THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
SILVER SPRING, MARYLAND

S1P-551-70
May 21, 1970

TO: R. E. Cashion

FROM: C. Cunningham

SUBJECT: CPME Anti-Coincidence and GM Tube Electronics

Introduction:

This report describes the anti-coincidence electronics for the CPME Proton Electron Telescope (PET) and for the Geiger-Mueller Tube Telescope (GT). A discussion of the saturating amplifiers used in conjunction with the GM Tubes is also included.

As shown in Figure 1, each of the anti-coincidence channels derives its input signal from a plastic scintillator-photomultiplier combination surrounding each of the telescope assemblies.

The two channels are identical up to and including the Discriminator and Anti-Coincidence Pulse Generators. The GT Channel uses leading edge timing to inhibit the shortened pulses from the saturating amplifiers in the GM Pulse Shaping and Anti-Coincidence Gate circuits. The PET channel employs trailing-edge timing and a delay line is used to deliver an anti-coincidence pulse to inhibit the strobe pulses from a zero-crossing detector in the PET pulse height electronics. The PET anti-coincidence pulse inhibits the coincidence gates in the PET Strobe Logic section.

Preliminary tests of the photomultipliers and scintillators indicate that the resolution of the system will be approximately 90 kev FWHM and that a threshold can be set at approximately 200 kev. The noise in the system is contributed almost entirely by the photomultiplier tubes, the contribution from the preamplifiers and amplifiers being nearly two orders of magnitude lower.

The output signals from both channels are read out into rate registers. This information can then be used for dead-time corrections and as a measure of the relative states of health of the photomultiplier tubes.

The power requirements for the two channels, as a function of counting rate, are shown below:

Power Requirements

	PET Channel	GT Channel
100 c/s	103 mw	99 mw
10^5 c/s	112 mw	109 mw
2×10^5 c/s	118 mw	123 mw
5×10^5 c/s	148 mw	159 mw

In addition, if all GM Tube channels are counting at 10^4 c/s, an additional 10 milliwatts of power is required.

Threshold drift is approximately 3-4% over the temperature range from -30°C to +50°C. The DC gain measurements on the photomultipliers indicate that these may exhibit gain variations of 30-40% over this range. For this reason, provision has been made for temperature compensation of the amplifiers to correct for photomultiplier gain variations. Pulse gain tests of the photomultipliers are currently in progress. When these are complete, appropriate temperature compensating elements will be selected.

The anti-coincidence pulse exhibits approximately 80 ns of "walk" over the full dynamic range in each of the channels.

Discussion:

Preamplifiers: The preamplifiers as shown in Figure A1 (appendix) employ a common-base stage buffered by an emitter-follower. This configuration is employed so that the low input resistance of the CB stage will degenerate the effects of the cable capacitance from the PM tube and permit the fast risetime of the PM pulse to be maintained. This is necessary in order to accommodate the high counting rates expected on these channels (approaching 2×10^5 c/s) and to minimize timing "walk" with pulse height variations. The preamplifiers each require approximately 4 mw of power.

Amplifiers: The preamplifiers drive a chain of amplifiers as shown in Figure 1. These amplifier assemblies are identical to those used in the PET solid-state detector channels, except that provision has been made for locating the temperature compensation sensistor in the shunt arm of the feedback network. The characteristics of these amplifiers have been treated in detail previously by S. A. Gary (S1P-548-70) and will not be discussed here. The feedback and coupling component values are shown in Figure A2.

Discriminators and Anti-coincidence Pulse Generators: The amplifiers drive a Discriminator and Anti-Coincidence Pulse Generator (Figure A3). These are contained in a single module. The discrimination level is approximately 110 mV in the PET channel and 150 mV in the GT channel. The discriminator drives a complementary one-shot which generates a fast rising pulse. In the GT channel this pulse width is set at approximately 650 ns (C7 = 75 pf) and drives the anti-coincidence gates directly.

In the PET channel, the anti-coincidence pulse width is set at approximately 300 ns (C7 = 75 pf) and drives a short-circuited 0.5 μsec delay line which delays the anti-coincidence pulse until the strobes in the PET electronics fire at zero-crossing.

Capacitor C7 is a tailor part and will be used to make final adjustment of the anti-coincidence pulse width in the GT channel.

Delay Line Buffer: The Delay Line Buffer (Figure A4) PET channel is simply a saturating amplifier which is triggered by the negative reflection from the delay line, and delivers a trigger pulse to the PET anti-coincidence pulse shaper. The saturating amplifier has a threshold set at approximately -400 mV to provide some noise margin at this point and to prevent secondary pulses due to ringing and secondary reflections in the delay line.

PET Anti-Coincidence Pulse Shaper: The signal from the Delay Line Buffer triggers the Anti-Coincidence Pulse Shaper (Figure A5). The four gates labeled U1 provide an adjustable delay in addition to the delay provided by the delay line. This permits the output pulse width to be minimized, thereby reducing the dead-time introduced into the PET electronics. The four gates provide an additional delay of approximately 200 ns, adjustable in 100 ns steps. Gates U2 and Q_1 and Q_2 form a one-shot and buffer to supply the anti-coincidence pulse to the strobe logic and to a rate-limiter which is for readout into a rate register.

GM Tube Saturating Amplifiers and Anti-Coincidence Gates: The signals from the GM tubes drive five Saturating Amplifiers (Figure A6). These provide negative-going output signals which drive the GM Tube Pulse Shaping and Anti-Coincidence Gates (Figure A7) or inverters. The signals from the three tubes (GM1, GM2A, and GM3) in the GT telescope are shortened and delayed and fed into the anti-coincidence gates U3 and U4. The delays provided by the chains of inverters insure that the anti-coincidence pulse ($\bar{S}$) will arrive at the inputs of the anti-coincidence gates in advance of the GM pulses. The anti-coincidence pulse also drives a rate-limiter for read out into a rate-register. The output pulses from the anti-coincidence gates are approximately 400 ns wide and drive rate-limiters which stretch them to the pulse widths required by the spacecraft registers and by the Sectored Data Commutator. The spare gate in U4 is used to invert the GM2B pulse. The GM2C pulse is inverted by an available gate in the In-Flight Calibrator Sub-Commutator.

In the Saturating Amplifiers C1 and R2 are adjusted to compensate for different pulse amplitudes from the GM tubes. These determine the threshold and output pulse width (typically 4-10 μsec). The output pulse has a fall-time of approximately 30 ns and a risetime of approximately 1 μsec.

Summary:

The performance characteristics of the PET and GT anti-coincidence electronics and the GM Pulse Shaping electronics are summarized in Figures 2 and 3. The PET anti-coincidence pulse shape is measured with a load of 7.5 KΩ, shunted by 75 pf, to simulate the load presented by 3 coincidence gates in the strobe logic.

The photomultiplier and bleeder string are shown in Figure A8.

