FINAL REPORT

FOR

AN EXPERIMENTAL EFFORT TO IMPROVE THE NIMBUS HIGH RESOLUTION INFRARED RADIOMETER

VOLUME II OF TWO VOLUMES

(1 May 1964 - 15 February 1965)

Contract No.: NAS 5-3683

Work Order: 65-2-4/65-1-65

Prepared by

ITT Industrial Laboratories
Fort Wayne, Indiana

For

National Aeronautics & Space Administration
Aeronomy and Meteorology Branch
Goddard Space Flight Center
Greenbelt, Maryland

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Contributors

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Approved by

W. H. Wallschlaeger,
Project Manager

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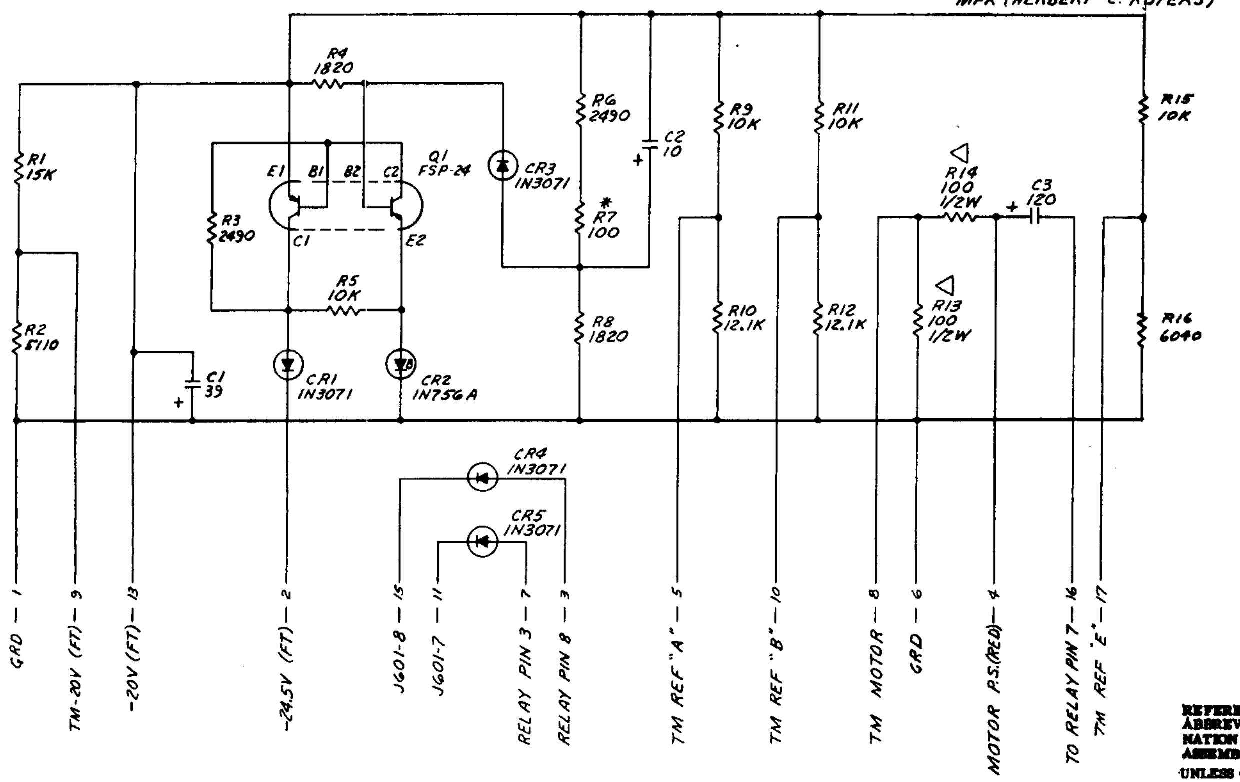
Space & Physical Sciences Dept.

TABLE OF CONTENTS

APPENDIX I

DRAWINGS

NOTE: * INDICATES TAILOR POINT.
◁ VALUES SPECIFIED BY MOTOR MFR (HERBERT C. ROTERS)



REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH
UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCE VALUES ARE IN OHMS, 1 % 1/4 W.
ALL CAPACITANCE VALUES ARE IN MICROFARADS, ± % 20 V.

LAST NUMBERS USED

C3
CR5
Q1
R16

REVISIONS

DRAWING NUMBER 4708093

QTY.	ITEM	DWG SIZE	PART NUMBER	DESCRIPTION
				LIST OF MATERIAL

ITT INDUSTRIAL LABORATORIES FORT WAYNE, IND.
A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

SCHEMATIC DIAGRAM TELEMETERING MODULE

C 4708093

SCALE — SHEET

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES AND INCLUDE CHEMICALLY APPLIED OR PLATED FINISHES
TOLERANCES

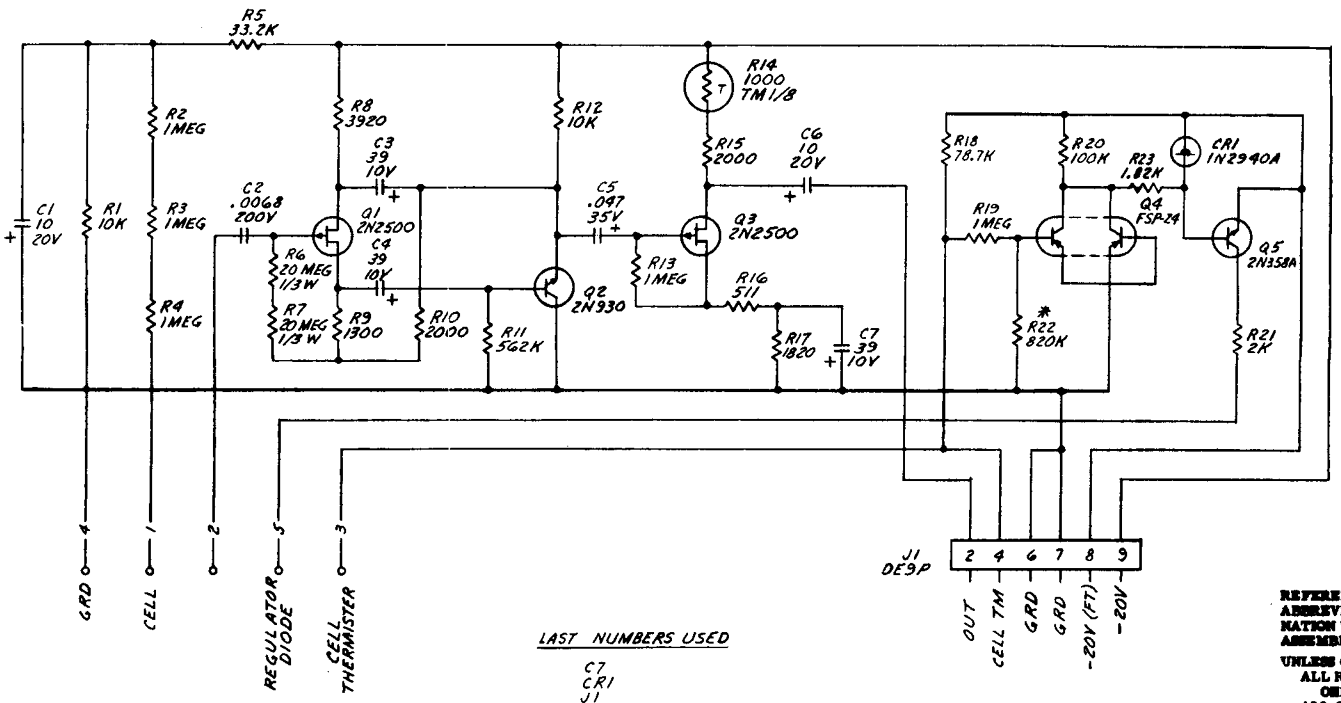
MATERIAL
FINISH

NEXT ASSEMBLY: 11-20752 — FIRST USED ON
APPLICATION

4708090

NOTES:

1. * INDICATES TAILOR POINT.
2. OMIT R1 FOR 20V CELL BIAS.



LAST NUMBERS USED

C7
CR1
J1
Q5
R23

REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH

UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCE VALUES ARE IN OHMS, 1 % 1/4 W.
ALL CAPACITANCE VALUES ARE IN MICROFARADS.

QTY.	ITEM	PART NUMBER	DESCRIPTION
			LIST OF MATERIAL

ITT INDUSTRIAL LABORATORIES FORT WAYNE, IND.
A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

SCHEMATIC DIAGRAM
LOW-NOISE PREAMPLIFIER (6-VOLT)

C 4708090

SCALE — SHEET

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES AND INCLUDE CHEMICALLY APPLIED OR PLATED FINISHES
TOLERANCES

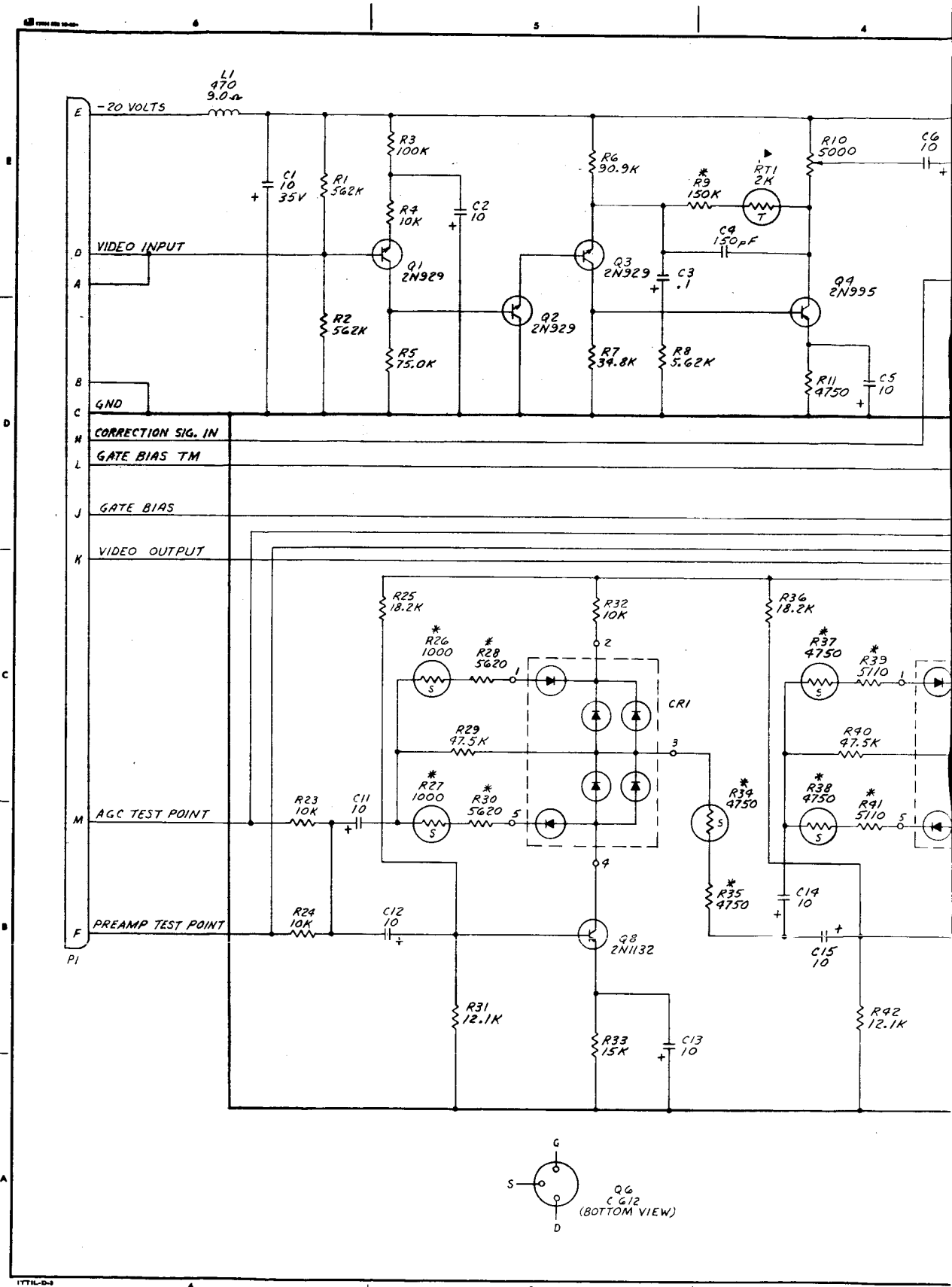
MATERIAL

FINISH

NEXT ASSEMBLY	FIRST USED ON
	11-20752

APPLICATION

4708090


L1 470 9.0Ω
E -20 VOLTS
D VIDEO INPUT
A
B
C GND
H CORRECTION SIG. IN
L GATE BIAS TM
J GATE BIAS
K VIDEO OUTPUT
M AGC TEST POINT
F PREAMP TEST POINT
P1
C1 10 35V
R1 562K
R3 100K
R4 10K
C2 10
Q1 2N929
R2 562K
R5 75.0K
Q2 2N929
R6 90.9K
R9 150K
RT1 2K
R10 5000
C6 10
C4 150pF
Q3 2N929
C3 .1
Q4 2N995
R7 34.8K
R8 5.62K
R11 4750
C5 10
R25 18.2K
R32 10K
R26 1000
R28 5620
CR1
R29 47.5K
R27 1000
R30 5620
R23 10K
C11 10
R24 10K
C12 10
Q8 2N1132
R31 12.1K
R33 15K
C13 10
R34 4750
R35 4750
R36 18.2K
R37 4750
R39 5110
R40 47.5K
R38 4750
R41 5110
C14 10
C15 10
R42 12.1K
Q6 C612 (BOTTOM VIEW)
G
S
D

4 (1)

4708099

REVISIONS

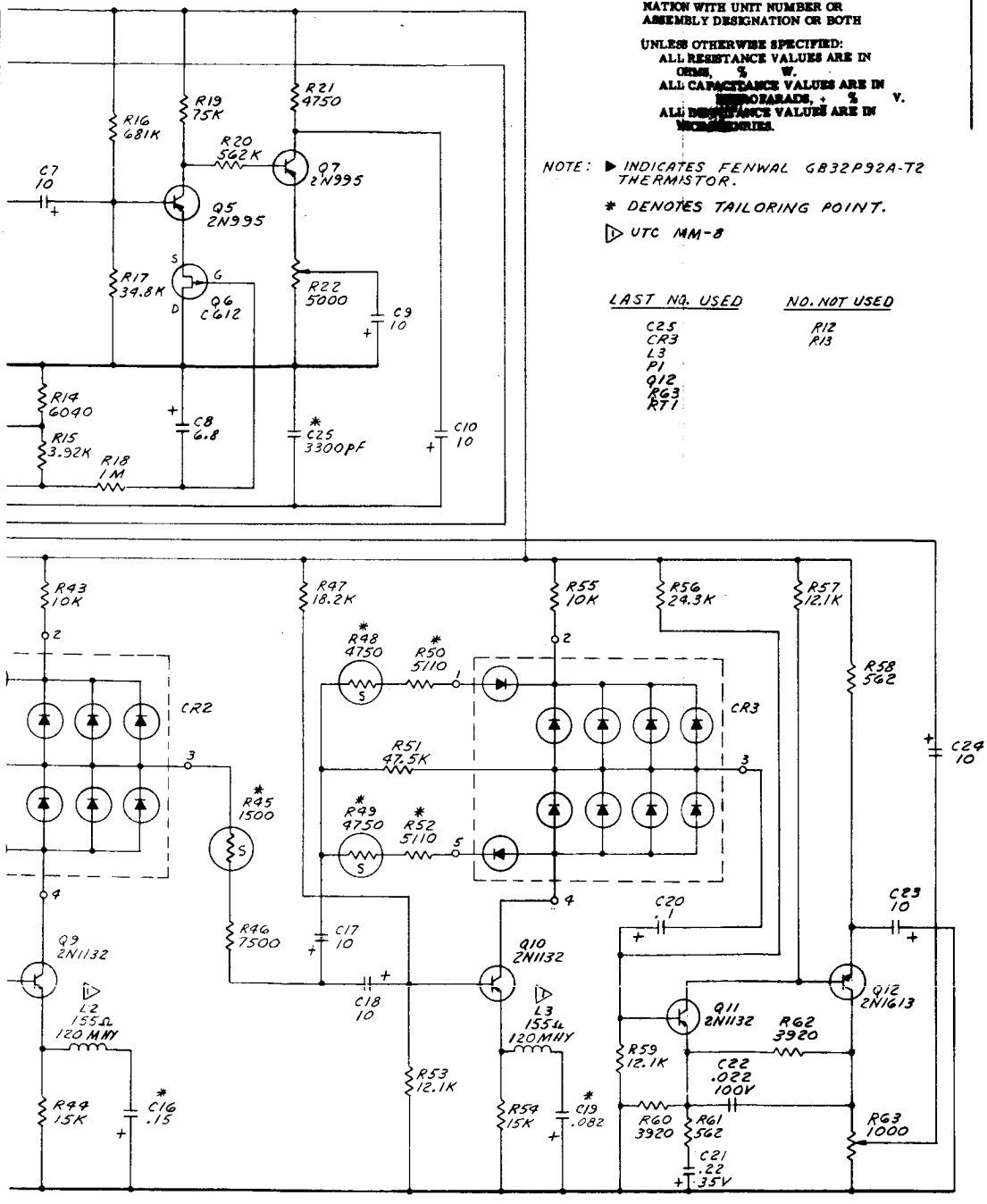
ZONE	LTR	CHGD BY & DATE	CHKD BY & DATE	ECN NUMBER

REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH

UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCE VALUES ARE IN OHMS, %, W.
ALL CAPACITANCE VALUES ARE IN MICROFARADS, ±, %, V.
ALL INDUCTANCE VALUES ARE IN MICROHENRIES.

NOTE: ▶ INDICATES FENWAL GB32P92A-T2 THERMISTOR.
* DENOTES TAILORING POINT.
▷ UTC MM-8

LAST NO. USED	NO. NOT USED
C25	R12
CR3	R13
L3	
P1	
Q12	
RG3	
RT1	



QTY	ITEM	DWG SIZE	PART NUMBER	DESCRIPTION

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED	MATERIAL
DIMENSIONS ARE IN INCHES AND INCLUDE CHEMICALLY APPLIED OR PLATED FINISHES	
TOLERANCES	FINISH
DECIMALS: 2 PLACE ± .02; 3 PLACE ± .005; FRACTIONS ± 1/64	
4 TO 24 INCL ± .03; ± .010; ± 1/32	
OVER 24 ± .08; ± .015; ± 1/16	
ANGLES ± 1/2°	
COMMERCIAL TOLERANCES APPLY TO STOCK SIZES	
SHOP PRACTICE, ESM SECT. 38, APPLIES	

NEXT ASSEMBLY	FIRST USED ON
C4708230	11-20752

APPLICATION

SIGNATURE & DATE	
DRAWN	16 Dec 69
CHKD	
MECH. APPVL	
ELECT. APPVL	9-2-69
STD.	
APPD	
E OF M	

ITT INDUSTRIAL LABORATORIES FORT WAYNE, IND.
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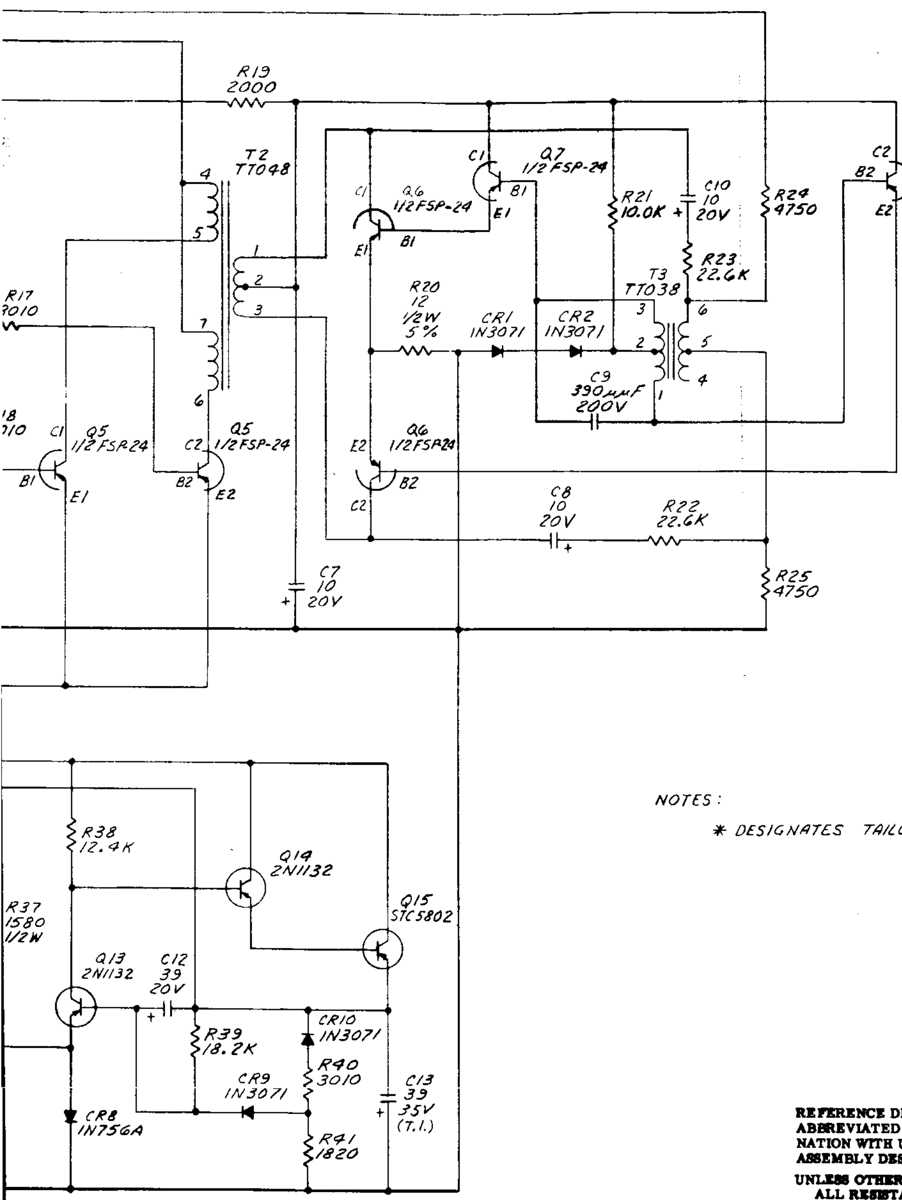
SCHEMATIC DIAGRAM
VIDEO BOARD

SCALE —

D 4708099 SHEET

2



T USED

NOTES:

✱ DESIGNATES TAILORING POINT.

REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH

UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCE VALUES ARE IN OHMS, 1 % 1/4 W.
ALL CAPACITANCE VALUES ARE IN MICROFARADS, ±10 % 100 V

REVISIONS

ZONE	LTR	CHKD BY & DATE	CHKD BY & DATE	ECN NUMBER

DRAWING NUMBER 4708133 REV.

QTY.	ITEM	DWG SIZE	PART NUMBER	DESCRIPTION
				LIST OF MATERIAL

		UNLESS OTHERWISE SPECIFIED
	11-20753	DIMENSIONS ARE IN INCHES AND INCLUDE CHEMICALLY APPLIED OR PLATED FINISHES
NEXT ASSEMBLY	FIRST USED ON	TOLERANCES
APPLICATION		

BASIC DIMENSION	2 PLACE	3 PLACE	FRACTIONS
UNDER 6	± .02	± .005	± 1/64
6 TO 24 INCL	± .03	± .010	± 1/32
OVER 24	± .06	± .015	± 1/16

ANGLES ± 1/2°
COMMERCIAL TOLERANCES APPLY TO STOCK SIZES
SHOP PRACTICE, ESM SECT. 38, APPLIES

MATERIAL

FINISH

SIGNATURE & DATE
DRAWN
CHKD.
MECH. APPVL.
ELECT. APPVL.
STD.
APPD
E OF M

ITT INDUSTRIAL LABORATORIES FORT WAYNE, IND.
A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

SCHEMATIC DIAGRAM OUTPUT-POWER-AGC BOARD

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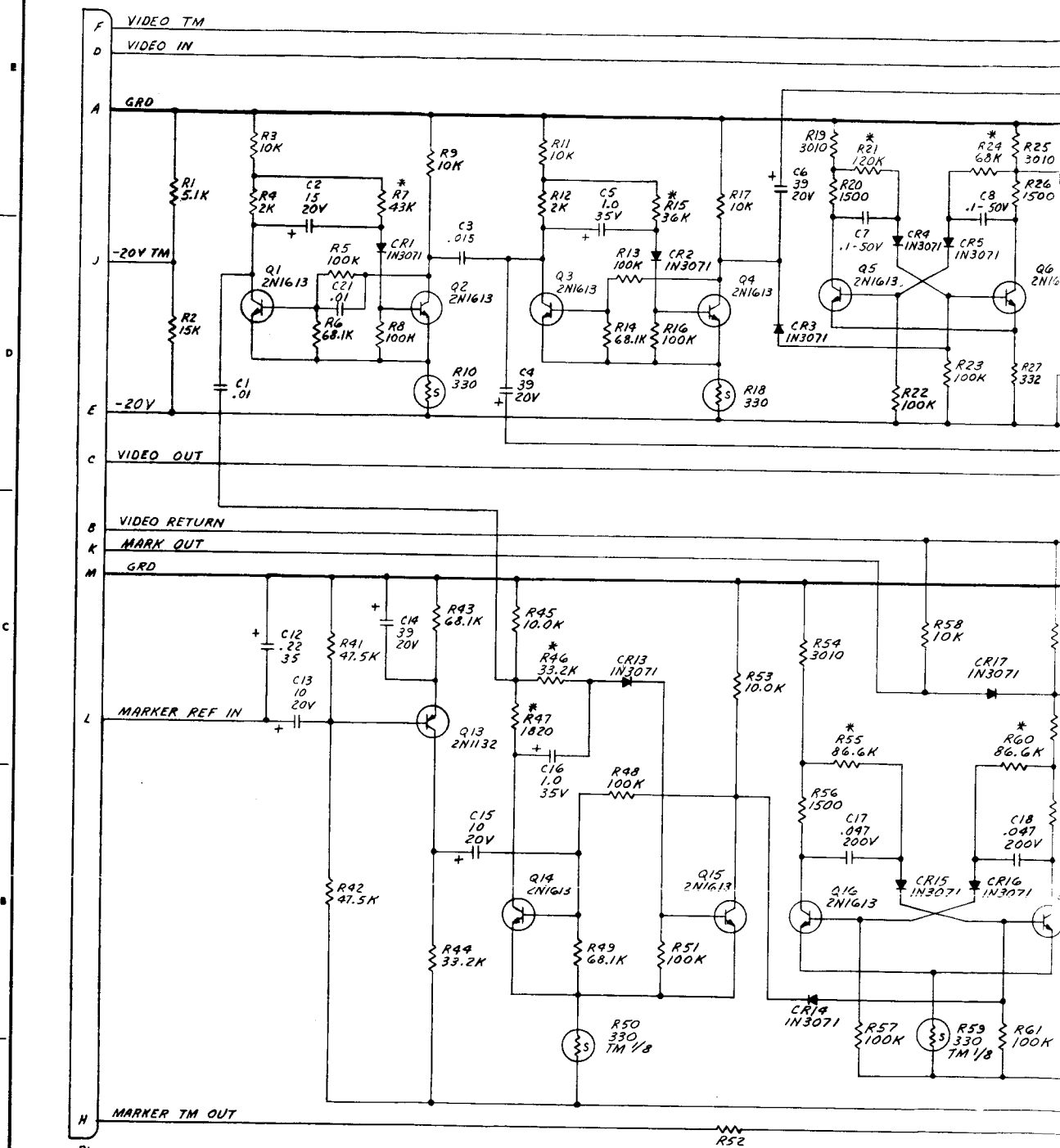
DWG SIZE D 4708133
SCALE — SHEET ISSUE

(2)



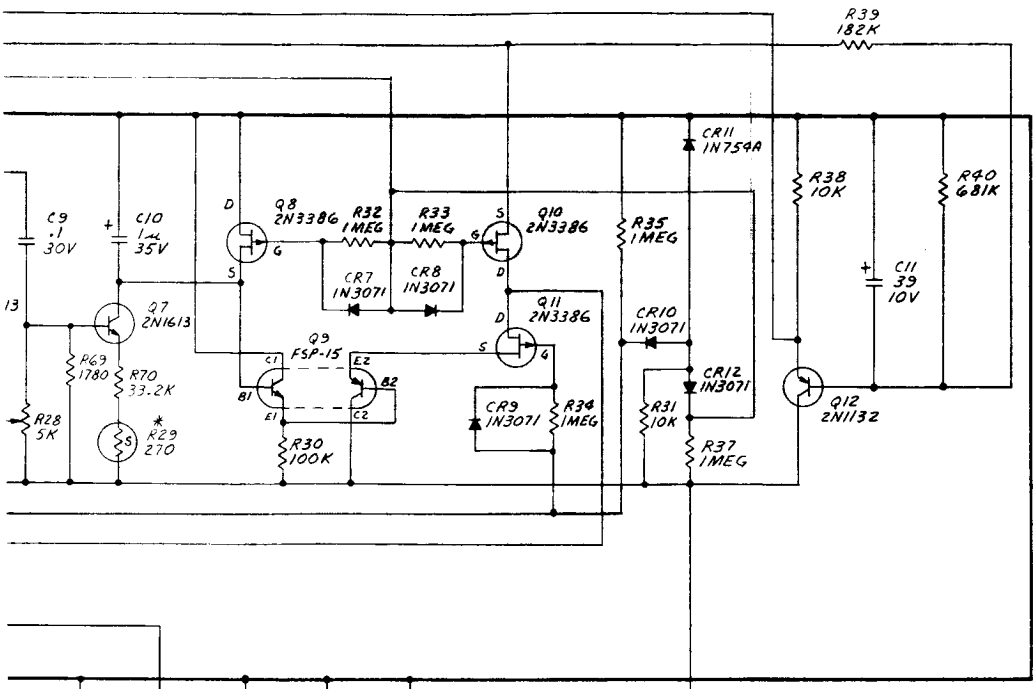
LAST NO. USED

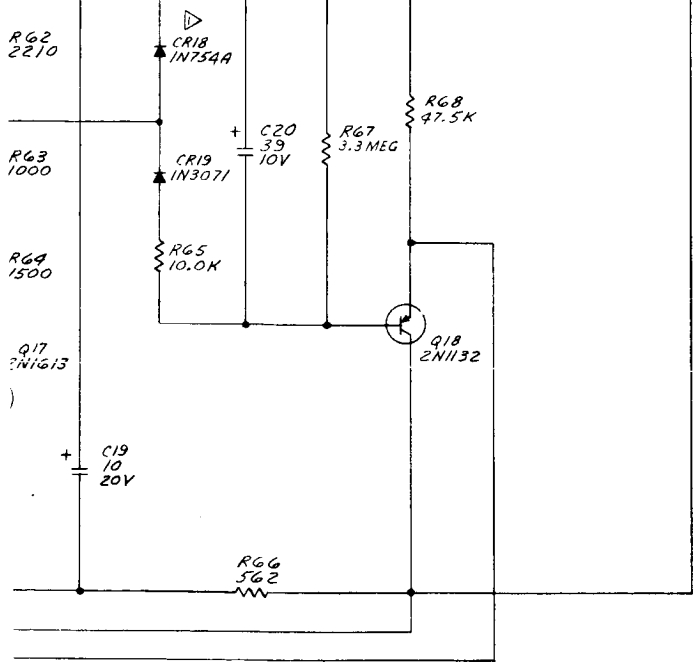
C21
CR19
P1
Q18
R70

NO. NOT USED

CR6
R36

6 (1)





NOTES:

* DESIGNATES TAILORING POINT.

▷ SELECTED FOR 5.75± .25 VDC @ 1.25 ma.

4708141

REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH

UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCE VALUES ARE IN OHMS, 1 % 1/4 W.
ALL CAPACITANCE VALUES ARE IN MICROFARADS, ±10 % 100 V.

QTY.	ITEM	DWG SIZE	PART NUMBER	DESCRIPTION

LIST OF MATERIAL

C4708135	11-20753	
NEXT ASSEMBLY	FIRST USED ON	
APPLICATION		

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES AND INCLUDE CHEMICALLY APPLIED OR PLATED FINISHES
TOLERANCES

BASIC DIMENSION	DECIMALS 2 PLACE	3 PLACE	FRACTIONS
UNDER 6	± .04	± .005	± 1/64
6 TO 24 INCL.	± .02	± .010	± 1/32
OVER 24	± .06	± .015	± 1/16

ANGLES ± 1/2°
COMMERCIAL TOLERANCES APPLY TO STOCK SIZES
SHOP PRACTICE, ESM SECT. 38, APPLIES

MATERIAL

FINISH

	SIGNATURE & DATE
DRAWN	J. L. Amstutz 26 OCT 59
CHKD.	
MECH. APPVL.	
ELECT. APPVL.	
STD.	
APPD	
E OF M	

ITT INDUSTRIAL LABORATORIES FORT WAYNE, IND.
A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

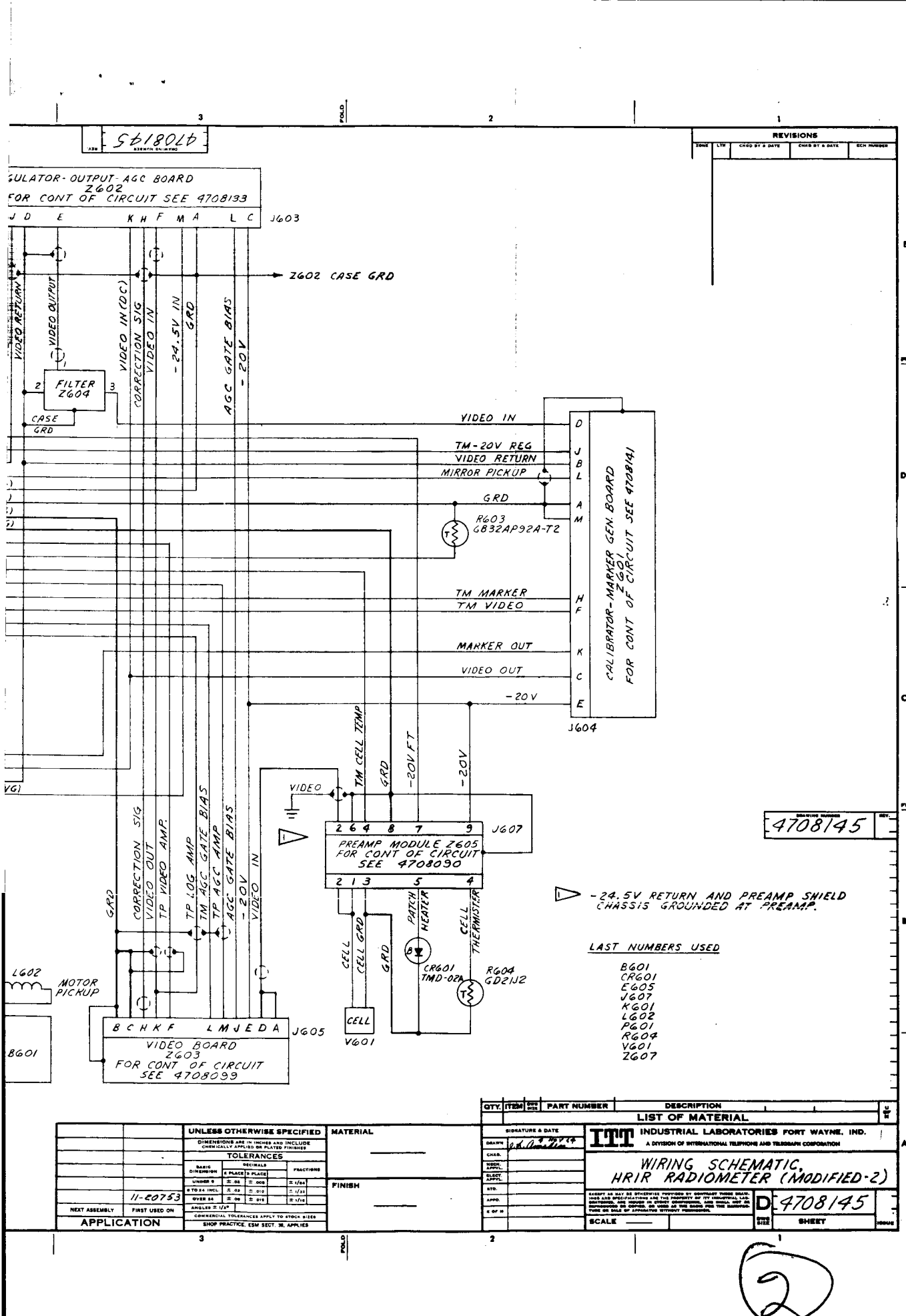
SCHEMATIC DIAGRAM
CALIBRATOR-MARKER GENERATOR

SCALE —

D 4708141

SHEET

(2)


4708145
REVISIONS
ZONE LTR CHGD BY & DATE CHKD BY & DATE ECN NUMBER
GULATOR-OUTPUT-AGC BOARD Z602
FOR CONT OF CIRCUIT SEE 4708133
J603
Z602 CASE GRD
VIDEO RETURN
VIDEO OUTPUT
VIDEO IN (QC)
CORRECTION SIG
VIDEO IN
-24.5V IN
GRD
AGC GATE BIAS
-20V
FILTER Z604
CASE GRD
VIDEO IN
TM -20V REG
VIDEO RETURN
MIRROR PICKUP
GRD
R603 GB32AP92A-T2
TM MARKER
TM VIDEO
MARKER OUT
VIDEO OUT
-20V
CALIBRATOR-MARKER GEN. BOARD Z601 FOR CONT OF CIRCUIT SEE 4708141
J604
VIDEO
TM CELL TEMP
GRD
-20V FT
-20V
PREAMP MODULE Z605 FOR CONT OF CIRCUIT SEE 4708090
J607
CORRECTION SIG
VIDEO OUT
TP VIDEO AMP
TP LOG AMP
TM AGC GATE BIAS
TP AGC AMP
AGC GATE BIAS
-20V
VIDEO IN
GRD
PATCH HEATER
CELL THERMISTER
CELL
CELL GRD
GRD
CRG01 TMD-02A
R604 GD21J2
CELL
V601
L602
MOTOR PICKUP
B601
B C H K F L M J E D A
J605
VIDEO BOARD Z603 FOR CONT OF CIRCUIT SEE 4708099
-24.5V RETURN AND PREAMP SHIELD CHASSIS GROUNDED AT PREAMP.
LAST NUMBERS USED
B601
CRG01
E605
J607
K601
L602
P601
R604
V601
Z607
QTY. ITEM DWG SIZE PART NUMBER DESCRIPTION
LIST OF MATERIAL
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES AND INCLUDE CHEMICALLY APPLIED OR PLATED FINISHES
TOLERANCES
MATERIAL
FINISH
SIGNATURE & DATE
DRAWN
CHKD.
ENGR. APPRL.
PROJ. APPRL.
STD.
APPD.
ITT INDUSTRIAL LABORATORIES FORT WAYNE, IND.
A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
WIRING SCHEMATIC, HRIR RADIOMETER (MODIFIED-2)
4708145
SCALE
SHEET
NEXT ASSEMBLY
FIRST USED ON
11-20753
APPLICATION
SHOP PRACTICE, ESM SECT. 38, APPLIES

2

APPENDIX II

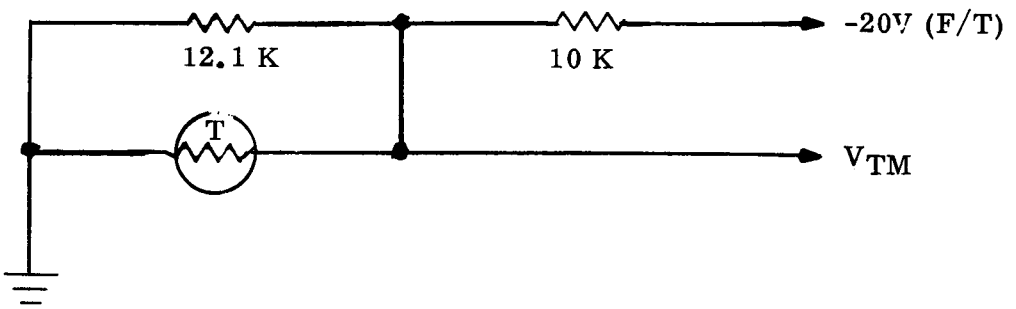
TELEMETRY COMPENDIUM

Several requirements are common to all points:

1. **All TM voltages are in the range 0 to -6.35 volts as required.**
2. **All points are analog functions.**
3. **The basic 16 second sampling rate is adequate for all points.**
4. **The PCM conversion accuracy of 1 count = 50 mv is adequate.**

Reference "A" Temperature (J602-1)

Measures the temperature of the portion of the radiometer housing used to provide a black body reference calibration during the back-scan.



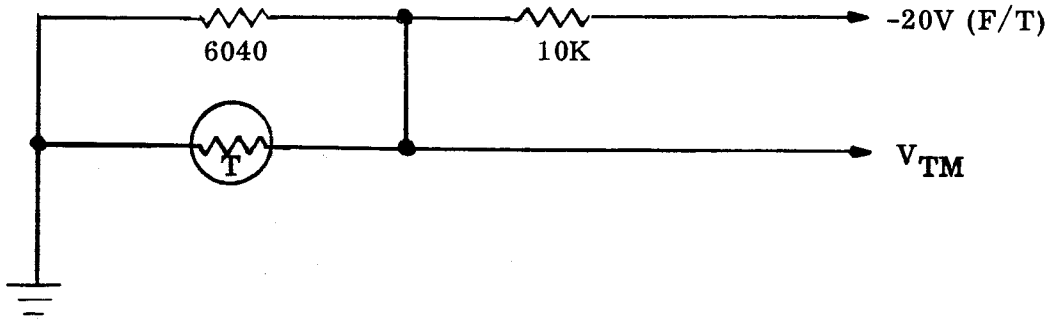
Impedance: See curve
Voltage: See curve (active day and night)
Failure Modes: TM open - no effect
TM Shorts - Continuous 2 ma power drain
Thermistor open - 10.8 volts at TM output
Thermistor shorts - zero TM volts, 2 ma power drain

Reference "B" Temperature (J602-9)

Same as Reference "A". Provide redundancy and temperature gradient indication.

Electronic Housing Temperature (Reference E) (J602-2)

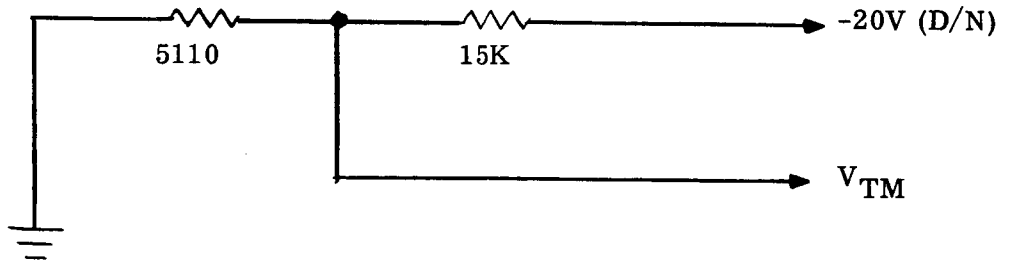
Measures the temperature of the electronics module.



Impedance: See curve
Voltage: See curve (active day and night)
Failure Modes: TM open - no effect
TM Shorts - Continuous 2 ma power drain
Thermistor open - 7.5 volts at TM output
Thermistor shorts - zero TM volts, 2 ma power drain

-20 Volt Regulator (J602-11)

Measures the output of the -20 volt regulator used for driving all electronics circuitry (except telemetry).



Impedance: 3.8 K
Voltage: Normally 5.1 volts $\pm$ 0.5 volts (night), zero volts (day)
Failure Modes: TM open - no effect; TM shorts - continuous 1.33 ma power drain

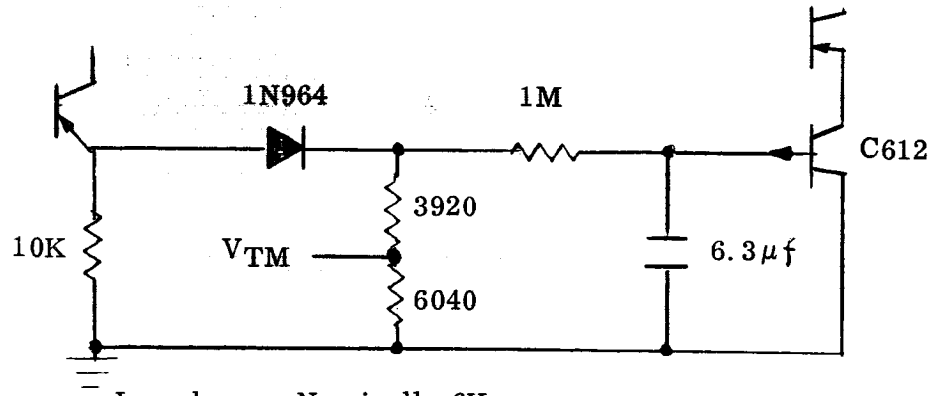
-20 Volts Full Time (J602-14)

Measures the output of the -20 volt regulator used for driving the telemetry functions and cell temperature control.

Same circuit and parameters as -20 volt regulator.

AGC Gate Bias (J602-15)

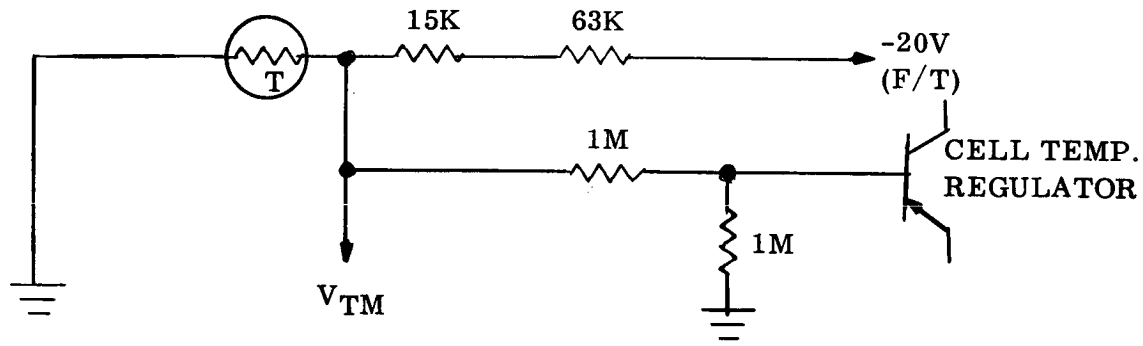
Provides an indication of the magnitude of injected radiation bias correction signal. Actually reads the voltage applied to the gate electrode of the AGC transistor.



Impedance: Nominally 6K
Voltage: See curve (active night only)
Failure Modes: TM open - no effect; TM shorts - zero TM volts

Cell Temperature (J602-10)

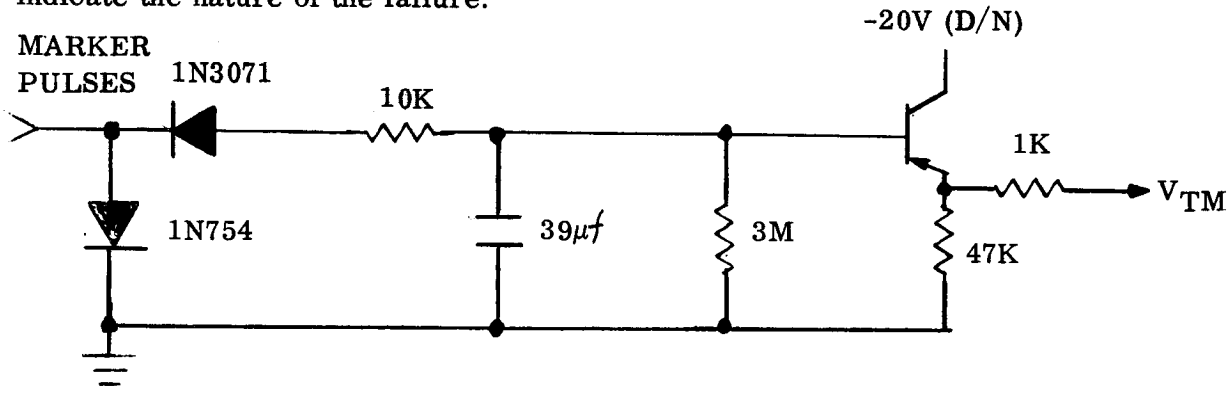
Measures the temperature of the radiating patch which is used for cooling the detector cell. Normal range of temperatures at this point is -70 to -80 degrees centigrade. The patch (and cell) temperature is automatically regulated.



Impedance: See curve
Voltage: See curve (active day and night)
Failure Modes: TM open - no effect
TM shorts - Loss of temperature control. Cell will cool to maximum level.
Thermistor opens - Loss of temperature control. Cell will not be allowed to cool.
Thermistor shorts - Same as TM shorts.

Marker Pulse (J602-4)

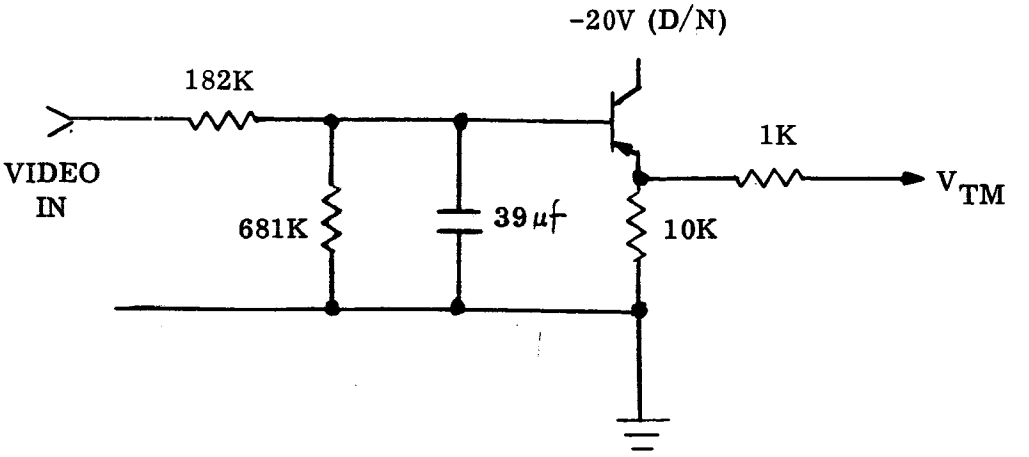
Seven pulses of 6 msec duration are generated each revolution of the scanning mirror. The presence of this signal indicates mirror rotation and marker generation. Absence indicates either motor or pulse generator failure. The seven pulses are fed to an integrating circuit having a time constant of 300 seconds, allowing an output voltage near -4 volts. If this signal falls below 2 volts, it is an indication of either the motor slowing down or pulse amplitude decreasing. Correlation of this signal with the sync pulse received from the recorder and the motor TM signal will indicate the nature of the failure.



Impedance: 47 K
Voltage: Nominally 4 volts (night), zero volts (day)
Failure Modes: TM open - no effect
TM Shorts - Transistor current increases to 20 ma (Max.)
Marker pulses unaffected

Video Output (J602-12)

The video signal as present at the output of the radiometer is fed to a long time-constant network where it is averaged, then applied to an emitter follower to reduce the output impedance. Since the video signal will vary from 0 to -6 volts during each scan interval, and the level will be determined by the temperature of the scene being viewed, it is impossible to predict the exact conditions at all times. The following limits are anticipated, assuming at least one look at outer space and one look at the reference surface of the radiometer. The maximum average signal will not exceed -3 volts, the minimum should not be less than -0.5 volts, and will vary between these limits depending on the average conditions of the earth in the field-of-view. A time constant of approximately 10 seconds will maintain the output voltage to within 10 percent of the average value.



Impedance: 10 K
Voltage: See text (night only), zero volts (day)
Failure Modes: TM open - no effect
TM shorts - Transistor current increases to 20 ma (Max.)
Video signal unaffected.

