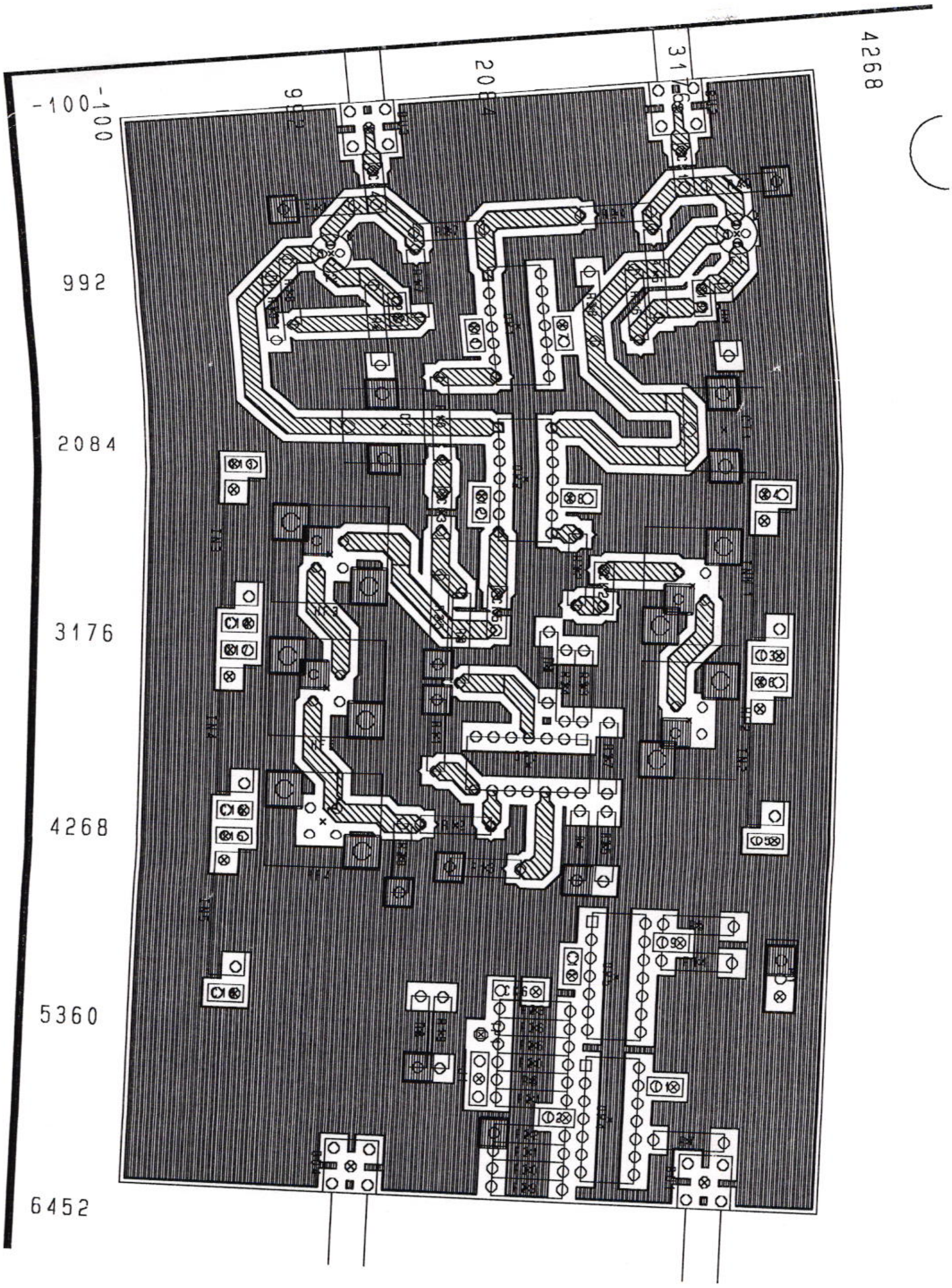
-100
992
2084
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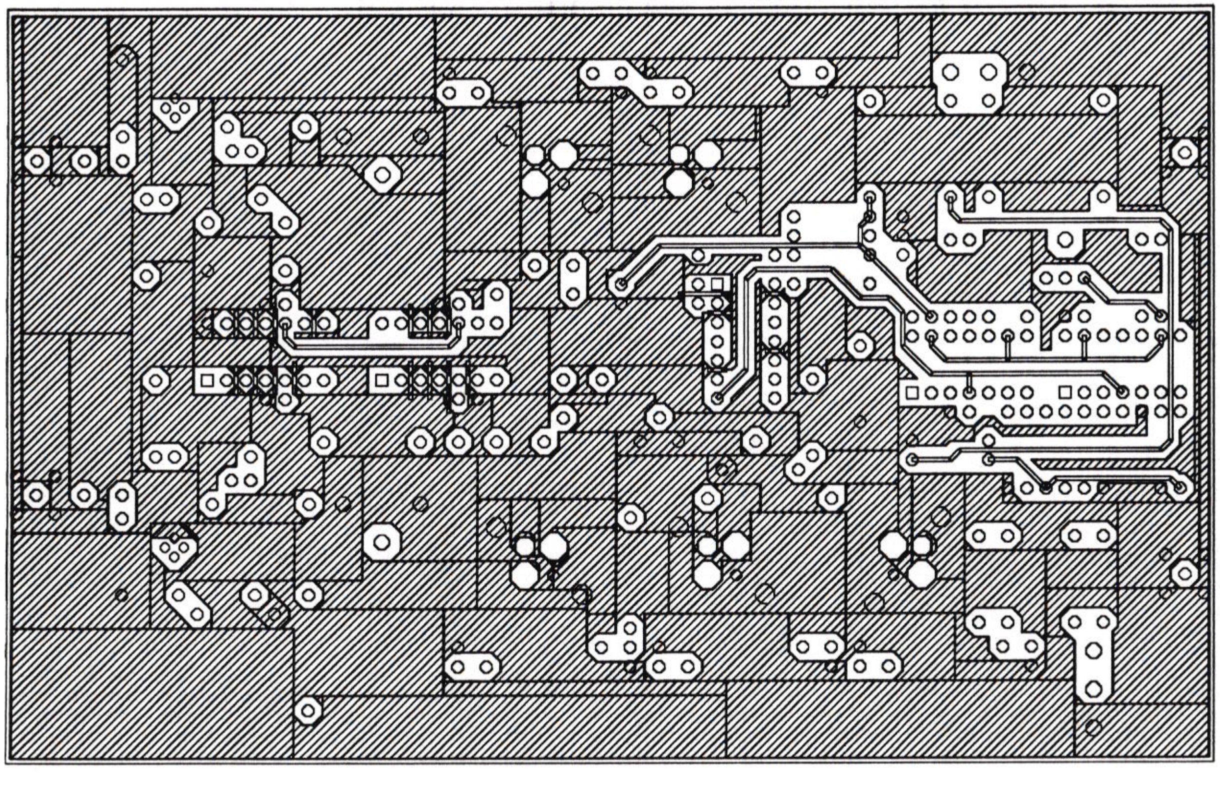

Bestückungsseite

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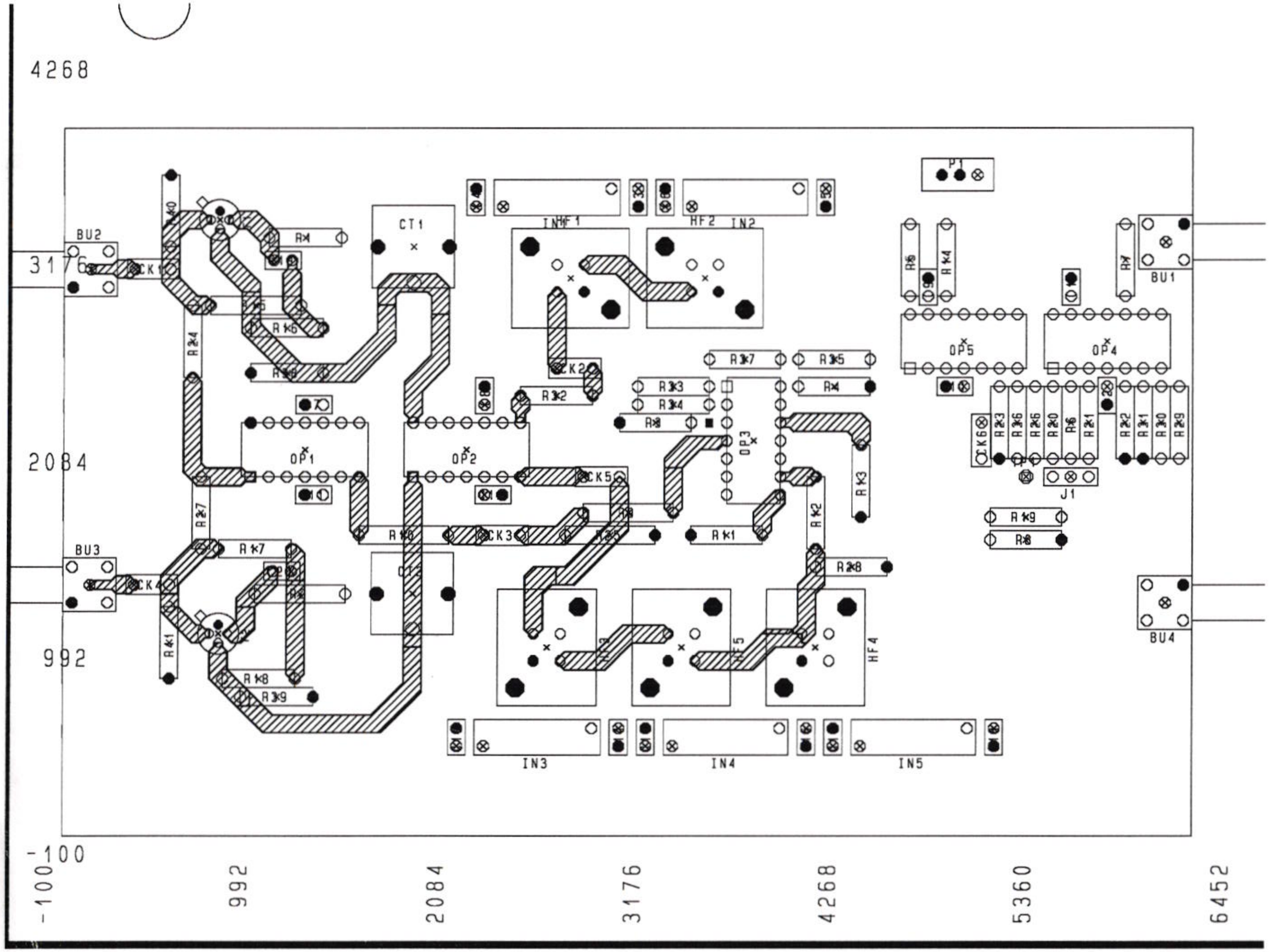

4268
3176
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992
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-100
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5360
6452
BU1
BU2
BU3
BU4
CT1
OP1
OP2
OP3
OP4
OP5
HF1
HF2
HF4
HF5
IN1
IN2
IN3
IN4
IN5
P1
J1
CK1
CK2
CK3
CK4
CK5
CK6

Danksagung

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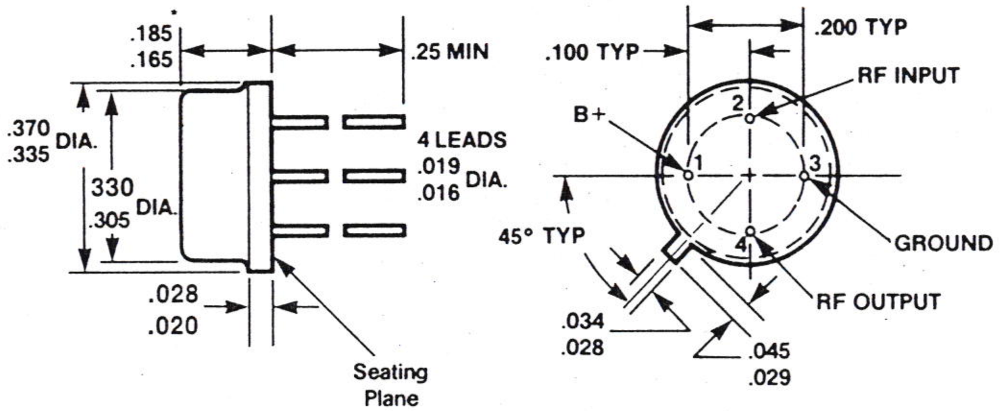
Mein ganz besonders herzlicher Dank gilt meinen Eltern, die mich in meinem Studium in allen Ihnen möglichen Bereichen unterstützt haben

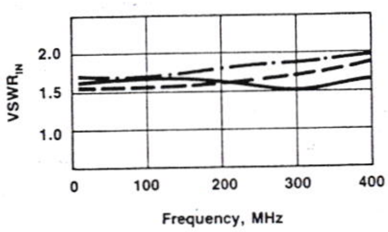
• TO-12 Case Drawings



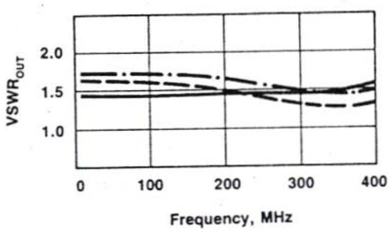
*For GPD-405 (TO-12T Case) these dimensions are $\frac{.230}{.260}$

CASE DRAWINGS

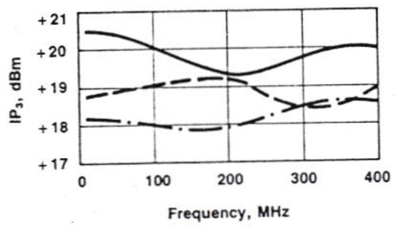
Input VSWR



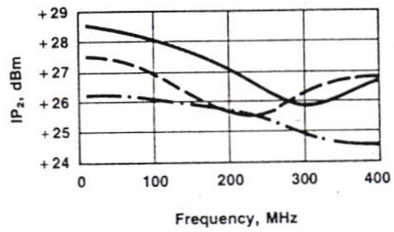
Output VSWR



Third-Order Intercept Point



Second-Order Intercept Point



AUTOMATIC NETWORK ANALYZER MEASUREMENTS (Typical production unit @ +25°C ambient)

NUMERICAL READINGS

BIAS = 15.00 VOLTS

FREQ MHz	VSWR IN	GAIN dB	PHASE DEG	PHASE DEV	GPDEL NSEC	VSWR OUT	ISOL dB
100.0	1.63	14.33	174.29	.02	.00	1.45	23.70
150.0	1.60	14.23	170.90	.05	.18	1.46	23.27
200.0	1.56	14.24	167.76	.33	.20	1.45	22.92
250.0	1.53	14.17	163.59	−.40	.20	1.45	22.76
300.0	1.53	14.23	160.48	−.11	.19	1.45	22.49
350.0	1.55	14.22	156.84	−.32	.18	1.47	22.00
400.0	1.58	14.09	154.18	.43	.17	1.51	21.79
450.0	1.68	14.11	150.88		.21	1.54	21.28
500.0	1.83	13.97	146.56		.21	1.61	21.01
550.0	2.06	13.81	143.23		.22	1.70	20.54
600.0	2.33	13.76	138.65		.26	1.82	20.37
650.0	2.67	13.38	133.97		.24	1.97	20.05
700.0	3.08	13.05	130.10		.22	2.15	19.79
750.0	3.60	12.74	126.17		.24	2.35	19.62
800.0	4.17	12.36	121.50		.22	2.58	19.88
850.0	4.74	11.56	118.16		.24	2.81	19.62
900.0	5.24	11.06	112.73		.27	3.05	20.33
950.0	5.71	10.37	108.40		.13	3.28	19.86
1000.0	6.03	9.51	108.17		.13	3.49	20.18

S-PARAMETERS, MAGNITUDES AND ANGLES

BIAS = 15.00 VOLTS

FREQ MHz	11 RATIO	11 ANGLE	21 dB	21 ANGLE	12 dB	12 ANGLE	22 RATIO	22 ANGLE
100.00	.235	−179.6	14.333	174.0	−23.399	15.6	.183	3.2
150.00	.230	−178.7	14.267	170.8	−23.288	23.6	.181	8.7
200.00	.221	−177.6	14.297	167.9	−23.158	28.4	.183	11.3
250.00	.209	−173.3	14.225	163.6	−22.753	36.3	.181	14.4
300.00	.207	−168.0	14.267	160.7	−22.286	42.9	.185	18.2
350.00	.212	−160.8	14.253	156.9	−22.099	49.7	.187	24.2
400.00	.228	−154.2	14.179	154.0	−21.392	55.4	.196	29.4
450.00	.258	−148.9	14.178	150.5	−21.186	58.8	.209	34.4
500.00	.298	−146.4	13.985	146.4	−20.985	64.6	.231	38.2
550.00	.346	−145.8	13.839	142.9	−20.484	67.1	.259	41.0
600.00	.400	−147.2	13.746	138.4	−20.250	71.3	.292	41.7
650.00	.457	−150.1	13.382	133.7	−20.036	75.1	.329	41.1
700.00	.512	−154.7	13.047	130.0	−19.837	77.9	.366	39.4
750.00	.569	−159.7	12.735	126.1	−19.672	79.9	.406	36.7
800.00	.617	−164.5	12.341	121.4	−19.820	81.9	.441	32.8
850.00	.653	−170.0	11.520	118.1	−19.530	86.9	.478	29.0
900.00	.684	−175.4	11.057	112.9	−20.285	85.9	.509	24.5
950.00	.709	179.2	10.382	108.3	−19.932	93.3	.534	19.9
1000.00	.720	174.1	9.476	108.0	−20.194	93.0	.555	15.3

GPD-402/-462

Thin Film Cascadable Amplifier Module 5-400 MHz

AVANTEK

FEATURES

- **Medium Output Level: +8 dBm (Typ)**
- **Low Cost**
- **Small Size**

TO-12 Case
(p. 403)

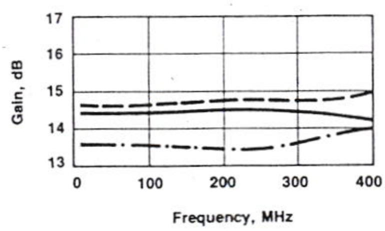
ELECTRICAL SPECIFICATIONS (Measured in a 50-ohm system @ +15 VDC nominal)

Symbol	Characteristic	Typical $T_C = 25°C$	Guaranteed Specifications		Unit
			$T_C = 0°\text{-}50°C$	$T_C = -55°\text{-} +85°C$	
BW	Frequency Range	5-400	5-400	5-400	MHz
GP	Small Signal Gain	14.0	13.0 Min.	12.0 Min.	dB
—	Gain Flatness	±1.0	—	—	dB
NF	Noise Figure	8.0	—	—	dB
—	Reverse Isolation	20.0			dB
$P_{1 dB}$	Power Output @ + 1 dB Compression	+8.0	—	—	dBm
—	Input VSWR	—	—	2.0:1 Max.	—
—	Output VSWR	—	—	2.0:1 Max.	—
IP_3	Two Tone 3rd Order Intercept Point	+18.0	—	—	dBm
IP_2	Two Tone 2nd Order Intercept Point	+24.0	—	—	dBm
I_D	DC Current	24		—	mA

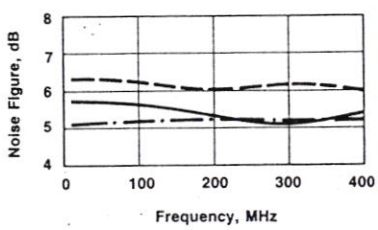
TYPICAL PERFORMANCE OVER TEMPERATURE (@ +15 VDC unless otherwise noted)

KEY: +25°C ———— +85°C – – – – −55°C —·—·—

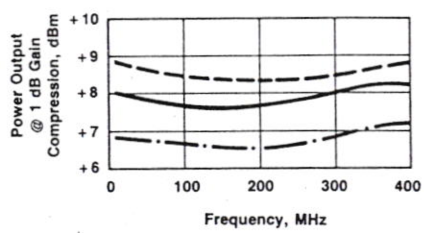
Gain



Noise Figure



Power Output



MAXIMUM RATINGS

DC Voltage .... +17 Volts
Continuous RF Input Power .... +13 dBm
Operating Case Temperature .... -55°C to +125°C
Storage Temperature .... -62°C to +150°C
"R" Series Burn-In Temperature .... +125°C

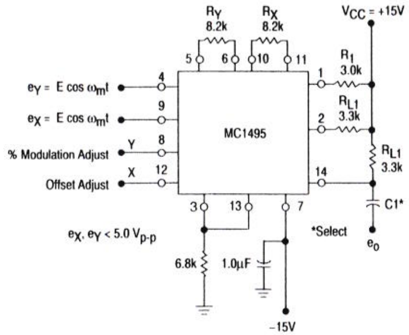
THERMAL CHARACTERISTICS*

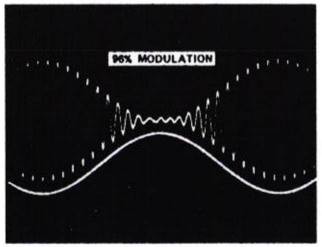
θ_{JC} .... 150°C/W
Active Transistor Power Dissipation .... 82 mW
Junction Temperature Above Case Temperature .... 12.3°C
MTBF .... 2,325,901 (402)/2,640,329 (462) Hrs.

*For further information, see High Reliability section.

WEIGHT: (typical) — 1.5 grams

Figure 30. Amplitude Modulation





The signal is applied to the unit's Y-input. Since the total input range is limited to 1.0 V_{p-p}, a 2.0 V swing, a current source of 2.0 mA and an R_Y value of 1.0 kΩ is chosen. This takes best advantage of the dynamic range and insures linear operation in the Y-channel.

Since the X-input varies between 0 and +1.0 V, the current source selected was 1.0 mA, and the R_X value chosen was 2.0 kΩ. This also insures linear operation over the X-input dynamic range. Choosing R_L = 100 assures wide bandwidth operation.

Hence, the scale factor for this configuration is:

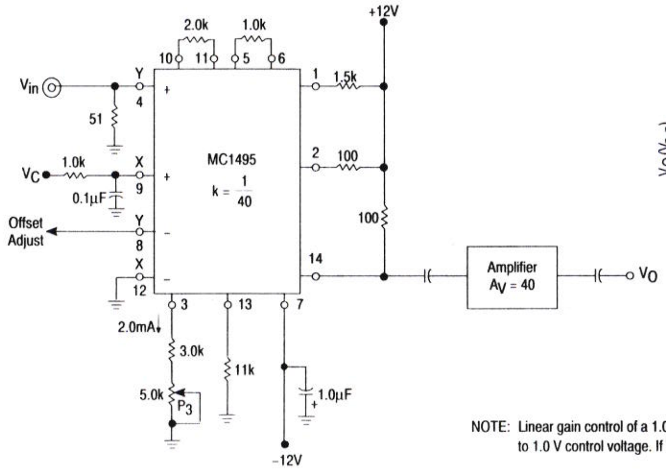
$$K = \frac{R_L}{R_X R_Y I_3}$$

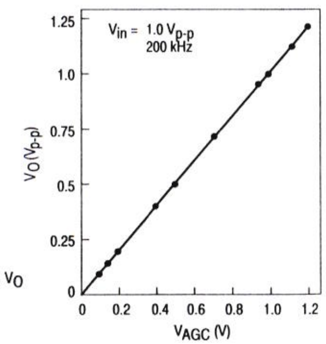
$$= \frac{100}{(2\,k)\,(1\,k)\,(2 \bullet 10^{+3})}\ V^{-1}$$

$$= \frac{1}{40}\ V^{-1}$$

The 2 in the numerator of the equation is missing in this scale factor expression because the output is single-ended and AC coupled.

Figure 31. Linear Gain Control





NOTE: Linear gain control of a 1.0 V_{p-p} signal is performed with a 0 V to 1.0 V control voltage. If V_C is 0.5 V the output will be 0.5 V_{p-p}.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MC3456

Dual Timing Circuit

The MC3456 dual timing circuit is a highly stable controller capable of producing accurate time delays, or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor per timer. For astable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor per timer. The circuit may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200 mA or drive MTTL circuits.