The Rate-Limiters, Sectored Data Commutator, In-Flight Calibrator Sub-Commutator and Channel Logic will be covered in a separate paper.

C. Cunningham

CC:ks
Distribution:
COBostrom
AFHogrefe
RECashion
DPPeletier
SAGary
SMKrimigis
REThompson
RCCole
CCunningham
Archives (2)
File

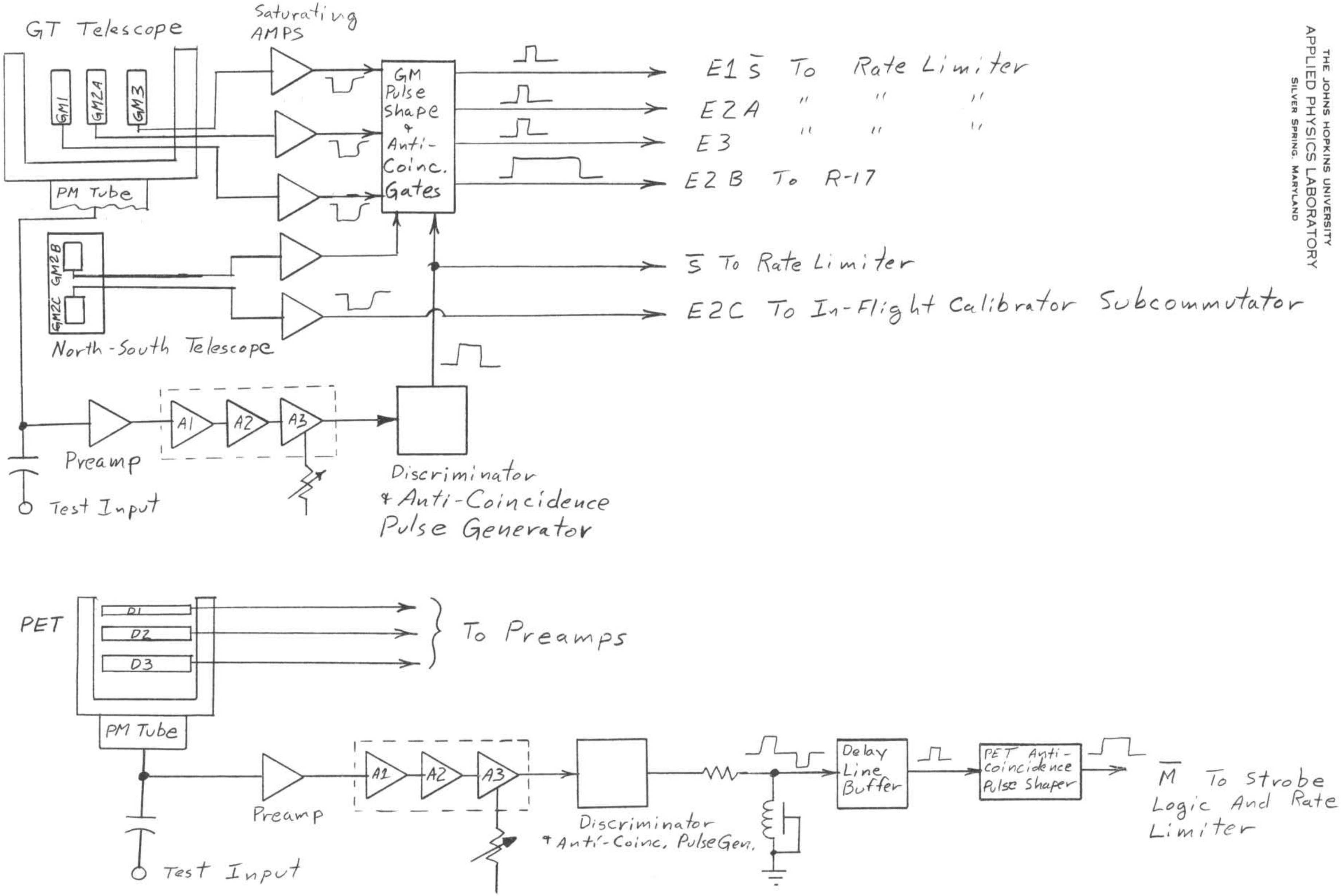


Figure 1

Block Diagram of CPME Anti-Coincidence and GM Tube Electronics

GM Electronics

TA	Sat. Amp. Pulse	Anti-Coincidence Pulse (C7 = 75 pf)	GM Anti-Coincidence Gate Pulse
$-40^\circ C$	PW $\approx$ 8 μs (FWHM) $t_r \approx$ 1 μsec $t_f \approx$ 30 ns	PW $\approx$ 540 ns (FWHM) $t_r <$ 20 ns $t_f \approx$ 80 ns	PW $\approx$ 400 ns (FWHM) $t_r \approx$ 50 ns $t_f \approx$ 30 ns
$+25^\circ C$	PW $\approx$ 12 μsec $t_r \approx$ 1 μsec $t_f \approx$ 30 ns	PW $\approx$ 660 ns $t_r <$ 20 ns $t_f \approx$ 80 ns	PW $\approx$ 395 ns (FWHM) $t_r \approx$ 40 ns $t_f \approx$ 30 ns
$+60^\circ C$	PW $\approx$ 13 μs $t_r \approx$ 1 μsec $t_f \approx$ 30 ns	PW $\approx$ 720 ns $t_r <$ 20 ns $t_f \approx$ 80 ns	PW $\approx$ 390 ns (FWHM) $t_r \approx$ 40 ns $t_f \approx$ 30 ns

Anti-Coincidence Threshold Drift: Approximately 3-4% over the above range of TA.

GM Threshold Drift: Approximately 20% over the above range of TA.

Power Requirements (100 c/s):

+8V	3.3 ma	(26.4 mw)
+6V	4.1 ma	(24.6 mw)
-6V	7.1 ma	(42.5 mw)
		93.5 mw

Figure 2

GM Electronics Performance Data

PET Electronics

TA	Discriminator Pulse (C7 = 22 pf)	Delay Line Buffer Pulse	Output Pulse (R_L = 7.5K) (C_L = 75pf)
	PW ≈ 270 ns	PW ≈ 360 ns	PW ≈ 560 ns
-40°C	t_r ≈ 40 ns	t_r ≈ 80 ns	t_r ≈ 30 ns
	t_f ≈ 120 ns	t_f ≈ 100 ns	t_f ≈ 20 ns
	PW ≈ 300 ns	PW ≈ 440 ns	PW ≈ 600 ns
+25°C	t_r ≈ 30 ns	t_r ≈ 60 ns	t_r ≈ 30 ns
	t_f ≈ 80 ns	t_f ≈ 80 ns	t_f ≈ 20 ns
	PW ≈ 320 ns	PW ≈ 520 ns	PW ≈ 620 ns
+60°C	t_r ≈ 30 ns	t_r ≈ 80 ns	t_r ≈ 30 ns
	t_f ≈ 80 ns	t_f ≈ 100 ns	t_f ≈ 20 ns

Anti-Coincidence Threshold Drift: Approximately 3-4% over the above range of TA.

