

ISSUED 7-73

ML-8906  
 ML-8907  
 ML-8906/AL

**MACHLETT**

**UHF Planar Triodes**  
 CW, Plate or Grid Pulsed  
 Phormat Cathode  
 High Cathode Current Capability  
 Extended Grid-Anode Insulator  
 3 GHz

**DESCRIPTION**

The ML-8906, ML-8907 and ML-8906/AL are ruggedized, high- $\mu$  planar triodes of ceramic-and-metal construction designed for use as grid-pulsed, plate-pulsed or CW oscillators, amplifiers or frequency multipliers in transmitting service at frequencies up to 3 GHz. They may also be used as pulse modulators, pulse amplifiers or voltage regulators. The ML-8907 is fitted with a radiator for forced-air cooling. The ML-8906 and ML-8906/AL are intended for conduction and convection cooling. The ML-8906/AL is specially processed and tested for application in airline avionics service where long life and uninterrupted service are of prime importance.

These tubes are provided with an extended grid-anode insulator in the tube envelope making them suitable for high-altitude operation. They employ a Phormat type cathode, which consists of an indirectly heated disc with an oxide

coating impregnated in a nickel matrix. This construction, in combination with proper plate series impedance, reduces to a minimum failures of the cathode due to voltage surges. The ceramic insulators of these tubes are provided with spew shields to minimize changes in grid-plate capacitance with life. Other features of these tubes include high cathode current capability, low interelectrode capacitance, high transconductance and great mechanical strength.

The envelopes of these tubes are dimensionally equivalent to the ML-7211, ML-7698, ML-7815, ML-7815R, ML-7815/AL and ML-7815R/AL. The ML-8906, ML-8907 and ML-8906/AL have a larger cathode surface than the ML-7815, ML-7815R, ML-7815/AL and ML-7815R/AL. The tubes can be used to replace the ML-7211 and ML-7698 with a reduction in heater power requirements.

**GENERAL CHARACTERISTICS**

**Electrical**

|  |              |            |
|--|--------------|------------|
| Heater Voltage (AC or DC)  |              |            |
| ML-8906, ML-8907 .....   | 6.0 $\pm$ 3  | V          |
| ML-8906/AL .....   | 5.7 $\pm$ 2% | V          |
| Heater Current   |              |            |
| ML-8906, ML-8907 (at 6.0 V) .....                                      | 1.00         | A          |
| ML-8906/AL (at 5.7 V) .....  | .95          | A          |
| Cathode Heating Time, minimum .....                                    | 60           | sec        |
| Amplification Factor .....   | 80           |            |
| Transconductance (I <sub>b</sub> =100 mA, E <sub>b</sub> =600 V) ..... | 30000        | $\mu$ mhos |
| Interelectrode Capacitance, without heater voltage                     |              |            |
| Grid-Plate .....   | 1.98         | pf         |
| Grid-Cathode .....   | 8.00         | pf         |
| Plate-Cathode, maximum .....   | .06          | pf         |

**Mechanical and Environmental**

|   |                           |
|---|---------------------------|
| Mounting Position .....                               | Optional                  |
| Type of Cooling                                       |                           |
| With radiator (ML-8907) .....                         | Forced-Air §              |
| Without radiator (ML-8906, ML-8906/AL) .....          | Conduction & Convection § |
| Maximum Envelope or Anode Temperature .....           | 250 °C                    |
| Non-Operating Shock, 11 millisecond .....             | 60 G                      |
| Vibration, All Axis, Operating, 55 to 500 Hertz ..... | 10 G                      |
| Altitude, maximum .....                               | 70000 ft                  |
| Net Weight  |                           |
| ML-8906, ML-8906/AL .....                             | 51 g                      |
| ML-8907 .....   | 63 g                      |

§ For cooling data refer to Machlett Application Notes, UHF Tubes — General

**MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS**

**CW RF Power Oscillator or Amplifier — Class C**

Maximum Ratings, Absolute Values

|   |      |     |
|---|------|-----|
| DC Plate Voltage                                | 2500 | V   |
| DC Grid Voltage                                 | -150 | V   |
| Instantaneous Peak Grid-Cathode Voltage         |      |     |
| Grid negative to cathode                        | -400 | v   |
| Grid positive to cathode                        | 30   | v   |
| DC Plate Current                                | 150  | mA  |
| DC Grid Current                                 | 45   | mA  |
| Plate Dissipation                               |      |     |
| Forced-air cooling (ML-8907)                    | 100  | W   |
| Conduction and convection (ML-8906, ML-8906/AL) | 10   | W   |
| Grid Dissipation                                | 1.5  | W   |
| Frequency                                       | 2.5  | GHz |