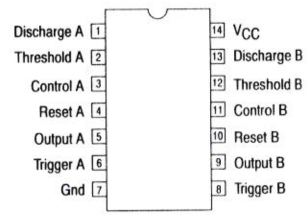
- Direct Replacement for NE556/SE556 Timers
- Timing From Microseconds Through Hours
- Operates in Both Astable and Monostable Modes
- Adjustable Duty Cycle
- High Current Output Can Source or Sink 200 mA
- Output Can Drive MTTL
- Temperature Stability of 0.005% per °C
- Normally "On" or Normally "Off" Output
- Dual Version of the Popular MC1455 Timer

DUAL TIMING CIRCUIT

SILICON MONOLITHIC INTEGRATED CIRCUIT

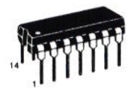
L SUFFIX
CERAMIC PACKAGE
CASE 632

PIN CONNECTIONS



(Top View)

P SUFFIX
PLASTIC PACKAGE
CASE 646

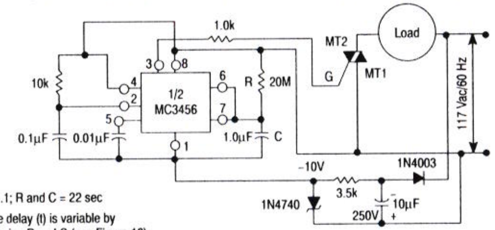


D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO-14)

ORDERING INFORMATION

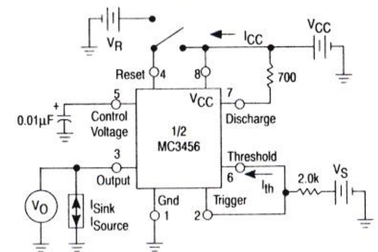
Device	Temperature Range	Package
MC3456L	0° to + 70°C	Ceramic DIP
MC3456P		Plastic DIP
NE556D		SO-14

Figure 1. 22 Second Solid State Time Delay Relay Circuit



t = 1.1; R and C = 22 sec
Time delay (t) is variable by changing R and C (see Figure 16).

Figure 3. General Test Circuit



Test circuit for measuring DC parameters (to set output and measure parameters):
a) When $V_S \geq 2/3\ V_{CC}$, V_O is low.
b) When $V_S \leq 1/3\ V_{CC}$, V_O is high.
c) When V_O is low, Pin 7 sinks current. To test for Reset, set V_O high, apply Reset voltage, and test for current flowing into Pin 7. When Reset is not in use, it should be tied to V_{CC}.

Figure 2. Block Diagram (1/2 Shown)

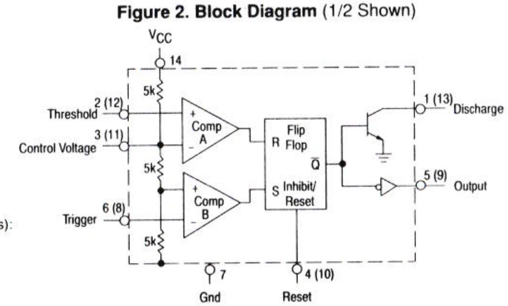
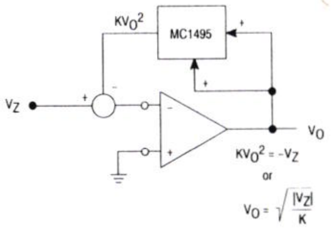


Figure 26. Basic Square Root Circuit



Square Root

A special case of the divide circuit in which the two inputs to the multiplier are connected together is the square root function as indicated in Figure 26. This circuit may suffer from latch-up problems similar to those of the divide circuit. Note that only one polarity of input is allowed and diode clamping (see Figure 27) protects against accidental latch-up.

This circuit also may be adjusted in the closed-loop mode as follows:

1. Set V_Z to –0.01 V and adjust P_4 (output offset) for V_O = +0.316 V, being careful to approach the output from the positive side to preclude the effect of the output diode clamping.
2. Set V_Z to –0.9 V and adjust P_2 (X adjust) for V_O = +3.0 V.
3. Set V_Z to –10 V and adjust P_3 (scale factor adjust) for V_O = +10 V.
4. Steps 1 through 3 may be repeated as necessary to achieve desired accuracy.

AC APPLICATIONS

The applications that follow demonstrate the versatility of the monolithic multiplier. If a potted multiplier is used for these cases, the results generally would not be as good because the potted units have circuits that, although they optimize DC multiplication operation, can hinder AC applications.

Frequency doubling often is done with a diode where the fundamental plus a series of harmonics are generated. However, extensive filtering is required to obtain the desired harmonic, and the second harmonic obtained under this technique usually is small in magnitude and requires amplification.

When a multiplier is used to double frequency the second harmonic is obtained directly, except for a DC term, which can be removed with AC coupling.

$$e_O = KE^2 \cos^2 \omega t$$

$$e_O = \frac{KE^2}{2} (1 + \cos 2\omega t).$$

A potted multiplier can be used to obtain the double frequency component, but frequency would be limited by its internal level-shift amplififer. In the monolithic units, the amplifier is omitted.

In a typical doubler circuit, conventional ± 15 V supplies are used. An input dynamic range of 5.0 V peak-to-peak is allowed. The circuit generates wave-forms that are double frequency; less than 1% distortion is encountered without filtering. The configuration has been successfully used in excess of 200 kHz; reducing the scale factor by decreasing the load resistors can further expand the bandwidth.

Figure 29 represents an application for the monolithic multiplier as a balanced modulator. Here, the audio input signal is 1.6 kHz and the carrier is 40 kHz.

Figure 27. Square Root Circuit

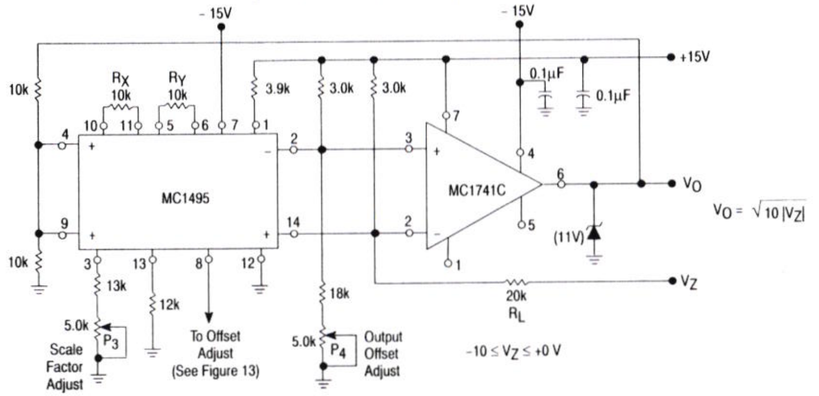
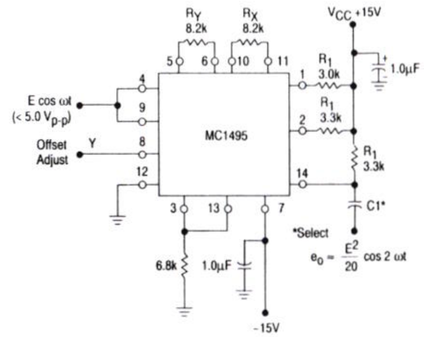


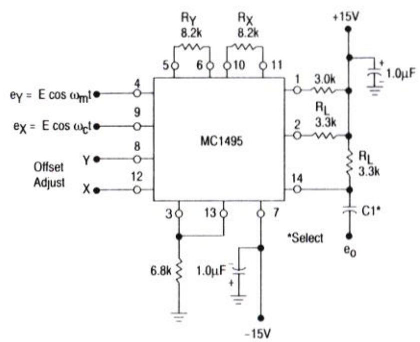
Figure 28. Frequency Doubler



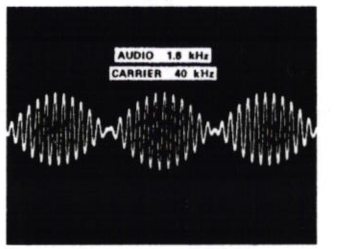
When two equal cosine waves are applied to X and Y, the result is a wave shape of twice the input frequency. For this example the input was a 10 kHz signal, output was 20 kHz.

Figure 29. Balanced Modulator

(A)



(B)



The defining equation for balanced modulation is

$$K(E_m \cos \omega_m t)(E_c \cos \omega_c t) =$$

$$\frac{KE_c E_m}{2} [\cos(\omega_c + \omega_m)t + \cos(\omega_c - \omega_m)t]$$

where ω_c is the carrier frequency, ω_m is the modulator frequency and K is the multiplier gain constant.

AC coupling at the output eliminates the need for level translation or an operational amplifier; a higher operating frequency results.

A problem common to communications is to extract the intelligence from single-sideband received signal. The ssb signal is of the form:

$$e_{ssb} = A \cos(\omega_c + \omega_m)t$$

and if multiplied by the appropriate carrier waveform, cos $\omega_c t$,

$$e_{ssb} e_{carrier} = \frac{AK}{2} [\cos(2\omega_c + \omega_m)t + \cos(\omega_c)t].$$

If the frequency of the band-limited carrier signal (ω_c) is ascertained in advance, the designer can insert a low pass filter and obtain the (AK/2) ($\cos\omega_c t$) term with ease. He/she also can use an operational amplifier for a combination level shift-active filter, as an external component. But in potted multipliers, even if the frequency range can be covered, the operational amplifier is inside and not accessible, so the user must accept the level shifting provided, and still add a low pass filter.

Amplitude Modulation

The multiplier performs amplitude modulation, similar to balanced modulation, when a DC term is added to the modulating signal with the Y-offset adjust potentiometer (see Figure 30).

Here, the identity is:

$$E_m(1 + m \cos \omega_m t) E_c \cos \omega_c t = KE_m E_c \cos \omega_c t +$$

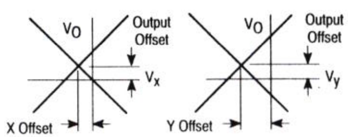
$$\frac{KE_m E_c m}{2} [\cos(\omega_c + \omega_m)t + \cos(\omega_c - \omega_m)t]$$

where m indicates the degrees of modulation. Since m is adjustable, via potentiometer P_1, 100% modulation is possible. Without extensive tweaking, 96% modulation may be obtained where ω_c and ω_m are the same as in the balanced modulator example.

Linear Gain Control

To obtain linear gain control, the designer can feed to one of the two MC1495 inputs a signal that will vary the unit's gain. The following example demonstrates the feasibility of this application. Suppose a 200 kHz sinewave, 1.0 V peak-to-peak, is the signal to which a gain control will be added. The dynamic range of the control voltage V_C is 0 V to +1.0 V. These must be ascertained and the proper values of R_X and R_Y can be selected for optimum performance. For the 200 kHz operating frequency, load resistors of 100 Ω were chosen to broaden the operating bandwidth of the multiplier, but gain was sacrificed. It may be made up with an amplifier operating at the appropriate frequency (see Figure 31).

X, Y and Output Offset Voltages



For most DC applications, all three offset adjust potentiometers (P_1, P_2, P_4) will be necessary. One or more offset adjust potentiometers can be eliminated for AC applications (see Figures 28, 29, 30, 31).

If well regulated supply voltages are available, the offset adjust circuit of Figure 13 is recommended. Otherwise, the circuit of Figure 14 will greatly reduce the sensitivity to power supply changes.

Scale Factor

The scale factor K is set by P_3 (Figure 21). P_3 varies I_3 which inversely controls the scale factor K. It should be noted that current I_3 is one-half the current through R_1. R_1 sets the bias level for Q_5, Q_6, Q_7, and Q_8 (see Figure 3). Therefore, to be sure that these devices remain active under all conditions of input and output swing, care should be exercised in adjusting P_3 over wide voltage ranges (see General Design Procedure).

Adjustment Procedures

The following adjustment procedure should be used to null the offsets and set the scale factor for the multiply mode of operation, (see Figure 21).

1. X-Input Offset
   (a) Connect oscillator (1.0 kHz, 5.0 V_{p-p} sinewave) to the Y-input (Pin 4).
   (b) Connect X-input (Pin 9) to ground.
   (c) Adjust X offset potentiometer (P_2) for an AC null at the output.
2. Y-Input Offset
   (a) Connect oscillator (1.0 kHz, 5.0 Vp-p sinewave) to the X-input (Pin 9).
   (b) Connect Y-input (Pin 4) to ground.
   (c) Adjust Y offset potentiometer (P_1) for an AC null at the output.
3. Output Offset
   (a) Connect both X and Y-inputs to ground.
   (b) Adjust output offset potentiometer (P_4) until the output voltage (V_O) is 0 Vdc.
4. Scale Factor
   (a) Apply +10 Vdc to both the X and Y-inputs.
   (b) Adjust P_3 to achieve + 10 V at the output.
5. Repeat steps 1 through 4 as necessary.

The ability to accurately adjust the MC1495 depends upon the characteristics of potentiometers P_1 through P_4. Multi-turn, infinite resolution potentiometers with low temperature coefficients are recommended.

DC APPLICATIONS

Multiply

The circuit shown in Figure 21 may be used to multiply signals from DC to 100 kHz. Input levels to the actual multiplier are 5.0 V (max). With resistive voltage dividers the maximum could be very large however, for this application two-to-one dividers have been used so that the maximum input level is 10 V. The maximum output level has also been designed for 10 V (max).

Squaring Circuit

If the two inputs are tied together, the resultant function is squaring; that is $V_O = KV^2$ where K is the scale factor. Note that all error terms can be eliminated with only three adjustment potentiometers, thus eliminating one of the input offset adjustments. Procedures for nulling with adjustments are given as follows:

A. AC Procedure:
   1. Connect oscillator (1.0 kHz, 15 Vp-p) to input.
   2. Monitor output at 2.0 kHz with tuned voltmeter and adjust P_3 for desired gain. (Be sure to peak response of the voltmeter.)
   3. Tune voltmeter to 1.0 kHz and adjust P_1 for a minimum output voltage.
   4. Ground input and adjust P_4 (output offset) for 0 Vdc output.
   5. Repeat steps 1 through 4 as necessary.

B. DC Procedure:
   1. Set $V_X = V_Y = 0$ V and adjust P_4 (output offset potentiometer) such that $V_O = 0$ Vdc
   2. Set $V_X = V_Y = 1.0$ V and adjust P_1 (Y-input offset potentiometer) such that the output voltage is + 0.100 V.
   3. Set $V_X = V_Y = 10$ Vdc and adjust P_3 such that the output voltage is + 10 V.
   4. Set $V_X = V_Y = -10$ Vdc. Repeat steps 1 through 3 as necessary.

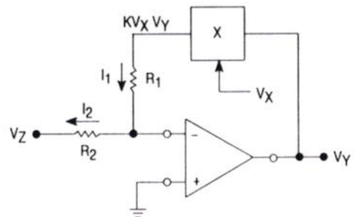


Figure 24. Basic Divide Circuit

Divide Circuit

Consider the circuit shown in Figure 24 in which the multiplier is placed in the feedback path of an operational amplifier. For this configuration, the operational amplifier will maintain a "virtual ground" at the inverting (–) input. Assuming that the bias current of the operational amplifier is negligible, then $I_1 = I_2$ and,

$$\frac{KV_XV_Y}{R1} = \frac{-V_Z}{R2} \quad (1)$$

Solving for V_Y, $$V_Y = \frac{-R1}{R2\,K}\frac{V_Z}{V_X} \quad (2)$$

If R1=R2, $$V_Y = \frac{-V_Z}{KV_X} \quad (3)$$

If R1= KR2, $$V_Y = \frac{-V_Z}{V_X} \quad (4)$$

Hence, the output voltage is the ratio of V_Z to V_X and provides a divide function. This analysis is, of course, the ideal condition. If the multiplier error is taken into account, the output voltage is found to be:

$$V_Y = -\left[\frac{R1}{R2\,K}\right]\frac{V_Z}{V_X} + \frac{\Delta E}{KV_X} \quad (5)$$

where ΔE is the error voltage at the output of the multiplier. From this equation, it is seen that divide accuracy is strongly dependent upon the accuracy at which the multiplier can be set, particularly at small values of V_Y. For example, assume that R1 = R2, and K = 1/10. For these conditions the output of the divide circuit is given by:

$$V_Y = \frac{-10\,V_Z}{V_X} + \frac{10\,\Delta E}{V_X} \quad (6)$$

From Equation 6, it is seen that only when $V_X = 10$ V is the error voltage of the divide circuit as low as the error of the multiply circuit. For example, when V_X is small, (0.1 V) the error voltage of the divide circuit can be expected to be a hundred times the error of the basic multiplier circuit.

In terms of percentage error,

$$\text{percentage error} = \frac{\text{error}}{\text{actual}} \times 100\%$$

or from Equation (5),

$$PE_D = \frac{\dfrac{\Delta E}{KV_X}}{\left[\dfrac{R1}{R2\,K}\right]\dfrac{V_Z}{V_X}} = \left[\frac{R2}{R1}\right]\frac{\Delta E}{V_Z} \quad (7)$$

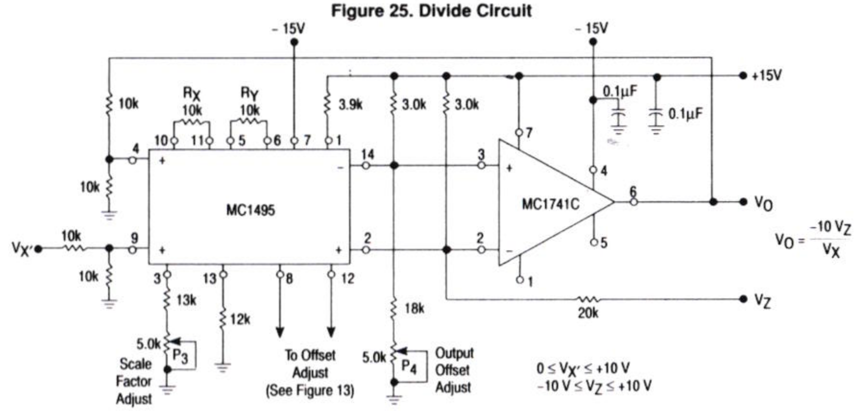
From Equation 7, the percentage error is inversely related to voltage V_Z (i.e., for increasing values of V_Z, the percentage error decreases).

A circuit that performs the divide function is shown in Figure 25.

Two things should be emphasized concerning Figure 25.
1. The input voltage ($V_{X'}$) must be greater than zero and must be positive. This insures that the current out of Pin 2 of the multiplier will always be in a direction compatible with the polarity of V_Z.
2. Pin 2 and 14 of the multiplier have been interchanged in respect to the operational amplifiers input terminals. In this instance, Figure 25 differs from the circuit connection shown in Figure 21; necessitated to insure negative feedback around the loop.

A suggested adjustment procedure for the divide circuit.
1. Set $V_Z = 0$ V and adjust the output offset potentiometer (P_4) until the output voltage (V_O) remains at some (not necessarily zero) constant value as $V_{X'}$ is varied between +1.0 V and +10 V.
2. Keep V_Z at 0 V, set $V_{X'}$ at +10 V and adjust the Y input offset potentiometer (P_1) until $V_O = 0$ V.
3. Let $V_{X'} = V_Z$ and adjust the X-input offset potentiometer (P_2) until the output voltage remains at some (not necessarily – 10 V) constant value as $V_Z = V_{X'}$ is varied between +1.0 and +10 V.
4. Keep $V_{X'} = V_Z$ and adjust the scale factor potentiometer (P_3) until the average value of V_O is –10 V as $V_Z = V_{X'}$ is varied between +1.0 V and +10 V.
5. Repeat steps 1 through 4 as necessary to achieve optimum performance.

Figure 25. Divide Circuit



To set currents I_3 and I_{13} to the desired value, it is only necessary to connect a resistor between Pin 13 and ground, and between Pin 3 and ground. From the schematic shown in Figure 3, it can be seen that the resistor values necessary are given by:

$$R_{13} + 500\ \Omega = \frac{|V-| - 0.7\ V}{I_{13}}$$

$$R_3 + 500\ \Omega = \frac{|V-| - 0.7\ V}{I_3}$$

Let V− = −15 V, then $R_{13} + 500 = \frac{14.3\ V}{1.0\ mA}$ or R_{13} = 13.8 kΩ

Let R_{13} = 12 kΩ. Similarly, R_3 = 13.8 kΩ, let R_3 = 15 kΩ

However, for applications which require an accurate scale factor, the adjustment of R_3 and consequently, I_3, offers a convenient method of making a final trim of the scale factor. For this reason, as shown in Figure 21, resistor R_3 is shown as a fixed resistor in series with a potentiometer.

For applications not requiring an exact scale factor (balanced modulator, frequency doubler, AGC amplifier, etc.) Pins 3 and 13 can be connected together and a single resistor from Pin 3 to ground can be used. In this case, the single resistor would have a value of 1/2 the above calculated value for R_{13}.

Step 2. The next step is to select R_X and R_Y. To insure that the input transistors will always be active, the following conditions should be met:

$$\frac{V_X}{R_X} < I_{13}, \qquad \frac{V_Y}{R_Y} < I_3$$

A good rule of thumb is to make $I_3R_Y \geq 1.5\ V_{Y(max)}$ and $I_{13}R_X \geq 1.5\,V_{X(max)}$. The larger the I_3R_Y and $I_{13}R_X$ product in relation to V_Y and V_X respectively, the more accurate the multiplier will be (see Figures 17 and 18).

Let $R_X = R_Y$ = 10 kΩ,

then I_3R_Y = 10 V

$I_{13}R_X$ = 10 V

since $V_{X(max)} = V_{Y(max)}$ = 5.0 V, the value of $R_X = R_Y$ = 10 kΩ is sufficient.

Step 3. Now that R_X, R_Y and I_3 have been chosen, R_L can be determined:

$$K = \frac{2R_L}{R_X\,R_Y\,I_3} = \frac{4}{10}, \text{ or } \frac{(2)\,(R_L)}{(10\ k)\,(10\ k)\,(1.0\ mA)} = \frac{4}{10}$$

Thus R_L = 20 kΩ.

Step 4. To determine what power supply voltage is necessary for this application, attention must be given to the circuit schematic shown in Figure 3. From the circuit schematic it can be seen that in order to maintain transistors Q_1, Q_2, Q_3 and Q_4 in an active region when the maximum input voltages are applied ($V_{X'} = V_{Y'}$ = 10 V or V_X = 5.0 V, V_Y = 5.0 V), their respective collector voltage should be at least a few tenths of a volt higher than the maximum input voltage. It should also be noticed that the collector voltage of transistors Q_3 and Q_4 is at a potential which is two diode-drops below the voltage at Pin 1. Thus, the voltage at Pin 1 should be about 2.0 V higher than the maximum input voltage. Therefore, to handle +5.0 V at the inputs, the voltage at Pin 1 must be at least +7.0 V. Let V_1 = 9.0 Vdc.

Since the current flowing into Pin 1 is always equal to $2I_3$, the voltage at Pin 1 can be set by placing a resistor (R_1) from Pin 1 to the positive supply:

$$R_1 = \frac{V+ - V_1}{2I_3}$$

Let V+ = 15 V, then $R_1 = \frac{15\ V - 9.0\ V}{(2)\,(1.0\ mA)}$

$$R_1 = 3.0\ k\Omega.$$

Note that the voltage at the base of transistors Q_5, Q_6, Q_7 and Q_8 is one diode-drop below the voltage at Pin 1. Thus, in order that these transistors stay active, the voltage at Pins 2 and 14 should be approximately halfway between the voltage at Pin 1 and the positive supply voltage. For this example, the voltage at Pins 2 and 14 should be approximately 11 V.

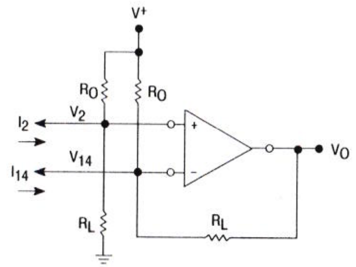
Step 5. For DC applications, such as the multiply, divide and square-root functions, it is usually desirable to convert the differential output to a single-ended output voltage referenced to ground. The circuit shown in Figure 22 performs this function. It can be shown that the output voltage of this circuit is given by:

$$V_O = (I_2 - I_{14})\,R_L$$

And since $I_A - I_B = I_2 - I_{14} = \frac{2I_X\,I_Y}{I_3} = \frac{2V_XV_Y}{I_3R_XR_Y}$

then $V_O = \frac{2R_L\,V_X'\,V_Y'}{4R_X\,R_X\,I_3}$ where, $V_X'\,V_Y'$ is the voltage at the input to the voltage dividers.

