its speed in the range set by the previous tests. In order to run this test, it was necessary to spin the torque converter shaft at approximately 400 rpm so that the charge pump would generate the line pressure necessary to operate the transmission. The torque and speed ranges of this test were different from the previous tests due to torque converter characteristics. The speed was limited by two conditions. These conditions were the lowest speed necessary to maintain line pressure and the lowest speed at which the required torque could be attained. The amount of torque which could be applied to the system was limited by the current limits of the dynamometer controller. The first gear Coast Performance test reached the current limit at the 50 lb-ft run. This was due to the slow output speed in first gear which was beyond the dynamometer torque-speed characteristics. The data recorded during this portion of the test were input and output torque, input and output speed, line pressure, sump temperature, outlet temperature, case hotspot temperature, and ambient temperature. The throttle valve was set to the idle position during the entire test.

The transmission was filled with Dexron II automatic transmission fluid through the entire test schedule. The physical and chemical properties of the transmission fluid were monitored throughout the test. The fluid did not appreciably change colors or properties throughout the tests. However, it should be noted that when operating in the coast performance mode this pump is turning at a slower speed which means less flow for cooling purposes. This could become a factor in the amount of power which could be transmitted under coast performance.
Following is a table of engine torque vs. throttle cable position. The transmission throttle cable was modulated for each engine torque level throughout the tests.

<table>
<thead>
<tr>
<th>ENGINE TORQUE (lb-ft)</th>
<th>THROTTLE CABLE POSITION (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>closed</td>
<td>0.00</td>
</tr>
<tr>
<td>10</td>
<td>0.125</td>
</tr>
<tr>
<td>20</td>
<td>0.25</td>
</tr>
<tr>
<td>30</td>
<td>0.38</td>
</tr>
<tr>
<td>40</td>
<td>0.50</td>
</tr>
<tr>
<td>50</td>
<td>0.62</td>
</tr>
<tr>
<td>60</td>
<td>0.75</td>
</tr>
<tr>
<td>70</td>
<td>0.88</td>
</tr>
<tr>
<td>80</td>
<td>1.0</td>
</tr>
</tbody>
</table>

open
CALIBRATION

The test apparatus was calibrated before and after a major test was completed. The major components calibrated were the torque sensors and the speed readouts. The torque sensors were calibrated with their respective readouts and attaching cables so that a total system accuracy was obtained. The calibration was performed by placing a set of known weights at a known distance to produce the resultant torque. The weights were weighed on a Toledo Digital Scale Model No. 1070, which is calibrated to a set of weights traceable to the National Bureau of Standards. A second calibration method was used as a check against the dead weights. This involved a hydraulic calibration stand which compared a calibrated torque cell (traceable to the National Bureau of Standards) to the test torque transducers. The calibration sheets contained in this section show the calculated torque and the actual torque which appeared on the readout (measured torque). The torque sensors were calibrated to the limits of the range over which they were to operate.

The speed readout was an AIRPAX counter (Model No. 761400110) which was calibrated in an operating range from 0 to 4500 rpm. The counter was calibrated with a Hewlett Packard electric counter (Model No. 5245L) used in conjunction with a WWVB frequency comparator (True Time, Inc. Model No. 60-TR). The accuracy of the digital readout was ±1 count.
CALIBRATION SHEET
HIMMELSTEIN TORQUE SENSOR #MCRT 6-02T (2-3)
CAL VALUE = 58.5 lb-ft
(Drive performance torque was positive. Direction of torque was clockwise.)

<table>
<thead>
<tr>
<th>CALCULATED TORQUE (lb-ft)</th>
<th>MEASURED TORQUE (lb-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>16.6</td>
<td>16.5</td>
</tr>
<tr>
<td>33.3</td>
<td>33.0</td>
</tr>
<tr>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>66.6</td>
<td>66.5</td>
</tr>
<tr>
<td>83.3</td>
<td>83.5</td>
</tr>
<tr>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>116.6</td>
<td>116.5</td>
</tr>
<tr>
<td>133.3</td>
<td>133.5</td>
</tr>
<tr>
<td>150.0</td>
<td>150.0</td>
</tr>
<tr>
<td>166.6</td>
<td>166.5</td>
</tr>
<tr>
<td>150.0</td>
<td>150.0</td>
</tr>
<tr>
<td>133.0</td>
<td>133.5</td>
</tr>
<tr>
<td>116.6</td>
<td>116.5</td>
</tr>
<tr>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>83.3</td>
<td>83.5</td>
</tr>
<tr>
<td>66.5</td>
<td>66.5</td>
</tr>
<tr>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>33.3</td>
<td>33.0</td>
</tr>
<tr>
<td>16.6</td>
<td>16.5</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
CALIBRATION SHEET
LEBOW TORQUE SENSOR #1648-5K
CAL VALUE = 271
(Coast performance torque was negative. Direction of torque is labeled above each column.)

<table>
<thead>
<tr>
<th>CALCULATED TORQUE (lb-ft)</th>
<th>MEASURED TORQUE (lb-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clockwise</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>41.6</td>
<td>42.0</td>
</tr>
<tr>
<td>83.3</td>
<td>84.0</td>
</tr>
<tr>
<td>125.0</td>
<td>125.5</td>
</tr>
<tr>
<td>166.6</td>
<td>167.0</td>
</tr>
<tr>
<td>208.3</td>
<td>209.0</td>
</tr>
<tr>
<td>250.0</td>
<td>251.0</td>
</tr>
<tr>
<td>291.6</td>
<td>293.0</td>
</tr>
<tr>
<td>333.3</td>
<td>335.0</td>
</tr>
<tr>
<td>375.0</td>
<td>377.0</td>
</tr>
<tr>
<td>416.6</td>
<td>419.0</td>
</tr>
<tr>
<td>375.0</td>
<td>377.5</td>
</tr>
<tr>
<td>333.0</td>
<td>335.0</td>
</tr>
<tr>
<td>291.6</td>
<td>293.0</td>
</tr>
<tr>
<td>250.0</td>
<td>251.5</td>
</tr>
<tr>
<td>208.3</td>
<td>210.0</td>
</tr>
<tr>
<td>166.6</td>
<td>168.0</td>
</tr>
<tr>
<td>125.0</td>
<td>126.5</td>
</tr>
<tr>
<td>83.3</td>
<td>84.0</td>
</tr>
<tr>
<td>41.6</td>
<td>42.0</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
CALIBRATION SHEET
LEBOW TORQUE SENSOR #1248-20K
CAL VALUE = 271
(Coast performance torque was negative. Direction of torque was counterclockwise.)

<table>
<thead>
<tr>
<th>CALCULATED TORQUE (lb-ft)</th>
<th>MEASURED TORQUE (lb-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clockwise</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>166.6</td>
<td>163.7</td>
</tr>
<tr>
<td>333.3</td>
<td>334.0</td>
</tr>
<tr>
<td>500.0</td>
<td>498.0</td>
</tr>
<tr>
<td>666.6</td>
<td>663.8</td>
</tr>
<tr>
<td>833.3</td>
<td>829.3</td>
</tr>
<tr>
<td>1000.0</td>
<td>999.6</td>
</tr>
<tr>
<td>1166.6</td>
<td>1163.7</td>
</tr>
<tr>
<td>1333.3</td>
<td>1329.7</td>
</tr>
<tr>
<td>1500.0</td>
<td>1497.7</td>
</tr>
<tr>
<td>1666.6</td>
<td>1666.0</td>
</tr>
<tr>
<td>1500.0</td>
<td>1498.5</td>
</tr>
<tr>
<td>1333.3</td>
<td>1329.2</td>
</tr>
<tr>
<td>1166.6</td>
<td>1165.7</td>
</tr>
<tr>
<td>1000.0</td>
<td>996.4</td>
</tr>
<tr>
<td>833.3</td>
<td>830.7</td>
</tr>
<tr>
<td>666.6</td>
<td>662.0</td>
</tr>
<tr>
<td>500.0</td>
<td>498.9</td>
</tr>
<tr>
<td>333.3</td>
<td>332.6</td>
</tr>
<tr>
<td>166.6</td>
<td>167.0</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
The instruments used in the test setup have been calibrated to insure the accuracy of the test data. The individual components utilized in the tests have manufacturers' specifications which guarantee the accuracy of the instrumentation. These accuracies are listed and combined in the Appendix section to determine the total system accuracy. The three major factors involved in the system accuracy are the torque signals, speed signals, and data reduction equipment. Worst case system accuracies for the torque sensors, cabling and readout were determined from the calibration charts and are shown below.

**TAPE RECORDER:** Sangamo Model #3500
**ACCURACY:** ±0.05% of Full Scale

**TORQUE SENSOR:** Lebow (1648-5K) + Daytronic (878A)
**ACCURACY:** \( \frac{(\text{Calculated Torque-Measured})}{\text{Full Scale Torque}} \times 100 = \frac{(210.0 - 208.3)}{416.66} \times 100 = ±0.408\% \text{ of Full Scale} \)

**TORQUE SENSOR:** Himmelstein (MCRT 6-62T(2-3)) + Daytronic (878)
**ACCURACY:** \( \frac{(\text{Calculated Torque-Measured})}{\text{Full Scale Torque}} \times 100 = \frac{(33.3 - 33.0)}{166.66} \times 100 = ±0.18\% \text{ of Full Scale} \)

**SPEED SENSOR:** Speed Pickup + Airpax Counter
**ACCURACY:** Calibration was ±1 Count (1/4000) \times 100 = ±0.025\% of Full Scale

**SPEED CONDITIONER** (Frequency to Voltage Converter-Daytronic 840)
**ACCURACY:** 0.05% of Average DC Voltage = ±0.10\% of Full Scale

**HEWLETT PACKARD ANALYZER** (HP 5451B Fourier Analyzer)
**ACCURACY:** 12 Bits = 2\(^{12}\) = 2048 Bits = 1 Volt
\( \frac{1}{2048} \times 100 = ±0.048\% \text{ of Full Scale} \)

**COMPUTER INTER NUMBER CALCULATION** (Method of Program Calculation)
= 0.5% of Full Scale

The inter number calculation error resulted from the method that the computer used to average the acquired data. This method is explained in the Appendix.