Typical Operation, Cathode Drive Amplifier

|                              |     |     |
|------------------------------|-----|-----|
| Frequency                    | .7  | GHz |
| DC Plate Voltage             | 630 | V   |
| DC Grid Voltage, approximate | -5  | V   |
| DC Cathode Current           | 140 | mA  |
| DC Grid Current              | 25  | mA  |
| Driving Power, approximate   | 4   | W   |
| Useful Power Output          | 45  | W   |

Typical Operation, Cathode Drive Oscillator

|                              |      |     |
|------------------------------|------|-----|
| Frequency                    | 2.5  | GHz |
| Heater Voltage               | 5.0  | V*  |
| DC Plate Voltage             | 1000 | V   |
| DC Grid Voltage, approximate | -20  | V   |
| DC Plate Current             | 140  | mA  |
| DC Grid Current, approximate | 30   | mA  |
| Useful Power Output          | 30   | W   |

\*The heater voltage is reduced approximately 15% in this application due to back heating of the cathode.

**Grid-Pulsed or Plate-Pulsed RF Oscillator or Amplifier — Class C**

Maximum Ratings, Absolute Values

|   |        |      |
|---|--------|------|
| Plate Voltage                                   |        |      |
| Grid-Pulsed, DC                                 | 3500   | V    |
| Plate-Pulsed, Peak Pulse Supply                 | 4500   | v    |
| DC Grid Voltage                                 | -150   | V    |
| Instantaneous Peak Grid-Cathode Voltage         |        |      |
| Grid negative to cathode                        |        |      |
| ML-8906, ML-8907                                | -700   | v    |
| ML-8906/AL                                      | -750   | v    |
| Grid positive to cathode                        |        |      |
| ML-8906, ML-8907                                | 200    | v    |
| ML-8906/AL                                      | 250    | v    |
| Pulse Plate Current                             | 5      | a    |
| Pulse Grid Current                              | 2.5    | a    |
| Average Plate Dissipation                       |        |      |
| Forced-air cooling (ML-8907)                    | 100    | W    |
| Conduction and convection (ML-8906, ML-8906/AL) | 10     | W    |
| Average Grid Dissipation                        |        |      |
| ML-8906, ML-8907                                | 1.5    | W    |
| ML-8906/AL                                      | 2      | W    |
| Pulse Duration                                  | 6      | μs** |
| Duty Factor                                     | 0.0033 | **   |
| Frequency                                       | 3      | GHz  |

\*\*For applications requiring longer pulse duration or higher duty factor, consult the Machlett Engineering Department.

Typical Operation, Grid-Pulsed RF Amplifier, ML-8906, ML-8907

|                          |       |     |
|--------------------------|-------|-----|
| Frequency                | 1.1   | GHz |
| Heater Voltage           | 6.0   | V   |
| Pulse Duration           | 3     | μs  |
| Duty Factor              | 0.002 |     |
| DC Plate Voltage         | 2200  | V   |
| DC Grid Voltage          | -50   | V   |
| Peak Video Plate Current | 2.5   | a   |
| Peak Video Grid Current  | 1     | a   |

|  |       |     |
|--|-------|-----|
| Driving Power during Pulse                               | 400   | W   |
| Useful Peak Power Output, approximate                    | 2.5   | kw  |
| Typical Operation, Grid-Pulsed RF Oscillator, ML-8906/AL |       |     |
| Frequency  | 1.1   | GHz |
| Heater Voltage   | 5.7   | V   |
| Pulse Duration   | .5    | μs  |
| Duty Factor  | 0.001 |     |
| DC Plate Voltage   | 2000  | V   |
| DC Grid Voltage  | -75   | V   |
| Peak Video Plate Current                                 | 1.1   | a   |
| Peak Video Grid Current                                  | .8    | a   |
| Useful Peak Power Output, approximate                    | 850   | w   |

Typical Operation, Plate-Pulsed RF Amplifier, ML-8906/AL

|                                       |       |     |
|---------------------------------------|-------|-----|
| Frequency                             | 1.1   | GHz |
| Heater Voltage                        | 5.7   | V   |
| Pulse Duration                        | 3.5   | μs  |
| Duty Factor                           | 0.001 |     |
| Peak Plate Pulse Supply Voltage       | 2000  | v   |
| DC Grid Voltage                       | -45   | V   |
| Peak Video Plate Current              | 2     | a   |
| Peak Video Grid Current               | 1     | a   |
| Driving Power                         | 300   | W   |
| Useful Peak Power Output, approximate | 2     | kw  |

Typical Operation, Plate-Pulsed RF Oscillator, ML-8906, ML-8907

|                                       |        |     |
|---------------------------------------|--------|-----|
| Frequency                             | 3      | GHz |
| Heater Voltage                        | 5.8    | V   |
| Pulse Duration                        | 3      | μs  |
| Duty Factor                           | 0.0025 |     |
| Peak Plate Pulse Supply Voltage       | 3500   | v   |
| Peak Video Plate Current              | 4.8    | a   |
| Peak Video Grid Current               | 1.5    | a   |
| Useful Peak Power Output, approximate | 3      | kw  |