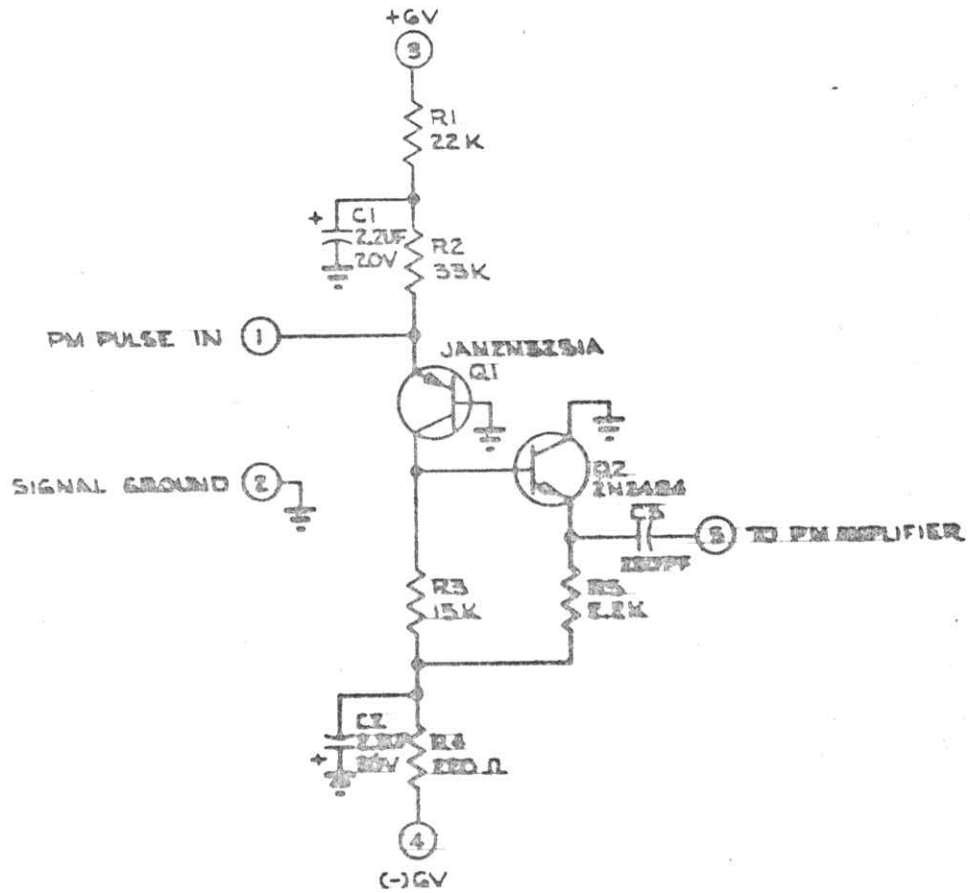
Total Delay: Approximately 1.4 μsec (Can be reduced to 1.2 or 1.3 μsec by using drive points A or B in PET Anti-Coincidence Pulse Shaper).

Power Drain:	+8V	4.5 ma	(36.0 mw)
	+6V	3.1 ma	(18.5 mw)
	-6V	8.0 ma	(48.0 mw)
			102.5 mw

Figure 3

PET Anti-Coincidence Electronics
Performance Data

Figure A1



NOTES-UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS ARE $\frac{1}{8}$W, 5%

HIGHEST REF DESIGNATION	
R5	C3
Q2	

FIND NO	ITEM NO	DWG SIZE	PART OR IDENTIFYING NUMBER	CIRCUIT SYMBOL OR ZONE	NOMENCLATURE OR DESCRIPTION	STOCK SIZE	MATERIAL AND/OR MATERIAL SPECIFICATION	MFG CODE	ISSUE REV.

LIST OF MATERIAL

PART NUMBER	SIZE	NEXT ASSEMBLY
	A	SRA-6536
	C	SRA-6531
SRA-6533	C	SRA-653

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS .XX = ± .03 .XXX = ± .010
ANGULAR ± 1/2°
DIM & TOL PER MIL STD 8C
BREAK SHARP EDGES REMOVE ALL BURRS

DRAWN BY J.T. MUELLER 3 MAR 70

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
8621 GEORGIA AVENUE SILVER SPRING MARYLAND