Figure 22. Level Shift Circuit



The choice of an operational amplifier for this application should have low bias currents, low offset current, and a high common mode input voltage range as well as a high common mode rejection ratio. The MC1456, and MC1741C operational amplifiers meet these requirements.

Referring to Figure 21, the level shift components will be determined. When $V_X = V_Y = 0$, the currents I_2 and I_{14} will be equal to I_{13}. In Step 3, R_L was found to be 20 kΩ and in Step 4, V_2 and V_{14} were found to be approximately 11 V. From this information R_O can be found easily from the following equation (neglecting the operational amplifiers bias current):

$$\frac{V2}{R_L} + I_{13} = \frac{V+ - V_2}{R_O}$$

And for this example, $\frac{11\ V}{20\ k\Omega} + 1.0\ mA = \frac{15\ V - 11\ V}{R_O}$

Solving for R_O: R_O = 2.6 kΩ, thus, select R_O = 3.0 kΩ

For R_O = 3.0 kΩ, the voltage at Pins 2 and 14 is calculated to be:

$$V_2 = V_{14} = 10.4\ V.$$

The linearity of this circuit (Figure 21) is likely to be as good or better than the circuit of Figure 5. Further improvements are possible as shown in Figure 23 where R_Y has been increased substantially to improve the Y linearity, and R_X decreased somewhat so as not to materially affect the X linearity. This avoids increasing R_L significantly in order to maintain a K of 0.1.

The versatility of the MC1495 allows the user to to optimize its performance for various input and output signal levels.

OFFSET AND SCALE FACTOR ADJUSTMENT

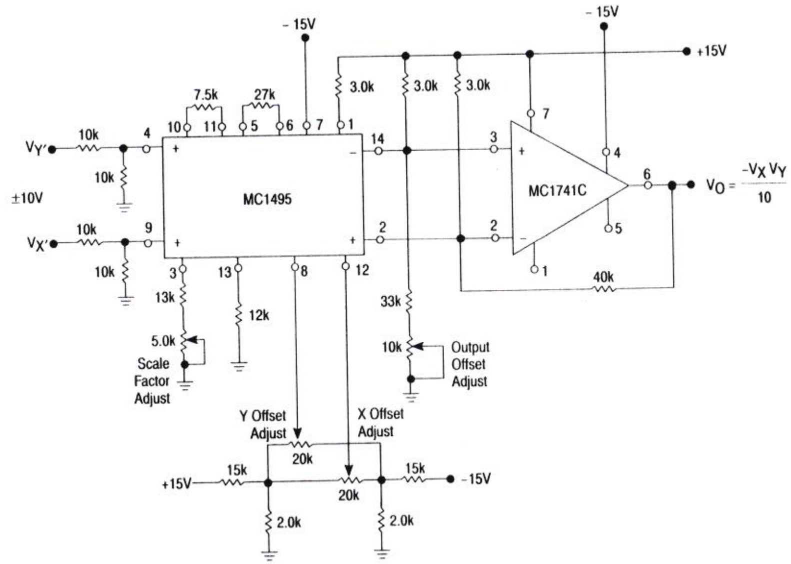
Offset Voltages

Within the monolithic multiplier (Figure 3) transistor base-emitter junctions are typically matched within 1.0 mV and resistors are typically matched within 2%. Even with this careful matching, an output error can occur. This output error is comprised of X-input offset voltage, Y-input offset voltage, and output offset voltage. These errors can be adjusted to zero with the techniques shown in Figure 21. Offset terms can be shown analytically by the transfer function:

$$V_O = K[V_x \pm V_{iox} \pm V_{x(off)}]\,[V_y \pm V_{ioy} \pm V_{y(off)}] \pm V_{OO} \quad (1)$$

Where:
- K = scale factor
- V_x = "x" input voltage
- V_y = "y" input voltage
- V_{iox} = "x" input offset voltage
- V_{ioy} = "y" input offset voltage
- $V_{x(off)}$ = "x" input offset adjust voltage
- $V_{y(off)}$ = "y" input offset adjust voltage
- V_{OO} = output offset voltage.

Figure 23. Multiplier with Improved Linearity



OPERATION AND APPLICATIONS INFORMATION

THEORY OF OPERATION

The MC1495 is a monolithic, four-quadrant multiplier which operates on the principle of variable transconductance. A detailed theory of operation is covered in Application Note AN489, *Analysis and Basic Operation of the MC1595.* The result of this analysis is that the differential output current of the multiplier is given by:

$$I_A - I_B = \Delta I = \frac{2V_X V_Y}{R_X R_Y I_3}$$

where, I_A and I_B are the currents into Pins 14 and 2, respectively, and V_X and V_Y are the X and Y input voltages at the multiplier input terminals.

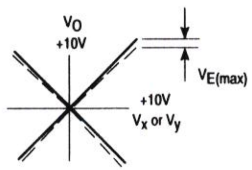
DESIGN CONSIDERATIONS

General

The MC1495 permits the designer to tailor the multiplier to a specific application by proper selection of external components. External components may be selected to optimize a given parameter (e.g. bandwidth) which may in turn restrict another parameter (e.g. maximum output voltage swing). Each important parameter is discussed in detail in the following paragraphs.

Linearity, Output Error, E_{RX} or E_{RY}

Linearity error is defined as the maximum deviation of output voltage from a straight line transfer function. It is expressed as error in percent of full scale (see figure below).



For example, if the maximum deviation, $V_{E(max)}$, is ±100 mV and the full scale output is 10 V, then the percentage error is:

$$E_R = \frac{V_{E(max)}}{V_{O(max)}} \bullet 100 = \frac{100 \bullet 10^{-3}}{10} \bullet 100 = \pm 1.0\%.$$

Linearity error may be measured by either of the following methods:

1. Using an X-Y plotter with the circuit shown in Figure 5, obtain plots for X and Y similar to the one shown above.
2. Use the circuit of Figure 4. This method nulls the level shifted output of the multiplier with the original input. The peak output of the null operational amplifier will be equal to the error voltage, $V_{E\ (max)}$.

One source of linearity error can arise from large signal nonlinearity in the X and Y input differential amplifiers. To avoid introducing error from this source, the emitter degeneration resistors R_X and R_Y must be chosen large enough so that nonlinear base-emitter voltage variation can be ignored. Figures 17 and 18 show the error expected from this source as a function of the values of R_X and R_Y with an operating current of 1.0 mA in each side of the differential amplifiers (i.e., $I_3 = I_{13}$ = 1.0 mA).

3 dB Bandwidth and Phase Shift

Bandwidth is primarily determined by the load resistors and the stray multiplier output capacitance and/or the operational amplifier used to level shift the output. If wideband operation is desired, low value load resistors and/or a wideband operational amplifier should be used. Stray output capacitance will depend to a large extent on circuit layout.

Phase shift in the multiplier circuit results from two sources: phase shift common to both X and Y channels (due to the load resistor-output capacitance pole mentioned above) and relative phase shift between X and Y channels (due to differences in transadmittance in the X and Y channels). If the input to output phase shift is only 0.6°, the output product of two sine waves will exhibit a vector error of 1%. A 3° relative phase shift between V_X and V_Y results in a vector error of 5%.

Maximum Input Voltage

$V_{X(max)}$, $V_{Y(max)}$ input voltages must be such that:

$$V_{X(max)} < I_{13} R_Y$$
$$V_{Y(max)} < I_3 R_Y$$

Exceeding this value will drive one side of the input amplifier to "cutoff" and cause nonlinear operation.

Current I_3 and I_{13} are chosen at a convenient value (observing power dissipation limitation) between 0.5 mA and 2.0 mA, approximately 1.0 mA. Then R_X and R_Y can be determined by considering the input signal handling requirements.

For $V_{X(max)} = V_{Y(max)}$ = 10 V;

$$R_X = R_Y > \frac{10\ V}{1.0\ mA} = 10\ k\Omega.$$

The equation $I_A - I_B = \dfrac{2V_X V_Y}{R_X R_Y I_3}$

is derived from $I_A - I_B = \dfrac{2V_X V_Y}{(R_X + \frac{2kT}{qI_{13}})(R_Y + \frac{2kT}{qI_3}) I_3}$

with the assumption $R_X >> \dfrac{2kT}{qI_{13}}$ and $R_Y >> \dfrac{2kT}{qI_3}$.

At T_A = +25°C and $I_{13} = I_3$ = 1.0 mA,

$$\frac{2kT}{qI_{13}} = \frac{2kT}{qI_3} = 52\ \Omega.$$

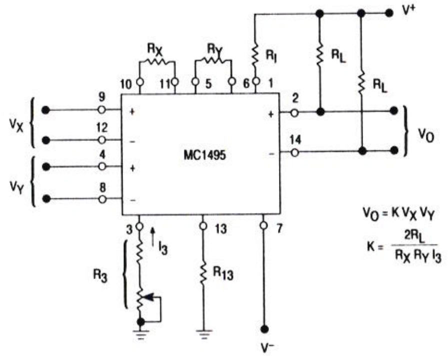
Therefore, with $R_X = R_Y$ = 10 kΩ the above assumption is valid. Reference to Figure 19 will indicate limitations of $V_{X(max)}$ or $V_{Y(max)}$ due to V_1 and V_7. Exceeding these limits will cause saturation or "cutoff" of the input transistors. See Step 4 of General Design Procedure for further details.

Maximum Output Voltage Swing

The maximum output voltage swing is dependent upon the factors mentioned below and upon the particular circuit being considered.

For Figure 20 the maximum output swing is dependent upon V+ for positive swing and upon the voltage at Pin 1 for negative swing. The potential at Pin 1 determines the quiescent level for transistors Q_5, Q_6, Q_7 and Q_8. This potential should be related so that negative swing at Pins 2 or 14 does not saturate those transistors. See General Design Procedure for further information regarding selection of these potentials.

Figure 20. Basic Multiplier



If an operational amplifier is used for level shift, as shown in Figure 21, the output swing (of the multiplier) is greatly reduced. See Section 3 for further details.

GENERAL DESIGN PROCEDURE

Selection of component values is best demonstrated by the following example. Assume resistive dividers are used at the X and Y-inputs to limit the maximum multiplier input to ± 5.0 V [$V_X = V_{Y(max)}$] for a ± 10 V input [$V_X' = V_{Y'(max)}$] (see Figure 21). If an overall scale factor of 1/10 is desired,

$$\text{then, } V_O = \frac{V_X' V_Y'}{10} = \frac{(2V_X)(2V_Y)}{10} = 4/10\ V_X V_Y$$

Therefore, K = 4/10 for the multiplier (excluding the divider network).

Step 1. The fist step is to select current I_3 and current I_{13}. There are no restrictions on the selection of either of these currents except the power dissipation of the device. I_3 and I_{13} will normally be 1.0 mA or 2.0 mA. Further, I_3 does not have to be equal to I_{13}, and there is normally no need to make them different. For this example, let

$$I_3 = I_{13} = 1.0\ mA.$$

Figure 21. Multiplier with Operational Amplifier Level Shift

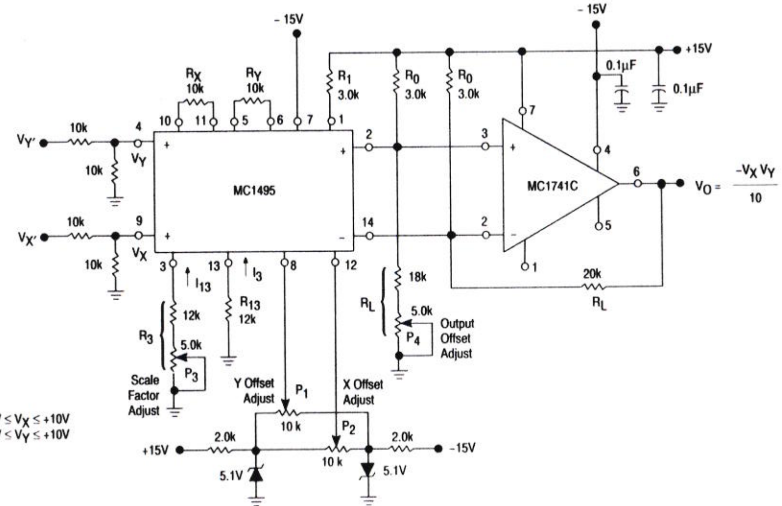
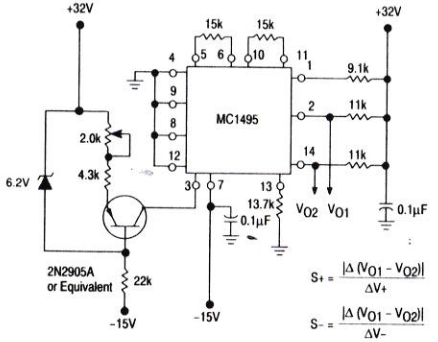


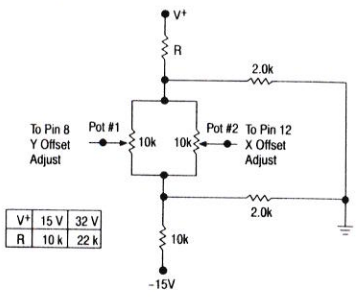
Figure 12. Power Supply Sensitivity



$$S+ = \frac{|\Delta (V_{O1} - V_{O2})|}{\Delta V+}$$

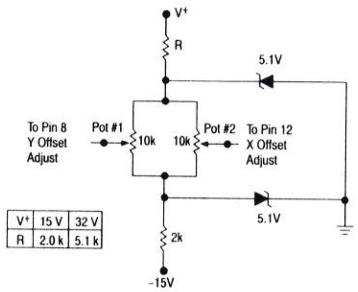
$$S- = \frac{|\Delta (V_{O1} - V_{O2})|}{\Delta V-}$$

Figure 13. Offset Adjust Circuit



V+	15 V	32 V
R	10 k	22 k

Figure 14. Offset Adjust Circuit (Alternate)



V+	15 V	32 V
R	2.0 k	5.1 k

Figure 15. Linearity versus Temperature

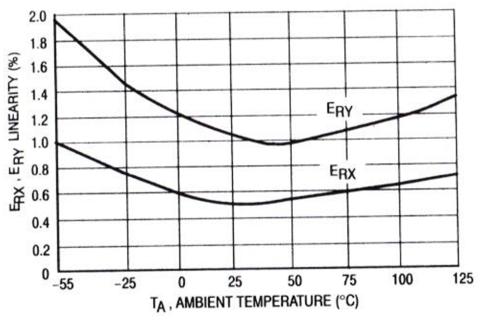


Figure 16. Scale Factor versus Temperature

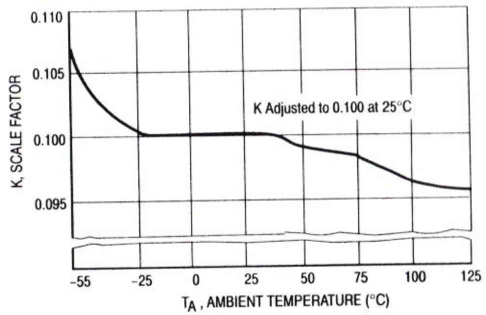


Figure 17. Error Contributed by Input Differential Amplifier

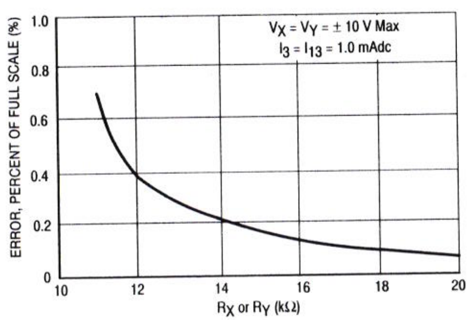


Figure 18. Error Contributed by Input Differential Amplifier

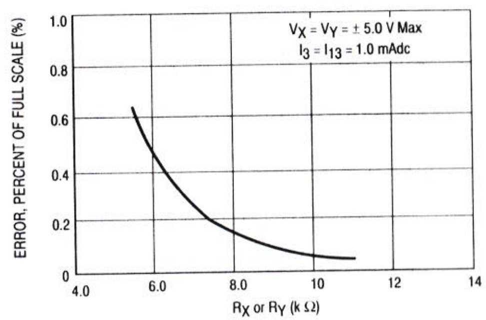
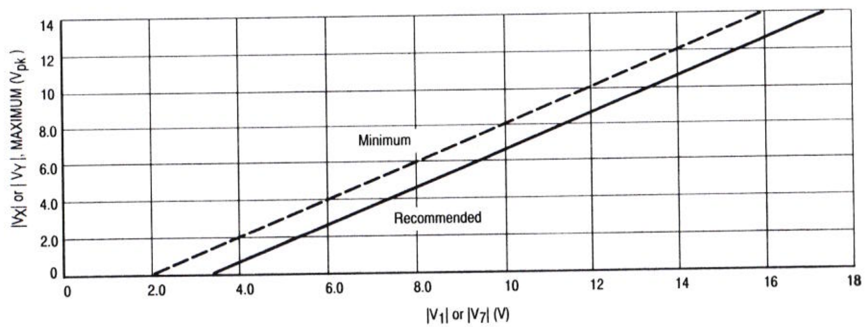


Figure 19. Maximum Allowable Input Voltage versus Voltage at Pin 1 or Pin 7



MAXIMUM RATINGS (T_A = +25°C, unless otherwise noted.)

Rating	Symbol	Value	Unit
Applied Voltage ($V_2–V_1$, $V_{14}–V_1$, $V_1–V_9$, $V_1–V_{12}$, $V_1–V_4$, $V_1–V_8$, $V_{12}–V_7$, $V_9–V_7$, $V_8–V_7$, $V_4–V_7$)	ΔV	30	Vdc
Differential Input Signal	$V_{12}–V_9$ $V_4–V_8$	$\pm(6+I_{13} R_X)$ $\pm(6+I_3 R_Y)$	Vdc
Maximum Bias Current	I_3 I_{13}	10 10	mA
Power Dissipation (Package Limitation) D Suffix, Plastic Package Derate above T_A = +25°C J Suffix, Ceramic Package Derate above T_A = +25°C	 P_D P_D	 862 145 750 5.0	 mW mW/°C mW °C/W
Operating Temperature Range MC1495 MC1595	T_A	0 to +70 –55 to +125	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

Figure 4. Linearity (Using Null Technique)

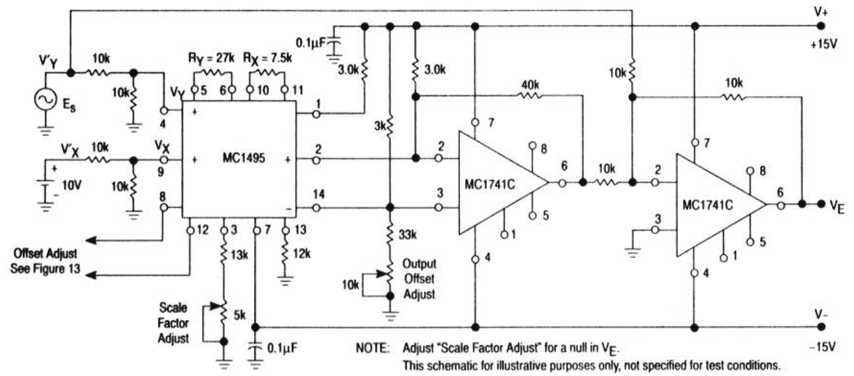


Figure 5. Linearity (Using X-Y Plotter Technique)

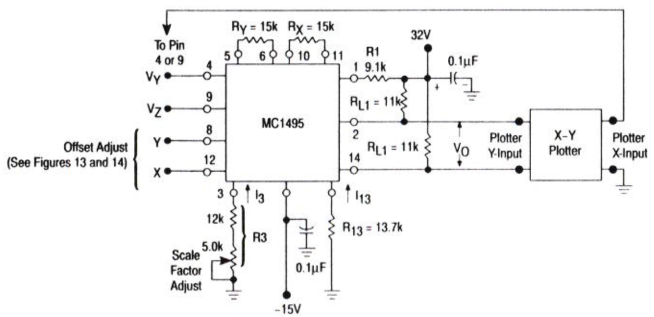


Figure 6. Input and Output Current

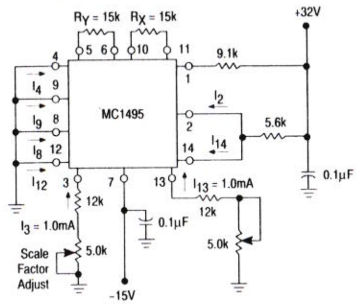


Figure 7. Input Resistance

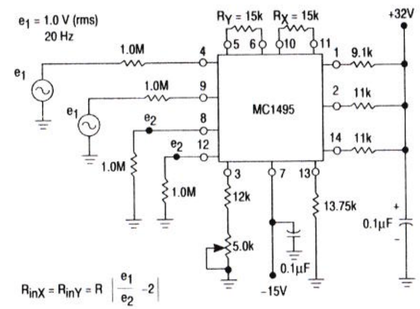


Figure 8. Output Resistance

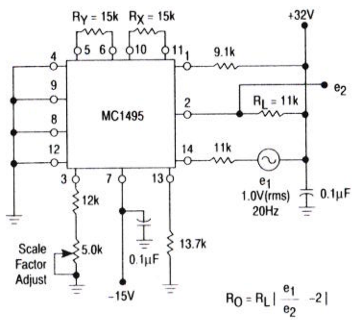


Figure 9. Bandwidth (R_L = 11kΩ)

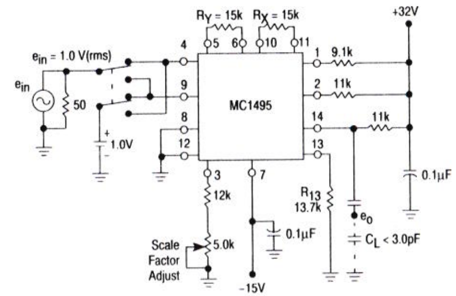


Figure 10. Bandwidth (R_L = 50 Ω)

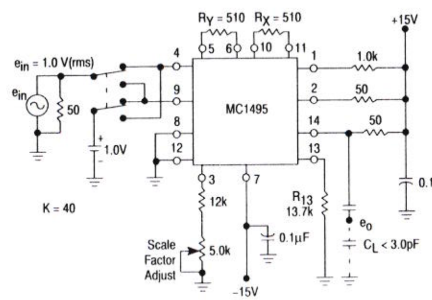
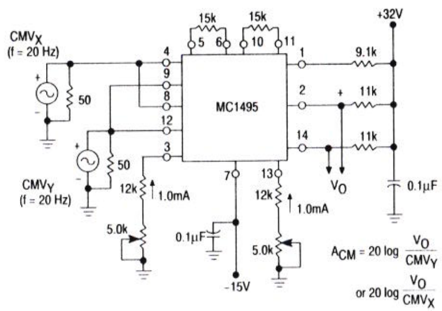


Figure 11. Common Mode Gain and Common Mode Input Swing



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MC1495
MC1595

Wideband Linear Four-Quadrant Multiplier

The MC1495/1595 is designed for use where the output is a linear product of two input voltages. Maximum versatility is assured by allowing the user to select the level shift method. Typical applications include: multiply, divide*, square root*, mean square*, phase detector, frequency doubler, balanced modulator/demodulator, and electronic gain control.

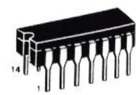
- Wide Bandwidth
- Excellent Linearity:
  - 2% max Error on X Input, 4% max Error on Y Input (MC1495)
  - 1% max Error on X Input, 2% max Error on Y Input (MC1595)
- Adjustable Scale Factor, K
- Excellent Temperature Stability
- Wide Input Voltage Range: ± 10 V
- ± 15 V Operation

*When used with an operational amplifier.

