SPARTA AS-30B

AUDIO CONSOLE

TECHNICAL MANUAL

AS-30B CONSOLE

SPECIFICATIONS

MIXERS:	Five
INPUTS:	Nine stereo pairs; One each for Mixers 1 through 4 and five for Mixer 5, plus external AIR input. Low-level; -55 db nominal from 150/250 ohms (50 ohm selected by jumper), standard on Mixer 1 (optional for Mixer 2). Hi-level; -10 dbm nominal from 600 ohm source, standard on Mixers 2 through 5. See note 1. AIR; Depends upon external monitor-amp.
OUTPUTS:	Program; 8 dbm into balanced 600 ohms at Ø vu. 22 dbm max. Audition; 8 dbm nominal into 600 ohms single-ended. (from 60 ohm source. See note 2). Monitor; lv nominal into hi-Z load. Cue; 0.lv nominal into hi-Z load. Phones; 1 mw nominal into 10K ohms.
FREQ. RESPONSE:	All outputs less than 2db down, 20 Hz to 20 kHz.
NOISE:	Below 65 db at Ø vu out with -55 db low level input Below 75 db at Ø vu out with -10 dbm hi-level input
DISTORTION:	All outputs less than 0.5% THD at normal operating levels. Less than 1% THD at max outputs.
CROSSTALK:	Below noise in all channels and modes
POWER:	117/234 vac, 50/60 Hz.
SIZE:	W, 15 1/2"; H, 6 5/8"; D, 10".
SHIPPING WT:	24 lbs (incl. pwr. supply)
MUTING:	Switch closure to rear-panel terminals from Mixers 1 to 3, closed in Aud. & Prog. modes for control of external DC relays.
NOTE 1:	Hi-level inputs are balanced-bridging to allow individual termination of input lines at rear panel, if required. Permits constant line load plus use of high-impedance sources.
NOTE 2:	Identical line amplifiers for Program and Audition outputs.

SPARTA ELECTRONIC CORPORATION

Dear Customer,

Careful attention to Quality Control is another important element in our daily effort to provide you with excellence of product and service. At SPARTA each piece of equipment and sub-assembly receives numerous inspections and tests in the process of production. The final results must measure within our exacting requirements before it is shipped to you. Listed below are just a few of the major check points and tests this particular piece of equipment has received before being prepared for shipment. Should you note any discrepancy in the appearance or operation of your SPARTA Products or if you have any general comments as to how we might be of greater service, your suggestions will be greatly appreciated.

AS-30B

Customer: Union Wire - Greenbay SERIAL NO. 291 DATE: 8/16/72

PWR. SUP. SERIAL NO: 690 CAL. BY Steve No. OF PREAMPS ——

	OUTPUT	DISTORTION	SIGNAL/NOISE	PHASE
CH-1L:	+ 8 dbm	.15 %	- 68 db	✓
CH-1R:	+ 8 dbm	.14 %	- 69 db	✓

CH-1L Freq. Resp. 1 KHz Ref. -2db at ____ Hz -2db at ____ KHz
CH-1R Freq. Resp. -2db at ____ Hz -2db at ____ KHz

MONO-STEREO MIC. R & L ____ MONO-STEREO OUT ____ CROSSTALK ____

	OUTPUT	DISTORTION	SIGNAL/NOISE	PHASE
CH-2L	+ 8 dbm	.14 %	- 79 db	✓
CH-2R	+ 8 dbm	.12 %	- 78 db	✓

Freq. Resp. CH-2L 18Hz-26K CH2-R 19-27K Level ✓ +8

	OUTPUT	DISTORTION	SIGNAL/NOISE	PHASE
CH-3 L	+ 8 dbm	.16 %	- 79 db	✓
CH-3 R	+ 8 dbm	.15 %	- 78 db	✓

Freq. Resp. CH-3L 20-24K CH3-R 19-30K

	OUTPUT	DISTORTION	SIGNAL/NOISE	PHASE
CH-4 L	+ 8 dbm	.12 %	- 79 db	✓
CH-4 R	+ 8 dbm	.11 %	- 78 db	✓

Freq. Resp. CH-4L 19-31K CH4-R 18-33

	OUTPUT	DISTORTION	SIGNAL/NOISE	PHASE
CH-5 L A Th. E	+ 8 dbm	.17 %	- 78 db	✓
CH-5 R A Th. E	+ 8 dbm	.17 %	- 78 db	✓

Freq. Resp. CH-5L 20-25K CH5-R 18-30K

	OUTPUT	DISTORTION	SIGNAL/NOISE	PHASE
Audition L	+ 8 dbm	.12 %	- 70 db	✓
Output R	+ 8 dbm	.10 %	- 71 db	✓

Monitor Air R & L ✓ Prog R & L ✓ Aud R & L ✓

PHONE ✓ CUE ✓ MUTING ✓

ASC-305B

TEP-3S ____ Wow & Flutter RTT ____ LTT ____

Calib by ____ Cart. ____ ____

3/29/71

AS-30B CONSOLE

DESCRIPTION

GENERAL:

The AS-30B is a desk-type Stereo Audio Console featuring five mixing channels with push-button-selected multiple inputs for Mixer 5. As normally supplied, the first mixer includes low-level preamplifiers for 50 to 150 ohm microphones and the remaining four are supplied with high-level balanced input transformers. The input transformers for Mixer 1 are located on cards to allow replacement with another pair of low-level preamplifiers.

The high-level inputs are balanced bridging, which avoids the source loading of the typical 600 ohm input and greatly increases the flexibility of the console. In the very-rare instance where a 600 ohm termination is required, it is a simple matter to add a pair of 620 ohm resistors across the line at either the source or load end. Some sources, such as Ampex and TEAC, provide for this internally. When operating from sources intended for single-ended, high-impedance loads,the minus input terminals of the consoles are connected to the shield and the console now appears as a single-ended high-impedance (10K) load.

The Audition and Program Amplifiers in the AS-30B are identical and interchangeable. In the Audition side, the line-amplifier gain is determined by internal resistors and is set to provide approximately the same level output as the Program side with normal gain control settings. The audition output terminals are fed directly from the audition line amplifiers from a single-ended source impedance of 60 ohms. The audition output is then capable of driving multiple loads with little, if any attenuation.

The input-source selection for Mixer 1 is via a push-button assembly which allows more than one source to be selected simultaneously. This feature, if used judiciously, will permit more than one source to be mixed simultaneously on the one mixer pot. If this is attempted, the individual source levels must be adjusted externally but the console will not load either source. It must be considered, however, that each of two sources will then be loaded by the other, and suitable isolation must be provided, if required.

INSTALLATION: Input and Output Connections, with the exception of the Mixer 1 XLR connectors, are made via rear-panel barrier strips. Spade lugs or fanning-strips are not required since the barrier strips are designed with captive plates to easily accommodate several stripped wires per terminal, either solid or stranded. Rear panel connections are clearly identified to facilitate installation without resorting to the manual or to a numbered diagram.

Audio connections are normally made with twisted-pair, shielded cable such as Belden 8737 (stranded) or 8739 (solid). Either may be used, although it is generally more satisfactory to use solid wire in a permanent installation where flexibility is not required since solid wire is easier to handle and less apt to inadvertently short to an adjacent terminal. Single-ended outputs and inputs can use the same type cable by simply clipping off the unused conductor. The input terminals include a ground connection for the cable shield and the transformer input windings are ungrounded or "floating". This prevents the possibility of setting up a severe ground-loop and also permits one side of the transformer input to be grounded for single-ended operation if desired. In like manner, the program line outputs are also isolated.

A central ground lug is provided on the rear panel for connection to the system master ground, and as heavy a guage strap or braid as practical should be used.

CIRCUIT DESCRIPTION, SPARTA AUDIO CONSOLES

GENERAL. The description to follow is generally applicable to all SPARTA consoles, mono or stereo, and outlines the basic system of selecting, mixing and amplifying the usual program-sources plus the methods used to process auxilliary functions such as cue and monitor signals. Features applicable to specific consoles are then discussed elsewhere in the appropriate manual sections.

Microphone Preamplifiers. With a nominal gain of 55db. the output level from the preamp to the mixer potentiometer is typically -10 to Ø dbm. depending, of course, on the sound level and microphone used. In a normal situation, then, the preamplifier output is at essentially the same level as the high-level input signals, resulting in approximately the same mixer-level settings for normal operation. Preamp gain can be changed to accommodate unusual situations by referring to the preamplifier circuit description.

As normally supplied by SPARTA, the input transformer is wired for use with 150/250 ohm microphones. A transformer tap is provided for easy conversion to use with 30/50 ohm microphones.

All SPARTA Audio Consoles are supplied as standard with a microphone preamplifier in the first mixer position. The preamplifiers are interchangeable with high-level input cards, however, so additional microphone preamplifiers may be incorporated, or alternately, all inputs may be high-level.

High-Level Inputs are brought to the primaries of input-isolation transformers which are suitably terminated and connected directly to the proper Mixer potentiometers. The primaries are floating (ungrounded) to allow single-ended connection and also to prevent the possibility of setting up undesired ground-loops or common-mode signals via the input cables.