SCHEMATIC DIAGRAM
PHOTO-MULTIPLIER PREAMP MODULE
CPME
IMP H + J SATELLITE

CODE IDENT NO 88898 SIZE C SRA-6533 ISSUE a

SCALE DO NOT SCALE PRINT SHEET 1 OF 1

FORM © 200-201

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
SILVER SPRING, MARYLAND

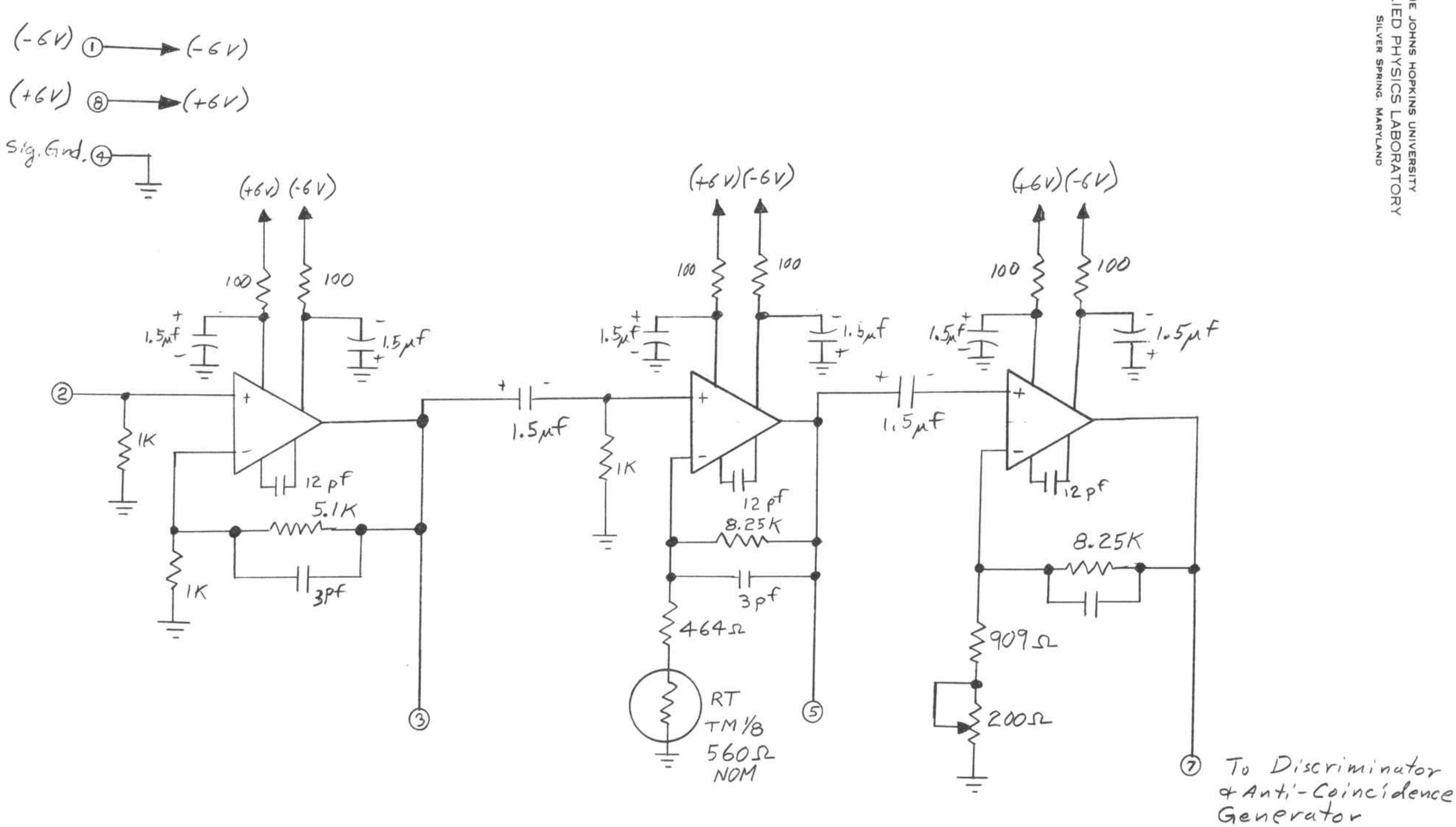


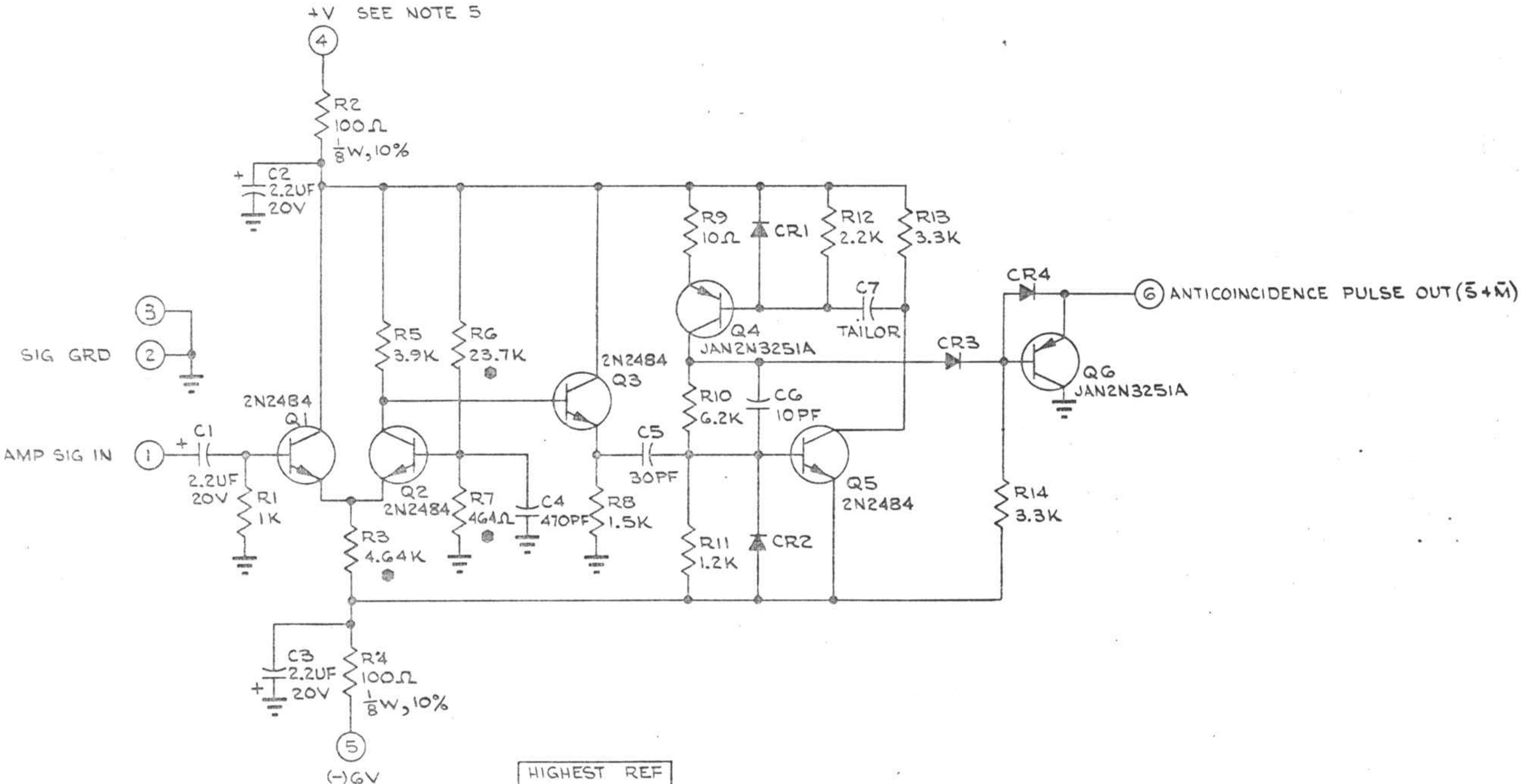
Figure 2A

Photomultiplier Amplifier Chains
PET and GT Anti-Coincidence Electronics

REVISIONS

ISSUE	BY & DATE	DESCRIPTION	CHECK	APPROVED & DATE

Figure A3



HIGHEST REF DESIGNATION	
R14	C7
Q6	CR4

NOTES - UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS ARE $\frac{1}{8}$ W, 5%
2. ALL RESISTORS MARKED ● ARE $\frac{1}{10}$ W, 1%
3. ALL DIODES ARE TXIN3064
4. C7 IS:
   10 PF NOM FOR PET
   33 PF NOM FOR GT
5. +V TO BE +6V FOR PET CHANNEL & +8V FOR GT CHANNEL

BASIC QTY / ASSY	ITEM NO.	DWG SIZE	PART OR IDENTIFYING NUMBER	CIRCUIT SYMBOL OR ZONE	NOMENCLATURE OR DESCRIPTION	STOCK SIZE	MATERIAL AND/OR MATERIAL SPECIFICATION	MFG CODE	ISSUE REV