Motor Rotation (J602-13)

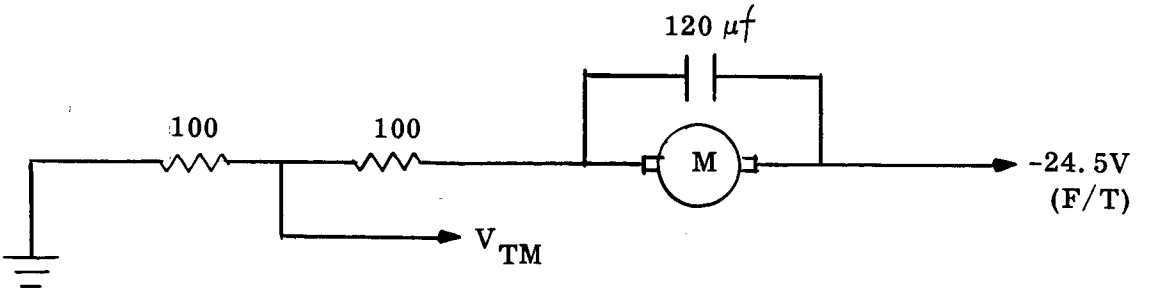
Indicates one of three possible conditions with respect to the drive motor:

1. Motor synchronous

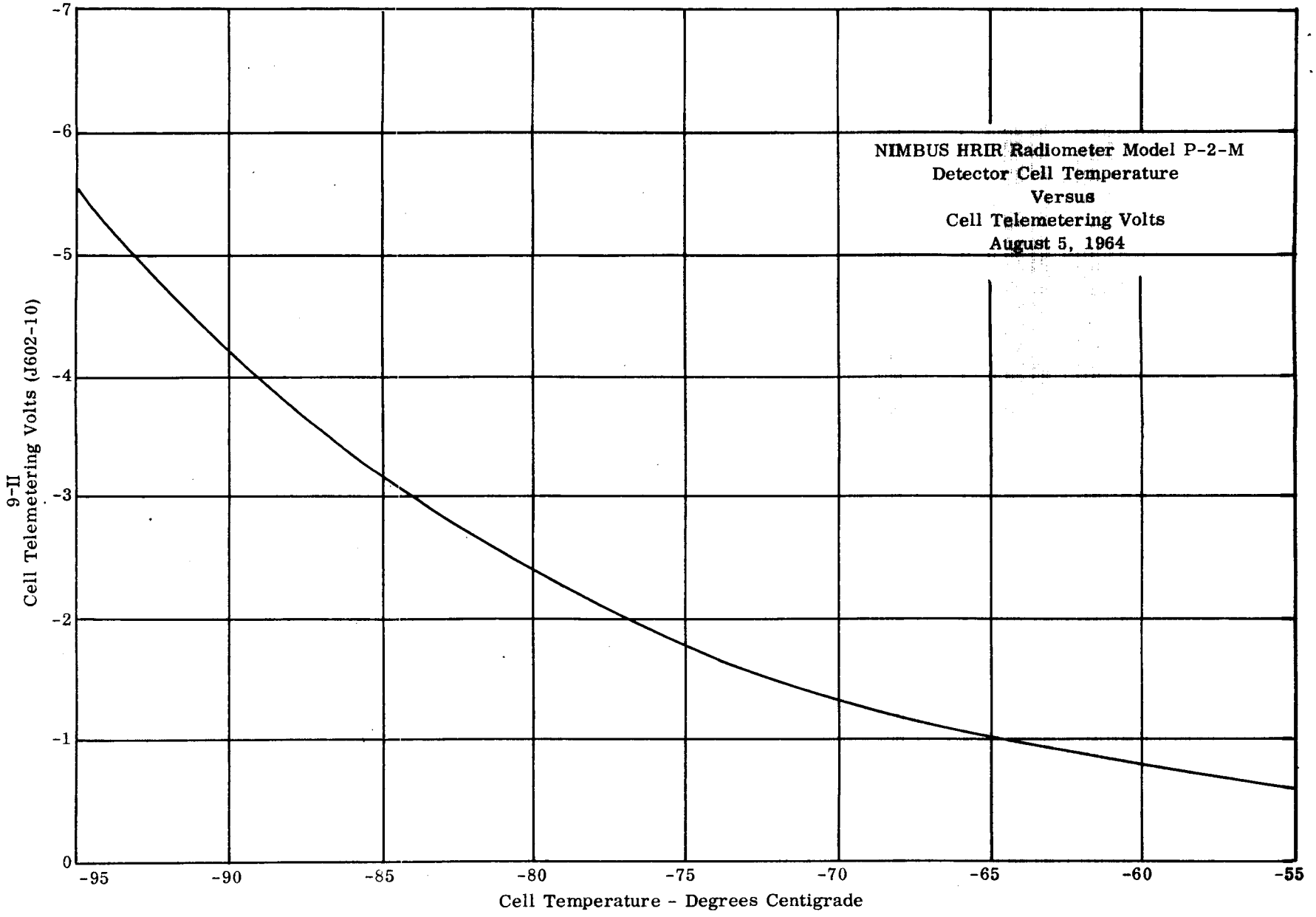
2. Motor stalled

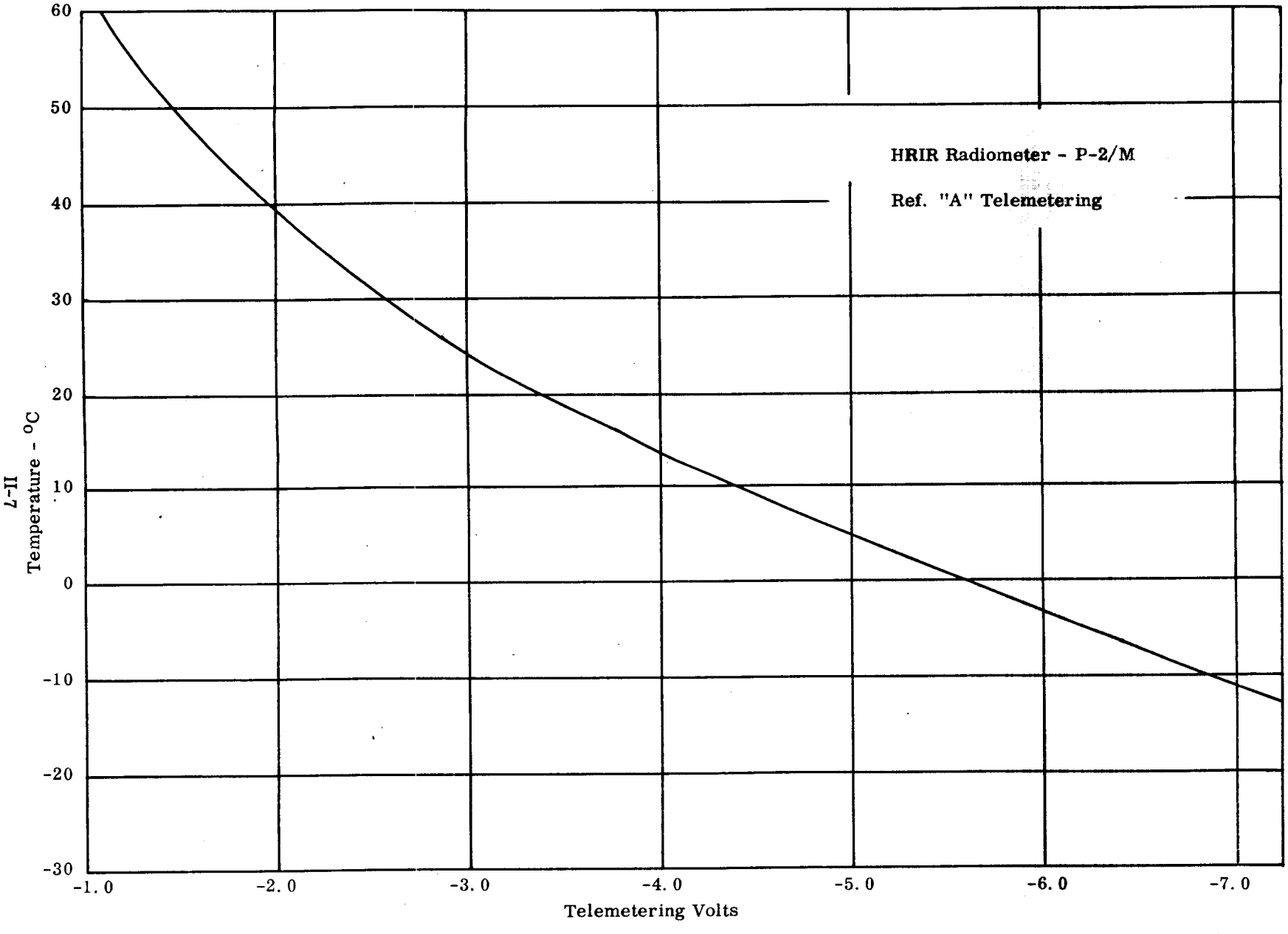
3. Motor off

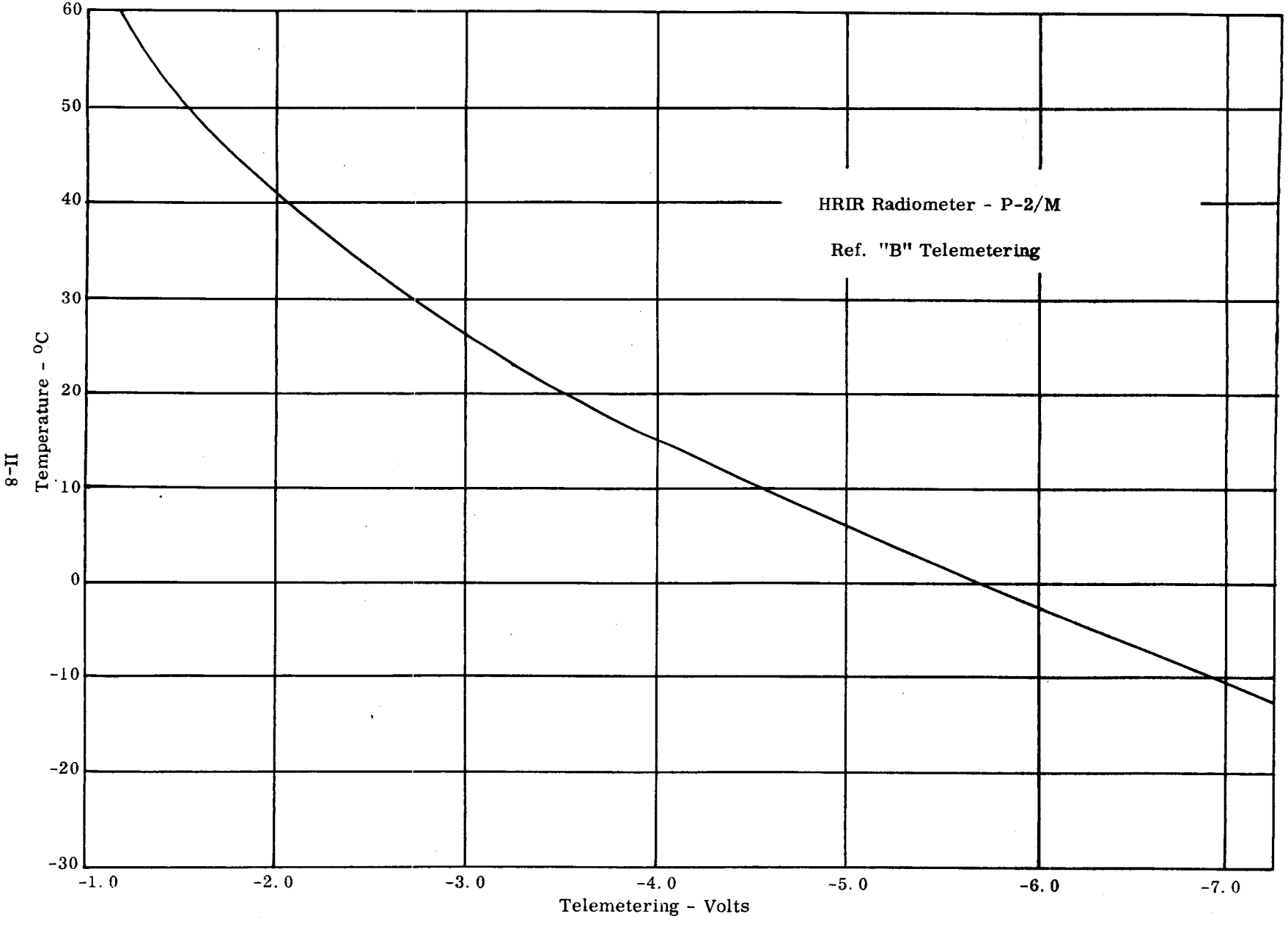
By measuring the voltage dropped across a portion of the series motor resistor, a measure of motor current and power is obtained. During synchronous rotation the output will be approximately -3 volts. Should the motor stall, the current will increase causing the output to increase to approximately -4 volts. When the motor is off, the output will read zero volts.

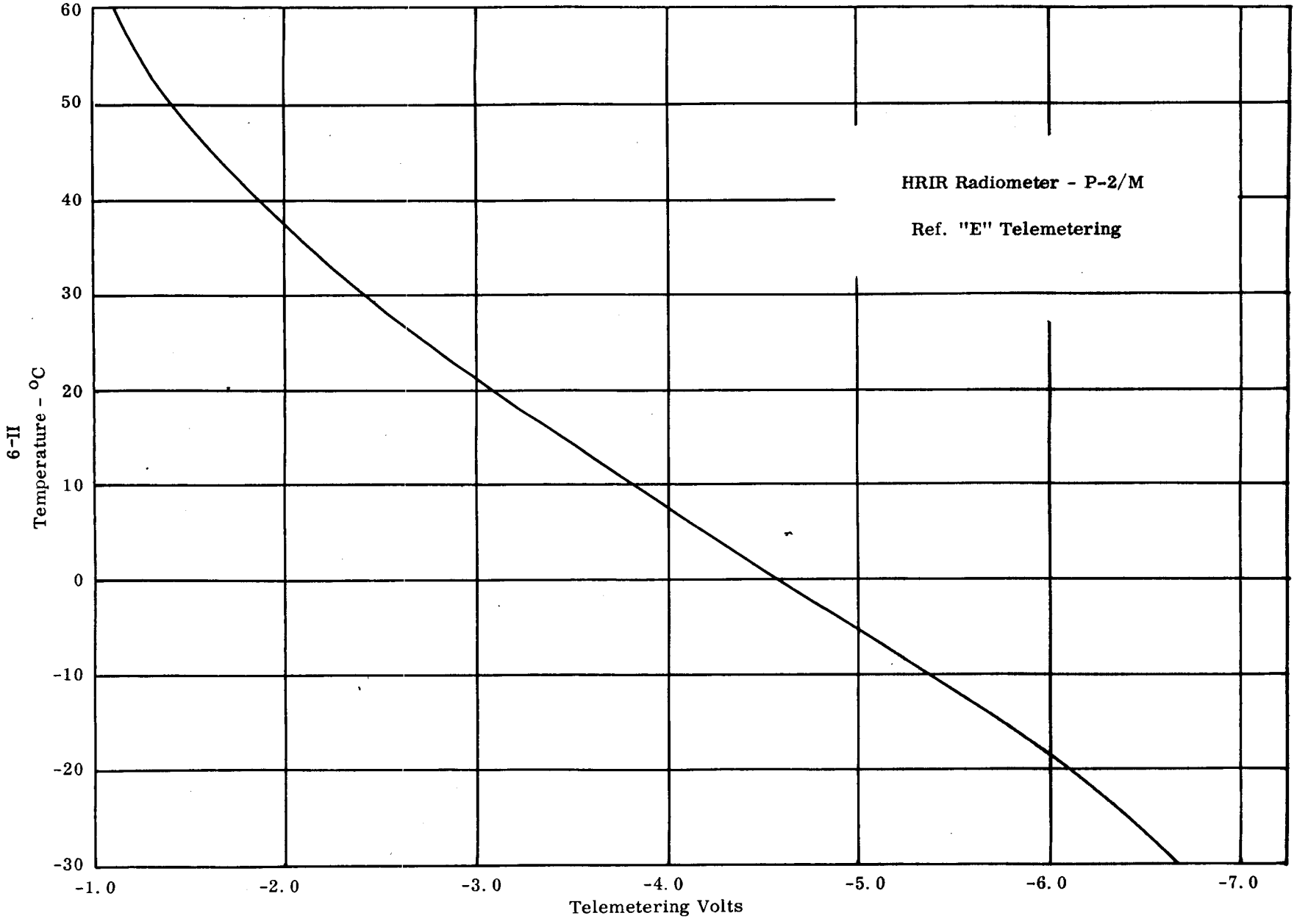


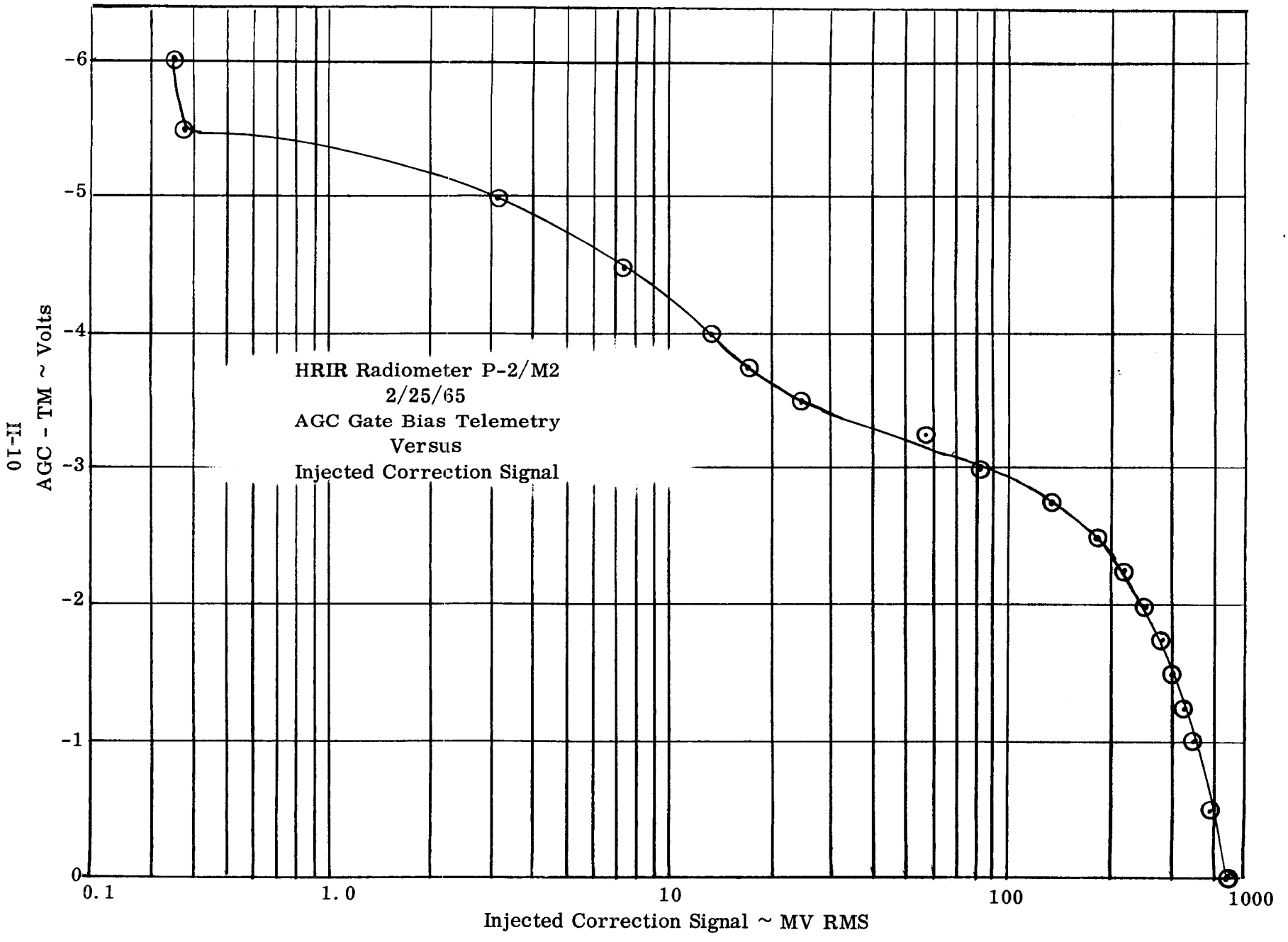
Impedance: 100 ohms
Voltage: See text
Failure Modes: TM open - no effect
TM shorts - reduced motor efficiency


NIMBUS HRIR Radiometer Model P-2-M
Detector Cell Temperature
Versus
Cell Telemetering Volts
August 5, 1964
Cell Telemetering Volts (J602-10)
-7
-6
-5
-4
-3
-2
-1
0
-95
-90
-85
-80
-75
-70
-65
-60
-55
Cell Temperature - Degrees Centigrade


HRIR Radiometer - P-2/M
Ref. "A" Telemetering
Temperature - °C
60
50
40
30
20
10
0
-10
-20
-30
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
Telemetering Volts

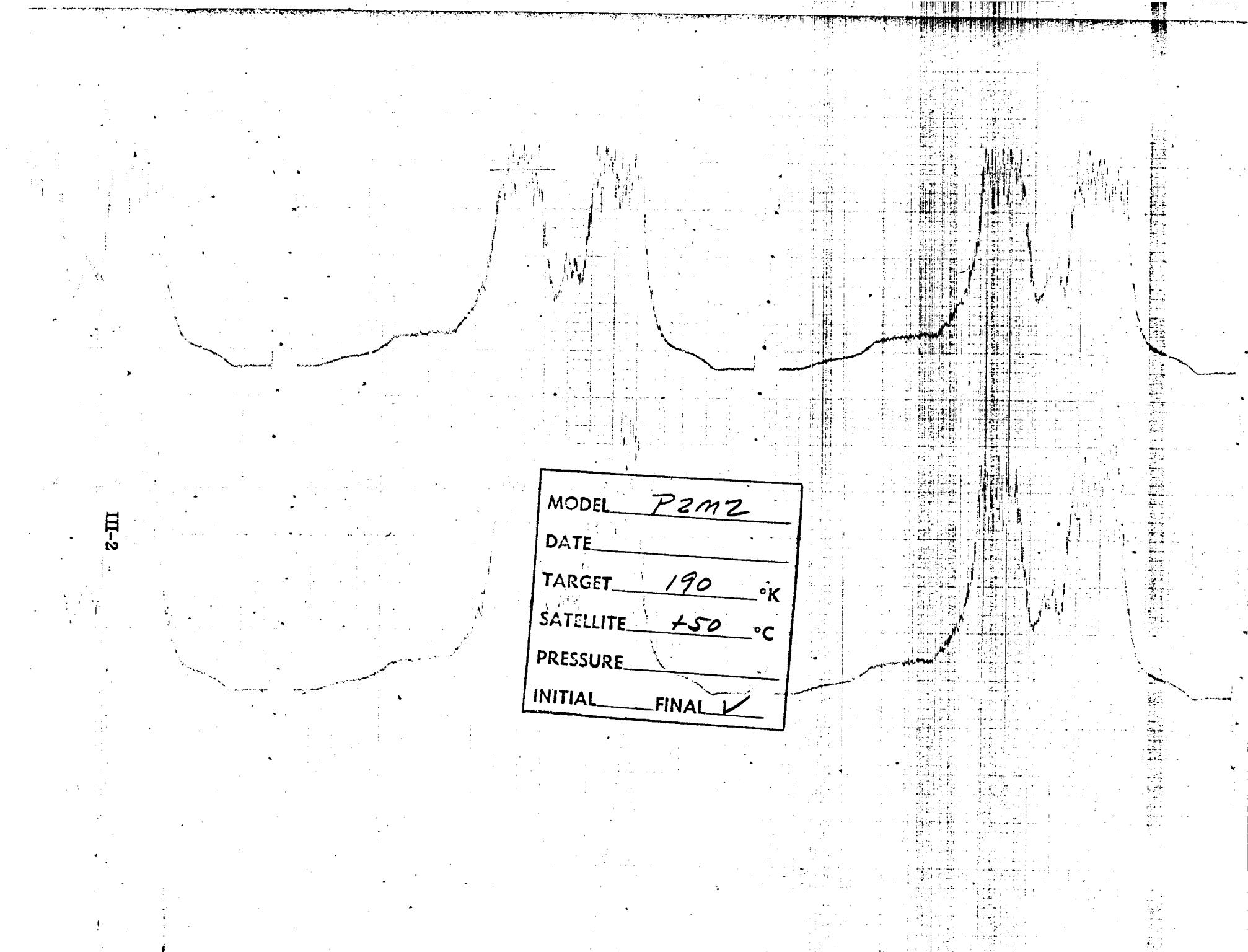

HRIR Radiometer - P-2/M
Ref. "B" Telemetering
Temperature - °C
60
50
40
30
20
10
0
-10
-20
-30
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
Telemetering - Volts

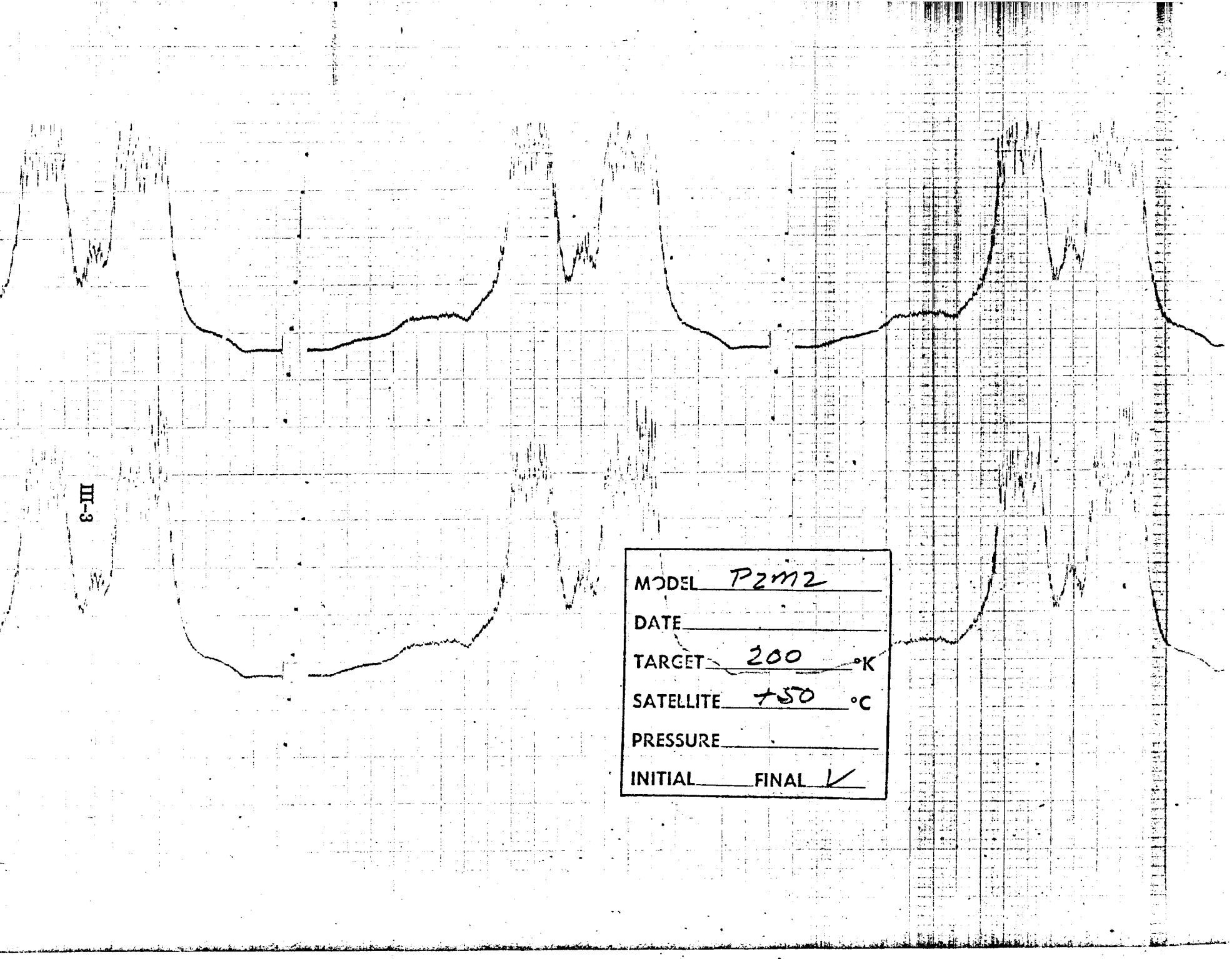

HRIR Radiometer - P-2/M
Ref. "E" Telemetering
Temperature - °C
60
50
40
30
20
10
0
-10
-20
-30
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
Telemetering Volts

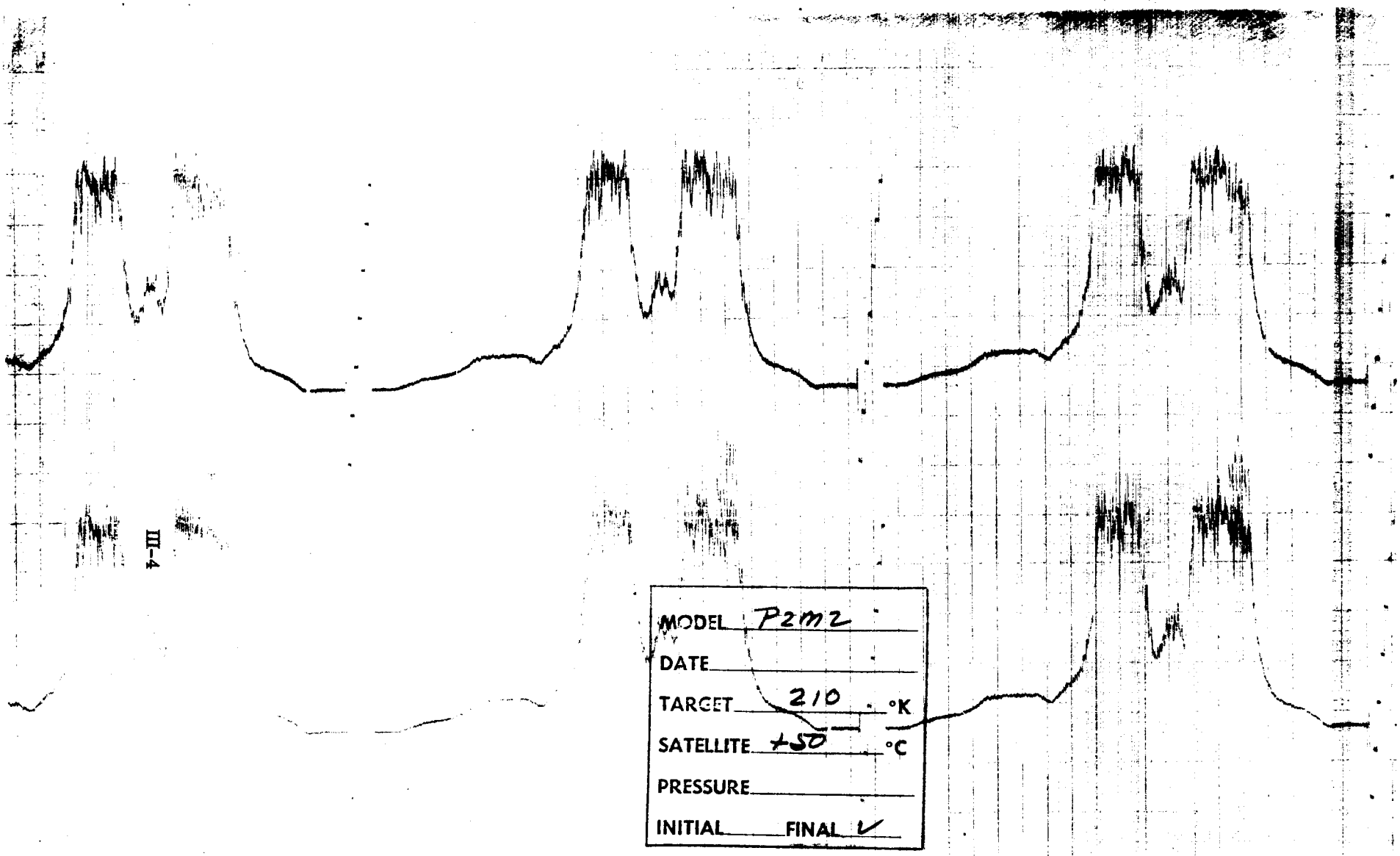

HRIR Radiometer P-2/M2
2/25/65
AGC Gate Bias Telemetry
Versus
Injected Correction Signal
AGC - TM ~ Volts
-6
-5
-4
-3
-2
-1
0
0.1
1.0
10
100
1000
Injected Correction Signal ~ MV RMS

