GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: June 6, 1979

Project Title: 35 GHz and 95 GHz Radar Field Test

Project No: A-2384

Project Director: C. P. Burns

Sponsor: Johns Hopkins University, Applied Physics Laboratory

Agreement Period: From 5/21/79 Until 7/31/79

Type Agreement: AP Contract No. 601062 (under US Govt. Prime Contract #N00024-78-C-5384)

Amount: $29,974

Reports Required: Monthly Progress; Monthly Fiscal; Final Technical

Sponsor Contact Person (s):

Technical Matters

Mr. P. W. Pickering
Technical Problem Sponsor

Contractual Matters
(thru OCA)

Mr. R. M. Stevens
Contract Representative

Johns Hopkins University
Applied Physics Laboratory
John Hopkins Road
Laurel, Maryland 20810
(301)792-7800

Defense Priority Rating:

Assigned to: Systems & Techniques (School/Laboratory)

COPIES TO:

Project Director
Division Chief (EES)
School/Laboratory Director
Dean/Director-EES
Accounting Office
Procurement Office
Security Coordinator (OCA)
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Library, Technical Reports Section
EES Information Office
EES Reports & Procedures
Project File (OCA)
Project Code (GTRI)
Other

CA-3 (3/76)

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

# SPONSORED PROJECT TERMINATION

Date: December 17, 1979

Project Title: 35 GHz and 95 GHz Radar Field Test

Project No: A-2384

Project Director: C.P. Burns

Sponsor: Johns Hopkins University, Applied Physics Laboratory

Effective Termination Date: 7/31/79

Clearance of Accounting Charges: 7/31/79

Grant/Contract Closeout Actions Remaining:

- [X] Final Invoice and Closing Documents
- [ ] Final Fiscal Report
- [X] Final Report of Inventions
- [X] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Assigned to: STL/SA (Laboratory)

COPIES TO:

Project Director
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Project File (OCA)
Project Code (GTRI)
Other _____

CA–4 (1/79)

APL SUBCONTRACT MONTHLY FISCAL REPORT

A-2384

ACC-15

For Period Ending May 31, 1979

Contractor Georgia Tech Research Institute
Georgia Institute of Technology

Contract No. A.P. Conr. no. 601062 Contract Amount 29,974
(under U.S. Gov't. Prime N00024-78-C-5384).

| Type of Obligation | Expenditures (1) Current Month | Expenditures (2) Cumulative Total | (3) Outstanding Commitments | (4) Estimated Costs (Expenditures plus Commitments (5) Next Month | (4) Estimated Costs (Expenditures plus Commitments (6) Total at Compl. |
|---|---|---|---|---|---|
| 1. Engineering | | | | | |
| Labor | 2,826.62 | 2,826.62 | | 3,650.00 | 12,168.00 |
| Burden @ ____% | | | | | |
| Total | 2,826.62 | 2,826.62 | | 3,650.00 | 12,168.00 |
| 2. Manufacturing | | | | | |
| Labor | | | | | |
| Burden @ ____% | | | | | |
| Total | | | | | |
| 3. Materials & Services | | | | 100.00 | 2,100.00 |
| 4. Equipment & Tooling | | | | | |
| 5. Subcontracts | | | | | |
| 6. Travel | | | | 3,300.00 | 5,262.00 |
| 7. Other Direct Costs | | | | | |
| a. Retirement | 277.86 | 277.86 | | 359.00 | 1,196.00 |
| b. Computer | - | - | | | -- |
| Total | 277.86 | 277.86 | | 359.00 | 1,196.00 |
| 8. Total (Lines 1 thru 7) | 3,104.48 | 3,104.48 | | 7,409.00 | 20,726.00 |
| 9. G&A @ 76 % | 2,148.23 | 2,148.23 | | 2,774.00 | 9,248.00 |
| 10. Total (Lines 8 and 9) | 5,252.71 | 5,252.71 | | 10,183.00 | 29,974.00 |
| 11. Fee or Profit | | | | | |
| 12. Grand Total | 5,252.71 | 5,252.71 | | 10,183.00 | 29,974.00 |

Total Amount Invoiced as of 5/31/79 (Voucher No. 1 to ____ incl) $ 5,252.71

Total Reimbursement Received to 5/31/79 (Voucher No. ____ to ____) $ -0-

Submitted By _____ 6/20/79
Name Date

Supervisor Accounting & Budgets
Title

Orig. & 1 copy: APL Contract Representative

A-2384

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

19 June 1979

Mr. R. M. Stevens
APL Contract Representative
The Johns Hopkins University
Applied Physics Laboratory
Johns Hopkins Road
Laurel, Maryland 20810

SUBJECT: Monthly Progress Report No. 1 covering the period 21 May 1979 through 31 May 1979

REFERENCE: Contract No. 601062, 35 GHz and 95 GHz Radar Field Test EES Project A-2384

Gentlemen:

Equipment preparation was completed during the reporting period. The 35 GHz radar was tested and was transported to APL on Tuesday, 29 May 1979. The radar and two field site operators arrived on Wednesday, 30 May 1979. Tests were initiated on 31 May 1979, and were expected to be completed by the end of the following week.

The 95 GHz radar was participating in a field test at Aberdeen, Md. during the reporting period. Arrangements for transfer of the radar to APL for the 95 GHz portion of the radar tests were in progress. On 31 May 1979, the magnetron of the 95 GHz transmitter at Aberdeen, Md. failed; alternative sources will be evaluated. Replacement of the 95 GHz magnetron is not feasible within the June 12, 1979 deadline for completion of testing.