LINEAR FOUR-QUADRANT MULTIPLIER

SILICON MONOLITHIC INTEGRATED CIRCUIT

D SUFFIX
PLASTIC PACKAGE
CASE 751A
(SO-14)



L SUFFIX
CERAMIC PACKAGE
CASE 632

Figure 1. Multiplier Transfer Characteristic

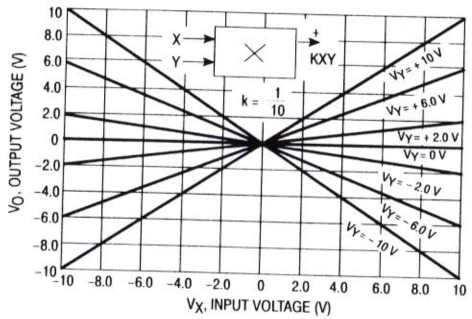


Figure 2. Transconductance Bandwidth

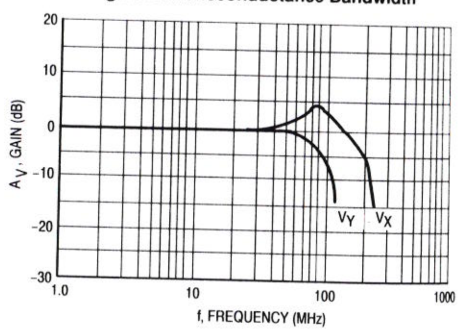
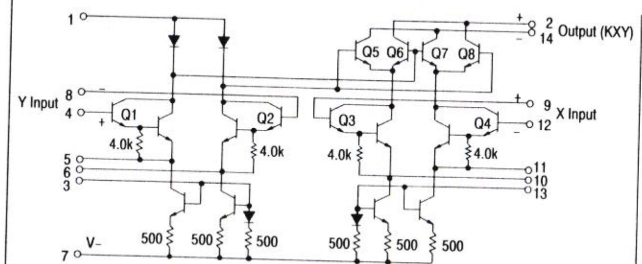


Figure 3. Circuit Schematic



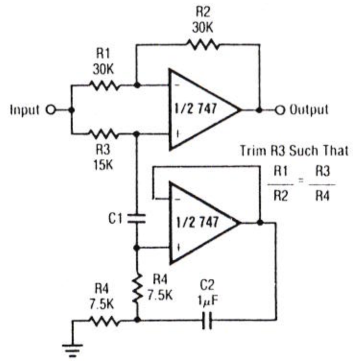
ORDERING INFORMATION

Device	Ambient Temperature Range	Package
MC1495D	0° to +70°C	SO-14
MC1595D		
MC1495L	−55° to +125°C	Ceramic DIP
MC1595L		

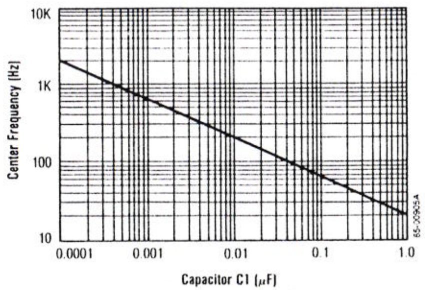
ELECTRICAL CHARACTERISTICS (+V = +32 V, −V = −15 V, T_A = +25°C, $I_3 = I_{13}$ = 1.0 mA, $R_X = R_Y$ = 15 kΩ, R_L = 11 kΩ, unless otherwise noted.)

Characteristics		Figure	Symbol	Min	Typ	Max	Unit
Linearity (Output Error in percent of full scale)		5					%
T_A = +25°C, $-10 < V_X < +10$ ($V_Y = \pm10$ V)	MC1495		E_{RX}	—	±1.0	±2.0	
	MC1595			—	±0.5	±1.0	
$-10 < V_Y < +10$ ($V_X = \pm10$ V)	MC1495		E_{RY}	—	±2.0	±4.0	
	MC1595			—	+1.0	±2.0	
T_A = 0° to +70°C, $-10 < V_X < +10$ ($V_Y = \pm10$ V)	MC1495		E_{RX}	—	±1.5	—	
$-10 < V_Y < +10$ ($V_X = \pm10$ V)			E_{RY}	—	±3.0	—	
T_A = −55° to +125°C, $-10 < V_X < +10$ ($V_Y = \pm10$ V)	MC1595		E_{RX}	—	±0.75	—	
$-10 < V_Y < +10$ ($V_X = \pm10$ V)			E_{RY}	—	±1.5	—	
Square Mode Error (Accuracy in percent of full scale after Offset and Scale Factor adjustment)		5	E_{SQ}				%
T_A = +25°C	MC1495			—	±0.75	—	
	MC1595			—	±0.5	—	
T_A = 0° to +70°C	MC1495			—	±1.0	—	
T_A = −55° to +125°C	MC1595			—	±0.75	—	
Scale Factor (Adjustable) $\left(K = \frac{2R_L}{I_3 R_X R_Y}\right)$		—	K	—	0.1	—	
Input Resistance (f = 20 Hz)	MC1495	7	R_{inX}	—	30	—	MΩ
	MC1595			—	35	—	
	MC1495		R_{inY}	—	20	—	
	MC1595			—	35	—	
Differential Output Resistance (f = 20 Hz)		8	R_O	—	300	—	kΩ
Input Bias Current $I_{bx} = \frac{(I_9 + I_{12})}{2}$, $I_{by} = \frac{(I_4 + I_8)}{2}$	MC1495	6	I_{bx}	—	2.0	12	µA
	MC1595			—	2.0	8.0	
	MC1495		I_{by}	—	2.0	12	
	MC1595			—	2.0	8.0	
Input Offset Current $\lvert I_9 - I_{12} \rvert$	MC1495	6	$\lvert I_{iox} \rvert$	—	0.4	2.0	µA
	MC1595			—	0.2	1.0	
$\lvert I_4 - I_8 \rvert$	MC1495		$\lvert I_{ioy} \rvert$	—	0.4	2.0	
	MC1595			—	0.2	1.0	
Average Temperature Coefficient of Input Offset Current (T_A = 0° to +70°C)	MC1495	6	$\lvert TC_{Iio} \rvert$	—	2.5	—	nA/°C
(T_A = −55° to +125°C)	MC1595			—	2.5		
Output Offset Current $\lvert I_{14} - I_2 \rvert$	MC1495	6	$\lvert I_{OO} \rvert$	—	20	100	µA
	MC1595				10	50	
Average Temperature Coefficient of Output Offset Current (T_A = 0° to +70°C)	MC1495	6	$\lvert TC_{IOO} \rvert$	—	20	—	nA/°C
(T_A = −55° to +125°C)	MC1595			—	20	—	
Frequency Response		9,10					
3.0 dB Bandwidth, R_L = 11 kΩ			$BW_{(3dB)}$	—	3.0	—	MHz
3.0 dB Bandwidth, R_L = 50 Ω (Transconductance Bandwidth)			$T_{BW(3dB)}$	—	80	—	MHz
3° Relative Phase Shift Between V_X and V_Y			f_ϕ	—	750	—	kHz
1% Absolute Error Due to Input-Output Phase Shift			f_θ	—	30	—	kHz
Common Mode Input Swing (Either Input)	MC1495	11	CMV	±10.5	±12	—	Vdc
	MC1595			±11.5	±13	—	
Common Mode Gain (Either Input)	MC1495	11	A_{CM}	−40	−50	—	dB
	MC1595			−50	−60	—	
Common Mode Quiescent Output Voltage		12	V_{O1}	—	21	—	Vdc
			V_{O2}	—	21	—	
Differential Output Voltage Swing Capability		9	V_O	—	±14	—	V_{pk}
Power Supply Sensitivity		12	S^+	—	5.0	—	mV/V
			S^-	—	10	—	
Power Supply Current		12	I_7	—	6.0	7.0	mA
DC Power Dissipation		12	P_D	—	135	170	mW

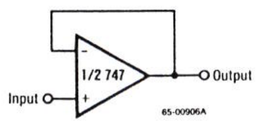
Typical Applications (Continued)



Notch Frequency as a Function of C1

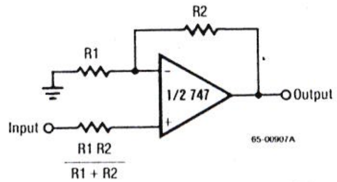


Notch Filter Using the 747 as a Gyrator



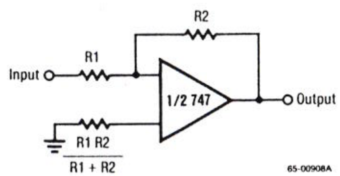
R_{IN} = 400MΩ
C_{IN} = 1pF
R_{OUT} << 1Ω
BW = 1MHz

Unity Gain Voltage Follower



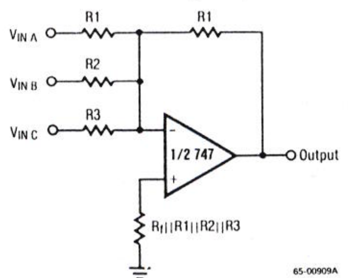
Gain	R1	R2	B.W.	R_{IN}
10	1kΩ	9kΩ	100kHz	400MΩ
100	100Ω	9.9kΩ	10kHz	280MΩ
1000	100Ω	99.9kΩ	1kHz	80MΩ

Non-Inverting Amplifier



Gain	R1	R2	B.W.	R_{IN}
1	10kΩ	10kΩ	1MHz	10kΩ
10	1kΩ	10kΩ	100kHz	1kΩ
100	1kΩ	100kΩ	10kHz	1kΩ
1000	100Ω	100kΩ	1kHz	100Ω

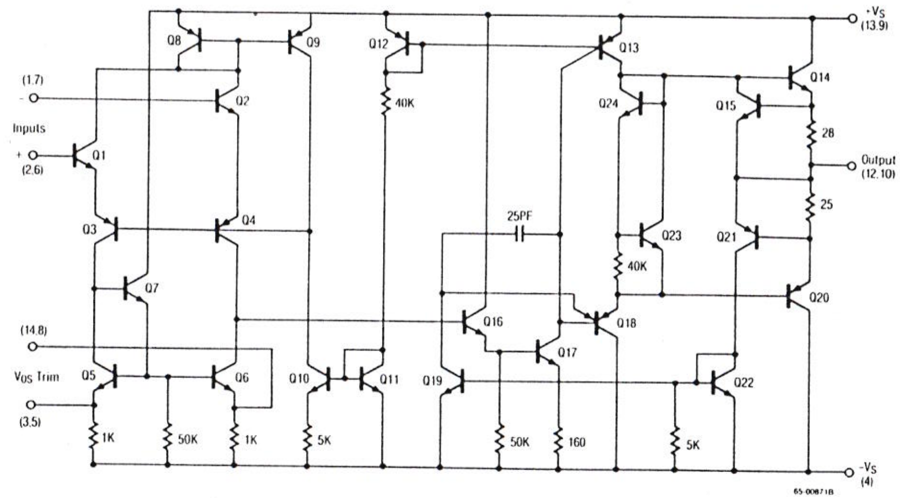
Inverting Amplifier



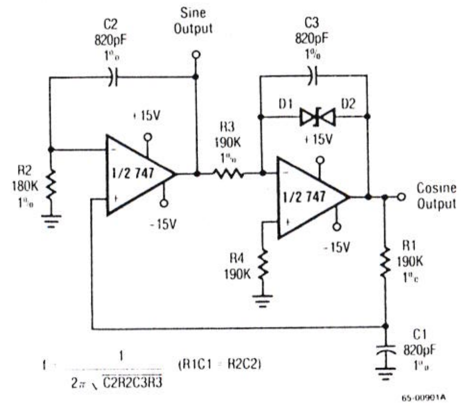
$$-V_O = V_{IN\,A}\left(\frac{R_f}{R1}\right) - V_{IN\,B}\left(\frac{R_f}{R2}\right) - V_{IN\,C}\left(\frac{R_f}{R3}\right)$$

Weighted Averaging Amplifier

Schematic Diagram (1/2 Shown)

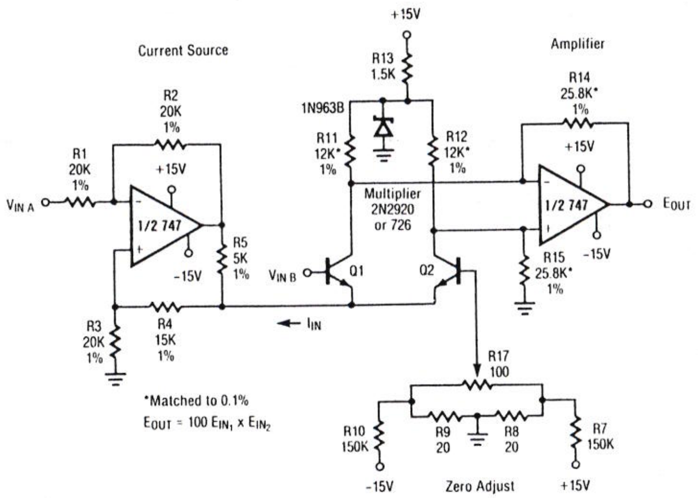


Typical Applications



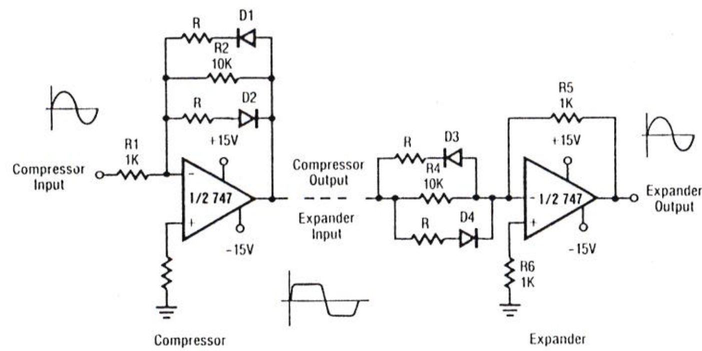
$$f = \frac{1}{2\pi\sqrt{C2R2C3R3}} \quad (R1C1 = R2C2)$$

Quadrature Oscillator



Analog Multiplier

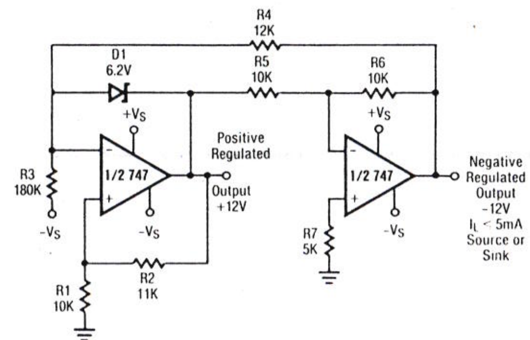
Typical Applications (Continued)



Maximum compression expansion ratio = R1/R (10KΩ > R ≥ 0)

Note: Diodes D1 through D4 are matched FD6666 or equivalent

Compressor/Expander Amplifiers



$$\text{Positive Output} = V_{D1} \times \frac{R1 + R2}{R2}$$

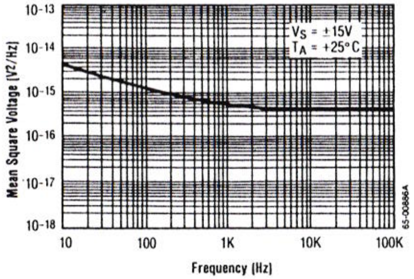
$$\text{Negative Output} = -\text{Positive Output} \times \frac{R6}{R5}$$

65-00904A

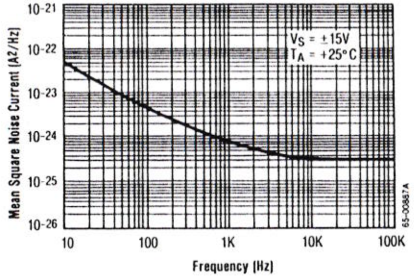
Tracking Positive and Negative Voltage References

Typical Performance Characteristics (Continued)

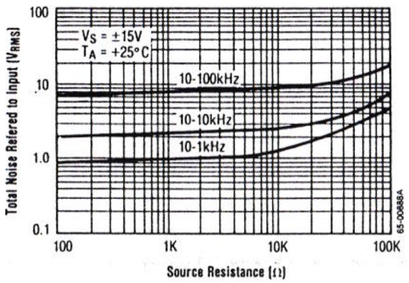
Input Noise Voltage as a Function of Frequency



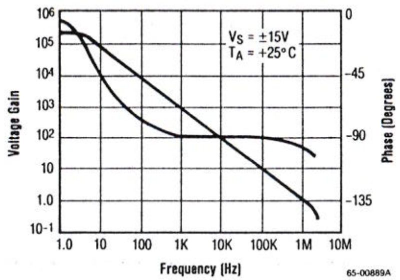
Input Noise Current as a Function of Frequency



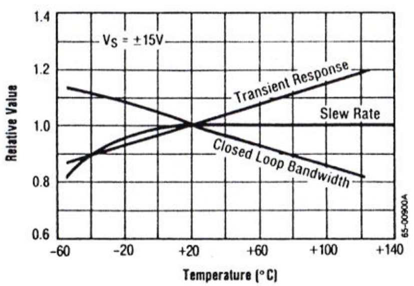
Broadband Noise for Various Bandwidths



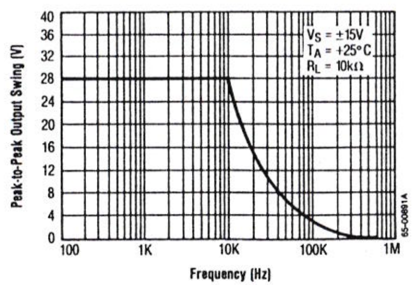
Open Loop Voltage Gain as a Function of Frequency



Frequency Characteristics as a Function of Ambient Temperature

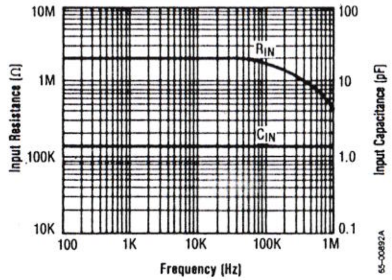


Output Voltage Swing as a Function of Frequency

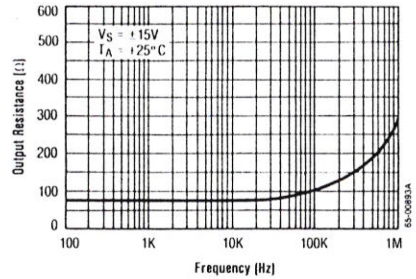


Typical Performance Characteristics (Continued)

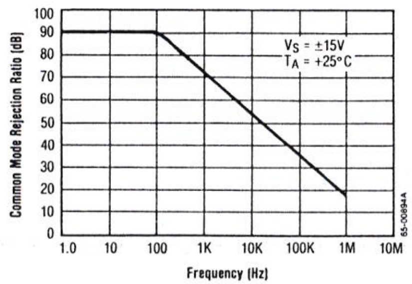
Input Resistance and Input Capacitance as a Function of Frequency



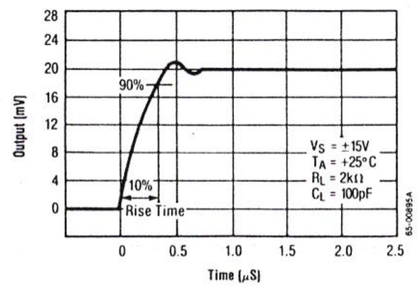
Output Resistance as a Function of Frequency



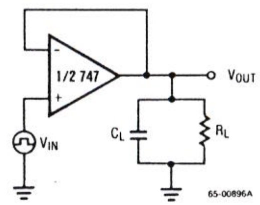
Common Mode Rejection Ratio as a Function of Frequency



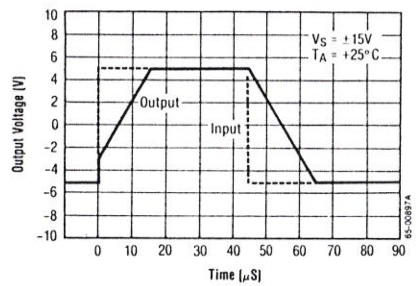
Transient Response



Transient Response Test Circuit

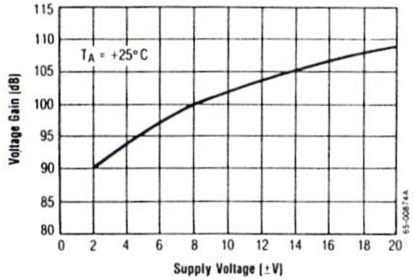


Voltage Follower Large Signal Pulse Response

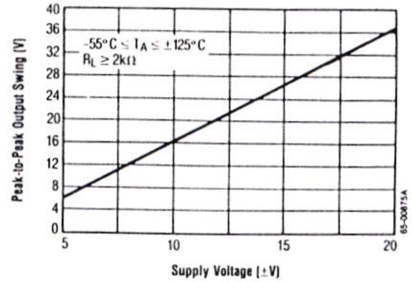


Typical Performance Characteristics (Continued)

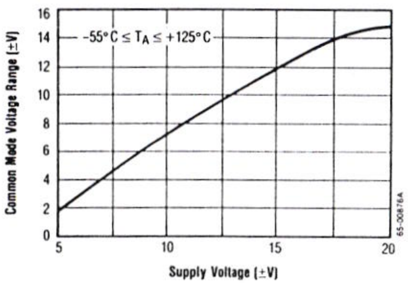
Open Loop Voltage Gain as a Function of Supply Voltage



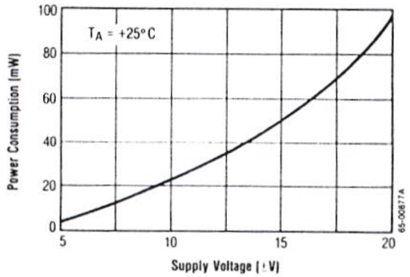
Output Voltage Swing as a Function of Supply Voltage



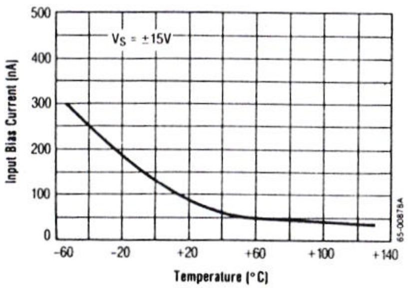
Input Common Mode Voltage Range as a Function of Supply Voltage



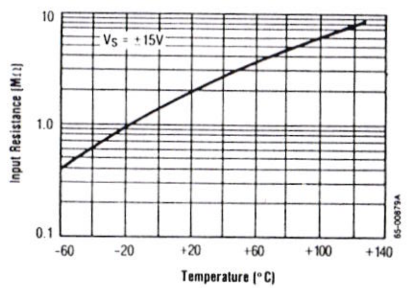
Power Consumption as a Function of Supply Voltage



Input Bias Current as a Function of Ambient Temperature

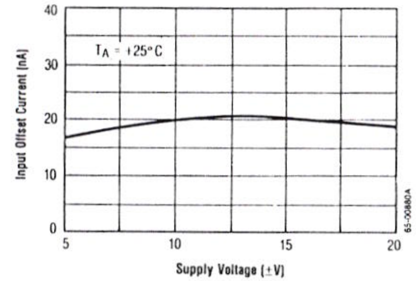


Input Resistance as a Function of Ambient Temperature

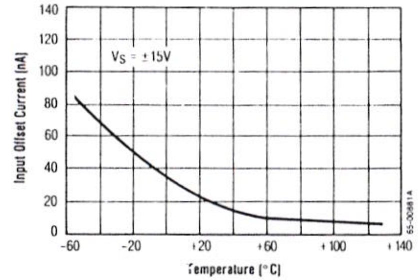


Typical Performance Characteristics (Continued)

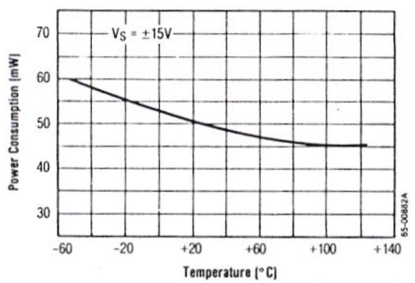
Input Offset Current as a Function of Supply Voltage



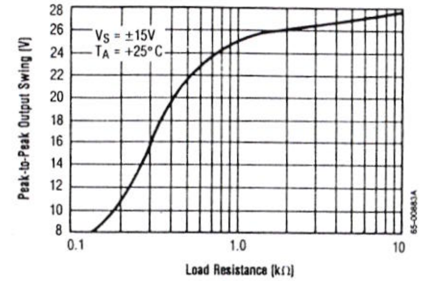
Input Offset Current as a Function of Ambient Temperature