Mixing takes place by feeding the output of each mixer potentiometer through a high-value series resistor (10K or 27K) to a common mixing bus, which in turn leads to a mixing amplifier. The mixing amplifier, which is usually located with the line amplifier, is specifically designed to have a very low input impedance, typically 100 ohms.

Since the Mixer feed resistors are so much higher in value, the mixer amp becomes a "current sink" and responds to the current in the feed resistors, which in turn is determined by the voltage available from the Mixer pots. The output of the mixer amp, then, is proportional to the sum of the currents at its input.

CIRCUIT DESCRIPTION, GENERAL

Mixer isolation is excellent with this system since the current from each feed resistor will follow the easiest path -- obviously into the mixer amp rather than to another Mixer pot. Changing one mixer-pot, then, will have relatively little effect upon the program level coming from another mixer-pot.

There is obviously a significant loss of program power in the mixer feed resistors, but the power levels are so low that it is a simple matter to recover the loss in the mixer amplifier. Mixer amp. gain is set to restore the program to substantially the same level as originally fed to the mixer pots , with the mixer-pots at their usual operating positions, about one o'clock.

Since a "current" mixer operates from a relatively high source impedance, it allows the use of high impedance mixer-pots. And since it is not critical of the precise source impedance, there is no need to resort to the bulk and cost of precision ladder attenuators.

Output of the mixer system is then fed to the Master gain control at essentially the same level as the original high-level program material. To test the entire mixer system, a -10 or Ø dbm signal is provided at a high-level input, the appropriate mixer pot is set at the normal operating position and the signal is viewed or measured across the Master gain control.

CIRCUIT DESCRIPTION, GENERAL

The Line Amplifier provides the final amplification between the Master gain control and the line output terminals. It must therefore recover the signal loss of the Master gain control, compensate for any losses in matching or isolation pads, and provide power-gain for driving the output line at rated level.

For a rated output of 8dbm into a 600 ohm line at zero VU, several factors must be considered: A minimum of 10 dbm of additional gain, without distortion, must be available to handle program peaks (headroom). Also, the output transformer must be isolated from the line with a pad, typically 4 db, to prevent interaction with line reactances. Finally, the line amplifier output-impedance must properly match the line transformer primary so the output terminals are a true 600 ohm source.

The line transformer must then handle a nominal level of 12dbm, and 22dbm on program peaks. The line amplifier must be capable of supplying 18dbm to the line plus the power-losses in the line pad, insertion loss in the transformer and internal loss necessary to obtain a proper impedance match. This is considered in detail in the line-amplifier section of the manual.

VU Meter. The standard VU meter contains rectifier diodes and consequently appears as a non-linear impedance to its signal source. To avoid introducing distortion on the program-line, it is necessary to provide isolation between the meter and the line.

It is also necessary to attenuate the level to the meter so it can indicate Ø vu when the line is at 8dbm and finally, the attenuator must be so designed as to appear to the meter as a 3.9K ohm source to preserve the linearity of the meter indication.

This latter requirement accounts for the meter pad being a "T" configuration rather than a simple series resistor. In SPARTA consoles, the metering source is the line transformer output, ahead of the line pad, which allows an added 4 db of attenuation in the meter pad for increased isolation. A balanced "H" pad is not required since the meter need not be balanced to ground.

Cue. Common to all SPARTA consoles is a "Cue" position on each Mixer potentiometer. In the simplest case, program material from each mixer, through the cue switches and isolation resistors, is delivered to a rear-panel termainal for feed to an external cue amplifier. In more elaborate consoles, a cue level control, internal amplifier and optional-use internal speaker are provided.

Monitor. Although provisions for program-line monitoring vary in different SPARTA consoles, in all cases the source of program material is the output stage of the program line amplifier. Since there are no active or non-linear components to follow, the monitor provides constant assurance of both level and quality, whereas the VU meter alone only indicates level.

CIRCUIT DESCRIPTION/MAINTENANCE

PREAMPLIFIER, 1018

The 1018 Preamplifier is supplied standard for operation with 150/250 ohm microphones and provides a nominal gain of 55db into a 600 ohm or higher load. A jumper is provided on the circuit board, either a wire or a low-value resistor, to accommodate 30/50 ohm microphones.

The 1018 Preamplifier differs from its predecessor, the 1008A, in several respects. The microphone transformer is a miniaturized PC-mounting type with extended high and low frequency response. The 1018 circuitry takes full advantage of the transformer's 80K secondary impedance to provide improved noise performance, expanded frequency response and excellent overload characteristics.

With normal microphone input levels, the output level to the mixer will be approx- 0 dbm. The maximum output level of the 1018 before clipping is in excess of 14 dbm, which assures more than adequate head-room in normal operation. In the event that microphones must be used, which provide unusually high output, a pad may be added in series with the microphone or a resistor in the 1018 may be changed in value to lower the preamp gain, as described later.

The input signal is amplified approximately 20db by the input transformer and then amplified a further 35db by transistors Q1 and Q2. The output signal from Q2 then passes through emitter-follower Q3 to provide the necessary low output impedance.

The emitter of Q2 is heavily bypassed to ground by capacitor C8; therefore the base impedance of Q2 is quite low, being essentially a forward-biased diode.

Most of the signal current from Q1 passes to the base of Q2, then, rather than through the much higher impedance of the collector resistor R3. This assures maximum current gain from Q1, although the voltage gain is relatively small.

The emitter of Q3 is not bypassed, however, so the base impedance of Q3 is relatively high compared to Q2's collector resistor R4. The signal current from Q2 must therefore cause a significant signal voltage across R4. This assures a maximum of voltage gain from Q2, and since Q3 is an emitter-follower this signal appears at the low impedance emitter of Q3.

A portion of the output signal determined by feedback attenuator R8/R9 appears at the emitter of Q1. Since Q1 and Q2 both invert the signals through them, the feed-back to the emitter of Q1 is in-phase with the signal input to the base of Q1. This consitutes negative feed-back, since the feed-back attempts to cancel the input signal. The open-loop gain (without feed-back) is extremely high, so the normal closed-loop gain is determined by the turns- ratio of the input transformer plus the ratio of R8 to R9. It can now be seen that changing the value of either R8 or R9 will change the gain of the amplifier proportionally. For example, if R9 were to be increased to 360 ohms, the voltage gain of the amplifier would decrease by 6db, since the output of the amplifier would only need to swing half as far to provide the same feed-back voltage to the emitter of Q1. Consequently, reasonable selection of gain can be obtained simply by selecting the value of R9.

The use of negative feedback to control gain via the input emitter also has the effect of raising the input impedance to Q1. This permits the use of a high-ratio input transformer for added voltage-gain without added noise. Distortion is also lowered with negative feed-back since any difference between the input and output wave-forms appears as an error signal. Distortion in the 1018 is held well below 0.1%.

A stable operating-point , or "Q", is one of the most important characteristics of an amplifier because the maximum signal output without clipping and therefore the headroom is determined by the average DC voltage at the emitter of Q3. The emitter can move no higher than the supply voltage and no lower than ground, so the ideal operating-point, permitting maximum dynamic range, is logically some-where near to one-half the supply voltage.

The emitter voltage of Q3 is set by the collector voltage of Q2 and since the collector current of Q2 is also the emitter current of Q2, any change in the collect-or voltage of Q2 also appears as an inverted change at the emitter of Q2. The bias current for Q1 is obtained through R6 from the emitter of Q2; therefore, any change of emitter voltage at Q2 results in a corrective change of bias current to Q1. This not only provides normal operating bias for Q1, but any change at Q2 is also fed-back to Q1, as an error signal to maintain the proper operating-point.

<u>Maintenance:</u> From the foregoing circuit description, it can be surmised that failure of any component involved in the DC biasing of the circuit, including leaky capacitors, will cause a shift in the operating-point of Q3. Stated in a more useful manner, if the emitter of Q3 is at a reasonable voltage, then all of the components involved must be functioning normally.

During trouble-shooting most components, including the transistors, can be removed from question simply by making two DC voltage measurements: First, the supply voltage at terminal 3, and second, the voltage at the emitter of Q3. When we consider that resistors may vary 5% or 10% and individual transistor gains may vary by a factor of 2 or more, it is reasonable to expect a possible variation of $\pm$ 20% or so in the operating point. This, then, would indicate a reasonable voltage range for the emitter of Q3 of from approximately 10.5 to 15.5 volts. In the event of catastrophic failure of any of the resistors or transistors, or of excessive leakage or shorts in any of the capacitors, it will almost invariably result in a gross shift of the operating-point towards the supply or towards ground. If the operating-point is beyond the limit given but still capable of moving further in either direction, the amplifier will still be operative; it simply will not have as much dynamic range or head room.

If the operating point is found to be correct, but the amplifier gain is abnormally high or low, (which usually would be accompanied by high distortion) it would most likely be due to either an open capacitor or a defective input transformer. Transistor failure would normally not be a factor simply because, at audio frequencies, a transistor cannot tell the difference between AC and DC, so we would look for a component which could alter the signal gain without affecting the DC operating-point. Excessive noise can be due to almost any component. The most likely suspects would be the input transistor, Q1, followed by the resistors and capacitors associated with the first stage since noise generated there would be subject to the most amplification.