From the instrument accuracy determined above, a system accuracy may be determined. There are two generally accepted methods for calculating a system error. These methods are the root mean square and the sum of the errors. Both methods are tabulated in the Appendix and charted below for torque, speed, power and efficiency readings.
<table>
<thead>
<tr>
<th>Error Type</th>
<th>ROOT MEAN SQUARE METHOD % OF FULL SCALE</th>
<th>SUM OF ERRORS METHOD % OF FULL SCALE</th>
<th>FULL SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque Error (Lebow)</td>
<td>0.416%</td>
<td>0.508%</td>
<td>416 lb-ft</td>
</tr>
<tr>
<td>Torque Error (Himm.)</td>
<td>0.193%</td>
<td>0.278%</td>
<td>166 lb-ft</td>
</tr>
<tr>
<td>Speed Error</td>
<td>0.124%</td>
<td>0.223%</td>
<td>4000 RPM</td>
</tr>
<tr>
<td>Power Out Error</td>
<td>0.662%</td>
<td>1.132%</td>
<td>137 HP</td>
</tr>
<tr>
<td>Efficiency Error</td>
<td>0.701%</td>
<td>1.732%</td>
<td>100%</td>
</tr>
</tbody>
</table>
DATA REDUCTION

The signals obtained from the torque and speed transducers of the test stand were placed directly into a Sangamo Tape Recorder Model No. 3500. The information on the tape was then fed into a computer which was used to compile the data. While in the computer, the data were reviewed to ensure their accuracy, and then a hard copy was printed out on a line printer.

The following procedure was used to record the input and output torque. The torque signals were placed in the tape recorder as voltage. A calibration value was determined in engineering units (lb-ft) for each torque sensor. The torques were recorded on channels one and two in the following manner:

CHANNEL 1: PRECALIBRATION ZERO CALIBRATION VOLTAGE PRERUN ZERO DATA
CHANNEL 2: PRECALIBRATION ZERO CALIBRATION VOLTAGE PRERUN ZERO DATA

This information was then fed into the computer which integrated and compiled a 2.5-second sample of data to obtain an average value in engineering units.

The frequency signals from the speed pickups were placed directly into the tape recorder. The data on the tape were then fed into a frequency-to-voltage unit which turned the frequency into a DC voltage which in turn was fed into the computer. The method for recording speeds is shown below.

CHANNEL 3: ZERO FREQUENCY CALIBRATION FREQUENCY PRERUN ZERO FREQUENCY DATA
CHANNEL 4: ZERO FREQUENCY CALIBRATION FREQUENCY PRERUN ZERO FREQUENCY DATA

The data on these channels were then fed into the computer which integrated and compiled a 2.5-second sample of data to obtain an average speed value in engineering units.

The computer was programmed to take the values of torques and speeds and calculate efficiency and power from them. From the data it has generated, the computer would print out the required graphs and data per the contract specification. The main advantage of taking data in this manner was that the computer would calculate an integrated average which would minimize the error in a fluctuating signal. Any fluctuation due to system resonance or gear teeth meshing would be integrated and averaged.
TEST RESULTS

The data contained in this segment of the report have been divided into three major sections. These sections are Drive Performance, Coast Performance, and No Load Losses. There are five data sheets for each test condition in the Drive Performance and Coast Performance tests. The organization of this data is described and listed in the Table of Contents. Cover sheets for Drive Performance, Coast Performance and No Load Losses have been placed at the beginning of each section to describe the enclosed sheets.
DRIVE PERFORMANCE

1st Gear
Graphs Contained in This Section

Torque Ratio -vs- Output Speed
Output Torque -vs- Output Speed
Input Speed -vs- Output Speed
Efficiency -vs- Output Speed
Efficiency -vs- Power Out

Drive Performance Tests
1981 MERCURY LYNX AX #03-124 6/15/81
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE FIRST
INPUT TORQUE 70 LB-FT(95, 2N-M)
OUTPUT TORQUE 30, 70, 100 N-M, LB-FT

OUTPUT SPEED RPM
INPUT SPEED RPM

OUTPUT SPEED RPM

1981 MERCURY LYNX ATX DE3-124 6/15/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 10 LB-FT (13,6N-M)
OUTPUT TORQUE:
1981 MERCURY LYNX AX 1103-124 6/15/81
EFFECTIVENESS VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 10 LB-FT (13,6N-M)
OUTPUT TORQUE
EFFICIENCY VS POWER OUT

GEAR RANGE: FIRST
INPUT TORQUE: 10 LB-FT (13.6 N-M)
OUTPUT TORQUE:

1981 MERCURY LYNX ATX DEN3-124 6/15/81

POWER OUT

EFFICIENCY %

0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 HP 5.0

0 1 0 1 1 2 2 2 3 kW 3
1981 MERCURY LYNX ATX DEN3-124 6/15/81
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 20 LB-FT (27.2 N-M)
OUTPUT TORQUE:

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DEN3-124 6/15/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE       FIRST
INPUT TORQUE     20 LB-FT (27.2 N-M)
OUTPUT TORQUE
EFFICIENCY VS OUTPUT SPEED

1981 MERCURY LYNX ATX DFENG 124 6/15/81
GEAR RANGE FIRST
INPUT TORQUE 20 LB-FT (27.2 N-M)
OUTPUT TORQUE

EFFICIENCY %
0 10 20 30 40 50 60 70 80 90 100

OUTPUT SPEED RPM
0 50 100 150 200 250 300 350 400 450 500
1981 MERCURY LYNX ATX DEN3-124 6/15/81
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 30 LB-FT (40.8N-M)
OUTPUT TORQUE: 

OUTPUT SPEED RPM
1981 MERCURY LYNX RTX WBN3-124 6/15/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 30 LB-FT (40 N-M)
OUTPUT TORQUE: 300 RPM
1981 MERCURY LYNX ATX DEC-124 6/15/81
TORQUE RATIO VS OUTPUT SPEED
GEAR RATIO FIRST
INPUT TORQUE 40 LBD-FT (54.4 H-M)
OUTPUT TORQUE
1981 MERCURY LYNX ATX DEN3-124 6/15/81
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 40 LB-FT (54.4 N-M)
OUTPUT TORQUE

OUTPUT SPEED RPM

OUTPUT TORQUE (N-M)
0 50 100 150 200 250 300 350 400 450 500
LB-FT
0 50 100 150 200 250 300 350 400 450 500
N-M

0 68 136 204 272 340 408 476 544 612 680
LB-FT
0 68 136 204 272 340 408 476 544 612 680
N-M
1981 MERCURY LYNX ATX IENG-124 6/15/81

EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 40 LB-FT (54.4 N-M)
OUTPUT TORQUE:
1981 MERCURY LYNX AX #124 6/15/81
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 50 LBF-FT (80 N-M)
OUTPUT TORQUE: ...
1981 MERCURY LYNX ATV M63-124 6/15/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE    FIRST
INPUT TORQUE   50 LB-FT (68 N-M)
OUTPUT TORQUE
1981 MERCURY LYNX ATX DEN3-124 6/15/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 50 LB-FT (68 N·M)
OUTPUT TORQUE: 

EFFICIENCY %

OUTPUT SPEED RPM
1981 MERCURY LYNX AX 124 6/15/81
EFFICIENCY VS POWER OUT
GEAR RANGE: FIRST
INPUT TORQUE: 60 L-B-FT (81.6 N·M)
OUTPUT TORQUE: 0-50 HP

EFFICIENCY %
POWER OUT
1981 MERCURY LYNX ATX DEN3-124 6/15/81
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 70 LBD-FT (96.2H-M)
OUTPUT TORQUE: 

TORQUE RATIO TO/Ti

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DENG-124 6/15/81
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE       FIRST
INPUT TORQUE     70 LB-FT (95.2 N-M)
OUTPUT TORQUE
1981 MERCURY LYNX ATX DEN3-124 6/15/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 70 LB-FT (95.2 N·M)
OUTPUT TORQUE:

INPUT SPEED RPM
0 50 100 150 200 250 300 350 400 450 500

OUTPUT SPEED RPM
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000
1981 MERCURY LYNX ATX DEN3-124 6/15/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 70 LB-FT (95.2 N·M)
OUTPUT TORQUE
1981 MERCURY LYNX ATX D6N3-124 6/15/81
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 80 LB-FT (108.8 N-M)
OUTPUT TORQUE:

TORQUE RATIO T0/T1

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DEN3-124 6/15/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 80 LB-FT (108.8 N-M)
OUTPUT TORQUE: 

INPUT SPEED RPM

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DEN3-124 6/15/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 80 LB-FT (109.8 N-M)
OUTPUT TORQUE:
DRIVE PERFORMANCE

2nd Gear
Graphs Contained in This Section

Torque Ratio -vs- Output Speed
Output Torque -vs- Output Speed
Input Speed -vs- Output Speed
Efficiency -vs- Output Speed
Efficiency -vs- Power Out

Drive Performance Tests
1981 MERCURY LYNX ATX DEN3-124 6/5/81
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 10 Lb-FT (13.6N-m)
OUTPUT TORQUE:

OUTPUT SPEED RPM

TORQUE RATIO To/Ti

0 100 200 300 400 500 600 700 800 900 1000

0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
1981 MERCURY LYNX ATX DENG-124 6/5/81
OUTPUT TORQUE VS: OUTPUT SPEED
GEAR: RANGE  12000  8700  5400  2100
INPUT TORQUE  10 LBF-FT (13,6 N-M)
OUTPUT TORQUE
1981 MERCURY LYNX ATX DEN3-124 6/5/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 10 LB-FT (13.6 N-M)
OUTPUT TORQUE:
1981 MERCURY LYNX ATX DEN3-124 6/5/81
OUTPUT TORQUE VS. OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 20 LB-FT (27.2 N-M)
OUTPUT TORQUE

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DSM-124 6/8/81
INPUT SPEED VS OUTPUT SPEED
GEAR RATIO: SECOND
INPUT TORQUE: 20 LB-FT (27.2 N·M)
OUTPUT TORQUE: 150
EFFICIENCY VS OUTPUT SPEED

1981 MERCURY LYNX ATX DEN3-124 6/5/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 20 LB-FT (27.2 N-M)
OUTPUT TORQUE
1981 MERCURY LYNX ATX DEN3-124 6/6/81
EFFICIENCY VS POWER OUT

GEAR RANGE: SECOND
INPUT TORQUE: 20 LB-FT (27.2 N-M)
OUTPUT TORQUE:

EFFICIENCY %

POWER OUT

100 90 80 70 60 50 40 30 20 10 0

0 1 2 3 4 5 6 7 8 9 10 HP
1981 MERCURY LYNX ATX 1375 24 6/5/81
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 30 LB-FT (40.8 N-M)
OUTPUT TORQUE:

TORQUE RATIO TO/T

OUTPUT SPEED RPM

0 100 200 300 400 500 600 700 800 900 1000

0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
1981 MERCURY LYNX ATX DEN3-124 6/5/81
OUTPUT TORQUE VS. OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 30 LB-FT (40.8 N-M)
OUTPUT TORQUE: 200 N-M, 244 LB-FT
OUTPUT SPEED: 0 - 1000 RPM