C. P. Burns, J. A. Scheer, and C. M. Luke met with Mr. Richard Pickering of APL on 24 May 1979 to discuss the radar test plan; C. P. Burns and N. T. Alexander visited the test site on 31 May 1979 to review the progress of the tests.

Respectfully submitted,

[redacted]

C. Pat Burns
Senior Research Engineer
Project Director

Approved:

[redacted]

J. Lee Edwards
Chief, Antennas and Countermeasures Division
Systems and Techniques Laboratory

CPB/rft

A-2384

ACC-15

APL SUBCONTRACT MONTHLY FISCAL REPORT

For Period Ending June 30, 1979 A-2384

Contractor Ga. Tech Research Institute
Ga. Inst. of Technology Contract No. A.P. Contr. No 601062 Contract Amount 29,974
Under U.S. Govt. Prime N00024-78-C-5384

| Type of Obligation | Expenditures (1) Current Month | Expenditures (2) Cumulative Total | (3) Outstanding Commitments | (4) Estimated Costs (Expenditures plus Commitments (5) Next Month | (4) Estimated Costs (Expenditures plus Commitments (6) Total at Compl. |
|---|---|---|---|---|---|
| 1. Engineering | | | | | |
| Labor | 4,457.55 | 7,284.17 | | 2,000.00 | 12,168.00 |
| Burden @ ____% | | | | | |
| Total | 4,457.55 | 7,284.17 | | 2,000.00 | 12,168.00 |
| 2. Manufacturing | | | | | |
| Labor | | | | | |
| Burden @ ____% | | | | | |
| Total | | | | | |
| 3. Materials & Services | 13.22 | 13.22 | | 50.00 | 2,100.00 |
| 4. Equipment & Tooling | | | | | |
| 5. Subcontracts | | | | | |
| 6. Travel | 3,229.79 | 3,229.79 | | 400.00 | 5,262.00 |
| 7. Other Direct Costs | | | | | |
| a. Retirement | 409.15 | 687.01 | | 196.60 | 1,196.00 |
| b. Computer | -- | -- | | -- | -- |
| Total | 409.15 | 687.01 | | 196.60 | 1,196.00 |
| 8. Total (Lines 1 thru 7) | 8,109.71 | 11,214.19 | | 2,646.60 | 20,726.00 |
| 9. G&A @ 76 % | 3,387.74 | 5,535.97 | | 1,520.00 | 9,248.00 |
| 10. Total (Lines 8 and 9) | 11,497.45 | 16,750.16 | | 4,166.60 | 29,974.00 |
| 11. Fee or Profit | -- | -- | | -- | -- |
| 12. Grand Total | 11,497.45 | 16,750.16 | | 4,166.60 | 29,974.00 |

Total Amount Invoiced as of 6/30/79 (Voucher No. 1 to 2 incl) $ 16,750.16

Total Reimbursement Received to 6/30/79 (Voucher No. ____ to ____) $ -0-

Submitted By [redacted] 7/24/79
Name Date

Manager, Accounting & Budgets
Title

Orig. & 1 copy: APL Contract Representative

A-2384

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

16 July 1979

Mr. R. M. Stevens
APL Contract Representative
The Johns Hopkins University
Applied Physics Laboratory
Johns Hopkins Road
Laurel, Maryland 20810

Subject: Monthly Progress Report No. 2 covering the period 1 June 1979 through 30 June 1979

Reference: Contract No. 601062, 35 GHz and 95 GHz Radar Field Test, EES Project A-2384

Gentlemen:

Testing of the 35 GHz receiver continued through 8 June 1979. All tests at this frequency were successfully completed. Detailed logs of the transmitted signal were kept and will be provided in the final letter report on this contract.

The 95 GHz transmitter magnetron failed on 31 May 1979. This magnetron had only a few hours of operating time, and after examination by the manufacturer was found to have a defective solder joint. The original magnetron was substituted for the defective unit, but operated only sporadically.

An alternative 95 GHz source was discussed with the APL technical monitor, Mr. Richard Pickering. Georgia Tech received a 5 Watt Impatt oscillator a few days prior to the failure of the 95 GHz magnetron, and the Impatt oscillator could have been used as a source for 95 GHz receiver testing. However, the low power output of the Impatt oscillator would not have permitted a realistic test of the receiver. Prior commitments on the 95 GHz receiver required that testing be completed by 12 June 1979, and therefore repair or replacement of the 95 GHz magnetron was not feasible within the available time frame. After further discussions between APL and Georgia Tech personnel, it was mutually agreed that the 95 GHz testing would be cancelled.

Testing at 95 GHz can be scheduled when the receiving system is available, if desired. The 95 GHz magnetron is being replaced by the manufacturer (English Electric Valve) at his cost, as the failure was found to be a manufacturing defect.

Respectfully submitted,

[redacted]

C. Pat Burns
Senior Research Engineer
Project Director

CPB/rft

Approved:

[redacted]

Néal T. Alexander
Head, Systems and Antennas Branch
Systems and Techniques Laboratory

A-2384

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

24 August 1979

Mr. R. M. Stevens
APL Contract Representative
The Johns Hopkins University
Applied Physics Laboratory
Johns Hopkins Road
Laurel, MD 20810

Subject: Final Letter Report Covering the Period 21 May 1979 Through 31 July 1979

Reference: Contract No. 601062, 35 GHz and 95 GHz Radar Field Test (A2384)

Gentlemen:

This report describes the performance testing of a millimeter wave receiver at the Applied Physics Laboratory of Johns Hopkins University, from 30 May to 8 June 1979. The purpose of this report is to furnish a log of transmitter site operation for correlation with recorded receiver data and to indicate any problems encountered.