CIRCUITRY DESCRIPTION/MAINTENANCE

Mixer & Line Amps 1020

The 1020 board consists of two independent amplifiers; a mixer amp and a program line amp. The mixer amp is characterized by very low input and moderate output impedances and the program line amp by high input and low output impedances.

Mixer Amplifier: The input signals to the mixer amplifier are obtained from a group of mixer potentiometers and each one must be capable of being switched or adjusted in level without affecting the level coming from the others. The mixer amplifier is specifically designed for very low input Z (100 ohms) and is supplied signal currents from the mixers through high value resistors of 10K ohms or more. Each input current, then, follows the path of least resistance into the mixer amplifier, independent of the condition of the other mixing channels, thereby providing excellent isolation between mixer channels.

With a very low input Z and high source Z, the input signals take the form of a current which is a linear function of the source voltage. The unusually low distortion characteristics accrue in part because small changes of an already low input Z have virtually no effect on the signal input currents. Obviously, the voltage attenuation of the mixer system is quite high -- it is the input current which determines the output voltage of the mixer amplifier. The output impedance is sufficiently low to serve as a voltage-source for the Master gain control. The mixer amplifier therefore operates in the "trans-impedance" mode; that is, the output voltage is a linear function of the input current, not the input voltage. A measure of voltage gain is not appropriate unless the input voltage is applied through a series feed resistor and the measured gain will then depend on the value of this resistor as well as the amplifier gain.

Circuit Operation: The first stage of the mixer amplifier Q1, is a conventional grounded-emitter amplifier with operating bias determined by current from the collector via R3. A decrease of collector voltage will cause a decrease of base current, resulting in a decrease of collector current which tends to raise the collector voltage. R3 then, forms a negative feedback path which assures that Q1's operating-point remains within a reasonable range. Normal operation of Q1 will be obtained at any collector voltage between approximately 5 and 20 volts.

Bias resistor R3 also performs a secondary function: Since signal voltage from Q1's collector is also fed back to the base, it is a negative-feedback path to the signal, as well. An input signal current to the base of Q1 is met by an opposing signal current from R3, with the result that R3 appears to the input signal as a shunt impedance much lower than the schematic value. This contributes towards lowering the input impedance of the amplifier.

The second stage Q2, is biased in the same manner as Q1 by R5. Although R5 does have the effect of lowering the input impedance of Q2, it is not nearly so effective since the voltage gain of Q2 is limited by the un-bypassed

Circuit Operation: (cont'd)

emitter resistor R8; therefore, the relative feedback signal current is much lower.

The voltage gain of Q2 is determined by the ratio of resistor R8 to the collector load impedance R7. Consider Q2 as having a typical beta of 100, and no external load on the collector. The emitter resistor R8 carries the collector current plus the base current, but since the base current is only 1% of the collector current, we can assume the emitter and base currents to be the same for all practical purposes.

The emitter is not bypassed, so a change of voltage at the base results in an equal change at the emitter. This in turn changes both emitter and collector currents by the same amount. But the collector current is flowing through a resistor, R7, which is ten times larger than R8, so it must cause ten times the voltage-change. The voltage-gain of Q2, then, must simply be the ratio of R7 to R8, or ten. In normal application, Q2 is loaded by the Master gain control (5K ohms) so the AC collector load impedance is 1.75 K ohms instead of 2.7K resulting in a normal stage gain of approximately 6.5, or 16db.

The unbypassed R8, then, forms a third negative-feedback path - - this time to fix the ac gain --- because the collector current through R8 produces an emitter voltage change which tends to cancel the input base voltage, thereby limiting the gain.

The collector voltage of Q2, like Q1, is not critical. The nominal signal level at the collector of Q2 is Ø dbm, or about 1 volt rms. If we allow for 12db of headroom, or 4 volts rms, the collector must be free to swing 12 volts peak-to-peak or 6 volts in either direction. So an operating-point between approximately 8 and 18 volts will assure normal operation.

Circuit Operation (cont'd)

The signal voltage at the emitter of Q2 is the same as at the base of Q2 and so is a second source of shunt negative feedback to the base of Q1. Only this time, the source is a low impedance (R8) permitting the feedback resistor R6 to be low, also. R6, then, is a fourth negative-feedback path and has the most significant effect in lowering the input Z of Q1. In addition, the source for R6 is a voltage which is a fixed portion of the output voltage. Therefore, R6 also serves to set the gain of Q1. When an input signal current is applied to Q1, the signal voltage at the emitter of Q2 can only rise to the point where the combined feedback currents from R3 and R6 approach cancellation of the input current, with hthe current through R6 being dominant.

Very low distortion results, typically 0.035%, since any difference of amplitude or phase between input and feedback currents appears as an error signal. The output voltage is therefore a linear reflection of the input current, which in turn is a linear function of voltage at the source end of the m ixer feed resistors.

Gain of the mixer amplifier may be verified by applying an input signal current of 10 microamps through a minimum resistance of 2K ohms. Signal level at the collector of Q1 should be about 130 mv, and at the collector of Q2 nearly 850 mv with the output connected to the 5K Master gain pot. With no external load, the output should be nearer to 1.3v.

Circuit Operation (cont'd)

Do not be concerned by 10 or 20% gain variations, since many 10% resistors are used and are easily compensated for by the normal control settings.

Line Amplifier: The input stage, Q3 and Q4, is a differential comparator which performs three separate functions: First is signal amplification wherein Q3 operates in the transconductance mode; that is, the collector current is a function of base voltage. Second, a large proportion of the average dc voltage at the emitters of Q6 and Q7, which appears at the base of Q4, is compared to the base voltage of Q3 to stabilize the operating-points of the output transistors. And third, a small proportion of the output signal, which is fed back to the base of Q4, is compared to the input signal at the base of Q3, thereby setting the ac gain.

When power is first applied, C13 must be charged to one-half of the supply voltage through Q6, and to protect Q6 the charging-rate must be limited. Q6 cannot turn on until Q5 and hence Q3 begin to conduct. But Q3 cannot conduct any faster than C6 can charge, so C6 not only filters the bias current to Q3, but also controls the charge-rate of C13.

The ideal dc operating-point for the output transistors Q6 and Q7 is one half of the supply voltage, because this is the point at which the greatest peak-to-peak output-voltage swing, or headroom, is available. When first turned on, C6 charges and the base of Q3 is brought to 40% of the supply voltage. As C13 charges, the voltage common to the emitters of Q6 and Q7 rises towards the supply. Upon reaching one-half of the supply voltage, 80% of this (or 40% of the supply voltage) reaches the base of Q4 via dc divider R16, R15, R14 and R22.

These resistors form a dc divider because C11 prevents output signal currents from reaching Q4 via R15/R14. Thus the comparator Q3/Q4 compares the dc operating-point of the output to the base voltage of Q3, which is as stable as R9, R10 and R11 will allow. The dc gain of the amplifier, then, is very nearly unity, resulting in an extremely stable operating-point.

The ac, or signal gain, is determined in very similar fashion: The output signal is taken from the load end of C13 so the feedback signal is a true representation of the line output. At very low frequencies, both amplitude and phase of the output will change due to the rising reactance of C13. This change will appear as an error-signal when compared with the input, and allows the reserve open-loop gain of the amplifier to correct the error, thereby permitting use of a capacitor of reasonable size and value while maintaining clean, undistorted response to below the audio range.

The ac feedback path is via divider R14 and R15 and gain is set by the ratio of these two resistors. The junction of R15 and R16 is at ac ground so R16 plays no part at audio frequencies. It can be seen, however, that ac gain would drop to near unity if C11 were open or removed. The ac gain is therefore set at 11, or 21 db.

The collector impedance of Q3 is so high that R13 has no effect on gain. In the event of circuit failure, however, it serves to protect Q5 by limiting base current. D1 provides ambient temperature compensation for

Line Amplifier (Cont'd)

Q6 and Q7, while R17, R20 and R21 provide operating bias and thermal stability. At maximum signal amplitudes Q6 and Q7 must approach saturation. Q6 can readily do so because its base current comes from Q5, and Q5's collector current is determined by its base current -- not its collector voltage. The base current to Q7, however, is dependent upon R18 and R19 and without C12 the base current would fall off as the base approached ground, resulting in clipping and/or distortion. With the junction of R18 and R19 "boot-strapped" from the output, R17 appears as a constant-current source to Q7 and the junction can be driven below ground.

R22 raises the source-impedance of the line amp, at the expense of nearly 6db of signal level, so as to provide a good match for the 60 ohm primary of the line output transformer. The transformer produces 10 db of voltage gain, which is followed by a 3 db loss in a resistive isolation pad. The rms signal voltage at the emitters of Q6 and Q7 is therefore the same as the rms voltage delivered to the external 600 ohm load.