Graph showing the relationship between output torque and output speed for a 1981 Mercury Lynx ATX DEN3-124 vehicle for gear range second, with input torque of 30 LB-FT (40.8 N-M) and output torque of 200 N-M, 244 LB-FT across the range of output speeds from 0 to 1000 RPM.
INPUT SPEED RPM

OUTPUT SPEED RPM

1981 MERCURY LYNX RTX DEN3-124 6/5/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 30 LB-FT (40.8 N-M)
OUTPUT TORQUE:

0 100 200 300 400 500 600 700 800 900 1000

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000
1981 MERCURY LYNX ATX DEN3-124 6/5/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 30 LB-FT (40.8 N·M)
OUTPUT TORQUE

INPUT SPEED RPM

OUTPUT SPEED RPM

EFFICIENCY %
1981 MERCURY LINX ATX DEN3-124 6/5/81
EFFICIENCY VS POWER OUT
GEAR RANGE SECOND
INPUT TORQUE 30 LB-FT (40.8 N·M)
OUTPUT TORQUE

POWER OUT

EFFICIENCY %
1981 MERCURY LYNX AX HEN3-124 6/5/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 40 LB-FT (54.4 N-M)
OUTPUT TORQUE: 
1981 MERCURY LYNX ATX DEN3-124 6/5/81
EFFICIENCY VS POWER OUT

GEAR RANGE: SECOND
INPUT TORQUE: 40 LB-FT (54.4 N-M)
OUTPUT TORQUE

EFFICIENCY %

POWER OUT

0 3 7 11 14 18 22 26 29 33 KW 37
1981 MERCURY LYNX ATX DEN3-124 6/5/81
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 50 LB-FT (68N-M)
OUTPUT TORQUE

OUTPUT SPEED RPM

[Graph showing the relationship between output torque and output speed.]
1981 MERCURY LYNX ATX DEN3-124 6/5/81
EFFICIENCY VS POWER OUT
GEAR RANGE 50:1 FTLB (68N-M)
INPUT TORQUE 1000 HP 50
OUTPUT TORQUE
1981 MERCURY LYNX ATX DEN3-124 6/5/81
EFFICIENCY VS OUTPUT SPEED

- GEAR RANGE
- SECOND

- INPUT TORQUE: 60 LB-FT (81.6 N-M)
- OUTPUT TORQUE
1981 MERCURY LYNX ATX DEN3-124 6/5/81

EFFICIENCY VS POWER OUT

GEAR RANGE: SECOND

INPUT TORQUE: 60 LB-FT (81.6 N-M)

OUTPUT TORQUE:

EFFICIENCY %

POWER OUT
1981 MERCURY LYNX ATX DEN3-124 6/5/81
OUTPUT TORQUE VS. OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 70 LB-FT (95.2 N-M)
OUTPUT TORQUE: 0 - 500 N-M (0 - 400 LB-FT)
OUTPUT SPEED RPM: 0 - 1000 RPM
INPUT SPEED VS OUTPUT SPEED

1981 MERCURY LYNX ATX DEN3-124 6/5/81

INPUT SPEED VS OUTPUT SPEED

GEAR RANGE: SECOND
INPUT TORQUE: 70 LB-FT (95.2 N-M)
OUTPUT TORQUE: 

INPUT SPEED RPM

OUTPUT SPEED RPM

0 100 200 300 400 500 600 700 800 900 1000

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000
1981 MERCURY LYNX ATX DEN3-124 6/5/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 70 LB-FT (95.2 N-M)
OUTPUT TORQUE:
1981 MERCURY LYNX ATX DEN3-124 6/5/81
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 80 LB-FT (108.8 N-M)
OUTPUT TORQUE

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DEN3-124 6/5/81
INPUT SPEED VS OUTPUT SPEED
GEAR RATIO: 2:1
INPUT TORQUE: 30 LB-FT (108.8 N-M)
OUTPUT TORQUE:
Efficiency vs Power Out

Gear Range: Second
Input Torque: 80 lb-ft (108.8 N·m)
Output Torque: 

1981 Mercury Lynx ATX V6N3-124 6/5/81
DRIVE PERFORMANCE

3rd Gear
Graphs Contained in This Section

Torque Ratio -vs- Output Speed
Output Torque -vs- Output Speed
Input Speed -vs- Output Speed
Efficiency -vs- Output Speed
Efficiency -vs- Power Out

Drive Performance Tests
1981 MERCURY LYNX ATX 5/7/81 VEN3 ± 124
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 10 LB-FT (13.6 N-M)
OUTPUT TORQUE:
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
EFFICIENCY VS POWER OUT
GEAR RANGE: THIRD
INPUT TORQUE: 10 LB-FT (13.6 N-M)
OUTPUT TORQUE: 

POWER OUT

0 1 2 3 4 5 6 7 8 9 10 HP

0 1 2 3 4 5 6 7 8 9 10 KW
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 20 LB-FT (27.2 N-M)
OUTPUT TORQUE

TORQUE RATIO T0/T1

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 20 LB-FT (27.2 N-M)
OUTPUT TORQUE
OUTPUT SPEED RPM

OUTPUT SPEED RPM
1981 MERCURY LYNX HTX 5/2/81 DENG-124
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 20 LB-F (27.2 N·M)
OUTPUT TORQUE:

EFFICIENCY %

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX 5/2/81 DENG-124
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 30 LB-FT (41.8 N-M)
OUTPUT TORQUE:
1981 MERCURY LYNX ATX 5/2/81 DENG-124
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 40 LB-FT (54.4 N·M)
OUTPUT TORQUE: 

OUTPUT SPEED RPM
1981 MERCURY LYNX MTX 5/2/81 DEN3-124

OUTPUT TORQUE VS. OUTPUT SPEED

GEAR RANGE: THIRD

INPUT TORQUE: 40 LB-FT (54.4 N-M)

OUTPUT TORQUE:
1981 MERCURY LYNX ATX 5/3/81 D3N3+124
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 40 LB-FT (54.4 N-M)
OUTPUT TORQUE:

INPUT SPEED RPM

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 40 LB-FT (54.4 N-M)
OUTPUT TORQUE: 

EFFICIENCY %

OUTPUT SPEED RPM
1981 MERCURY LYNX 5/3/81 DENSO-124
EFFICIENCY VS POWER OUT
GEAR RANGE: THIRD
INPUT TORQUE: 40 LB-FT (54.4 N-M)
OUTPUT TORQUE
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 50 LB-FT (68 N-M)
OUTPUT TORQUE:

PLEASE PROVIDE THE RELEVANT TEXT FOR THIS IMAGE AS NEED TO REVIEW IT.
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
OUTPUT TORQUE VS. OUTPUT SPEED
GEAR RANGE
THIRD
INPUT TORQUE: 50 LB-FT (68 N-M)
OUTPUT TORQUE:
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
EFFICIENCY VS POWER OUT
GEAR RANGE: THIRD
INPUT TORQUE: 50 LB-FT (68 N-M)
OUTPUT TORQUE:
TORQUE RATIO T0/T1

1981 MERCURY LYNX ATX 5/2/81 DEN3+124
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 60 LB-FT (81.6 N-M)
OUTPUT TORQUE:

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 60 LB-FT (81.6 N-M)
OUTPUT TORQUE

OUTPUT SPEED RPM

OUTPUT TORQUE

LB-FT

N-M

27

20

2

0

0

200

400

600

800

1000

1200

1400

1600

1800

2000

271

200

244

180

217

160

210

140

190

120

163

100

136

80

106

60

163

20

0
INPUT SPEED VS OUTPUT SPEED

- Gear Range: THIRD
- Input Torque: 60 LB-FT (81.6 N-M)
- Output Torque:

1981 MERCURY LYNX ATX 5/2/81 DEN3-124

INPUT SPEED RPM

OUTPUT SPEED RPM
EFFICIENCY %

1981 MERCURY LYNX ATX 5/2/81 DEN3-124
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 80 LB-FT (113 N-M)
OUTPUT TORQUE:

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
EFFICIENCY VS POWER OUT
GEAR RANGE: THIRD
INPUT TORQUE: 60 LB-FT (81;6N-M)
OUTPUT TORQUE: 

EFFICIENCY %

0 5 10 15 20 25 30 35 40 45 HP 50

POWER OUT

0 3 7 11 14 18 22 26 29 33 KW 37
1981 MERCURY LYNX ATX 5/8/81 DENO-124
OUTPUT TORQUE VS OUTPUT SPEED

GEAR RANGE: THIRD
INPUT TORQUE: 70 LB-FT (95.2 N-M)
OUTPUT TORQUE

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 80 LB-FT (108.8 N-M)
OUTPUT TORQUE: 0.0
OUTPUT SPEED RPM: 0 - 2000
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
OUTPUT TORQUE VS. OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 80 LB-FT (108.8 N-M)
OUTPUT TORQUE

OUTPUT SPEED RPM
INPUT SPEED RPM

OUTPUT SPEED RPM

1981 MERCURY LYNX ATX 5/2/81 DEN5-124
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 80 LB-FT (108.8 N·M)
OUTPUT TORQUE:
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 80 LB-FT (108.8 N-m)
OUTPUT TORQUE

EFFICIENCY %

OUTPUT SPEED RPM
0 200 400 600 800 1000 1200 1400 1600 1800 2000
CROSS SECTIONAL ROAD LOAD PERFORMANCE

3rd Gear
Graphs Contained in This Section

Torque Ratio -vs- Output Speed
Output Torque -vs- Output Speed
Input Speed -vs- Output Speed
Efficiency -vs- Output Speed
Efficiency -vs- Power Out

Drive Performance Tests
1981 MERCURY LYNX ATX 5/2/81 DEN3+124
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 25 LB-FT (34 N-M)
INPUT TORQUE: 25 LB-FT (34 N-M)
OUTPUT TORQUE VS. OUTPUT SPEED

1981 MERCURY LYNX ATX 5/2/81 DENV-124

INPUT TORQUE: 25 LB-FT (34 N-M)

OUTPUT SPEED RPM

OUTPUT TORQUE N-M LB-FT
1981 MERCURY LYNX 5/2/81 DEN3-124
OUTPUT TORQUE VS. OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 47 LB-FT (63.9 N-M)
OUTPUT SPEED RPM
INPUT SPEED RPM