**Pulse Modulator or Pulse Amplifier**

Maximum Ratings, Absolute Values

|   |        |      |
|---|--------|------|
| DC Plate Voltage                                | 3500   | V    |
| Peak Plate Voltage                              | 4500   | v    |
| DC Grid Voltage                                 | -150   | V    |
| Instantaneous Peak Grid-Cathode Voltage         |        |      |
| Grid negative to cathode                        | -750   | v    |
| Grid positive to cathode                        | 150    | v    |
| DC Plate Current                                | 150    | mA   |
| Pulse Cathode Current                           | 7.5    | a    |
| Average Plate Dissipation                       |        |      |
| Forced-air cooling (ML-8907)                    | 100    | W    |
| Conduction and convection (ML-8906, ML-8906/AL) | 10     | W    |
| Average Grid Dissipation                        | 1.5    | W    |
| Cutoff Amplification Factor                     | 60     |      |
| Pulse Duration                                  | 6      | μs** |
| Duty Factor                                     | 0.0033 | **   |

\*\*For applications requiring longer pulse duration or higher duty factor, consult the Machlett Engineering Department

**CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN**

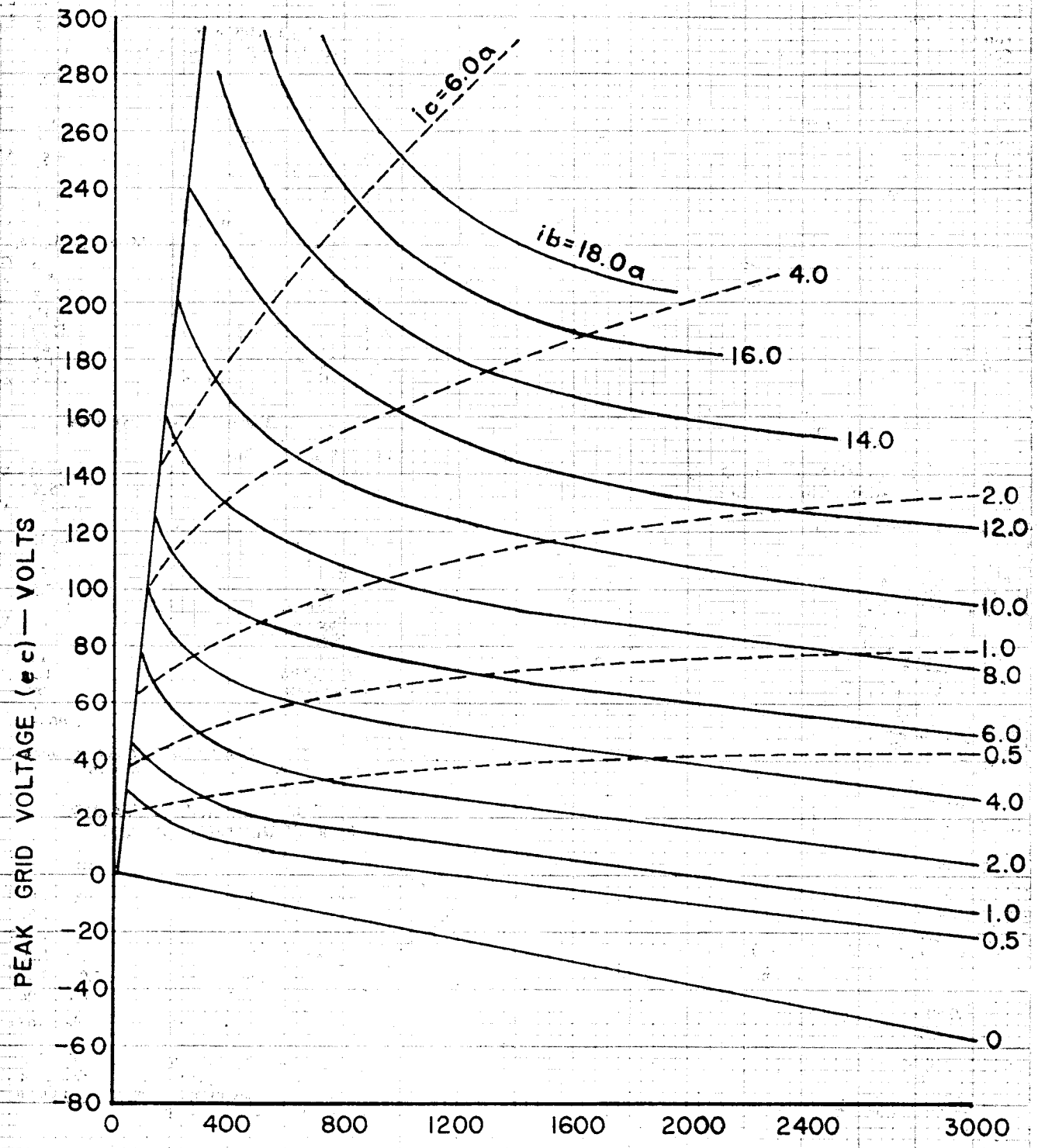
|  | Min  | Max     |
|--|------|---------|
| Filament Current   |      |         |
| ML-8906, ML-8907 (at 6.0 V)  | .90  | 1.05 A  |
| ML-8906/AL (at 5.7 V)  | .87  | 1.02 A  |
| Cut-Off Bias (Note 1)  | —    | -30 V   |
| Grid-Plate Capacitance (Note 2)  | 1.85 | 1.20 pf |
| Grid-Cathode Capacitance (Note 2)  | 7.0  | 9.0 pf  |
| Plate-Cathode Capacitance (Note 2)   | —    | .06 pf  |
| Note 1 — Measured at 1 mA of plate current and a plate voltage of 1000 Vdc.  |      |         |
| Note 2 — Capacitance values are given for a cold tube. When the cathode is heated to its proper temperature, the grid-cathode capacitance will increase by approximately 1 pf due to thermal expansion of the cathode support structure. |      |         |