If we assume a nominal Ø dbm voltage-level at the top of the Master gain control the 1020 line amplifier will produce 8 dbm (at Ø vu) into the output line with 13 db of gain left to recover the voltage loss in the Master gain control. This corresponds to normal operation at about the one-o'clock position.

Component failures, if they occur, will almost always result in a shift of operating-point. If the operating-points in the 1020 are normal, all of the components associated with dc operation must be normal, including transistors. So if an amplifier then has no ac gain, the logical suspects will be capacitors which may open without affecting dc operation. Capacitors C2, C8, and

Line Amplifier (cont'd)

C10 may safely be ignored at this time since they are only effective above the audio spectrum.

Noise or hiss, may be due to almost any component but these associated with Q1 or Q3 and Q4 would be most suspect since subsequent gain is the highest. Hum (120 Hz) would of course lead one to the power supply.

Distortion will be practically non-existent if normal dc and ac gain is obtained. The line amplifier, for example has an open-loop gain of more than 66 db, providing more than 45 db of feedback so that distortion is almost un-measureable. If distortion does·arise, it will almost always be the result of transistor substitution.

WARRANTY

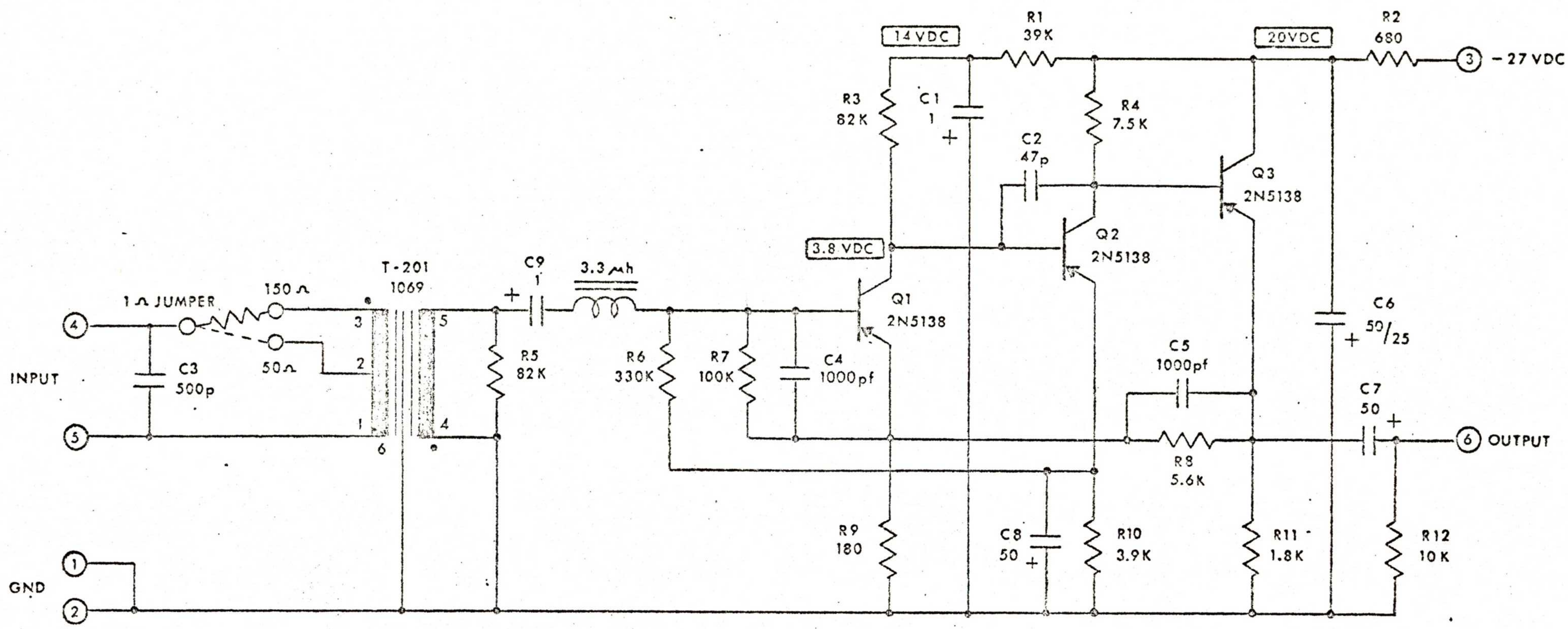
SPARTA ELECTRONIC CORPORATION warrants to the purchaser of SPARTA Electronic Products that any part thereof, which proves to be defective within one year from the date of shipment, will be repaired or replaced free of charge if returned to the factory prepaid. All returns must be specifically authorized by the factory prior to shipment.

SPARTA reserves the right to make changes in design and improvements upon its products without assuming any obligation to install the same upon any of its products theretofore manufactured.

High voltage transformers, modulation transformers, reactors and filter chokes carry an extended warranty of 50% of the replacement cost being allowed should failure occur during the second year. Electron tubes and silicon rectifiers bear only the warranty of the manufacturer thereof in effect at the time of shipment to Purchaser.

Accessories supplied by, but not manufactured by SPARTA ELECTRONIC CORPORATION, shall carry only such manufacturer's standard warranty and are specifically excluded from SPARTA ELECTRONIC CORPORATION's warranty.

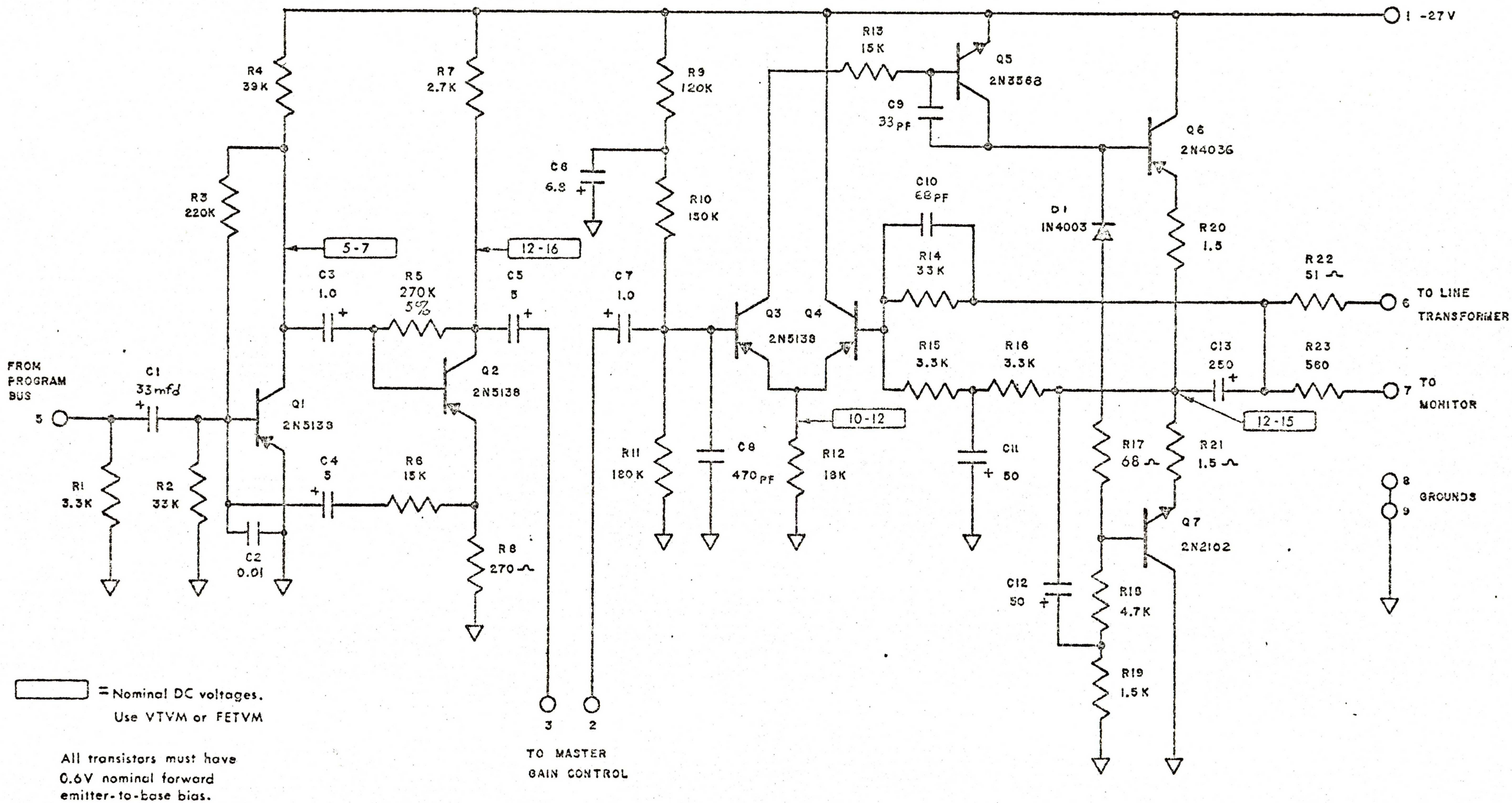
This warranty is expressly in lieu of all other warranties express or implied and does not apply to normal wear and tear or damage resulting from shipment, misuse, unauthorized modifications, or any other modifications, or any other cause or condition except normal usage. Replacement parts supplied under this warranty carry only the unexpired portion of the original warranty.