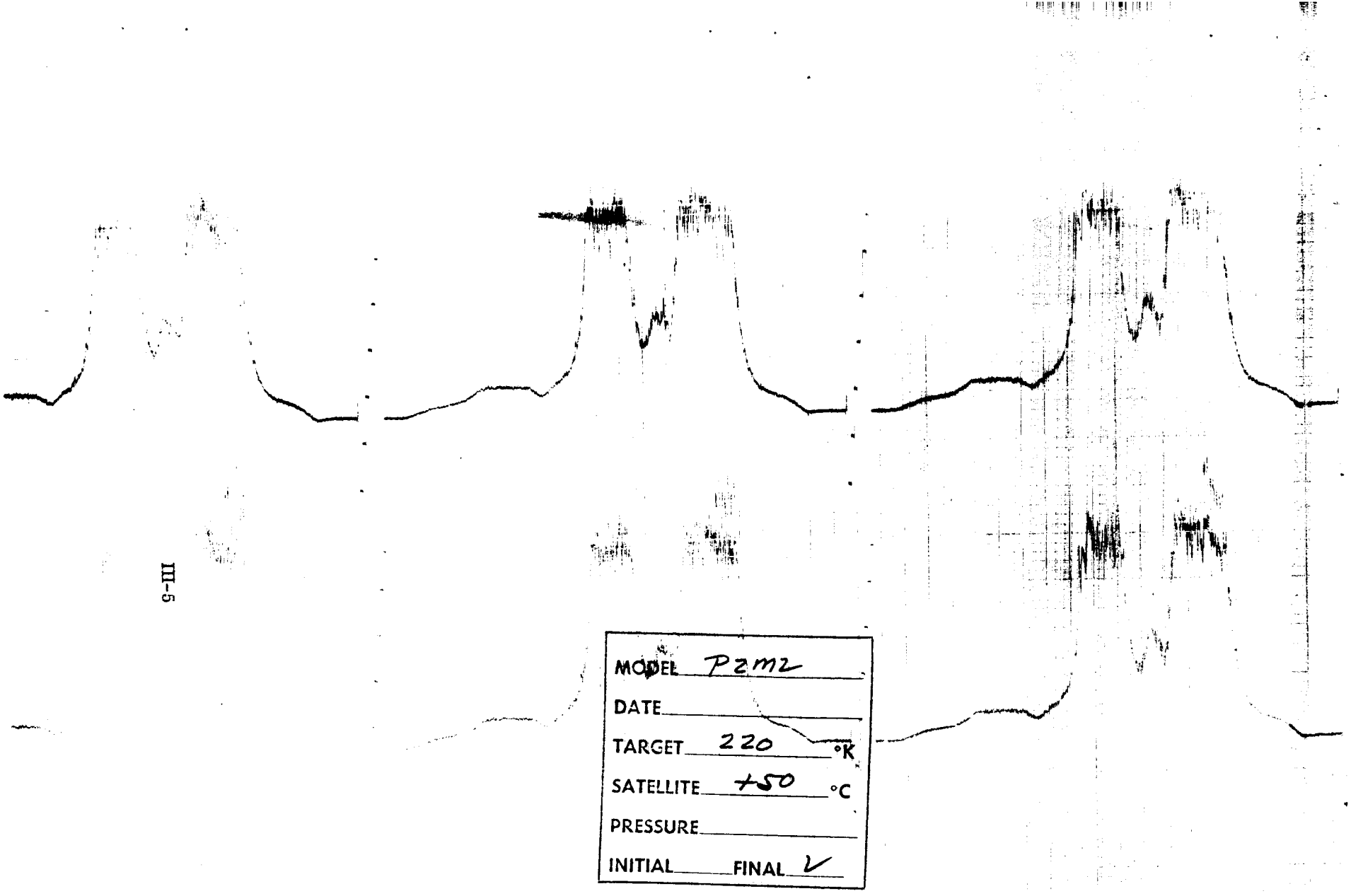
APPENDIX III

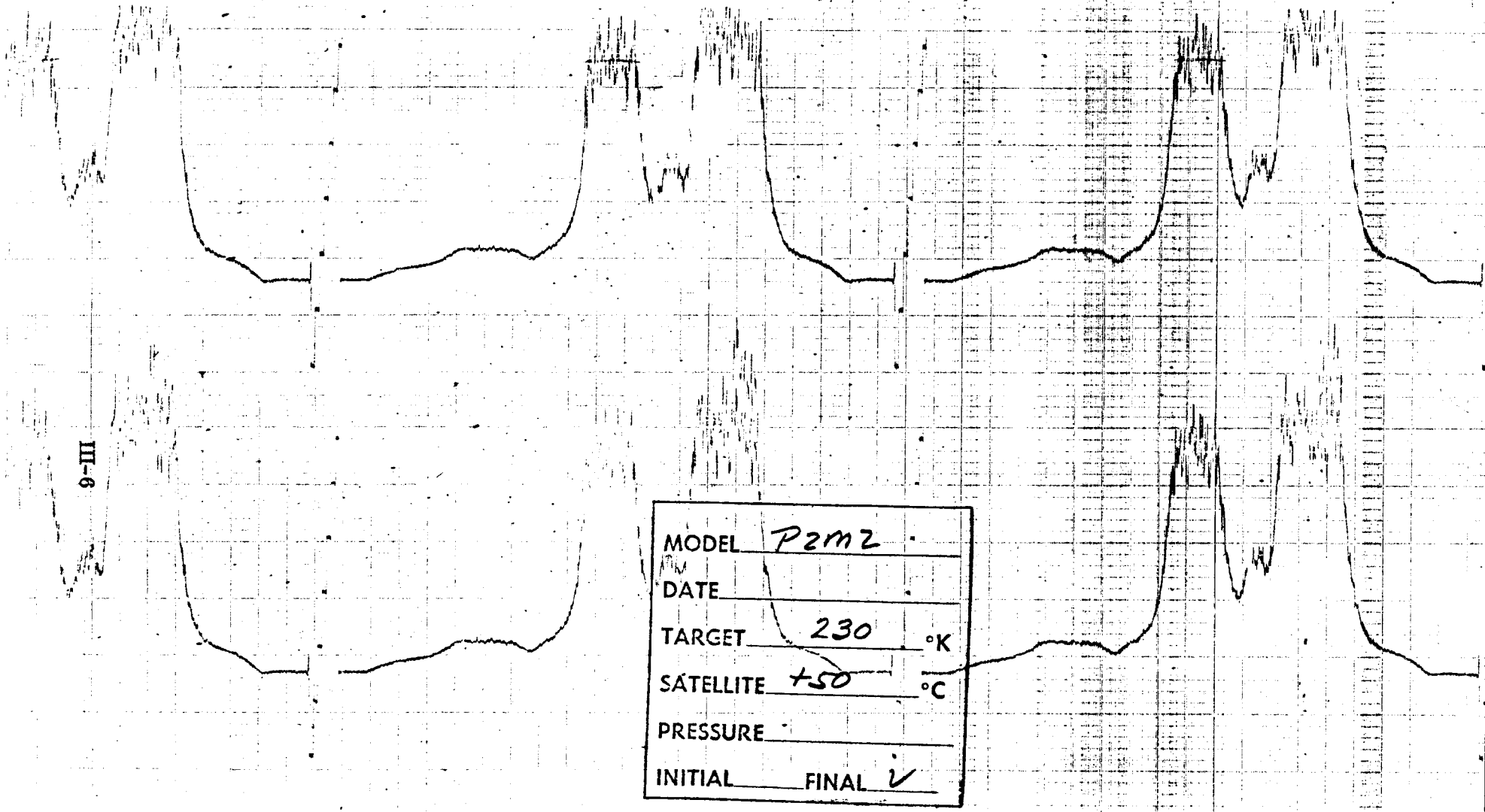
CALIBRATION VISICORDER CHARTS

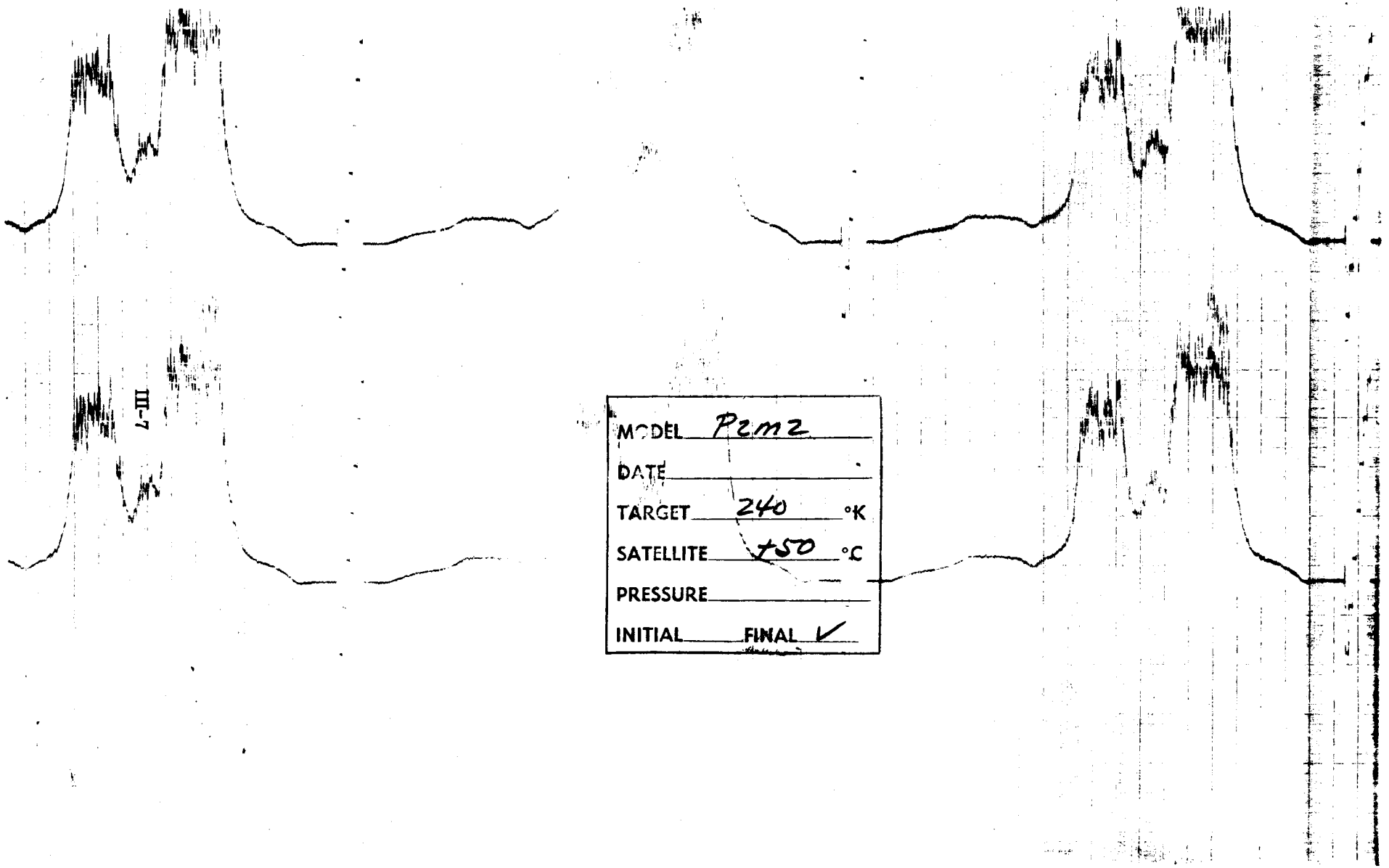

MODEL P2M2
DATE
TARGET 190 °K
SATELLITE +50 °C
PRESSURE
INITIAL FINAL ✓

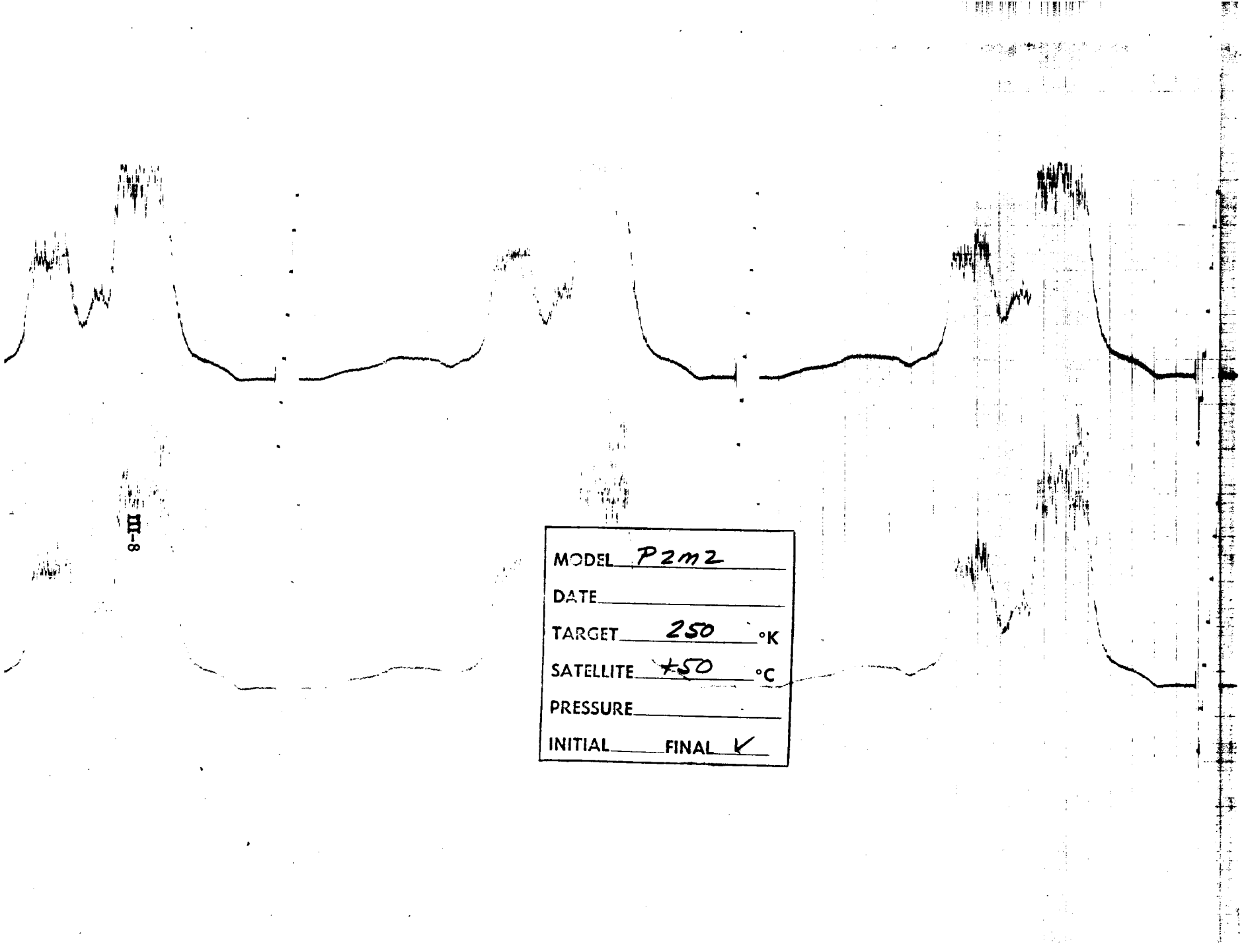

III-3
MODEL P2M2
DATE
TARGET 200 °K
SATELLITE +50 °C
PRESSURE
INITIAL FINAL ✓

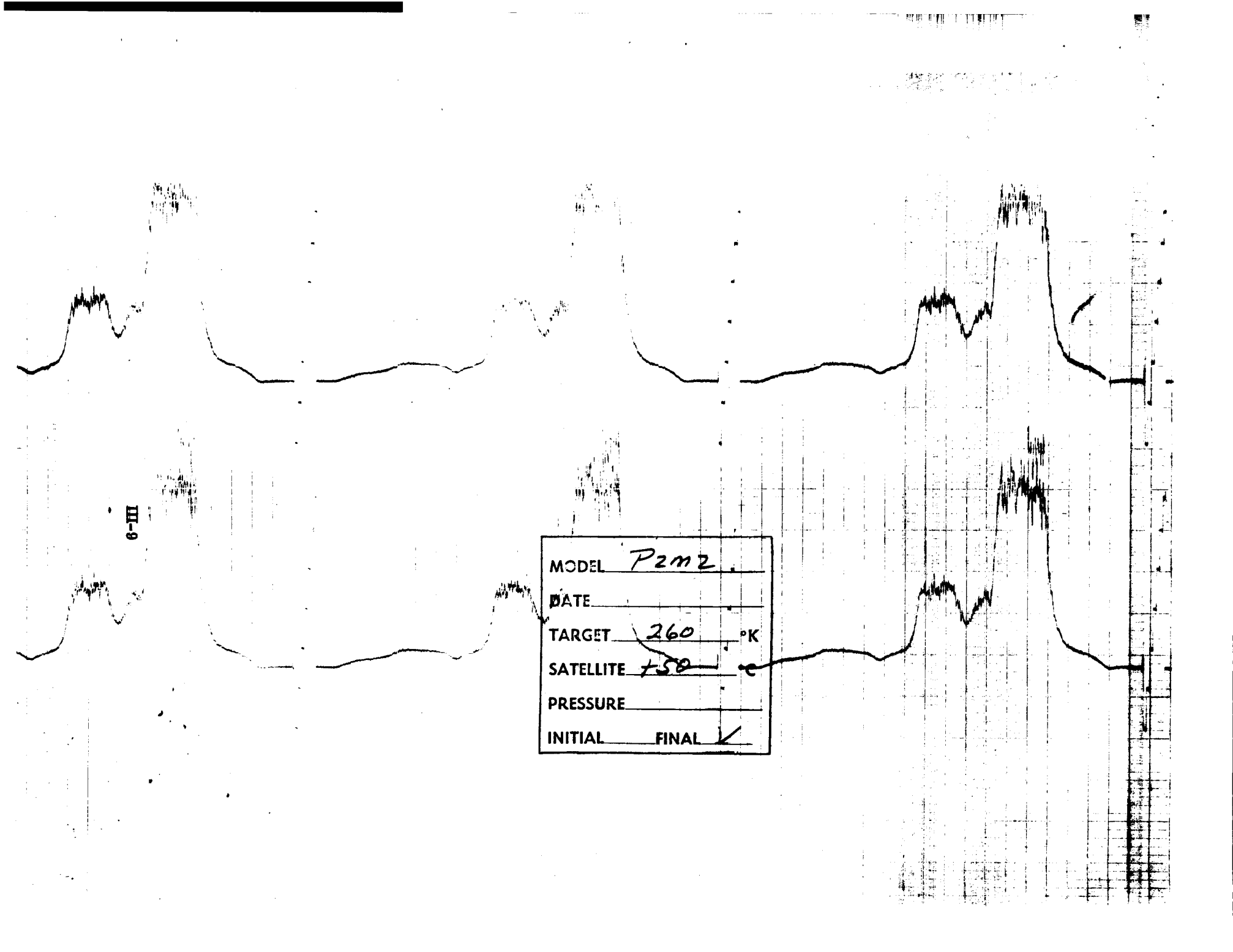

III-4
MODEL P2M2
DATE
TARGET 210 °K
SATELLITE +50 °C
PRESSURE
INITIAL FINAL ✓

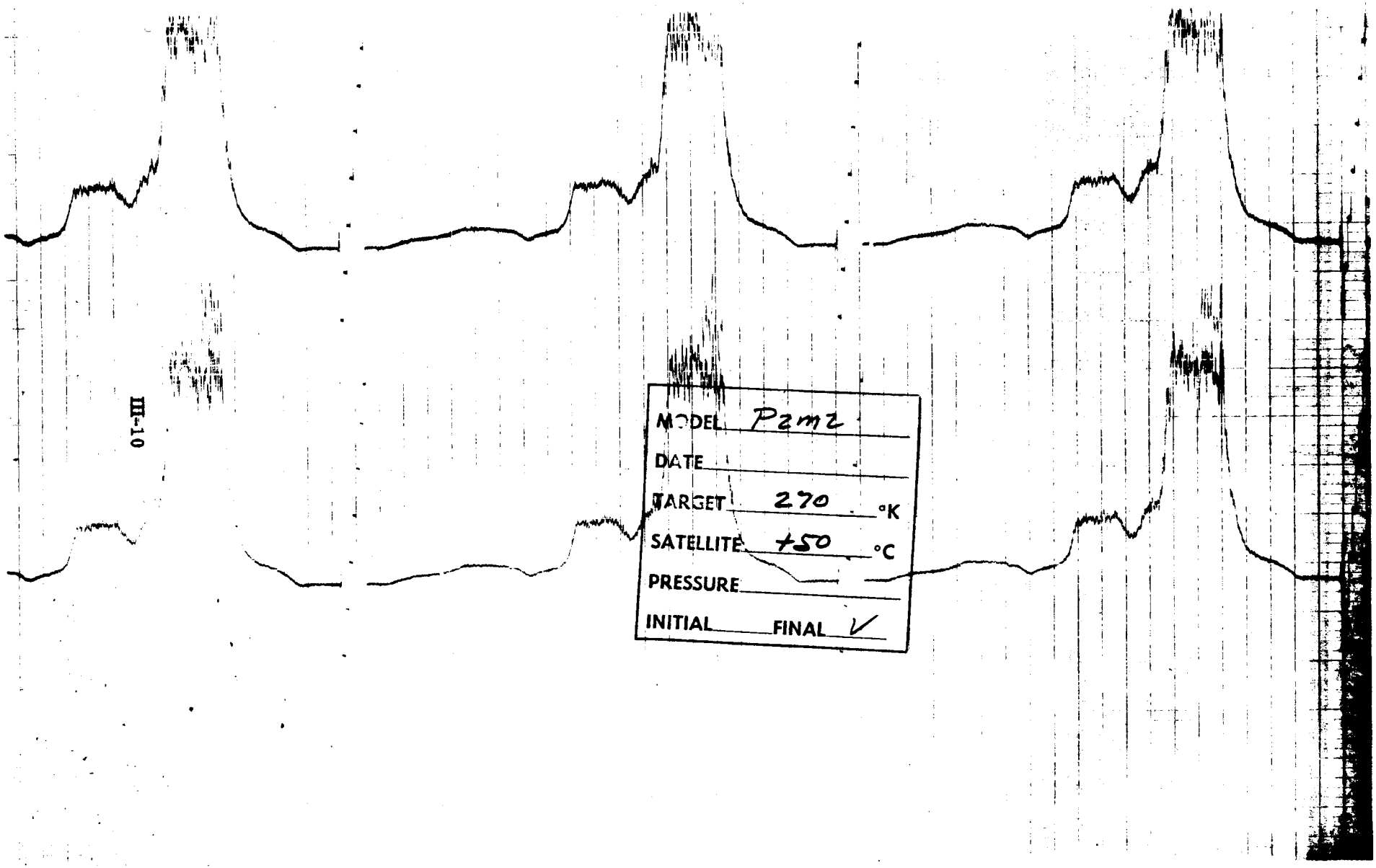

MODEL P2M2
DATE
TARGET 220 °K
SATELLITE +50 °C
PRESSURE
INITIAL FINAL V

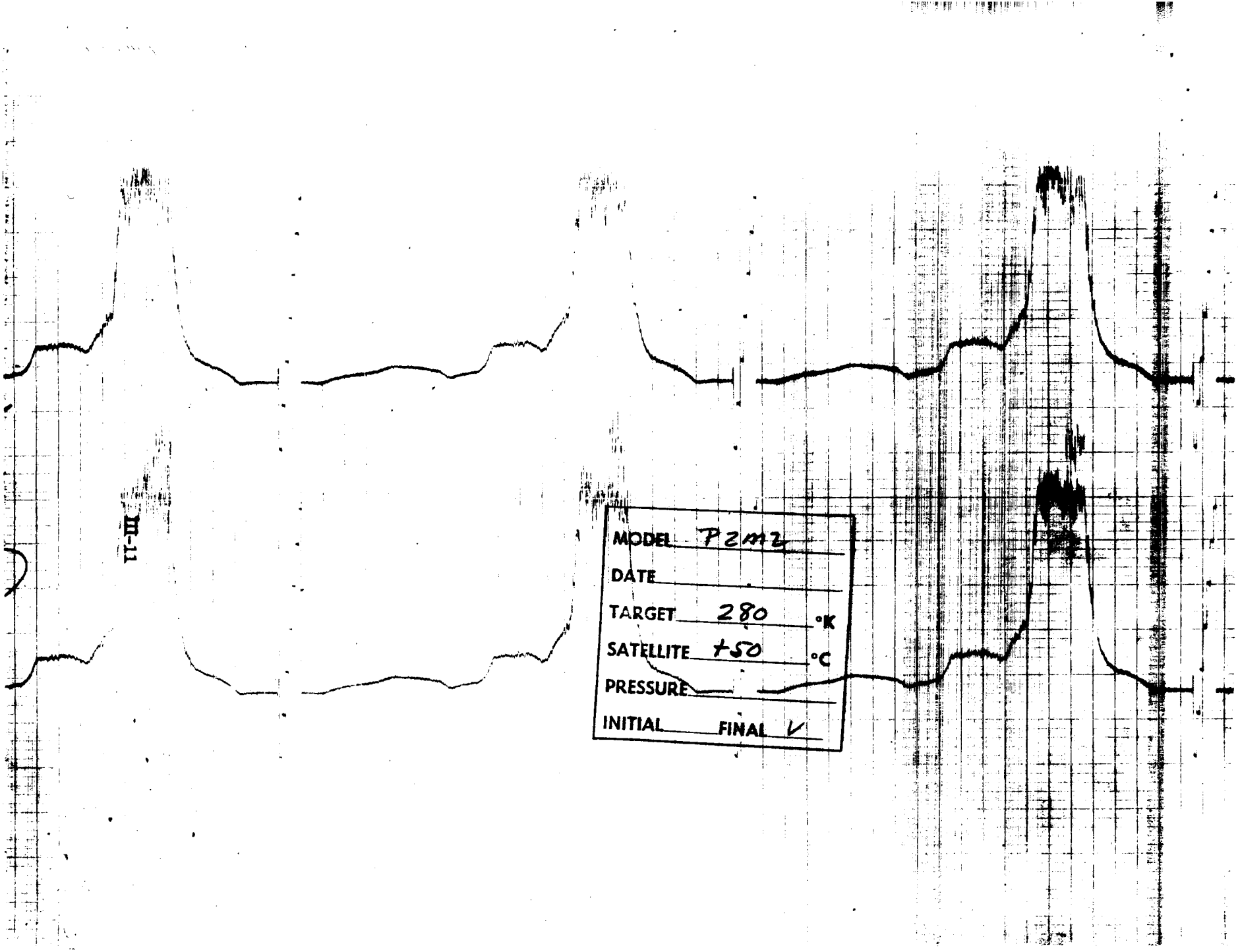

MODEL P2M2
DATE
TARGET 230 °K
SATELLITE +50 °C
PRESSURE
INITIAL FINAL V

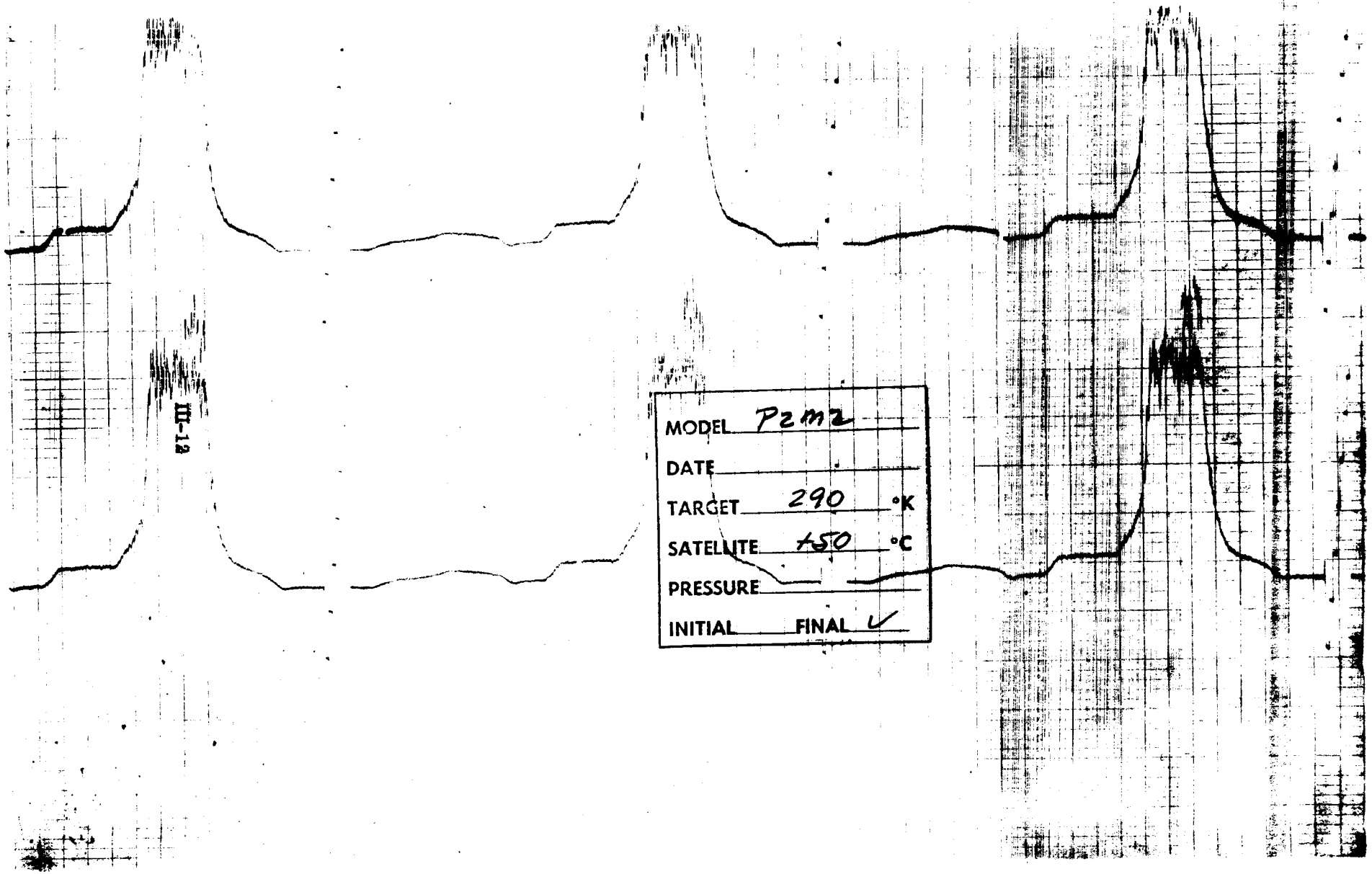

III-7
MODEL PZM2
DATE
TARGET 240 °K
SATELLITE 150 °C
PRESSURE
INITIAL FINAL ✓

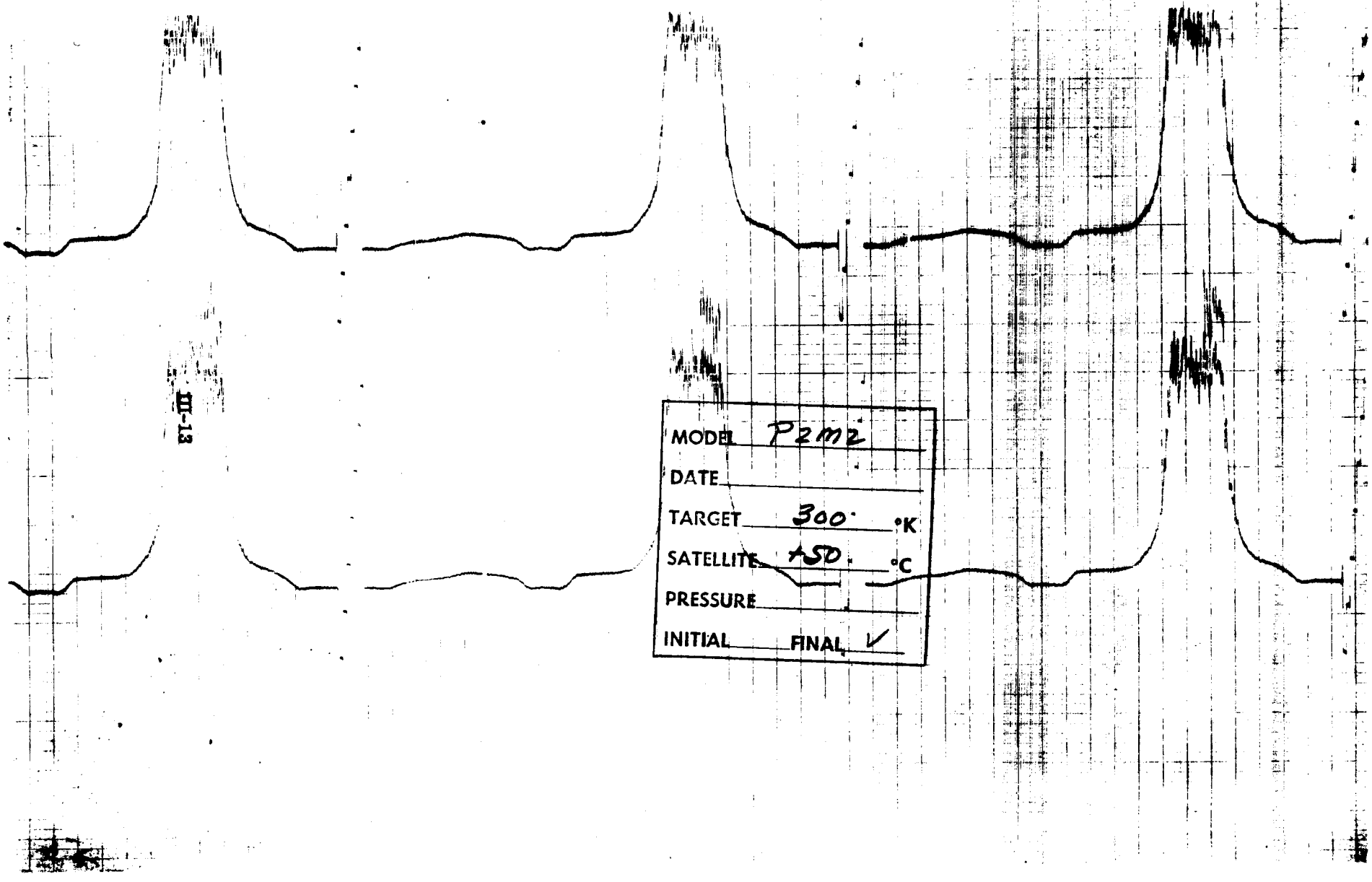

III-8
MODEL P2M2
DATE
TARGET 250 °K
SATELLITE +50 °C
PRESSURE
INITIAL FINAL

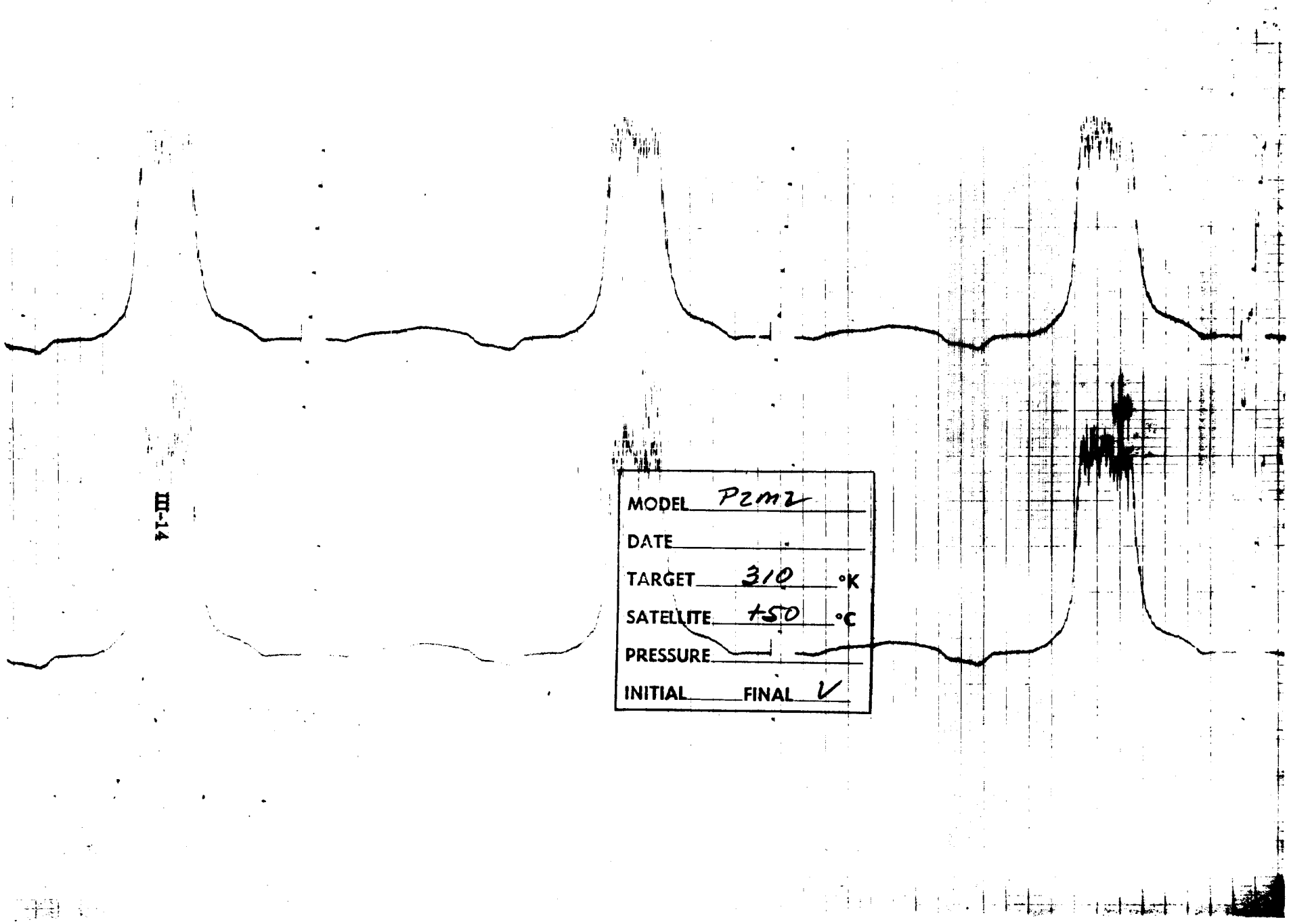

6-III
MODEL P2M2
DATE
TARGET 260 °K
SATELLITE +50
PRESSURE
INITIAL FINAL

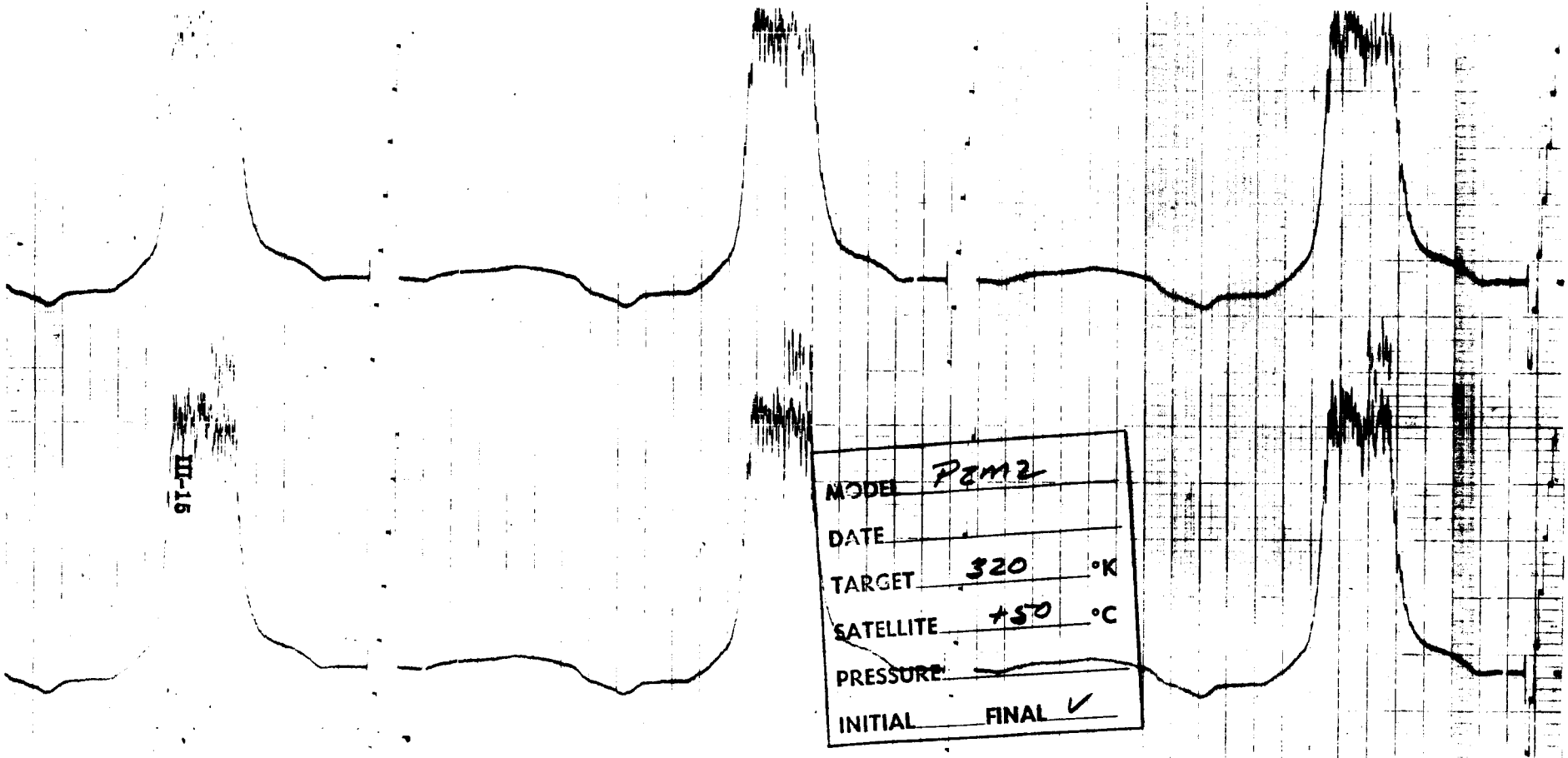

III-10
MODEL Pzm2
DATE
TARGET 270 °K
SATELLITE +50 °C
PRESSURE
INITIAL FINAL V

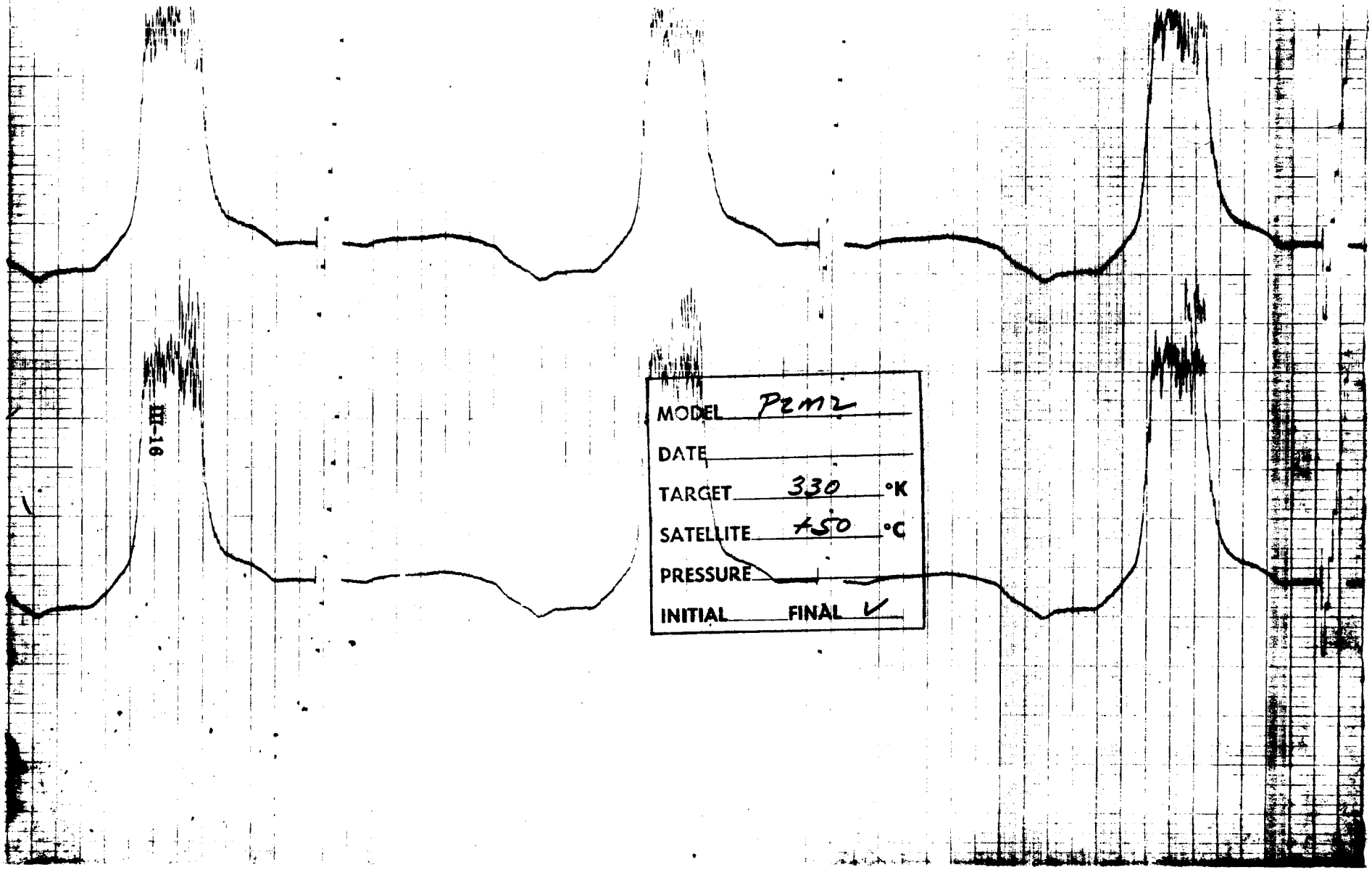

III-11
MODEL P2M2
DATE
TARGET 280 °K
SATELLITE +50 °C
PRESSURE
INITIAL FINAL V

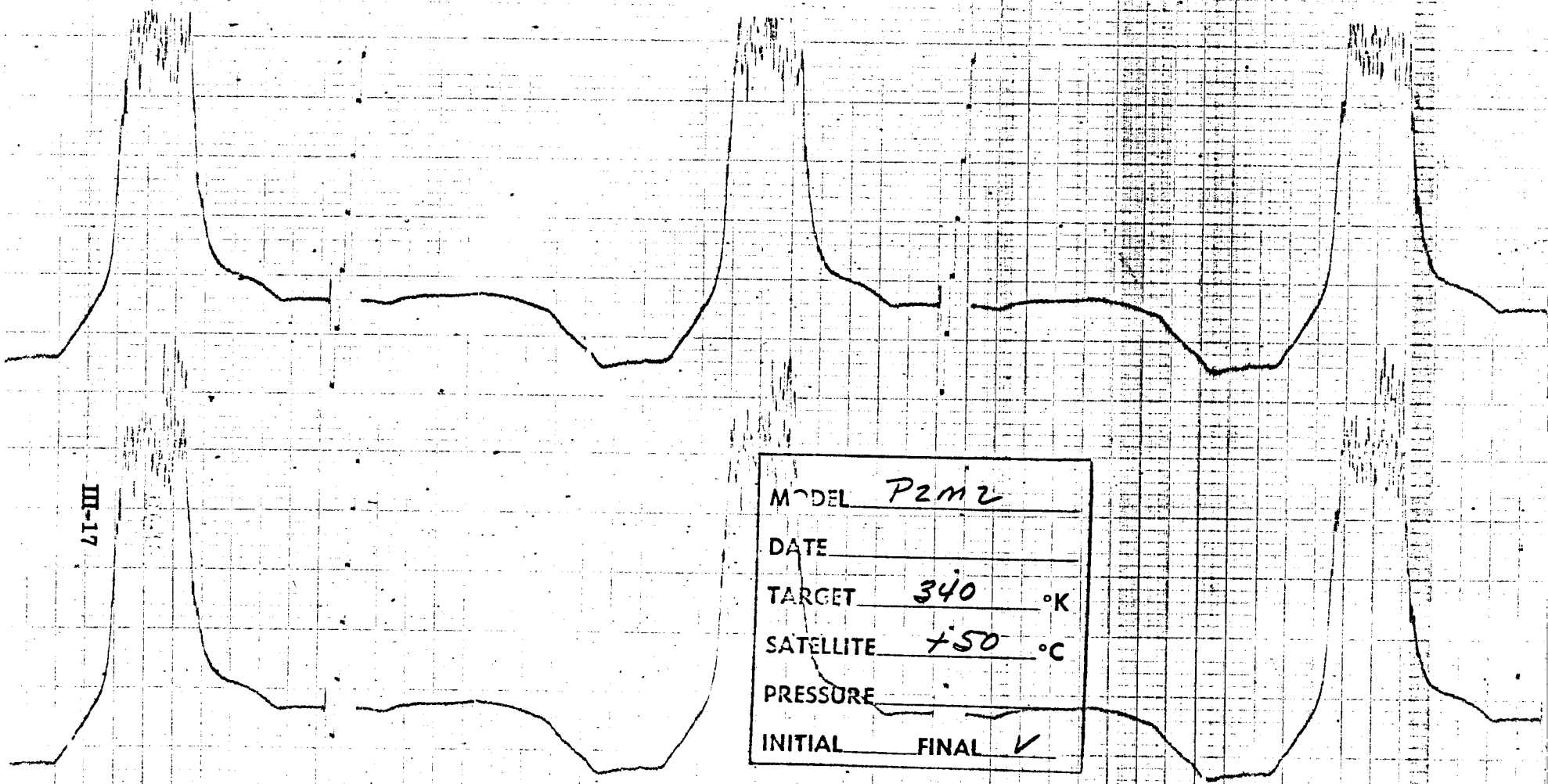

III-12
MODEL P2M2
DATE
TARGET 290 °K
SATELLITE 450 °C
PRESSURE
INITIAL FINAL

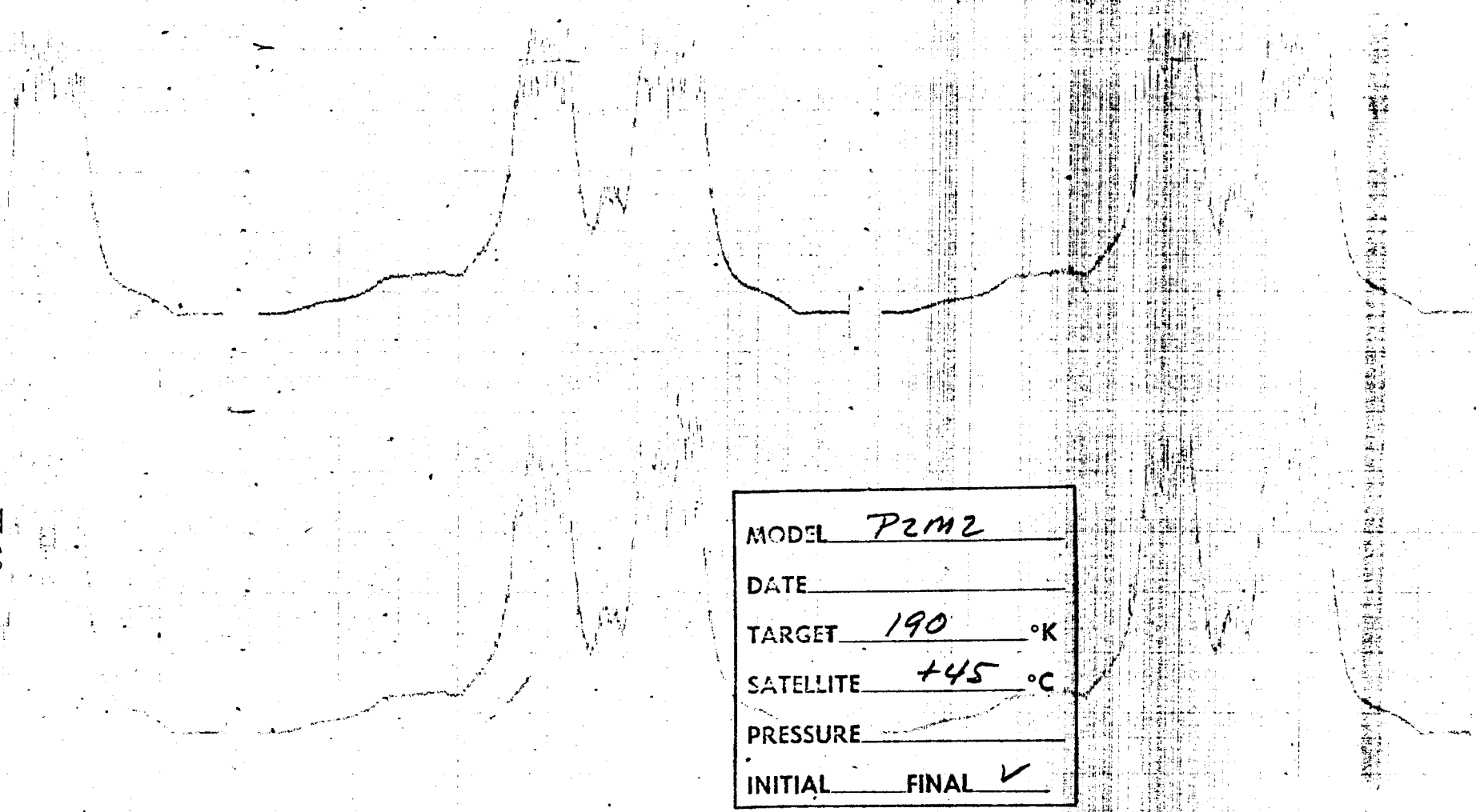

III-13
MODEL P2M2
DATE
TARGET 300° °K
SATELLITE +50 °C
PRESSURE
INITIAL FINAL ✓

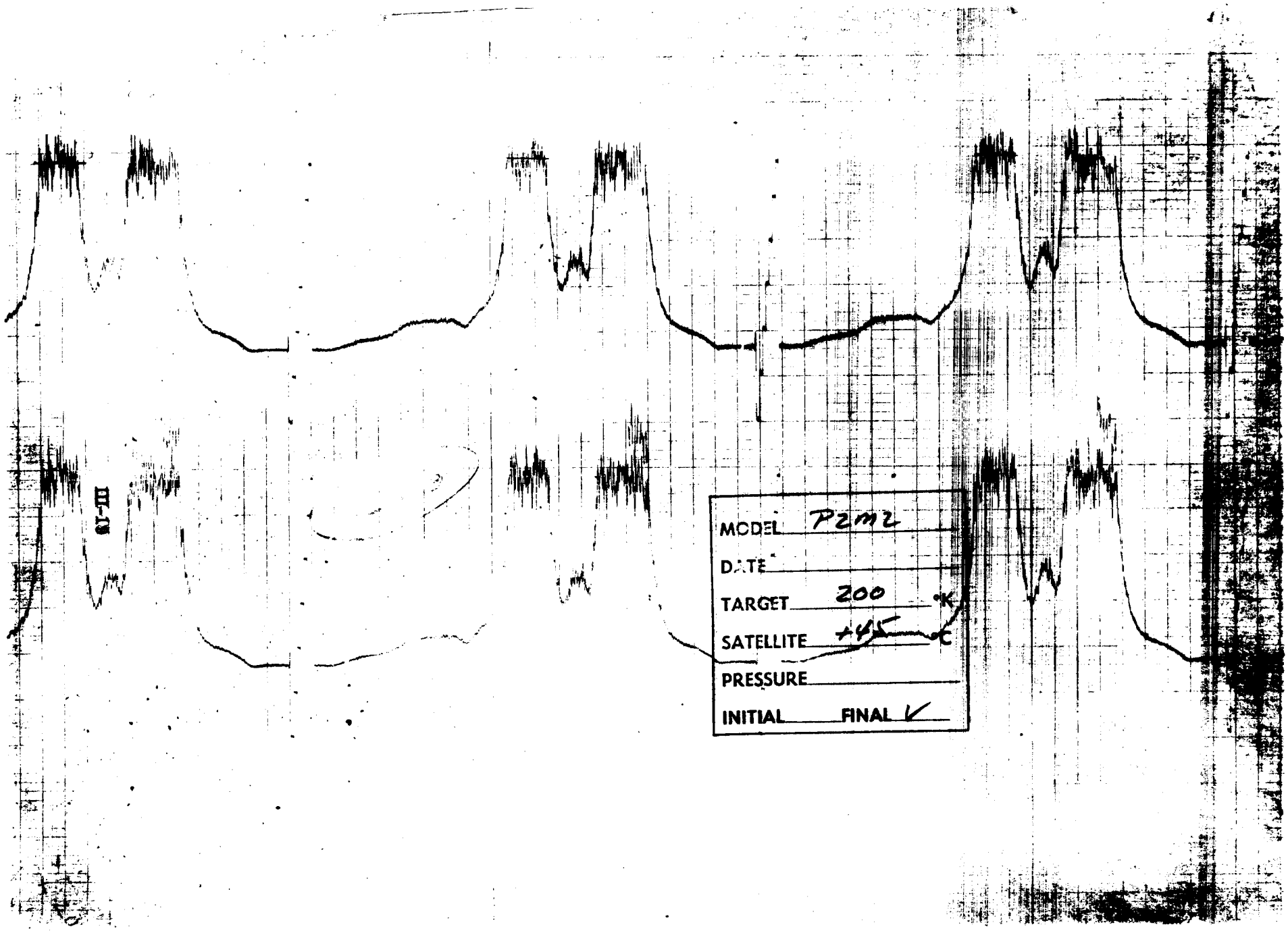

MODEL PZM2
DATE
TARGET 310 °K
SATELLITE +50 °C
PRESSURE
INITIAL FINAL V

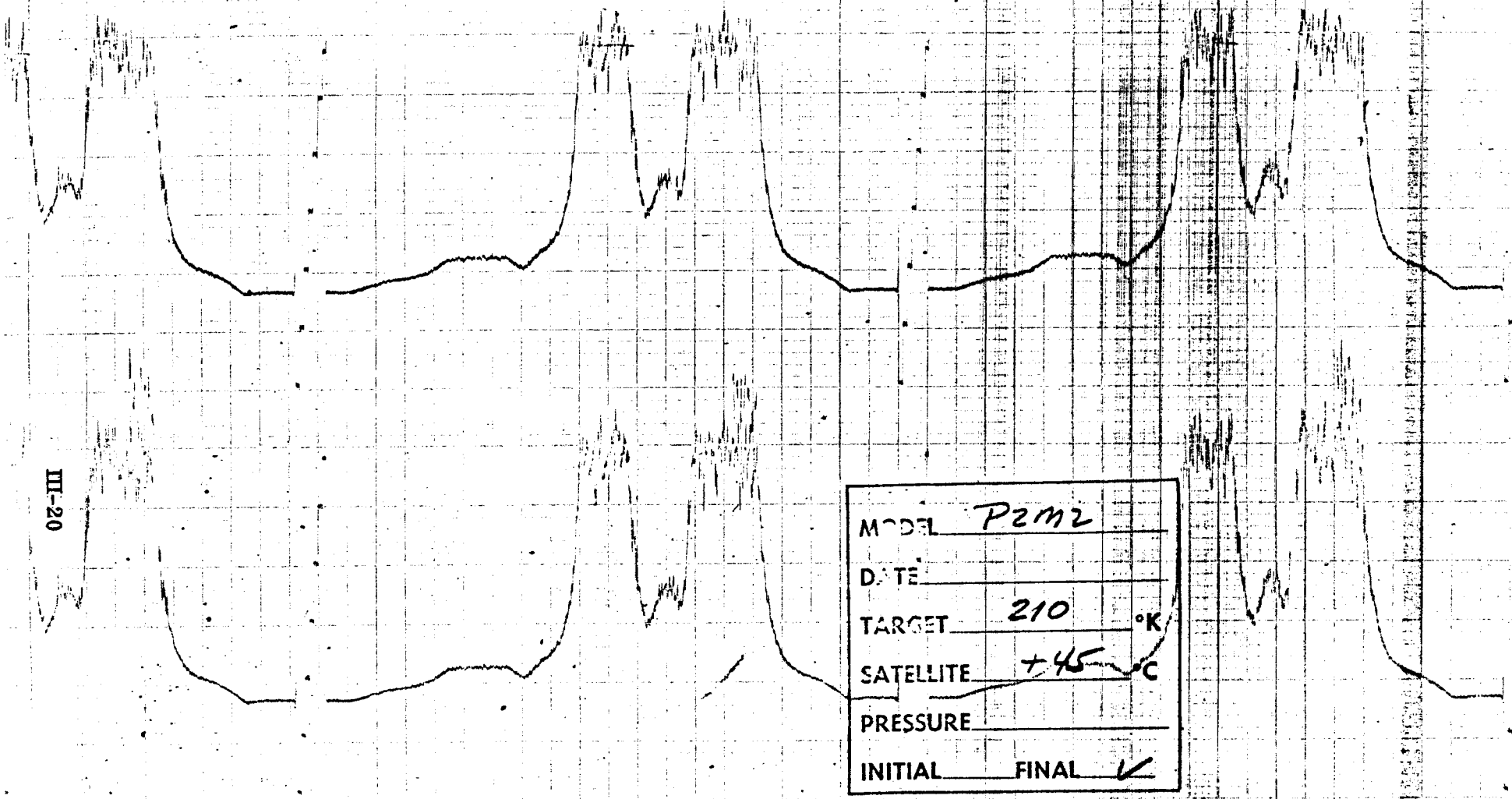

III-15
MODEL PFM2
DATE
TARGET 320 °K
SATELLITE +50 °C
PRESSURE
INITIAL FINAL ✓

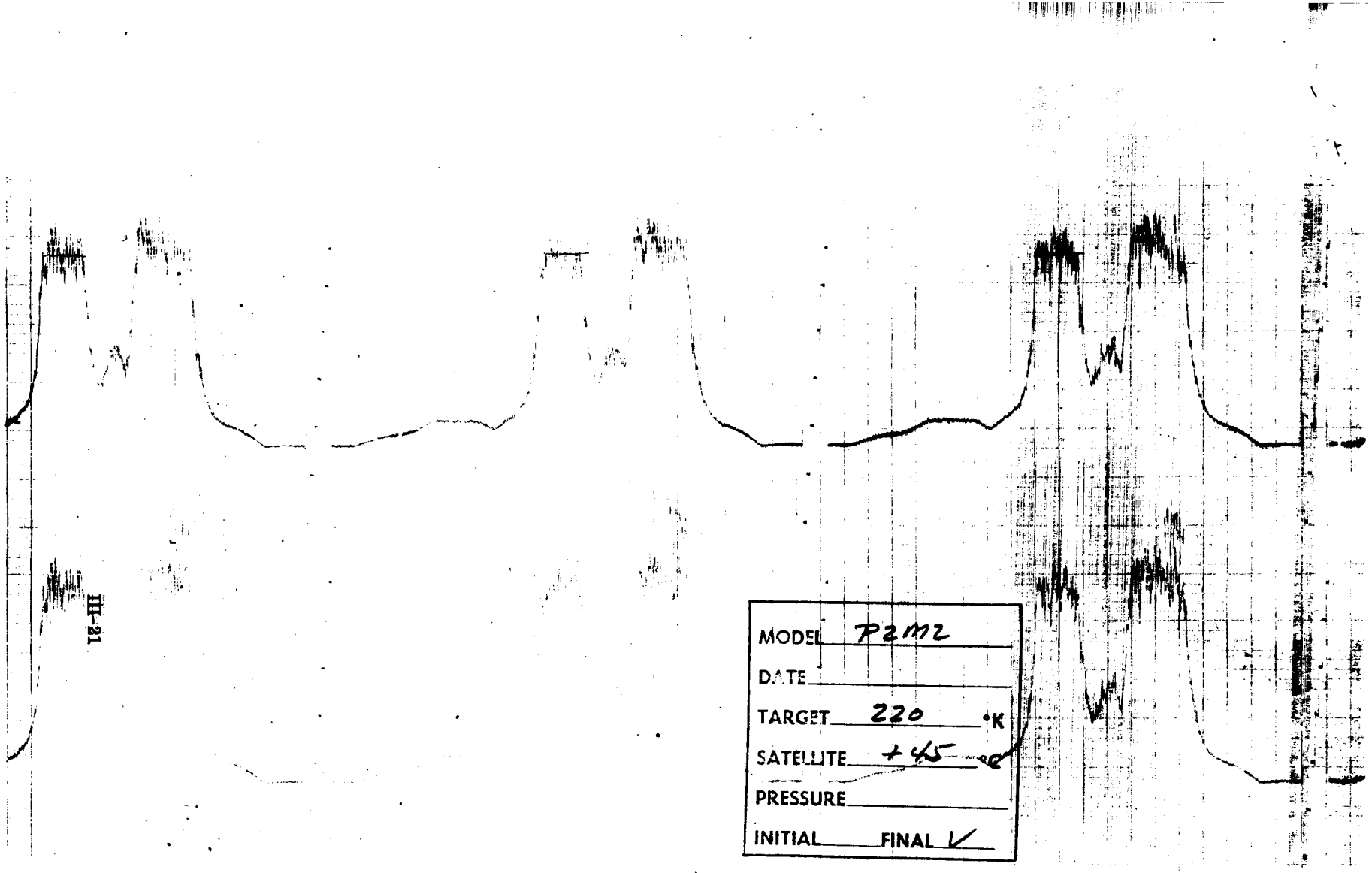

III-18
MODEL PEM2
DATE
TARGET 330 °K
SATELLITE 450 °C
PRESSURE
INITIAL FINAL ✓

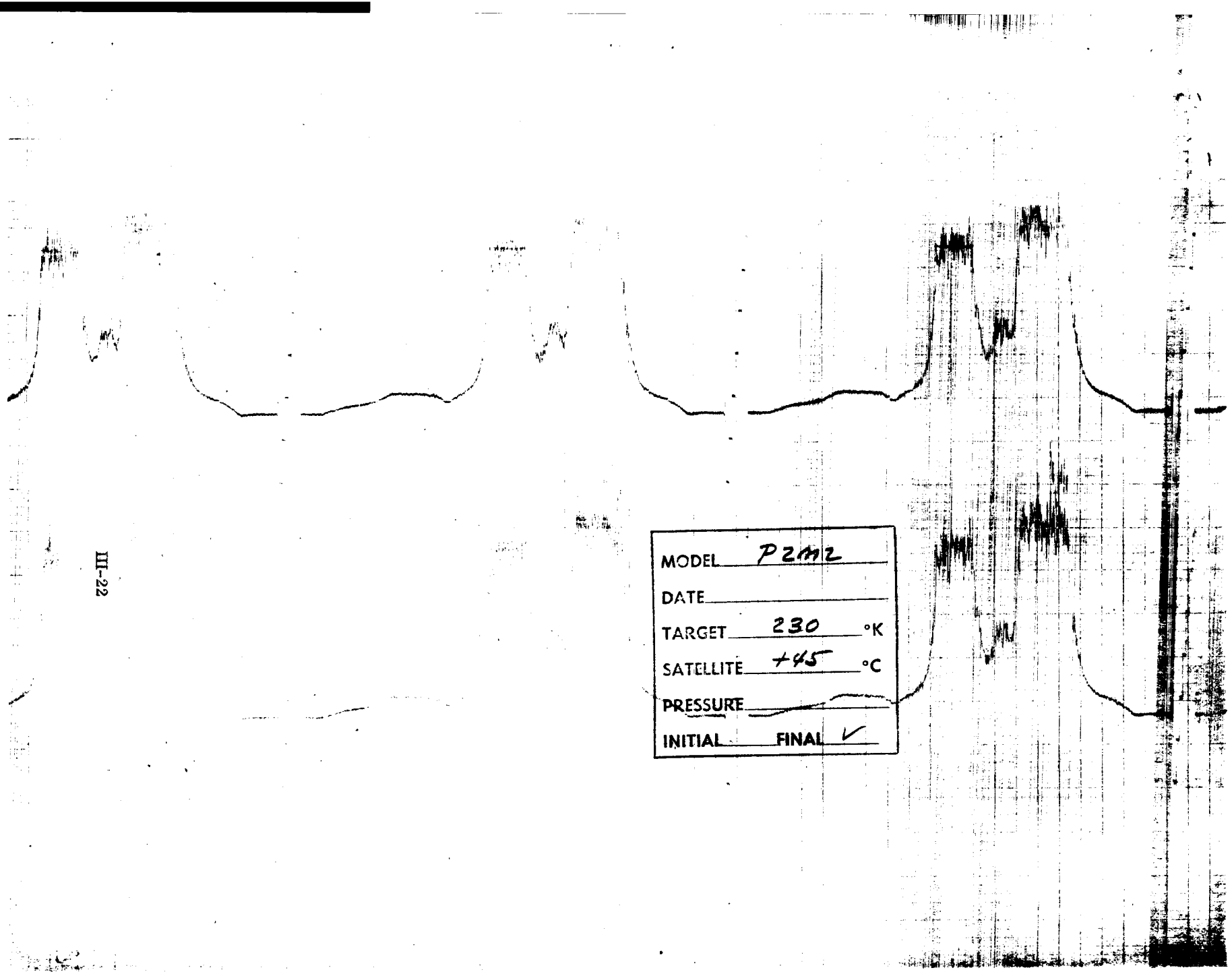

MODEL Pzm2
DATE
TARGET 340 °K
SATELLITE +50 °C
PRESSURE
INITIAL FINAL ✓

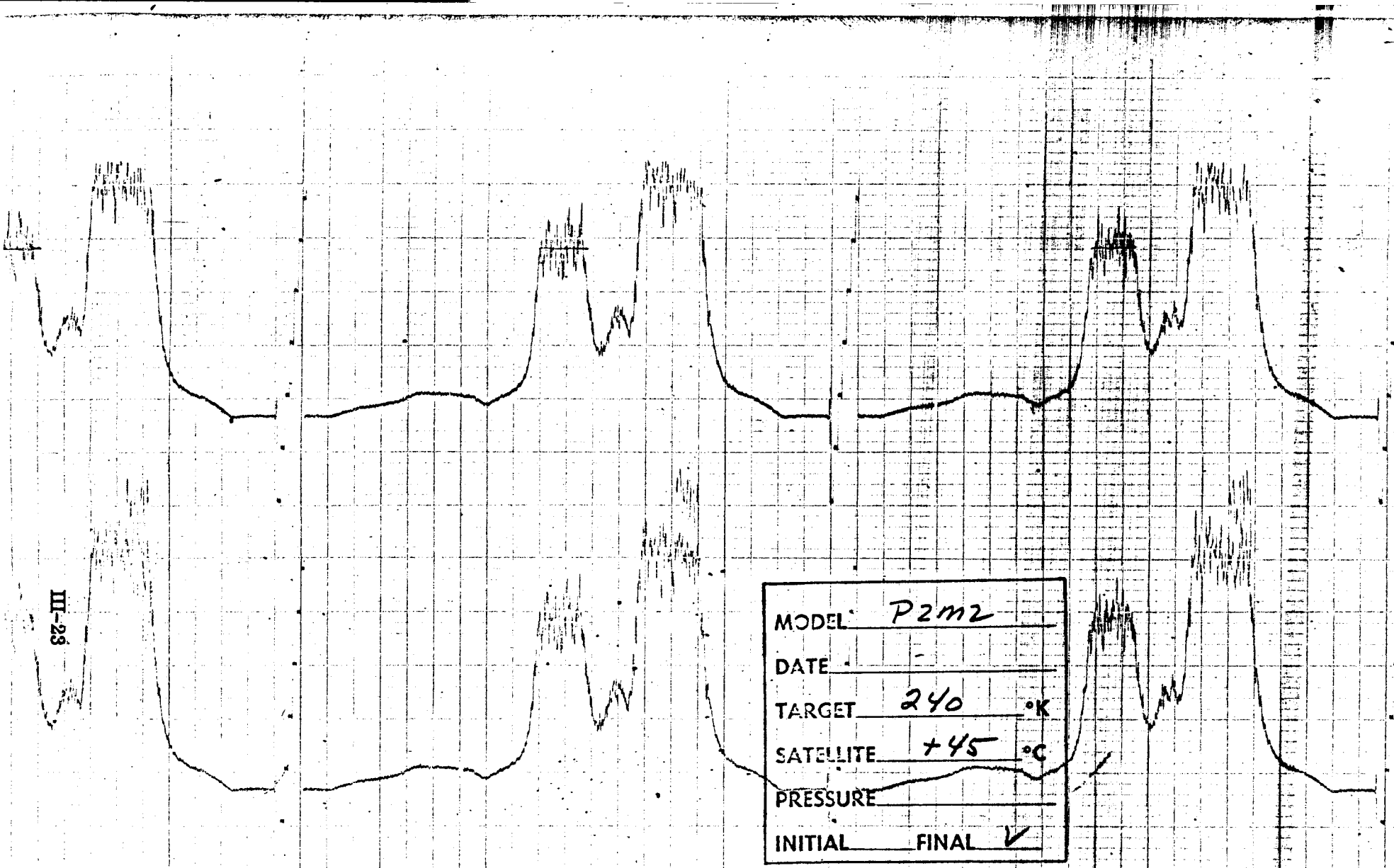

MODEL P2M2
DATE
TARGET 190 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓

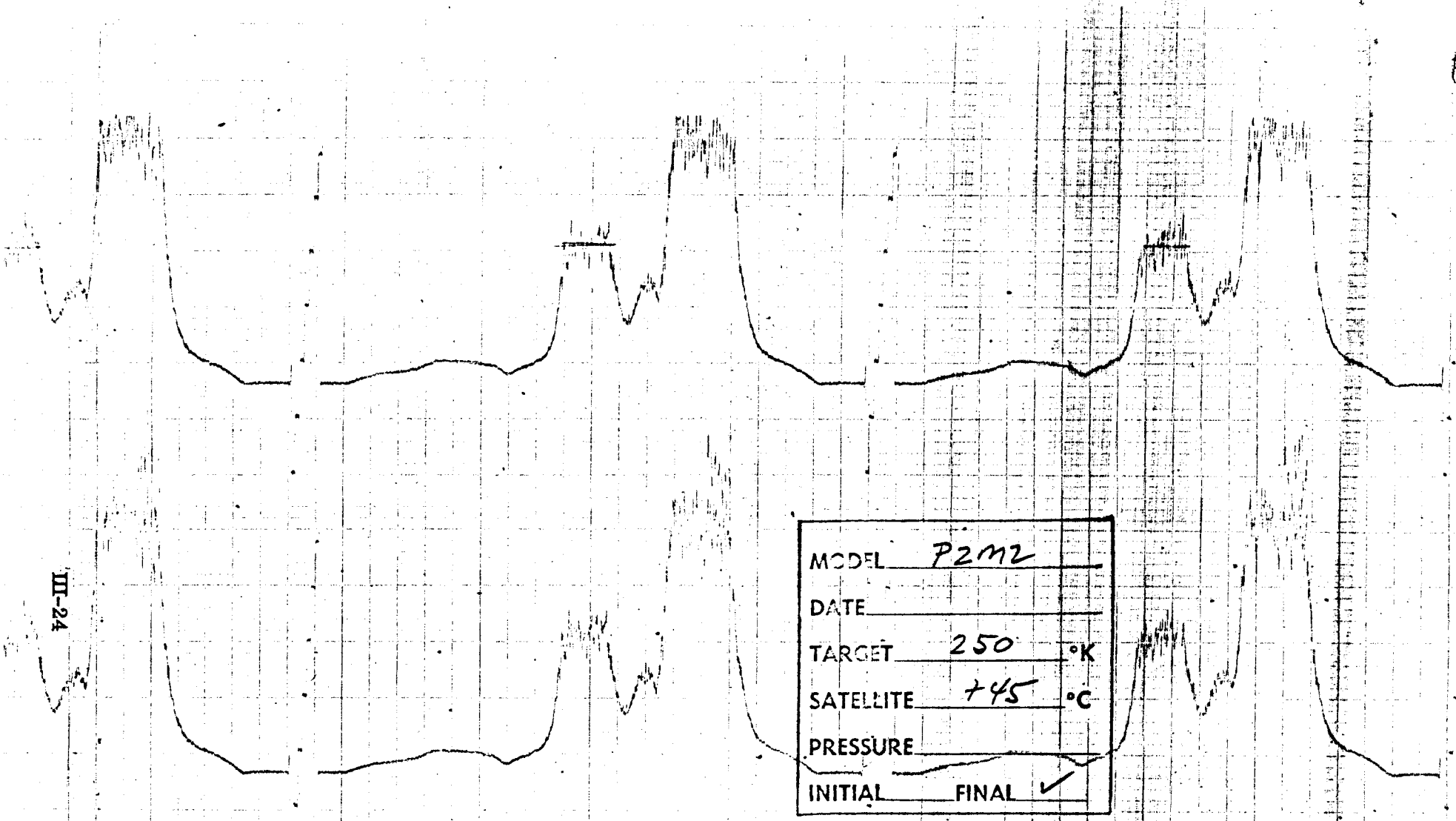

MODEL P2M2
DATE
TARGET 200 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓

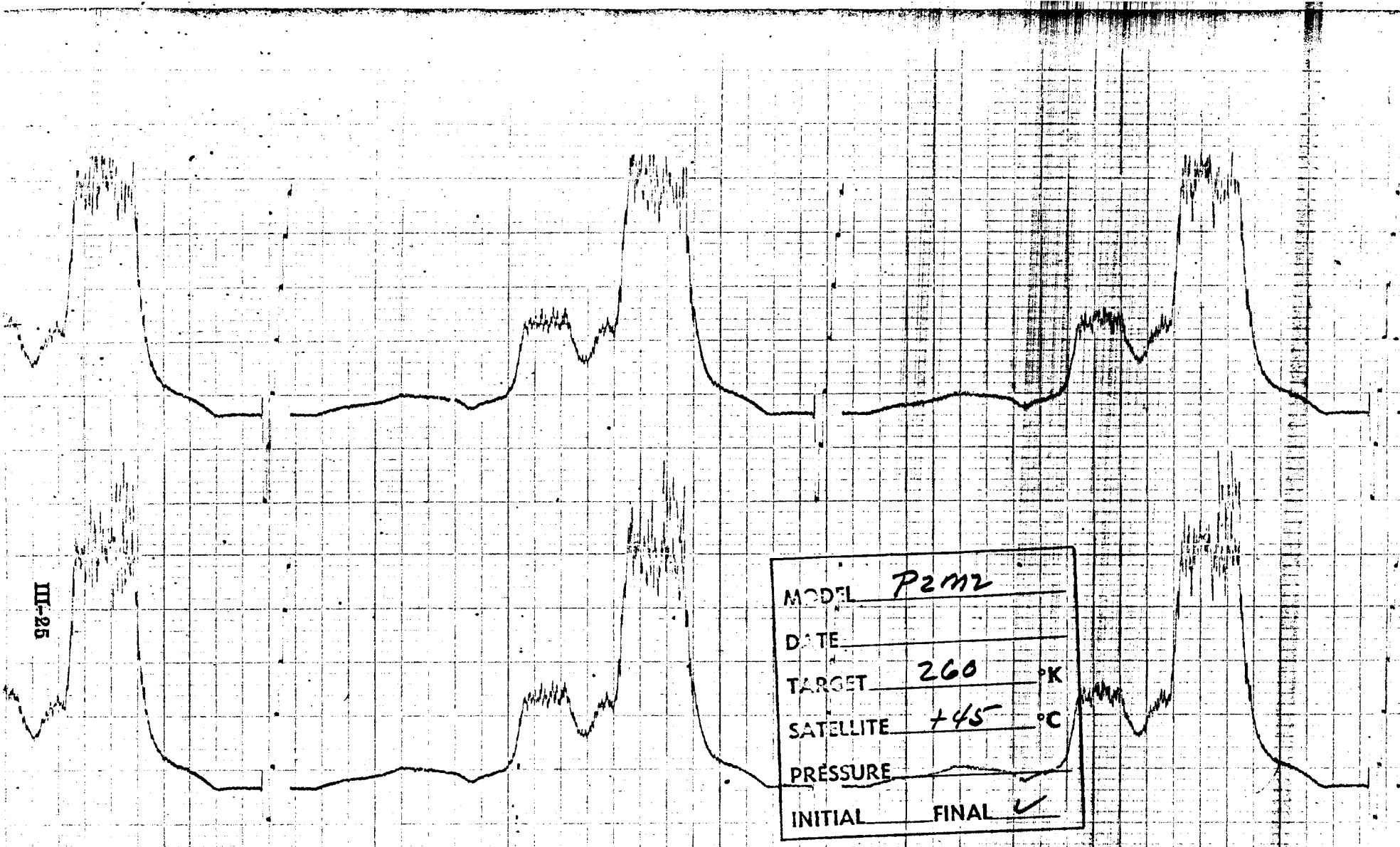

MODEL P2M2
DATE
TARGET 210 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓

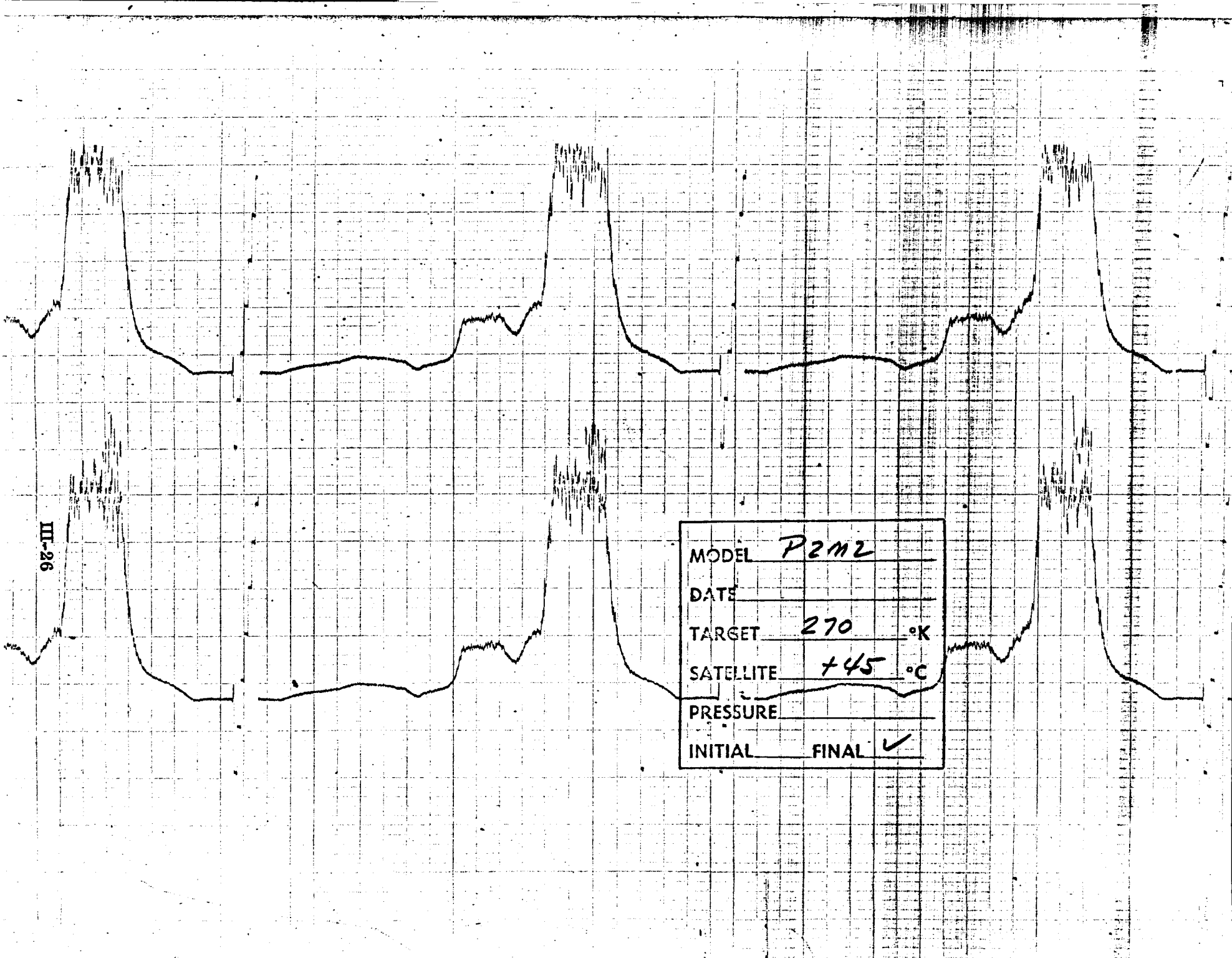

III-21
MODEL P2M2
DATE
TARGET 220 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓

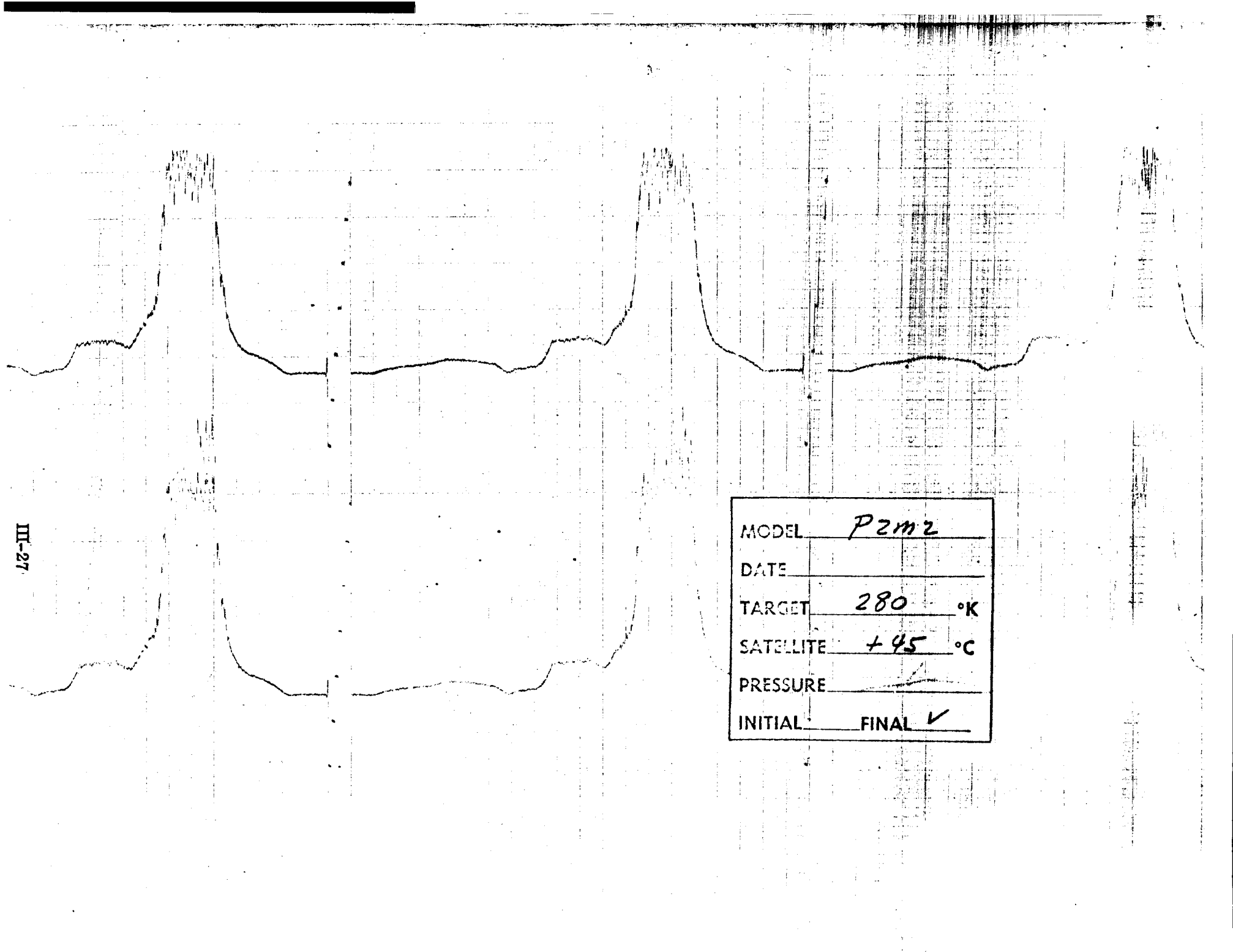

MODEL P2M2
DATE
TARGET 230 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓

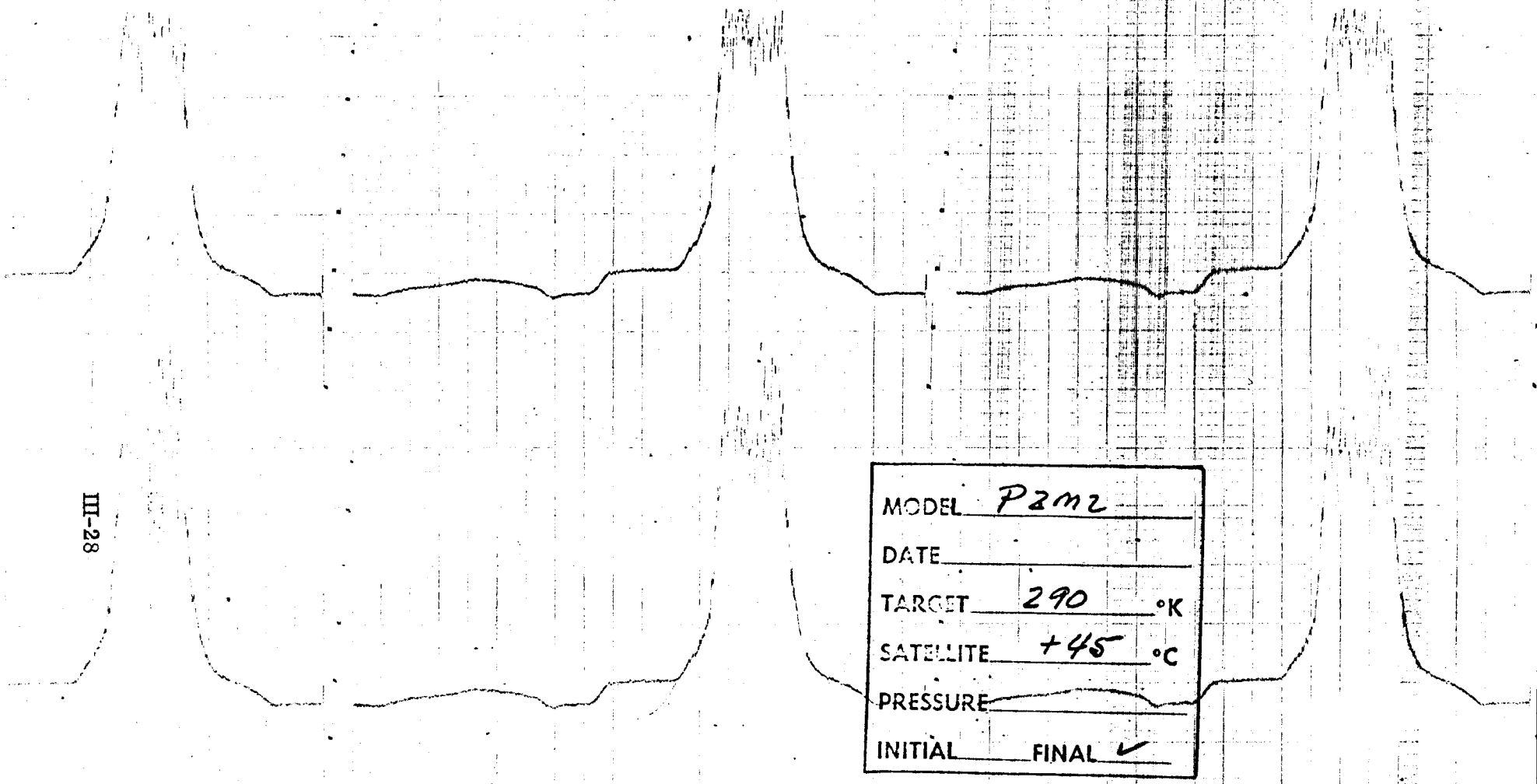

MODEL P2m2
DATE
TARGET 240 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓

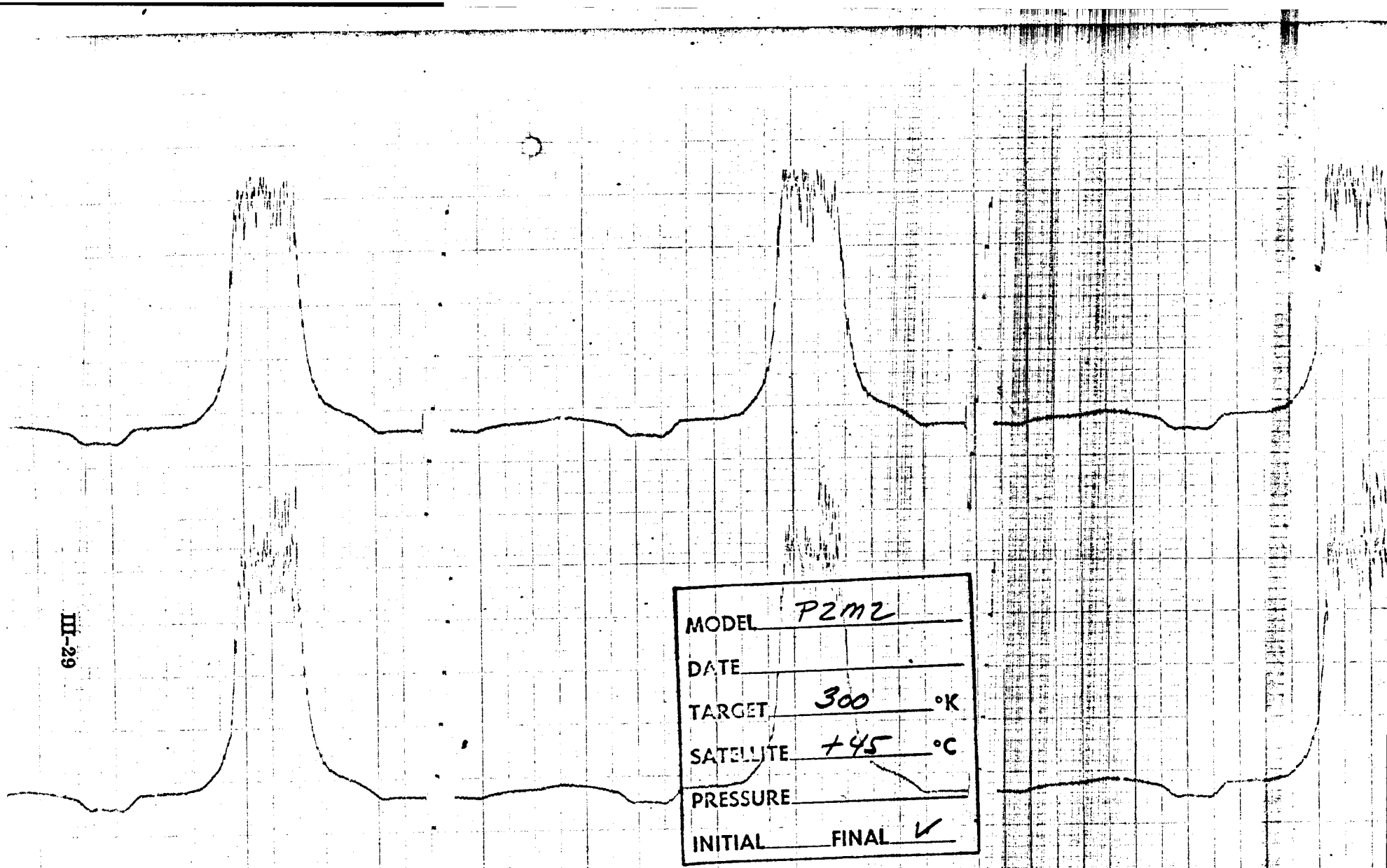

MODEL P2M2
DATE
TARGET 250 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓

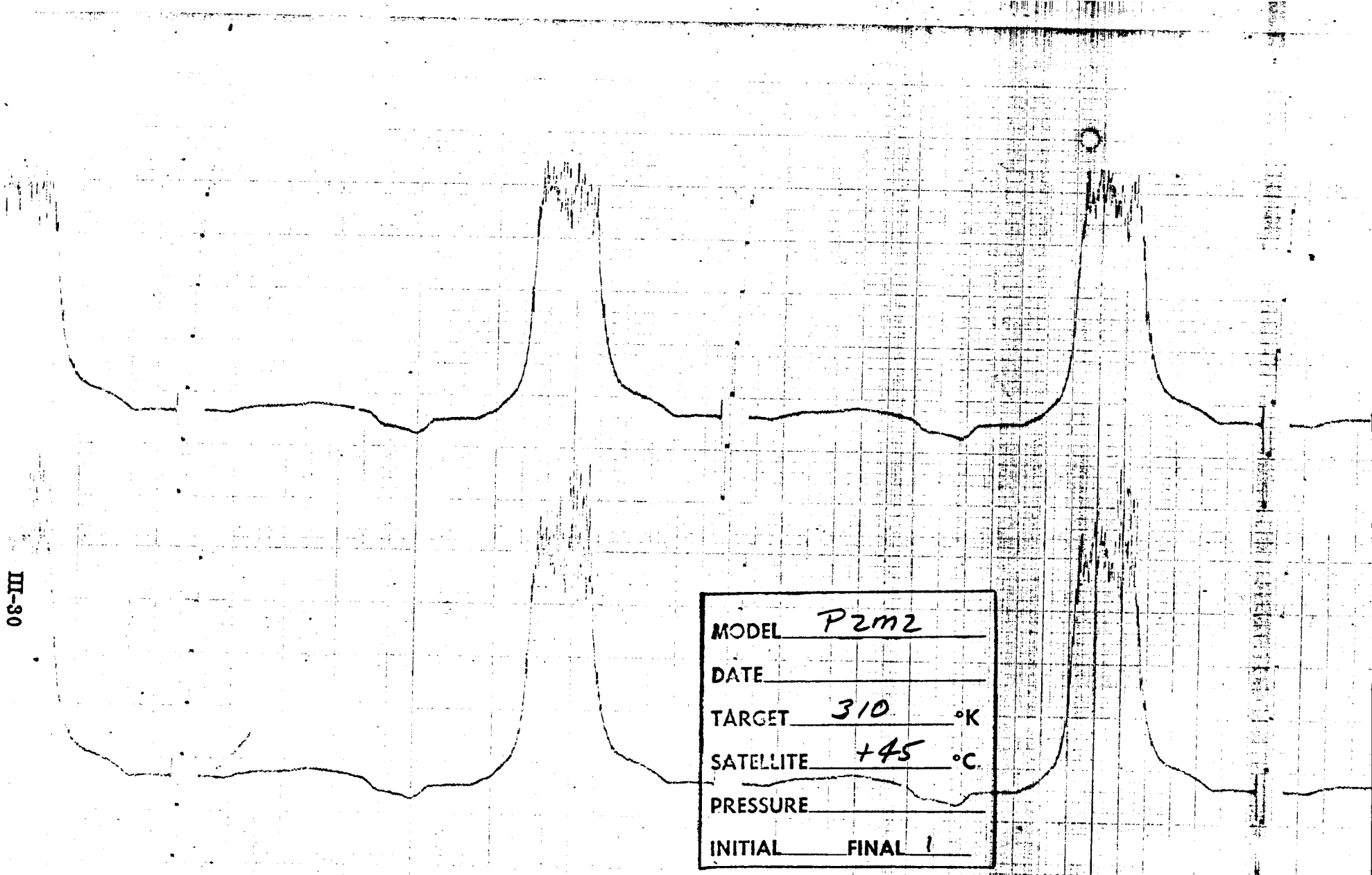

MODEL P2M2
DATE
TARGET 260 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL

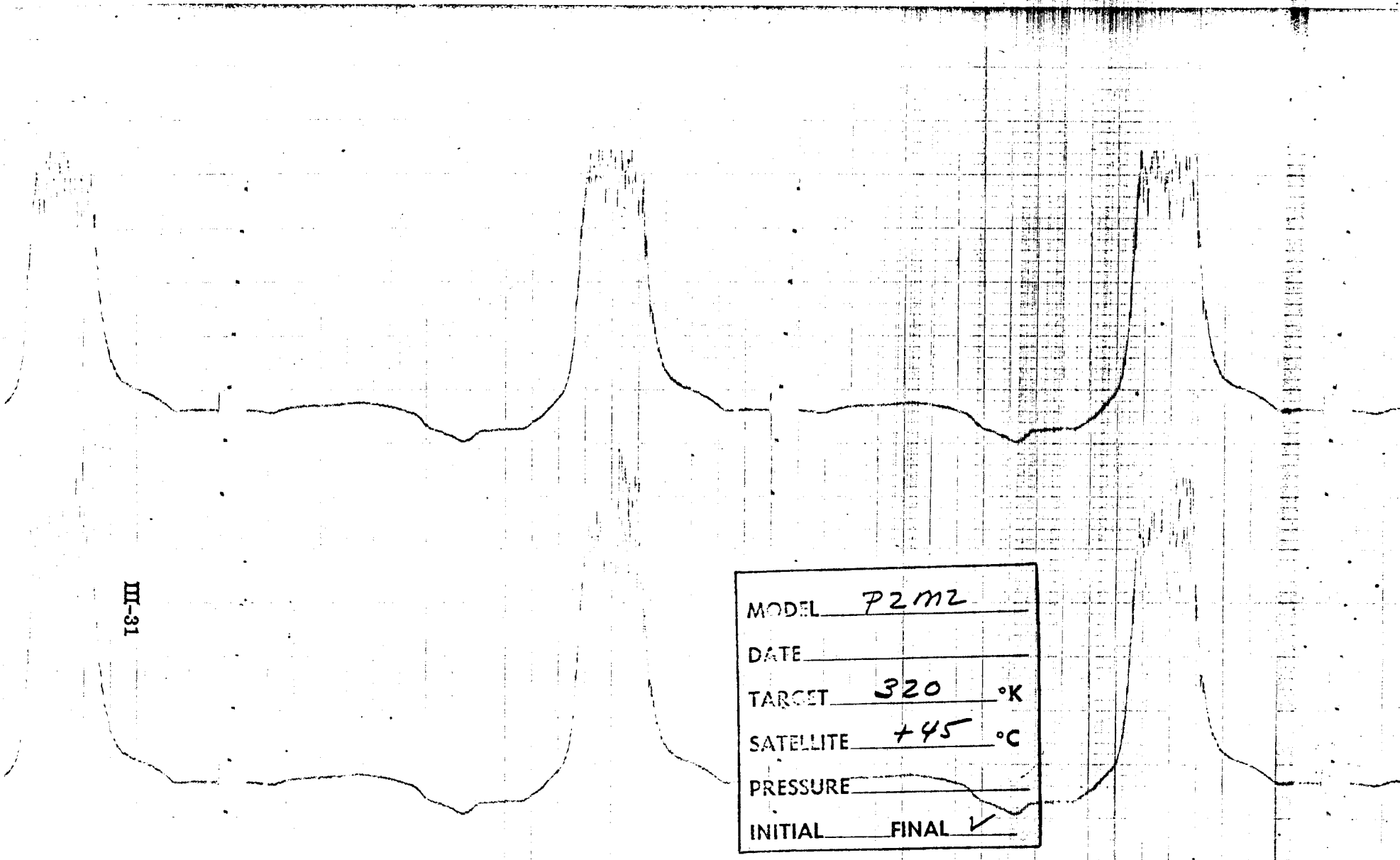

MODEL P2M2
DATE
TARGET 270 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓

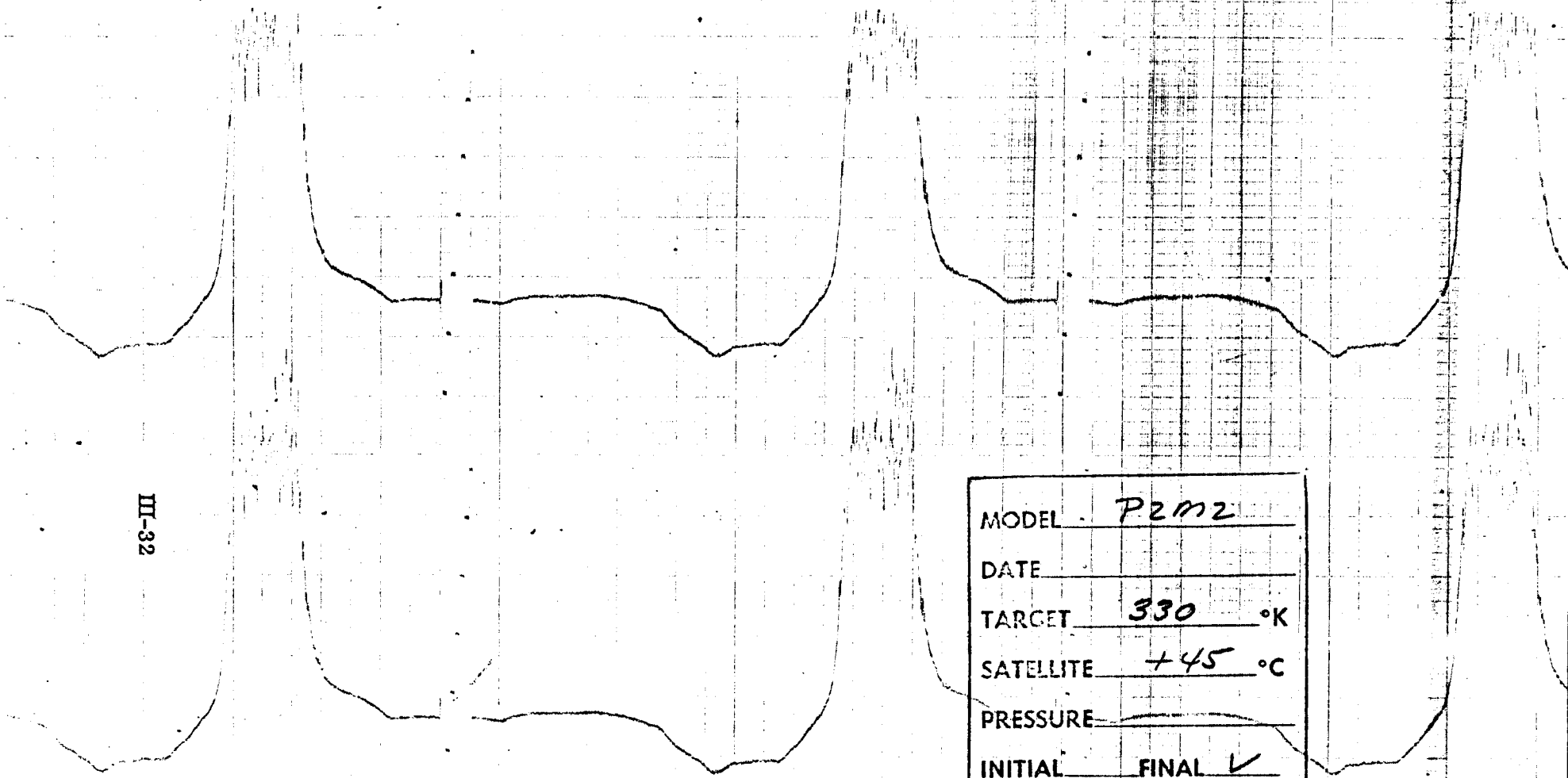

MODEL Pzm2
DATE
TARGET 280 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓

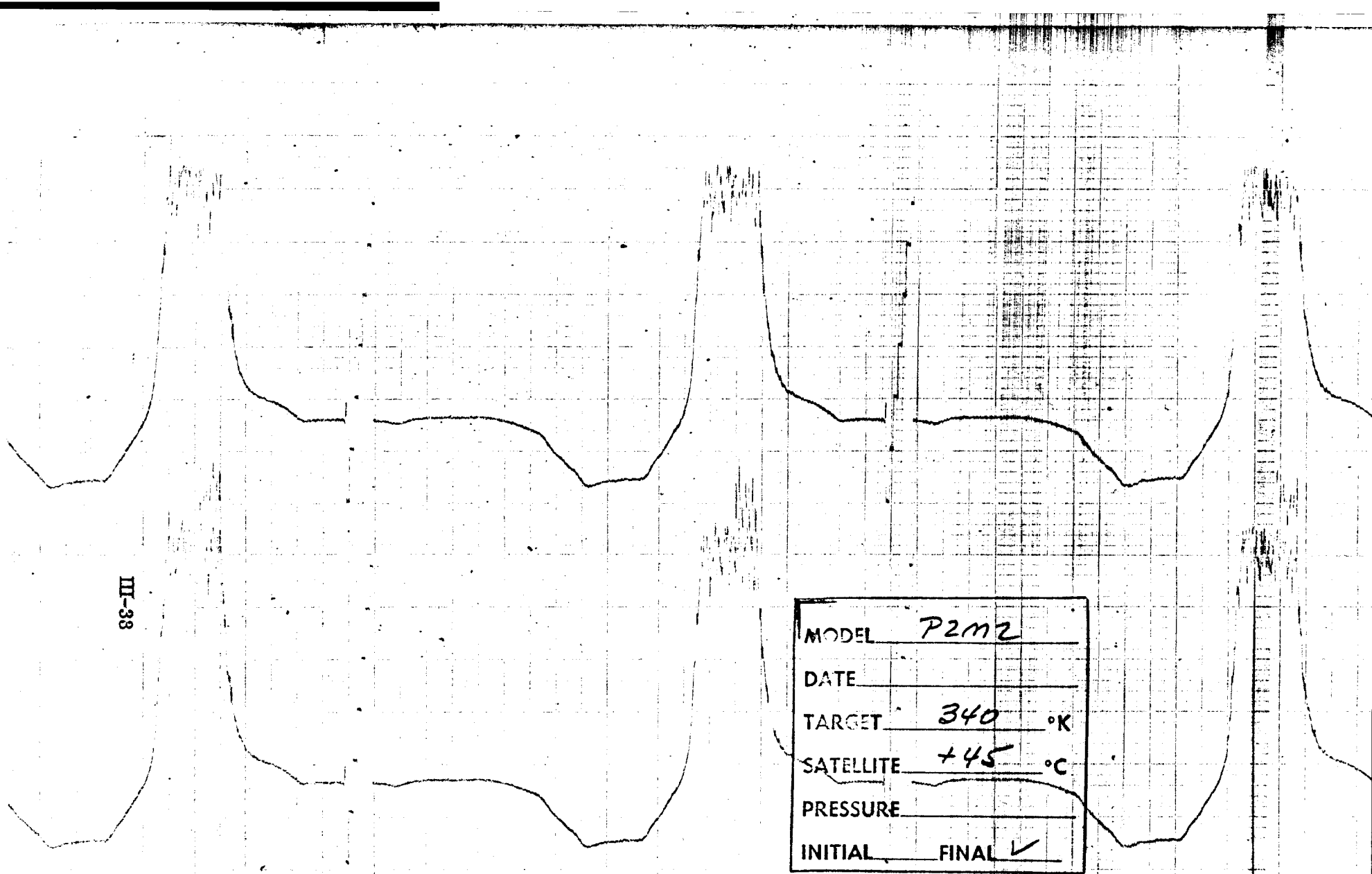

MODEL P2M2
DATE
TARGET 290 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓

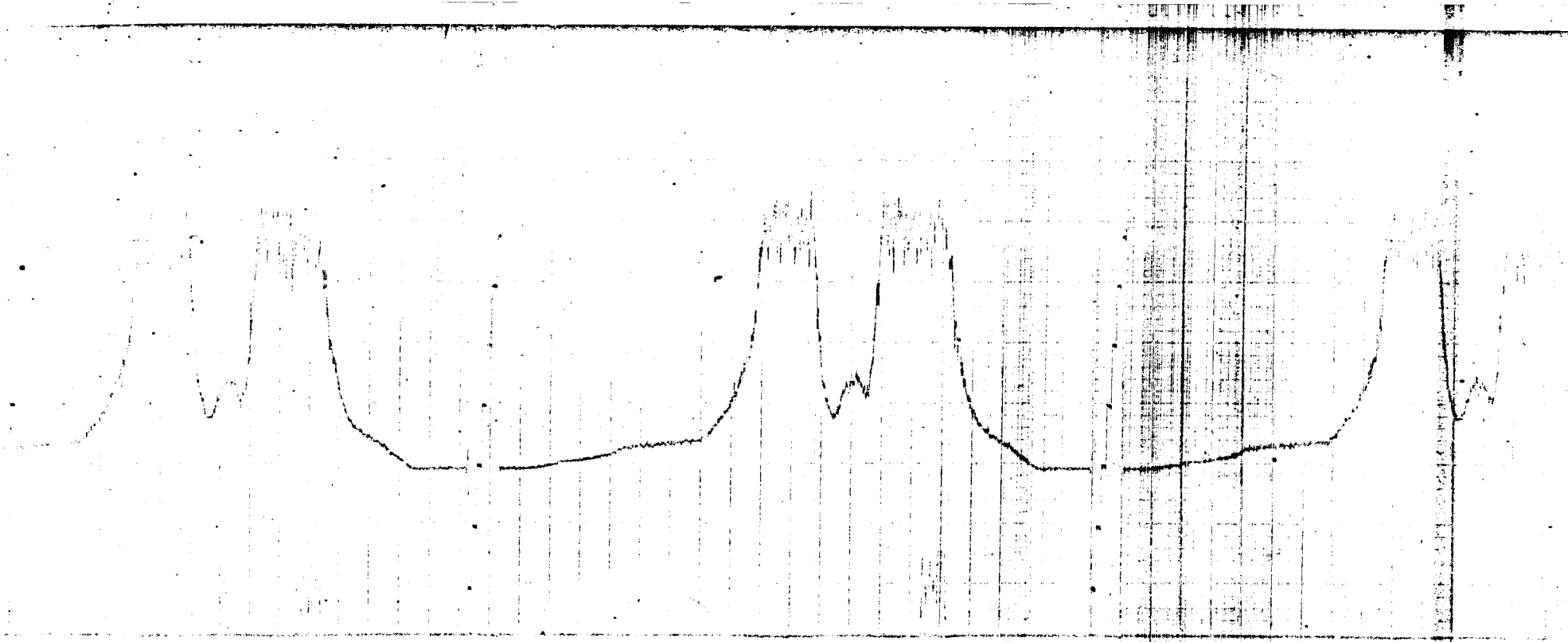

MODEL PZM2
DATE
TARGET 300 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓


MODEL P2M2
DATE
TARGET 310 °K
SATELLITE +45 °C.
PRESSURE
INITIAL FINAL 1


MODEL P2M2
DATE
TARGET 320 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓


MODEL PZM2
DATE
TARGET 330 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓


MODEL P2M2
DATE
TARGET 340 °K
SATELLITE +45 °C
PRESSURE
INITIAL FINAL ✓



MODEL P2m2

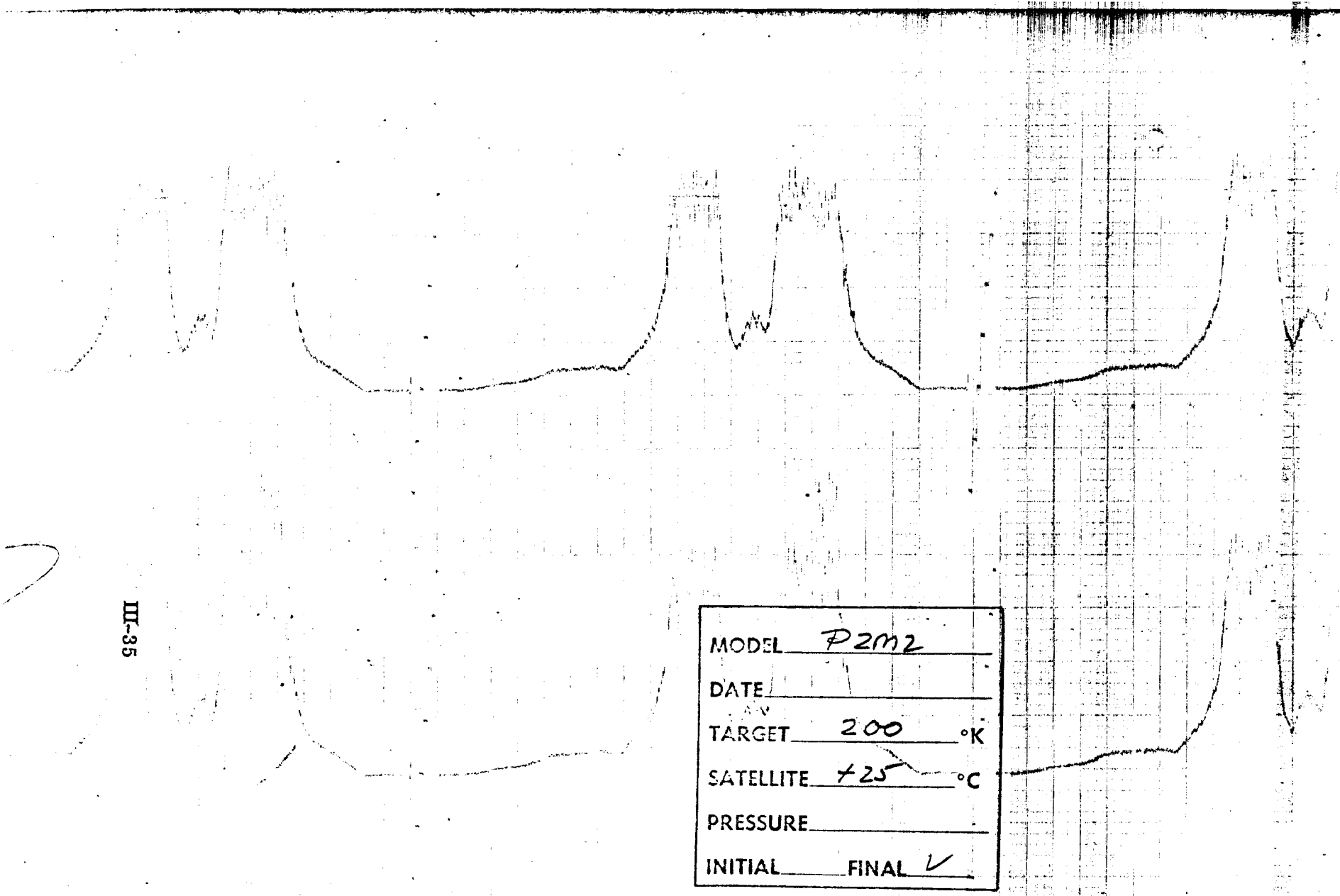
DATE

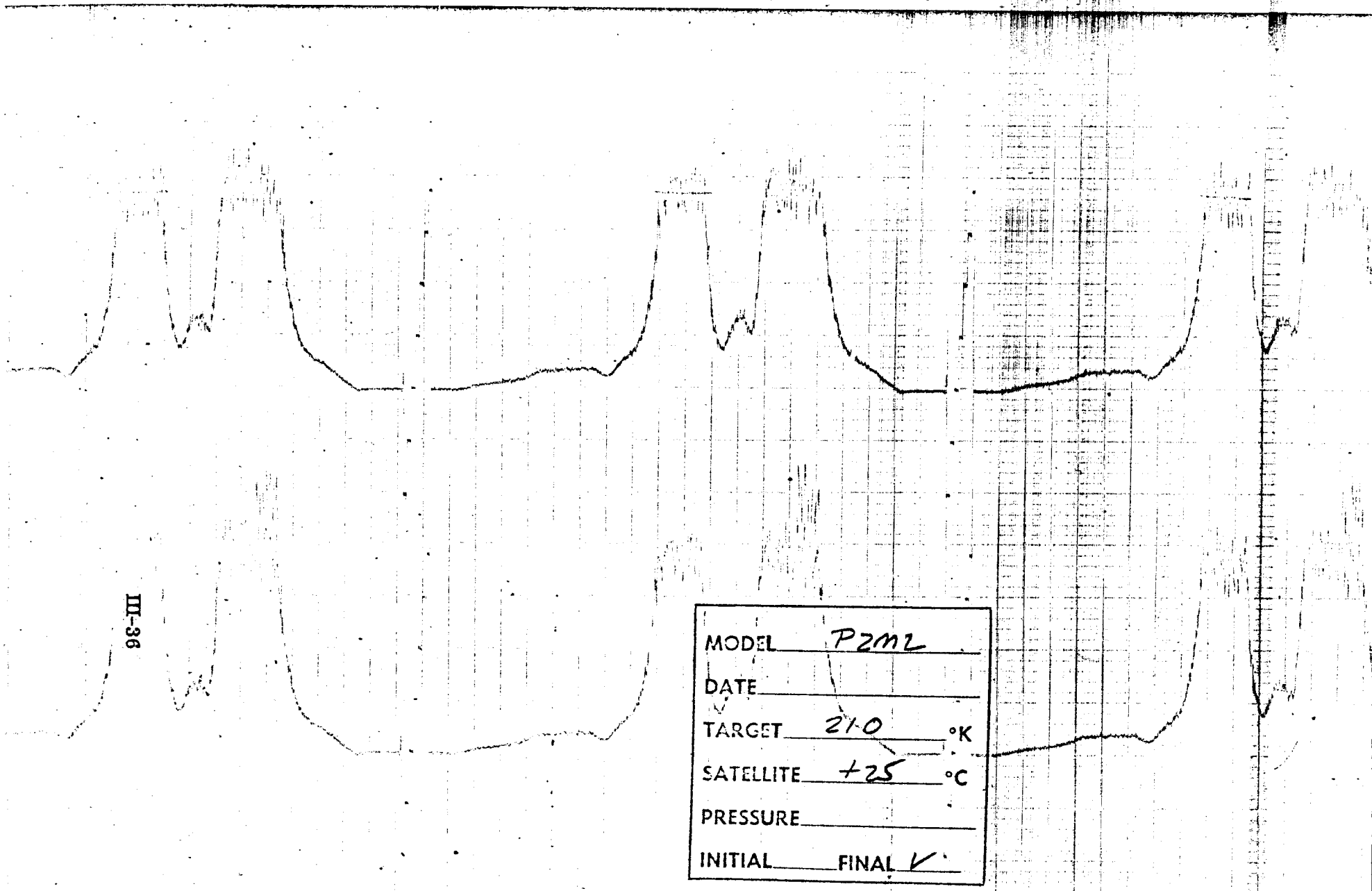
TARGET 190 °K

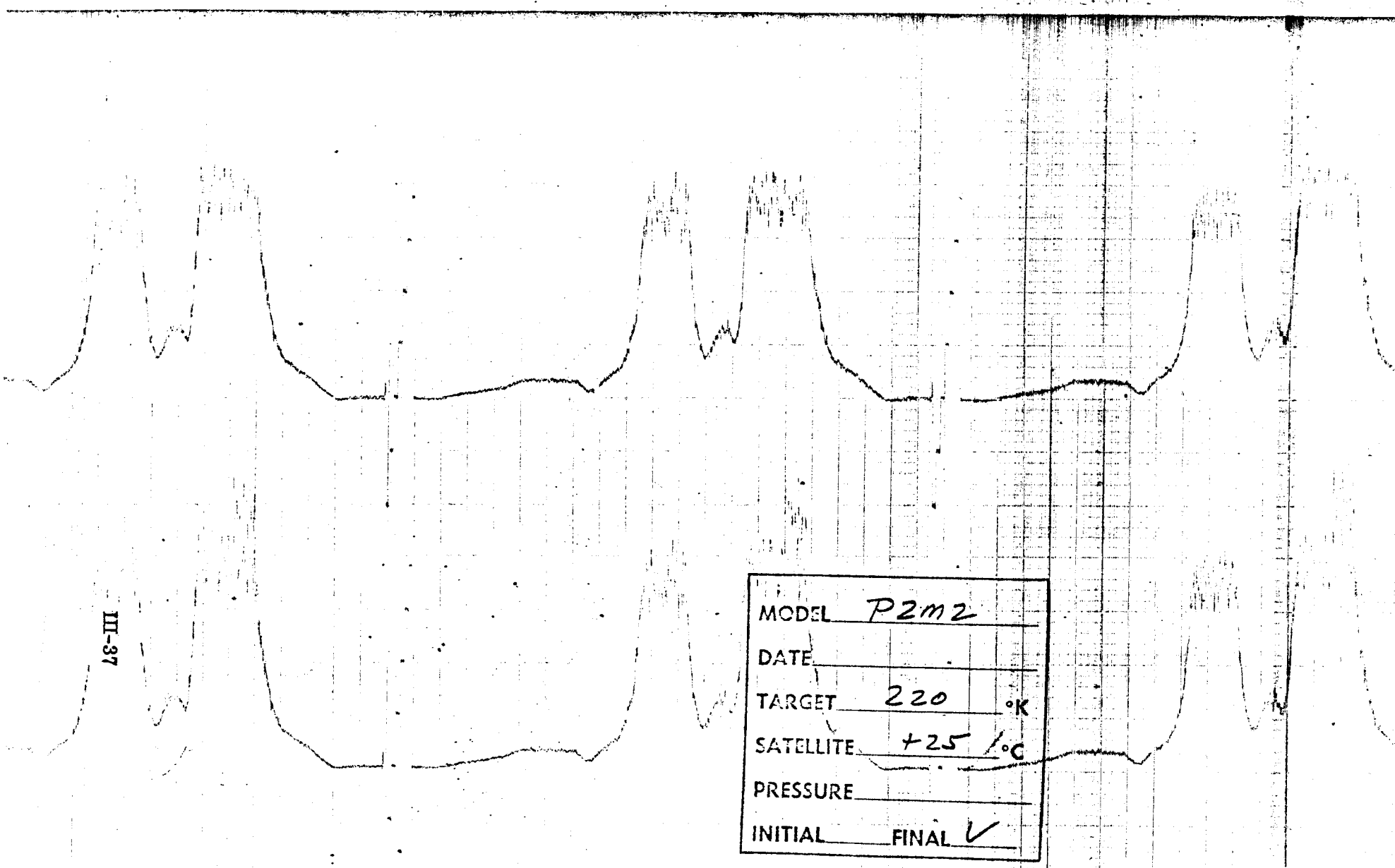
SATELLITE +25 °C

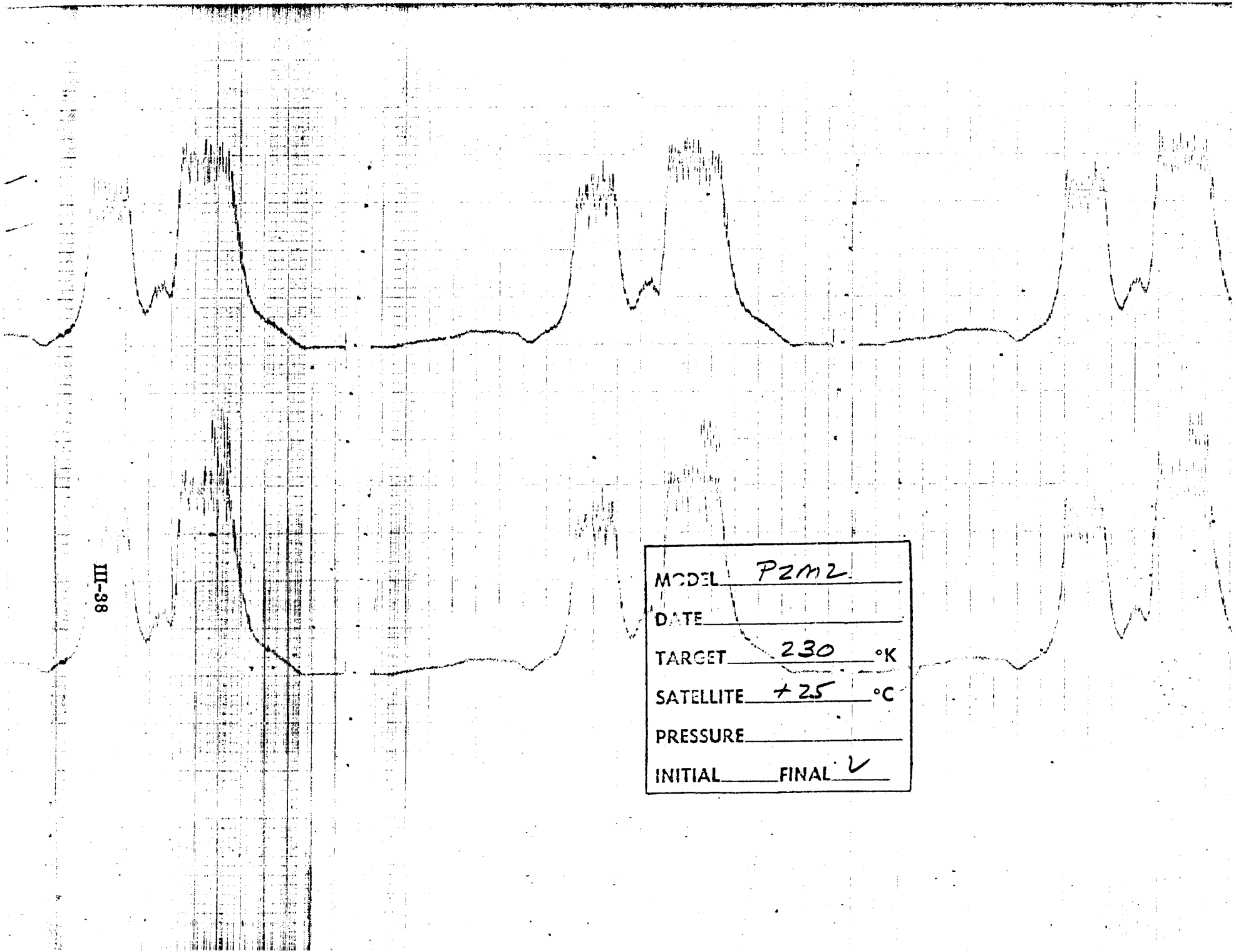
PRESSURE

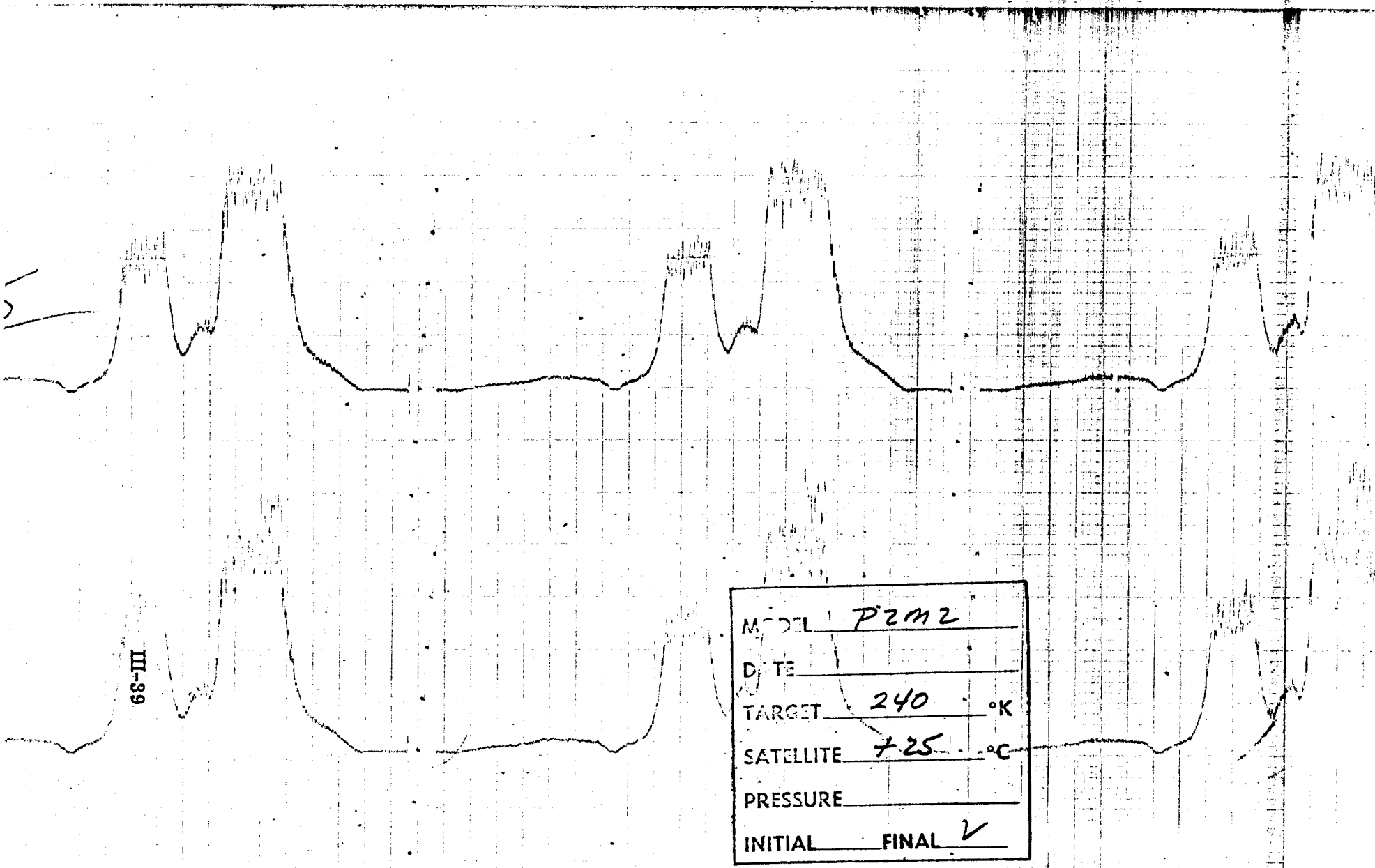
INITIAL FINAL ✓

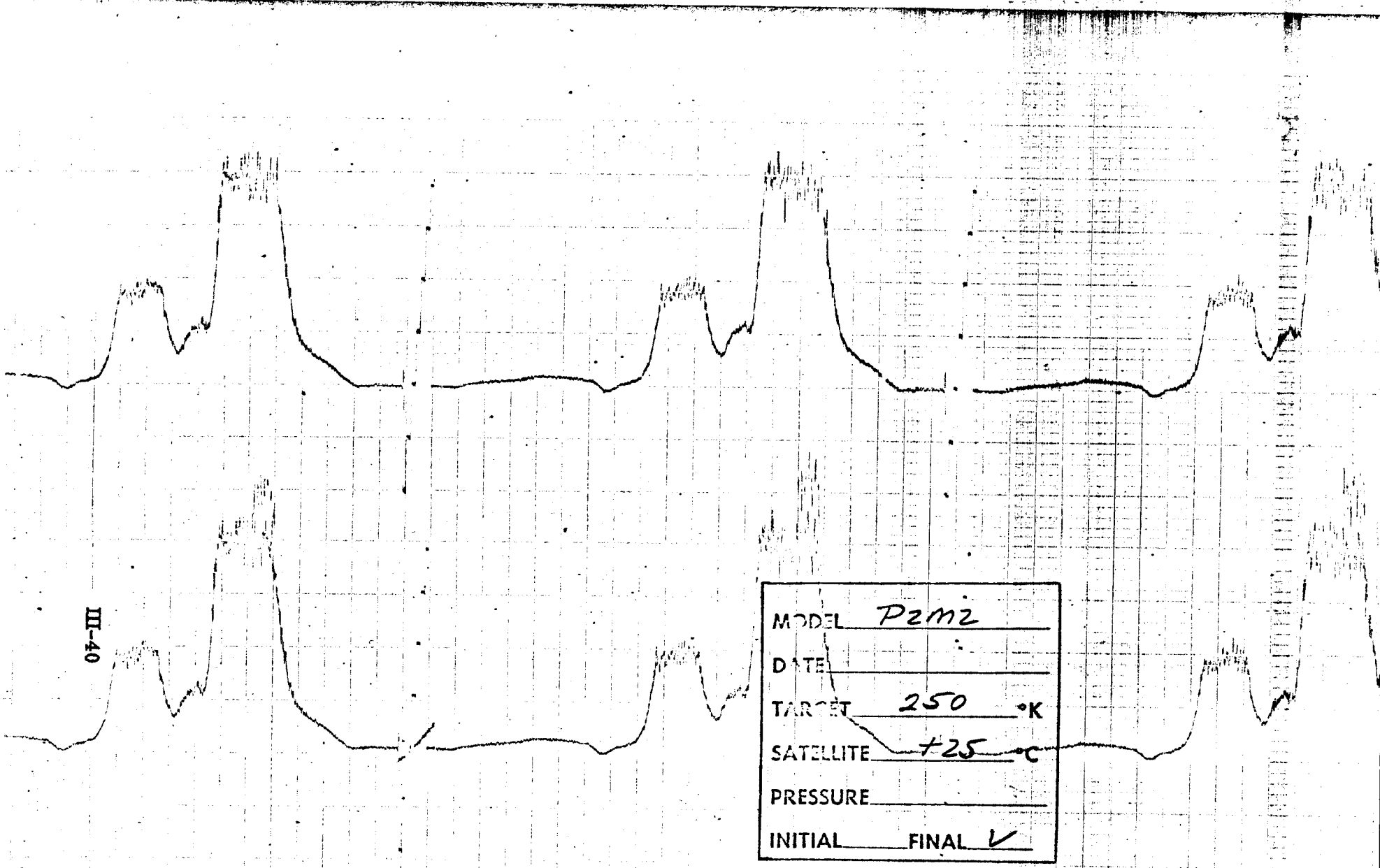

MODEL P2M2
DATE
TARGET 200 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL ✓

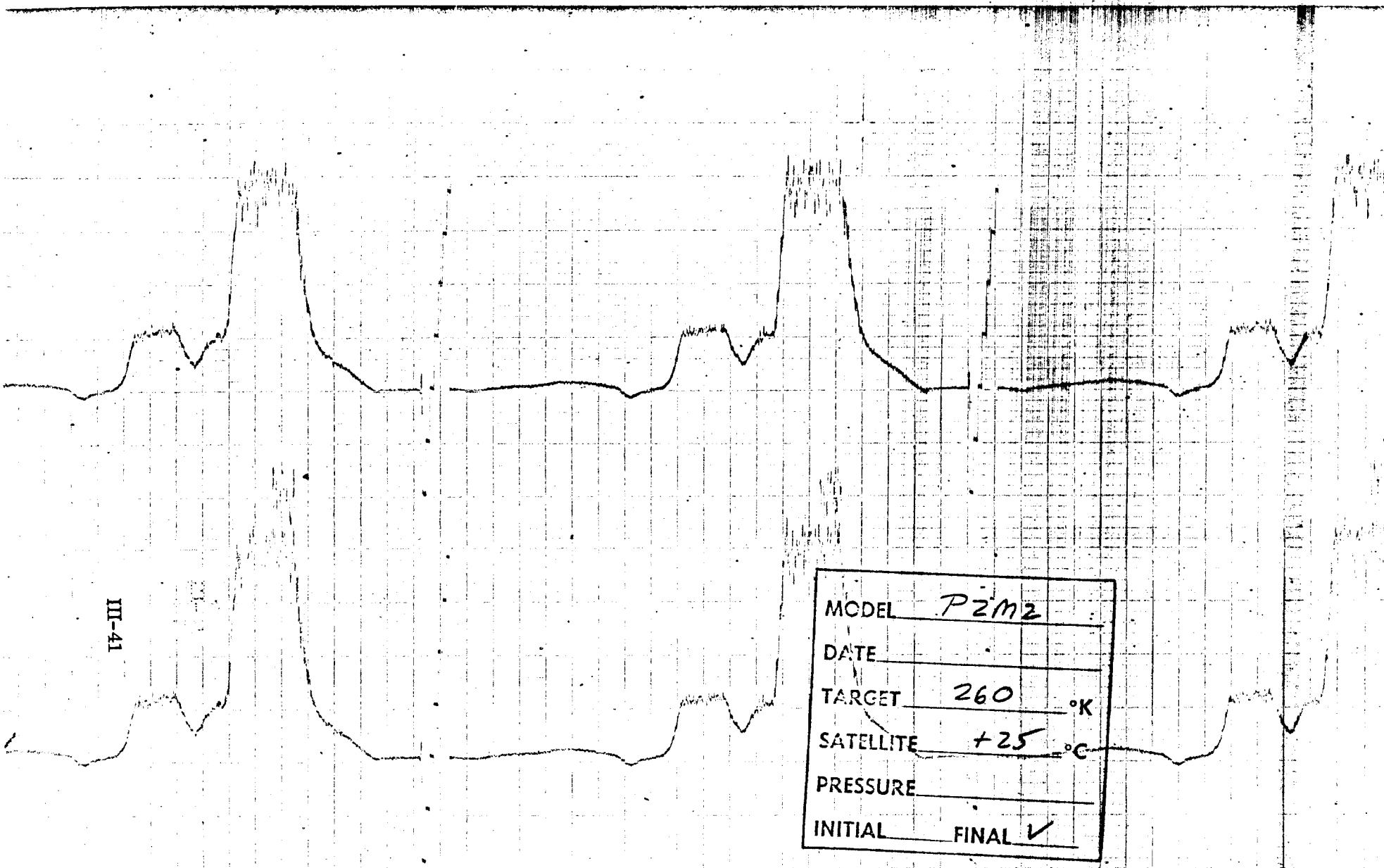

MODEL P2M2
DATE
TARGET 210 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL

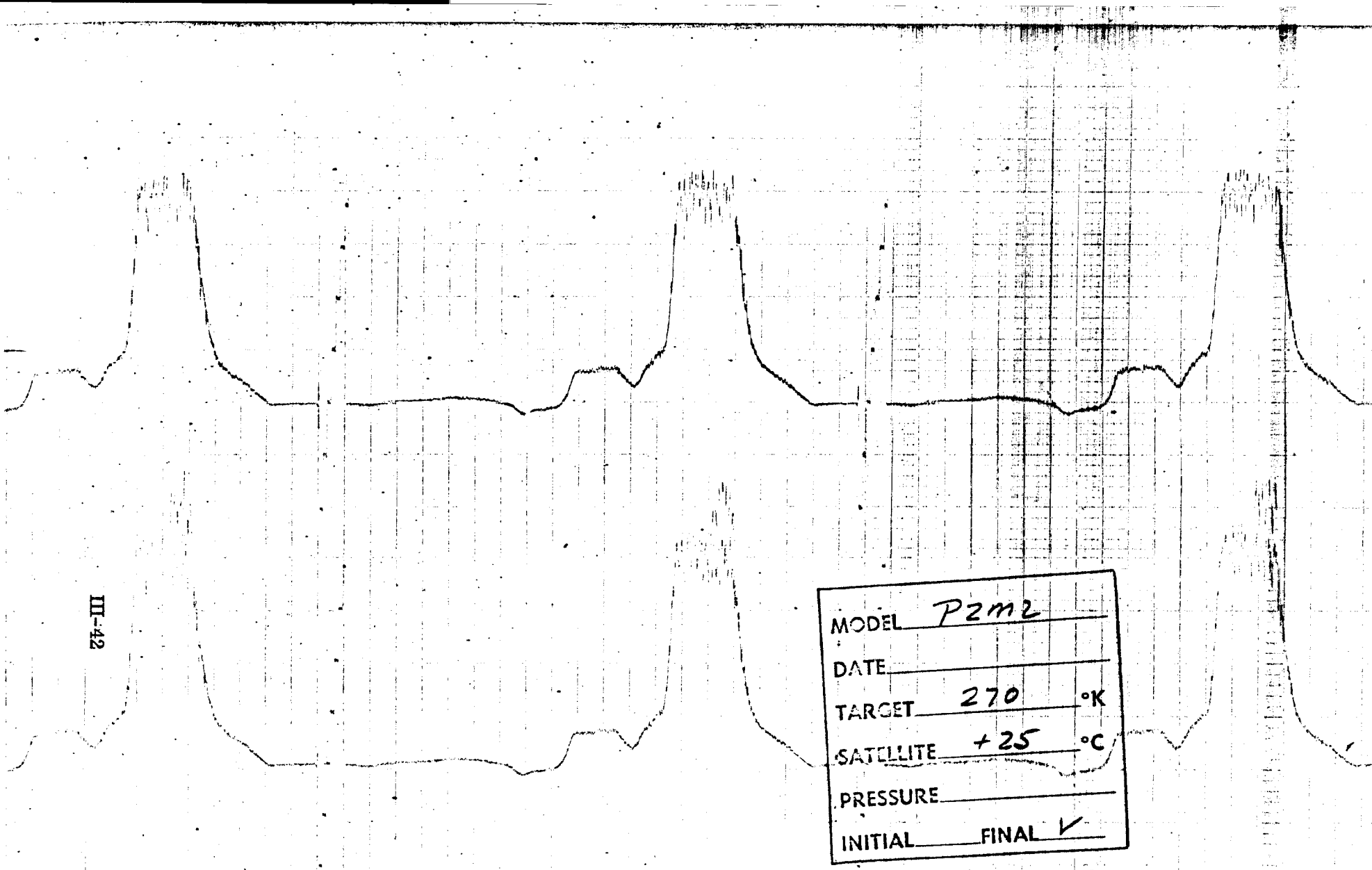

MODEL P2m2
DATE
TARGET 220 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL V

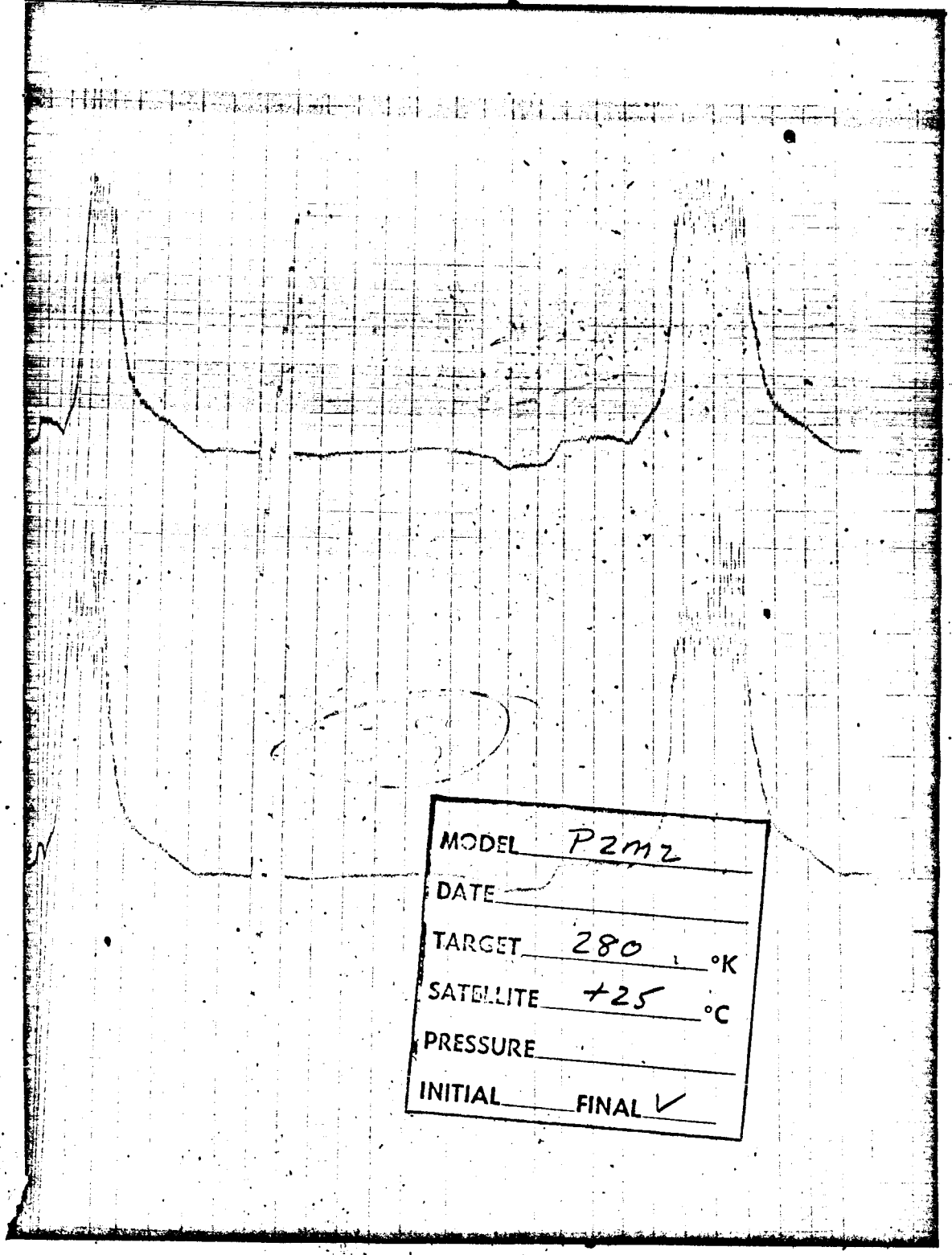

MODEL PZM2
DATE
TARGET 230 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL V

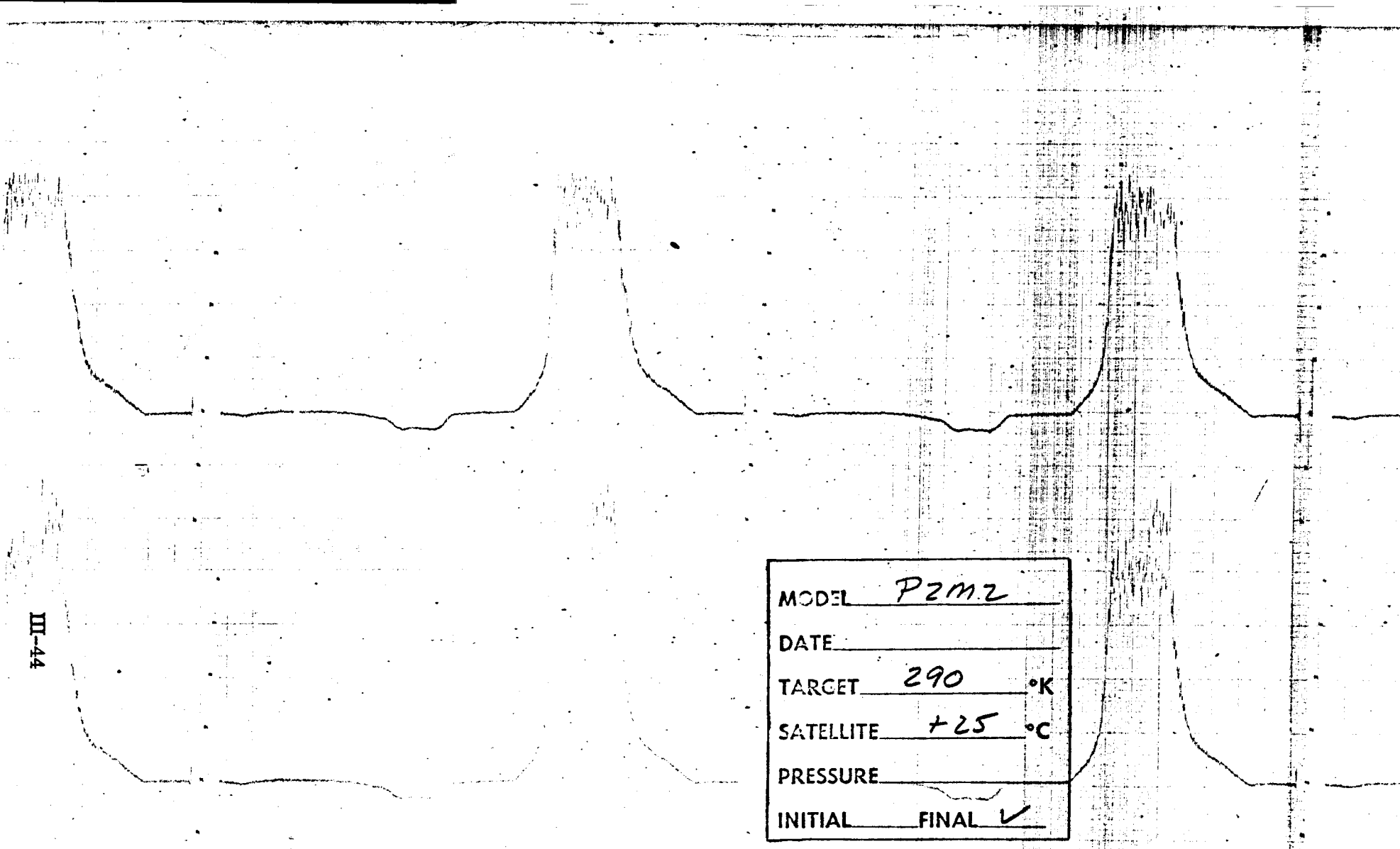

MODEL PZM2
DATE
TARGET 240 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL V

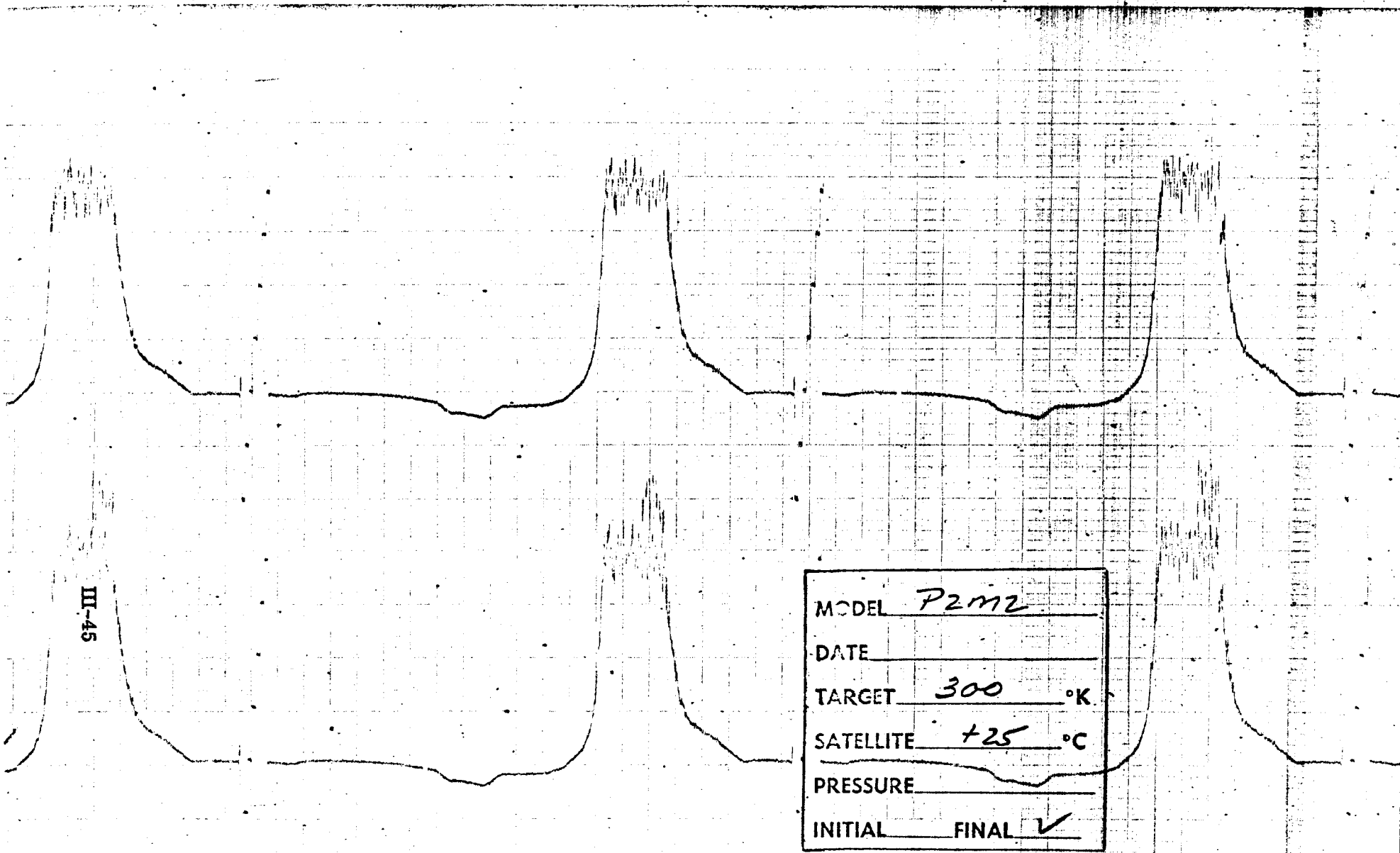

MODEL Pzm2
DATE
TARGET 250 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL V

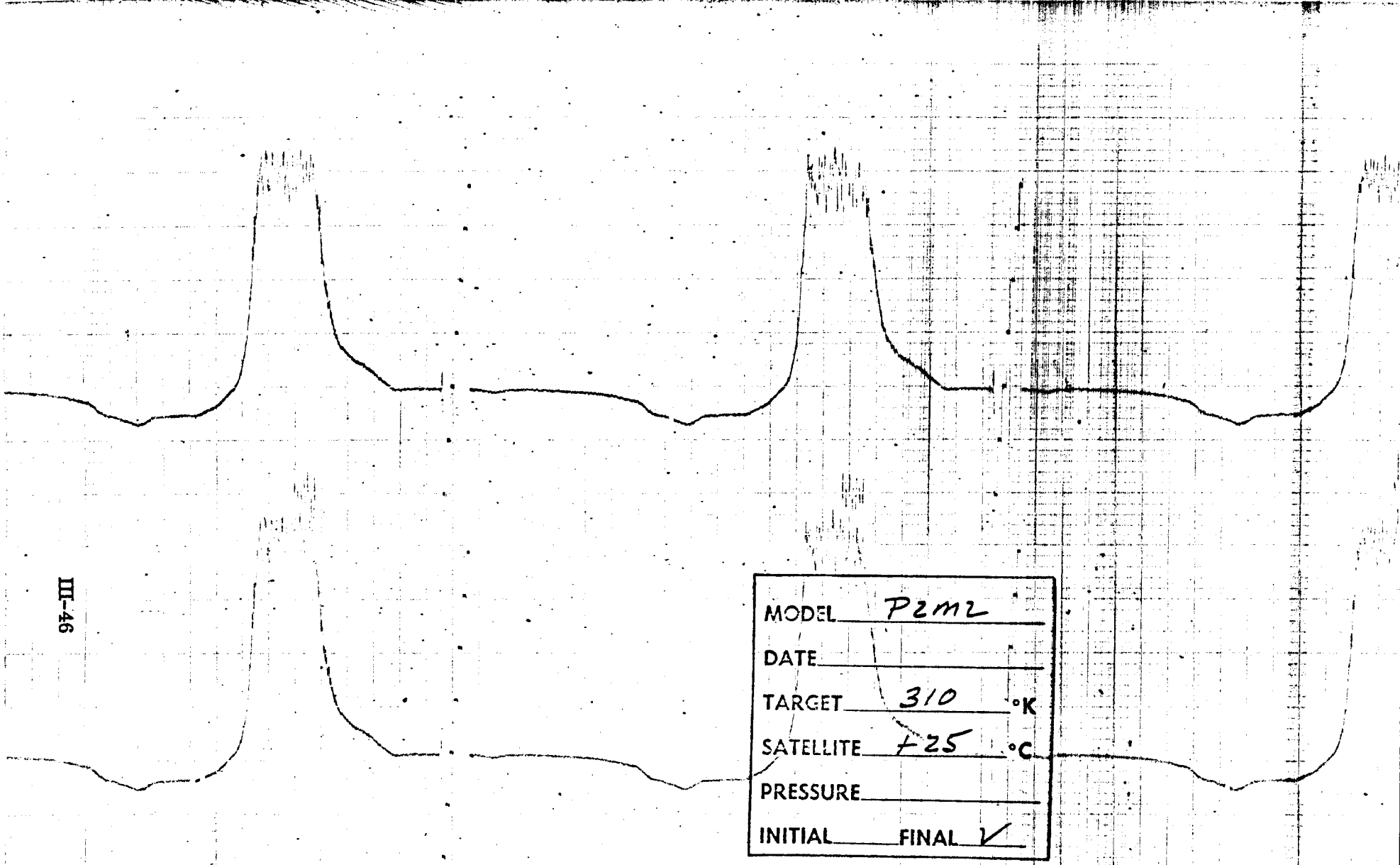

MODEL PZM2
DATE
TARGET 260 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL ✓

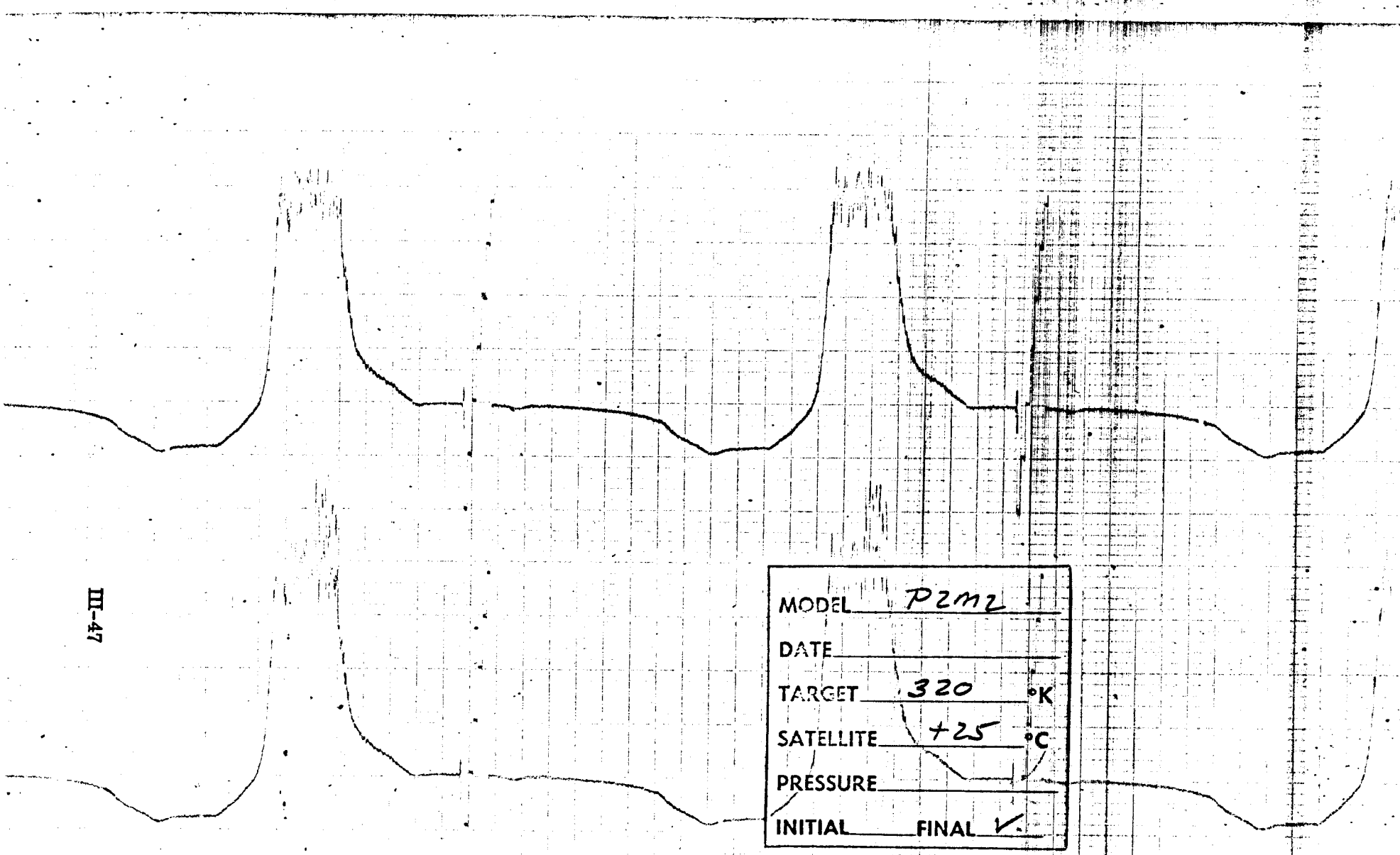

MODEL Pzm2
DATE
TARGET 270 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL ✓

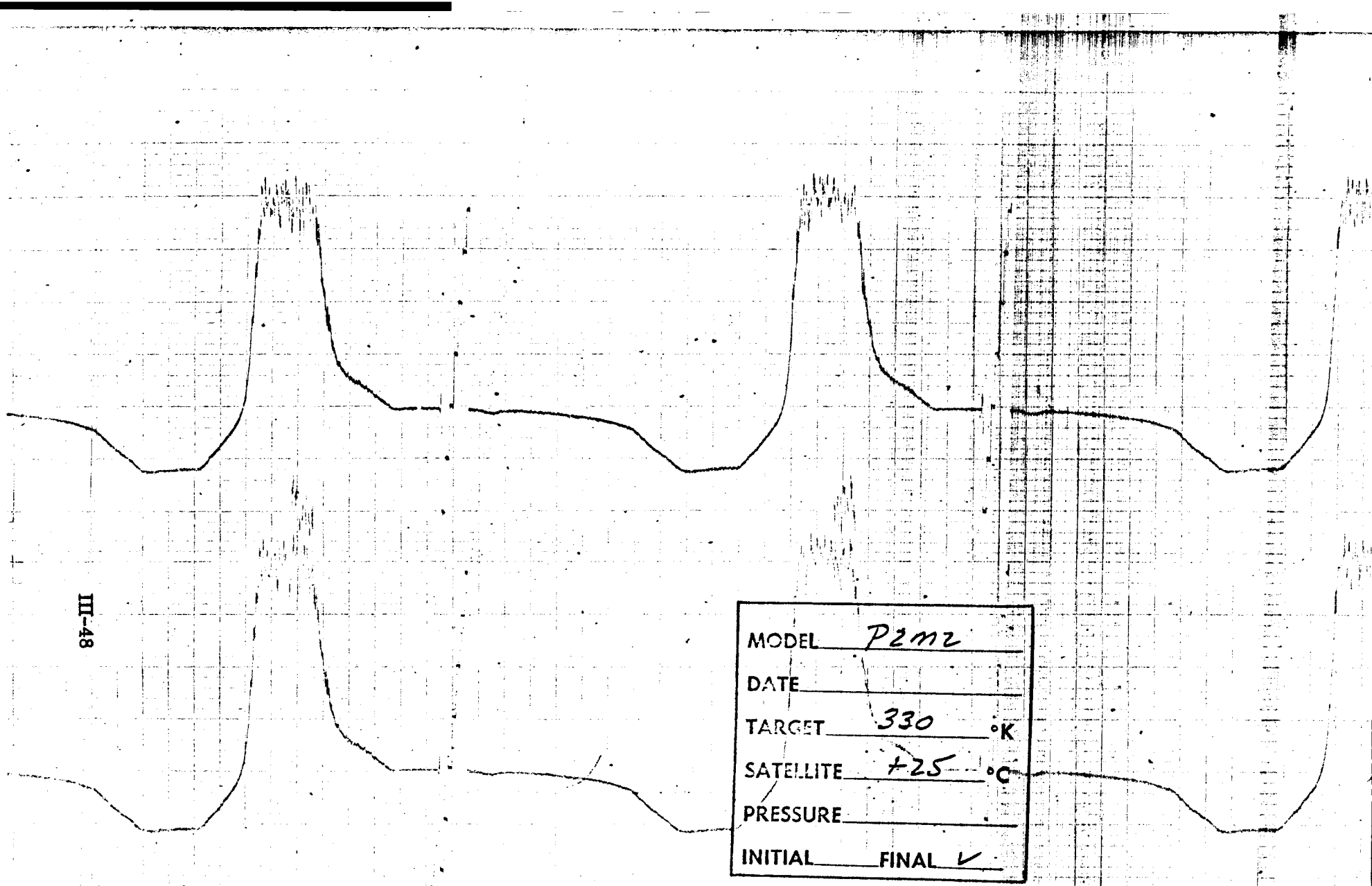

MODEL P2M2
DATE
TARGET 280 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL ✓

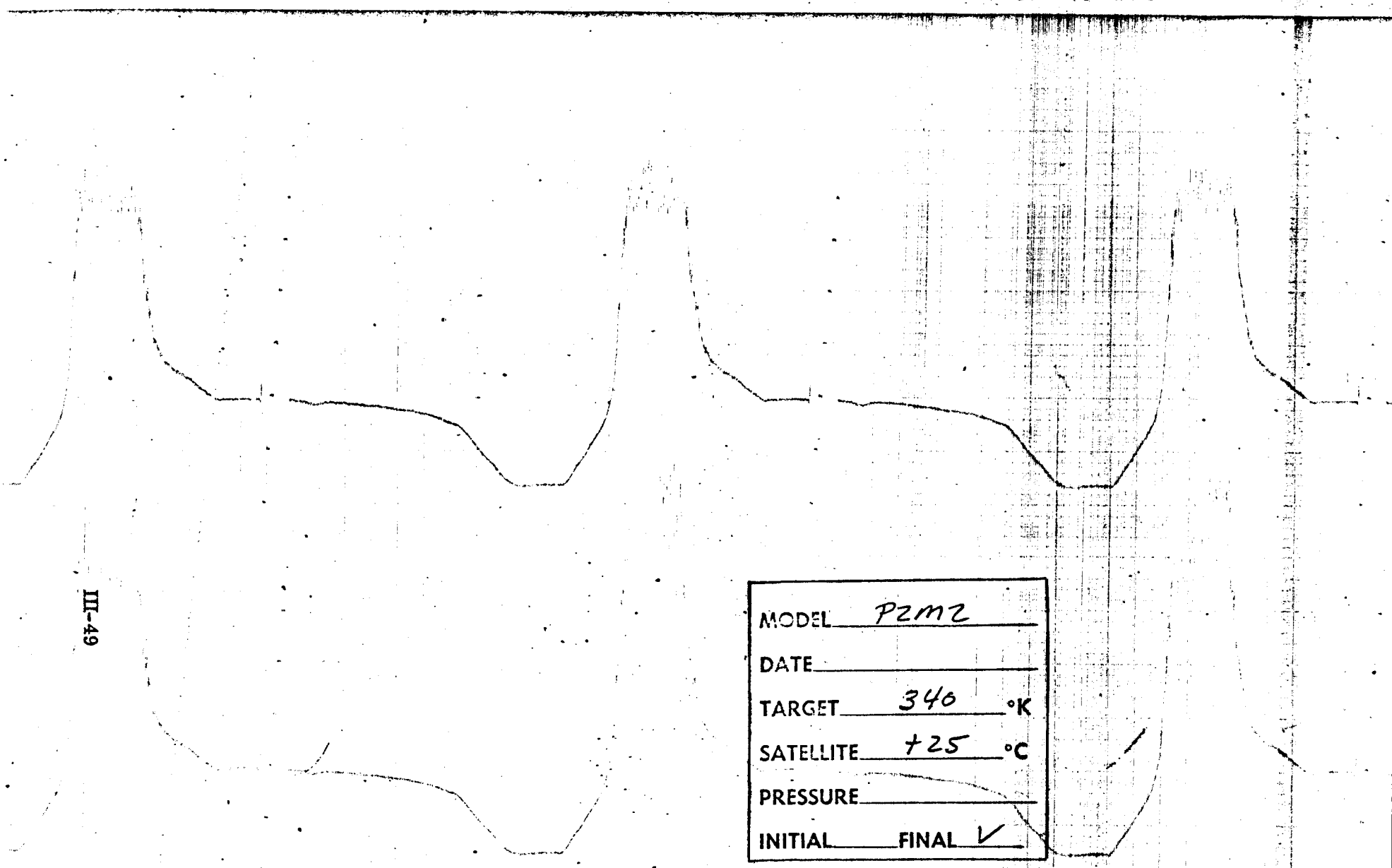

MODEL P2M2
DATE
TARGET 290 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL ✓

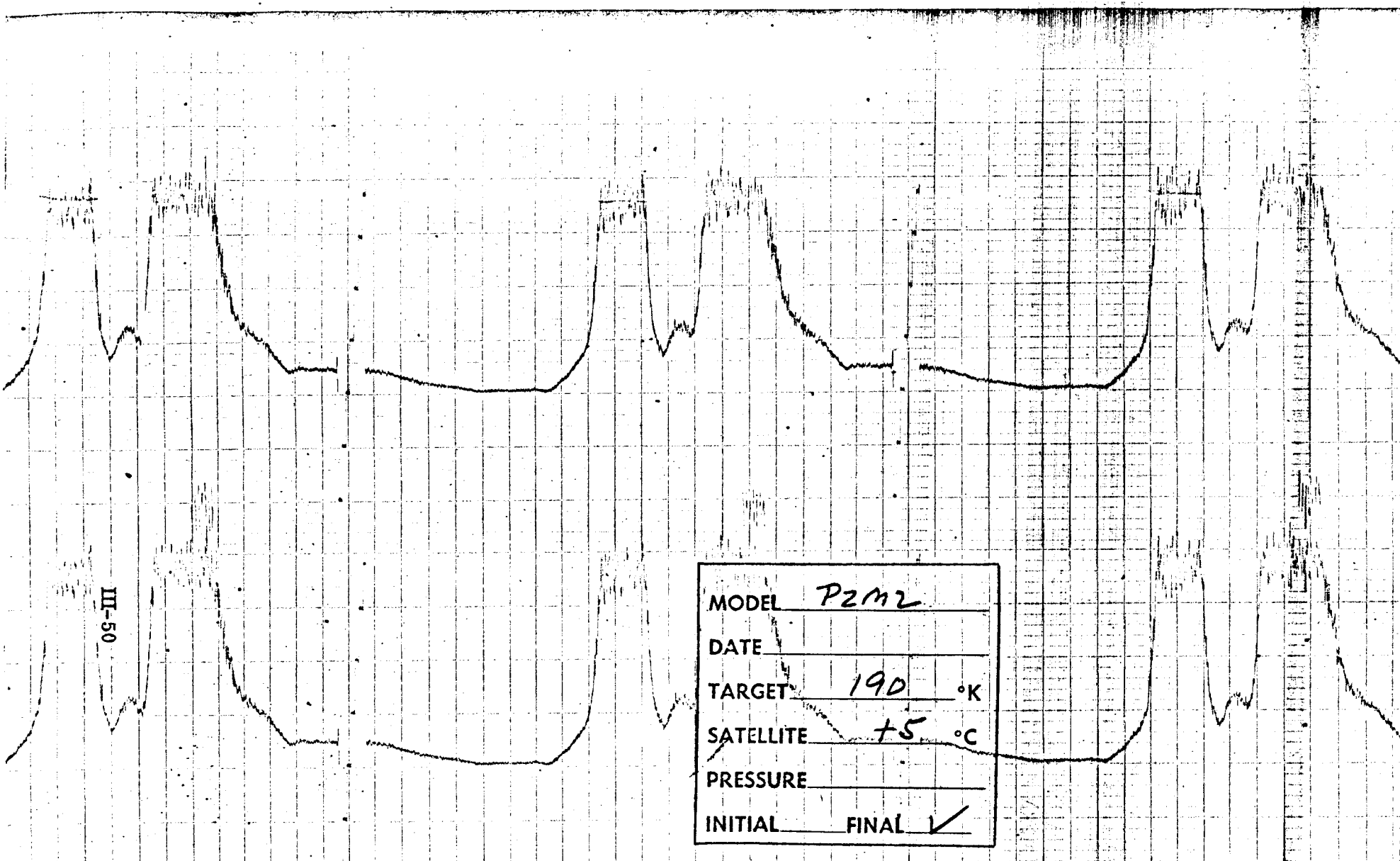

MODEL P2M2
DATE
TARGET 300 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL ✓

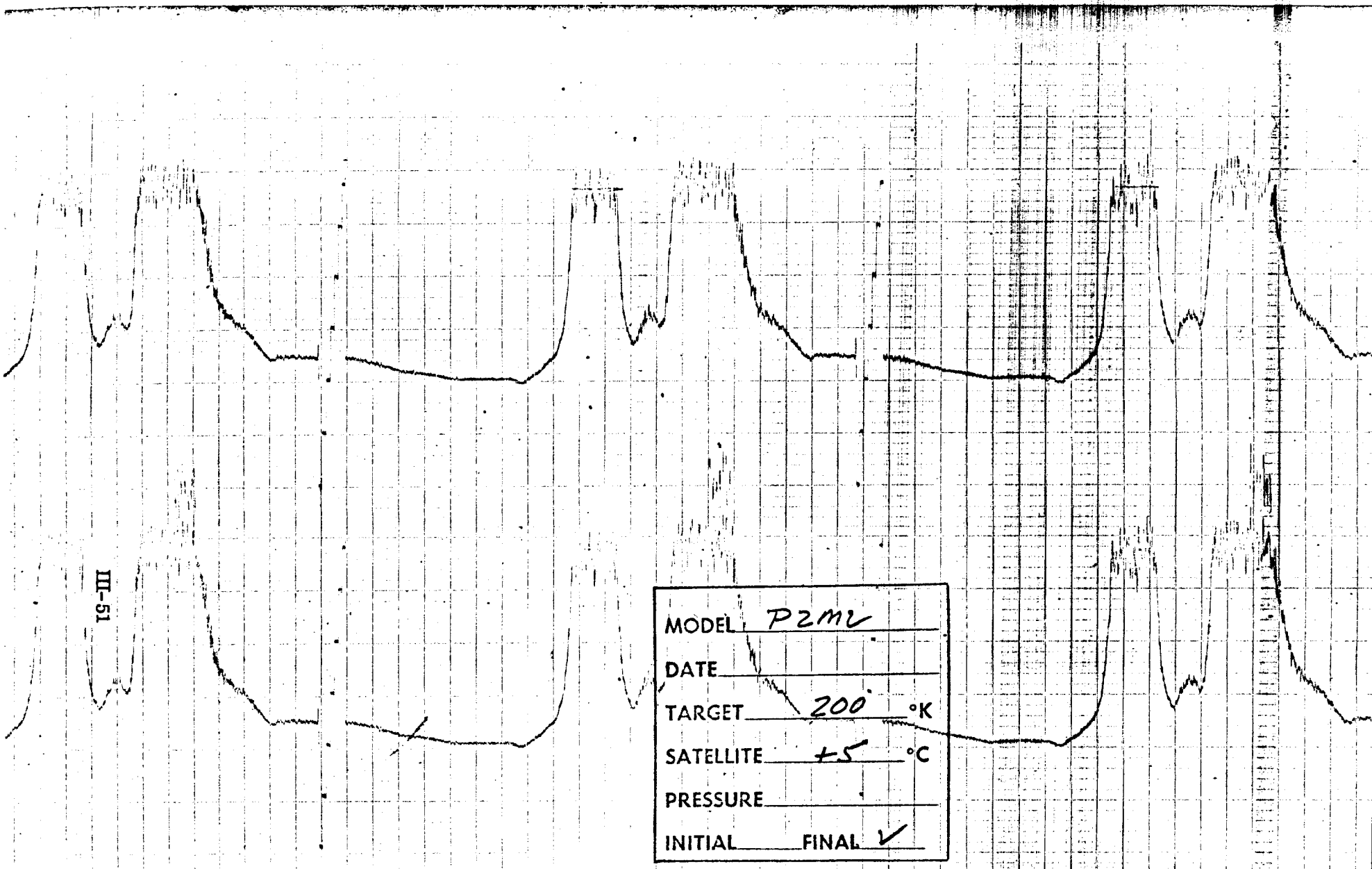

MODEL P2M2
DATE
TARGET 310 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL ✓

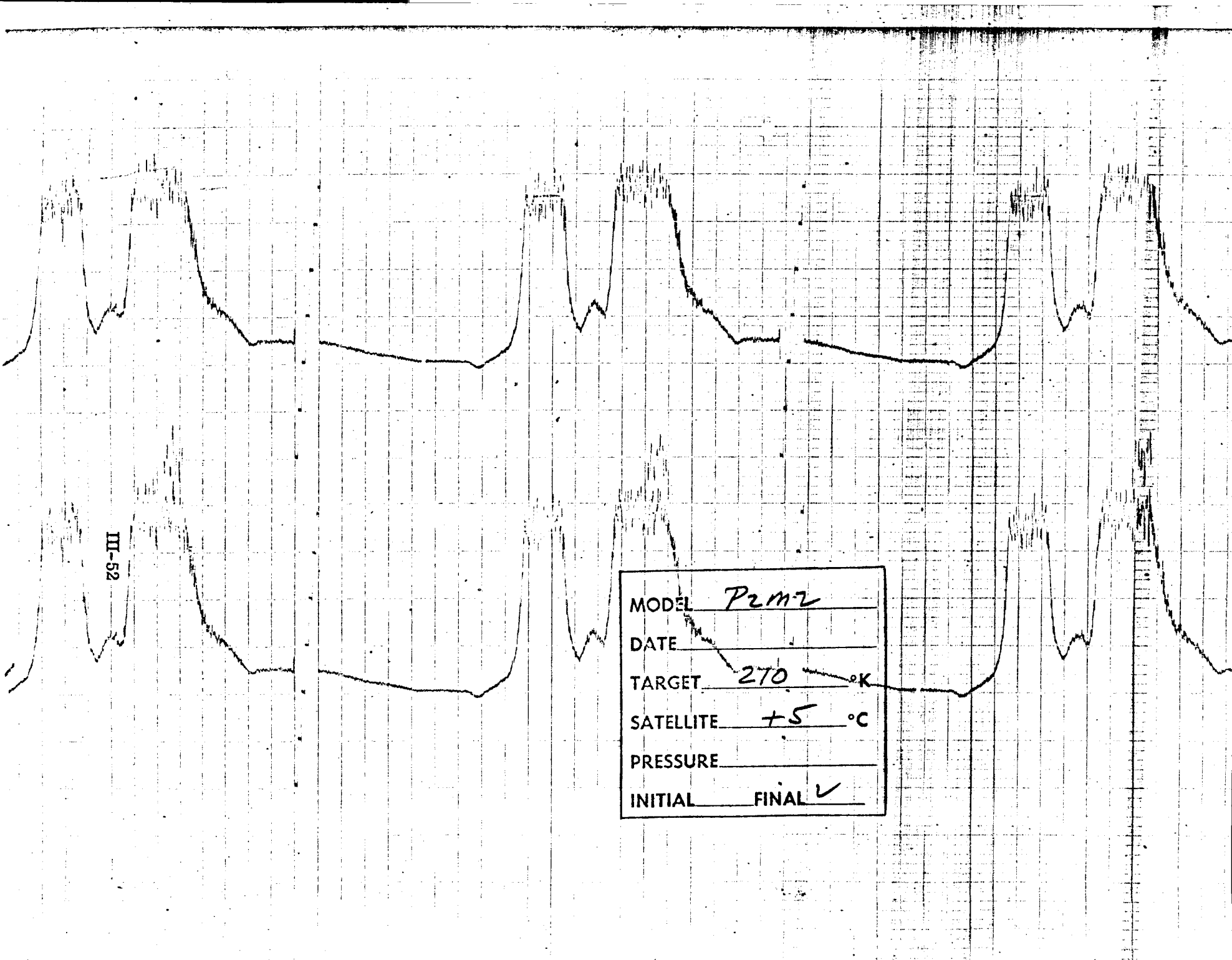

MODEL P2M2
DATE
TARGET 320 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL V.