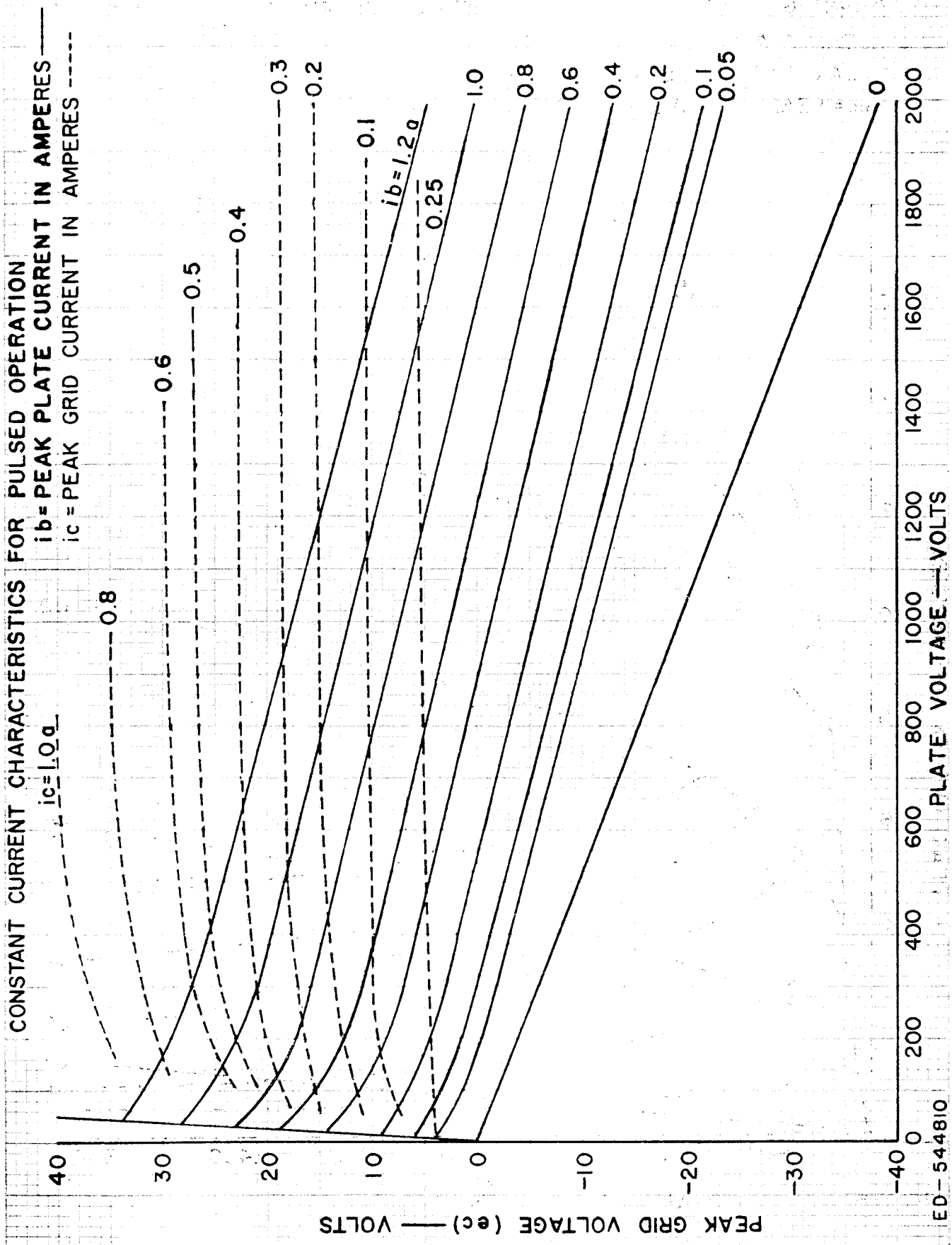
**APPLICATION NOTES**

Before designing equipment for use with these tubes and before installing tubes in equipment, refer to the general information given in the Machlett publications entitled *Application Notes, UHF Tubes — General and Application Notes, UHF Triodes, Extended Life AL Series Tubes for Airline Operation.*