1008A-5	1018	FUNCTION
1	4	INPUT
2	5	INPUT
3	1	GND
4	2	GND
5	—	N.C.
6	6	OUTPUT
7	3	−27 VDC

ECR243
ECR234
ECR105
ECR50
ECR43

SPARTA ELECTRONIC CORPORATION			
1018 MICROPHONE PREAMP (401 BOARD)			
DRAWN	CHECKED	DATE	NUMBER
SMU	RKO	8-28-69 / 2-9-70	S-11-F



[box] = Nominal DC voltages. Use VTVM or FETVM

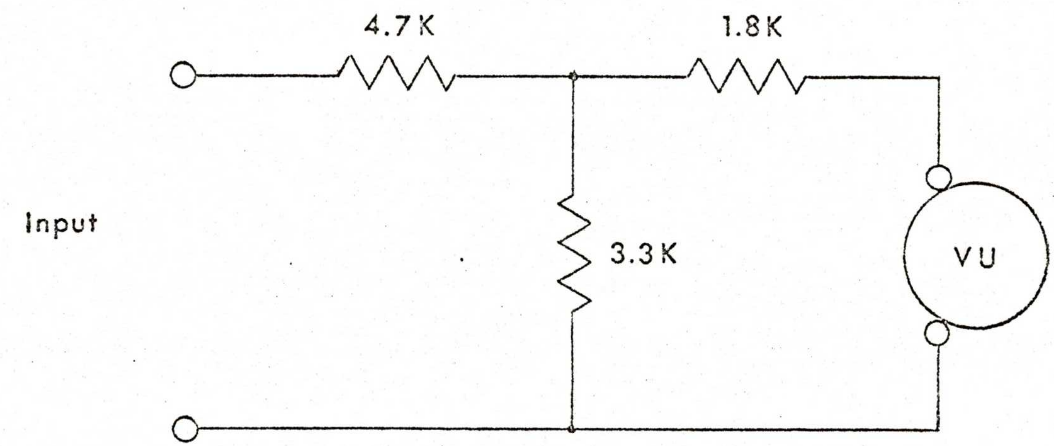
All transistors must have 0.6V nominal forward emitter-to-base bias.

J ECR278
H ECR199, C9 was 10pf
G ECR177
F 13Oct70 ECR 150
E 15 JULY70: ECR 114, Q5 WAS 2N3568
D 12 FEB70: ECR 52
C 6FEB70: ECR 46

SPARTA ELECTRONIC CORPORATION SACRAMENTO, CALIFORNIA

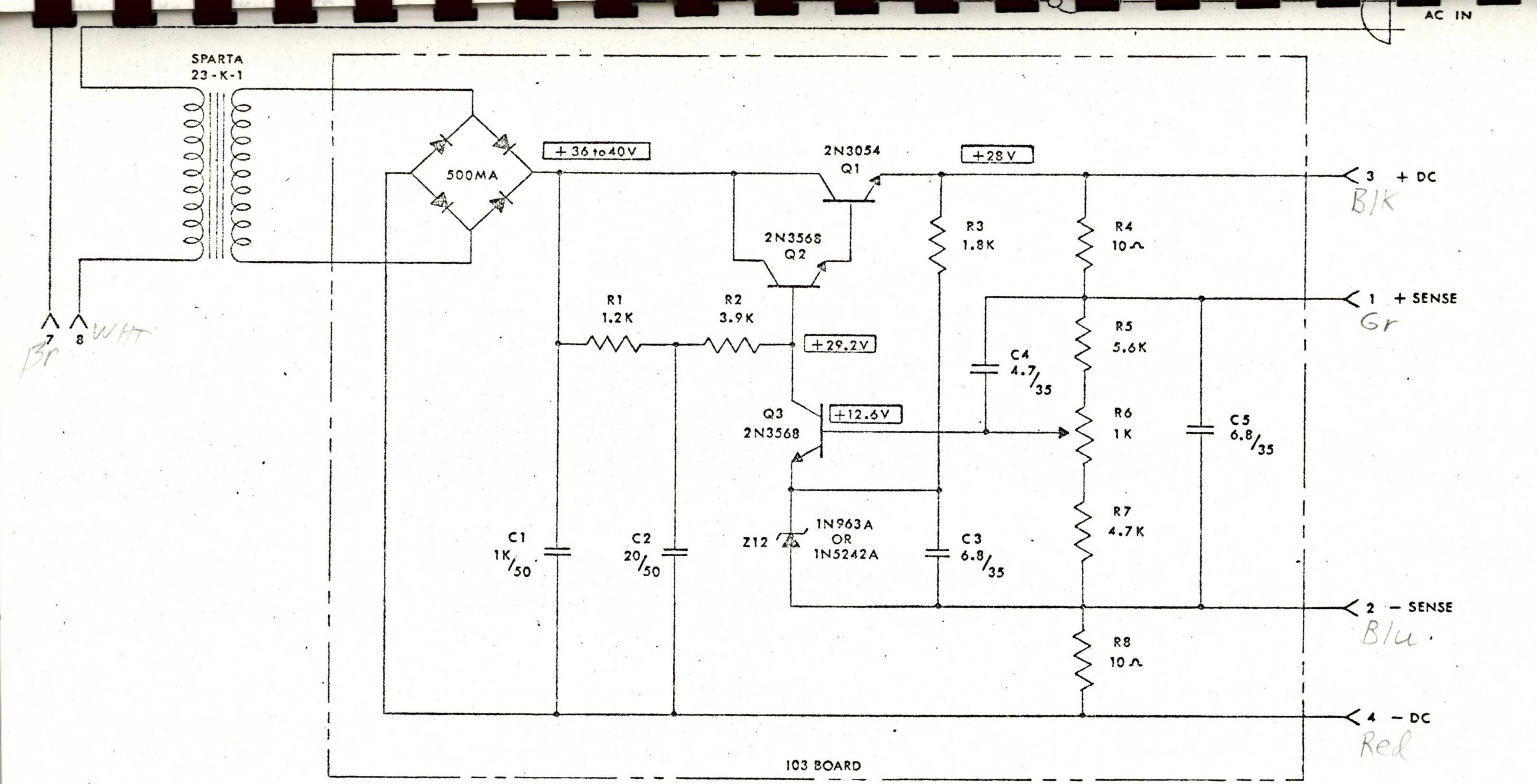
TITLE 1020 PROGRAM LINE AMP & MIXER AMP

DRWN.	DATE 4-15-69	SHT OF	DWG.NO.
APPD.	REV. 12 FEB 70	1 1	S-2J



All resistors $\frac{1}{2}$ W, 5%

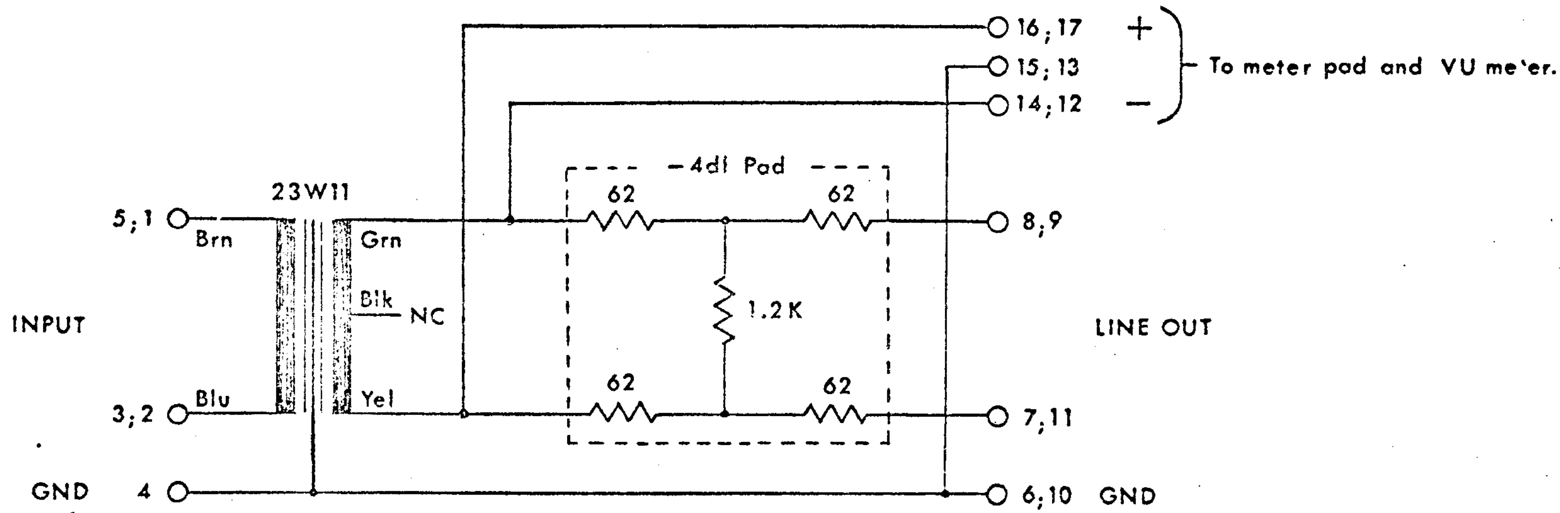
SPARTA ELECTRONIC CORP				
905 METER PAD				
Drawn	Checked	Date	Revised	Number
smu	RKO	11-20-69		S-23



Output 28VDC
DC volts refer to neg. buss
Resistors ½ w, 10%
Capacitors in mfd

SPARTA ELECTRONIC CORPORATION, SACRAMENTO, CALIFORNIA 95828 — A DIVISION OF COMPUTER EQUIPMENT CORPORATION			TITLE: PS-6 POWER SUPPLY	
DWN Smill	DATE 21 Oct 70	SCALE	SHT	DWG NO. S-107A
APPD	DATE		OF	

A ECR 186; add connector nos.