Several minor problems and one serious problem were experienced during the test. The problem with carrier leakage is discussed below. The others will be described in the comments section of the log beside each event.

Carrier Leakage

To measure power levels captured by a receiver, it is important that measured transmitter power be within the passband of the receiver, otherwise wasted power outside the passband will simulate a degraded minimum discernable signal. For this reason the cause of leakage as well as means to eliminate or avoid it should be determined.

The modulator in the radar consists of a 35 GHz carrier with gated 240 MHz modulation applied through a single sideband (SSB) generator to produce a 35.24 GHz upper sideband (USB) signal. At the output of the SSB generator, carrier leakage is 20 dB below the USB level; however, two stages of saturating Impatt amplification follow. These saturating amplifiers reduce the difference in power level to only 1.9 dB. The final Impatt amplifier is gated and there are PIN diode switches between the amplifiers, and after the final amplifier. Because of the gate and PIN switches, leakage is turned on 50 ns before the USB and left on for 50 ns after the USB, producing about 100 ns of leakage, only

1.9 dB down from the USB level. If not compensated for, this carrier leakage level will cause an error in average power measurement, especially for narrow pulse widths. The adopted solution was to reduce the level into the amplifiers to bring them out of saturation. Leakage was reduced to a level 10 to 14 dB below the USB. A nominal figure of 12 dB was used in the calculations. All leakage levels were accounted for in measurements of transmitted power (see Appendix 1). Adding this attenuation also caused some reduction in USB transmitted power. Because of this reduction, minimum pulse width measurements were made at a higher pulse repetition frequency than was previously planned due to the sensitivity of the average power meter.

95 GHz Tests

Because of equipment and scheduling problems, the 95 GHz field test was cancelled by mutual agreement of Georgia Tech and the APL technical representative.

Respectfully submitted,

[redacted]

C. Pat Burns
Senior Research Engineer
Project Director

CPB/vcy

# TRANSMITTER LOG

Date 5/31/79 Event I Sensitivity

PW = 49 ns PRI = 205 μs Frequency = 34.99 GHz (Dip Meter) Varactor Source

| Time | $P_T$ | Remarks |
|---|---|---|
| 1010 | -16.5 | 903/MDS |
| 1020 | -8.5 | 903/TS |
| 1041 | -12.4 | TD/MDS |
| 1050 | -4.5 | TD/TS |
| 1110 | +.6 | IFM/MDS |
| 1120 | +8.3 | IFM/TS |
| 1137 | +13.1 | 6 dB Step |
| 1145 | +19.1 | 6 dB Step |
| 1348 | +25.3 | 6 dB Step |

There was as much as 2 dB variation in measured power ($P_m$) during this part of Event 1. The cause was found to be an intermitent thermistor connector. The problem was corrected before proceeding with the 230 ns pulse width.

PW = 230 ns PRI = 205 μs Frequency = 34.99 GHz (Dip Meter) Varactor Source

| Time | $P_T$ | Remarks |
|---|---|---|
| 1430 | +24.1 | 6 dB Step |
| 1443 | +18.1 | 6 dB Step |
| 1449 | +12.1 | 6 dB Step |
| 1457 | +6.3 | 6 dB Step |
| 1507 | +.2 | 6 dB Step |
| 1517 | -2.9 | IFM/MDS |
| 1523 | -5.9 | 6 dB Step |
| 1530 | -11.9 | TD/MDS |
| 1536 | -17.9 | 6 dB Step |
| 1538 | -26.9 | 903/MDS |
| 1542 | -18.8 | 903/TS |
| 1548 | -3.9 | TD/TS |

Date 6/1/79 Event 2 Pulse Width Variation

PRI = 202 $\mu$s Frequency = 35.25 GHz (Dip Meter) Stalo Source

| Time | Pulse Width (ns) | $P_T$ (dBm) | Remarks | |
|---|---|---|---|---|
| 1058 | 280 | -13.1 | MDS/TD | All 6 dB steps are |
| 1100 | 280 | -5.1 | TS/TD | referenced to TS/TD |
| 1107 | 280 | -27.1 | MDS/903 | unless otherwise noted. |
| 1108 | 280 | -19.2 | TS/903 | |
| 1115 | 280 | +.9 | 6 dB Step | |
| 1123 | 280 | +6.9 | 6 dB Step | |
| 1129 | 280 | +12.7 | 6 dB Step | |
| 1136 | 280 | +16.2 | 3 dB Below TD SAT | |
| 1149 | 103 | -21.0 | MDS/903 | |
| 1153 | 103 | -13.0 | TS/903 MDS/TD | |
| 1155 | 103 | -5.0 | TS/TD | |
| 1159 | 103 | +1.0 | 6 dB Step | |
| 1204 | 103 | -2.0 | MDS/IFM | |
| 1210 | 280 | -4.7 | MDS/IFM | |
| 1218 | 103 | +4.0 | 6 dB Step Above MDS/IFM | |
| 1220 | 103 | +7.0 | 6 dB Step | |
| 1223 | 103 | +13.0 | 6 dB Step | |
| 1229 | 103 | +15.6 | 3 dB Below TD SAT | |
| 1240 | 48.5 | -12.7 | MDS/903 | |
| 1242 | 48.5 | -4.7 | TS/903 | |
| 1246 | 48.5 | -8.2 | MDS/TD | |
| 1247 | 48.5 | -.2 | TS/TD | |
| 1255 | 48.5 | +5.8 | 6 dB Step | |
| 1259 | 48.5 | +2.3 | MDS IFM | |
| 1301 | 48.5 | +11.8 | 6 dB Step | |
| 1304 | 48.5 | +17.8 | 6 dB Step | |
| 1308 | 48.5 | +14.3 | 3 dB Below TD SAT | |