CONSTANT CURRENT CHARACTERISTICS FOR PULSED OPERATION

$i_b$  = PEAK PLATE CURRENT IN AMPERES ———  
 $i_c$  = PEAK GRID CURRENT IN AMPERES - - - -



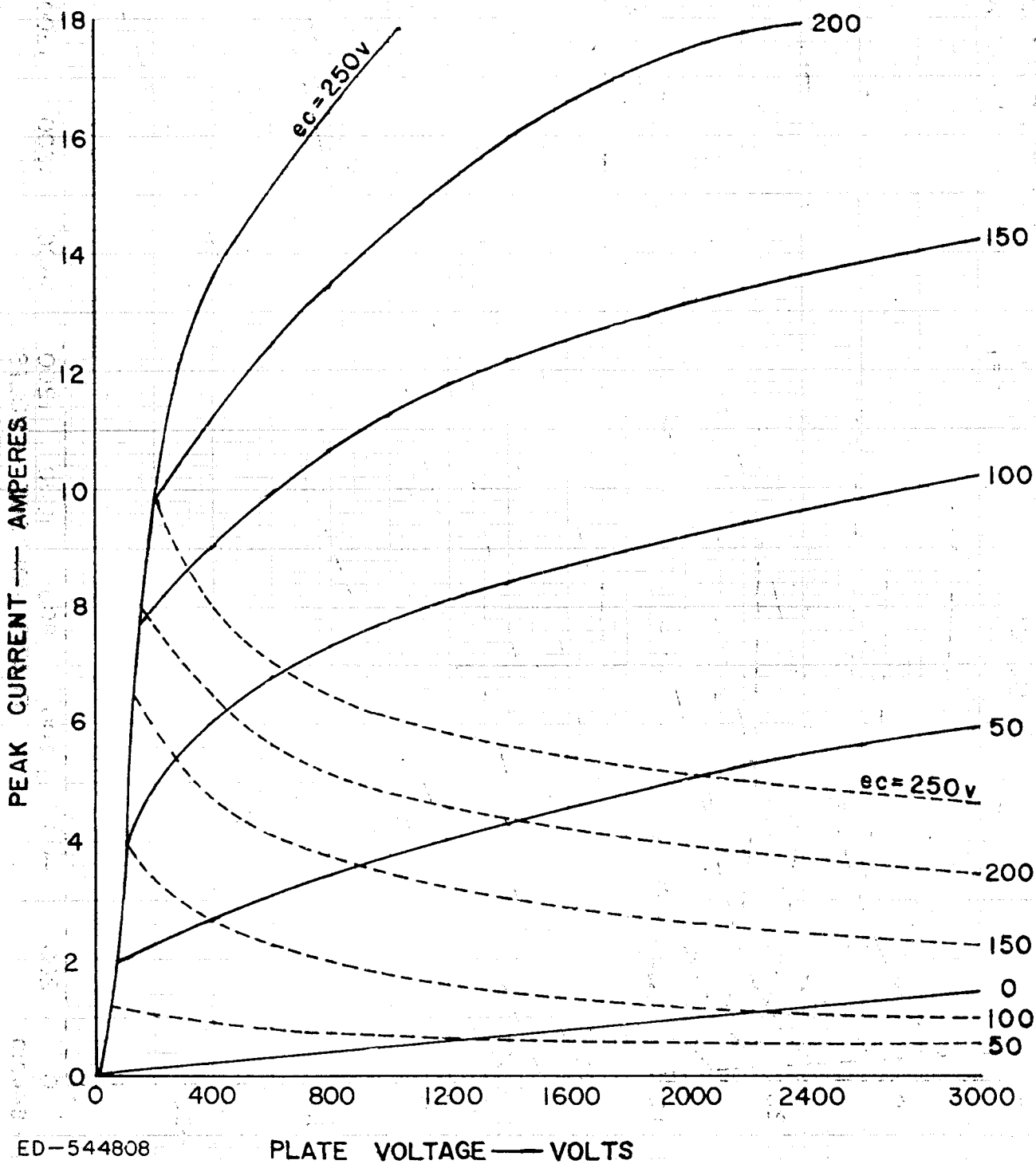


CONSTANT GRID-VOLTAGE CHARACTERISTICS FOR PULSED OPERATION

PEAK PLATE CURRENT ( $i_b$ ) ———

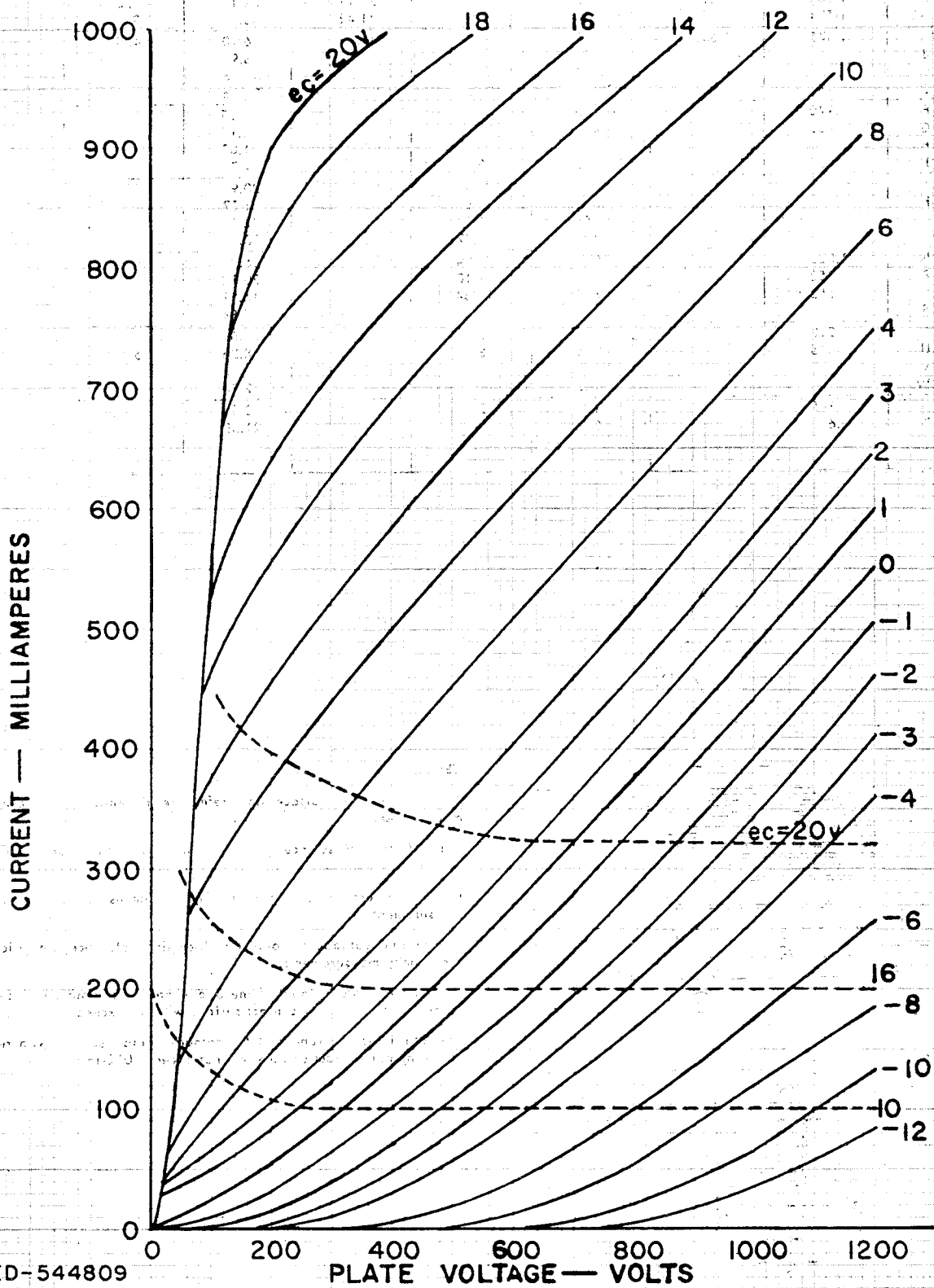
PEAK GRID CURRENT ( $i_c$ ) - - - - -

$e_c$  = PEAK POSITIVE GRID VOLTAGE IN VOLTS



### CONSTANT GRID - VOLTAGE CHARACTERISTICS

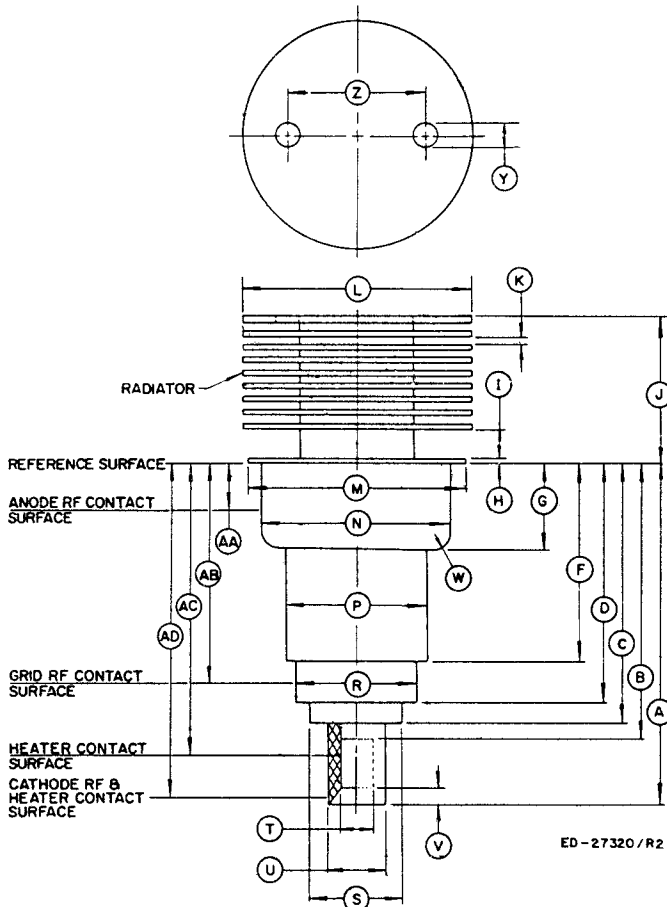
PLATE CURRENT ( $i_b$ ) ———  
GRID CURRENT ( $i_c$ ) - - - -  
 $e_c$  = GRID VOLTAGE IN VOLTS



DIMENSIONS FOR OUTLINE OF ML-8907

The millimeter dimensions are derived from the original inch dimensions.

| Ref. | Inches  |         |         | Millimeters |         |         | Notes   |
|------|---------|---------|---------|-------------|---------|---------|---------|
|      | Minimum | Nominal | Maximum | Minimum     | Nominal | Maximum |         |
| A    | 1.815   |         | 1.875   | 46.10       |         | 47.62   |         |
| AA   | .035    | .198    | .361    | .89         | 5.03    | 9.17    | 1, 5    |
| AB   | 1.185   | 1.225   | 1.265   | 30.10       | 31.12   | 32.13   | 2, 5    |