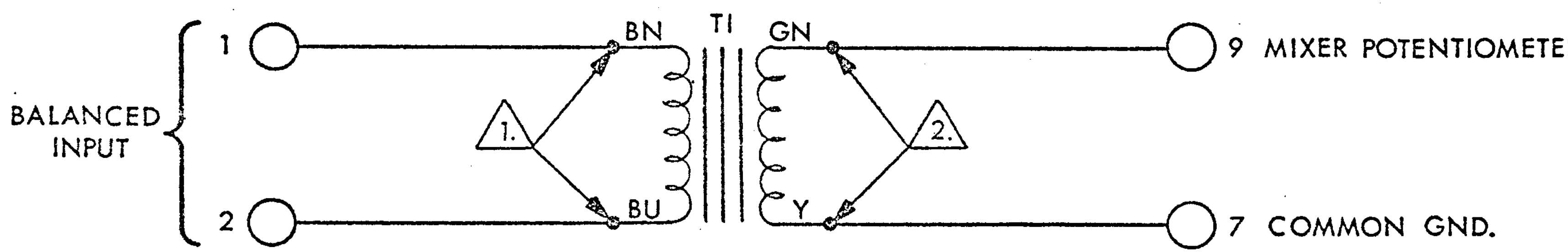
Primary, 60 ohm
Secondary, 600 ohm
−1db, 20Hz to 20KHz at 24dbm

Resistors $\frac{1}{2}$ W 5%

SPARTA ELECTRONIC CORP

1022 DUAL OUTPUT CARD

Drawn	Checked	Date	Revised	Number
SMU	[illegible]	11-20-69	ECR98 8JUN70	S-22-C

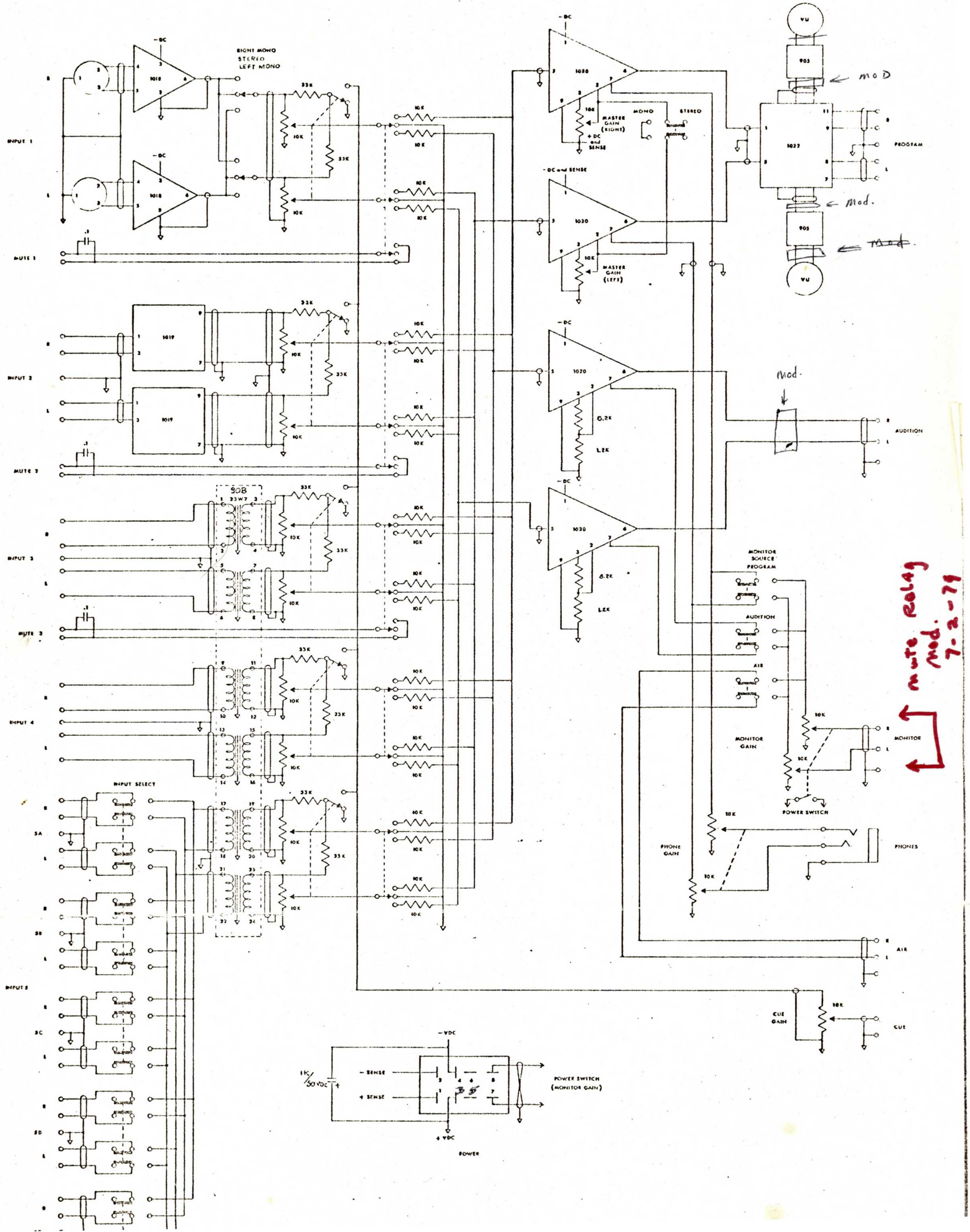


TI. SPARTA 23W7, 10K ohms, 1:1 TURNS RATIO. OPTIONAL, 600 ohms, 1:1 TURNS RATIO.

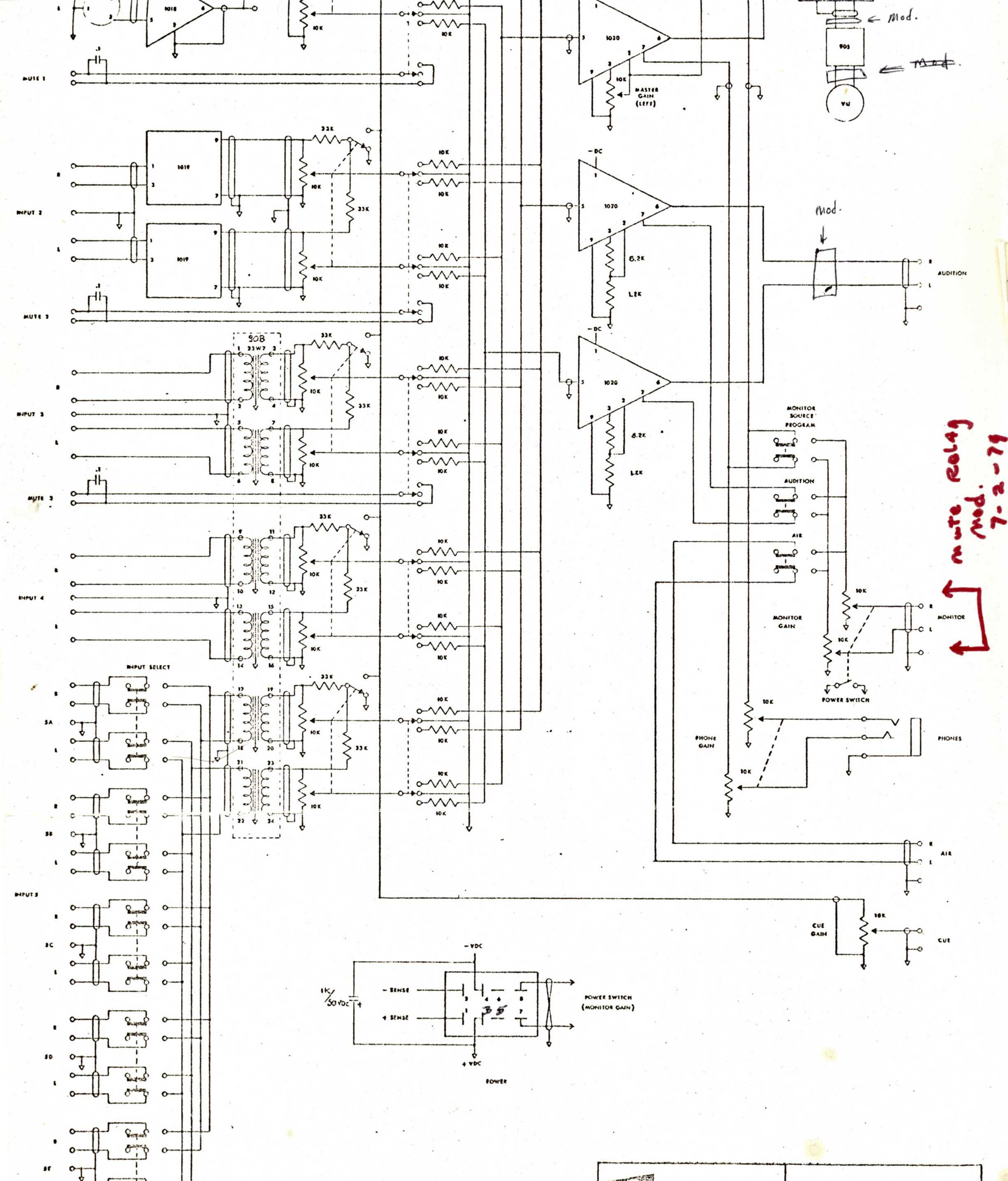
(1.) OPTIONAL 620 ohm TERMINATION RESISTOR, USE WITH 10K BRIDGING TRANSFORMER ONLY.