Date 6/1/79 Event 2 Pulse Width Variation

PRI = 102 μs Frequency = 35.25 GHz (Dip Meter) Stalo Source

| Time | Pulse Width (ns) | $P_T$ (dBm) | Remarks |
|---|---|---|---|
| 1511 | 23 | -9.2 | MDS/903 |
| 1518 | 23 | -12.4 | MDS/TD |
| 1520 | 23 | -4.2 | TS/TD |
| 1522 | 23 | +1.8 | 6 dB Step |
| 1524 | 23 | +7.9 | 6 dB Step |
| 1526 | 23 | +4.3 | MDS/IFM |
| 1528 | 23 | +13.8 | 6 dB Step |
| 1530 | 23 | +14.9 | 3 dB Below TD SAT |

Date 6/4/79 Event 2 Pulse Width Variation

PRI = 50.5 μs Frequency = 35.25 GHz (Dip Meter) Stalo Source

| Time | Pulse Width (ns) | $P_T$ (dBm) | Remarks |
|---|---|---|---|
| 1031:50 | 14 | -12 | MDS/TD |
| 1036:10 | 14 | -7 | MDS/903 |
| 1041:05 | 14 | -4 | TS/TD |
| 1047:50 | 14 | +2 | 6 dB Step |
| 1049:35 | 14 | +8 | 6 dB Step |
| 1052:35 | 14 | +3.9 | MDS/IFM |
| 1053:45 | 14 | +14 | 6 dB Step |
| 1054:10 | 14 | 20 | 6 dB Step |
| 1109:00 | 14 | 14.9 | 3 dB Below TD SAT |
| 1119:35 | 8 | -1.9 | MDS/903 |
| 1123:10 | 8 | -7.9 | MDS/TD |
| 1124:15 | 8 | .2 | TS/TD |
| 1128:00 | 8 | 6.2 | 6 dB Step |
| 1134:50 | 8 | 6.2 | MDS/IFM |
| 1135:40 | 8 | 12.2 | 6 dB Step |
| 1138:00 | 8 | 18.1 | 6 dB Step |
| 1146:15 | 8 | 20.3 | 3 dB Below TD SAT |
| 1341:20 | 8 | -1.2 | MDS/903 |
| 1343:45 | 8 | +6.8 | TS/903 |
| 1347:50 | 8 | +18.9 | 6 dB Step |
| 1356:20 | 14 | -7.2 | MDS/903 |
| 1357:50 | 14 | +.7 | TS/903 |

Date 6/4/79 Event 3 PRI (Pulse Repetition Interval) Variation

PW = 105 ns Frequency = 35.25 GHz (Dip Meter) Stalo Source

| Time | PRI (μs) | $P_T$ (dBm) | Remarks |
|---|---|---|---|
| 1425:30 | 820 | -18.0 | MDS/903 |
| 1427:30 | 820 | -10.0 | TS/903 |
| 1430:40 | 820 | -12.0 | MDS/TD |
| 1432:00 | 820 | -4.0 | TS/TD |
| 1434:35 | 820 | +2.0 | 6 dB Step |
| 1438:00 | 820 | -1.0 | MDS/IFM |
| 1438:50 | 820 | +8.0 | 6 dB Step |
| 1440:50 | 820 | 14.0 | 6 dB Step |
| 1443:10 | 820 | 12.1 | 3 dB Below TD SAT |
| 1450:40 | 410 | -19.8 | MDS/903 |
| 1451:30 | 410 | -11.8 | TS/903 |
| 1453:45 | 410 | -13.8 | MDS/TD |
| 1454:45 | 410 | -5.9 | TS/TD |
| 1456:35 | 410 | +.3 | 6 dB Step |
| 1500:30 | 410 | -.8 | MDS/IFM |
| 1501:30 | 410 | +6.2 | 6 dB Step |
| 1503:00 | 410 | +12.2 | 6 dB Step |
| 1507:15 | 410 | +14.2 | 3 dB Below TD SAT |
| 1515:35 | 102 | -23.9 | MDS/903 |
| 1516:45 | 102 | -15.9 | TS/903 MDS/TD |
| 1519:20 | 102 | -7.9 | TS/TD |
| 1521:00 | 102 | -1.9 | 6 dB Step |
| 1522:00 | 102 | +4.0 | 6 dB Step |
| 1523:45 | 102 | +10.1 | 6 dB Step |
| 1527:15 | 102 | +11.0 | 3 dB Below TD SAT |