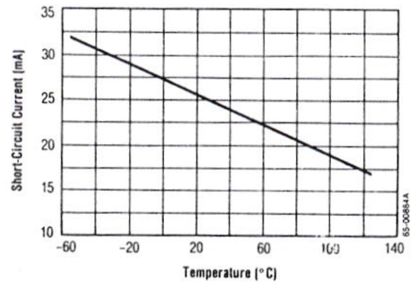
Power Consumption as a Function of Ambient Temperature



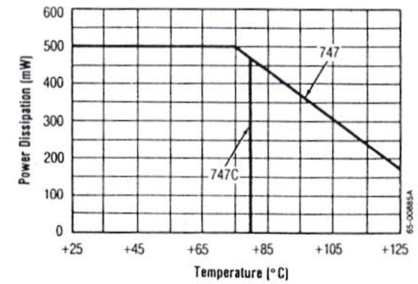
Output Voltage Swing as a Function of Load Resistance



Output Short Circuit Current as a Function of Ambient Temperature



Absolute Maximum Power Dissipation as a Function of Ambient Temperature



Thermal Characteristics

	14-Lead Plastic DIP	14-Lead Ceramic DIP	10-Lead TO-100 Metal Can
Max. Junction Temp.	125°C	175°C	175°C
Max. P_D T_A <50°C	468 mW	1042 mW	658 mW
Therm. Res θ_{JC}	—	60°C/W	50°C/W
Therm. Res. θ_{JA}	160°C/W	120°C/W	190°C/W
For T_A >50°C Derate at	6.25 mW/°C	8.33 mW/°C	5.26 mW/°C

Electrical Characteristics (V_S = ±15V and T_A = +25°C unless otherwise noted)

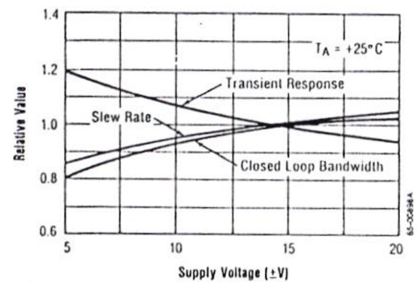
Parameters	Test Conditions	RM747 Min	RM747 Typ	RM747 Max	RC747 Min	RC747 Typ	RC747 Max	Units
Input Offset Voltage	$R_S \le 10$ kΩ		1.0	5.0		2.0	6.0	mV
Input Offset Current			20	200		20	200	nA
Input Bias Current			80	500		80	500	nA
Input Resistance (Diff. Mode)		0.3	2.0		0.3	2.0		MΩ
Large Signal Voltage Gain	$R_L \ge 2$ kΩ, V_{OUT} = ±10V	50	200		50	200		V/mV
Output Voltage Swing	$R_L \ge 10$ kΩ	±12	±14		±12	±14		V
	$R_L \ge 2$ kΩ	±10	±13		±10	±13		V
Input Voltage Range		±12	±13		±12	±13		V
Common Mode Rejection Ratio	$R_S \le 10$ kΩ	80	90		70	90		dB
Power Supply Rejection Ratio	$R_S \le 10$ kΩ	76	90		76	90		dB
Power Consumption			100	170		100	170	mW
Transient Response								
Rise Time	V_{IN} = 20 mV, R_L = 2 kΩ		0.3			0.3		µS
Overshoot	$C_L \le 100$ pF		5.0			5.0		%
Slew Rate	$R_L \ge 2$ kΩ		0.5			0.5		V/µS
Channel Separation	f = 1 kHz		98			98		dB

Electrical Characteristics (-55°C ≤ T_A ≤ +125°C for RM747; 0°C ≤ T_A ≤ +70°C for RC747)

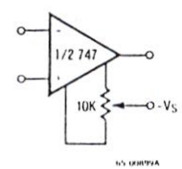
Parameters	Test Conditions	RM747 Min	RM747 Typ	RM747 Max	RC747 Min	RC747 Typ	RC747 Max	Units
Input Offset Voltage	$R_S \le 10$ kΩ			6.0			7.5	mV
Input Offset Current	T_A = +125°C, T_A = +70°C			200			300	nA
	T_A = -55°C T_A = 0°C			500			300	nA
Input Bias Current	T_A = +125°C, T_A = +70°C			500			800	nA
	T_A = -55°C, T_A = 0°C			1500			800	nA
Large Signal Voltage Gain	$R_L \ge 2$ kΩ, V_{OUT} = ±10V	25			25			V/mV
Output Voltage Swing	$R_L \ge 10$K	±12			±10			V
	$R_L \ge 2$ kΩ	±10						V
Common Mode Rejection Ratio	$R_S \le 10$ kΩ	70			70			dB
Power Supply Rejection Ratio	R_S = ≤ 10 kΩ	76		150	76		150	dB
Power Consumption	T_A = +125°C			150			150	mW
	T_A = -55°C			200			200	mW
Input Voltage Range		±12			±12			V

Typical Performance Characteristics

Frequency Characteristics as a Function of Ambient Temperature



Voltage Offset Null Circuit



RC747 General Purpose Operational Amplifier

LgNr. 13144

Features

- Short circuit protection
- No frequency compensation required
- No latch-up
- Large common mode and differential voltage ranges
- Low power consumption
- Parameter tracking over temperature range
- Gain and phase match between amplifiers

Description

The RC/RM747 integrated circuits are high gain, operational amplifiers internally compensated and constructed on a single silicon chip using an advanced epitaxial process.

The military version, RM747, operates over a temperature range from -55°C to +125°C. The commercial version, RC747, operates from 0°C to +70°C.

Combining the features of the 741 with the close parameter matching and tracking of a dual device on a monolithic chip results in unique performance characteristics. Excellent channel separation allows the use of the dual device in all single 741 operational amplifier applications providing high packaging density. It is especially well suited for applications in differential-in, differential-out as well as in potentiometric amplifiers and where gain and phase matched channels are mandatory.

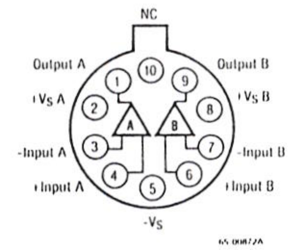
Ordering Information

Part Number	Package	Operating Temperature Range
RC747N	N	0°C to +70°C
RC747T	T	0°C to +70°C
RM747D	D	-55°C to +125°C
RM747D/883B*	D	-55°C to +125°C
RM747T	T	-55°C to +125°C
RM747T/883B*	T	-55°C to +125°C

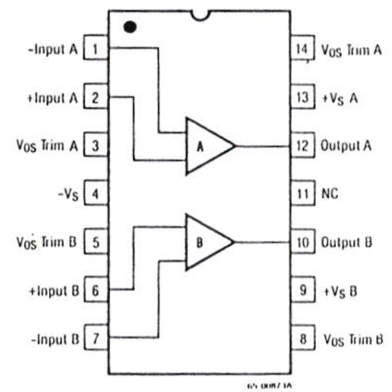
Notes:
*/883B suffix denotes Mil-Std-883, Level B processing
N = 14-lead plastic DIP
D = 14-lead ceramic DIP
T = 10-lead metal can TO-99
Contact a Raytheon sales office or representative for ordering information on special package/temperature range combinations.

Connection Information

10-Lead TO-100 Metal Can
(Top View)



14-Lead Dual In-Line Package
(Top View)



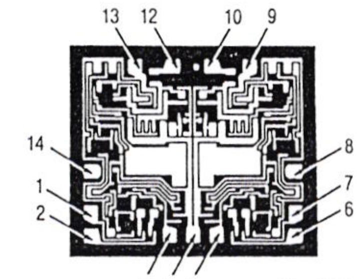
$+V_s$ A is internally connected to $+V_s$ B for the 747S

Absolute Maximum Ratings

Supply Voltage
RM747 .... ±22V
RC747 .... ±18V
Differential Input Voltage 30V
Input Voltage* .... ±15V
Output Short-Circuit Duration** .... Indefinite
Storage Temperature
Range .... -65°C to +150°C
Operating Temperature Range
RM747 .... -55°C to +125°C
RC747 .... 0°C to +70°C
Lead Soldering Temperature
(60 sec) .... +300°C

*For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
**Short-circuit may be to ground or either supply. Rating applies to +125°C case temperature or +75°C ambient temperature for RC747.

Mask Pattern



65-01251A

Die Size: 62 x 72 mils
Min. Pad Dimensions: 4 x 4 mils

TV-Umbau zum Monitor 1.12.76

Response
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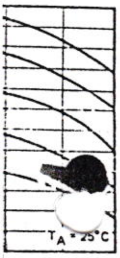

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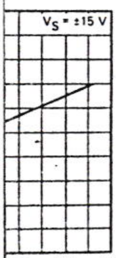

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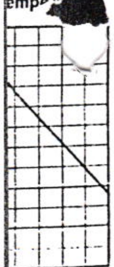


Am733/733C

Differential Video Amplifier

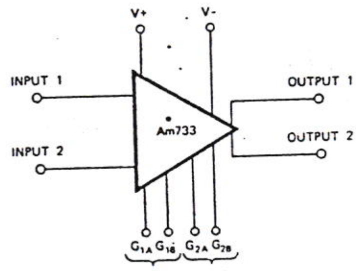
Distinctive Characteristics

- The Am733 and Am733C differential video amplifiers are functionally, electrically and pin-for-pin equivalent to the Fairchild µA733 and 733C.
- Bandwidths: 40 to 120 MHz
- Rise Times: 2.5 to 10 ns
- Propagation Delay: 3.6 to 10 ns
- 100% reliability assurance testing in compliance with MIL STD 883.
- Electrically tested and optically inspected dice for hybrid manufacturers.
- Mixing privilege for obtaining price discounts. Refer to price list.
- Available in metal can, hermetic dual-in-line or hermetic flat packages.

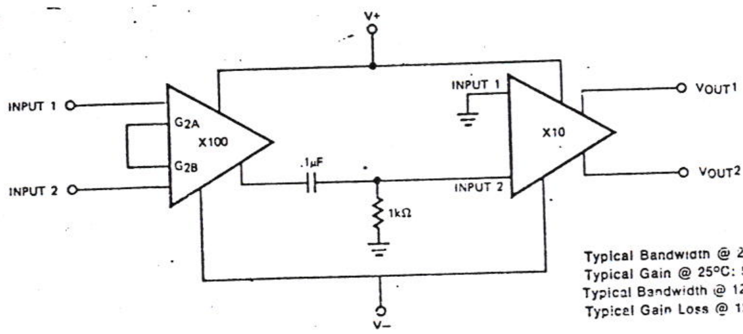
FUNCTIONAL DESCRIPTION

The Am733 is a monolithic two-stage differential input, emitter follower differential output video amplifier. Internal series-shunt feedback is used to obtain fixed gains of 10, 100 or 400, and adjustable gains from 10 to 400 by the use of an external resistor.

FUNCTIONAL DIAGRAM



TYPICAL APPLICATION
HIGH-GAIN WIDEBAND AMPLIFIER



Typical Bandwidth @ 25°C: 65 MHz
Typical Gain @ 25°C: 54 dB
Typical Bandwidth @ 125°C: 57 MHz
Typical Gain Loss @ 125°C: 1 dB

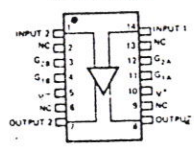
ORDERING INFORMATION

Part Number	Package Type	Temperature Range	Order Number
Am733C	Metal Can	0°C - +70°C	U5F7733393
	DIP	0°C - +70°C	U6A7733393
	Flat Pak	0°C - +70°C	U3F7733393
Am733	Metal Can	−55°C - +125°C	U5F7733312
	DIP	−55°C - +125°C	U6A7733312
	Flat Pak	−55°C - +125°C	U3F7733312
Am733	Dice	Note	UXX7733XXD

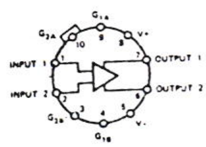
Note: The dice supplied will contain units which meet 0°C to 70°C, and −55°C to +125°C temperature ranges.

CONNECTION DIAGRAMS
Top Views

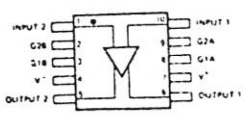
Dual-In-Line



Metal Can



Flat Package



NOTES.
(1) On Metal Can, pin 5 is connected to case.
(2) On DIP, pin 5 is connected to bottom of package.
(3) On Flat Package, pin 4 is connected to bottom of package.

TV-Umbau zum Monitor 1.12.76

Response
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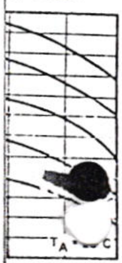

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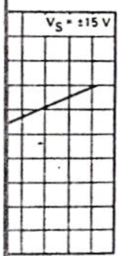

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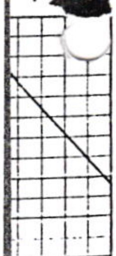


85 105 125
RE – °C

Am733/733C

Differential Video Amplifier

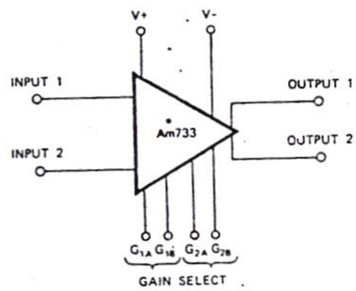
Distinctive Characteristics

- The Am733 and Am733C differential video amplifiers are functionally, electrically and pin-for-pin equivalent to the Fairchild μA733 and 733C.
- Bandwidths: 40 to 120 MHz
- Rise Times: 2.5 to 10 ns
- Propagation Delay: 3.6 to 10 ns
- 100% reliability assurance testing in compliance with MIL STD 883.
- Electrically tested and optically inspected dice for hybrid manufacturers.
- Mixing privilege for obtaining price discounts. Refer to price list.
- Available in metal can, hermetic dual-in-line or hermetic flat packages.

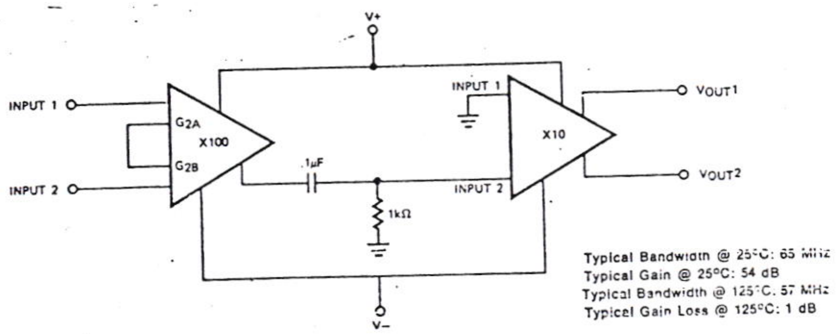
FUNCTIONAL DESCRIPTION

The Am733 is a monolithic two-stage differential input, emitter follower differential output video amplifier. Internal series-shunt feedback is used to obtain fixed gains of 10, 100 or 400, and adjustable gains from 10 to 400 by the use of an external resistor.

FUNCTIONAL DIAGRAM



TYPICAL APPLICATION
HIGH-GAIN WIDEBAND AMPLIFIER



Typical Bandwidth @ 25°C: 65 MHz
Typical Gain @ 25°C: 54 dB
Typical Bandwidth @ 125°C: 57 MHz
Typical Gain Loss @ 125°C: 1 dB

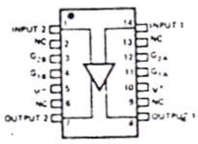
ORDERING INFORMATION

Part Number	Package Type	Temperature Range	Order Number
Am733C	Metal Can	0°C - +70°C	U5F7733393
	DIP	0°C - +70°C	U6A7733393
	Flat Pak	0°C - +70°C	U3F7733393
Am733	Metal Can	–55°C - +125°C	U5F7733312
	DIP	–55°C - +125°C	U6A7733312
	Flat Pak	–55°C - +125°C	U3F7733312
Am733	Dice	Note	UXX7733XXD

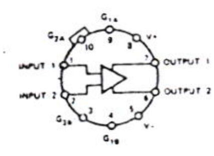
Note: The dice supplied will contain units which meet 0°C to 70°C, and –55°C to +125°C temperature ranges.

CONNECTION DIAGRAMS
Top Views

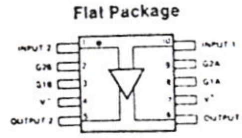
Dual-In-Line



Metal Can



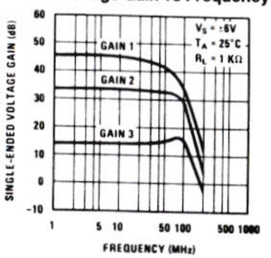
Flat Package



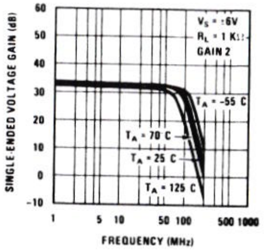
NOTES.
(1) On Metal Can, pin 5 is connected to case.
(2) On DIP, pin 5 is connected to bottom of package.
(3) On Flat Package, pin 4 is connected to bottom of package.

Typical Performance Characteristics (Continued)

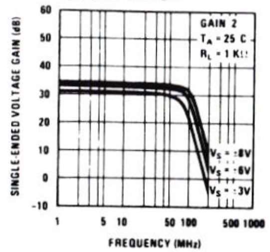
Voltage Gain vs Frequency



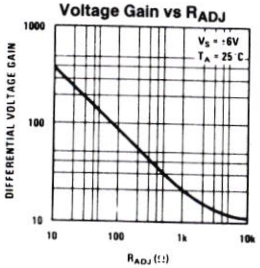
Gain vs Frequency Temperature



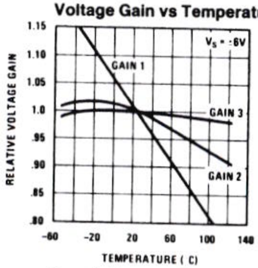
Gain vs Frequency vs Supply Voltage



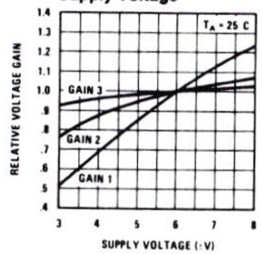
Voltage Gain vs R_{ADJ}



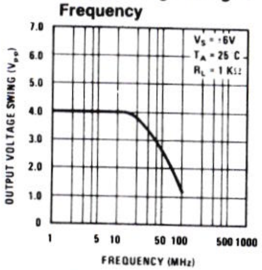
Voltage Gain vs Temperature



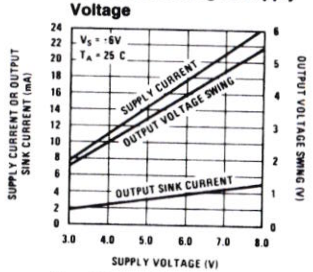
Voltage Gain vs Supply Voltage



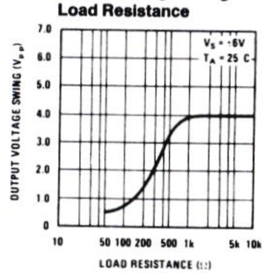
Output Voltage Swing vs Frequency



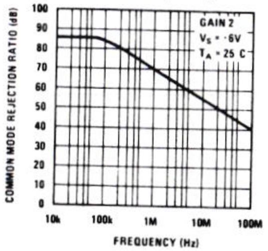
Supply Current, Output Voltage and Current Swing vs Supply Voltage



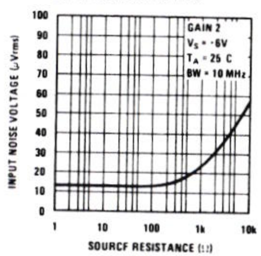
Output Voltage Swing vs Load Resistance



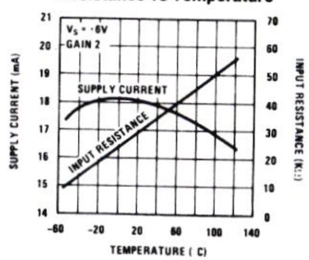
Common Mode Rejection Ratio vs Frequency



Input Noise Voltage vs Source Resistance



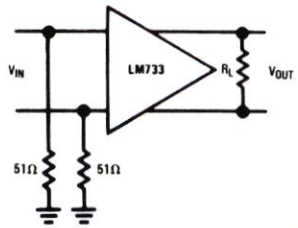
Supply Current and Input Resistance vs Temperature



TL/H/7866-7

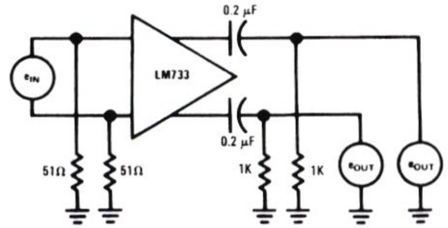
Test Circuits

Test Circuit 1



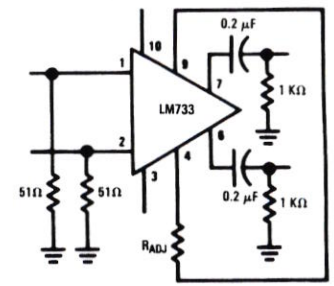
TL/H/7866-3

Test Circuit 2



TL/H/7866-4

Voltage Gain Adjust Circuit

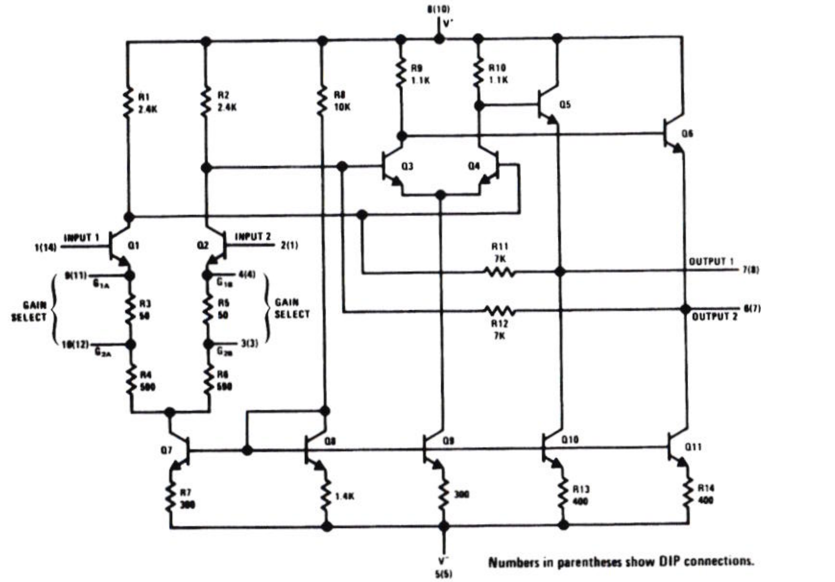


TL/H/7866-5

$V_S = 6V$, $T_A = 25°C$

(Pin numbers apply to TO-5 package)

Schematic Diagram



Numbers in parentheses show DIP connections.