(2.) TERMINATING RESISTOR, 620 ohms, REQUIRED WITH 600 ohm TRANSFORMER ONLY.

SPARTA ELECTRONIC CORPORATION			
1019 LINE TRANSFORMER ASSY HIGH-LEVEL INPUT, 065-0069			
DRAWN	CHECKED	DATE	NUMBER
BJS.	RKO	7-23-71	S-137



RIGHT MONO
STEREO
LEFT MONO
INPUT 1
MUTE 1
INPUT 2
MUTE 2
INPUT 3
MUTE 3
INPUT 4
INPUT SELECT
INPUT 5
908
MASTER GAIN (RIGHT)
MASTER GAIN (LEFT)
MONO
STEREO
VU
905
1022
PROGRAM
AUDITION
MONITOR SOURCE PROGRAM
AIR
MONITOR GAIN
MONITOR
POWER SWITCH
PHONE GAIN
PHONES
CUE GAIN
CUE
POWER SWITCH (MONITOR GAIN)
POWER
← mod
← Mod.
mod.
mute Relay Mod. 7-2-79



SPARTA ELECTRONIC CORPORATION
SACRAMENTO, CALIFORNIA 95826

AS-30B
AUDIO CONSOLE

DWN			SCALE
APPD	RKO		S-109 C

ECR 306
ECR 235
ECR 174

RFI

ELIMINATION

Radio frequency interference, or RFI, is always a possibility when audio equipment is operated in the presence of RF fields. It can be particularly troublesome in solid-state systems containing low-level program lines and high-gain preamplifiers because less RF voltage or current is needed in such systems to cause interference.

With properly-designed audio equipment, particularly that intended for use by radio broadcasters, the incidence of RFI is relatively low provided proper installation practices have been followed, yet RFI does occur in even the best of installations because of its virtually unpredictable nature. It does not necessarily require a strong field for RFI to result, and it is not uncommon for an audio system to be unaffected by a nearby high-power transmitter, yet be ridden with RFI from a distant source at a different frequency.

The obvious question, of course, is "Why can't audio equipment be made RFI-proof?" The answer, unfortunately, cannot be so obvious for although normal gain and frequency response of an amplifier can easily be limited to the audio range, this is not the case for individual components and conductors. Capacitors, resistors, inductors, wires and transistors continue to function as such at frequencies far beyond the bounds of the audio spectrum. The wire that is a simple conductor at audio frequencies may become a highly efficient antenna or inductor at radio frequencies: The insignificant stray capacitance at audio frequencies can become a very effective coupling or tuning capacitor at radio frequencies: The semiconductor junction that is a linear control element at audio levels will become an excellent diode detector or modulator if sufficient RF energy reaches it.

The task of RFI suppression, then, is just that -- suppression rather than elimination. No matter what pains are taken at the design and manufacturing levels to minimize susceptibility to RF, the possibility will still exist simply because there is no way to force a component such as a semiconductor to recognize the difference between a change of voltage or current at audio frequencies and a similar or greater change at some higher frequency. Fortunately, there are many effective preventative measures that can be taken, and the ultimate solution to RFI becomes that of providing reasonable suppression during initial design and manufacture followed by additional effort during subsequent installation, if required by an unusually severe environment. It is well to note that the best of built-in suppression can be undone by improper or careless installation.

The symptoms of RFI are varied, depending upon the strength of the field, how it is entering the system, where and how it is being detected, and what kind of modulation it carries. An AM carrier may enter a system, be partially or completely detected by a non-linear element (more on this later) and produce the modulation superimposed over the normal program. If the two programs are different, the intruder is usually recognized as such quite readily; if they are the same, the symptoms may appear as hum, noise, raspiness or similar distortion. Also, if the RFI is strong enough, the result may be a completely blocked amplifier stage with only noise or perhaps silence as a symptom.

An audio system normally does not contain the necessary elements for FM detection, so when the intruding carrier is frequency modulated the symptom is usually that of an un-modulated carrier; hum, noise, distortion of the normal program, or again the silence of a blocked amplifier stage. If the offender is a VHF FM carrier, however, it will most often be entering the audio system via a conductor or cable that is resonant or "tuned" at or near the frequency of the interfering carrier; quite literally a tuned antenna. In such a case the FM can be converted to AM by riding the slope of the tuned element and subsequently be detected by a non-linear element so as to exhibit the symptoms of AM RFI.

When RFI is due to a TV transmitter, the symptoms will most often, though not always, be characterized by a raucus 60 Hz. buzz due to the AM frame-rate sync-pulse. Since two carriers may be involved, one AM and one FM, the symptoms may also become involved, even to the extent of including those of a completely separate carrier from another source. No matter how complex the symptoms, however, there are two factors common to all forms of RFI. First, RF energy is entering the system by a path or paths that can be located and interrupted. Second, the RF is being detected by a non-linear element or rectifier that can be located and suppressed.

The process of eliminating or suppressing RFI, then, involves two basic steps; preventing or minimizing the transfer of RF into the system, and preventing detection of the RF. The first step is simplified considerably by identifying the source and particularly the frequency of the interfering carrier, and the second requires locating the point at which it is being detected.

When considering the means whereby RF energy can enter an audio system, one must be constantly aware that stray capacitances may be excellent conductors for RF and that any wire or metal structure will be resonant at many different frequencies. The most prevalent example, of course, is the twisted-pair shielded audio cable feeding a console which may act as a quarter-wave stub antenna at one frequency and as a multi-wavelength long-wire antenna at a much higher frequency. Of nearly equal importance are instances where turntable tone-arm leads act as VHF antennas -- particularly troublesome because of their locations in very low-level, high impedance circuits -- and AC power-lines, which can be very efficient long-wire antennas at the lower radio frequencies.

The search for the route of RFI is generally a process of eliminating, one by one, the connecting cables by which RF may be entering the system. At the same time, judicious use of operating switches and potentiometers will provide positive clues as to the source. For example, if reducing a turn-table mixer control to zero will stop the interference it is a near certain indicator that both injection and detection are taking place in that channel and prior to the mixer control, perhaps in another part of the system.

If a connecting cable is found to be an offender, the first step is to examine the connections at both ends and particularly the way the shield is connected. In most instances best operation will be obtained when the shield is connected at the load or console end and left open at the source end. This is because the equipment at each end of the connecting cable will always have some sort of return to a common ground, and connecting the shield at both ends completes a loop which quite often will respond to magnetic fields. There is no hard and fast rule, however, and it is wise to try various combinations.

When the interference is in the VHF range, it will often be found that shortening or lengthening a cable will eliminate RFI by "detuning" it. Also, it may be found that simply moving or re-routing will accomplish the same effect. In such cases it most often found that touching cables or connections will result in a change of level or symptoms of the RFI. Needless to say, connecting cables should never be coiled and tied in loops. If one must be shortened but not cut, fold it back and forth upon itself and tie it securely.

The next step, if cable-dress and shielding techniques are insufficient, is to bypass program-carrying conductors to ground or shield terminals with suitable capacitors. Since the reactance of a capacitor decreases as frequency increases, the procedure is to choose a capacitor value which will have no significant effect at program-line impedances and frequencies, yet form a low reactance shunt path to ground for the radio frequencies. For the typical 600 ohm system, a value of 0.001 mfd to 0.002 mfd is nearly ideal since the reactance is about 5K ohms at the higher audio frequencies, falls to 100 ohms at the middle of the AM broadcast band, and is close to 1 ohm at the middle of the FM-TV bands.