Date 6/4/79 Event 3 PRI (Pulse Repetition Interval) Variation

PW = 105 ns Frequency = 35.24 GHz (Dip Meters) Stalo Source

| Time | PRI ( s) | $P_T$ (dBm) | Remarks |
|---|---|---|---|
| 1533:25 | 51 | -24.0 | MDS/903 |
| 1533:55 | 51 | -16.0 | TS/903 |
| 1536:40 | 51 | -15.0 | MDS/TD |
| 1537:20 | 51 | -7.0 | TS/TD |
| 1538:50 | 51 | -1.0 | 6 dB Step |
| 1540:45 | 51 | -1.9 | MDS/IFM |
| 1541:15 | 51 | +5.0 | 6 dB Step |
| 1542:25 | 51 | +11.0 | 6 dB Step |
| 1545:00 | 51 | +10.0 | 3 dB Below TD SAT |
| 1550:00 | 102 | -2.0 | MDS/IFM |

Date 6/4/79 Event 3 PRI (Pulse Repetition Interval) Variation

PW = 229 ns Frequency = 35.24 GHz (Dip Meter) Stalo Source

| Time | PRI ($\mu$s) | $P_T$ (dBm) | Remarks |
|---|---|---|---|
| 1612:40 | 51 | -28.5 | MDS/903 |
| 1613:35 | 51 | -21.5 | TS/903 |
| 1616:50 | 51 | -19.5 | MDS/TD |
| 1617:20 | 51 | -11.5 | TS/TD |
| 1620:20 | 51 | -5.5 | 6 dB Step |
| 1622:30 | 51 | +1.5 | 6 dB Step |
| 1624:40 | 51 | +6.6 | 6 dB Step |
| 1629:10 | 51 | +16.5 | 3 dB Below TD SAT |
| 1633:35 | 105 | -29.4 | MDS/903 |
| 1634:35 | 105 | -21.4 | TS/903 |
| 1635:30 | 105 | -17.4 | MDS/TD |
| 1636:25 | 105 | -9.3 | TS/TD |
| 1639:40 | 105 | -3.4 | 6 dB Step |
| 1640:20 | 105 | -4.4 | MDS/IFM |
| 1642:00 | 51 | -5.4 | MDS/IFM |
| 1644:30 | 105 | +2.6 | 6 dB Step |
| 1645:35 | 105 | +8.7 | 6 dB Step |
| 1647:15 | 105 | +12.6 | 3 dB Below TD SAT |

Date 6/5/79 Event 3 PRI (Pulse Repetition Interval) Variation

PW = 229 ns Frequency = 35.24 GHz (Dip Meter) Stalo Source

| Time | PRI (μ s) | $P_T$ (dBm) | Remarks |
|---|---|---|---|
| 0941:15 | 408 | -27.7 | MDS/903 |
| 0942:15 | 408 | -19.7 | TS/903 |
| 0944:20 | 408 | -15.7 | MDS/TD |
| 0947:00 | 408 | -7.7 | TS/TD |
| 0950:15 | 408 | -1.7 | 6 dB Step |
| 0953:15 | 408 | +4.3 | 6 dB Step |
| 0956:00 | 408 | -3.5 | MDS/IFM |
| 0957:15 | 408 | +10.3 | 6 dB Step |
| 1002:30 | 408 | +14.3 | 3 dB Below TD SAT |
| 1010:30 | 820 | -27.7 | MDS/903 |
| 1011:20 | 820 | -19.7 | TS/903 |
| 1013:15 | 820 | -14.7 | MDS/TD |
| 1014:25 | 820 | -6.8 | TS/TD |
| 1015:50 | 820 | -.8 | 6 dB Step |
| 1018:00 | 820 | -2.6 | MDS/IFM |
| 1018:50 | 820 | +5.3 | 6 dB Step |
| 1020:45 | 820 | +11.4 | 6 dB Step |
| 1023:50 | 820 | +12.3 | 3 dB Below TD SAT |
| 1030:40 | 202 | -28.8 | MDS/903 |
| 1031:30 | 202 | -20.8 | TS/903 |

At 10:40 the Stalo came unlocked causing the transmitter to have an irregular chirp in frequency.

Date 6/5/79 Event 4 Modulation Variation/Chirp

PW = 48 nsec PRI = 102 $\mu$sec Varactor Gunn Source

| Time (Hours) | Frequency (GHz) Low | High | IPFA (MHz/nsec) | $P_T$ (dBm) | Remarks |
|---|---|---|---|---|---|
| 120630 | 34.99 | 35.02 | 1.75 | -10.7 | TS/903 |
| 120800 | 34.99 | 35.02 | 1.50 | | |
| 121000 | 34.99 | 35.02 | 1.25 | | |
| 121200 | 35.00 | 35.03 | 1.00 | | |
| 121330 | 35.00 | 35.03 | 0.75 | | |
| 121445 | 35.02 | 35.03 | 0.50 | | |
| 121600 | 35.03 | 35.04 | 0.25 | | |
| 121745 | 35.01 | 35.01 | OFF | -10.7 | TS/903 |
| 122200 | 34.99 | 35.02 | 1.75 | -6.6 | TS/TD |
| 122930 | 34.99 | 35.02 | 1.50 | | |
| 123100 | 34.99 | 35.02 | 1.25 | | |
| 123230 | 35.00 | 35.03 | 1.00 | | |
| 123400 | 35.00 | 35.03 | 0.75 | | |
| 123510 | 35.02 | 35.03 | 0.50 | | |
| 123610 | 35.03 | 35.04 | 0.25 | | |
| 123715 | 35.01 | 35.01 | OFF | -6.6 | TS/TD |
| 123920 | 34.99 | 35.02 | 1.75 | -.7 | 6 dB above TS/TD |
| 124215 | 34.99 | 35.02 | 1.50 | | |
| 124400 | 34.99 | 35.02 | 1.25 | | |
| 124530 | 35.00 | 35.03 | 1.00 | | |
| 124715 | 35.00 | 35.03 | 0.75 | | |
| 124840 | 35.02 | 35.03 | 0.50 | | |
| 125017 | 35.03 | 35.04 | 0.25 | | |
| 125810 | 35.01 | 35.01 | OFF | -.7 | 6 dB above TS/TD |

Air conditioner inoperative
Temperature $\approx 80^{\circ}$F
Frequency data of questionable accuracy
(Frequency of Varactor measured by measuring Varactor voltage, frequency vs. voltage calibration was done at room temperature).