OUTPUT SPEED RPM

1981 MERCURY LYNX ATX 5/2/81 DEN3-124
INPUT SPEED VS OUTPUT SPEED
GEAR: RANGE: THIRD
INPUT TORQUE: OUTPUT TORQUE: 47 LB-FT (63.9 N-M)
1981 MERCURY LYNX ATX 5/2/81 REN3-124
Eﬃciency vs Output Speed
Gear Range: Third
Input Torque: 47 lb-ft (63.9 N·m)
Output Torque: 0
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
EFFICIENCY VS POWER OUT
GEAR RANGE: THIRD
INPUT TORQUE: OUTPUT TORQUE: 79 LB-FT (107.4 N-M)

EFFICIENCY %

POWER OUT

0 2 4 6 8 10 12 14 16 18 20 HP
0 1 2 4 5 7 8 10 11 13 14 Kw
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 110 LB-FT (149.6 N-M)
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 110 LB-FT (149.6 N-M)
OUTPUT TORQUE: 120 N-M (168 LB-FT)
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 110 LB-FT (149.6 N-M)
OUTPUT TORQUE:
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
EFFICIENCY VS POWER OUT
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 110 LB-FT (159,6 N·M)

POWER OUT
EFFICIENCY %

OUTPUT SPEED RPM

1981 MERCURY LYNX HTX 5/2/81 DENG-124

EFFICIENCY VS OUTPUT SPEED

GEAR RANGE: THIRD

INPUT TORQUE

OUTPUT TORQUE: 145 LF-FT (197,2N-M)
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
EFFICIENCY VS POWER OUT
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 145 LB-FT (197.2 N-M)
1981 MERCURY LYNX 5/2/81 DEN3-124
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 177 L.E.-FT (240,7 N-M)
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 177 LB-FT (240.7 N-M)
1981 MERCURY LYNX ATX 5/3/81 DEN3-124
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 200 LB-FT (282.8 N-M)
1981 MERCURY LYNX RTX 5/2/81 DEN3+124
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 208 LB-FT (292,8N-M)
OUTPUT TORQUE:
1981 MERCURY LYNX ATM 5/2/81 DEN3=124
EFFICIENCY VS POWER OUT
GEAR RANGE: THIRD
INPUT TORQUE:
OUTPUT TORQUE: 206 LB-FT (282 EN-M)

POWER OUT
INPUT SPEED RPM

OUTPUT SPEED RPM

1981 MERCURY LYNX ATX 5/2/81 DEN3-124
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 243 LB-FT (330, EN-M)
1981 MERCURY LYNX ATX 5/2/81 DEN3-124
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 243 LB-FT (330.5 N-M)

EFFICIENCY %

OUTPUT SPEED RPM
COAST PERFORMANCE

1st Gear
Graphs Contained in This Section

- Torque Ratio -vs- Output Speed
- Output Torque -vs- Output Speed
- Input Speed -vs- Output Speed
- Efficiency -vs- Output Speed
- Efficiency -vs- Power Out

Coast Performance Tests
1981 MERCURY LYNX HTX DEN3-124 7/23/81
INPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE
OUTPUT TORQUE: 10 LB-FT (13.6 N·M)
INPUT SPEED RPM

OUTPUT SPEED RPM

1981 MERCURY LYNX ATX DEN3-124 7/23/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE: 10 LB-FT (13.6 N-M)
OUTPUT TORQUE: 10 LB-FT (13.6 N-M)
1981 MERCURY LYNX ATX D4N3-124 7/23/81
EFFICIENCY VS POWER OUT
GEAR RANGE: FIRST
INPUT TORQUE
OUTPUT TORQUE: 30 LB·FT (40 N·M)
1981 MERCURY LYNX ATX DEN3-124 7/23/81
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE:
FIRST
INPUT TORQUE:
OUTPUT TORQUE: 40 LB-FT (54.4 N-M)
EFFICIENCY %

1981 MERCURY LYNX ATX DFN3-124 7/23/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE
OUTPUT TORQUE: 10 LB-FT (54,4 N-M)

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DEN3-124 7/23/81
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: FIRST
INPUT TORQUE
OUTPUT TORQUE: 50 LB-FT (68N-M)

TORQUE RATIO T0/T1

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DEN3-124 7/23/81
EFFICIENCY VS POWER OUT
GEAR RANGE: FIRST
INPUT TORQUE
OUTPUT TORQUE: 50 LB-FT (GEN-M)
COAST PERFORMANCE

2nd Gear
Graphs Contained in This Section

Torque Ratio -vs- Output Speed
Output Torque -vs- Output Speed
Input Speed -vs- Output Speed
Efficiency -vs- Output Speed
Efficiency -vs- Power Out

Coast Performance Tests
1981 MERCURY LYNX ATX DEN3-124 7/14/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE:
OUTPUT TORQUE: 10 LB-FT (13.6 N-M)
OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DEN3-124 7/14/81
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: OUTPUT TORQUE: 20 LF-FT (27.2 N-M)

TORQUE RATIO T0/T1

OUTPUT SPEED RPM

0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000
1981 MERCURY LYNX ATX D2N3-124 7/14/81
OUTPUT TORQUE VS. OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE
OUTPUT TORQUE: 20 LB-FT (27.2 N-M)
1981 MERCURY LYNX ATX D63-124 7/14/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE
OUTPUT TORQUE: 20 LB-FT (27.2N-m)
1981 MERCURY LYNX ATX DEN3-124 7/14/81

EFFICIENCY VS OUTPUT SPEED

OUTPUT SPEED RPM

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000

EFFFICIENCY %

0 10 20 30 40 50 60 70 80 90 100

OUTPUT TORQUE: 30 LB-FT (40; EN-M)
1981 MERCURY LYNX ATX DEN3-124 7/14/81
OUTPUT TORQUE VS. OUTPUT SPEED

Gear: Range: Second
Input Torque: 40 LB-FT (54.4 N-M)
Output Torque:
1981 MERCURY LYNX ATX DENG-124 7/14/81
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE
OUTPUT TORQUE: 50:LB-FT(68N-M)
1981 MERCURY LYNX ATX DENS-124 7/14/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE SECOND
INPUT TORQUE
OUTPUT TORQUE 50 LB-FT (68N-M)

OUTPUT SPEED RPM

INPUT SPEED RPM
1981 MERCURY LYNX HTX MEND-124 7/14/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE
OUTPUT TORQUE: 50 lb-ft (68 N-m)

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DEN3-124 6/15/81
OUTPUT TORQUE VS. OUTPUT SPEED
GEAR: RANGE Second
INPUT TORQUE: 60 LB-FT (81.6 N-M)
OUTPUT TORQUE: 250 to 450 N-M (280 to 500 LB-FT)
EFFICIENCY VS OUTPUT SPEED

1981 MERCURY LYNX ATX PMS-124 7/14/81
GEAR RANGE: SECOND
INPUT TORQUE
OUTPUT TORQUE: 60 LB-FT (816N-M)

EFFICIENCY %

OUTPUT SPEED RPM
OUTPUT TORQUE VS. OUTPUT SPEED

1981 MERCURY LYNX RTX DEN3-124 7/14/81
INPUT TORQUE 70 LB-FT (95.2 N-M)
OUTPUT TORQUE

OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DEN3-124 7/14/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 70 LB-FT (95.2 N-M)
OUTPUT TORQUE:
1981 MERCURY LYNX RX DEN3-124 7/14/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 70 lb-ft (95,2N-m)
OUTPUT TORQUE: 

EFFICIENCY %

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000
OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DEN3-124 7/14/81
EFFICIENCY VS POWER OUT

GEAR RANGE: SECOND
INPUT TORQUE: 70 LB-FT (952 N-M)
OUTPUT TORQUE: 

EFFICIENCY %

POWER OUT

0 5 10 15 20 25 30 35 40 45 50
0 3 7 11 14 18 22 26 29 33 KW 37
1981 MERCURY LYNX ATX DEN3-124 7/14/81
OUTPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE: 80 LB-FT (108.8 N·M)
OUTPUT TORQUE: 80 LB-FT (108.8 N·M)
1981 MERCURY LYNX RTX DEN3-124 7/14/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: SECOND
INPUT TORQUE
OUTPUT TORQUE: 80 LB-FT (108.8 N-M)
1981 MERCURY LYNX ATX DEN3-124 7/14/81
EFFICIENCY VS POWER OUT

GEAR RANGE: SECOND

INPUT TORQUE

OUTPUT TORQUE: 80 LB-FT (108.7N-M)
COAST PERFORMANCE

3rd Gear
Graphs Contained in This Section

Torque Ratio -vs- Output Speed
Output Torque -vs- Output Speed
Input Speed -vs- Output Speed
Efficiency -vs- Output Speed
Efficiency -vs- Power Out

Coast Performance Tests
INPUT SPEED RPM

OUTPUT SPEED RPM

INPUT SPEED VS OUTPUT SPEED

GEAR RANGE: THIRD

INPUT TORQUE

OUTPUT TORQUE: 10 LB-FT (13.6 N-M)

1981 MERCURY LYNN HTX DEN3-124 7/15/81

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000

0 200 400 600 800 1000 1200 1400 1600 1800 2000

268
1981 MERCURY LYNX HIX DEN3-124 7/15/81
EFFICIENCY VS POWER OUT
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 10 LB-FT (13 GN-M)
1981 MERCURY LYNX ATX DEN3-124 7/23/81
INPUT TORQUE VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 20 LB-FT (27.24 N-M)
OUTPUT SPEED RPM
1981 MERCURY LYNX ATX DEN3-124 7/15/81

INPUT SPEED VS OUTPUT SPEED

GEAR: RANGE: THIRD
INPUT TORQUE: 20;LD-FT(27;2N-M)
OUTPUT TORQUE: 20;LD-FT(27;2N-M)
1981 MERCURY LYNX ATX DEN3-124 7/15/81
EFFICIENCY VS POWER OUT
GEAR RANGE: THIRD
INPUT TORQUE: 20 LB-FT (27.2 N-M)
OUTPUT TORQUE: 20 LB-FT (27.2 N-M)
1981 MERCURY LYNX HTX DEN3-124 7/15/81
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 30 LB-FT (40; 3N-M)
1981 MERCURY LYNX ATX 124 7/23/81
INPUT TORQUE VS. OUTPUT SPEED

GEAR RANGE: THIRD

INPUT TORQUE: 20 LB-FT (24 N-M)
OUTPUT TORQUE: 30 LB-FT (40 N-M)
1981 MERCURY LYNX ATX DEN3-124 7/15/81
EFFICIENCY VS POWER OUT
GEAR RANGE: THIRD
INPUT TORQUE: 30 LI-FT (40;8N-M)
OUTPUT TORQUE: 33 KW 37
1981 MERCURY LYNX HTX DEN3-124 7/15/81
TORQUE RATIO VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 40 LB-FT (54.4 N·M)
1981 MERCURY LYNX ATX BEN3-124 7/15/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 440 LBF-FT (60.2 N·M)
OUTPUT TORQUE: 40 LBF-FT (54.4 N·M)
1981 MERCURY LYNX ATX DFN3-124 7/15/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 50 LB-FT (68 N-M)