The capacitors used should be low-inductance types, such as disc ceramics, and lead-lengths should be kept short: Otherwise the capacitor and leads could become resonant at a frequency which could add rather than cure RFI. The preceding given values can be extrapolated to other impedance levels simply by following the reciprocal relationship; if the audio line impedance is higher, the capacitor should be proportionally smaller, and visa-versa.

In severe circumstances RF chokes may be inserted in series with the audio lines, and with bypass capacitors to ground at each end a very effective filter section will result, if lead lengths are kept short. The Ohmite Z-50 and Z-144 chokes are typical and quite popular for suppression at the higher frequencies. Alternately, passing audio leads through ferrite beads is very effective and space-saving at VHF frequencies. Chokes are generally not too practical at AM broadcast frequencies, however, since those with high enough reactance usually have enough DC resistance to affect audio levels in low-impedance lines. When filtering AC power lines, 0.01 to 0.1 mfd, 600 volt capacitors may be used, although it may be simpler and more effective to employ a commercial filter designed for the purpose.

The suggestions so far have dealt with means of preventing RF from entering the audio system. Of equal importance and often the most effective approach is to isolate and suppress the point of detection. Even though it may require going into the circuitry of equipment in the audio system, it often requires less effort than adding multiple filters to prevent the RF from entering in the first place. As an aid in locating points at which RF can be detected, it will help to consider some circumstances that can result in a non-linear junction, or rectifier.

Considering one of the earliest known forms of an RF detector, the galena crystal and cat's-whisker, we can see the effects of RF detection resulting from point-contact of two dissimilar metals. The significant factor is that a junction of any two dissimilar metals or metal compounds is potential detector. Now, we cannot prevent such junctions in an audio system because they exist virtually every time a connection is made. What we can do, however, is assure that every connection is secure and tight so there is no possibility of introducing a voltage-drop -- audio <u>or</u> RF.

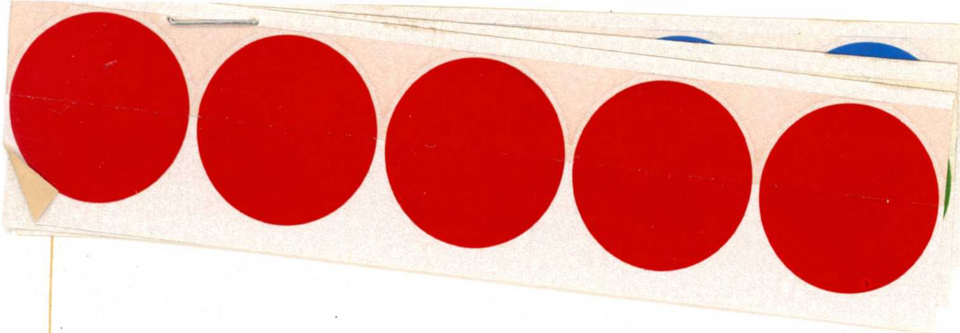
In this context we must also consider a very common cause of RFI in turntable systems. Connections to the tone-arm cartridge are made with small push-on clips because soldering to the cartridge pins directly would likely destroy the cartridge. The combination of a loose clip, particularly if oxidized, plus the tone arm lead (an excellent VHF antenna) and the following high-gain amplifiers is an excellent invitation to RFI. Also, the usual tone arm with plug-in cartridge-shell and plug-in connecting cable provides two additional sets of contacts at which RFI detection can take place.

Within the circuitry of individual equipments of an audio system, the most common offender is the emitter-to-base junction of a transistor. This junction is a forward-biased diode, with bias set so that a change of base current with signal will produce a linear but amplified change of collector current. Should RF energy reach such a junction, the bias could shift to a non-linear area and result in distortion of the normal program material. If the RF is amplitude modulated, it is likely that partial or full detection would take place, resulting in audible recognition of the AM component along with normal program. A sufficiently high level of RF, however, could completely block a transistor causing complete loss of any audible symptom, so it becomes quite necessary to allow for varying symptoms with varying levels of interference when attempting to locate an offending junction.

Once the point of detection is determined, the solution is much the same as earlier described; shunt capacitors with short leads, and series inductors in severe instances. It is usually easiest and most effective to add a capacitor directly across the emitter-to-base junction. The most effective value of capacitor will vary with particular circuit paramaters but a value of 100 pf is a good starting-point. As a general guide, the capacitor should be as large as practical without causing a loss at the highest audio frequencies.

The input impedance at the base of a transistor is usually measured in thousands of ohms, and the signal current is generally quite small. If it is found that a capacitor reduces but does not adequately suppress the RFI, it will often suffice to then add a series resistor of perhaps 100 to 1 K ohms in series with the signal path immediately preceding the shunt capacitor, and substituting an inductor for the resistor in particularly severe instances. These latter extremes are rarely necessary, however, since most audio equipment designs include equivalent suppression at the most-likely points of RFI detection.

We can conclude that RFI is always a possibility in an audio system and can appear unexpectedly when a change or addition is made tothe system or when another transmitter goes on the air. We can also conclude that RFI suppression is a logical process of eliminating or minimizing RF paths into the audio system, or locating and suppressing the points at which detection is taking place, or both. Most important, we can conclude that all instances of RFI can be suppressed by systematic application of one or more of the foregoing suggestions.



COLORDOTS

SPARTA COLORDOTS will provide Channel Audio Source Identification for the fader controls on SPARTA Audio Consoles. For example: CH 1, Red for Control Mike; Two Green on CH #5 & 6 for Turntables; Blue for Cartridge Machines, etc. Five each; Red, Green and Blue Colordots are provided with each Audio Console. To install, be sure the surface of the knob is clean and free of dust or grease. The Colordots may be easily removed or changed after initial installation.

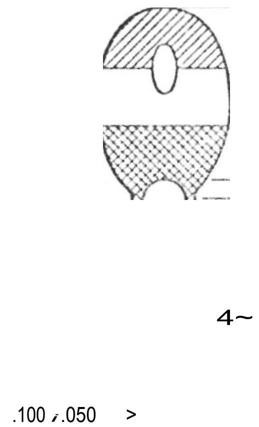
No modification to the knob is necessary and your Colordots. made of heavy acetate, will last for years. Since Colordots are transparent, a code or reference can be incorporated underneath which will be clearly seen for the life of the console. The use of a broad black bar, for example will quickly show a mixer in the cue position. Extra colordots not used on knobs can be applied to other key areas providing additional references.

Additional kits may be ordered. Please specify CIK-1 @ $1.00 each.

CIK-1 CHANNEL IDENTIFICATION KIT

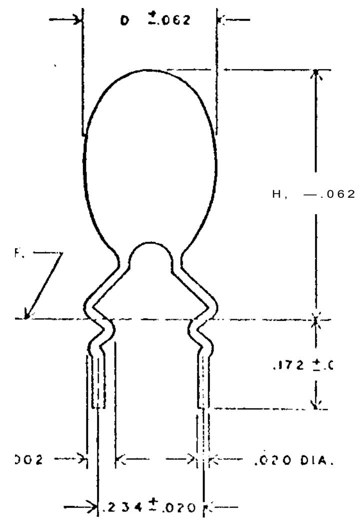
5 - Red Colordots
5 - Green Colordots
5 - Blue Colordots

Solid Tantalum Electrolytic Capacitors



POLARITY INDICATION—WITH DOT MULTIPLIER AS VIEWED ABOVE POSITIVE LEAD IS ON RIGHT.

TAG—STRAIGHT LEADS

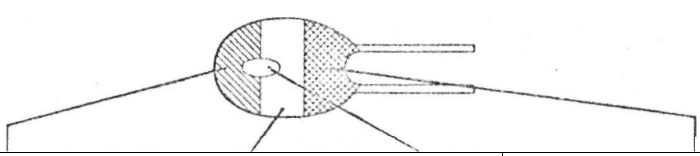


TAG—CRIMPED LEADS
(SPECIAL ORDER ONLY)

CASE DIMENSIONS—TYPE TAG — TABLE 3

CASE	DIA. (D)	LENGTH (H)	•(Hi)
1	.138	.238	.378
2	.159	.258	.397
3	.159	.278	.421
4	.178	.278	.421
5	.178	.298	.437
6	.219	.338	.457
7	.238	.338	.457

•CRIMPED LEAD VERSION ONLY



MARKING CODE — TABLE 4

CAPACITANCE (MFDS)				WORKING VOLTAGE	
COLOR	CAP 1ST SIGNIFICANT NUMBER	RING 2ND SIGNIFICANT NUMBER	DOT MULTIPLIER	COLOR	VOLTAGE
BLACK	—	0	xl	WHITE	3
BROWN	1	1	xlO	YELLOW	6.3
RED	2	2	—	BLACK	10
ORANGE	3	3	—	GREEN	16
YELLOW	4	4	—	BLUE	20
GREEN	5	5	—	GREY	25
BLUE	6	6	—	PINK	35
VIOLET	7	7	—		
GREY	8	8	xO.Ol		
WHITE	9	9	xO.l		