| AC   | 1.534   | 1.631   | 1.728   | 38.96       | 41.43   | 43.89   | 3, 6    |
| AD   | 1.475   | 1.645   | 1.815   | 37.46       | 41.78   | 46.10   | 4, 5, 6 |
| B    |         |         | 1.534   |             |         | 38.96   |         |
| C    |         |         | 1.475   |             |         | 37.46   |         |
| D    | 1.289   |         | 1.329   | 32.74       |         | 33.76   |         |
| F    | .970    |         | 1.010   | 24.64       |         | 25.65   |         |
| G    | .462    |         | .477    | 11.73       |         | 12.12   |         |
| H    |         |         | .040    |             |         | 1.02    |         |
| I    | .125    |         | .185    | 3.18        |         | 4.70    |         |
| J    | .766    |         | .826    | 19.46       |         | 20.98   |         |
| K    | .025    |         | .046    | .64         |         | 1.17    |         |
| L    | 1.234   |         | 1.264   | 31.34       |         | 32.11   |         |
| M    | 1.180   |         | 1.195   | 29.97       |         | 30.35   |         |
| N    | 1.025   |         | 1.035   | 26.04       |         | 26.29   | 5       |
| P    | .752    |         | .792    | 19.10       |         | 20.12   |         |
| R    | .655    |         | .665    | 16.64       |         | 16.89   | 5       |
| S    |         |         | .545    |             |         | 13.84   |         |
| T    | .213    |         | .223    | 5.41        |         | 5.66    | 6       |
| U    | .315    |         | .325    | 8.00        |         | 8.26    | 5, 6    |
| V    |         |         | .086    |             |         | 2.18    |         |
| W    |         |         | .100    |             |         | 2.54    |         |
| Y    | .105    |         | .145    | 2.67        |         | 3.63    |         |
| Z    | .650    |         | .850    | 16.51       |         | 21.59   |         |



NOTES:

1. Anode rf contact surface and reference dimension for eccentricity measurements.
2. Grid rf contact surface and reference dimension for eccentricity measurements.
3. Heater contact surface and reference dimension for eccentricity measurements.
4. Heater and cathode rf contact surface and reference dimension for eccentricity measurements.
5. The total indicated runout of the anode and grid contact surface with respect to the cathode contact surface will not exceed .020 inch.
6. The total indicated runout of the cathode contact surface with respect to the heater contact surface will not exceed .012 inch.