LIST OF MATERIAL

	A	SRA-6544		
	C	SRA-6543		
SRA-6541	C	SRA-6542	QTY NA	
PART NUMBER	SIZE	NEXT ASSEMBLY		USED ON

EFFECTIVITY-END ITEM SER NO | WEIGHT

SURFACE TREATMENT (BEFORE ASSY) | SURFACE ROUGHNESS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS
XX = ± .03
XXX = ± .010
ANGULAR ± 1/2
DIM & TOL PER MIL STD 8B
BREAK SHARP EDGES REMOVE ALL BURRS

DRAWN BY: J.T. MUELLER 6 MAR 70
CHECK: [signature] 3/17/70
STRESS | GROUP | THERMAL | SYSTEM | RF | RELIABILITY | ATTITUDE | POWER | RELEASE INITIAL | FINAL

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
8621 GEORGIA AVENUE SILVER SPRING MARYLAND

SCHEMATIC DIAGRAM

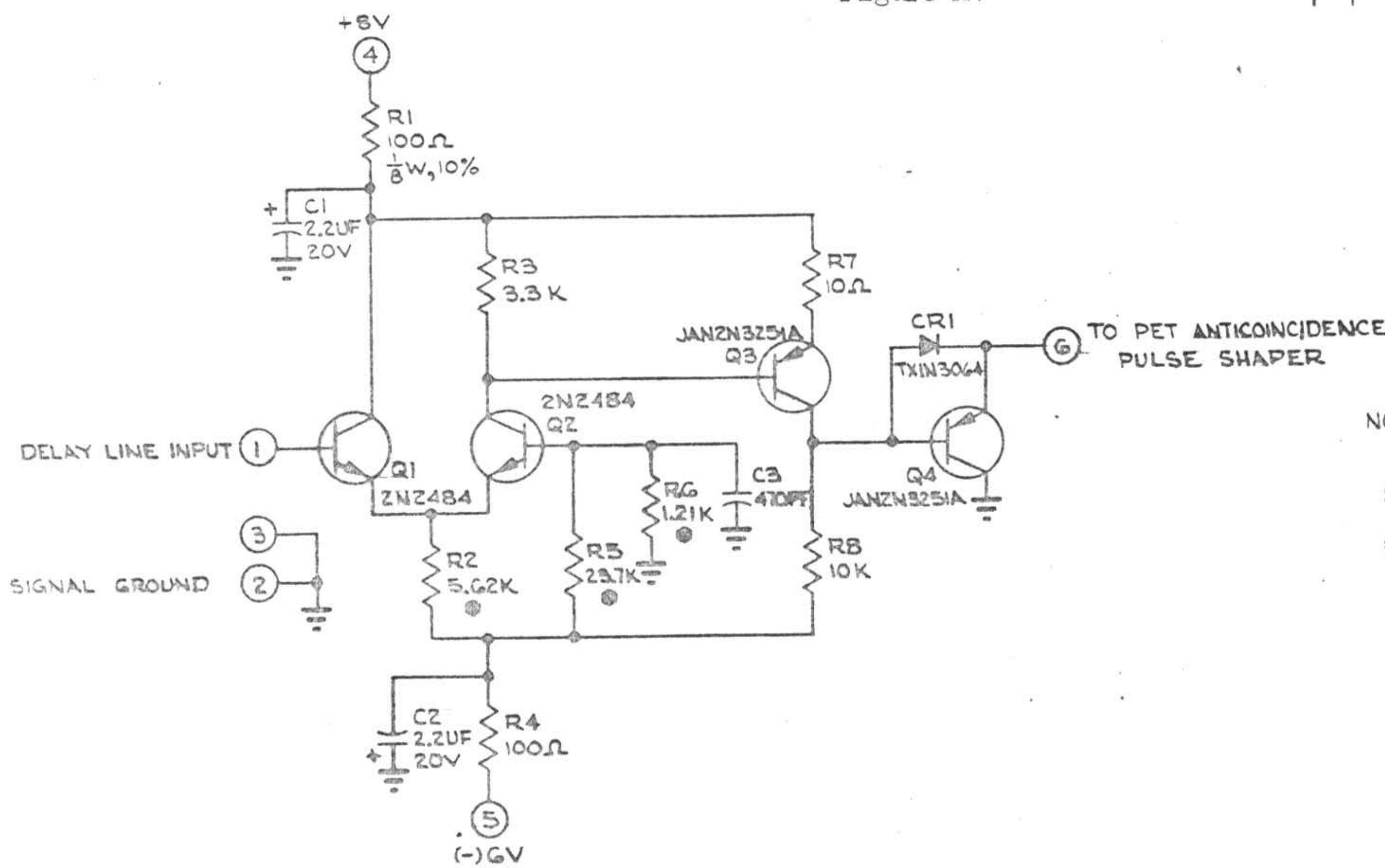
DISCR & ANTICOINCIDENCE PULSE GEN MODULE
CPME
IMP H+J SATELLITE

CODE IDENT NO	SIZE		ISSUE
88898	C	SRA-6541	a

SCALE | DO NOT SCALE PRINT | SHEET 1 OF 1

FORM ● SDO-301

Figure A4



NOTES - UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE 1/8 W, 5%
2. ALL RESISTORS MARKED ● ARE 1/10 W, 1%
3. Q1 AND Q2 ARE A MATCHED PAIR

HIGHEST REF DESIGNATION	
R8	C3
Q4	CR1

REVISIONS

ISSUE	BY & DATE	DESCRIPTION	CHECK	APPROVED & DATE

LIST OF MATERIAL

BASIC QTY ASSY	ITEM NO.	DWG SIZE	PART OR IDENTIFYING NUMBER	CIRCUIT SYMBOL OR ZONE	NOMENCLATURE OR DESCRIPTION	STOCK SIZE	MATERIAL AND/OR MATERIAL SPECIFICATION	MFG CODE	ISSUE REV.

PART NUMBER	SIZE	NEXT ASSEMBLY	QTY NA	USED ON	EFFECTIVITY END ITEM SER NO	WEIGHT
	A	SRA-G524	REF			
	C	SRA-G523	REF			
SRA-G521	C	SRA-G522	REF			

SURFACE TREATMENT (BEFORE ASSY)

SURFACE ROUGHNESS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS
XX = ± .03
XXX = ± .010
ANGULAR ± 1/2°
DIM & TOL PER MIL STD 8B
BREAK SHARP EDGES REMOVE ALL BURRS

DRAWN BY: J.T. MUELLER — PROJ — DATE: 27 FEB 70
CHECK — DATE — STRESS — DATE
GROUP — DATE — THERMAL — DATE
SYSTEM — DATE — RF — DATE
RELIABILITY — DATE — ATTITUDE — DATE
POWER — DATE
RELEASE INITIAL — FINAL

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
8621 GEORGIA AVENUE SILVER SPRING, MARYLAND