TL/H/7866-8

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Diffential Input Voltage	±5V
Common Mode Input Voltage	±6V
V_{CC}	±8V
Output Current	10 mA
Power Dissipation (Note 1)	500 mW
Junction Temperature	+150°C
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	
LM733	−55°C to +125°C
LM733C	0°C to +70°C
Lead Temperature (Soldering, 10 sec.)	260°C

Electrical Characteristics (T_A = 25°C, unless otherwise specified, see test circuits, V_S = ±6.0V)

Characteristics	Test Circuit	Test Conditions	LM733			LM733C			Units
			Min	Typ	Max	Min	Typ	Max	
Differential Voltage Gain									
Gain 1 (Note 2)	1		300	400	500	250	400	600	
Gain 2 (Note 3)			90	100	110	80	100	120	
Gain 3 (Note 4)		R_L = 2 kΩ V_{OUT} = 3 Vp-p	9.0	10	11	8.0	10	12	
Bandwidth									
Gain 1	2			40			40		MHz
Gain 2				90			90		MHz
Gain 3				120			120		MHz
Rise Time									
Gain 1	2	V_{OUT} = 1 Vp-p		10.5			10.5		ns
Gain 2				4.5	10		4.5	12	ns
Gain 3				2.5			2.5		ns
Propagation Delay		V_{OUT} = 1 Vp-p							
Gain 1	2			7.5			7.5		ns
Gain 2				6.0	10		6.0	10	ns
Gain 3				3.6			3.6		ns
Input Resistance									
Gain 1				4.0			4.0		kΩ
Gain 2			20	30		10	30		kΩ
Gain 3				250			250		kΩ
Input Capacitance		Gain 2		2.0			2.0		pF
Input Offset Current				0.4	3.0		0.4	5.0	μA
Input Bias Current				9.0	20		9.0	30	μA
Input Noise Voltage		BW = 1 kHz to 10 MHz		12			12		μVrms
Input Voltage Range	1		±1.0			±1.0			V
Common Mode Rejection Ratio									
Gain 2	1	V_{CM} = ±1V f ≤ 100 kHz	60	86		60	86		dB
Gain 2		V_{CM} = ±1V f = 5 MHz		60			60		dB
Supply Voltage Rejection Ratio									
Gain 2	1	ΔV_S = ±0.5V	50	70		50	70		dB
Output Offset Voltage									
Gain 1	1	R_L = ∞		0.6	1.5		0.6	1.5	V
Gain 2 and 3				0.35	1.0		0.35	1.5	V
Output Common Mode Voltage	1	R_L = ∞	2.4	2.9	3.4	2.4	2.9	3.4	V
Output Voltage Swing	1	R_L = 2k	3.0	4.0		3.0	4.0		
Output Sink Current			2.5	3.6		2.5	3.6		mA
Output Resistance				20			20		Ω
Power Supply Current	1	R_L = ∞		18	24		18	24	mA

Electrical Characteristics (Continued)

(The following specifications apply for −55°C < T_A < 125°C for the LM733 and 0°C < T_A < 70°C for the LM733C, V_S = ±6.0V)

Characteristics	Test Circuit	Test Conditions	LM733			LM733C			Units
			Min	Typ	Max	Min	Typ	Max	
Differential Voltage Gain									
Gain 1	1	R_L = 2 kΩ, V_{OUT} = 3 Vp-p	200		600	250		600	
Gain 2			80		120	80		120	
Gain 3			8.0		12.0	8.0		12.0	
Input Resistance Gain 2			8			8			kΩ
Input Offset Current					5			6	μA
Input Bias Current					40			40	μA
Input Voltage Range	1		±1			±1			V
Common Mode Rejection Ratio									
Gain 2	1	V_{CM} = ±1V f ≤ 100 kHz	50			50			dB
Supply Voltage Rejection Ratio									
Gain 2	1	ΔV_S = ±0.5V	50			50			dB
Output Offset Voltage									
Gain 1	1	R_L = ∞			1.5			1.5	V
Gain 2 and 3					1.2			1.5	V
Output Voltage Swing	1	R_L = 2k	2.5			2.8			V_{pp}
Output Sink Current			2.2			2.5			mA
Power Supply Current	1	R_L = ∞			27			27	mA

Note 1: The maximum junction temperature of the LM733 is 150°C, while that of the LM733C is 100°C. For operation at elevated temperatures devices in the TO-100 package must be derated based on a thermal resistance of 150°C/W junction to ambient or 45°C/W junction to case. Thermal resistance of the dual-in-line package is 90°C/W.

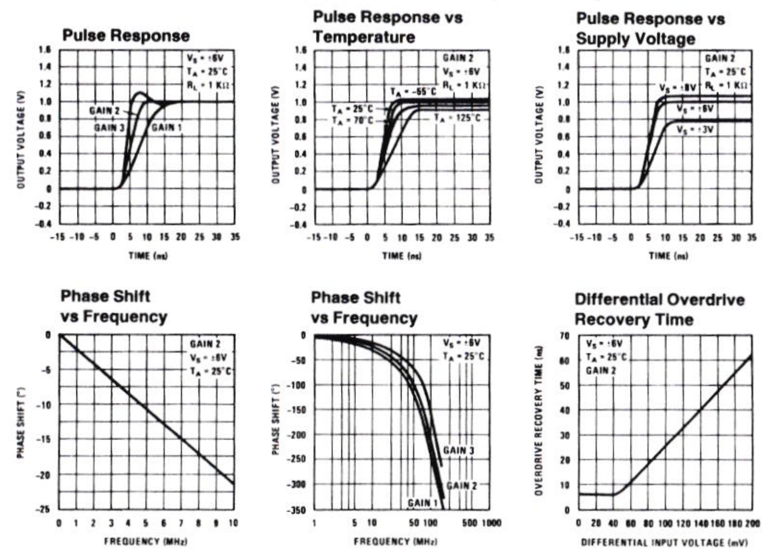
Note 2: Pins G1A and G1B connected together.

Note 3: Pins G2A and G2B connected together.

Note 4: Gain select pins open.

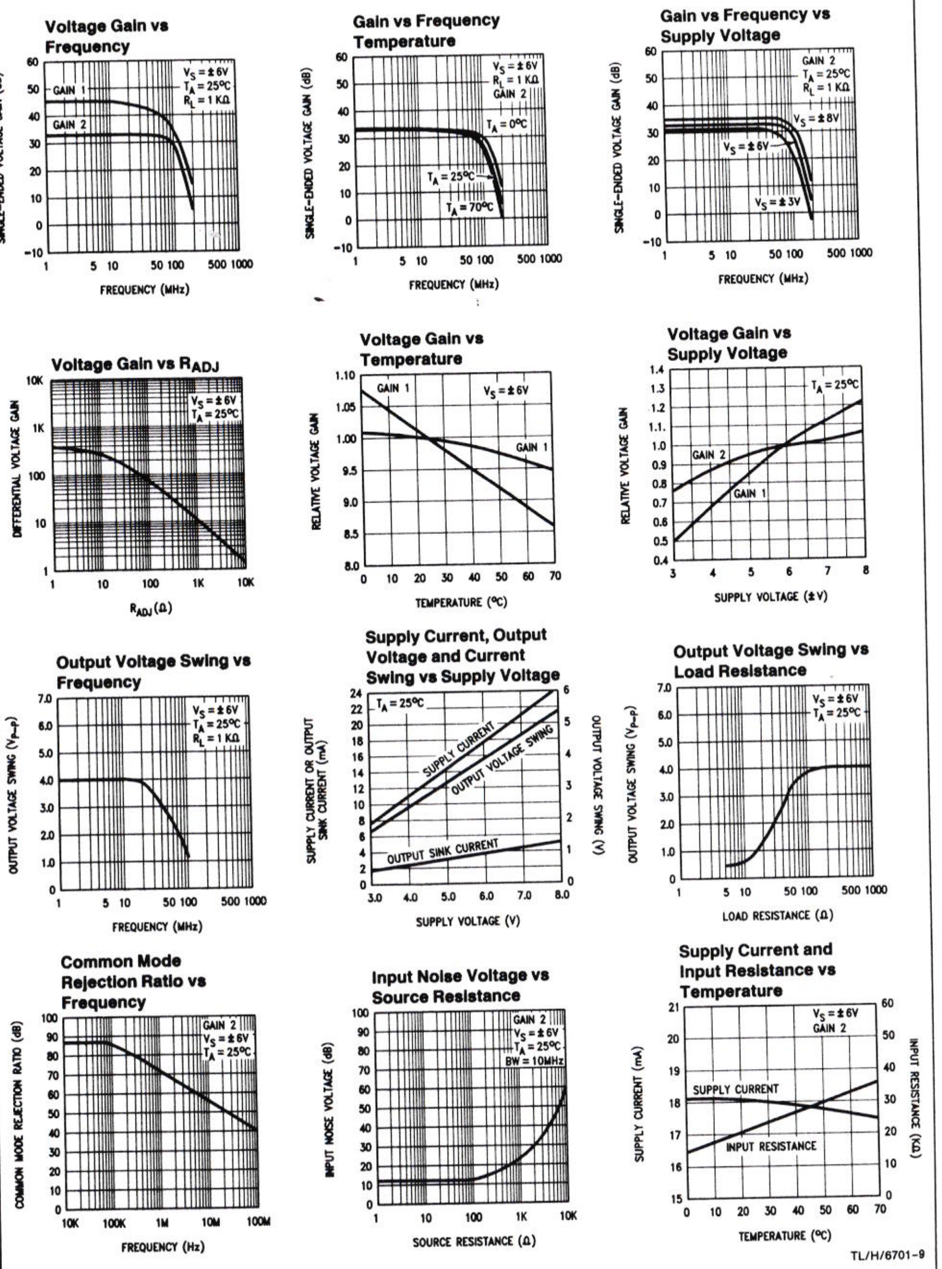
Note 5: Refer to RETS733X drawing for specifications of LM733H version.

Typical Performance Characteristics



TL/H/7866-6

Typical Performance Characteristics (Continued)



TL/H/6701-9

National Semiconductor Corporation

LM733/LM733C Differential Amp

General Description

The LM733/LM733C is a two-stage, differential input, differential output, wide-band video amplifier. The use of internal series-shunt feedback gives wide bandwidth with low phase distortion and high gain stability. Emitter-follower outputs provide a high current drive, low impedance capability. Its 120 MHz bandwidth and selectable gains of 10, 100 and 400, without need for frequency compensation, make it a very useful circuit for memory element drivers, pulse amplifiers, and wide band linear gain stages.

The LM733 is specified for operation over the −55°C to +125°C military temperature range. The LM733C is specified for operation over the 0°C to +70°C temperature range.

Features

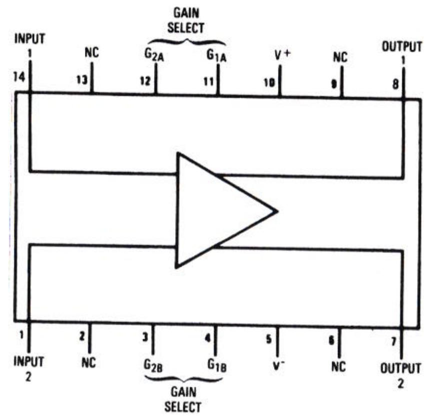
- 120 MHz bandwidth
- 250 kΩ input resistance
- Selectable gains of 10, 100, 400
- No frequency compensation
- High common mode rejection ratio at high frequencies

Applications

- Magnetic tape systems
- Disk file memories
- Thin and thick film memories
- Woven and plated wire memories
- Wide band video amplifiers

Connection Diagrams

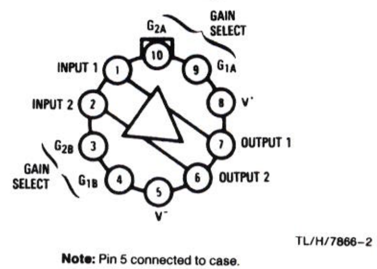
Dual-In-Line Package



TL/H/7866-1

Top View
Order Number LM733CN
See NS Package Number N14A

Metal Can Package



TL/H/7866-2

Note: Pin 5 connected to case.

Top View
Order Number LM733H or LM733CH
See NS Package Number H10D

JFET Low-Frequency/Low-Noise

The following table is a listing of small-signal JFETs intended for low-noise applications in the audio range. These devices exhibit good linearity and are candidates for hi-fi and instrumentation equipment.

Bestell-bezeichnung	$R_e\ Y_{fs}$ @ f mmho Min	MHz	$R_e\ Y_{os}$ @ f µmho Max	MHz	C_{iss} pF Max	C_{rss} pF Max	$V_{(BR)GSS}$ $V_{(BR)GDO}$ V Min	$V_{GS(off)}$ V Min	Max	I_{DSS} mA Min	Max
Case 20-03 – TO-206 AF (TO-72) – N-Channel											
2N4220	1.0	15	10	15	6.0	2.0	30	–	4.0	0.5	3.0
2N4220A	1.0	15	10	15	6.0	2.0	30	–	4.0	0.5	3.0
2N3821	1.5	15	10	15	6.0	3.0	50	–	4.0	0.5	2.5
2N4221	2.0	15	20	15	6.0	2.0	30	–	6.0	2.0	6.0
2N3822	2.0	15	20	15	6.0	3.0	50	–	6.0	2.0	10
2N4222	2.5	15	40	15	6.0	2.0	30	–	8.0	5.0	15
2N4222A	2.5	15	40	15	6.0	2.0	30	–	8.0	5.0	15
Case 20-03 – TO-206AF (TO-72) – P-Channel											
2N3909A	2.2	0.001	100	0.001	9.0	3.0	20	0.3	7.9	1.0	15
Case 29-04 – TO-226AA (TO-92) – N-Channel											
2N5458	1.5	15	50	15	7.0	3.0	25	1.0	7.0	2.0	9.0
2N5457	2.0	15	50	15	7.0	3.0	25	0.5	6.0	1.0	5.0
2N5459	2.0	15	50	15	7.0	3.0	25	2.0	8.0	4.0	16
Case 29-04 – TO-226AA (TO-92) – P-Channel											
2N5460	1.0	0.001	50	0.001	7.0	2.0	40	0.75	6.0	1.0	5.0
2N5463	1.0	0.001	75	0.001	7.0	2.0	60	0.5	4.0	1.0	5.0
2N5461	1.5	0.001	50	0.001	7.0	2.0	40	0.5	7.5	2.0	9.0
2N5462	2.0	0.001	50	0.001	7.0	2.0	40	1.8	9.0	4.0	16
2N5465	2.0	0.001	75	0.001	7.0	2.0	60	1.5	6.0	4.0	16

JFET High-Frequency Amplifiers

The following is a listing of small-signal JFETs that are intended for hi-frequency applications. These are candidates for VHF/UHF oscillators, mixers and front-end amplifiers.

Bestell-bezeichnung	$R_e\ Y_{fs}$ @ f mmho Min	MHz	$R_e\ Y_{os}$ @ f µmho Max	MHz	C_{iss} pF Max	C_{rss} pF Max	NF @ R_G = 1 K dB Max	f MHz	$V_{(BR)GSS}$ $V_{(BR)GDO}$ V Min	$V_{GS(off)}$ V Min	Max	I_{DSS} mA Min	Max
Case 20-03 – TO-206AF (TO-72) – N-Channel													
2N4416	4.0	400	100	400	4.0	0.8	4.0	400	30	2.0	6.0	5.0	15
Case 27-02 – TO-206AC (TO-52) – N-Channel													
U310	10	0.001	150	100	5.0	2.5	3.0*	450	25	2.5	6.0	24	60

*Typical

Gehäuse s. Seite A05.066–A05.068

JFET High-Frequency Ampli

Bestell-bezeichnung	$R_e\ Y_{fs}$ @ f mmho Min	MHz
Case 29-04 – TO-226AA (TO-92) – N-Cha		
2N5484	2.5	100
2N5485	3.0	400
2N5486	3.5	400
J309	12*	100
J310	12*	100

JFET Switches and Chopper

The following is a listing of JFETs intende

Bestell-bezeichnung	$r_{ds(on)}$ Ω Max
Case 20-03 – TO-206AF (TO-72) – P-Cha	
2N3993	150
Case 22-03 – TO-206AA (TO-18) – N-Cha	
2N4856	26
2N4859	25
2N4391	30
2N4091	30
2N4857	40
2N4860	40
2N4092	50
2N4392	60
2N4858	60
2N4861	60
2N4093	80
2N4393	100
2N3972	100
Case 29-04 – TO-226AA (TO-92) – N-Cha	
2N5638	30
J111	30
J112	30
MPF4392	60
2N5639	60
MPF4393	100
2N5640	100
J113	100
BF246A	35*

*Typical

Gehäuse s. Seite A05.066–A05.068

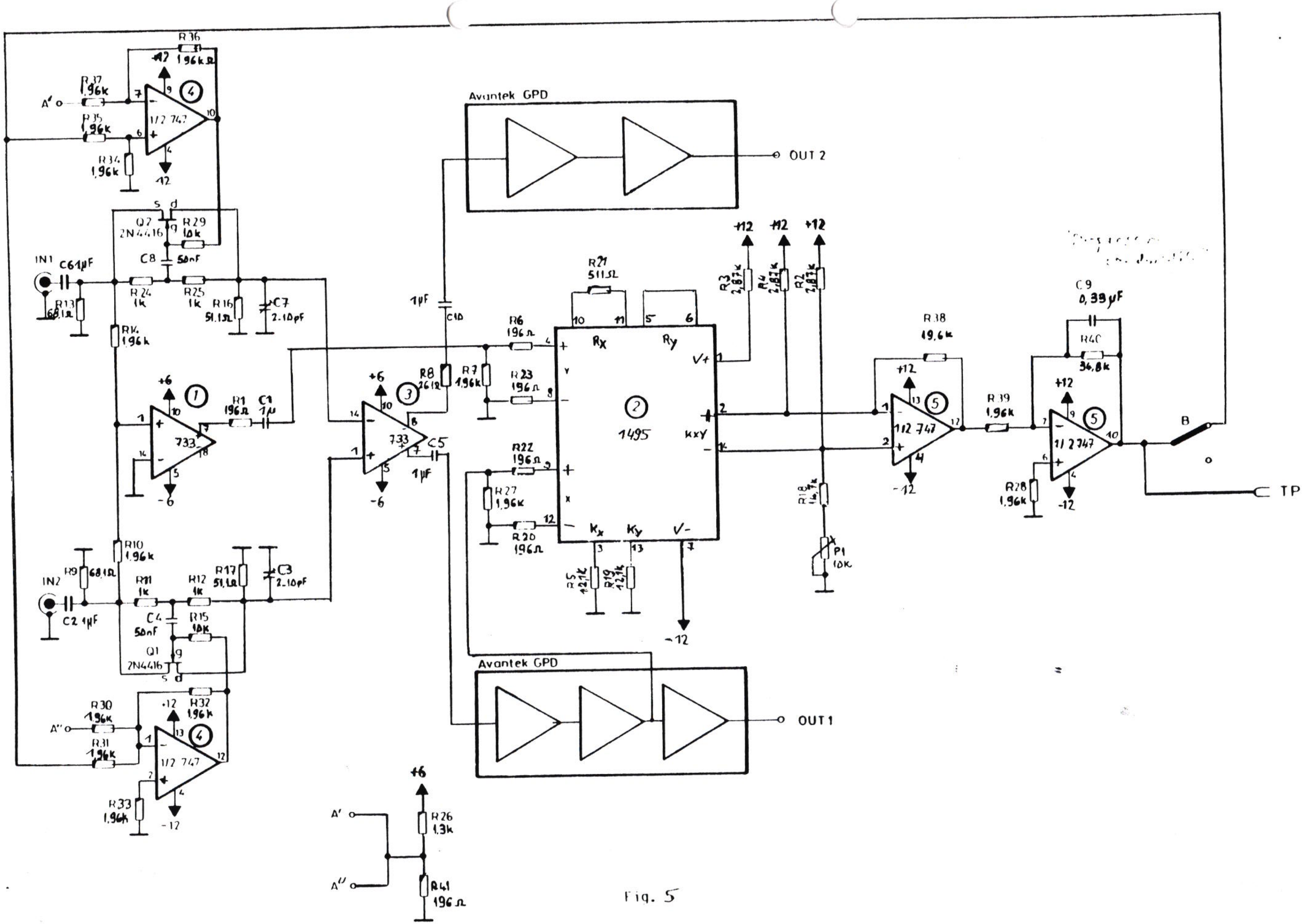
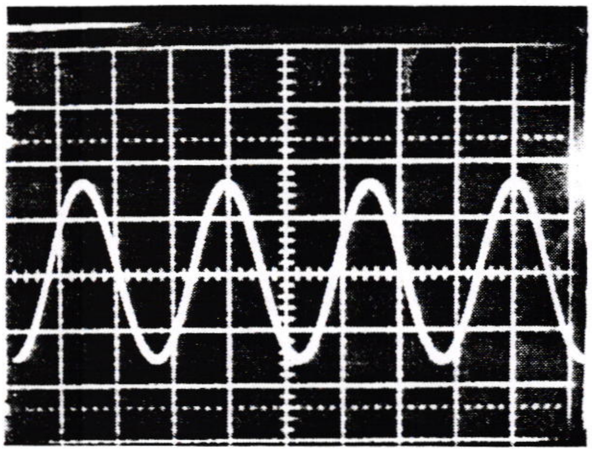
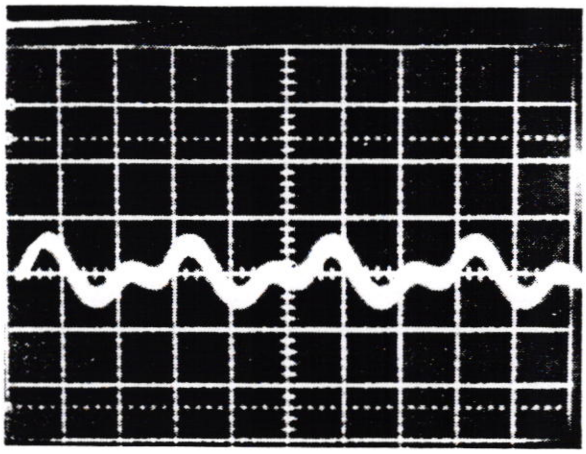

Avantek GPD
OUT 2
Avantek GPD
OUT 1
IN1
IN2
1495
1/2 747
733
TP
A'
A''
B

Fig. 5

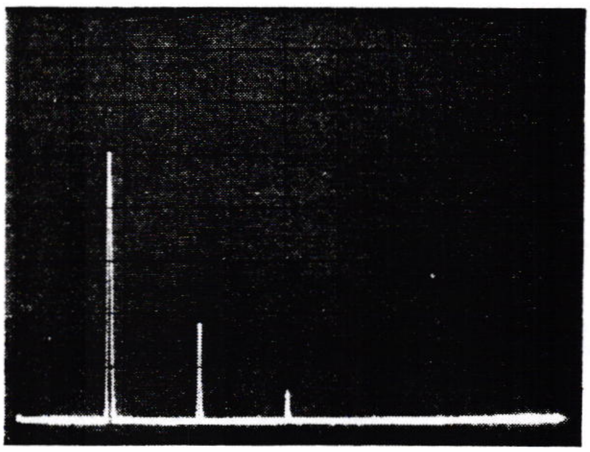


a)

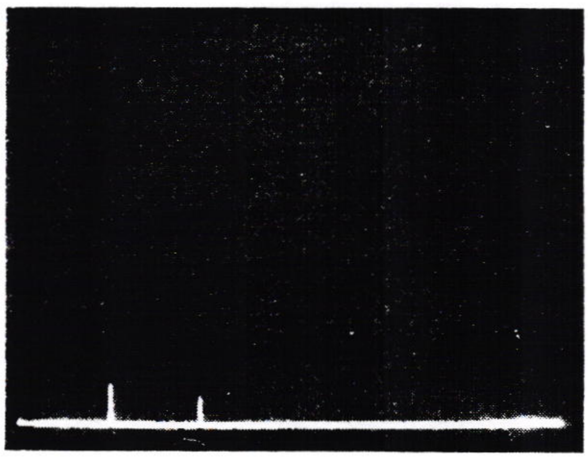


b)

Fig. 6



a)



b)

Fig. 7

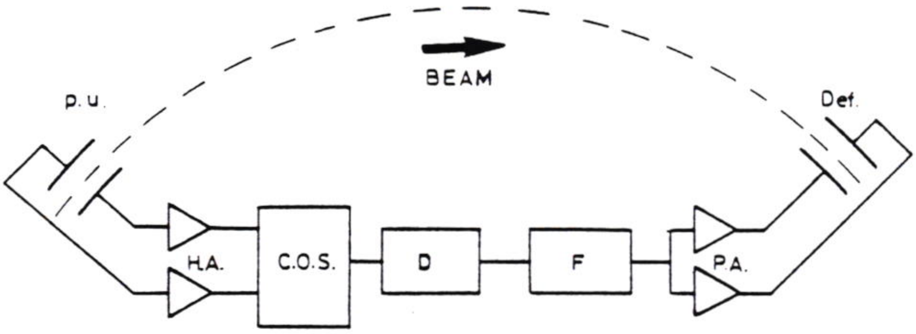

BEAM
p.u.
Def.
H.A.
C.O.S.
D
F
P.A.