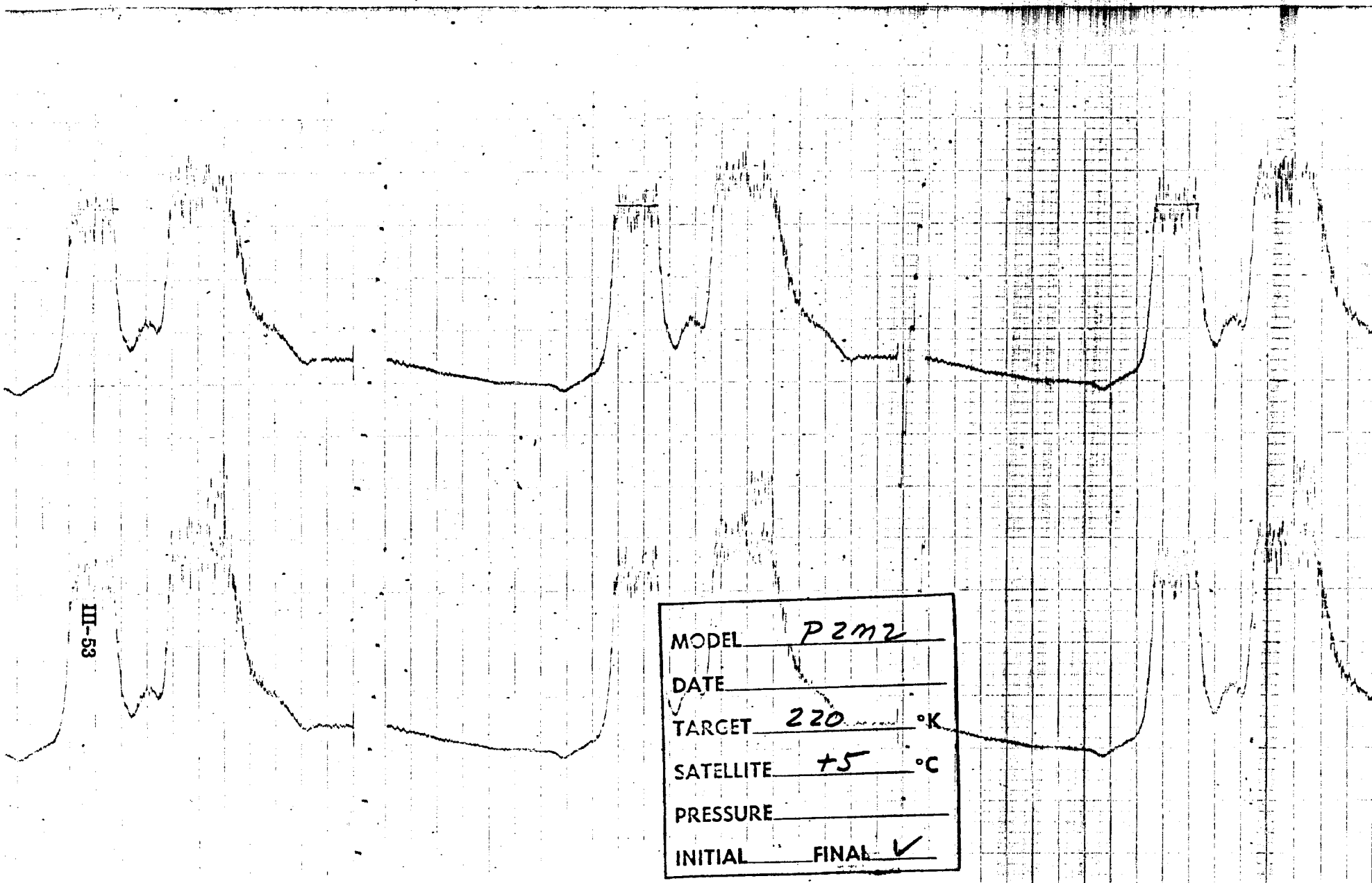

MODEL P2M2
DATE
TARGET 330 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL ✓

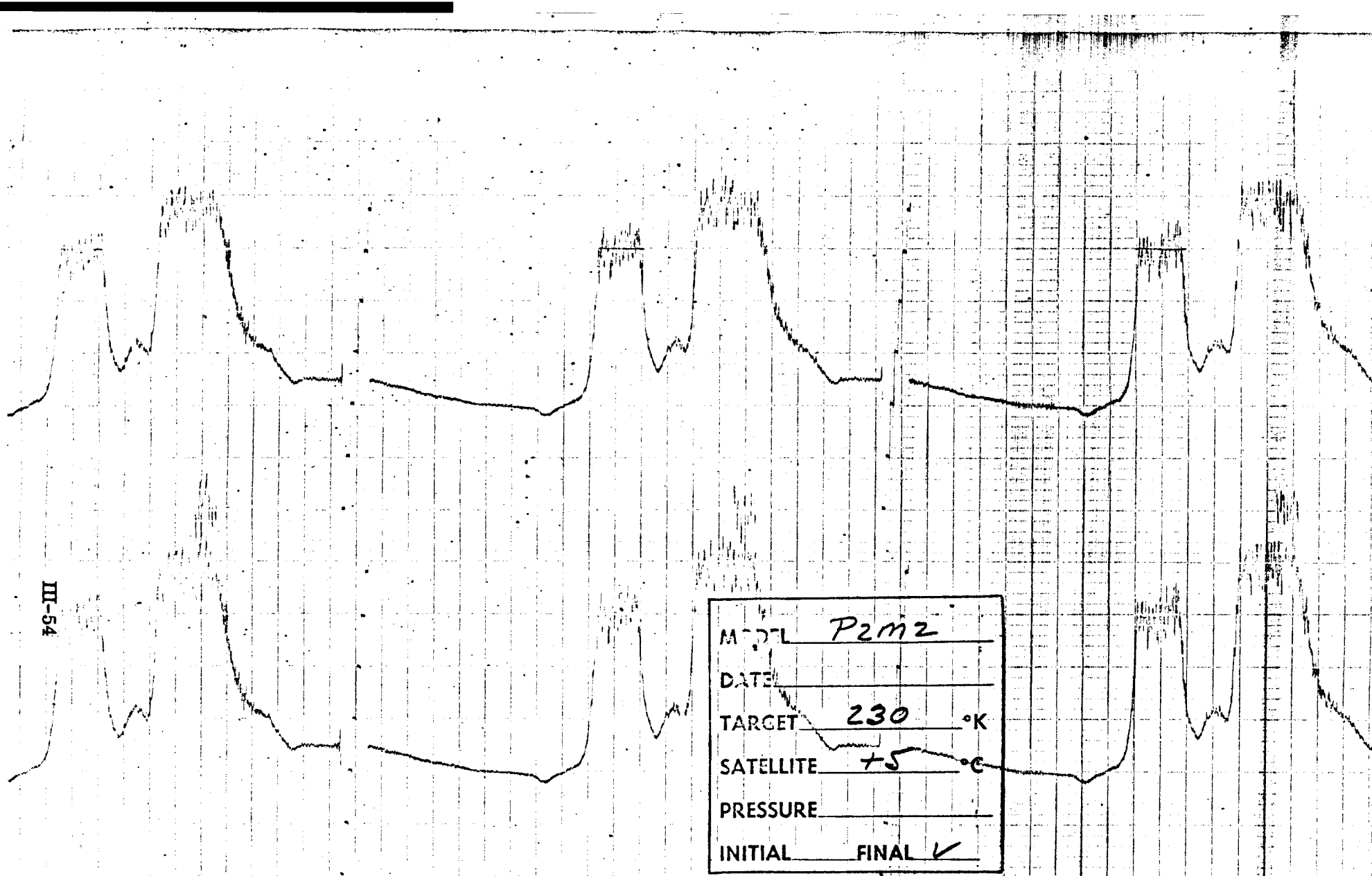

MODEL PZM2
DATE
TARGET 340 °K
SATELLITE +25 °C
PRESSURE
INITIAL FINAL V

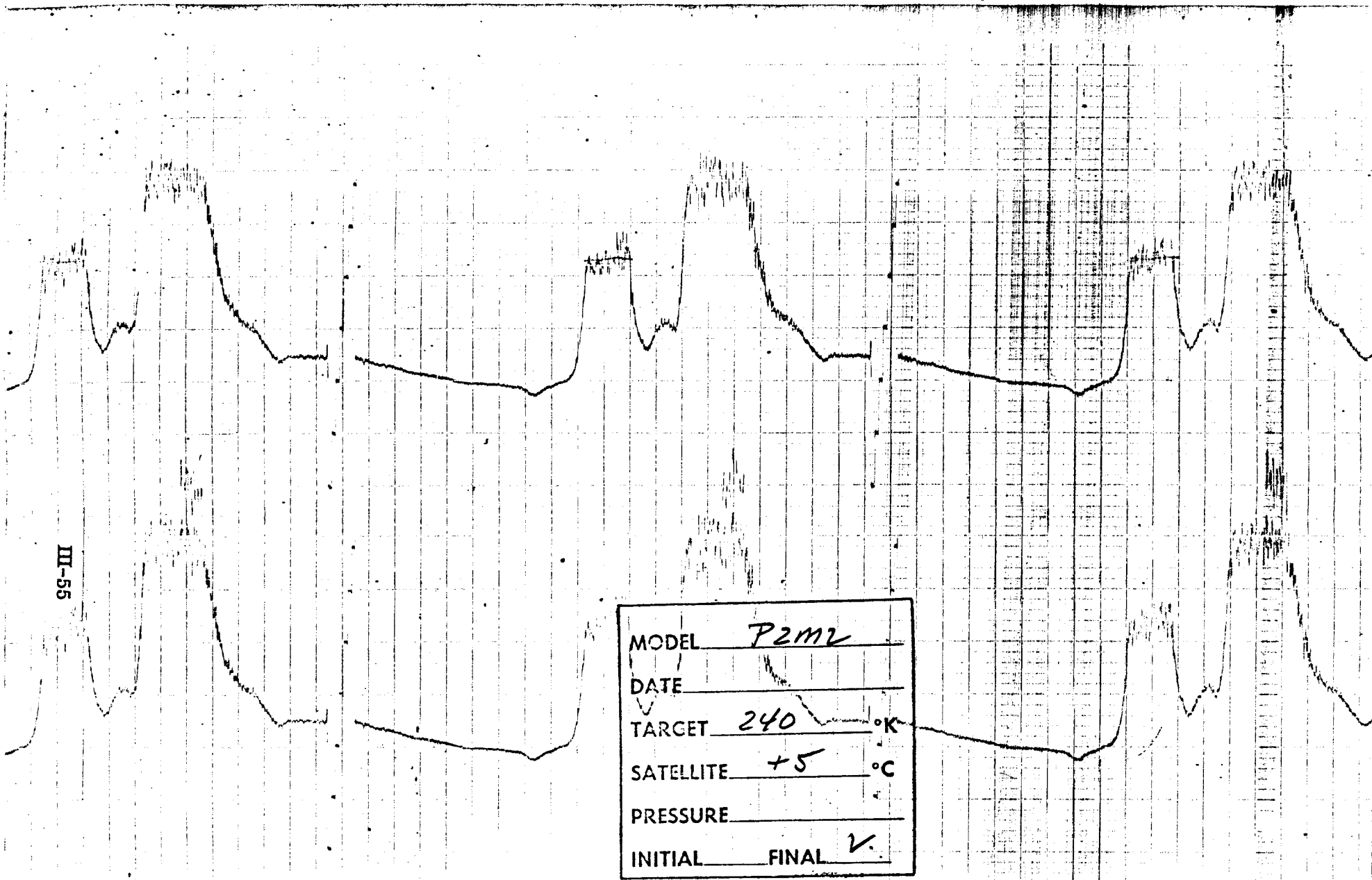

MODEL PZM2
DATE
TARGET 190 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

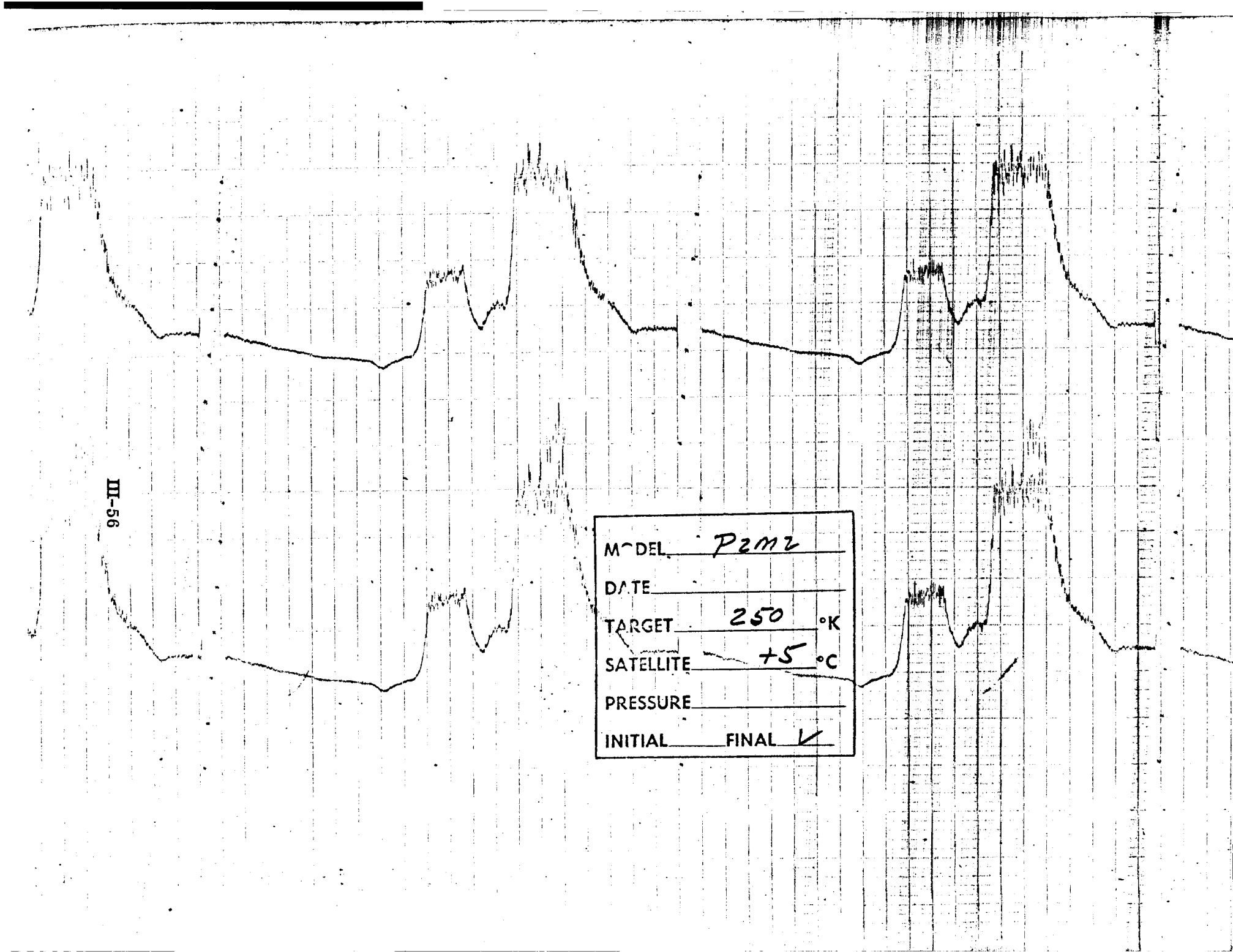

MODEL P2M2
DATE
TARGET 200° °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

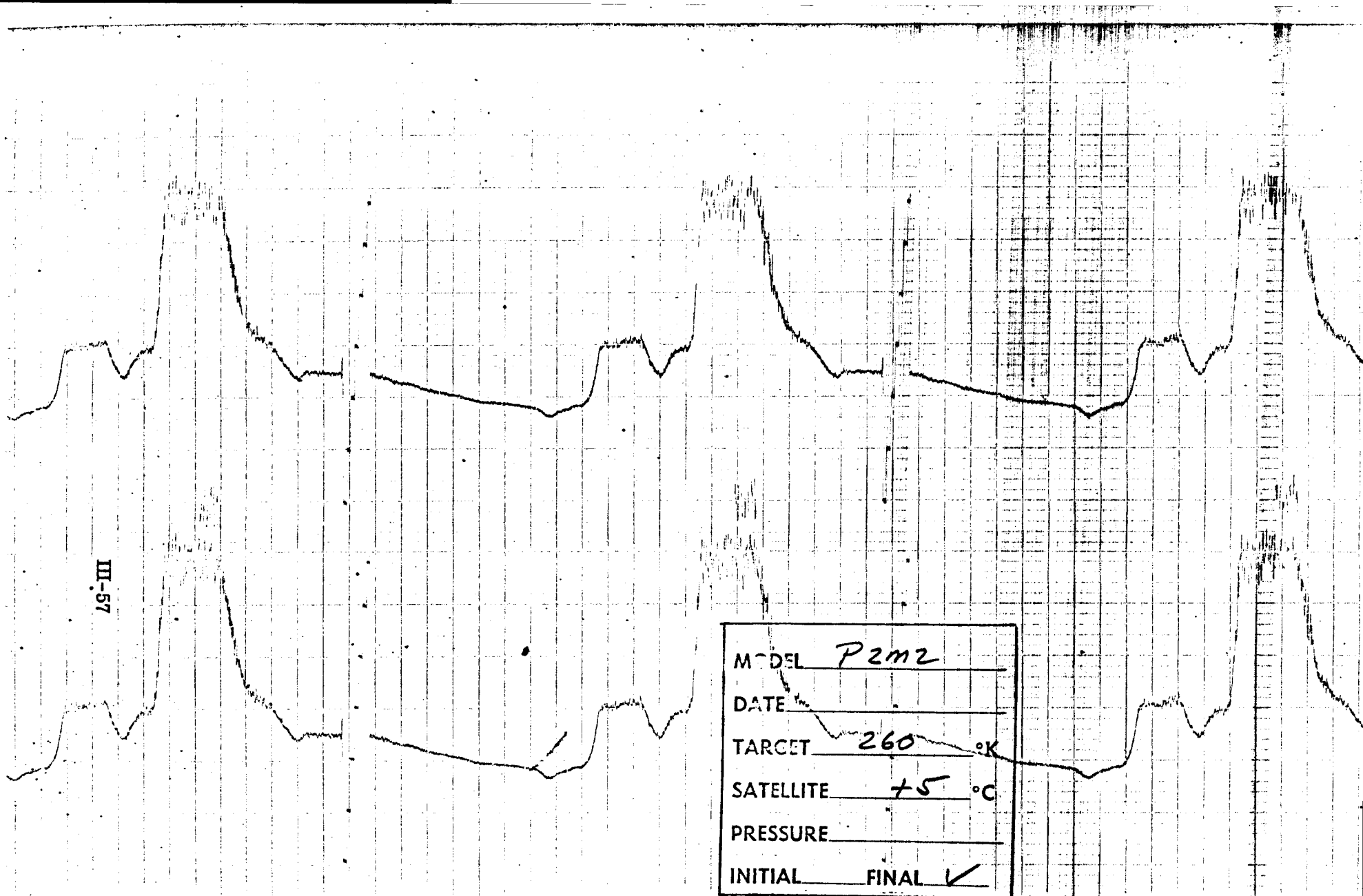

III-52
MODEL P2M2
DATE
TARGET 270 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

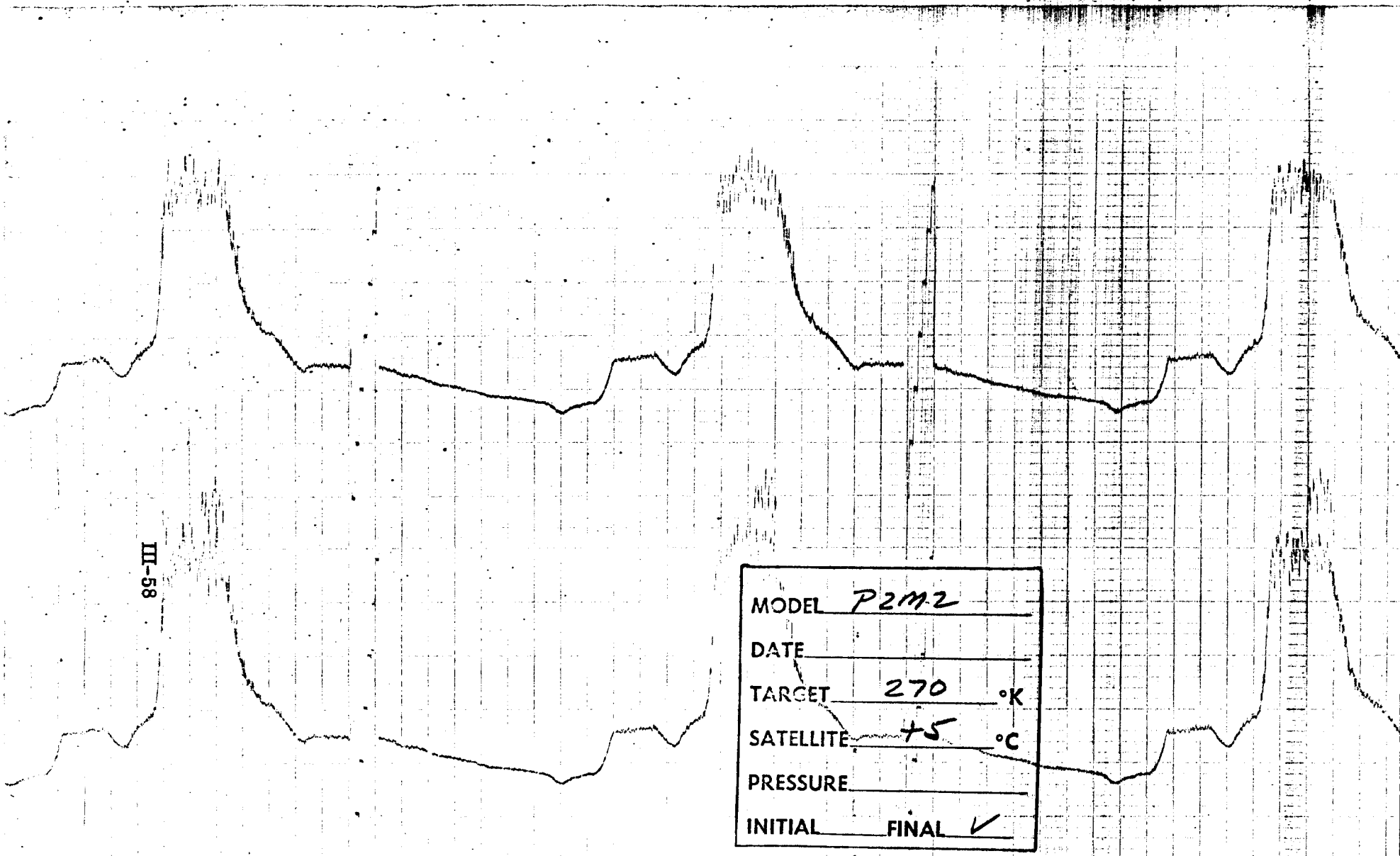

MODEL P2N2
DATE
TARGET 220 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

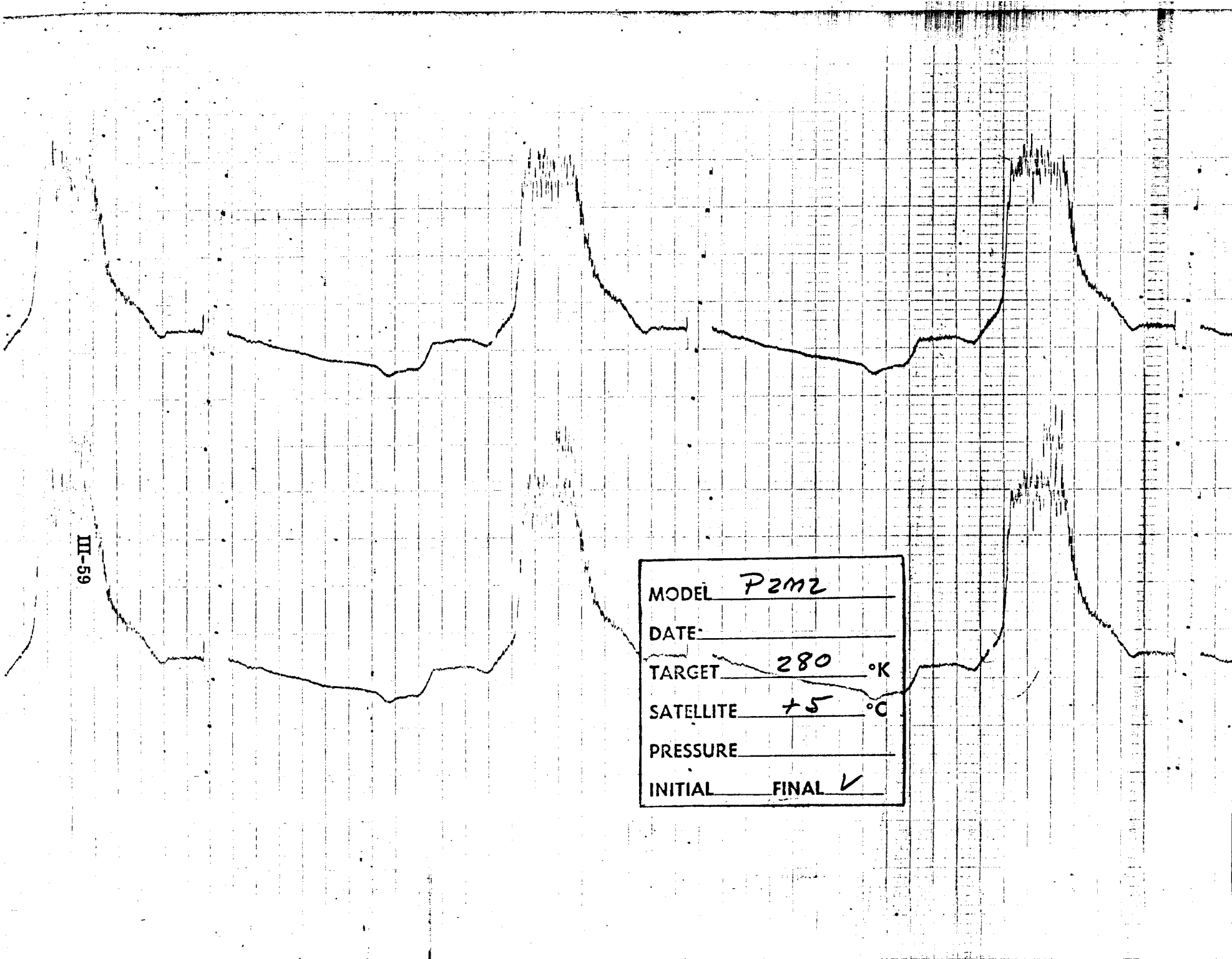

MODEL P2M2
DATE
TARGET 230 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

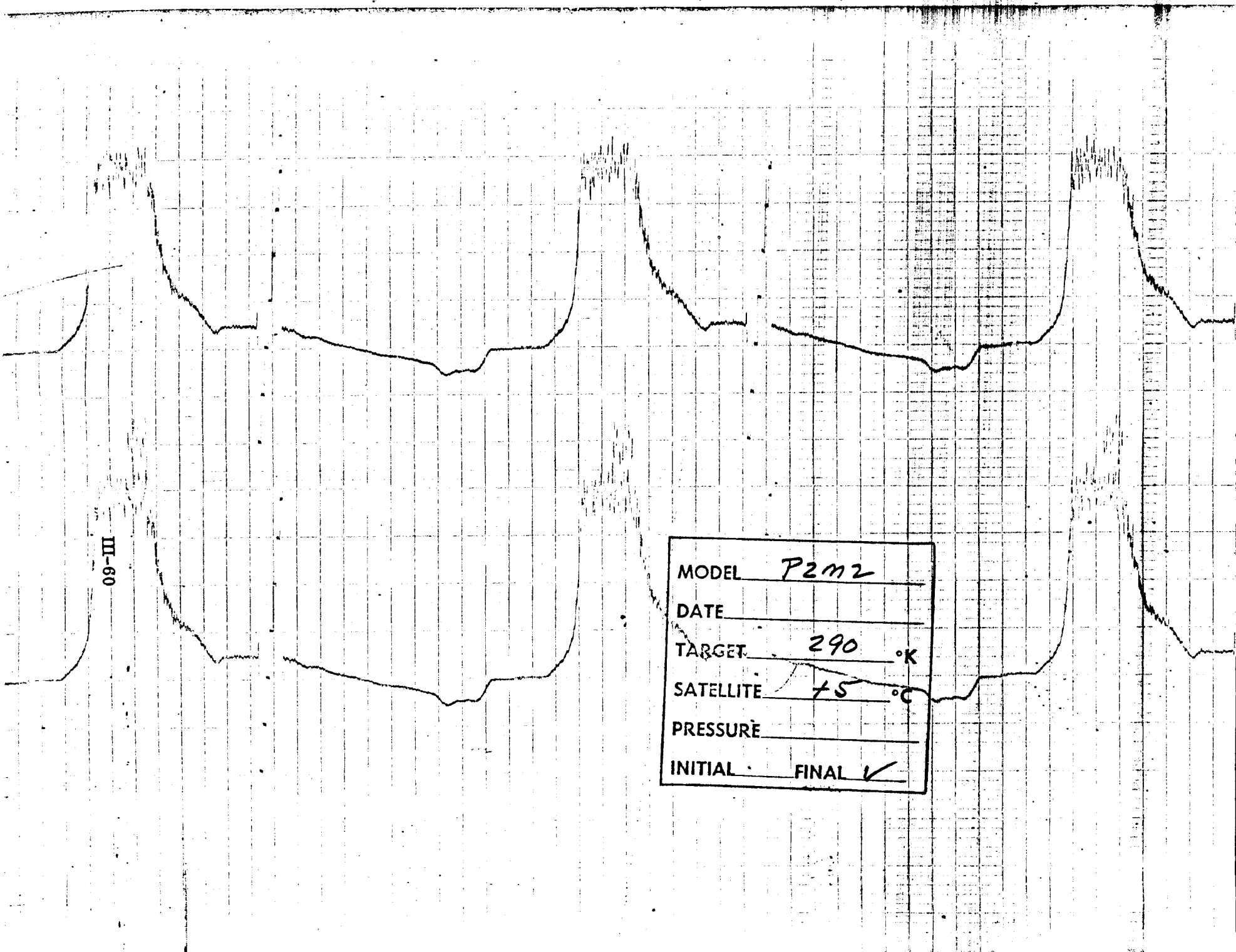

MODEL P2M2
DATE
TARGET 240 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL V.

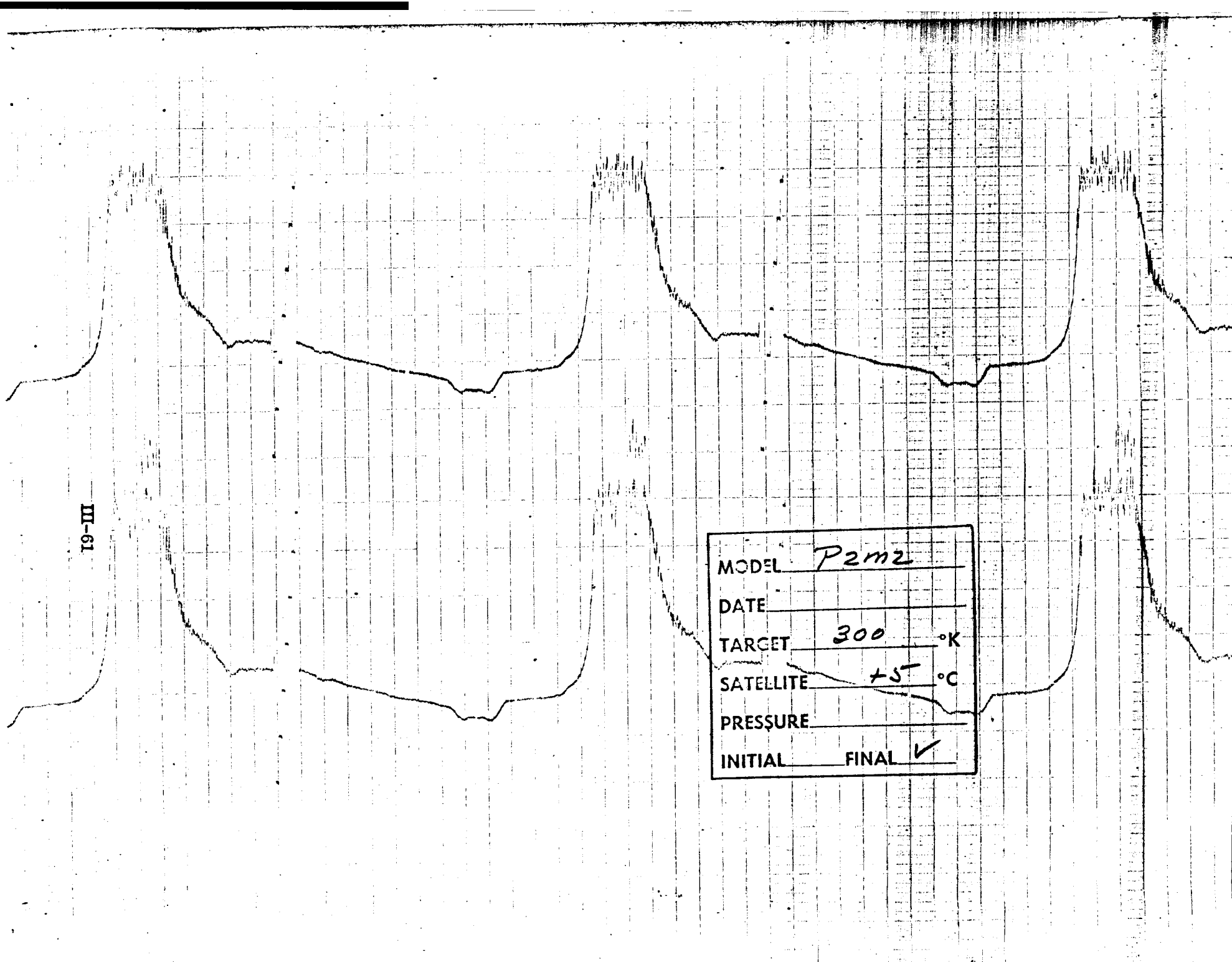

MODEL P2M2
DATE
TARGET 250 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL

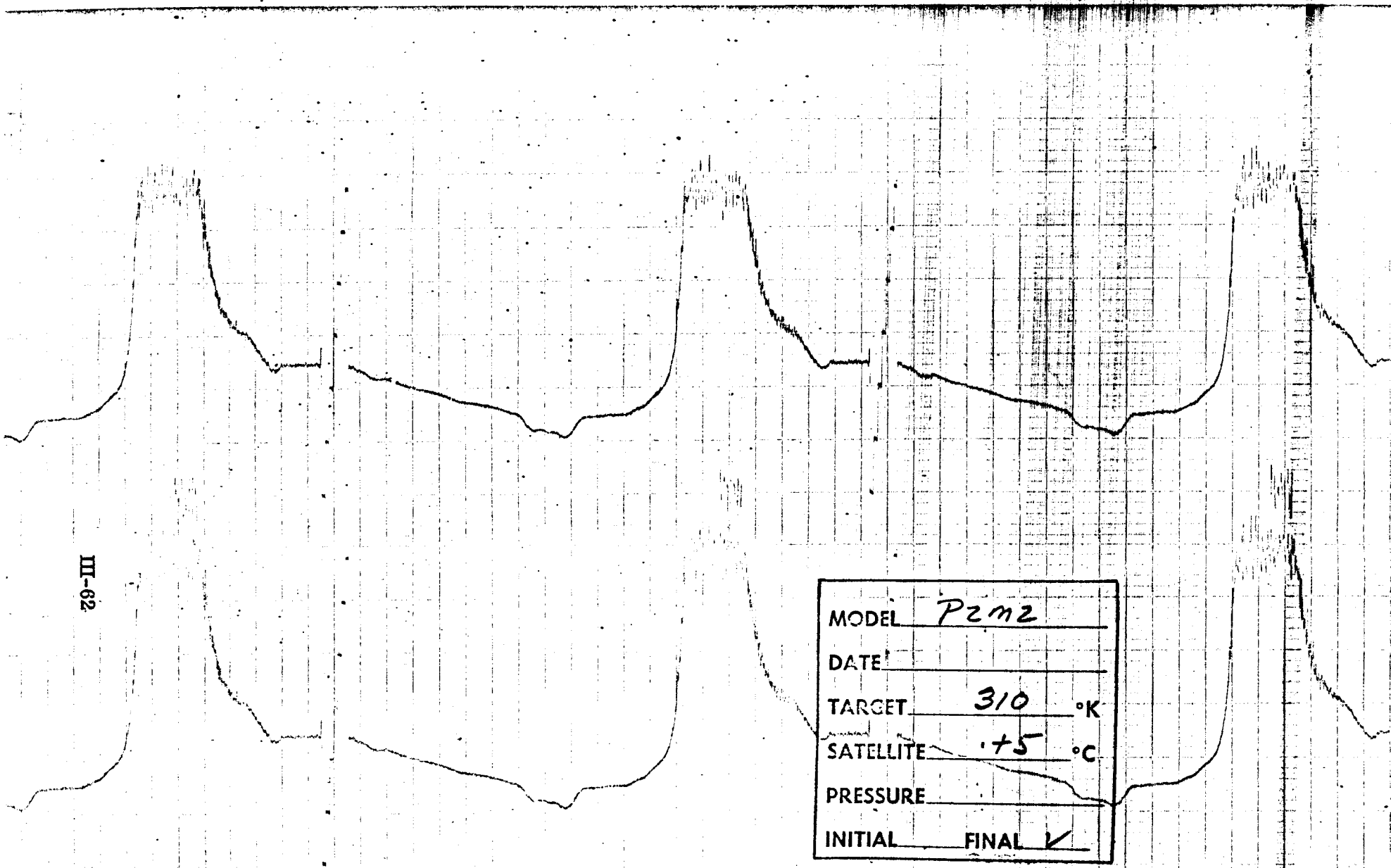

MODEL P2M2
DATE
TARGET 260 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

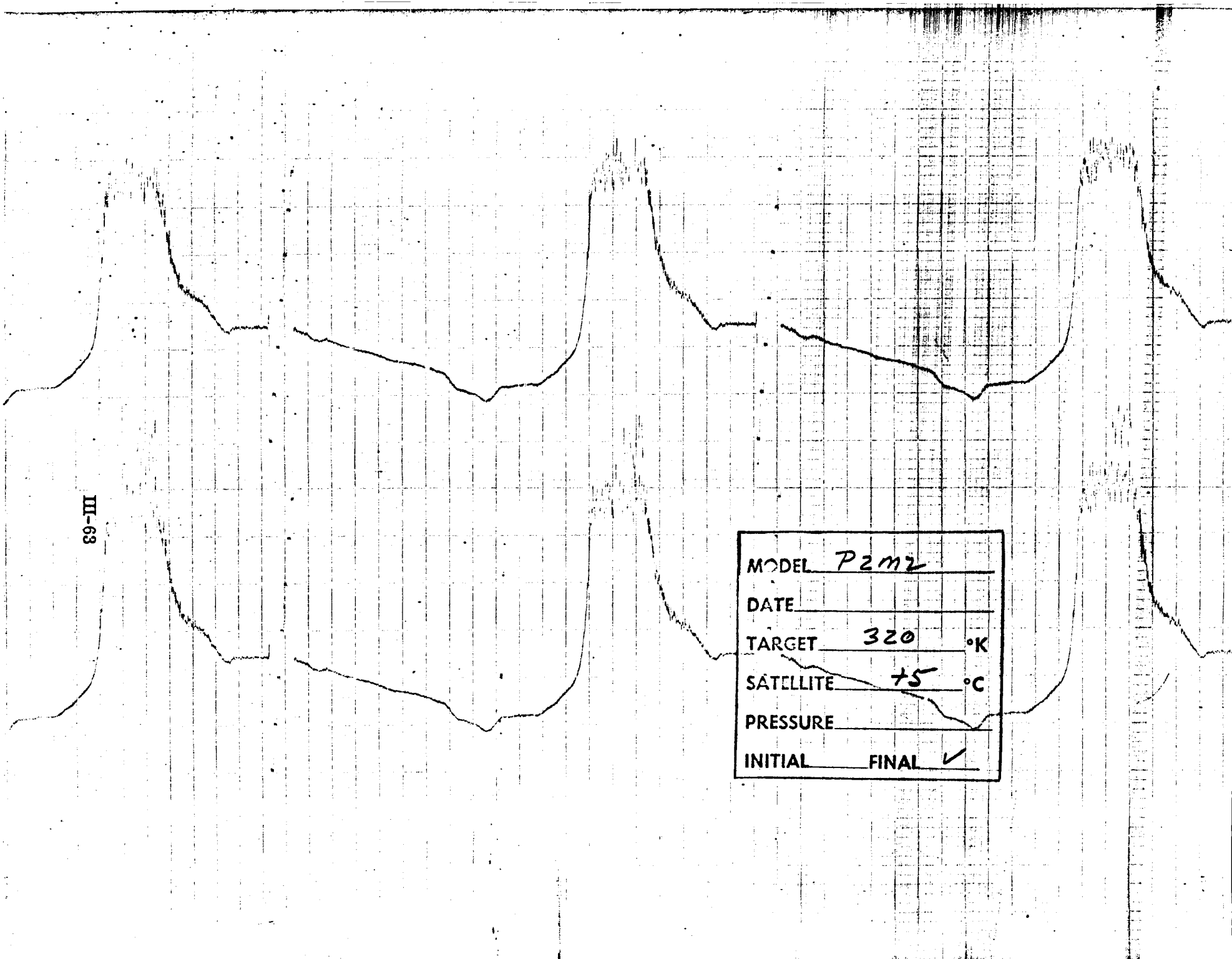

MODEL P2M2
DATE
TARGET 270 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

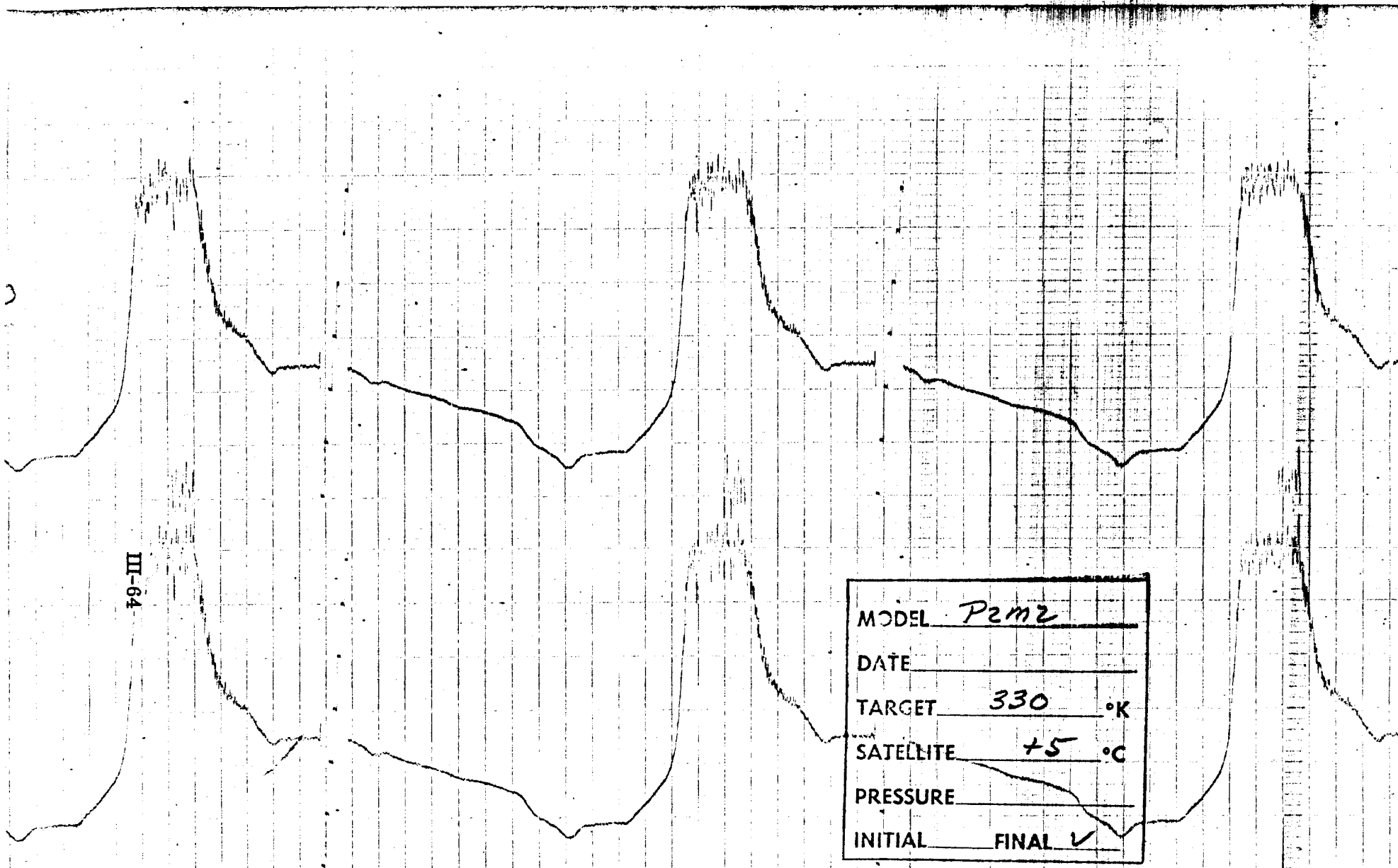

MODEL P2M2
DATE
TARGET 280 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

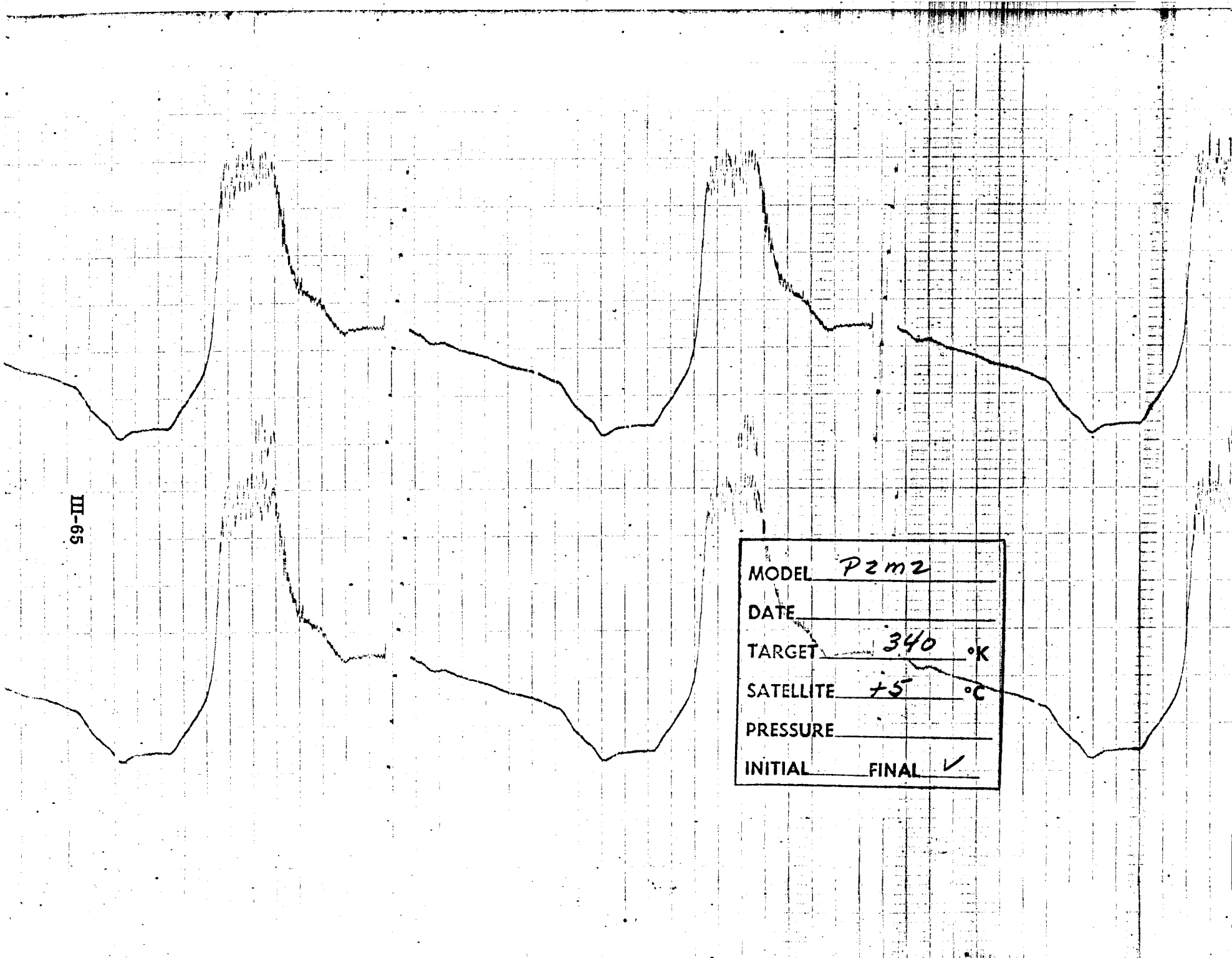

MODEL P2m2
DATE
TARGET 290 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

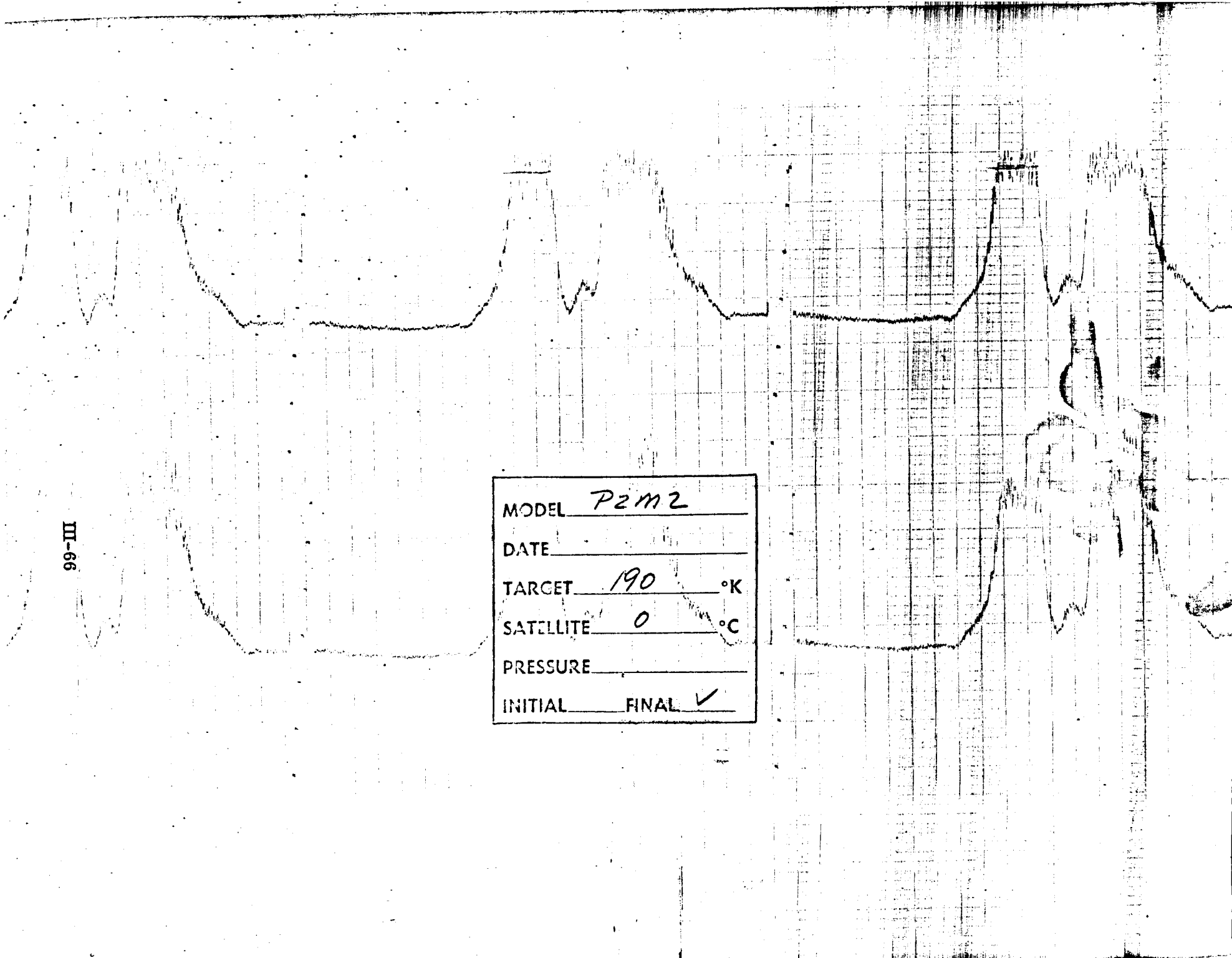

MODEL P2M2
DATE
TARGET 300 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

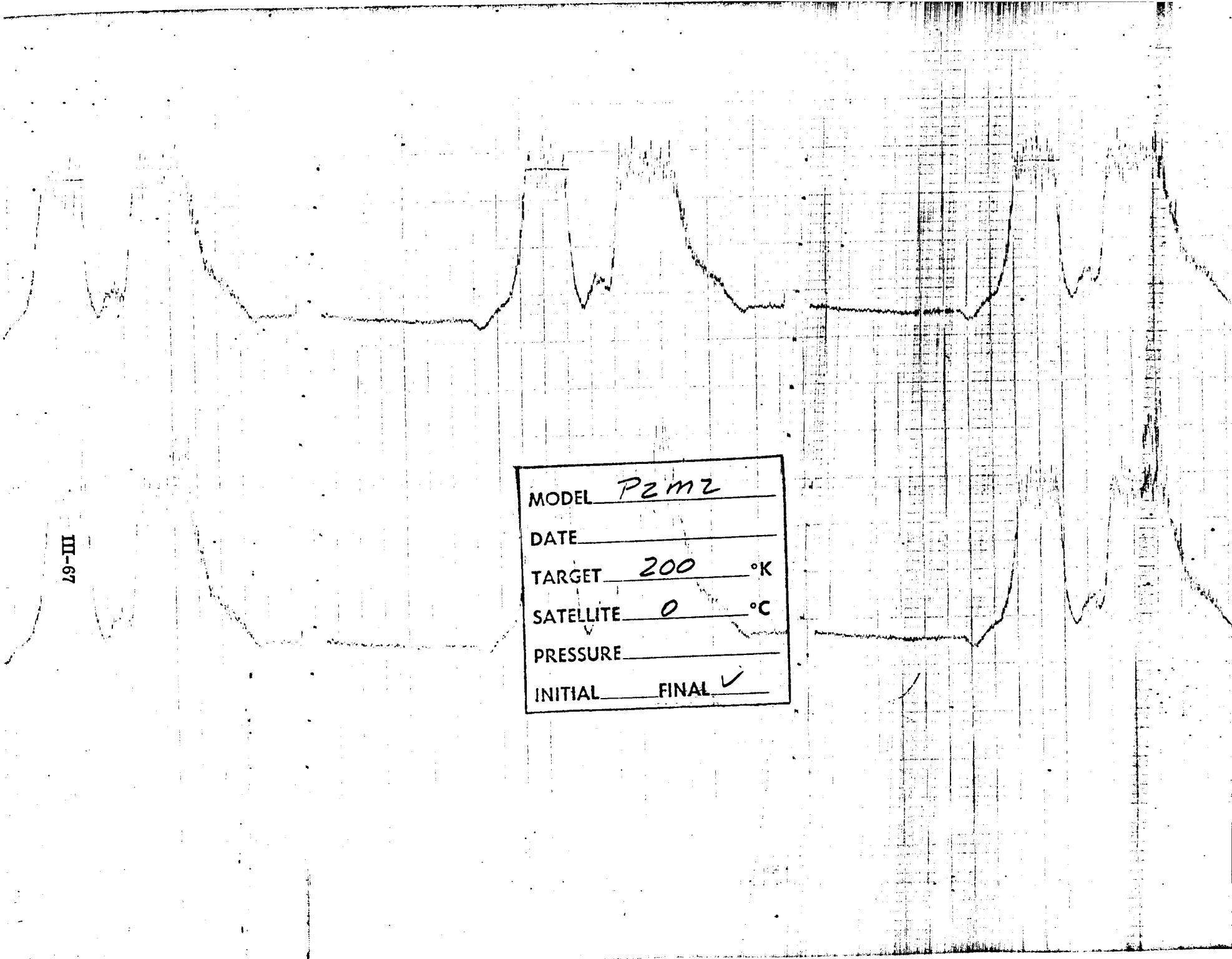

MODEL Pzm2
DATE
TARGET 310 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

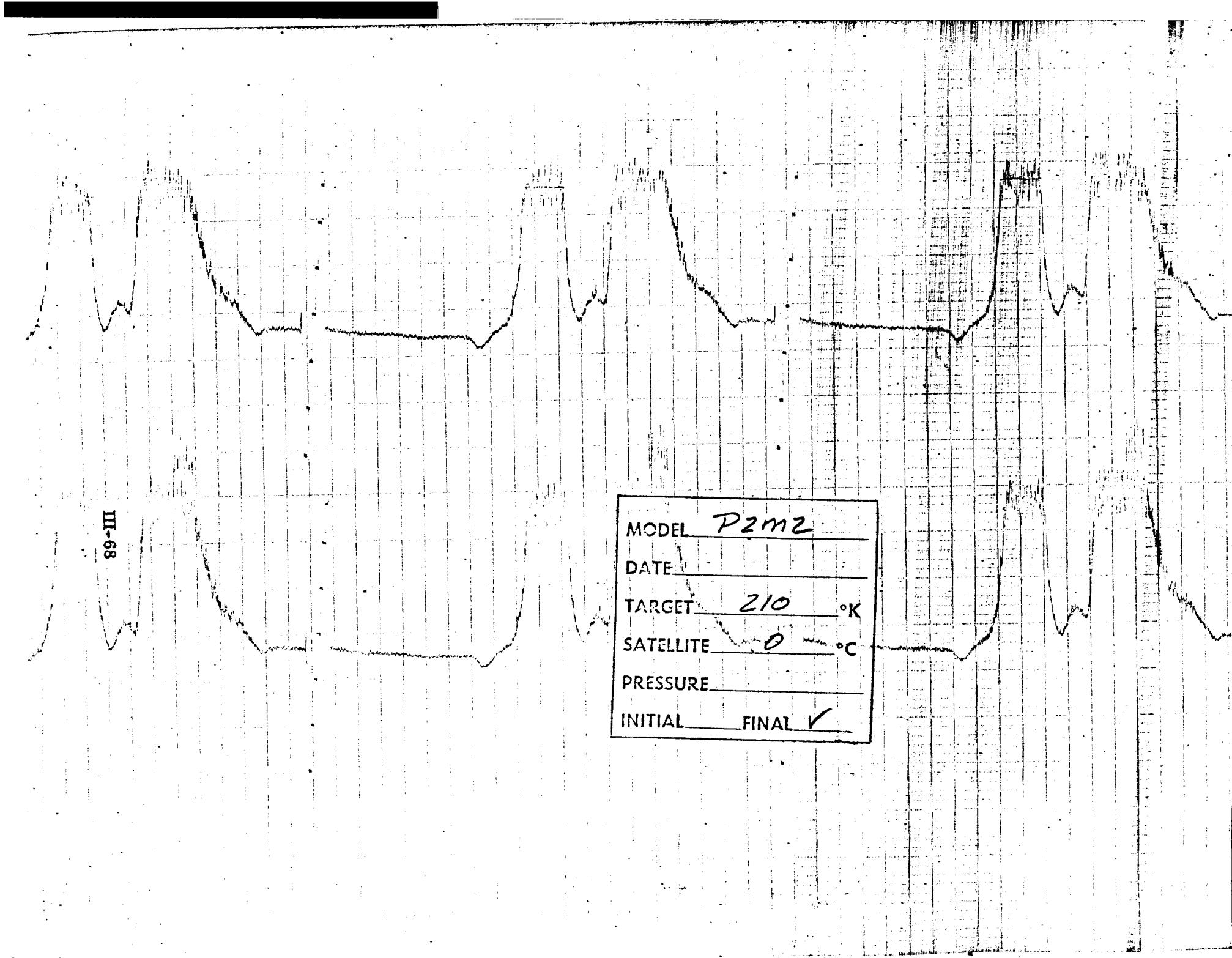

MODEL P2M2
DATE
TARGET 320 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

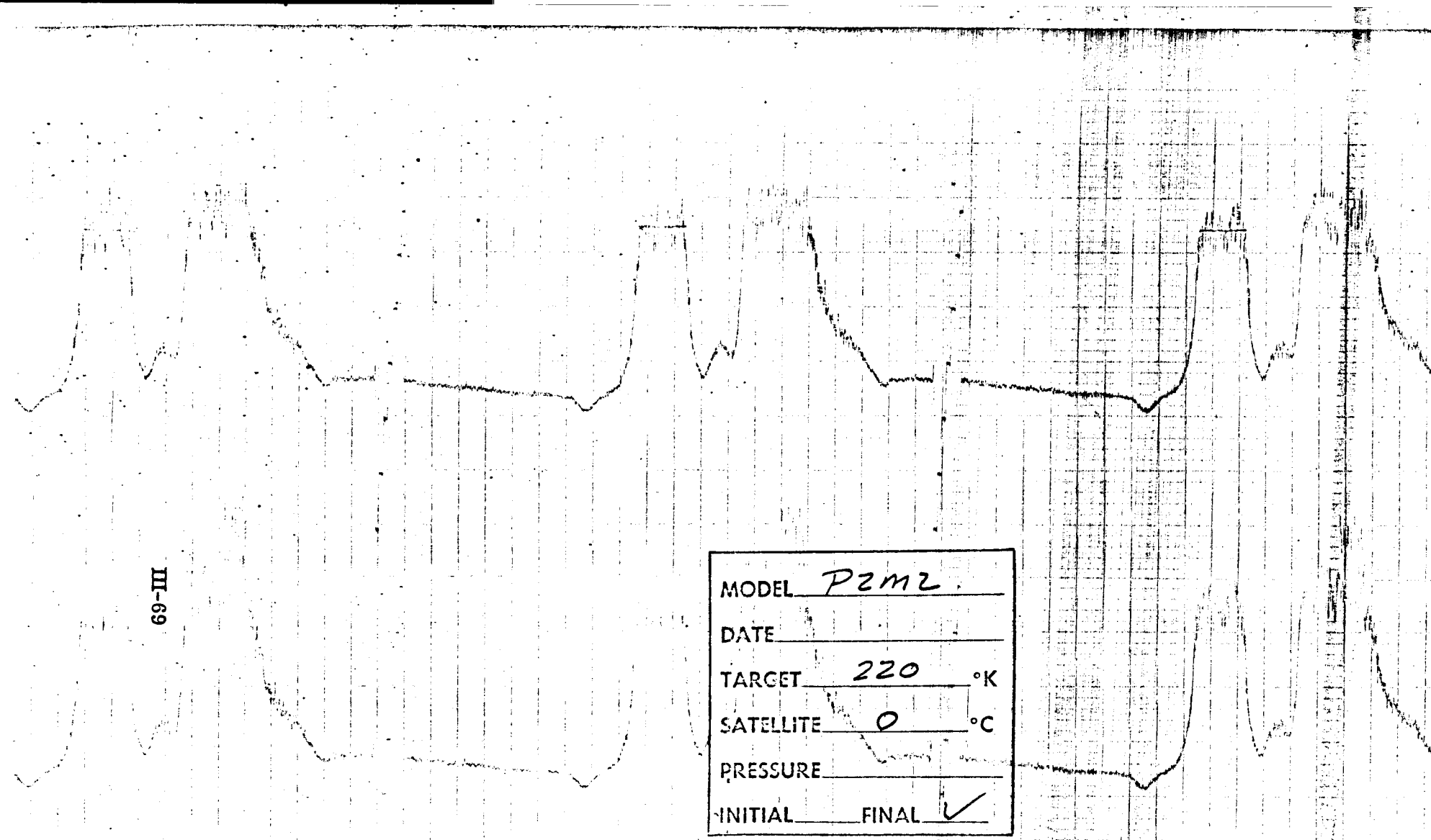

III-64
MODEL P2M2
DATE
TARGET 330 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

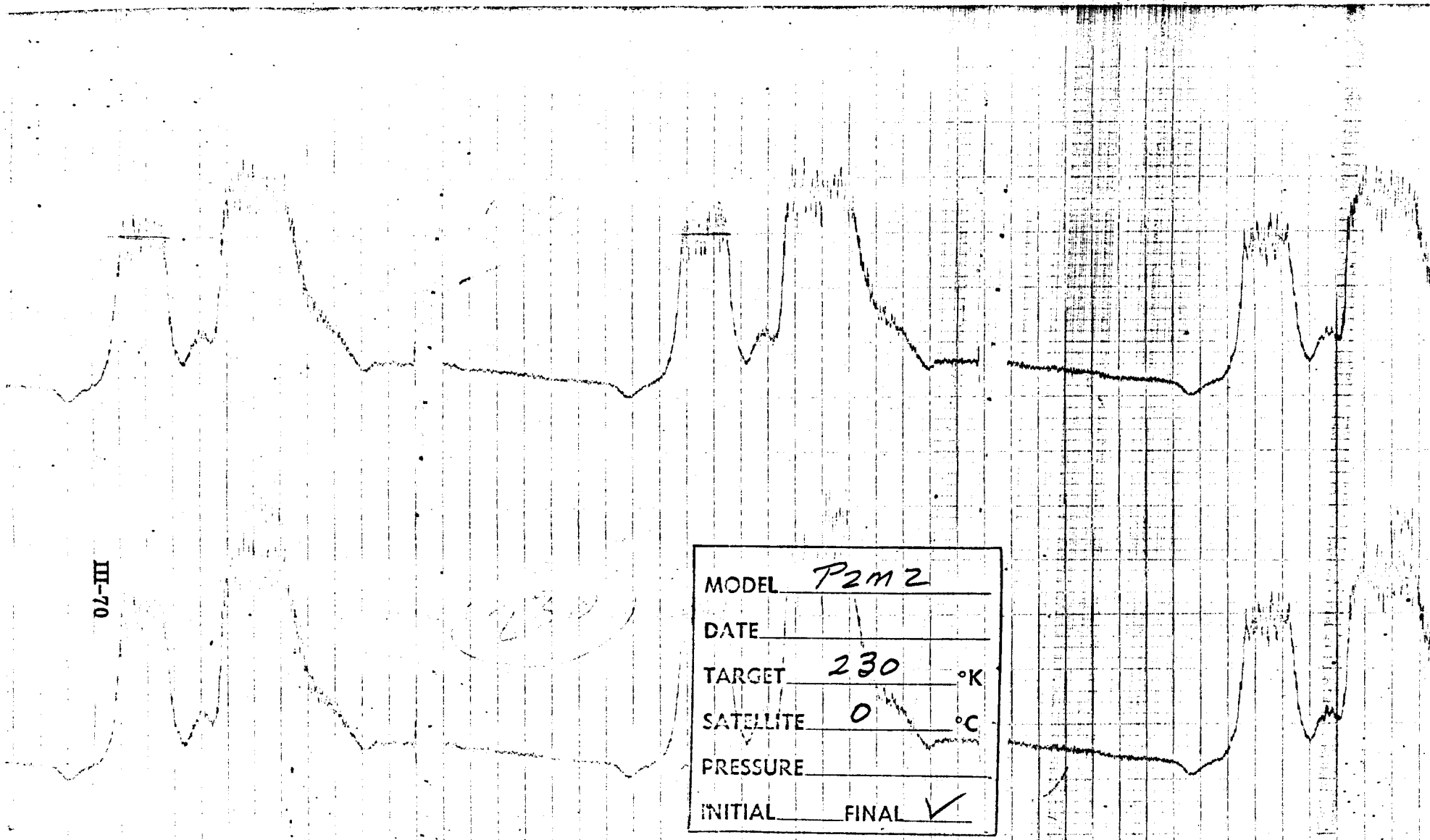

MODEL Pzm2
DATE
TARGET 340 °K
SATELLITE +5 °C
PRESSURE
INITIAL FINAL ✓

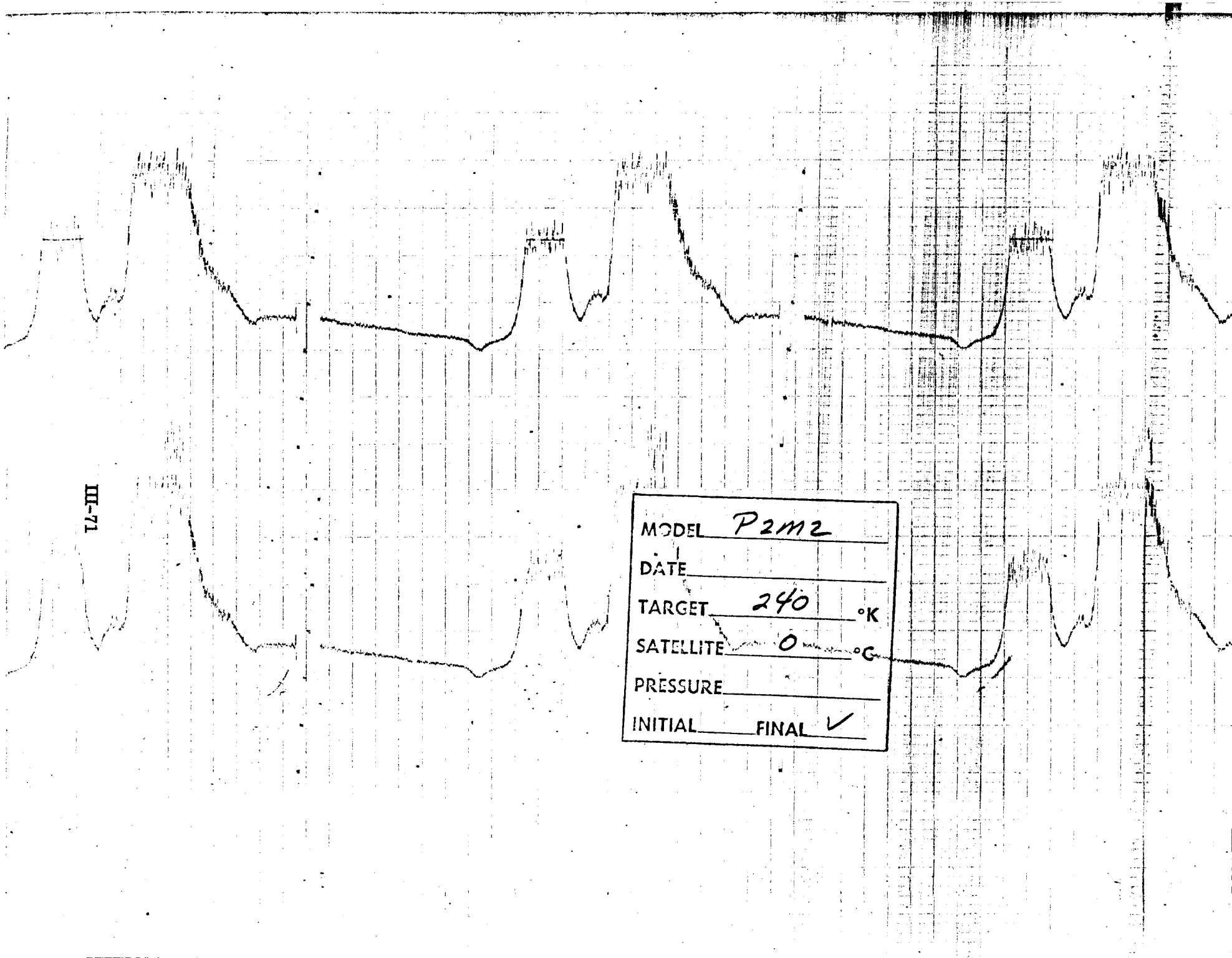

MODEL Pzm2
DATE
TARGET 190 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓

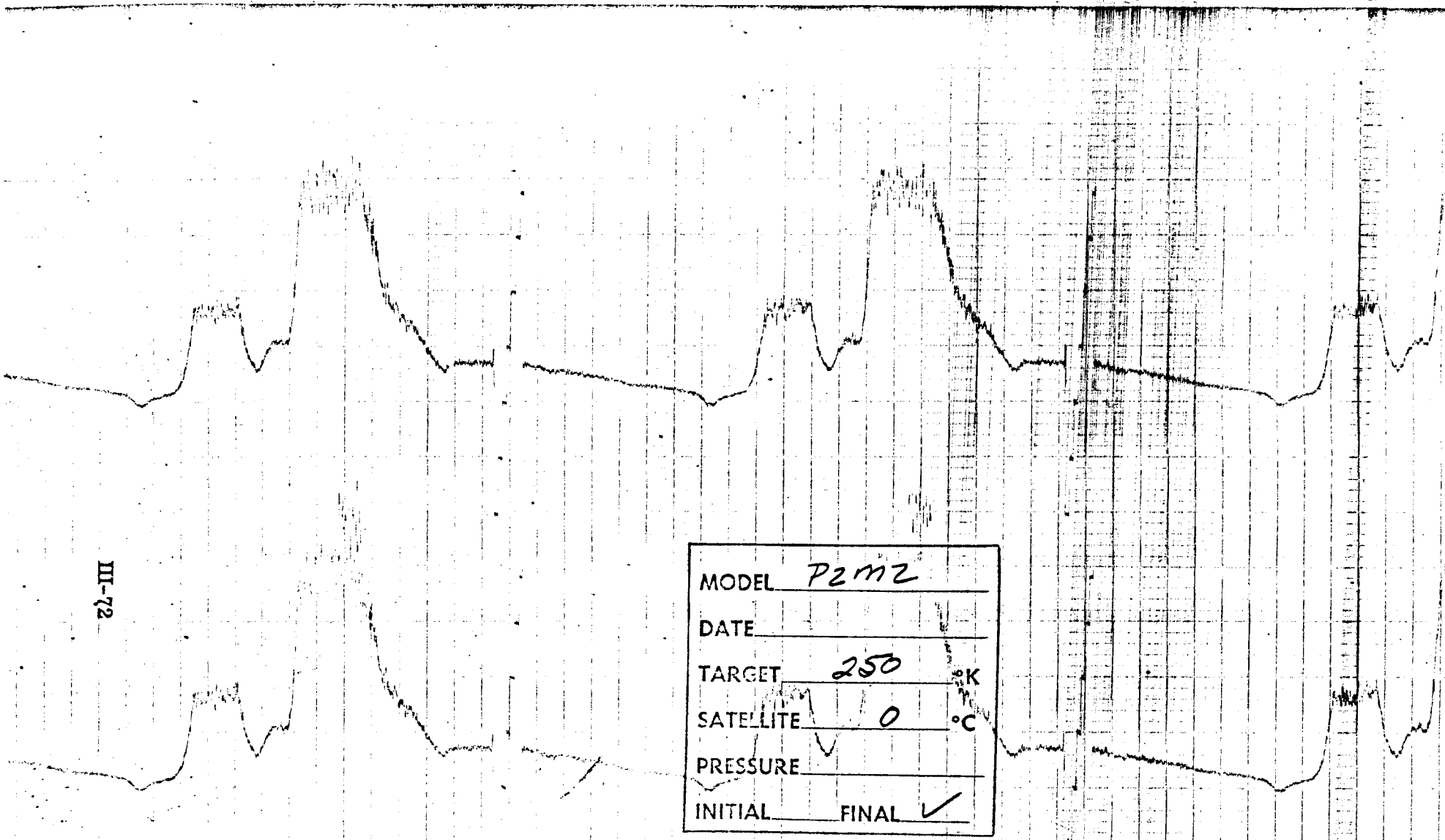

MODEL Pzm2
DATE
TARGET 200 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓

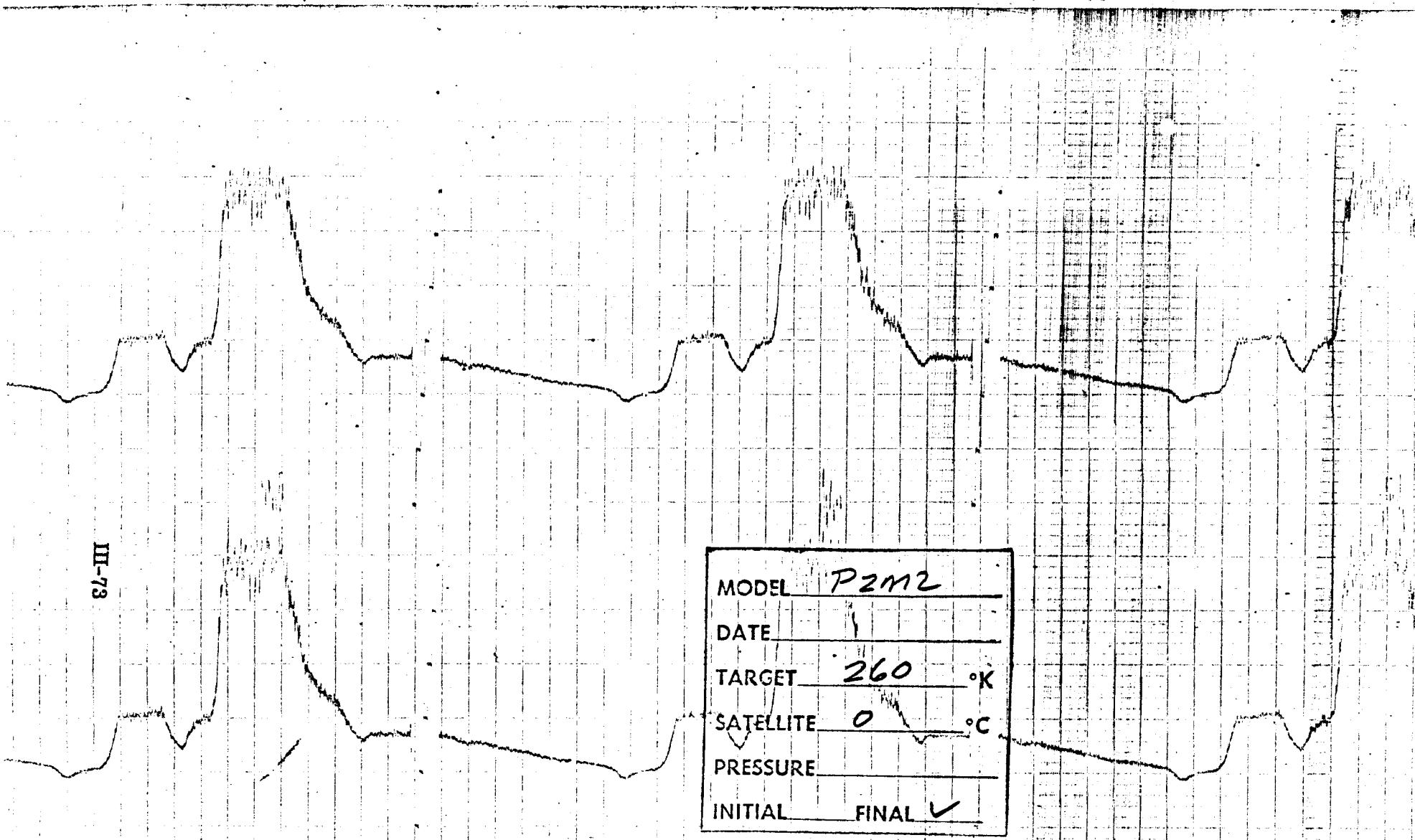

III-68
MODEL P2M2
DATE
TARGET 210 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓

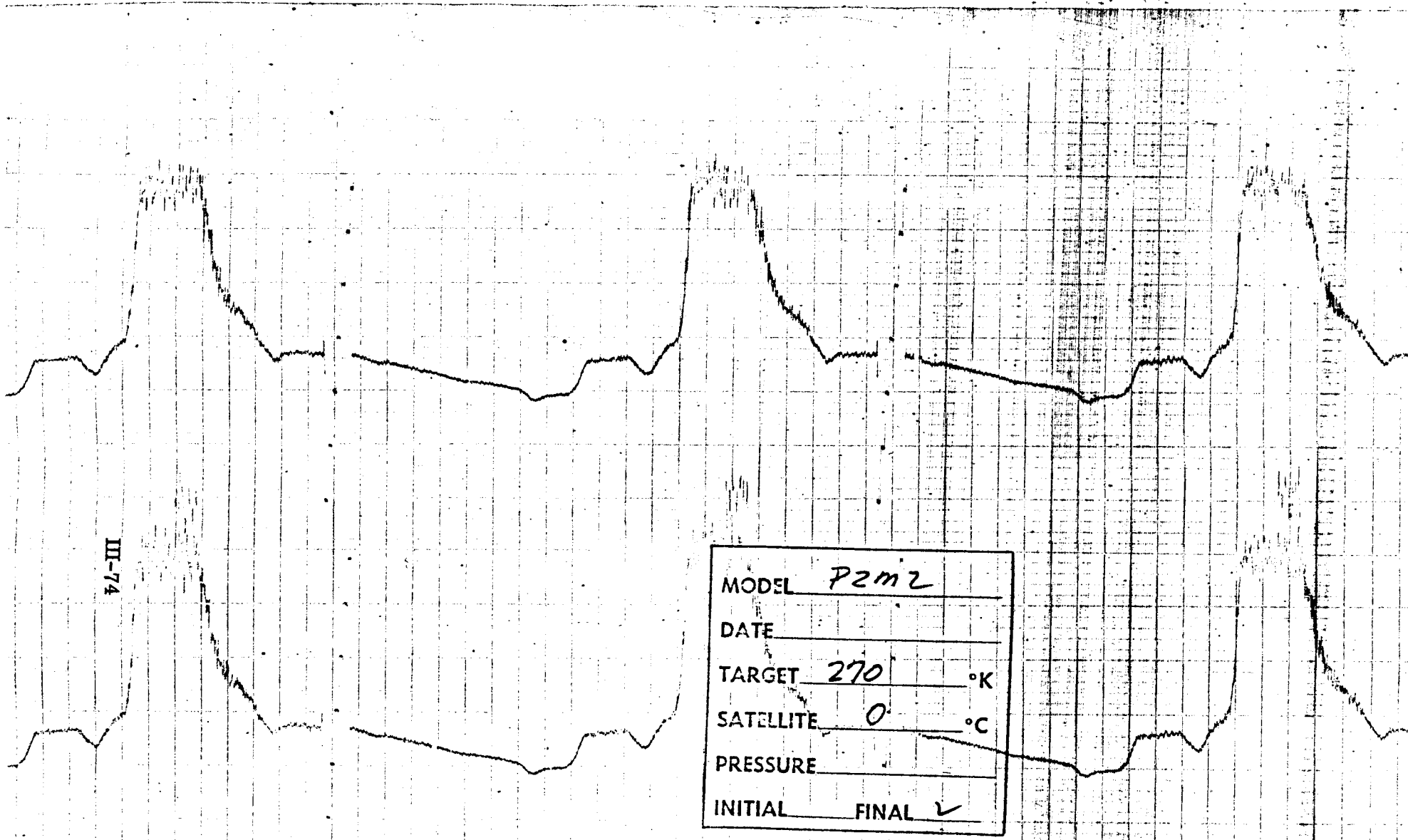

MODEL Pzm2
DATE
TARGET 220 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓

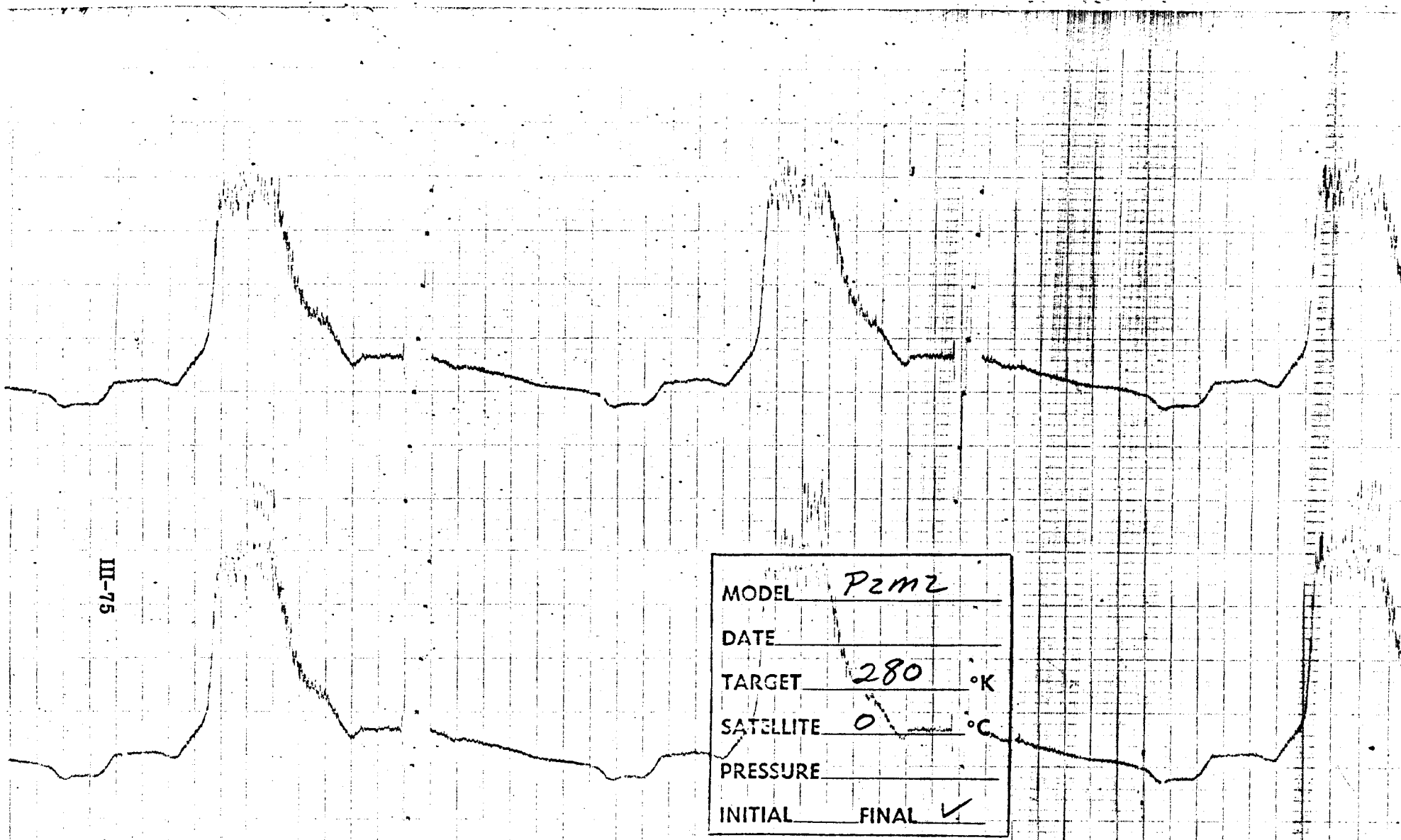

MODEL P2M2
DATE
TARGET 230 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓

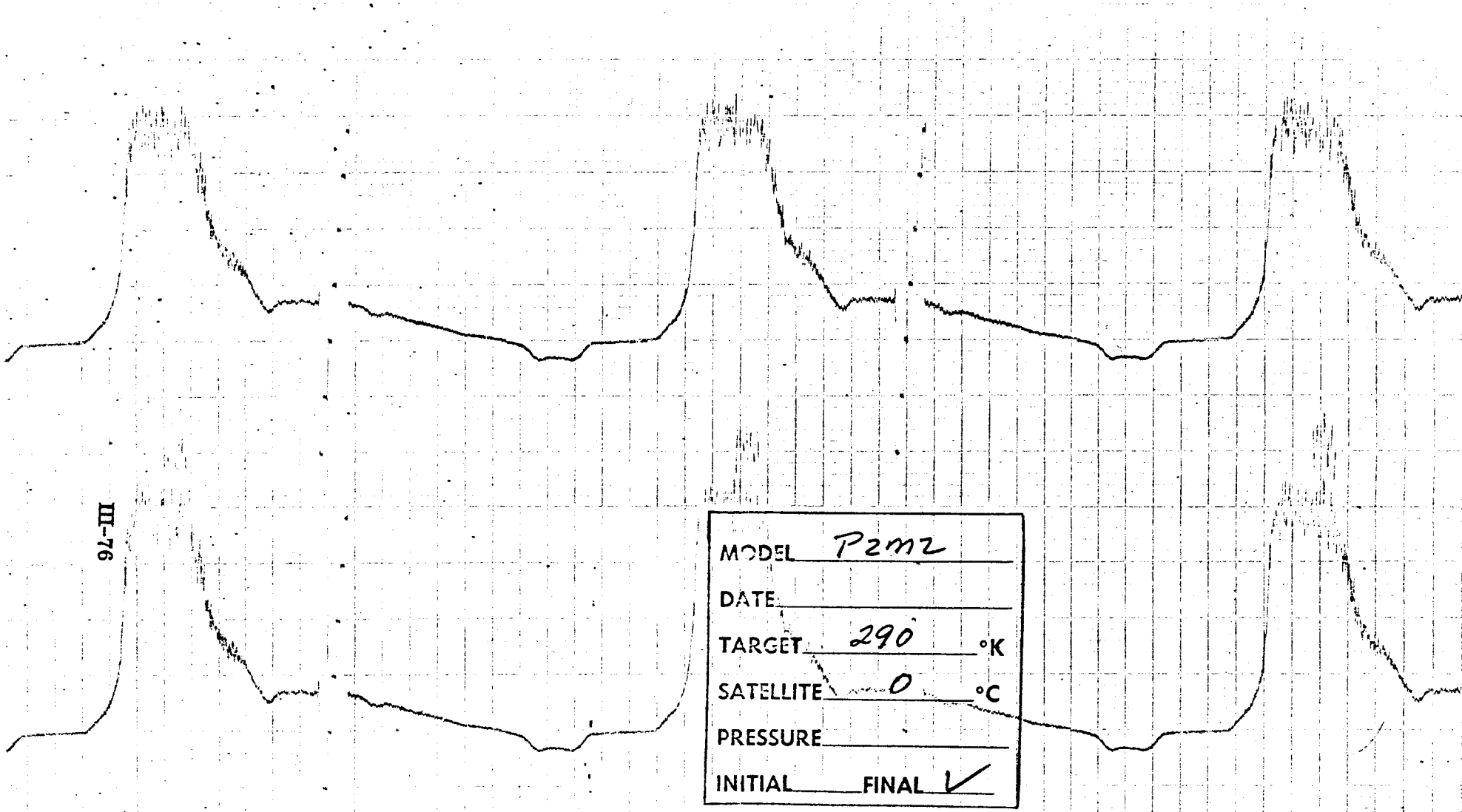

III-71
MODEL P2M2
DATE
TARGET 240 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓

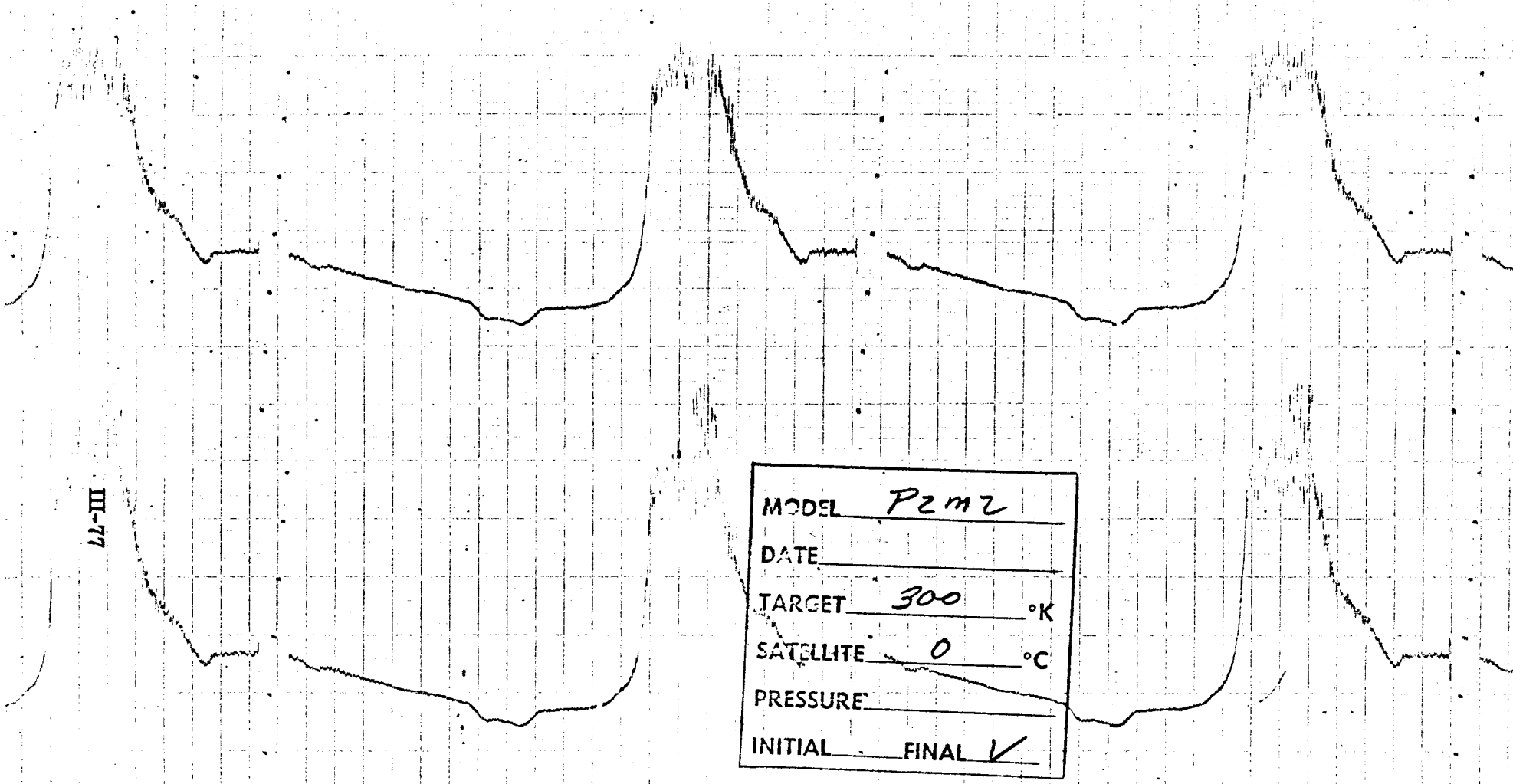

MODEL P2M2
DATE
TARGET 250 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓

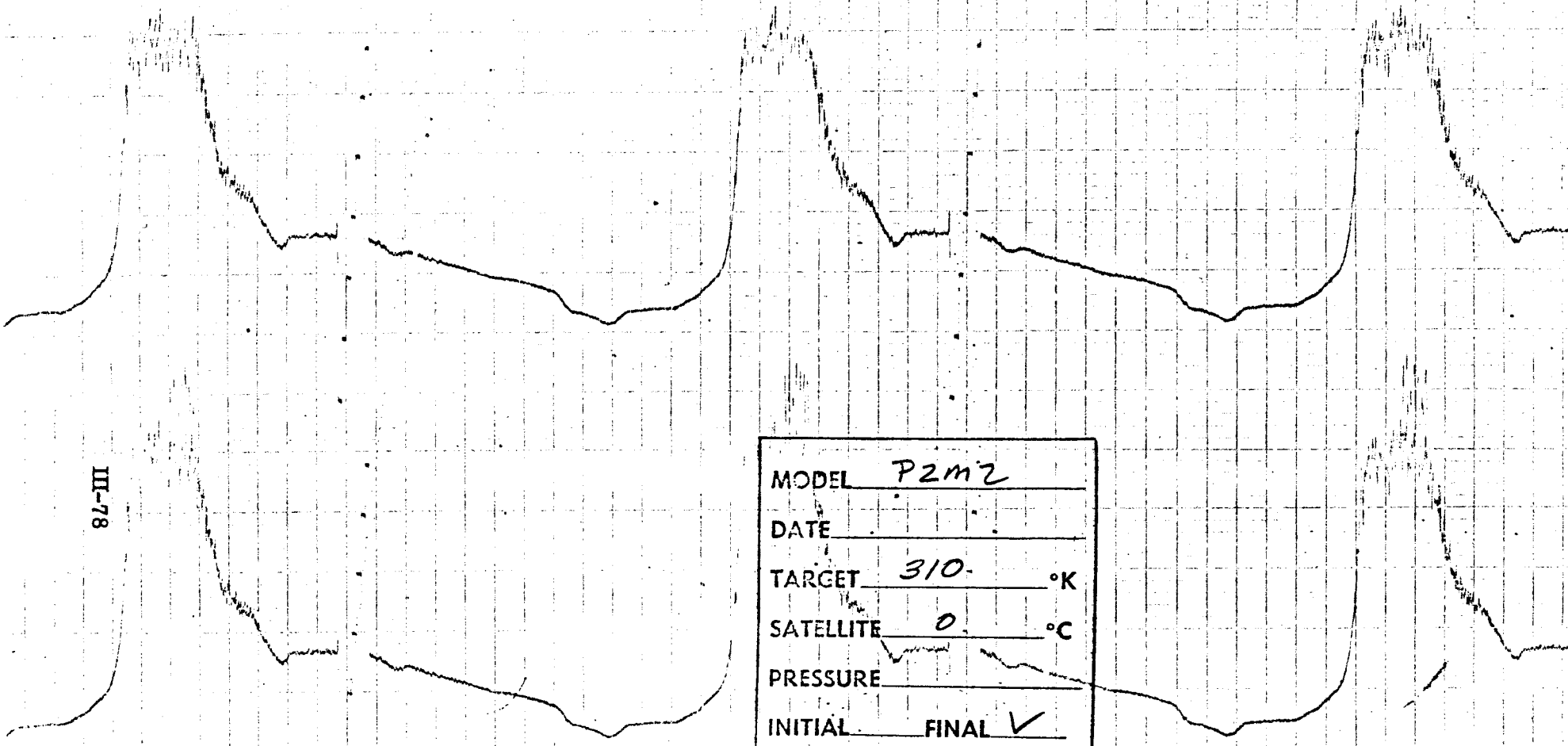

MODEL P2M2
DATE
TARGET 260 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓

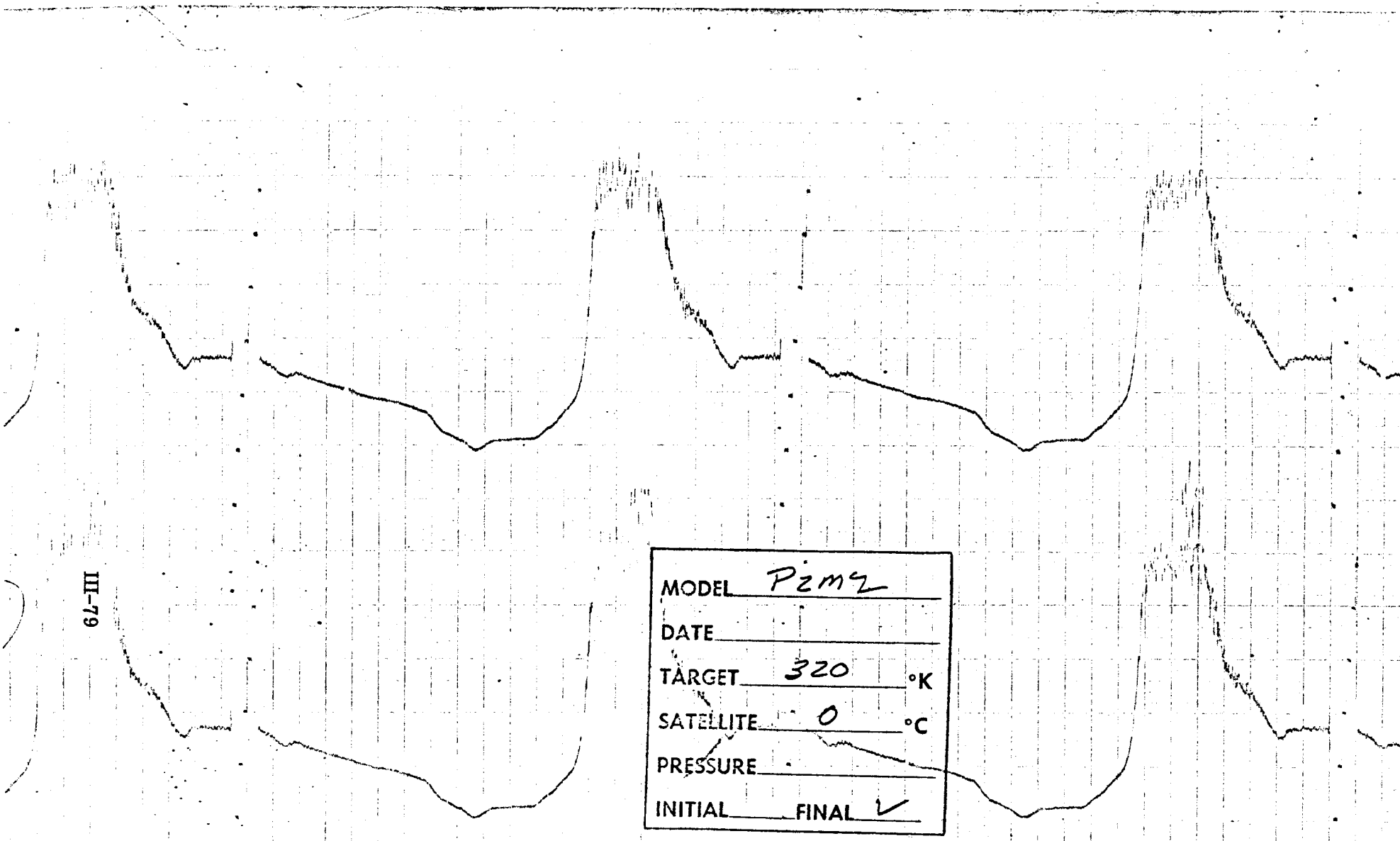

MODEL Pzm2
DATE
TARGET 270 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL

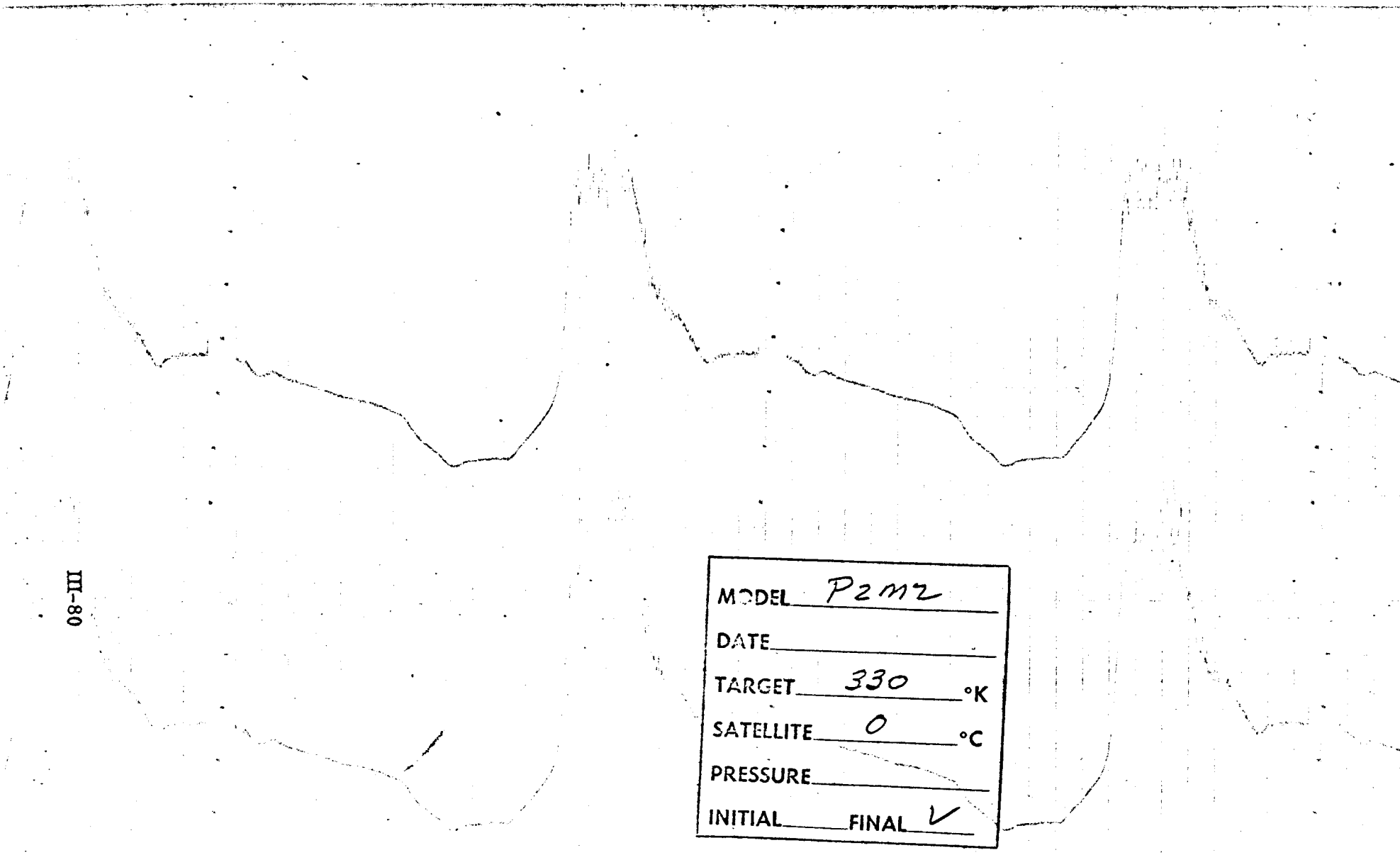

MODEL Pzm2
DATE
TARGET 280 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓

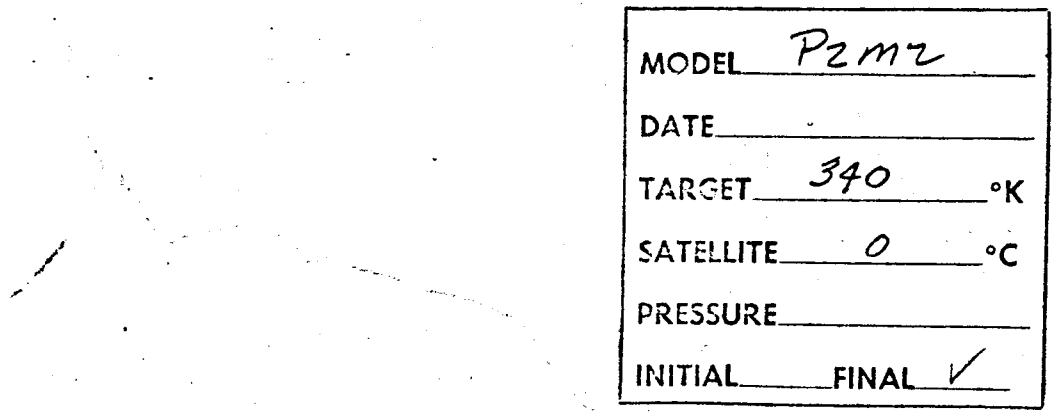

MODEL P2M2
DATE
TARGET 290 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓


MODEL Pzm2
DATE
TARGET 300 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL V


MODEL P2M2
DATE
TARGET 310 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓


MODEL Pemq
DATE
TARGET 320 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓


MODEL P2M2
DATE
TARGET 330 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL V


MODEL Pzm2
DATE
TARGET 340 °K
SATELLITE 0 °C
PRESSURE
INITIAL FINAL ✓

APPENDIX IV

CONNECTOR PIN DESIGNATIONS

1. Connector J-601, Power and Signal

Type: DA 15P, Male, 15 Contact

Recommended Mating Connector: DA 15S with Cannon 20419 Screw Lock

Contact	Purpose
1	Marker pulse output
2	Video output
3	No connection
4	Video signal return
5	Chassis ground
6	Motor sync, phase 1
7	Relay control, Off
8	Relay control, On
9	No connection
10	No connection
11	-24.5 Volt to electronics (day/night)
12	System ground
13	Motor sync, phase 2, lagging phase 1
14	-24.5 Volt supply (full time)
15	Relay control common

2. Connector J-602 Telemetering

Type: DA 15S, Female, 15 Contact

Recommended Mating Connector: DA 15P with Cannon 20419 Screw Lock

Contact	Purpose
1	Telemetering, reference surface temperature A (Ref. "A")
2	Telemetering, electronic housing temperature (Ref. "E")
3	Test Point No. 4 (AGC output)
4	Telemetering, marker pulse
5	Test Point No. 1* (Video Amp Output)
6	Test Point No. 2* (Ref. Sig. Output)
7	Test Point No. 3* (Log Amp Output)
8	System Ground
9	Telemetering, reference surface temp. B (Ref. "B")
10	Telemetering, detector cell temperature
11	Telemetering, -20 Volt regulator
12	Telemetering, video output
13	Telemetering, mirror rotation
14	Telemetering, -20 volt supply (full time)
15	Telemetering, AGC Gate bias

APPENDIX V

DETECTOR CELL DATA

Serial No.	H75B4
Bias Voltage	6 volts
Load Resistance	2.5 Megohms
Frequency	1470 cps
Measured Signal	225 mv
Measured Noise	1.1 mv
Source Temperature	500 degrees K
Calculated 3.4 to 4.2 Micron D*	2.72×10^{10} cm $cps^{1/2}$/watt

APPENDIX VI

FIELD EFFECT TRANSISTOR DATA

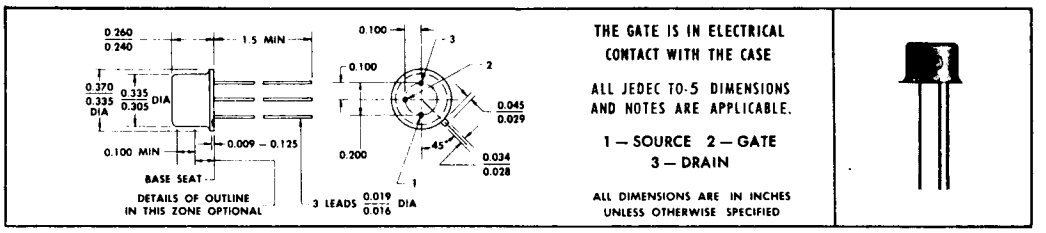
TYPES 2N2497, 2N2498, 2N2499, 2N2500
P-CHANNEL DIFFUSED PLANAR SILICON FIELD-EFFECT TRANSISTORS

TYPES 2N2497, 2N2498, 2N2499, 2N2500
BULLETIN NO. DL-S 633519, MAY 1963
REPLACES BULLETINS NO. DL-S 622727 AND DL-S 622749, JUNE 1962

FOR SMALL-SIGNAL, LOW-NOISE APPLICATIONS

- **Guaranteed 10 cps Noise Figure (2N2500)**
- **High Input Impedance (>5 megohms at 1 kc)**
- **High Nuclear Radiation-Damage Resistance**

***mechanical data**



***absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)**

Gate Current	10 ma
Total Device Dissipation at (or below) 25°C Free-Air Temperature (See Note 1)	0.5 w
Total Device Dissipation at (or below) 25°C Case Temperature (See Note 2)	1.5 w
Storage Temperature Range	−195°C to +300°C

***electrical characteristics at 25°C free-air temperature (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	2N2497		2N2498		2N2499		2N2500		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
BV_{DGO}	Drain-Gate Breakdown Voltage (See Note 3)	$I_D = -10\ \mu a$, $I_S = 0$	−20		−20		−20		−20		v
I_{GSS}	Gate Cutoff Current	$V_{GS} = 10$ v, $V_{DS} = 0$		0.01		0.01		0.01		0.01	μa
I_{GSS}	Gate Cutoff Current	$V_{GS} = 10$ v, $V_{DS} = 0$, $T_A = 150°C$		10		10		10		10	μa
$I_{D(on)}$	Zero-Gate-Voltage Drain Current	$V_{DS} = -10$ v, $V_{GS} = 0$	−1	−3	−2	−6	−5	−15	−1	−6	ma
$I_{D(off)}$	Pinch-Off Drain Current	$V_{DS} = -15$ v, V_{GS} = (See Note 4)		−10		−10		−10		−10	μa
r_{DS}	Static Drain-Source Resistance	$I_D = -100\ \mu a$, $V_{GS} = 0$		1000		800		600			ohm
$\lvert y_{is}\rvert$	Small-Signal Common-Source Input Admittance	$V_{DS} = -10$ v, I_D = (See Note 5), f = 1 kc		0.2		0.2		0.2		0.2	μmho
$\lvert y_{fs}\rvert$	Small-Signal Common-Source Forward Transfer Admittance		1000	2000	1500	3000	2000	4000	1000	2200	μmho
$\lvert y_{rs}\rvert$	Small-Signal Common-Source Reverse Transfer Admittance			0.1		0.1		0.1		0.1	μmho
$\lvert y_{os}\rvert$	Small-Signal Common-Source Output Admittance			20		40		100		20	μmho
$\lvert y_{fs}\rvert$	Small-Signal Common-Source Forward Transfer Admittance	$V_{DS} = -10$ v, I_D = (See Note 5), f = 10 mc	900		1350		1800		900		μmho
C_{iss}	Common-Source Short-Circuit Input Capacitance	$V_{GS} = 0$, $V_{DS} = -10$ v, f = 140 kc		32		32		32		32	pf

***operating characteristics at 25°C free-air temperature**

NF	Spot Noise Figure	$V_{DS} = -5$ v, $I_D = -1$ ma, f = 1 kc, $R_G = 1$ MΩ		3		3		4		1	db
		$V_{DS} = -5$ v, $I_D = -1$ ma, f = 10 cps, $R_G = 10$ MΩ								5	db

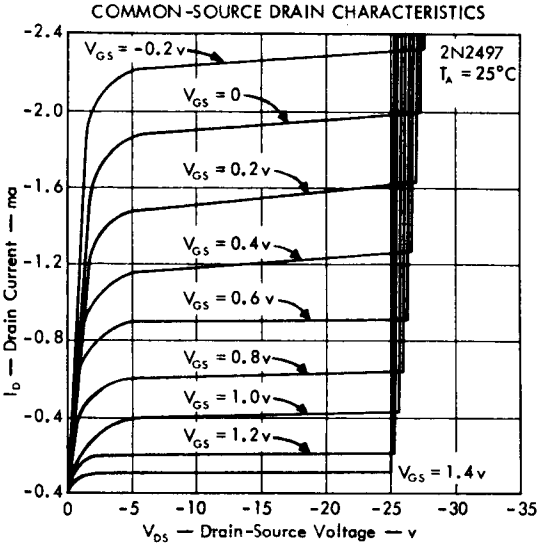
NOTES: 1. Derate linearly to 175°C free-air temperature at the rate of 3.3 mw/C°.
2. Derate linearly to 175°C case temperature at the rate of 10 mw/C°.
3. This parameter corresponds closely to BV_{DSS} (the Drain-Source Breakdown Voltage for $V_{GS} = 0$). BV_{DSX} (the Drain-Source Breakdown Voltage for other values of V_{GS}) may be calculated from: $|BV_{DSX}| \cong |BV_{DGO}| - |V_{GS}|$.

	2N2497	2N2498	2N2499	2N2500
NOTE 4: V_{GS} =	5 v	6 v	8 v	6 v
NOTE 5: I_D =	−1 ma	−2 ma	−5 ma	−1 ma

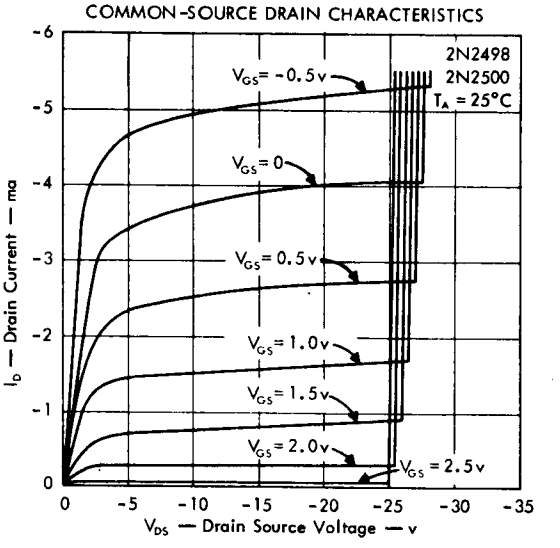
*Indicates JEDEC registered data.

TYPES 2N2497, 2N2498, 2N2499, 2N2500
P-CHANNEL DIFFUSED PLANAR SILICON FIELD-EFFECT TRANSISTORS

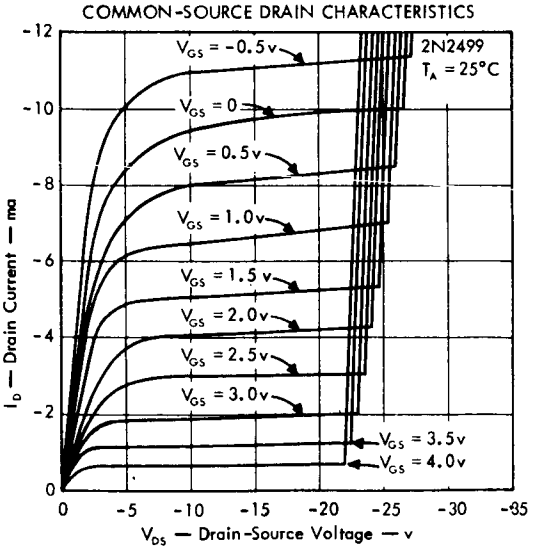
COMMON-SOURCE DRAIN CHARACTERISTICS



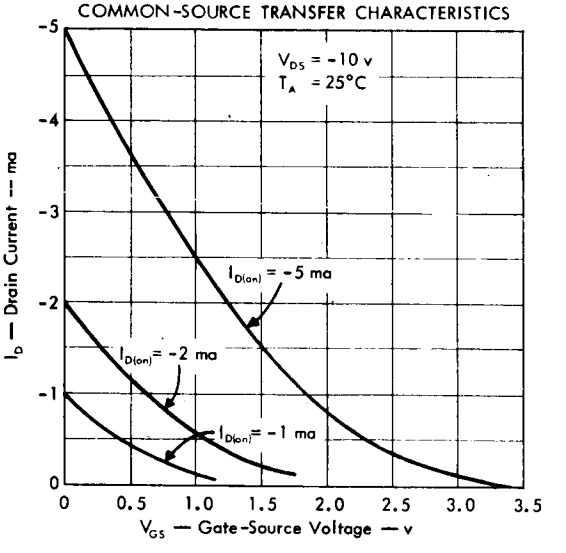
COMMON-SOURCE DRAIN CHARACTERISTICS



COMMON-SOURCE DRAIN CHARACTERISTICS

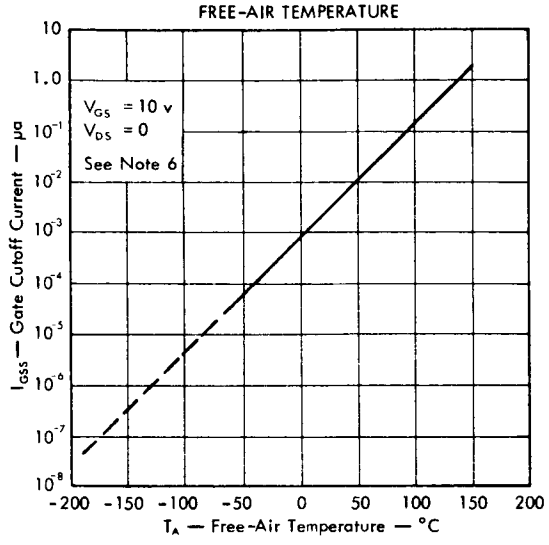


COMMON-SOURCE TRANSFER CHARACTERISTICS

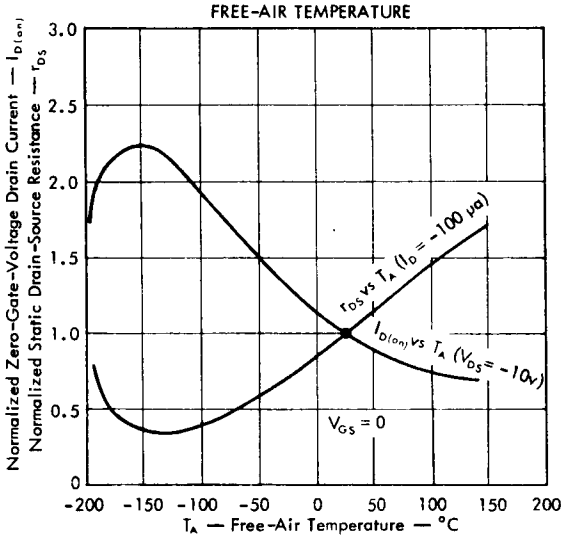


TYPICAL CHARACTERISTICS

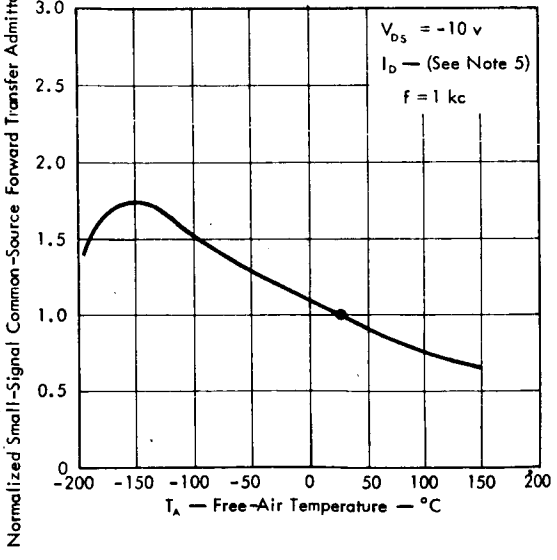
GATE CUTOFF CURRENT
vs
FREE-AIR TEMPERATURE



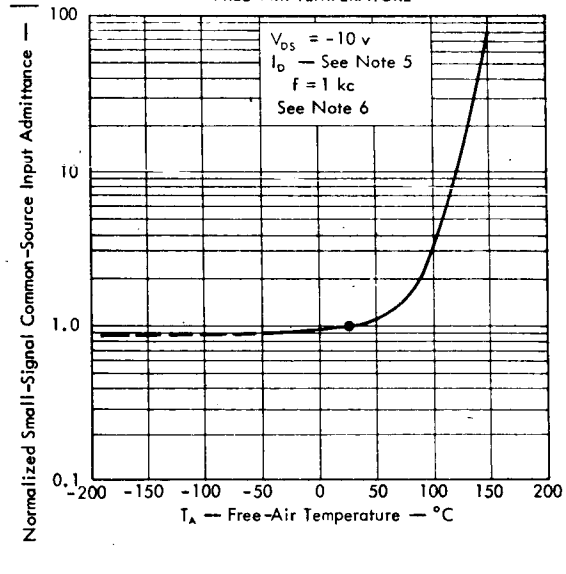
NORMALIZED ZERO-GATE-VOLTAGE DRAIN CURRENT
AND STATIC DRAIN-SOURCE RESISTANCE
vs
FREE-AIR TEMPERATURE



NORMALIZED SMALL-SIGNAL COMMON-SOURCE
FORWARD TRANSFER ADMITTANCE
vs
FREE-AIR TEMPERATURE



NORMALIZED SMALL-SIGNAL COMMON-SOURCE
INPUT ADMITTANCE
vs
FREE-AIR TEMPERATURE

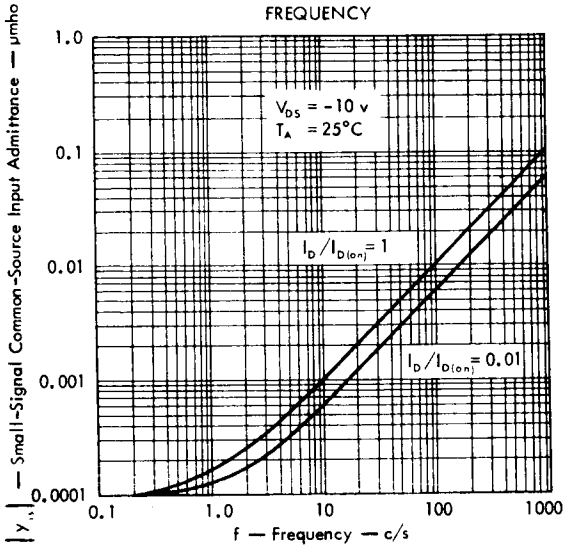


NOTE 6: Dashed lines are extrapolations necessary because of test equipment limitation.

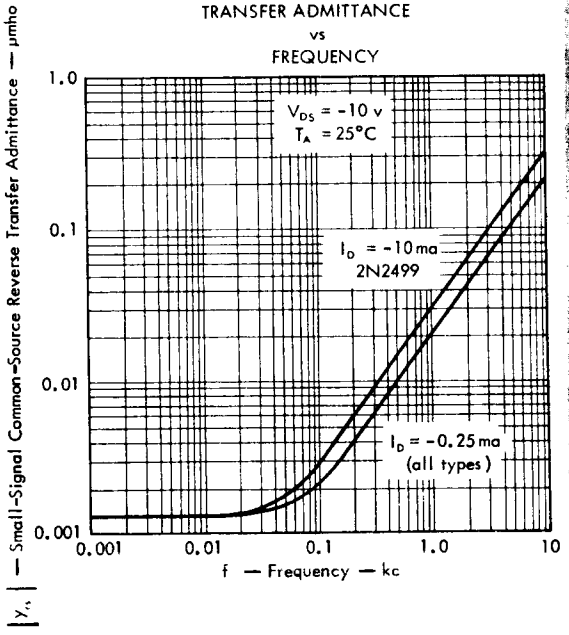
TYPES 2N2497, 2N2498, 2N2499, 2N2500
P-CHANNEL DIFFUSED PLANAR SILICON FIELD-EFFECT TRANSISTORS

TYPICAL CHARACTERISTICS

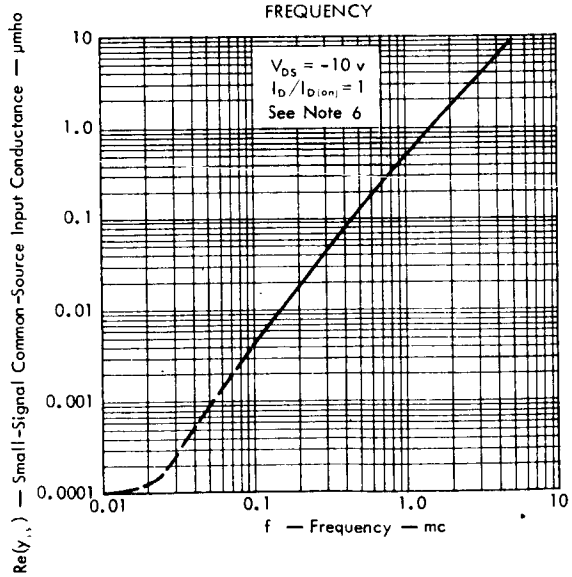
SMALL-SIGNAL COMMON-SOURCE INPUT ADMITTANCE
vs
FREQUENCY



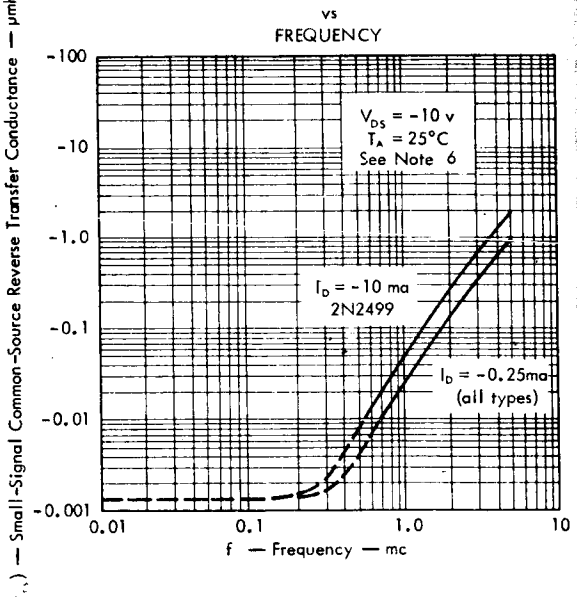
SMALL-SIGNAL COMMON-SOURCE REVERSE
TRANSFER ADMITTANCE
vs
FREQUENCY



SMALL-SIGNAL COMMON-SOURCE INPUT CONDUCTANCE
vs
FREQUENCY



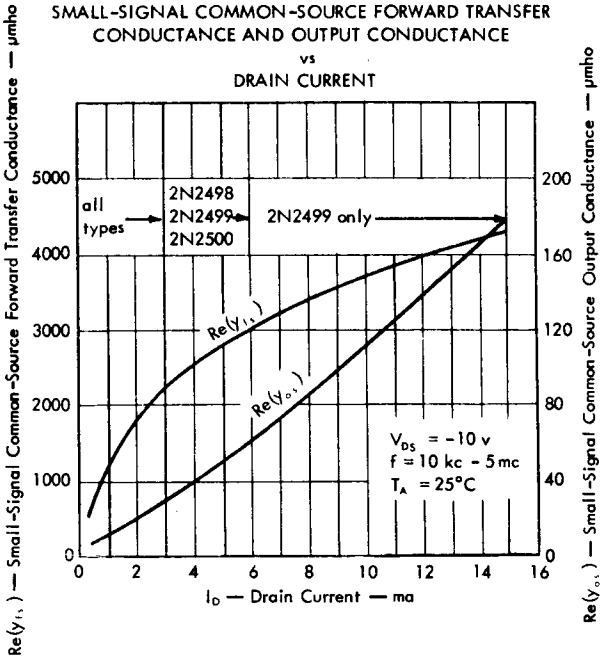
SMALL-SIGNAL COMMON-SOURCE REVERSE
TRANSFER CONDUCTANCE
vs
FREQUENCY



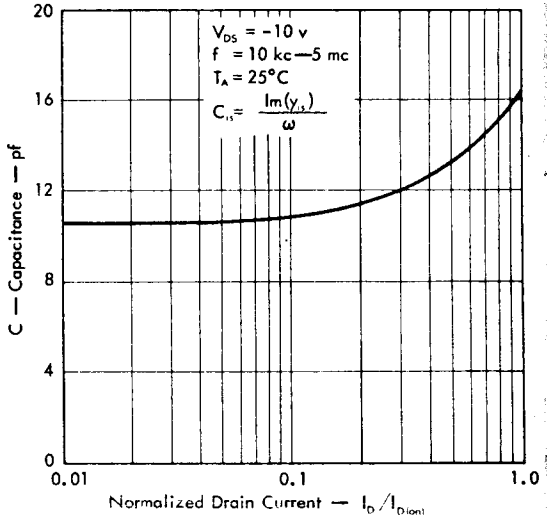
NOTE 6: Dashed lines are extrapolations necessary because of test equipment limitation.

TYPICAL CHARACTERISTICS

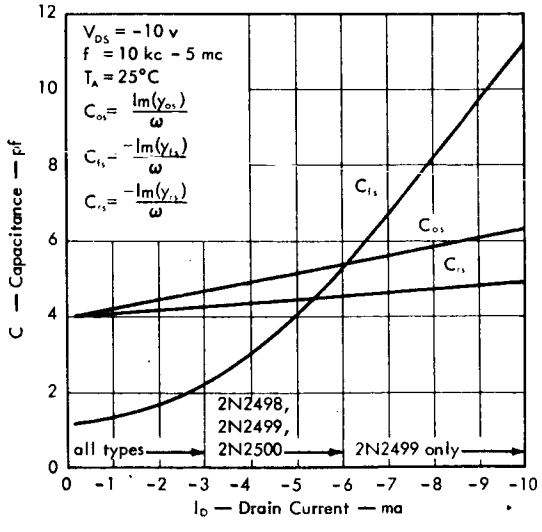
SMALL-SIGNAL COMMON-SOURCE FORWARD TRANSFER CONDUCTANCE AND OUTPUT CONDUCTANCE vs DRAIN CURRENT



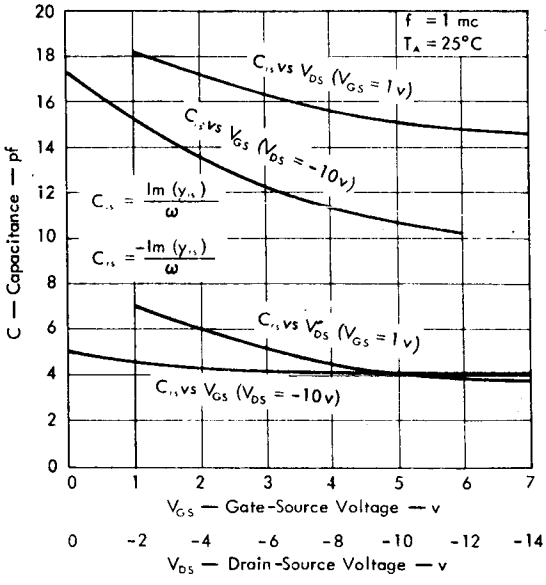
CAPACITIVE COMPONENT OF INPUT ADMITTANCE vs NORMALIZED DRAIN CURRENT



CAPACITIVE COMPONENT OF OUTPUT, FORWARD TRANSFER, AND REVERSE TRANSFER ADMITTANCE vs DRAIN CURRENT



CAPACITIVE COMPONENT OF INPUT AND REVERSE TRANSFER ADMITTANCE vs DRAIN-SOURCE AND GATE-SOURCE VOLTAGE



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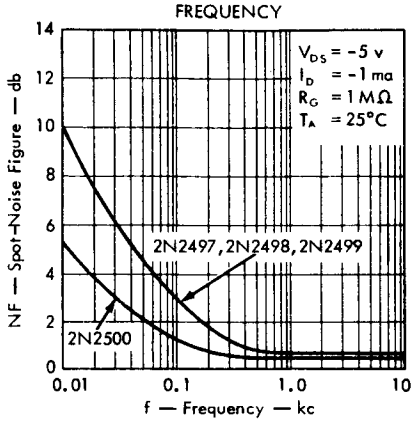
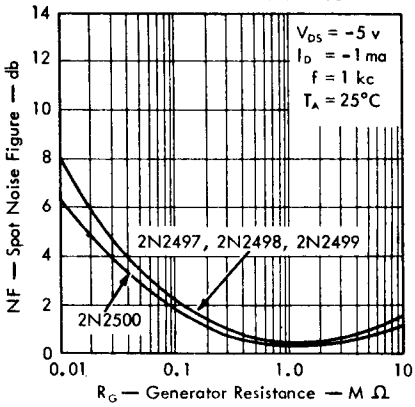
TYPES 2N2497, 2N2498, 2N2499, 2N2500
P-CHANNEL DIFFUSED PLANAR SILICON FIELD-EFFECT TRANSISTORS

TYPICAL CHARACTERISTICS

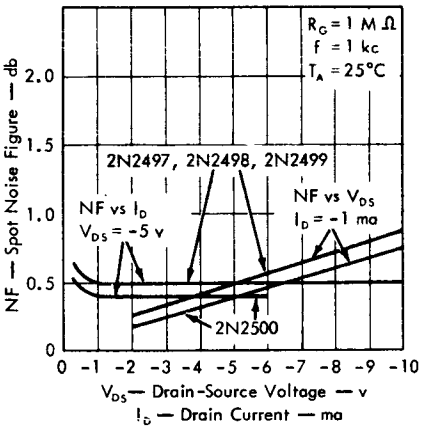
SPOT NOISE FIGURE
vs
FREQUENCY



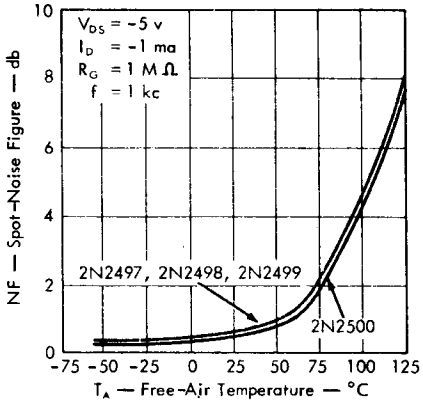
SPOT NOISE FIGURE
vs
GENERATOR RESISTANCE



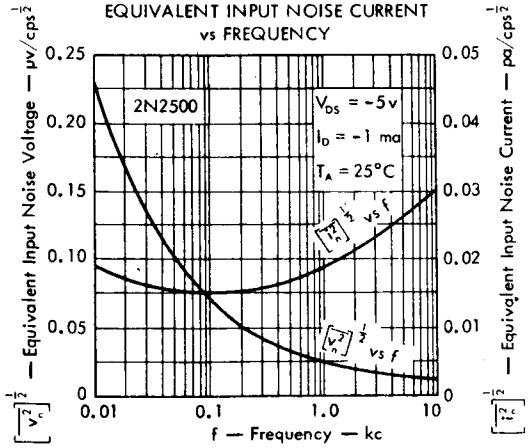
SPOT NOISE FIGURE
vs
DRAIN-SOURCE VOLTAGE AND DRAIN CURRENT



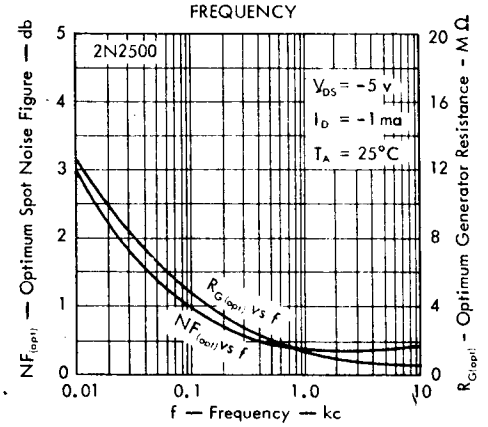
SPOT NOISE FIGURE
vs
FREE-AIR TEMPERATURE



EQUIVALENT INPUT NOISE VOLTAGE AND
EQUIVALENT INPUT NOISE CURRENT
vs FREQUENCY

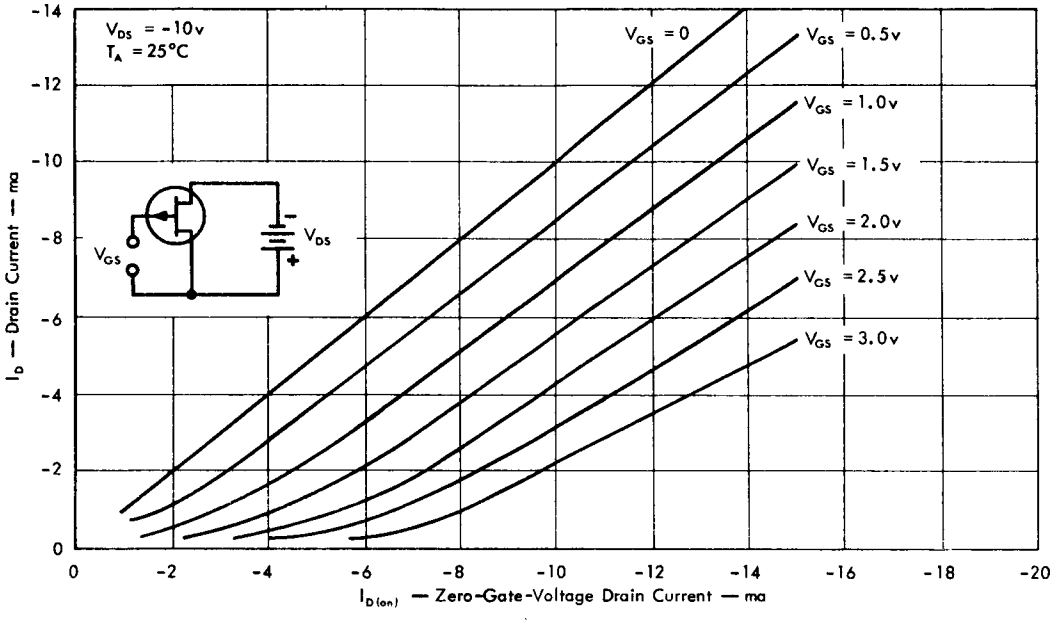


OPTIMUM SPOT NOISE FIGURE AND
OPTIMUM GENERATOR RESISTANCE
vs
FREQUENCY

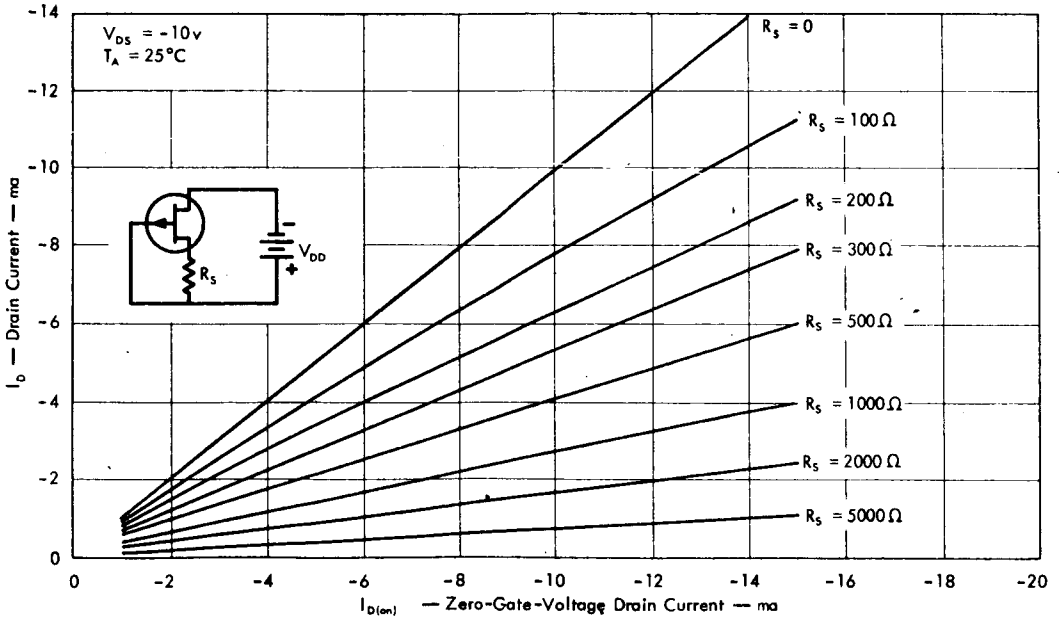


BIAS DESIGN CURVES

DRAIN CURRENT
vs
ZERO-GATE-VOLTAGE DRAIN CURRENT



DRAIN CURRENT
vs
ZERO-GATE-VOLTAGE DRAIN CURRENT



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TYPES 2N2497, 2N2498, 2N2499, 2N2500
P-CHANNEL DIFFUSED PLANAR SILICON FIELD-EFFECT TRANSISTORS

PARAMETER MEASUREMENT INFORMATION

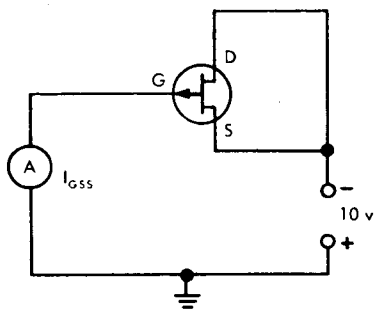
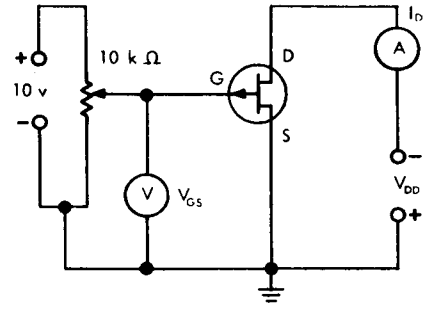


FIGURE 1 — GATE CUTOFF CURRENT TEST CIRCUIT



* FIGURE 2 — PINCH-OFF DRAIN CURRENT TEST CIRCUIT

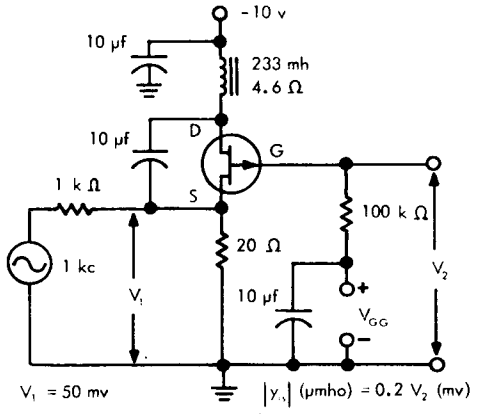


FIGURE 3 — INPUT ADMITTANCE TEST CIRCUIT

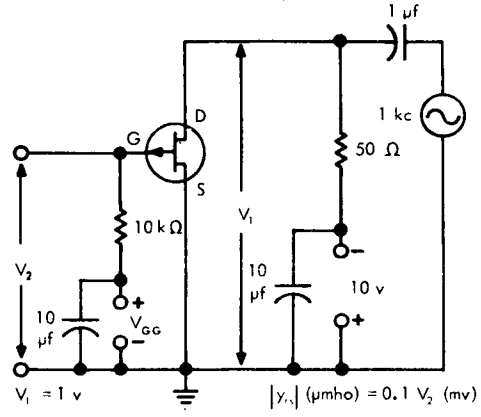
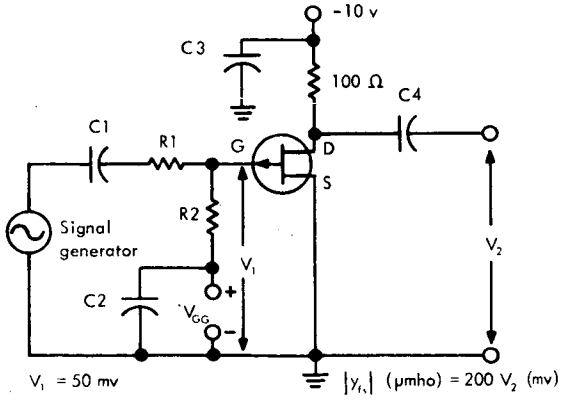


FIGURE 4 — REVERSE TRANSFER ADMITTANCE TEST CIRCUIT



f	R1	R2	C1	C2	C3	C4
1 kc	1 kΩ	10Ω	10μf	10 μf	10μf	10μf
10 mc	30Ω	20Ω	39pf	0.02μf	0.02 μf	0.02μf

FIGURE 5 — FORWARD TRANSFER ADMITTANCE TEST CIRCUIT

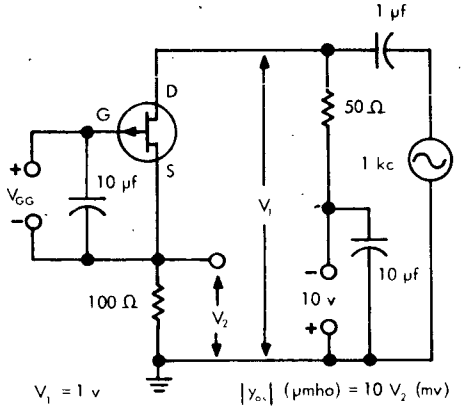


FIGURE 6 — OUTPUT ADMITTANCE TEST CIRCUIT

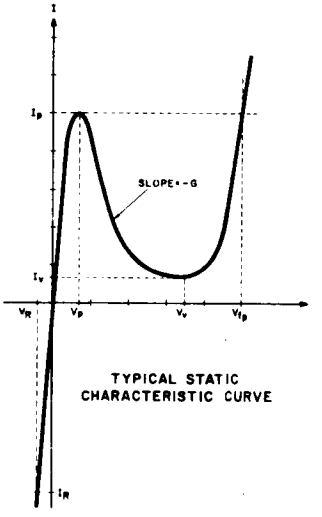
* Indicates JEDEC registered data.

Appendix VII

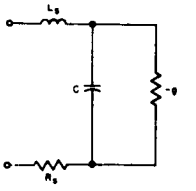
1N3219, 1N3219A

Outline Drawing No. 3

The 1N3219 and 1N3219A are germanium tunnel diodes which make use of the quantum mechanical tunneling phenomenon thereby attaining unique negative conductance characteristics and very high frequency performance. These small stripline type packages are designed for microwave communications, radar, very high frequency amplifiers and oscillator applications. The very low series inductance plus controlled low capacity permits very high frequency performance in the S band.



TYPICAL STATIC CHARACTERISTIC CURVE



EQUIVALENT CIRCUIT (BIASED IN NEGATIVE CONDUCTANCE REGION)

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Current

Forward (−55 to + 100°C)	5	ma
Reverse (−55 to +100°C)	10	ma

Temperature

Storage	−55 to + 100	°C

ELECTRICAL CHARACTERISTICS: (25°C)

		Min.	Typ.	Max.	
Peak Point Current	I_P	2.0	2.2	2.4	ma
Valley Point Current	I_V		0.28	0.48	ma
Peak Point Voltage	V_P		60		mv
Valley Point Voltage	V_V		350		mv
Forward Voltage ($I_F = I_P = 2.2$ ma)	V_{fp}	450	500	600	mv
Reverse Voltage ($I_R = 2.2$ ma)	V_R		20		mv
Negative Conductance	−G	10	18	25	x10^{-3}mho
Series Resistance	R_S		0.7	3.0	ohm
Series Inductance	L_S		0.3	0.5	nh
Total Capacity 1N3219	C	1.5	14	20	pf
Total Capacity 1N3219A	C	1.5	7	10	pf

Color Code: (counter clockwise on flange)
1N3219 Orange–Red–Brown–White–Black
1N3219A Orange–Red–Brown–White–Brown

APPENDIX VIII

PROPERTIES OF SYNTHANE G-10

Mechanical Properties

Resin	G-10 Epoxy
Tensile Strength, psi	
Lengthwise	35,000
Crosswise	30,000
Compression Strength, psi	
Flatwise	60,000
Edgewise	40,000
Flexural Strength psi (1/8" thick)	
Lengthwise	50,000
Crosswise	40,000
Modulus of Elasticity in Flexure, psi	
Lengthwise	2,500,000
Crosswise	2,000,000
Shear Strength, psi	19,000
Izod Impact, ft. lbs, per inch of notch	
Flatwise	7.0
Edgewise	5.5
Bond Strength, lbs.	

Electrical Properties

Resin	G-10 Epoxy
Dielectric Strength, VPM	
Perpendicular to laminations	
Short Time Test	
1/16"	500
1/8"	
Dissipation Factor, 1 megacycle Condition A	0.025
Dissipation Constant, 1 megacycle Condition A	5.8
Insulation Resistance, megohms Condition: 96 hrs., 90% relative humidity, 95° F	200,000
Arc Resistance, seconds	80
Water Absorption, %, 24 hrs.	
1/16"	0.35
1/8"	0.20
1/2"	0.10

General Properties

Resin	G-10 Epoxy
Rockwell Hardness, M Scale	110
Specific Gravity	1.82
Coeff. of Ther. Expansion, Cm/Cm/^{o}C	0.7×10^{-5}
Maximum Constant Operating Temperature, ^{o}F	300
Thickness	
Minimum	0.015"
Maximum	1"
Standard Colors	Natural (Gray White)
Standard Finishes	Semi Gloss

APPENDIX IX PROPERTIES OF TITANIUM ALLOY WIRE

Mechanical Properties	Guaranteed RT Minimum	Typical Strength (% RT) & Ductility 400F	600F	800F	1000F
Ultimate tensile strength, psi	125,000	92	87	92	76
Yield strength, 0.2% offset, psi	120,000	85	74	80	72
El in 2" (> 0.025" thick) pct	10	23	23	18	34
Reduction in area, percent	25				
Bend Radius	3T 1 3.5T 2				
Impact, Charpy V, ft-lb.					
Welded Bend Radius	3 T				
Hardness	RC 32-36				
Rupture, stress to produce in ( ) hr, psi					
Creep data, stress to produce ( ) percent elongation in ( ) hr., psi		0.5% 500 hr 131,000 3	0.2% 500 hr 107,000 3		

Physical Properties		
Modulus of elasticity, psi, (10^6) tension	15	
Modulus of elasticity, psi, (10^6) torsion	6.2	
Density, lb/cu inch	0.176	
Melting Range, deg F		
Specific Electrical Resistivity micro ohms/cm/sq cm	153 annealed 142 STA	
Specific heat, Btu/lb/deg F	0.12 at RT to 200F	
Thermal conductivity, Btu/hr/sq ft/^{o}F/ft	4 at room temperature	
Mean coefficient of thermal expansion per deg F, (10^{-6}) 32-212 F 32-600 F 32-1000F 32-1200F 32-1500F	Room temperature to 400F: 5.4 5.9	

Oxidation characteristics in air	400F	600F	800F	1000F
SHORT TIME	Good	Good	Good	Moderate
LONG TIME	Good	Good	Moderate-Good	Moderate