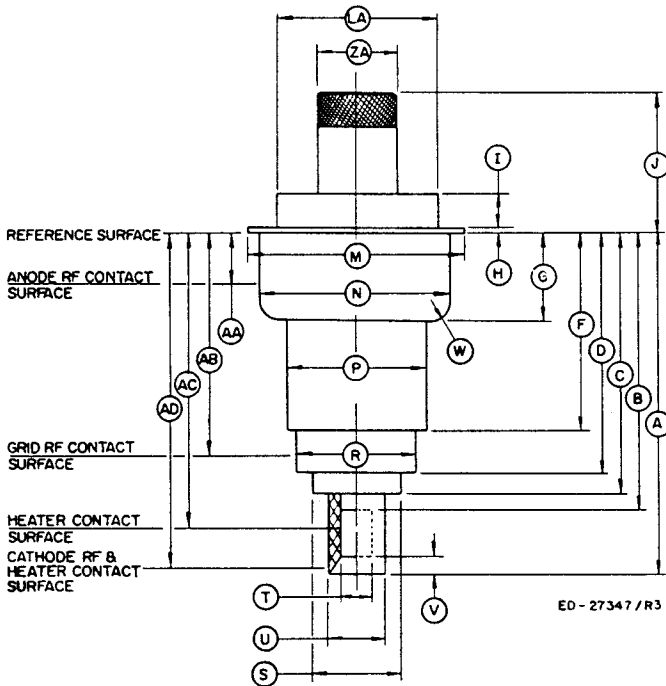
OUTLINE — ML-8907

**DIMENSIONS FOR OUTLINE OF ML-8906 and ML-8906/AL**

The millimeter dimensions are derived from the original inch dimensions.

| Ref. | Inches  |         |         | Millimeters |         |         | Notes   |
|------|---------|---------|---------|-------------|---------|---------|---------|
|      | Minimum | Nominal | Maximum | Minimum     | Nominal | Maximum |         |
| A    | 1.815   |         | 1.875   | 46.10       |         | 47.62   |         |
| AA   | .035    | .198    | .361    | .89         | 5.03    | 9.17    | 1, 5    |
| AB   | 1.185   | 1.225   | 1.265   | 30.10       | 31.12   | 32.13   | 2, 5    |
| AC   | 1.534   | 1.631   | 1.728   | 38.96       | 41.43   | 43.89   | 3, 6    |
| AD   | 1.475   | 1.645   | 1.815   | 37.46       | 41.78   | 46.10   | 4, 5, 6 |
| B    |         |         | 1.534   |             |         | 38.96   |         |
| C    |         |         | 1.475   |             |         | 37.46   |         |
| D    | 1.289   |         | 1.329   | 32.74       |         | 33.76   |         |
| F    | .970    |         | 1.010   | 24.64       |         | 25.65   |         |
| G    | .462    |         | .477    | 11.73       |         | 12.12   |         |
| H    |         |         | .040    |             |         | 1.02    |         |
| I    |         |         | .185    |             |         | 4.70    |         |
| J    | .766    |         | .826    | 19.46       |         | 20.98   |         |
| LA   | .840    |         | .860    | 21.34       |         | 21.84   |         |
| M    | 1.180   |         | 1.195   | 29.97       |         | 30.35   |         |
| N    | 1.025   |         | 1.035   | 26.04       |         | 26.29   | 5       |
| P    | .752    |         | .792    | 19.10       |         | 20.12   |         |
| R    | .655    |         | .665    | 16.64       |         | 16.89   | 5       |
| S    |         |         | .545    |             |         | 13.84   |         |
| T    | .213    |         | .223    | 5.41        |         | 5.66    | 6       |
| U    | .315    |         | .325    | 8.00        |         | 8.26    | 5, 6    |
| V    |         |         | .086    |             |         | 2.18    |         |
| W    |         |         | .100    |             |         | 2.54    |         |
| ZA   | .427    |         | .447    | 10.85       |         | 11.35   |         |

OUTLINE — ML-8906 & ML-8906/AL



**NOTES:**

1. Anode rf contact surface and reference dimension for eccentricity measurements.
2. Grid rf contact surface and reference dimension for eccentricity measurements.
3. Heater contact surface and reference dimension for eccentricity measurements.
4. Heater and cathode rf contact surface and reference dimension for eccentricity measurements.
5. The total indicated runout of the anode and grid contact surface with respect to the cathode contact surface will not exceed .020 inch.
6. The total indicated runout of the cathode contact surface with respect to the heater contact surface will not exceed .012 inch.



**THE MACHLETT LABORATORIES, INC.**

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