Fig. 1

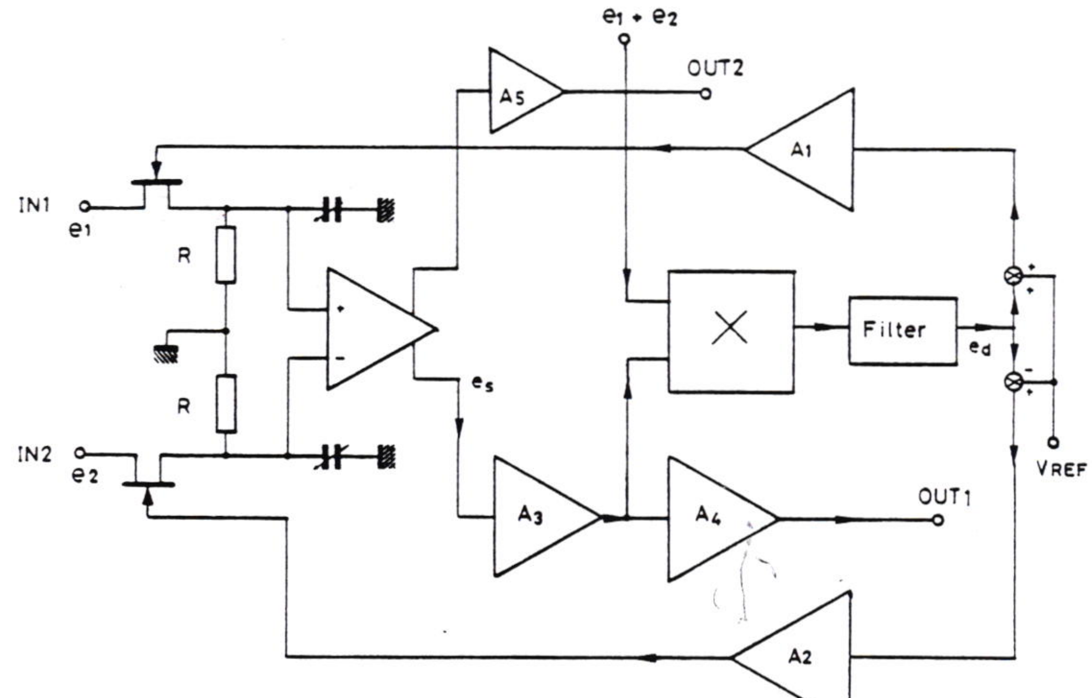

e1 + e2
OUT2
A5
A1
IN1
e1
R
R
IN2
e2
es
Filter
ed
VREF
A3
A4
OUT1
A2

Fig. 2

- Suppression factor for sinusoidal input signals at 8 MHz carrier frequency, with 1.25 amplitude ratio: 34 dB min. at 500 mV_{pp} common-mode input signal.
- Output impedance: 50 Ω.
- Output (1): Suppressed signal output, to be used for transverse feedback loop.
- Output (2): Observation output, with lower suppression factor.

4. CALIBRATION PROCEDURE

4.1 Internal switch in open-loop position

a) Apply a 5 MHz, 20 mV_{pp} signal to one of the inputs, terminating the other one with 50 Ω. Gradually increase the input level, observing the output signal.

b) Verify that there is a 3 V_{pp} min. saturation level of the GPD amplifier.

c) Check the gain value of 35 ± 3 dB.

d) Repeat the above measurements, interchanging the inputs.

4.2 Internal switch in closed-loop position

a) With both inputs 50 Ω terminated, adjust the offset potentiometer P1 until "zero" is reached on a 3 V voltmeter range at test point TP.

b) With a phase splitter (50 Ω), apply a 8 MHz 500 mV_{pp} signal to both inputs and observe the output with a 50 Ω input scope.

c) Set trimmers C_3 and C_7 to their minimum capacitance value. Identify the one that reduces the output signal and use it to adjust a minimum on that signal. A strong second harmonic component should be observed (see Fig. 6b).

d) Verify that when reducing the input level by 10 dB steps, the output reduces smoothly. If not, retouch potentiometer P1 in order to get the minimum output signal at minimum input level.

e) Connect the splitter, with 2 dB difference in its output levels (specially made for this purpose), to the inputs. Care must be taken that the length of the cables used is matched within 0.15 ns (0.5 degrees at 8 MHz).

f) Adjust a 1100 mV_{pp} signal at the input of the splitter.

g) Connect the spectrum analyser to the output. Verify that when inverting the inputs, the first harmonic of the output signal remains at approximately the same level. If not, retouch the trimmers used in step (c) (see Fig. 7).

h) Short-circuit switch B with a wire in order to assure closed-loop operation of the module.

Considering the Fourier development of the signals, it can be proved[2)] that the power content (PC) of the differential voltage after suppression becomes

$$PC = kf^2t^2 \sum n^2c_n^2 \,, \qquad n = 1, 2, 3, \ldots ,$$

where t is the FET time constant, f is the fundamental frequency of the carrier, and c_n its Fourier coefficients.

The suppression factor can now be written as

$$F = \frac{\sum c_n^2}{kf^2t^2 \sum n^2c_n^2} \,, \qquad n = 1, 2, 3, \ldots .$$

Using an RF FET such as the 2N 4416, a time constant as low as t = 0.4 ns can be achieved.

For a bunch-formed carrier the form factor

$$\frac{\sum c_n^2}{\sum n^2c_n^2} \approx 0.6 \,,$$

and for the PS Booster the highest carrier repetition frequency is f = 8 MHz. Under these conditions the suppression factor becomes

$$F = 10^3 \,.$$

This figure reduces the output power, at the present highest intensity of the PSB beam and with a gain of 2000 from pick-up to deflector, to less than 10 W.

2.3 Circuit details

The self-balancing bridge is made up of two attenuators with 2N 4416 FETs as controllable resistors. The lengths of the paths on the printed circuit from the inputs through the attenuators up to the differential amplifier inputs are carefully equalized, in order to avoid phase differences between the signals. A phase difference of 0.8 degrees at the fundamental frequency of the carrier reduces the suppression factor by a factor of two. This corresponds to a delay of 0.3 ns, so the lengths of the cables from the pick-up to the closed-orbit suppressor have to be equalized accordingly in order not to degrade the circuit performance. An adjustable coaxial delay line has been introduced in the signal path after the head amplifiers in order to adjust this length in the actual operating conditions.

The trimmers C_3 and C_7 provide the means for adjusting the reactive component of the bridge at balance.

1. SUMMARY AND INTRODUCTION

In the PSB (along with most circular particle accelerators and storage rings) transverse instabilities can develop, giving rise to fast oscillations of the beam around its equilibrium position (closed orbit).

These oscillations can be damped by feeding back to the beam (through an electromagnetic deflector) a signal that is proportional to them, and with the proper phase[1] (Fig. 1).

As the power requirements of the deflector-driving amplifier depend on the amplitude of the signals it has to handle, there is a practical interest in keeping these signals no larger than is required for damping.

The instability signal can be obtained from an electrostatic pick-up similar to those normally used for orbit observation. Such a pick-up produces two signals, consisting of two bunch-shaped carriers modulated in opposite phase by the beam position. The difference between these two signals no longer contains the carrier, but only two sidebands with the spectrum of the beam position.

The beam position is the sum of the closed orbit plus the instabilities. The closed orbit can be, and normally is, predominant; therefore it largely determines the power in the spectrum and hence the power requirements of the deflector-driving amplifier.

It might therefore be interesting to remove the closed-orbit component of the pick-up difference signal and leave only the component due to the instabilities, which we need in order to operate the feedback system. This is what the circuit described in the following sections is designed to do, taking advantage of the fact that the closed orbit and the instabilities occupy different portions of the composite signal spectrum.

2. CIRCUIT DESCRIPTION

2.1 Functional description

The circuit is realized as a self-balancing bridge[2], reaching its equilibrium point when the closed-orbit component of the difference signal is zero. The bridge is shown in the block diagram (Fig. 2) as two FET-controlled attenuators driven by the phase opposing signals coming from amplifiers A_1 and A_2. These closed-orbit signals are obtained by phase detection through an analog multiplier, making the product of the sum and difference signals, followed by a low-pass filter.

The transverse displacements of the beam appear as an amplitude modulation of the bunch signals. Whilst the amplitude of the modulating wave is the same on

Beckert

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN/PS/BR.80-5
4 March 1980

CLOSED-ORBIT SIGNAL SUPPRESSOR FOR THE TRANSVERSE FEEDBACK OF THE PSB

C. Christiansen*)

CONTENTS

*) Visitor from La Plata University, Argentina.

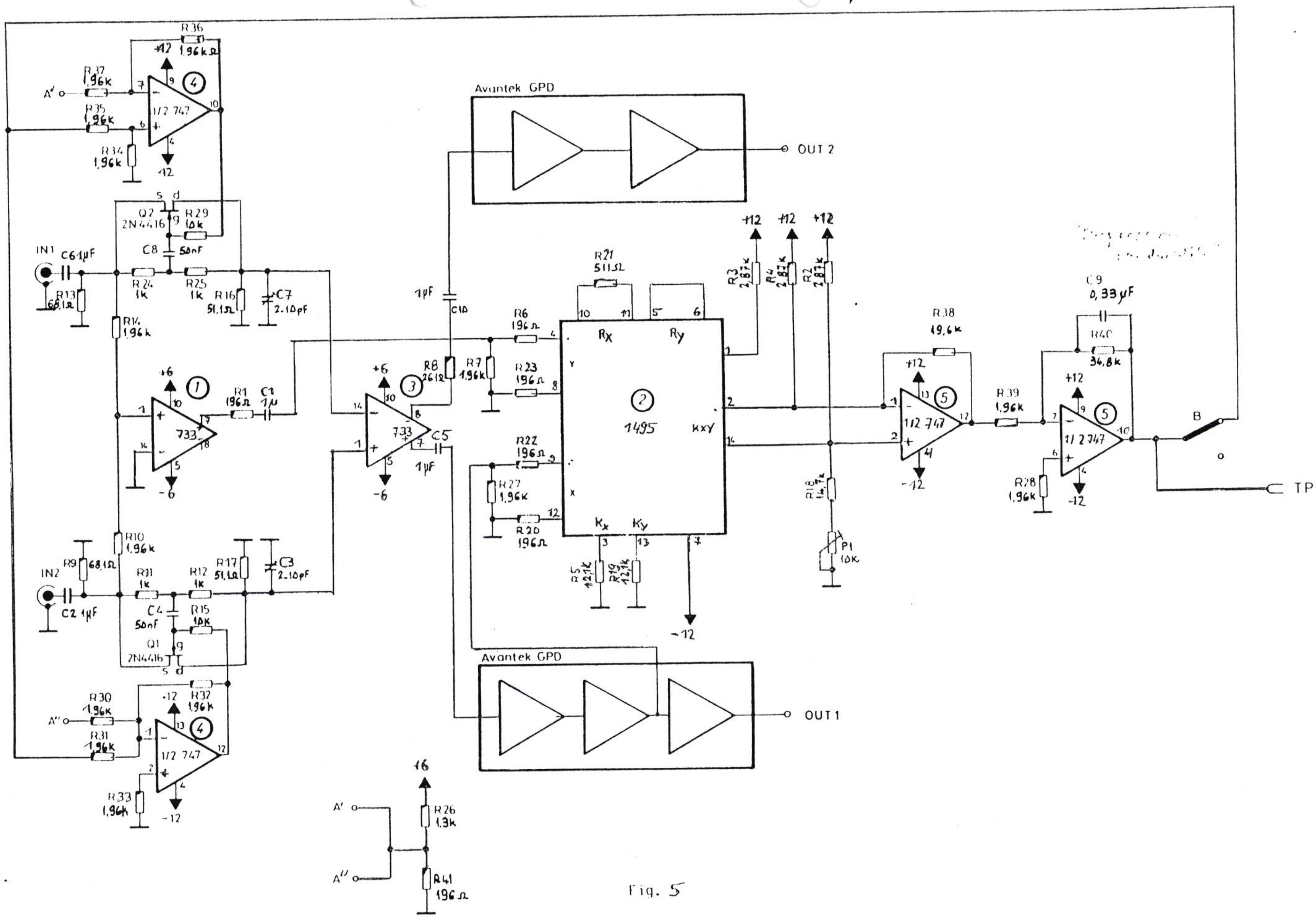
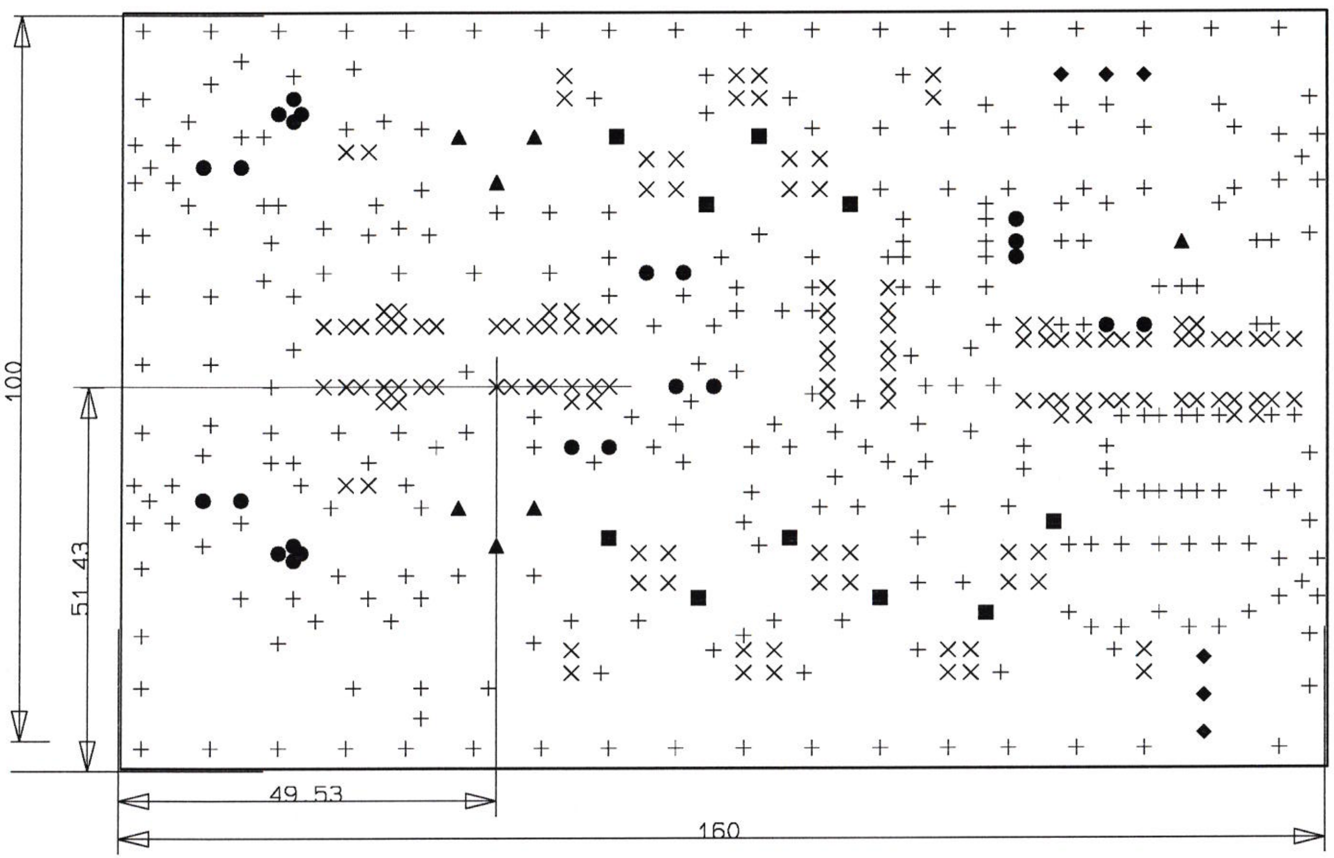

Avantek GPD
OUT 2
Avantek GPD
OUT 1
IN1
IN2
TP
B
1495
Rx
Ry
Kx
Ky
KXY
1/2 747
733
R36 1,96kΩ
R37 1,96k
R35 1,96k
R34 1,96k
Q2 2N4416
R29 10k
C8 50nF
C6 1µF
R13 68,1Ω
R24 1k
R25 1k
R16 51,1Ω
C7 2-10pF
R14 1,96k
R1 196Ω
C1 1µ
R8 261Ω
R6 196Ω
R7 1,96k
R23 196Ω
R22 196Ω
R27 1,96k
R20 196Ω
R21 511Ω
C10
1µF
C5
1µF
R3 2,87k
R4 2,87k
R2 2,87k
R18 19,6k
R39 1,96k
R28 1,96k
C9 0,33µF
R40 34,8k
P1 10K
R5 12,1k
R19 12,1k
R10 1,96k
R9 68,1Ω
C2 1µF
R31 1k
R12 1k
R17 51,1Ω
C3 2-10pF
C4 50nF
R15 10k
Q1 2N4416
R30 1,96k
R32 1,96k
R31 1,96k
R33 1,96k
R26 1,3k
R41 196Ω
A'
A''
+12
-12
+6
-6

Fig. 5



■	1.600	P /0010
◆	1.400	P /0006
▲	1.300	P /0007
+	0.900	P /0280
×	0.800	P /0130
●	0.600	P /0023
■	0.025	P /0002

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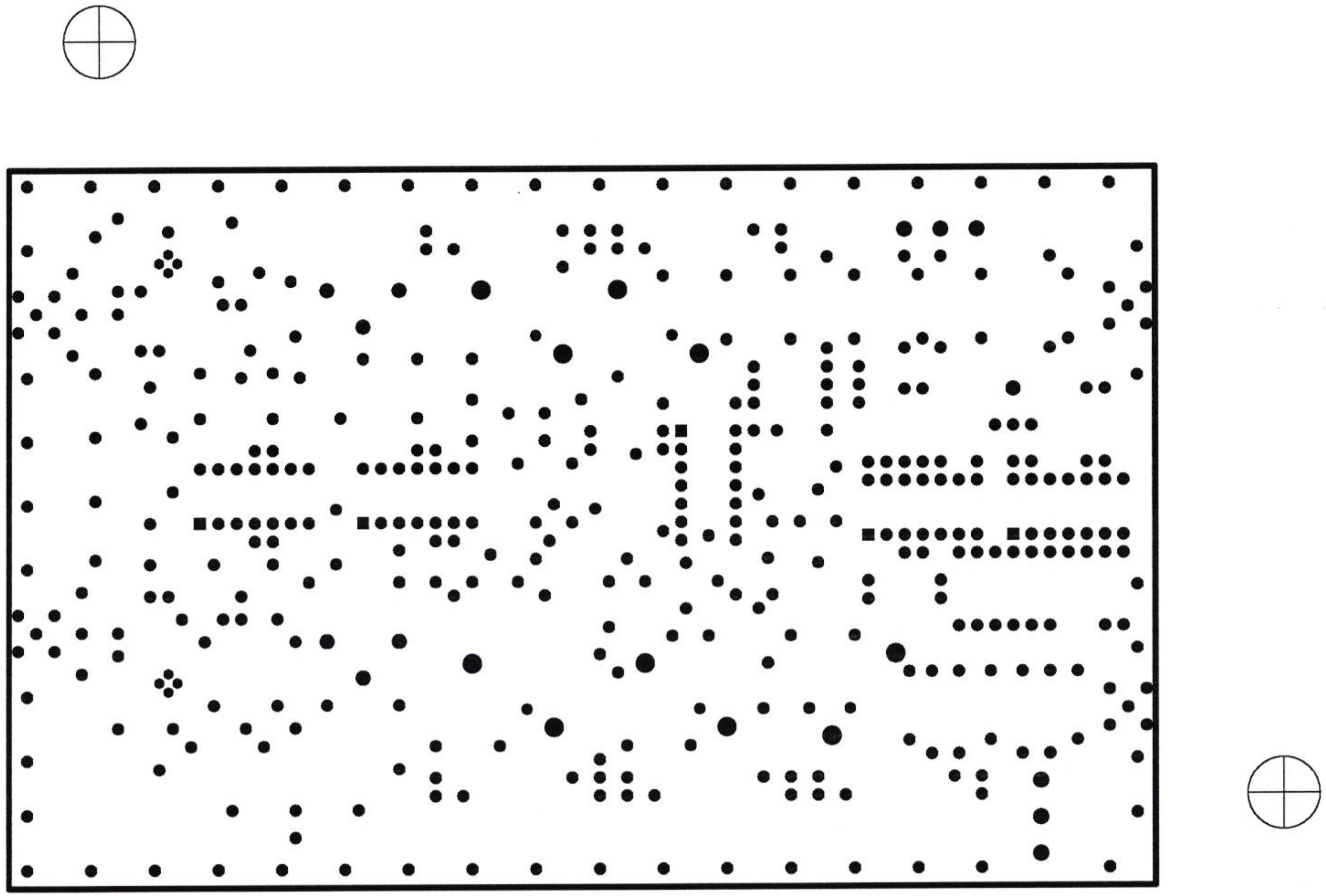
Bohrkontrollfilm mit Masszeichnung fuer die Platine SISU



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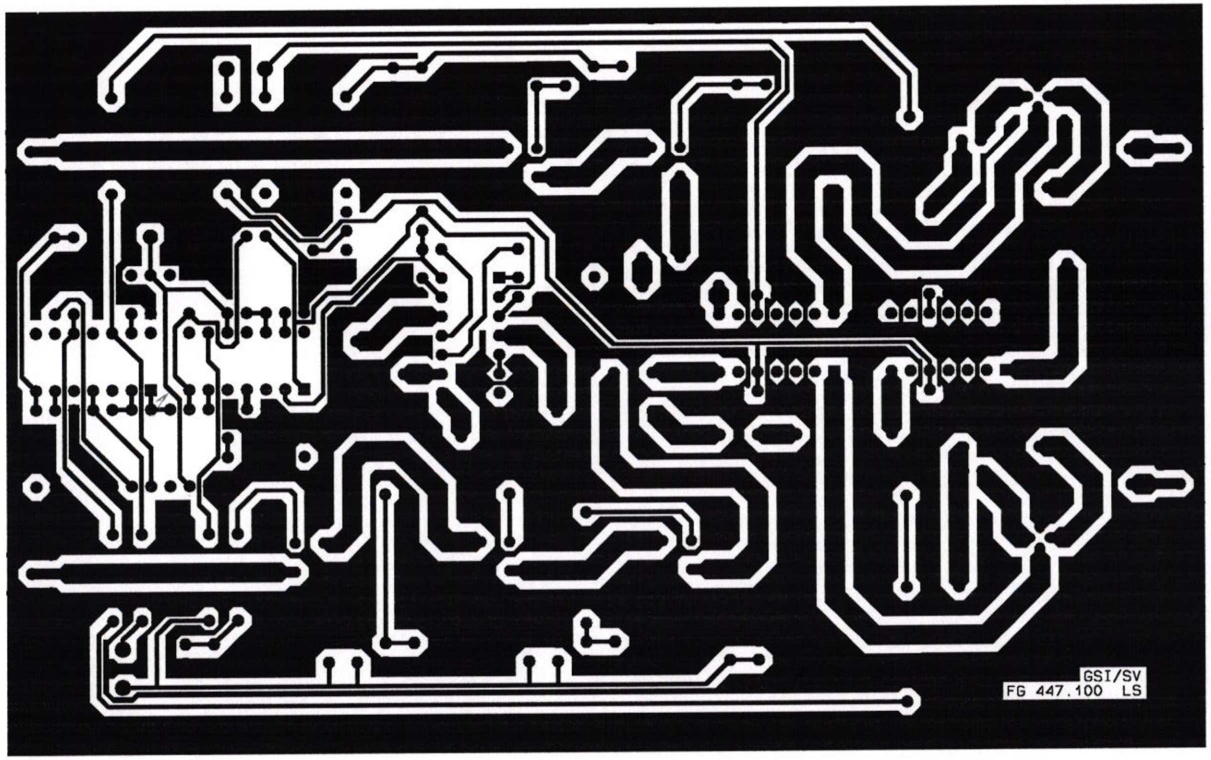