SCHEMATIC DIAGRAM
DELAY LINE BUFFER CORDWOOD MODULE
CPME
IMP H+J SATELLITE

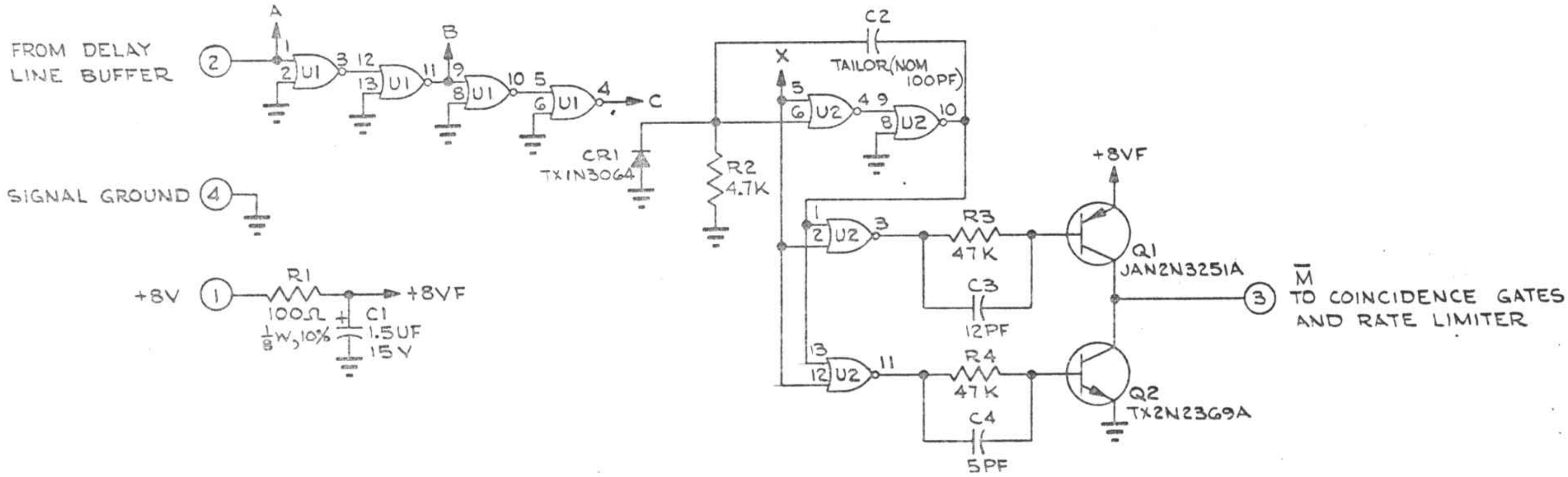
CODE IDENT NO	SIZE		ISSUE
88898	C	SRA-G521	a

SCALE — DO NOT SCALE PRINT — SHEET 1 OF 1

FORM SDO-301

REVISIONS				
ISSUE	BY & DATE	DESCRIPTION	CHECK	APPROVED & DATE

Figure A5



NOTES-UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE $\frac{1}{8}$W, 5%
2. INTEGRATED CIRCUITS ARE CD4001 (RCA)
3. PIN 7 OF I.C.'S IS SIG GRD; PIN 14 IS +8FV
4. POINT X IS CONNECTED TO A, B OR C DEPENDING ON REQUIRED DELAY

HIGHEST REF DESIGNATION	
R4	Q2
C4	CR1
U2	

BASIC QTY/ASSY	ITEM NO	DWG SIZE	PART OR IDENTIFYING NUMBER	CIRCUIT SYMBOL OR ZONE	NOMENCLATURE OR DESCRIPTION	STOCK SIZE	MATERIAL AND/OR MATERIAL SPECIFICATION	MFG CODE	ISSUE REV

LIST OF MATERIAL

PART NUMBER	SIZE	NEXT ASSEMBLY	QTY/NA	USED ON	EFFECTIVITY: END ITEM SER NO	WEIGHT
	A	SRA-G540	REF			
	C	SRA-G539	REF			
SRA-G537	C	SRA-G538	REF			

SURFACE TREATMENT (BEFORE ASSY) — SURFACE ROUGHNESS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS: XX = ± .03; XXX = ± .010
ANGULAR ± 1/2°
DIM & TOL PER MIL STD 8B
BREAK SHARP EDGES REMOVE ALL BURRS

DRAWN BY: J.T. MUELLER — DATE: 4 MAR 70
CHECK: C. Cunningham [illegible]

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
8621 GEORGIA AVENUE, SILVER SPRING, MARYLAND

SCHEMATIC DIAGRAM
PET ANTICOINCIDENCE PULSE SHAPER
CPME
IMP H + J SATELLITE

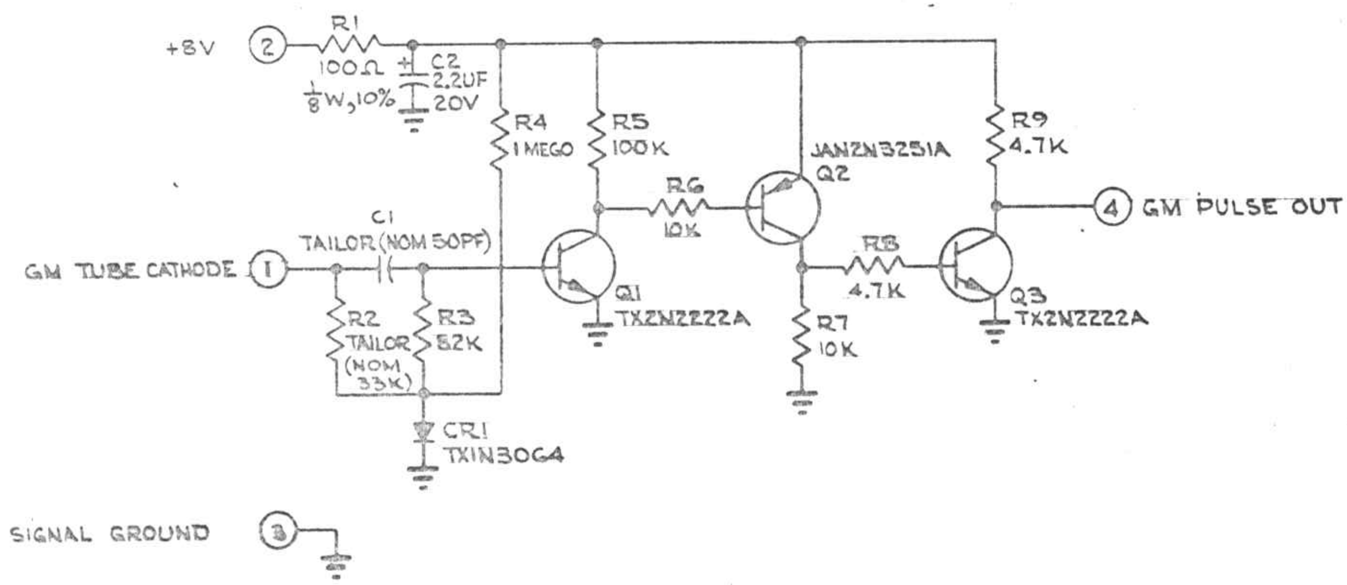
CODE IDENT NO	SIZE		ISSUE
88898	C	SRA-G537	a

SCALE — DO NOT SCALE PRINT — SHEET 1 OF 1

FORM # SDO-301

REVISIONS				
ISSUE	BY & DATE	DESCRIPTION	CHECK	APPROVED & DATE

Figure A6



NOTES-UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS ARE $\frac{1}{8}$W, 5%
2. CR1 SELECTED ACCORDING TO Q1 Vbe CHARACTERISTICS

HIGHEST REF DESIGNATION	
R9	C2
Q3	CR1

BASIC QTY/ASSY	ITEM NO	DWG SIZE	PART OR IDENTIFYING NUMBER	CIRCUIT SYMBOL OR ZONE	NOMENCLATURE OR DESCRIPTION	STOCK SIZE	MATERIAL AND/OR MATERIAL SPECIFICATION	MFG CODE	ISSUE REV.