Date 6/6/79 Event 4 Chirp

PW = 48 nsec PRI = 103 μsec Varactor Gunn Source

| Time (Hours) | Frequency (GHz) Low | High | IPFA (MHz/nsec) | $P_T$ (dBm) | Remarks |
|---|---|---|---|---|---|
| 115400 | 34.96 | 35.02 | 1.75 | -17.2 | MDS/903 |
| 115500 | 34.96 | 35.02 | 1.75 | -9.1 | TS/903 |
| 120040 | 34.99 | 35.02 | 1.50 | | |
| 120200 | 34.99 | 35.02 | 1.25 | | |
| 120325 | 35.00 | 35.03 | 1.00 | | |
| 120500 | 35.00 | 35.03 | 0.75 | | |
| 120605 | 35.02 | 35.03 | 0.50 | | |
| 120715 | 35.03 | 35.04 | 0.25 | | |
| 120820 | 35.01 | 35.01 | OFF | -9.1 | TS/903 |
| 121040 | 34.99 | 35.02 | 1.75 | -13.1 | MDS/TD |
| 121145 | 34.99 | 35.02 | 1.75 | -5.2 | TS/TD |
| 121320 | 34.99 | 35.02 | 1.50 | | |
| 121435 | 34.99 | 35.02 | 1.25 | | |
| 121535 | 35.00 | 35.02 | 1.00 | | |
| 121645 | 35.00 | 35.03 | 0.75 | | |
| 121845 | 35.02 | 35.03 | 0.50 | | |
| 121915 | 35.03 | 35.04 | 0.25 | | |
| 122215 | 35.01 | 35.01 | OFF | -5.2 | TS/TD |
| 122430 | 34.99 | 35.01 | 1.75 | +.8 | 6 dB above TS/TD |
| 122715 | 34.99 | 35.02 | 1.50 | | |
| 123445 | 34.99 | 35.02 | 1.25 | | |
| 123825 | 35.00 | 35.02 | 1.00 | | |
| 123925 | 35.00 | 35.03 | 0.75 | | |
| 124025 | 35.02 | 35.03 | 0.50 | | |
| 124130 | 35.03 | 35.04 | 0.25 | | |
| 124230 | 35.01 | 35.01 | OFF | +.8 | 6 dB above TS/TD |
| 143400 | 34.99 | 35.01 | 1.75 | +6.7 | 12 dB above TS/TD |
| 143440 | 34.99 | 35.02 | 1.50 | | |
| 143720 | 34.99 | 35.02 | 1.25 | +6.7 | |
| 143925 | 35.00 | 35.02 | 1.00 | +6.7 | 12 dB above TS/TD |

Date 6/6/79 Event 4 Chirp

PW = 48 nsec PRI = 103 μsec Varactor Gunn Source

| Time (Hours) | Frequency (GHz) Low | High | IPFA (MHz/nsec) | $P_T$ (dBm) | Remarks |
|---|---|---|---|---|---|
| 144025 | 35.00 | 35.03 | 0.75 | +6.72 | 12 dB above TS/TD |
| 144125 | 35.02 | 35.03 | 0.50 | | |
| 144240 | 35.03 | 35.03 | 0.25 | | |
| 144350 | 35.01 | 35.01 | OFF | +6.7 | 12 dB above TS/TD |
| 144505 | 34.99 | 35.01 | 1.75 | +12.8 | 18 dB above TS/TD |
| 144750 | 34.99 | 35.02 | 1.50 | | |
| 145815 | 34.99 | 35.02 | 1.25 | | |
| 150015 | 35.00 | 35.02 | 1.00 | | |
| 150125 | 35.00 | 35.03 | 0.75 | | |
| 150225 | 35.02 | 35.03 | 0.50 | | |
| 150425 | 35.03 | 35.04 | 0.25 | | |
| 150550 | 35.01 | 35.01 | OFF | +12.8 | 18 dB above TS/TD |

Air conditioner working for all data 6/6/79.