EFFICIENCY % vs OUTPUT SPEED RPM
INPUT SPEED RPM

OUTPUT SPEED RPM

1981 MERCURY LYNX ATX D3-124 7/15/81
INPUT SPEED VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE
OUTPUT TORQUE: 60 LB-FT (81 GN-M)
1981 MERCURY LYNX ATX DEN3-124 7/15/81
EFFICIENCY VS OUTPUT SPEED
GEAR RANGE: THIRD
INPUT TORQUE: 60 LB-FT (215N-M)
OUTPUT TORQUE: 70 LB-FT (95.2 N-M)

INPUT TORQUE VS OUTPUT SPEED (7/23/81)

1981 MERCURY LYNX ATX DEN3-124

INPUT TORQUE

OUTPUT SPEED RPM

GAIN RANGE: THIRD

INPUT TORQUE

OUTPUT TORQUE

N-M (LB-FT)

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000
Graphs Contained in This Section

Torque Loss -vs- Input Speed

No Load Losses
NO LOAD LOSSES

1st Gear (Closed Throttle)
NO LOAD LOSSES

1st Gear (Open Throttle)
1981 MERCURY LYNX ATX DEN3-124 6/15/81
TORQUE LOSS VS INPUT SPEED
GEAR RANGE: FIRST OPEN THROTTLE
INPUT TORQUE: OUTPUT TORQUE

TORQUE LOSS

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000
INPUT SPEED RPM

13.6 12.2 11 9.5 8.1 6.8 5.4 4 2.7 1.3 0
N-M LB-FT
NO LOAD LOSSES

2nd Gear (Closed Throttle)
1981 MERCURY LYNX ATX DEN3-124 6/15/81
TORQUE LOSS VS INPUT SPEED
GEAR RANGE SECOND CLOSED THROTTLE
INPUT TORQUE OUTPUT TORQUE

TORQUE LOSS vs INPUT SPEED

<table>
<thead>
<tr>
<th>Input Speed (RPM)</th>
<th>Torque Loss (N-m/Lb-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.3</td>
</tr>
<tr>
<td>500</td>
<td>2.7</td>
</tr>
<tr>
<td>1000</td>
<td>4.0</td>
</tr>
<tr>
<td>1500</td>
<td>5.4</td>
</tr>
<tr>
<td>2000</td>
<td>6.8</td>
</tr>
<tr>
<td>2500</td>
<td>8.1</td>
</tr>
<tr>
<td>3000</td>
<td>9.5</td>
</tr>
<tr>
<td>3500</td>
<td>10.2</td>
</tr>
<tr>
<td>4000</td>
<td>12.2</td>
</tr>
<tr>
<td>4500</td>
<td>13.6</td>
</tr>
<tr>
<td>5000</td>
<td>14.0</td>
</tr>
</tbody>
</table>
NO LOAD LOSSES

2nd Gear (Open Throttle)
1981 MERCURY LYNX ATX DEM3-124 6/15/81
TORQUE LOSS VS INPUT SPEED
- GEAR RANGE
- SECOND OPEN THROTTLE
- INPUT TORQUE
- OUTPUT TORQUE

Torque Loss (N-m) vs Input Speed (RPM)
NO LOAD LOSSES

3rd Gear (Closed Throttle)
NO LOAD LOSSES

3rd Gear (Open Throttle)
1981 MERCURY LYNX ATX DEN3-124 6/15/81
TORQUE LOSS VS INPUT SPEED
GEAR RANGE = THIRD OPEN THROTTLE
INPUT TORQUE = OUTPUT TORQUE
APPE N D I X

ROOT MEAN SQUARE METHOD

TORQUE ERROR (HIMMELSTEIN) = \( \sqrt{(\text{TORQUE TRANS. ERROR})^2 + (\text{TAPE RECORDER ERROR})^2 + (\text{ANALYZER ERROR})^2} \)
\[ = \sqrt{(0.18)^2 + (0.05)^2 + (0.048)^2} = \pm 0.193\% \text{ of Full Scale} \]

TORQUE ERROR (LEBOW) = \( \sqrt{(\text{TORQUE TRANS. ERROR})^2 + (\text{TAPE RECORDER ERROR})^2 + (\text{ANALYZER ERROR})^2} \)
\[ = \sqrt{(0.41)^2 + (0.05)^2 + (0.048)^2} = \pm 0.416\% \text{ of Full Scale} \]

SPEED ERROR = \( \sqrt{(\text{SPEED SENSOR})^2 + (\text{SPEED CONDITIONER})^2 + (\text{TAPE RECORDER ERROR})^2 + (\text{ANALYZER ERROR})^2} \)
\[ = \sqrt{(0.025)^2 + (0.1)^2 + (0.05)^2 + (0.048)^2} = \pm 0.142\% \text{ of Full Scale} \]

POWER OUT ERROR = \( \sqrt{(\text{TORQUE ERROR (LEBOW)})^2 + (\text{SPEED ERROR})^2 + (\text{COMPUTER CALCULATION ERROR})^2} \)
\[ = \sqrt{(0.416)^2 + (0.124)^2 + (0.5)^2} = \pm 0.662\% \text{ of Full Scale} \]

EFFICIENCY ERROR = \( \sqrt{(\text{TORQUE ERROR (LEBOW)})^2 + (\text{SPEED ERROR})^2 + (\text{TORQUE ERROR (HIMM)})^2 + (\text{SPEED ERROR})^2 + (\text{COMPUTER CALCULATION ERROR})^2} \)
\[ = \sqrt{(0.416)^2 + (0.124)^2 + (0.193)^2 + (0.124)^2 + (0.5)^2} = \pm 0.701\% \text{ of Full Scale} \]

SUM OF ERROR METHOD

TORQUE ERROR (HIMMELSTEIN) = (TORQUE TRANSDUCER ERROR) + (TAPE RECORDER ERROR) + (ANALYZER ERROR)
\[ = (0.18) + (0.05) + (0.048) = \pm 0.278\% \text{ of Full Scale} \]

TORQUE ERROR (LEBOW) = (TORQUE TRANS. ERROR) + (TAPE RECORDER ERROR) + (ANALYZER ERROR)
\[ = (0.41) + (0.05) + (0.048) = \pm 0.508\% \text{ of Full Scale} \]

SPEED ERROR = (SPEED SENSOR) + (SPEED CONDITIONER) + (TAPE RECORDER ERROR) + (ANALYZER ERROR)
\[ = (0.025) + (0.1) + (0.05) + (0.048) = \pm 0.223\% \text{ of Full Scale} \]

POWER OUT ERROR = (TORQUE ERROR (LEBOW)) + (SPEED ERROR) + (COMPUTER CALCULATION ERROR)
\[ = (0.508) + (0.124) + (0.5) = \pm 1.132\% \text{ of Full Scale} \]

EFFICIENCY ERROR = (TORQUE ERROR (LEBOW)) + (SPEED ERROR) + (TORQUE ERROR (HIMM)) + (SPEED ERROR) + (COMPUTER CALCULATION ERROR)
\[ = (0.508) + (0.223) + (0.278) + (0.223) + (0.5) = \pm 1.732\% \text{ of Full Scale} \]
The inter number computer calculation error was determined by taking a set of sample calculations and comparing the accurate multiplication to the computer multiplication. A sample comparison is given below.

DATA DRIVE
PERFORMANCE

\[ T_i = 80 \text{ LB-FT} \]

<table>
<thead>
<tr>
<th>ACCURACY CALCULATION</th>
<th>COMPUTER CALCULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_i = 80.8853 ), ( T_o = 241.4830 )</td>
<td>( T_o/T_i = 2.9855 ), ( T_o/T_i = 2.9849 )</td>
</tr>
</tbody>
</table>

Comparison = \( \frac{(2.9855 - 2.9849)}{2.9855} \times 100 = 0.020\% \)

Since every calculation was not checked in this manner, a factor of safety was added to 0.020\%, and 0.5\% was used as the inter number computer calculation error.
OTHER MANUALS

To locate specific manuals in the documentation shipped with the system, refer to the System Configuration Notice for the contents of each binder.

SYSTEM SPECIFICATIONS & CHARACTERISTICS

The specifications in Table 1-1 describe the system’s warranted performance. Those items under the heading of “Characteristics” go beyond the guaranteed specifications and give typical performance for some additional parameters and operations. These are included only to give you information which may be useful in applying the system.

Table 1-1. System Specifications and Characteristics

<table>
<thead>
<tr>
<th>SPECIFICATIONS</th>
<th>EXECUTION TIMES*</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANALOG-TO-DIGITAL CONVERTER</td>
<td>Fourier Transform: &lt;55 ms</td>
</tr>
<tr>
<td>Input Voltage Range: ±0.125V to ±5V peak in steps of 2.</td>
<td>Stable Power Spectrum Average: &lt;80 ms</td>
</tr>
<tr>
<td>Input Channels: dc or ac.</td>
<td>Stable Tri-Spectrum Average: &lt;220 ms</td>
</tr>
<tr>
<td>Input Coupling: 2 channels wired for 4 standard, 4 channels optional with plug-in cards.</td>
<td></td>
</tr>
<tr>
<td>Resolution: 12 bits including sign.</td>
<td></td>
</tr>
<tr>
<td>Input Frequency Range: dc to 50 kHz, 5 Hz to 50 kHz, ac coupled ±100 kHz optional.</td>
<td></td>
</tr>
<tr>
<td>Sample Rate:</td>
<td></td>
</tr>
<tr>
<td>Internal: 100 kHz max. (1, 2, 3, or 4 channels simultaneously).</td>
<td>Fourier Transform: &gt;7.5 kHz</td>
</tr>
<tr>
<td>Input Frequency Range: 100 kHz optional on 1, 2, 3, or 4 channels.)</td>
<td>Stable Power Spectrum Average: ±4 kHz</td>
</tr>
<tr>
<td>External: An external time base may be used to allow external control of the sampling rate up to 100 kHz (±200 kHz optional).</td>
<td>Stable Tri-Spectrum Average: ±1.9 kHz</td>
</tr>
<tr>
<td>One sample can be taken for each clock pulse (ITL level).</td>
<td></td>
</tr>
<tr>
<td>Internal Clock Accuracy: ±0.01%.</td>
<td></td>
</tr>
</tbody>
</table>