LIST OF MATERIAL

PART NUMBER	SIZE	NEXT ASSEMBLY	QTY/NA	USED ON
	A	SRA-G532	REF	
	C	SRA-G531	REF	
SRA-G329	C	SRA-G530	REF	

SURFACE TREATMENT (BEFORE ASSY) — EFFECTIVITY END ITEM SER NO — WEIGHT — SURFACE ROUGHNESS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS
XX = ± .03
XXX = ± .010
ANGULAR ± 1/2°
DIM & TOL PER MIL STD 8B
BREAK SHARP EDGES REMOVE ALL BURRS

DRAWN BY: J.T. MUELLER 2MAR70
CHECK: Cunningham (signature)
PROJ — STRESS — GROUP — THERMAL — SYSTEM — RF — RELIABILITY — ATTITUDE — POWER — RELEASE INITIAL — FINAL

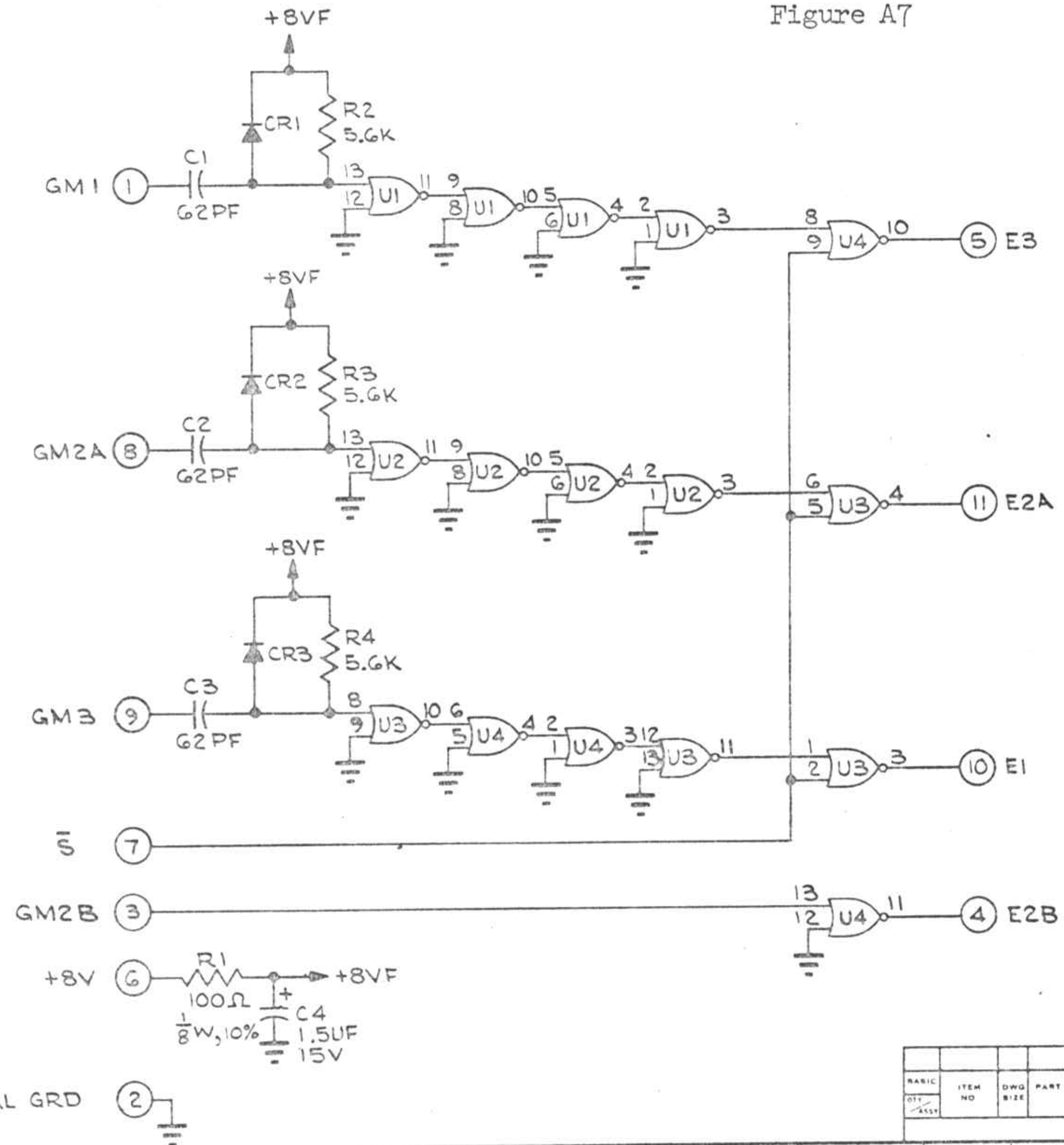
THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
8621 GEORGIA AVENUE SILVER SPRING MARYLAND

SCHEMATIC DIAGRAM
GM TUBE SATURATING AMP MODULE
CPME
IMP H+J SATELLITE

CODE IDENT NO	SIZE		ISSUE
88898	C	SRA-G529	a

SCALE — DO NOT SCALE PRINT — SHEET 1 OF 1

Figure A7



NOTES-UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS ARE $\frac{1}{8}$W, 5%
2. ALL DIODES ARE TX1N3064
3. ALL I.C.'S ARE CD 4001 (RCA)
4. I.C. POWER IS PIN 14 +8VF; PIN 7 SIGNAL GRD

HIGHEST REF DESIGNATION	
R4	C4
U4	CR3

REVISIONS

ISSUE	BY & DATE	DESCRIPTION	CHECK	APPROVED & DATE

LIST OF MATERIAL

BASIC QTY/ASSY	ITEM NO	DWG SIZE	PART OR IDENTIFYING NUMBER	CIRCUIT SYMBOL OR ZONE	NOMENCLATURE OR DESCRIPTION	STOCK SIZE	MATERIAL AND/OR MATERIAL SPECIFICATION	MFG CODE	ISSUE REV