Date 6/6/79 Event 4 Chirp

PW = 230 nsec PRI = 103 μsec Varactor Gunn Source

| Time (Hours) | Frequency (GHz) Low | High | IPFA (MHz/nsec) | $P_T$ (dBm) | Remarks |
|---|---|---|---|---|---|
| 150900 | 35.01 | 35.01 | OFF | -25.8 | MDS/903 |
| 151125 | 34.94 | 35.02 | 1.75 | -18.0 | TS/903 |
| 151920 | 34.99 | 35.04 | 0.25 | | |
| 151945 | 34.96 | 35.03 | 0.50 | | |
| 152325 | 34.95 | 35.03 | 0.75 | | |
| 152440 | 34.94 | 35.02 | 1.00 | | |
| 152545 | 34.94 | 35.02 | 1.25 | | |
| 152650 | 34.93 | 35.02 | 1.50 | | |
| 152810 | 34.93 | 35.01 | 1.75 | | |
| 152945 | 35.01 | 35.01 | OFF | -18.0 | TS/903 |
| 153120 | 35.01 | 35.01 | OFF | -15.0 | MDS/TD |
| 153210 | 35.01 | 35.01 | OFF | -7.0 | TS/TD |
| 153545 | 34.99 | 35.04 | 0.25 | | |
| 153825 | 34.96 | 35.03 | 0.50 | | |
| 154125 | 34.95 | 35.03 | 0.75 | | |
| 154615 | 34.94 | 35.02 | 1.00 | | |
| 155020 | 34.94 | 35.02 | 1.25 | | |
| 155225 | 34.93 | 35.02 | 1.50 | | |
| 155600 | 34.93 | 35.01 | 1.75 | -7.0 | TS/TD |
| 160545 | 35.01 | 35.01 | OFF | -1.0 | 6 dB above TS/TD |
| 160810 | 34.99 | 35.04 | 0.25 | | |
| 160945 | 34.96 | 35.03 | 0.50 | | |
| 161140 | 34.95 | 35.03 | 0.75 | | |
| 161315 | 34.94 | 35.02 | 1.00 | | |
| 161530 | 34.94 | 35.02 | 1.25 | | |
| 161730 | 34.93 | 35.01 | 1.50 | | |
| 161920 | 34.93 | 35.01 | 1.75 | -1.0 | 6 dB above TS/TD |
| 162130 | 35.01 | 35.01 | OFF | +5.0 | 12 dB above TS/TD |
| 162300 | 34.99 | 35.04 | 0.25 | +5.0 | 12 dB above TS/TD |

Date 6/6/79 Event 4 Chirp

PW = 230 nsec PRI = 103 μsec Varactor Gunn Source

| Time (Hours) | Frequency (GHz) Low | High | IPFA (MHz/nsec) | $P_T$ (dBm) | Remarks |
|---|---|---|---|---|---|
| 162450 | 34.96 | 35.03 | 0.50 | +5.0 | 12 dB above TS/TD |
| 162700 | 34.95 | 35.03 | 0.75 | | |
| 163215 | 34.94 | 35.03 | 1.00 | | |
| 163420 | 34.94 | 35.02 | 1.25 | | |
| 163545 | 34.93 | 35.02 | 1.50 | | |
| 163730 | 34.93 | 35.01 | 1.75 | +5.0 | 12 dB above TS/TD |

Date 6/7/79 Event 5 Pulse-to-Pulse Frequency Agility

PW = 230 ns PRI = 103 μs $P_T$ = 3.4 dBm (Peak) TS/TD + 12 dB
Frequency Variation 34.94 - 35.03 GHz
Varactor Gunn Source

| Time | PRF/Step | MHz/Step | Remarks |
|---|---|---|---|
| 14:46:00 | OFF | OFF | MDS/TD Frequency 35.01 GHz |
| 14:47:10 | OFF | OFF | TS/TD + 12 dB Frequency 35.01 GHz |
| 14:52:10 | 1024 | 32 | All rest TS/TD + 12 dB (3.4 dBm pk) |
| 14:54:20 | 1024 | 16 | and 34.94 to 35.03 GHz |
| 14:57:25 | 1024 | 8 | |
| 15:50:40 | 1025 | 4 | |
| 15:51:30 | 1024 | 2 | |
| 15:53:50 | 1024 | 1 | |
| 16:16:30 | 1024 | .5 | |
| 16:27:10 | 512 | 32 | |
| 16:29:50 | 512 | 16 | |
| 16:32:00 | 512 | 8 | |
| 16:33:10 | 512 | 4 | |
| | 512 | 2 | |
| 16:37:35 | 512 | 1 | |
| 16:38:25 | 512 | .5 | |
| 16:41:10 | 128 | 32 | |
| 16:42:15 | 128 | 16 | |
| 16:43:25 | 128 | 8 | |
| 16:47:15 | 128 | 4 | |
| 16:49:00 | 128 | 2 | |
| 16:50:30 | 128 | 1 | |
| 16:52:30 | 128 | .5 | |
| 17:01:25 | 1 | 32 | |
| 17:04:10 | 1 | 16 | |

Date 6/7/79 Event 5 Pulse-to-Pulse Frequency Agility

PW = 230 ns PRI = 103 μs $P_T$ = 3.4 dBm (Peak) TS/TD + 12 dB

Frequency Variation 34.94 - 35.03 GHz

Varactor Gunn Source

| Time | PRF/Step | MHz/Step | Remarks |
|---|---|---|---|
| 17:05:30 | 1 | 8 | |
| 17:05:50 | 1 | 4 | |
| 17:09:45 | 1 | 2 | |
| 17:11:20 | 1 | 1 | |
| 17:14:50 | 1 | .5 | |

Date 6/8/79 Event 5 Pulse-to-Pulse Frequency Agility

PW = 110 ns PRI = 50 $\mu$s $P_T$ = 28 dBm (Peak) No 240 MHz modulation
Frequency Variation 34.67 - 34.77 GHz (measured with spectrum analyzer)

| Time | PRF/Step | MHz/Step | Remarks |
|---|---|---|---|
| 11:40:00 | 1 | 32 | |
| 11:42:25 | 1 | 16 | No 240 MHz modulation |
| 11:43:45 | 1 | 8 | |
| 11:44:00 | 1 | 4 | Varactor Gunn Source |
| 11:44:10 | 1 | 2 | |
| 11:44:30 | 1 | 1 | |
| 11:44:45 | 1 | .5 | |