DISPLAY UNIT

<table>
<thead>
<tr>
<th>VERTICAL SCALING</th>
<th>MAXIMUM REAL TIME DATA ACQUISITION RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Scale Calibration: Data in memory is automatically scaled to give a maximum on-screen calibrated display. The scale factor is given in volts/division, volts/division, or dB offset.</td>
<td>(Single Channel):</td>
</tr>
<tr>
<td>Log Display Range: 80 dB with a scale factor ranging from 0 to ±998 dB. Offset selectable in 4 dB steps.</td>
<td>BS 256: 10 kHz</td>
</tr>
<tr>
<td>Linear Display Range: ±4 divisions with scale factor ranging from 1 x 10^-12 to 5 x 10^-12 in steps of 1, 2, and 4.</td>
<td>BS 1024: 39 kHz (±25 kHz)</td>
</tr>
<tr>
<td>Digital UP/DOWN Scale: Allows 8 up-scale and 2 down-scale steps (calibrated continuous scale factor).</td>
<td>BS 4096: 80 kHz (±30 kHz)</td>
</tr>
<tr>
<td>Horizontal Scale Calibration:</td>
<td></td>
</tr>
<tr>
<td>Linear Sweep Length: 10, 10.24 or 12.8 divisions.</td>
<td></td>
</tr>
<tr>
<td>Log Horizontal: 0.5 decades/division.</td>
<td></td>
</tr>
<tr>
<td>Markers: Intensity markers every 8th or every 32nd point.</td>
<td></td>
</tr>
</tbody>
</table>

BASE SOFTWARE

<table>
<thead>
<tr>
<th>Transform Accuracy:</th>
<th>OFF-LINE BSFA SOFTWARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>The expected rms value of computational error introduced in either the forward or inverse FFT will not exceed 0.1% of the rms value of the transform result.</td>
<td>Center Frequency Range: dc to one-half the Real Time Data Acquisition Rate</td>
</tr>
<tr>
<td>Dynamic Range: &gt;75 dB for a minimum detectable spectral component in the presence of one full scale spectral component after twenty ensemble averages for a block size of 1024.</td>
<td>Center Frequency Resolution: Continuous resolution to the limit of the frequency accuracy for center frequencies &gt;0.02% of the sampling frequency.</td>
</tr>
<tr>
<td>CENTER FREQUENCY ACCURACY</td>
<td>Frequency Accuracy: ±0.01%</td>
</tr>
<tr>
<td>Bandwidth Selection: In steps of 1/5n where n = 2, 3, 4, etc.</td>
<td>Bandwidth Selection: In steps of 1/5n where n = 2, 3, 4, etc.</td>
</tr>
<tr>
<td>Max. Resolution Enhancement: &gt;400</td>
<td>Max. Resolution Enhancement: &gt;400</td>
</tr>
<tr>
<td>Dynamic Range:* 90 dB from peak out-of-band spectral component to the peak level of the passband noise.</td>
<td></td>
</tr>
<tr>
<td>80 dB from peak in-band spectral component to the peak level of the passband noise.</td>
<td></td>
</tr>
<tr>
<td>Out-of-Band Rejection: &gt;90 dB</td>
<td></td>
</tr>
<tr>
<td>Passband Flatness of the Digital Filter: ±0.01 dB</td>
<td></td>
</tr>
</tbody>
</table>

ENVIRONMENTAL CONDITIONS

<table>
<thead>
<tr>
<th>Temperature Range: 0°C to 40°C</th>
<th>ENVIRONMENTAL CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>For band limited random noise type signals at block size 1024, no display, no Hanning.</td>
<td>Temperature Range: 0°C to 40°C (±10°C)</td>
</tr>
<tr>
<td>After eight ensemble averages of a power spectrum at block size 1024. Reduced by 10 dB at the exact center of the band.</td>
<td>Temperature Range: 0°C to 40°C (±10°C)</td>
</tr>
<tr>
<td>These rates apply to systems with modules 5456A and 5453A/B having a serial prefix lower than 1842.</td>
<td>Temperature Range: 0°C to 40°C (±10°C)</td>
</tr>
</tbody>
</table>
FM RECORD/REPRODUCE SPECIFICATIONS

Input Sensitivity: 0.1 to 2.5 volts rms; adjustable with input attenuator for ±40% deviation. Can be extended to 10 volts.

Nominal Input Level: ±1.4 volts peak.

Nominal Input Impedance: 100 K ohms resistive, shunted by less than 100 pf, unbalanced to ground.

Frequency Response:

Flat Amplitude Filter DC to 20 KHz, at 60 ips, ±0.5 db; ±40 deviation.

Linear Phase Filter DC to 12 KHz, at 60 ips, ±0.5 db; ±40% deviation.

DC to 20 KHz at 60 ips, ±0.5, -3 db; ±40% deviation.

Frequency Responses (Optional): DC to 80 KHz at 120 ips using ±40% deviation with IRIG intermediate band center frequency of 432 KHz. Upper frequency limit and center frequencies are proportionately lower at lower speeds, to 3-3/4 ips.

DC to 10 KHz at 60 ips using ±40% deviation with IRIG low band frequency of 54 KHz for improved S/N ratios. Upper frequency limit and center frequencies are proportionately lower at lower speeds.

DC Drift (Oscillator and Discriminator): Less than ±0.5% of peak-to-peak deviation per 10°F after 20 minute warm-up.

Signal/Noise Ratio 46 db at 60 ips.
DC Linearity: Less than ±0.5% of peak-to-peak deviation reference to best straight line through zero.

AC Distortion: Less than 1.5% total harmonic distortion at all speeds.

Transient Response (60 ips):
- Flat Amplitude Filter (+1/2 db) Rise Time (10% to 90% points) - 22 microseconds. Overshoot - less than 15%.
- Linear Phase Filter (+1/2, -3 db) Rise Time (10% to 90% points) - 18 microseconds. Overshoot - less than 2.5%.

Output Level (±40% deviation): ±1.4 volts peak, into 1000 ohms, with short circuit protection (SCP).

Output Current (±40% deviation): ±3 milliamperes peak with SCP.

Output Impedance: Less than 50 ohms, unbalanced to ground, with SCP.

GENERAL

Configuration: One standard 19 inch wide equipment enclosure for 14 channel FM or Direct Record/Reproduce System. For 28-32 vdc operation. Additional enclosure furnished for operation from other power supplies. Optional Rack Mounting Kit available.

Recorder Size (28-32 v): 26-1/8 inches high by 19 inches wide by 12 inches deep for a 7 channel-6 speed record/reproduce system or a 14 channel-6 speed record, 2 speed reproduce system. Additional enclosure (7-1/2 inches height) which attaches to portable
### Rotating Shaft Torque Sensors

**Model 1602**
> Low capacity torque sensors.

<table>
<thead>
<tr>
<th>Capacity (Oz. In.)</th>
<th>Max. Speed (RPM)</th>
<th>Model</th>
<th>Protected for Overloads to (Oz. In.)</th>
<th>Torsional Stiffness (Lb. In./Rad.)</th>
<th>Rotating Inertia (Lb.-In.²)</th>
<th>Weight (Lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>20,000</td>
<td>1602-50</td>
<td>150</td>
<td>400</td>
<td>.35</td>
<td>3/4</td>
</tr>
<tr>
<td>100</td>
<td>20,000</td>
<td>-100</td>
<td>300</td>
<td>1,000</td>
<td>.35</td>
<td>3/4</td>
</tr>
<tr>
<td>200</td>
<td>20,000</td>
<td>-200</td>
<td>600</td>
<td>2,500</td>
<td>.35</td>
<td>3/4</td>
</tr>
<tr>
<td>500</td>
<td>20,000</td>
<td>-500</td>
<td>1,500</td>
<td>5,500</td>
<td>.35</td>
<td>3/4</td>
</tr>
<tr>
<td>1,000</td>
<td>20,000</td>
<td>-1K</td>
<td>1,500</td>
<td>8,000</td>
<td>.35</td>
<td>3/4</td>
</tr>
</tbody>
</table>

**Models 1604, 1605 & 1607**
> Utility rotating shaft torque sensor recommended for general application.

<table>
<thead>
<tr>
<th>Capacity (Lb. In.)</th>
<th>Max. Speed (RPM)</th>
<th>Model</th>
<th>Protected for Overloads to (Lb. In.)</th>
<th>Torsional Stiffness (Lb. In./Rad.)</th>
<th>Rotating Inertia (Lb.-In.²)</th>
<th>Weight (Lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>15,000</td>
<td>1604-50</td>
<td>150</td>
<td>5,000</td>
<td>1.0</td>
<td>18</td>
</tr>
<tr>
<td>100</td>
<td>15,000</td>
<td>-100</td>
<td>300</td>
<td>13,500</td>
<td>1.0</td>
<td>18</td>
</tr>
<tr>
<td>200</td>
<td>15,000</td>
<td>-200</td>
<td>600</td>
<td>33,000</td>
<td>1.0</td>
<td>18</td>
</tr>
<tr>
<td>500</td>
<td>15,000</td>
<td>-500</td>
<td>1,500</td>
<td>85,000</td>
<td>1.0</td>
<td>18</td>
</tr>
<tr>
<td>1,000</td>
<td>15,000</td>
<td>-1K</td>
<td>3,000</td>
<td>150,000</td>
<td>1.0</td>
<td>18</td>
</tr>
<tr>
<td>2,000</td>
<td>15,000</td>
<td>-2K</td>
<td>6,000</td>
<td>225,000</td>
<td>1.0</td>
<td>18</td>
</tr>
<tr>
<td>2,000</td>
<td>15,000</td>
<td>1605-2K</td>
<td>6,000</td>
<td>700,000</td>
<td>3.25</td>
<td>28</td>
</tr>
<tr>
<td>5,000</td>
<td>15,000</td>
<td>-5K</td>
<td>15,000</td>
<td>950,000</td>
<td>3.25</td>
<td>28</td>
</tr>
<tr>
<td>10,000</td>
<td>15,000</td>
<td>-10K</td>
<td>20,000</td>
<td>1,000,000</td>
<td>3.25</td>
<td>28</td>
</tr>
<tr>
<td>20,000</td>
<td>4,000</td>
<td>1607-20K</td>
<td>60,000</td>
<td>6,800,000</td>
<td>52.0</td>
<td>75</td>
</tr>
<tr>
<td>50,000</td>
<td>4,000</td>
<td>-50K</td>
<td>150,000</td>
<td>11,800,000</td>
<td>57.0</td>
<td>75</td>
</tr>
<tr>
<td>100,000</td>
<td>4,000</td>
<td>-100K</td>
<td>150,000</td>
<td>19,950,000</td>
<td>180.0</td>
<td>75</td>
</tr>
</tbody>
</table>