PART NUMBER	SIZE	NEXT ASSEMBLY	QTY	USED ON
	A	SRA-G520	REF	
	C	SRA-G519	REF	
SRA-G517	C	SRA-G518	REF	

SURFACE TREATMENT (BY TYPE ASSY) | EFFECTIVITY END ITEM SER NO | WEIGHT | SURFACE ROUGHNESS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS
XX = ± .03
XXX = ± .010
ANGULAR ± 1/2°
DIM & TOL PER MIL STD 8B
BREAK SHARP EDGES REMOVE ALL BURRS

DRAWN BY: J.T. MUELLER 26 FEB 70
CHECK: C. Cunningham 3/18/4

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
8621 GEORGIA AVENUE SILVER SPRING MARYLAND

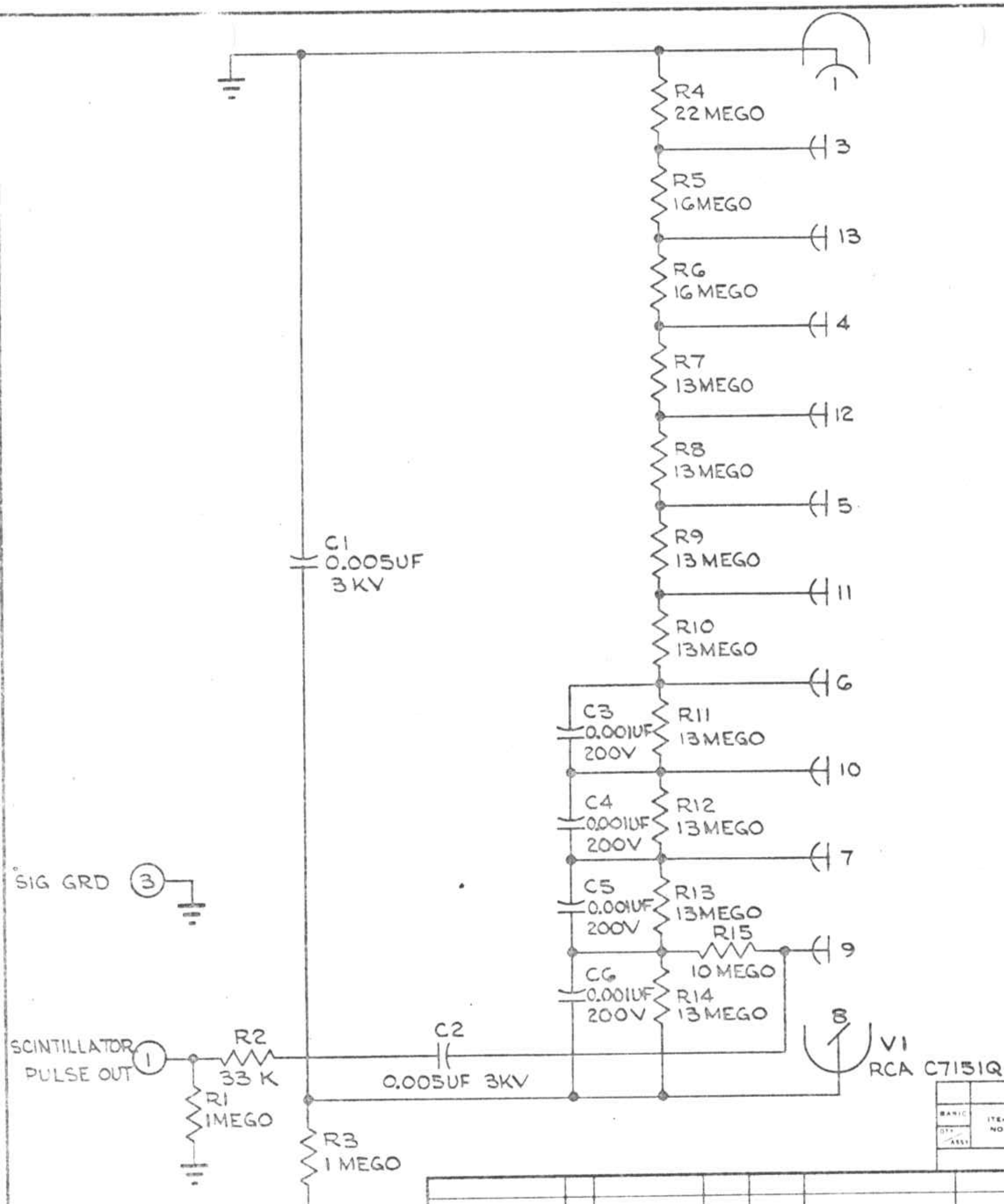
SCHEMATIC DIAGRAM
GM TUBE PULSE-SHAPING + ANTI-COINCIDENCE GATE
CPME
IMP H + J SATELLITE

CODE IDENT NO	SIZE		ISSUE
88898	C	SRA-G517	a

SCALE | DO NOT SCALE PRINT | SHEET 1 OF 1

FORM SDO-301

Figure A8



NOTES-UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS ARE ¼W, 5%
2. THE COAX CONNECTED TO PIN 1 IS TO BE GROUNDED TO SIG GRD

HIGHEST REF DESIGNATION	
R15	C6
V1	

REVISIONS				
ISSUE	BY & DATE	DESCRIPTION	CHECK	APPROVED & DATE

BASIC QTY ASSY	ITEM NO	DWG SIZE	PART OR IDENTIFYING NUMBER	CIRCUIT SYMBOL OR ZONE	NOMENCLATURE OR DESCRIPTION	STOCK SIZE	MATERIAL AND/OR MATERIAL SPECIFICATION	MFG CODE	ISSUE REV

LIST OF MATERIAL

PART NUMBER	SIZE	NEXT ASSEMBLY	QTY	USED ON	EFFECTIVITY END ITEM SER NO	WEIGHT
	A	SRA-6548	REF			
	C	SRA-6547	REF			
SRA-6545	C	SRA-6546	REF			

SURFACE TREATMENT (BEFORE ASSY)

SURFACE ROUGHNESS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS
XX = ± .03
XXX = ± .010
ANGULAR ± 1/2°
DIM & TOL PER MIL STD 8B
BREAK SHARP EDGES, REMOVE ALL BURRS

DRAWN BY J.T. MUELLER 9 MAR 70
CHECK [signature]
PROJ / STRESS / GROUP / THERMAL / SYSTEM / RF / RELIABILITY / ATTITUDE / POWER / RELEASE INITIAL / FINAL

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
8621 GEORGIA AVENUE SILVER SPRING, MARYLAND

SCHEMATIC DIAGRAM
PM TUBE BLEEDER STRING ASSY
CPME
IMP H+J SATELLITE

CODE IDENT NO	SIZE		ISSUE
88898	C	SRA-6545	a

SCALE DO NOT SCALE PRINT SHEET 1 OF 1

FORM SDO-301