Event 12 Simulated Unknown Transmissions

| Date | Time | PW (ns) | PRI ($\mu$s) | $P_T$ (dBm pk) | PPFA PRF/Step | PPFA MHz/Step | IPFA MHz/ns | Frequency (GHz) Low | Frequency (GHz) High | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 6/7 | 17:20:30 | 230 | 103 | 3.4 | OFF | OFF | OFF | --- | 35.01 | No Agility |
| 6/7 | 17:26:48 | 230 | 103 | 3.4 | OFF | OFF | 1.75 | 34.93 | 35.01 | Chirp |
| 6/7 | 17:32:30 | 230 | 103 | 3.4 | 1024 | 4 | OFF | 34.94 | 35.03 | PPFA |
| 6/7 | 17:36:23 | 15 | 103 | .8 | 1024 | 4 | OFF | 34.94 | 35.03 | PPFA |
| 6/7 | 17:54:54 | 100 | 103 | 31.7 | 1024 | 4 | 1.75 | 35.00 | 35.03 | Chirp and PPFA |
| 6/8 | 11:47:15 | 110 | 50 | 28.0 | OFF | OFF | 1.75 | 34.72* | 34.78* | Chirp |
| 6/8 | 12:00:00 | 200 | 200 | 28.9 | OFF | OFF | 1.00 | 34.99 | 35.05 | Chirp |
| 6/8 | 12:08:00 | 110 | 50 | 28.0 | 1 | 32 | OFF | 34.67* | 34.77* | PPFA |
| 6/8 | 15:00:15 | 110 | 100 | 31.0 | 1024 | 4 | OFF | 34.67* | 34.77* | PPFA |

Frequency measured with Dip Meter except, * measured with Spectrum Analyzer.

Tests on 6/8 were performed without 240 MHz modulation.

Test at 15:00 simulated radar scan with absorbent material.

Varactor Gunn Source

## Test Parameters

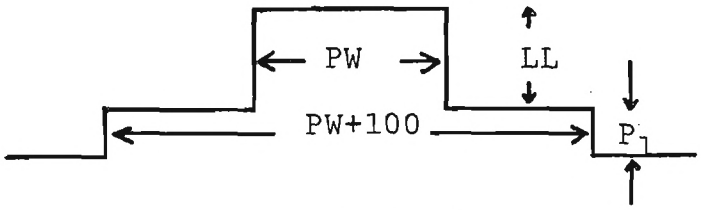
| | |
|---|---|
| Transmit Antenna Beam Width | $1.3^{o} \times 1.3^{o}$ |
| Gain - Transmit Antenna | 43 dB |
| Sidelobes - Transmit Antenna | > 20 dB down |
| Polarization | Vertical only |
| Range | 518 meters |

## Test Equipment

| | | |
|---|---|---|
| Tektronix | 475A | Oscilloscope |
| Hewlett Packard | 432A | Power Meter |
| Hewlett Packard | R486A | Thermistor Mount |
| Alpha/TRG | A551 | Frequency Dip Meter |
| Tektronix | 7L18 | Spectrum Analyzer Plug In |

# APPENDIX 1

Derivation of Leakage Level/Duty Factor Compensation




$P_m$ = power measured (average)

$P_L$ = power of leakage (peak or average)

$P_{mp}$ = power of main pulse (contained in PW-received)/ 240 MHz modulated (peak or average)

LL = leakage level (difference between $P_{mp_{pk}}$ and $P_{L_{pk}}$, dB)

PK = peak

Avg = average

PRI = pulse repetition interval

PW = pulse width

There are four measured quantities. They are: $P_m$, LL, PW, and PRI. From these all other values are derived.

Given:

$$P_{m_{avg}} = P_L + P_{mp} \qquad \text{avg. in mW} \qquad (1)$$

$$P_{mp_{pk}} = P_L + LL \qquad \text{pk in dBm} \qquad (2)$$

or

$$P_{mp} = P_L \, 10^{LL/10} \qquad \text{pk in mW} \qquad (3)$$

solving for $P_L$ and substituting back into (1) taking into account duty factors yields:

$$P_{m_{avg}} = P_{mp_{pk}} \, 10^{-LL/10} \, \frac{PW + 100\ ns}{PRI} + P_{mp_{pk}} \, \frac{PW}{PRI} \quad \text{in mW} \qquad (4)$$

$$= \frac{P_{mp_{pk}}}{PRI} \, PW \, (1 + 10^{-LL/10}) + 100\ ns \, 10^{-LL/10} \quad \text{in mW} \qquad (5)$$

solving for $P_{mp_{pk}}$

$$P_{mp_{pk}} = \frac{P_{m_{avg}} \, PRI}{PW \, (1 + 10^{-LL/10}) + 100\ ns \, 10^{-LL/10}} \quad \text{in mW} \qquad (6)$$

$$P_{mp_{pk}} = P_{m_{avg}} + 10 \log \frac{PRI}{PW \, (1 + 10^{-LL/10}) + 100\ ns \, 10^{-LL/10}} \quad \text{in dBm} \qquad (7)$$