**Model 1615**
> Standard flange housing mount with AND pads to match Army-Navy mountings standard.

**Model 1648**
> Flange drive units recommended for use when short length is mandatory.

<table>
<thead>
<tr>
<th>Capacity (Lb. In.)</th>
<th>Max. Speed (RPM)</th>
<th>Model</th>
<th>Protected for Overloads to (Lb. In.)</th>
<th>Torsional Stiffness (Lb. In./Rad.)</th>
<th>Rotating Inertia (Lb.-In.²)</th>
<th>Weight (Lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>15,000</td>
<td>1615A-50</td>
<td>150</td>
<td>1,500</td>
<td>1.0</td>
<td>24</td>
</tr>
<tr>
<td>100</td>
<td>15,000</td>
<td>-100</td>
<td>300</td>
<td>4,000</td>
<td>1.1</td>
<td>24</td>
</tr>
<tr>
<td>200</td>
<td>15,000</td>
<td>-200</td>
<td>600</td>
<td>10,000</td>
<td>1.2</td>
<td>24</td>
</tr>
<tr>
<td>500</td>
<td>15,000</td>
<td>-500</td>
<td>1,500</td>
<td>20,000</td>
<td>1.3</td>
<td>24</td>
</tr>
<tr>
<td>1K</td>
<td>15,000</td>
<td>-1K</td>
<td>1,500</td>
<td>25,000</td>
<td>1.4</td>
<td>24</td>
</tr>
<tr>
<td>50</td>
<td>15,000</td>
<td>1615K-50</td>
<td>75</td>
<td>1,620</td>
<td>1.04</td>
<td>25</td>
</tr>
<tr>
<td>100</td>
<td>15,000</td>
<td>-100</td>
<td>150</td>
<td>4,570</td>
<td>1.05</td>
<td>25</td>
</tr>
<tr>
<td>200</td>
<td>15,000</td>
<td>-200</td>
<td>300</td>
<td>12,900</td>
<td>1.06</td>
<td>25</td>
</tr>
<tr>
<td>500</td>
<td>15,000</td>
<td>-500</td>
<td>750</td>
<td>940,000</td>
<td>1.97</td>
<td>25</td>
</tr>
<tr>
<td>1,000</td>
<td>15,000</td>
<td>-1K</td>
<td>1,500</td>
<td>204,000</td>
<td>2.00</td>
<td>25</td>
</tr>
<tr>
<td>2,000</td>
<td>15,000</td>
<td>-2K</td>
<td>3,000</td>
<td>347,000</td>
<td>2.08</td>
<td>26</td>
</tr>
<tr>
<td>5,000</td>
<td>15,000</td>
<td>-5K</td>
<td>7,500</td>
<td>500,000</td>
<td>2.38</td>
<td>26</td>
</tr>
<tr>
<td>10,000</td>
<td>15,000</td>
<td>-10K</td>
<td>15,000</td>
<td>574,000</td>
<td>2.76</td>
<td>26</td>
</tr>
</tbody>
</table>

**GENERAL SPECIFICATIONS**: (All Models)

- **SENSOR**: Four arm bonded foil strain gage bridge
- **BRIDGE RESISTANCE**: 350 ohms nominal
- **BRIDGE VOLTAGE**: 20 volts maximum, 3 KHz
- **OUTPUT**: 2 to 2.5 millivolt/volt nominal
- **LINEARITY**: 0.1% of full scale
- **COMPENSATED TEMPERATURE RANGE**: 30°F to 150°F
- **USEABLE TEMPERATURE RANGE**: 0°F to 200°F
- **EFFECT OF TEMPERATURE ON ZERO**: .002% of full scale/°F
- **EFFECT OF TEMPERATURE ON OUTPUT**: .002% of reading/°F

---

**Lebow**
**DEN3-124**
TECHNICAL SPECIFICATION

MCRT® 6-02T Non-Contact Torquemeter

MAX. TORQUE—15,000 lb.-in.
SPEED — 0 - 7,500 rpm

GENERAL DESCRIPTION
The MCRT® 6-02T is a compact, high accuracy, flanged torquemeter well adapted for vehicle drive-line measurements and continuous monitoring and feedback applications. It uses a rotating strain gage torque bridge, temperature compensated for drift and modulus. The bridge is connected to a stationary electronic readout via integral, non-contact rotary transformers.

The torquemeter is immune to water, lubricants, coolants, vibration, etc. The elimination of slip-rings permits high accuracy low level measurements with long, maintenance-free life. Thrust and bending loads are inherently cancelled by the transducer design. An optional, integral non-contact speed pickup may be specified when ordering.

Linearity: 0.1%

Temperature Effects: From 75 to 175° F maximum drift is 0.2% of full scale and maximum error due to modulus change is 0.2% of reading.

Maximum Operating Temperature: 220° F, assuming permanent lubrication. Above 175° F, the maximum shaft speed may have to be derated.

Readout: Any carrier amplifier suitable for strain gage service may be used.

Excitation Voltage: 10 volts rms, maximum.
Nominal Output: 0.75 millivolts/volt [open circuit].

Standard Ratings:

<table>
<thead>
<tr>
<th>MODEL</th>
<th>FULL SCALE TORQUE (lb.-in.)</th>
<th>TORSIONAL STIFFNESS (lb.-in./rad.)</th>
<th>MAXIMUM BENDING MOMENT (lb.-in.)</th>
<th>MAXIMUM ROTATING INERTIA (in.-oz. sec.²)</th>
<th>MAXIMUM WEIGHT (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCRT® 6-02T</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- (1-3)</td>
<td>1,000</td>
<td>602,000</td>
<td>500</td>
<td>0.60</td>
<td>13.8</td>
</tr>
<tr>
<td>- (2-3)</td>
<td>2,000</td>
<td>1,375,000</td>
<td>1,000</td>
<td>0.60</td>
<td>13.8</td>
</tr>
<tr>
<td>- (4-3)</td>
<td>4,000</td>
<td>2,640,000</td>
<td>2,000</td>
<td>0.60</td>
<td>13.8</td>
</tr>
<tr>
<td>- (6-3)</td>
<td>6,000</td>
<td>2,430,000</td>
<td>3,000</td>
<td>0.90</td>
<td>17.0</td>
</tr>
<tr>
<td>- (10-3)</td>
<td>10,000</td>
<td>2,930,000</td>
<td>5,000</td>
<td>0.90</td>
<td>17.0</td>
</tr>
<tr>
<td>- (15-3)</td>
<td>15,000</td>
<td>3,530,000</td>
<td>5,500</td>
<td>0.90</td>
<td>17.0</td>
</tr>
</tbody>
</table>

Overload Capacity: 2 times full scale rating.

Shaft Speed: 0 to 7,500 rpm, bi-directional. Optional speed pickup produces 60 pulses per shaft revolution.

Construction: Load carrying members (flanges, shaft) are 17-4 PH high strength stainless steel.

NOTES:
[2] When combined axial and bending loads are present, the bending capacity must be de-rated. Consult factory.
[3] Stator should be compliantly restrained from rotating.
The Model 840 Frequency-to-Voltage Converter is a conditioner-amplifier module that accepts input signals in a wide range of frequencies, wave shapes, and voltage levels and produces standard system output voltages precisely proportional to the frequency or repetition rate of the input signal. It is intended for use in "800" systems for measurement of flow, rpm, and similar phenomena that can be derived from magnetic pickups, turbine flowmeters, or other frequency-producing sources.

Nine selectable frequency ranges accommodate virtually all mechanical measurement requirements. An internal crystal oscillator reference and adjustable output span allow precise calibration of the indicating device in terms of frequency, rpm, or any other chosen units appropriate to the particular measurement. In flow measurement, for example, the Model 840 can be used with the Model 890 Digital Indicator and calibrated, using the front panel controls, so as to indicate directly in gallons per minute or gallons per hour, provided only that the flowmeter K Factor (cycles per gallon) is known.

The Model 840 is also used in conjunction with the Model 862 Multiplier Module in an instrument that can display torque, rpm, and shaft horsepower in digital engineering units. Additional information on this and other instrument combinations is contained under the Model 862 description.

*If fluid specific gravity is also known, calibration can be made in units of mass flow, such as Pounds per Hour. For applications where specific gravity is subject to change, corrections can be entered manually on a calibrated dial (see Model 868, p 46) or applied automatically by a temperature sensing channel (see Model 862, page 42).* 

**SPECIFICATIONS**

**Input:**
- Type: any AC signal, grounded or floating, irrespective of waveform.
- Sensitivity: Three ranges (Lo, Med, & Hi), plus vernier, allow adjustment of threshold level from 5 mV to 50 volts (peak). Maximum continuous input voltage is 25 v, 100 v, & 250 v (RMS), respectively. Input is undamaged by momentary peak voltage of 500 volts on any range. Differential input impedance is 20K ohms, 400K ohms, and 8 Megohms, respectively.
- Common mode rejection: greater than 60 dB to 2 kHz and greater than 30 dB to 100 kHz.
- Frequency ranges: 100 Hz, 200 Hz, and 500 Hz; with multipliers of X1, X10, X100; each with 100% overrange.

**Output:**
- Standard One Volt Data Signal: (see Table One, page 7).
- Standard Ten Volt Output Signal: (see Table One, page 7).
- Step-function response (to 99% of final value): 800 ms for X1 multiplier, 80 ms for X10 and X100 multipliers.
- Step-function response (to 99.9% of final value): 2.5 sec for X1 multiplier, 250 ms for X10 and X100 multipliers.
- Ripple and noise (max.): less than 0.2% of full scale from 10% to 100% of scale.
- Accuracy: 0.05% of scale (based on average value of DC input).
- Housing: standard full width module.
- Operating temperature range: -50 to +120 degrees F.
- Power requirements: 105-130 volts, 50-400 Hz.

**PRICE:** Model 840 Frequency-to-Voltage Converter $495.00
Dynamometer Characteristics

General Electric

No 1739498  Type TCL-20  Class 4-125-2700
Amperes 360  Volts 250
Absorbs 125 hp  Delivers 75 hp
Speeds 2700/6000  Insts. GE I-7360-B
Torque Arm 15.756
RATINGS: 500 HP from 3400 to 6000 RPM (1014-3 WIG)  
400 HP from 2700 to 6000 RPM (1014-2 WIG)  
250 HP from 1800 to 6000 RPM (1014-1 WIG)
## SLIP RING TORQUE SENSORS

### Model 1102
Low capacity torque sensors.

<table>
<thead>
<tr>
<th>Capacity (Dz. In.)</th>
<th>Max. Speed (RPM)</th>
<th>Model</th>
<th>Protected for overloads to (Dz. In.)</th>
<th>Torsional Stiffness (Lb. In./Rad.)</th>
<th>Rotating Inertia (Lb.-In.²)</th>
<th>Weight (Lbs.)</th>
<th>Brush Life Factor x 10⁴</th>
<th>Ring Diameter (In.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>20,000</td>
<td>1103-10</td>
<td>20</td>
<td>112</td>
<td>.01</td>
<td>%</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>20</td>
<td>20,000</td>
<td>-20</td>
<td>40</td>
<td>113</td>
<td>.01</td>
<td>%</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>50</td>
<td>20,000</td>
<td>1102-50</td>
<td>150</td>
<td>665</td>
<td>.076</td>
<td>2</td>
<td>8.2</td>
<td>0.750</td>
</tr>
<tr>
<td>200</td>
<td>20,000</td>
<td>-100</td>
<td>300</td>
<td>1,070</td>
<td>.067</td>
<td>2</td>
<td>8.2</td>
<td>0.750</td>
</tr>
<tr>
<td>200</td>
<td>20,000</td>
<td>-200</td>
<td>600</td>
<td>1,790</td>
<td>.680</td>
<td>2</td>
<td>8.2</td>
<td>0.750</td>
</tr>
<tr>
<td>500</td>
<td>20,000</td>
<td>-500</td>
<td>1,000</td>
<td>3,480</td>
<td>.682</td>
<td>2</td>
<td>8.2</td>
<td>0.750</td>
</tr>
<tr>
<td>1,000</td>
<td>20,000</td>
<td>-1K</td>
<td>1,500</td>
<td>4,850</td>
<td>.682</td>
<td>2</td>
<td>8.2</td>
<td>0.750</td>
</tr>
</tbody>
</table>

### Models 1104 thru 1109, 1114, 1118 and 1211
Standard rotating shaft torque sensor for general application.

<table>
<thead>
<tr>
<th>Capacity (Lb. In.)</th>
<th>Max. Speed (RPM)</th>
<th>Model</th>
<th>Protected for overloads to (Lb. In.)</th>
<th>Torsional Stiffness (Lb. In./Rad.)</th>
<th>Rotating Inertia (Lb.-In.²)</th>
<th>Weight (Lbs.)</th>
<th>Brush Life Factor x 10⁴</th>
<th>Ring Diameter (In.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>16,000</td>
<td>1114-100</td>
<td>300</td>
<td>7,000</td>
<td>1.19</td>
<td>11</td>
<td>25.9</td>
<td>1.187</td>
</tr>
<tr>
<td>200</td>
<td>16,000</td>
<td>-200</td>
<td>600</td>
<td>17,200</td>
<td>1.12</td>
<td>11</td>
<td>25.9</td>
<td>1.187</td>
</tr>
<tr>
<td>500</td>
<td>16,000</td>
<td>-500</td>
<td>1,000</td>
<td>25,300</td>
<td>1.09</td>
<td>11</td>
<td>25.9</td>
<td>1.187</td>
</tr>
<tr>
<td>1,000</td>
<td>16,000</td>
<td>-1K</td>
<td>1,500</td>
<td>36,200</td>
<td>1.10</td>
<td>11</td>
<td>25.9</td>
<td>1.187</td>
</tr>
<tr>
<td>100</td>
<td>9,000</td>
<td>1104-100</td>
<td>150</td>
<td>6,430</td>
<td>1.52</td>
<td>11</td>
<td>15.4</td>
<td>2.000</td>
</tr>
<tr>
<td>200</td>
<td>9,000</td>
<td>-200</td>
<td>300</td>
<td>17,000</td>
<td>1.53</td>
<td>11</td>
<td>15.4</td>
<td>2.000</td>
</tr>
<tr>
<td>500</td>
<td>9,000</td>
<td>-500</td>
<td>750</td>
<td>45,200</td>
<td>1.59</td>
<td>11</td>
<td>15.4</td>
<td>2.000</td>
</tr>
<tr>
<td>1,000</td>
<td>9,000</td>
<td>-1K</td>
<td>1,500</td>
<td>103,000</td>
<td>1.59</td>
<td>11</td>
<td>15.4</td>
<td>2.000</td>
</tr>
<tr>
<td>2,000</td>
<td>9,000</td>
<td>-2K</td>
<td>3,000</td>
<td>182,500</td>
<td>1.60</td>
<td>11</td>
<td>15.4</td>
<td>2.000</td>
</tr>
<tr>
<td>5,000</td>
<td>8,500</td>
<td>1105-5K</td>
<td>7,500</td>
<td>475,000</td>
<td>3.59</td>
<td>28</td>
<td>14.0</td>
<td>2.187</td>
</tr>
<tr>
<td>10,000</td>
<td>8,500</td>
<td>10K</td>
<td>15,000</td>
<td>750,000</td>
<td>4.09</td>
<td>28</td>
<td>14.0</td>
<td>2.187</td>
</tr>
<tr>
<td>20,000</td>
<td>8,500</td>
<td>1106-20K</td>
<td>30,000</td>
<td>2,610,000</td>
<td>15.18</td>
<td>42</td>
<td>10.2</td>
<td>3.000</td>
</tr>
<tr>
<td>50,000</td>
<td>4,000</td>
<td>1107-50K</td>
<td>75,000</td>
<td>7,220,000</td>
<td>53.06</td>
<td>74</td>
<td>7.2</td>
<td>4.250</td>
</tr>
<tr>
<td>100,000</td>
<td>4,000</td>
<td>-10K</td>
<td>150,000</td>
<td>12,450,000</td>
<td>56.14</td>
<td>74</td>
<td>7.2</td>
<td>4.250</td>
</tr>
<tr>
<td>120,000</td>
<td>2,400</td>
<td>1108-120K</td>
<td>180,000</td>
<td>15,400,000</td>
<td>265.41</td>
<td>162</td>
<td>5.3</td>
<td>5.750</td>
</tr>
<tr>
<td>240,000</td>
<td>2,400</td>
<td>-240K</td>
<td>360,000</td>
<td>23,300,000</td>
<td>285.35</td>
<td>162</td>
<td>5.3</td>
<td>5.750</td>
</tr>
<tr>
<td>360,000</td>
<td>2,100</td>
<td>1109-360K</td>
<td>540,000</td>
<td>28,000,000</td>
<td>400.00</td>
<td>240</td>
<td>4.4</td>
<td>7.000</td>
</tr>
<tr>
<td>600,000</td>
<td>2,100</td>
<td>-600K</td>
<td>900,000</td>
<td>40,000,000</td>
<td>577.00</td>
<td>240</td>
<td>4.4</td>
<td>7.000</td>
</tr>
<tr>
<td>840,000</td>
<td>450</td>
<td>1118-840K</td>
<td>1,260,000</td>
<td>Consult Factory</td>
<td>Consult Factory</td>
<td>3.3</td>
<td>9.000</td>
<td>9.000</td>
</tr>
<tr>
<td>1,200,000</td>
<td>450</td>
<td>-120K</td>
<td>1,800,000</td>
<td>Consult Factory</td>
<td>Consult Factory</td>
<td>3.3</td>
<td>9.000</td>
<td>9.000</td>
</tr>
<tr>
<td>1,800,000</td>
<td>450</td>
<td>-180K</td>
<td>2,700,000</td>
<td>Consult Factory</td>
<td>Consult Factory</td>
<td>3.3</td>
<td>9.000</td>
<td>9.000</td>
</tr>
<tr>
<td>2,400,000</td>
<td>450</td>
<td>1121-240K</td>
<td>3,600,000</td>
<td>Consult Factory</td>
<td>Consult Factory</td>
<td>3.0</td>
<td>10.000</td>
<td>10.000</td>
</tr>
<tr>
<td>3,600,000</td>
<td>350</td>
<td>1121-240K</td>
<td>4,500,000</td>
<td>Consult Factory</td>
<td>Consult Factory</td>
<td>3.0</td>
<td>10.000</td>
<td>10.000</td>
</tr>
</tbody>
</table>

### Model 1115
Flange housing mount with AND pads to match Army-Navy mountings standard. Spline drive.

### Models 1228, 1248, 1241
Flange drive for use when short length is mandatory.

For 12,000 RPM with air-oil mist lubrication.

### Specifications

<table>
<thead>
<tr>
<th>Output at rated capacity milivolts per volt nominal</th>
<th>Standard</th>
<th>&quot;W&quot; Option</th>
<th>Temperature effect on output of reading per °F</th>
<th>Specifications</th>
<th>Standard</th>
<th>&quot;W&quot; Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonlinearity of rated output</td>
<td>- 0.1%</td>
<td>-0.15%</td>
<td>Temperature effect on zero of rated output per °F</td>
<td>- 0.002%</td>
<td>- 0.002%</td>
<td></td>
</tr>
<tr>
<td>Hysteresis of rated output</td>
<td>- 0.1%</td>
<td>-0.15%</td>
<td>Insulation resistance, bridge/case megohms at 50 VDC</td>
<td>- 0.002%</td>
<td>- 0.002%</td>
<td></td>
</tr>
<tr>
<td>Repeatability of rated output</td>
<td>- 0.1%</td>
<td>-0.07%</td>
<td>Number of bridges</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Repeatability of rated output</td>
<td>- 0.1%</td>
<td>-0.07%</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Zero balance of rated output</td>
<td>- 0.1%</td>
<td>-1.0%</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Bridge resistance ohms nominal</td>
<td>350</td>
<td>350</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Temperature range, compensated °F</td>
<td>70°F to 170°F</td>
<td>70° to 170°F</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Temperature range, usable °F</td>
<td>65° to 200°</td>
<td>65 to 200°</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Lebow**

DEN3-124
### Abstract

The small passenger car transmission test was initiated to supply electric vehicle manufacturers with technical information regarding the performance of commercially available transmissions. This information would enable EV manufacturers to design a more energy efficient vehicle. With this information the manufacturers would be able to estimate vehicle driving range as well as speed and torque requirements for specific road load performance characteristics. This report covers the testing of a Mercury Lynx automatic transmission. This transmission was tested in accordance with a passenger car automatic transmission test code (SAE J651b) which required drive performance, coast performance, and no load test conditions. Under these conditions, the transmission attained maximum efficiencies in the mid-ninety percent range both for drive performance test and coast performance tests. The major results of this test are the torque, speed and efficiency curves which are located in the data section of this report. These graphs map the complete performance characteristics for the Mercury Lynx automatic transmission.

### Key Words (Suggested by Author(s))

- Electric vehicles
- Transmissions
- Torque converters