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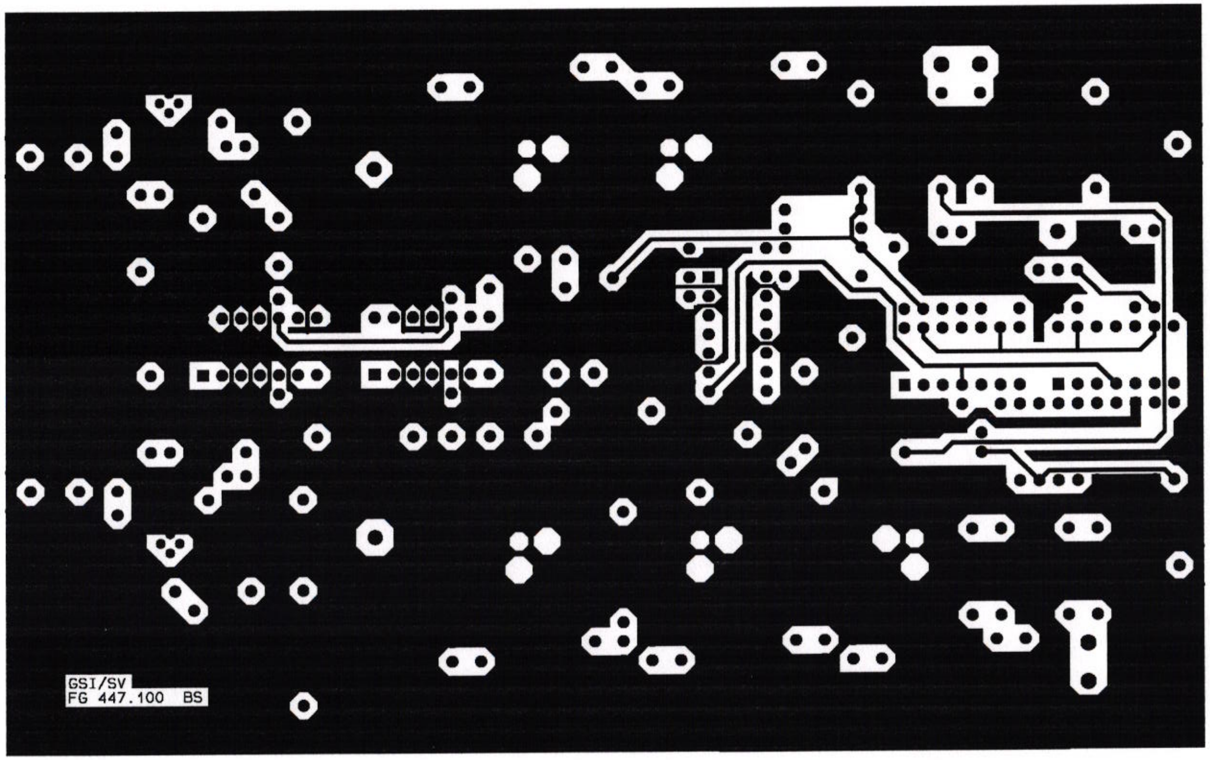

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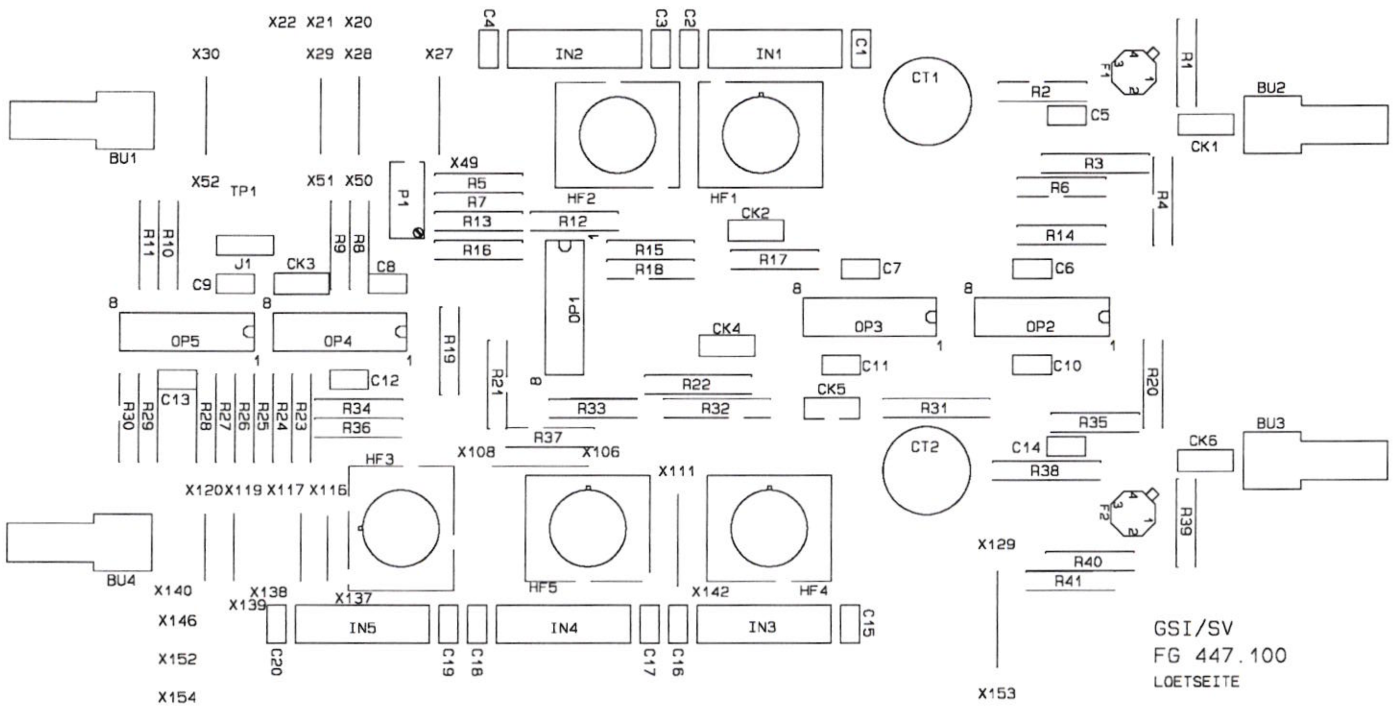

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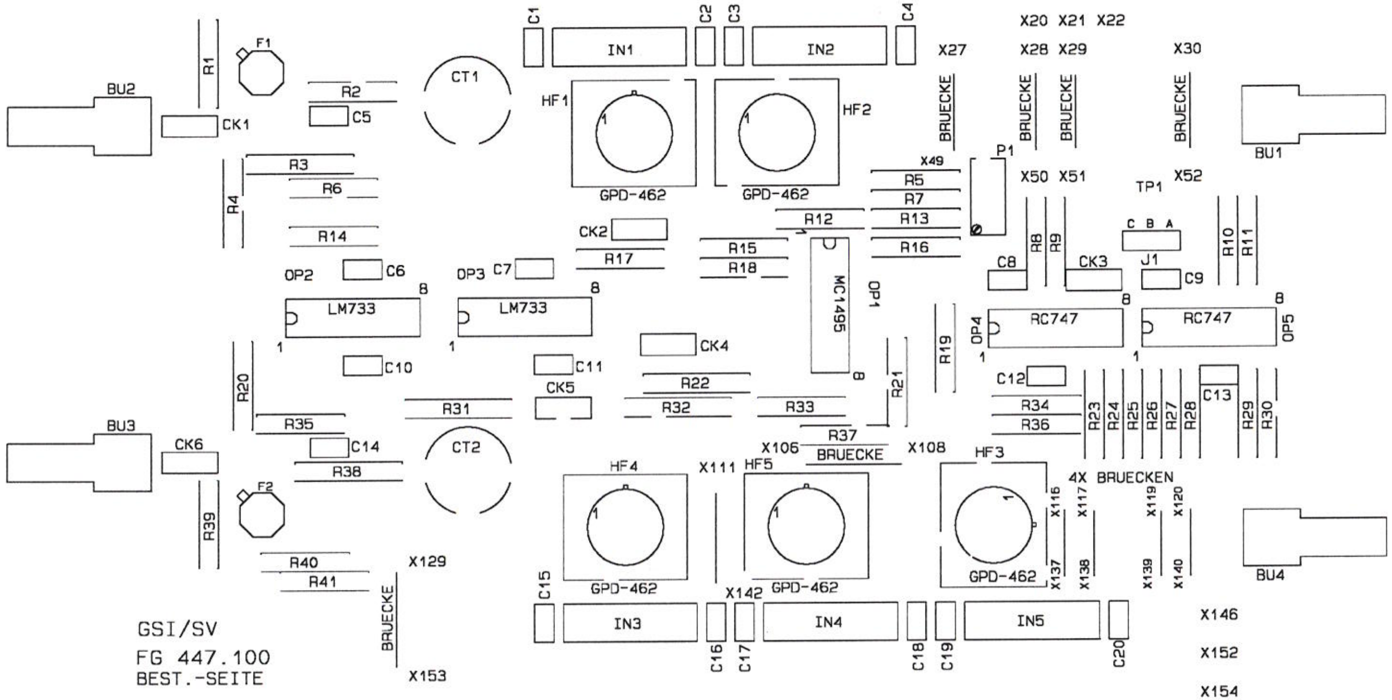

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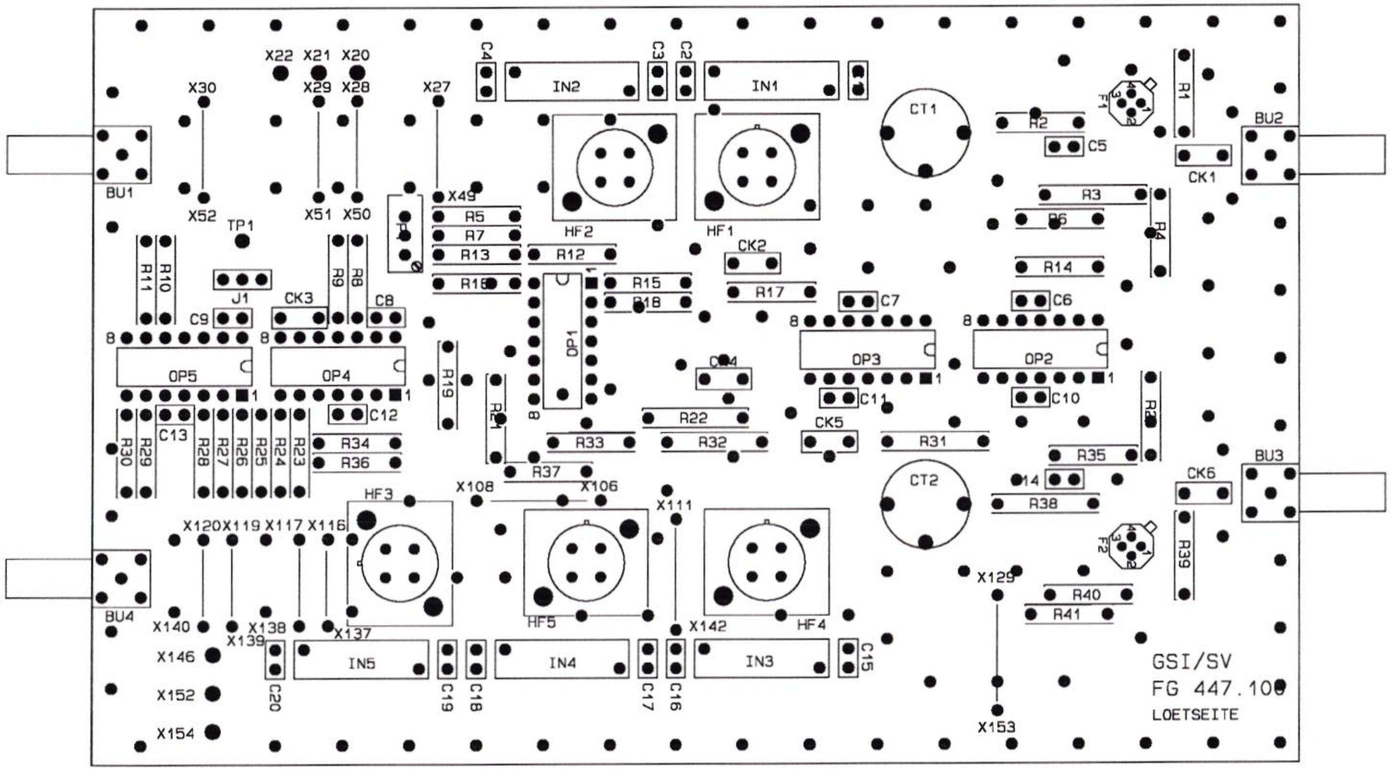

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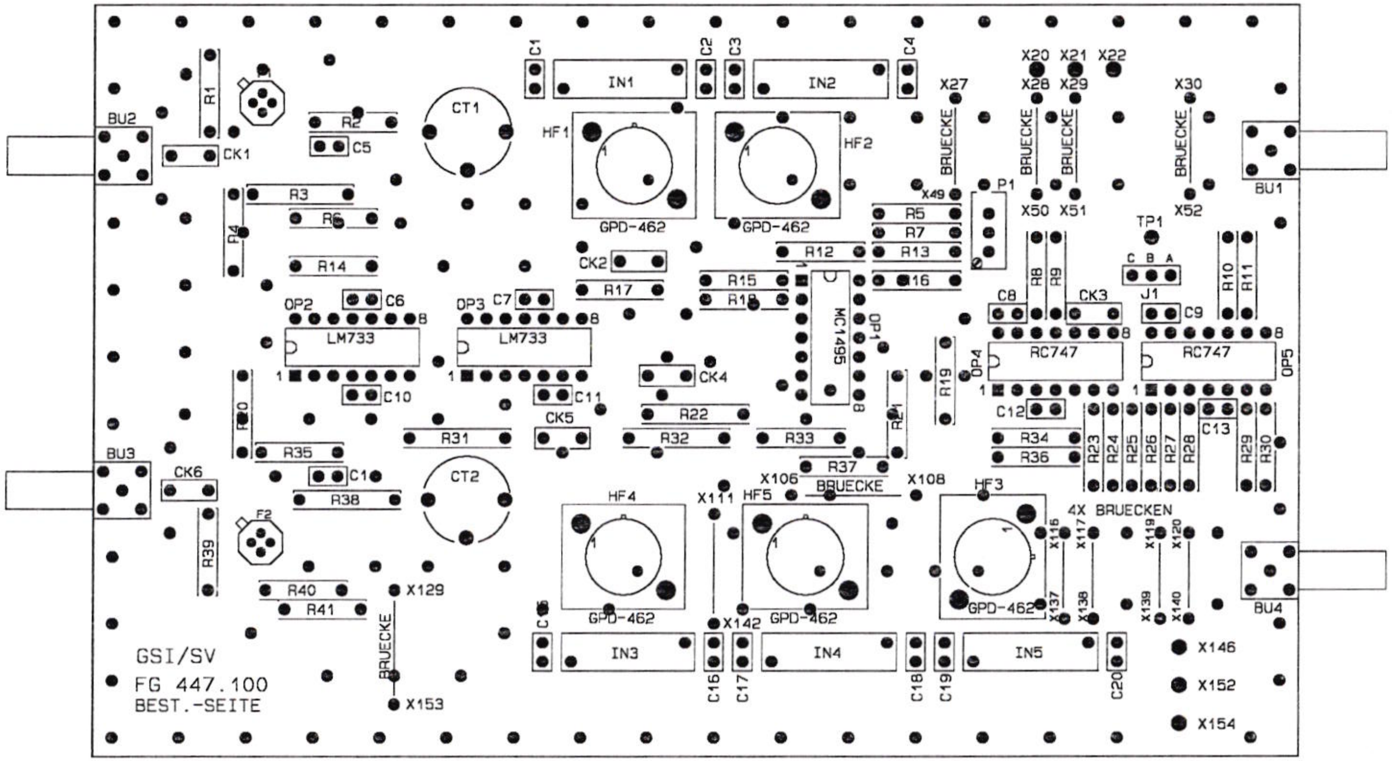


GSI SISUKON1 SISU FG 447.100
25-OCT-1995 LOOS

E L E K T R . S T U E C K L I S T E

*RM: 1 EINHEIT = 2.54MM

ST.	BAUTEIL-BEZEICHNUNG	WERT/TYP	RM	HERSTELLER	LG-NR.	BEMERKUNGEN	AUFRUF-NAHME
2	R22,R31	196R	5		10 071	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	196R*J5
1	R8	19K6	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	19K6*J4
3	R6,R35,R40	1K0	4		10 047	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K0*J4
1	R3	1K0	5		10 071	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	1K0*J5
1	R36	1K3	4		10 050	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K3*J4
11	R4,R9,R11,R20,R23,R25	1K96	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	1K96*J4
	R27,R28,R29,R30,R37						
1	R32	1K96	5		10 071	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	1K96*J5
1	R17	261R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	261R*J4
3	R5,R13,R15	2K87	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	2K87*J4
1	R24	34K8	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	34K8*J4
1	R12	511R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	511R*J4
2.	R14,R41	51R1	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	51R1*J4
2	R1,R39	68R1	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	68R1*J4
2	F1,F2	2N4416		MOTOROLA	APL-DL	JFET HIGH-FREQUENCY AMPLIFIER, N-FET TO-72 GEH.	2N4416
1	TP1	VERO12			16 082	VERO-FEDERPIN O/BOHR.1.2	VERO12
	SILBERDRAHT 1mm UND ISOLIERMAT. FÜR BRÜCKEN						
1	LEITERPLATTE	FG 447.100					

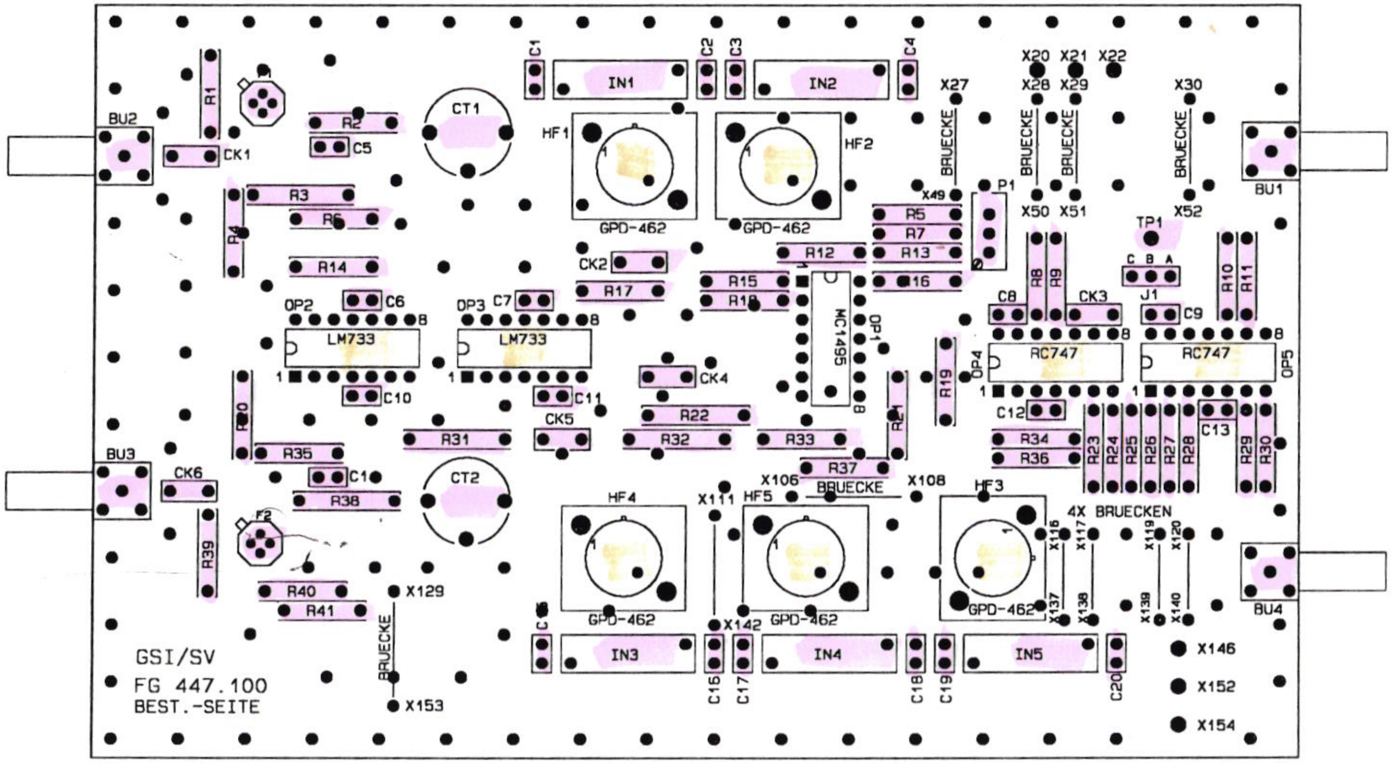
GSI DARMSTADT	BEZ.: SISU	NUMMER: FG 447.100	BEARB.: LOOS	DATUM 24.Oct.1995	BLATT 2 VON 2

E L E K T R . S T U E C K L I S T E

*RM: 1 EINHEIT = 2.54MM

ST.	BAUTEIL-BEZEICHNUNG	WERT/TYP	RM	HERSTELLER	LG-NR.	BEMERKUNGEN	AUFRUF-NAHME
5		DIP14*D1			13 322	CAB/DALEKTRON 110-91-314 DUAL-IN-LINE ZUM LOETEN	
4	BU1,BU2,BU3,BU4	BU594-211		ERNI	APL-DL	KOAXIALKONTAKT ABGEW., 5 LOETANSCHL, NR.: 594 211	BU594*D1
18	C1,C2,C3,C4,C6,C7	100N	1	UNION CARB	11 096	Union Carbide C320C104K1R5CA stehend Vielschicht-K	100N*A
	C8,C9,C10,C11,C12,C13						
	C15,C16,C17,C18,C19,C20						
5	CK1,CK2,CK4,CK5,CK6	1U0		UNION CARB	11 313	UNION CARBIDE C330C105K5R5CA STEHEND VIELSCHICHT-K	1U0*A
1	CK3	330N		UNION CARB	11 334	UNION CARBIDE C330C334K5R5CA STEHEND VIELSCHICHT-K	330N*A
2	C5,C14	47N	1	UNION CARB	11 309	Union Carbide C320C473K1R5CA stehend Vielschicht-K	47N*A
2	CT1,CT2	CT3P-12P		BUERKLIN	APL	KER. SCHEIBENTRIMMER NR.:70D-163, TYP 10S-TRIKO 06	CT3P-12P*B1
5	MONTAGEMAT			AVANTEK	APL-DL	ACCESSORY-PACK, NR.: 330-006756-001	
5	HF1,HF2,HF3,HF4,HF5	GPD-462		AVANTEK	APL-DL	HF-VERSTAERKER	GPD-462
1	KURZSCHL.-BU			COMATEL	16 009	KURZSCHLUSSBUCHSE ISOLIERT MIT OEFFNUNG F. PRUEFCL	
	J1	WW-L. ZUSCHN	1		16 080	COMATEL 385.0358.120.400 WW-LEISTE ZUSCHN. 1X3PINS	JU1X3*B2
5	IN1,IN2,IN3,IN4,IN5	14UH	6			INDUKTIVITAET 14UH RM=15.24MM	14UH
2	OP2,OP3	LM733		NATIONAL	APL-DL	LM733 DIFFERENTIAL AMPLIFIER	LM733
1	OP1	MC1495		MOTOROLA	APL-DL	MC1495 WIDEBAND LINEAR 4-QUADRANT MULTIPLIER	MC1495
2	OP4,OP5	RC747		SIGNETICS	13 144	RC747 GENERAL PURPOSE OPERATIONAL AMPLIFIER	RC747
1	P1	10K			10 807	POTI-BECKMAN 66WR- 10K/0.10W/5%	P10K*66
1	R2	10K	4		10 071	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	10K*J4
1	R38	10K	5		10 071	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	10K*J5
2	R16,R18	12K1	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	12K1*J4
1	R7	14K7	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	14K7*J4
2	R10,R26	196K	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	196K*J4
4	R19,R21,R33,R34	196R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	196R*J4

GSI DARMSTADT	BEZ.: SISU	NUMMER: FG 447.100	BEARB.: LOOS	DATUM 24.Oct.1995	BLATT 1 VON 2



GSI SISUKON1 SISU FG 447.100
25-OCT-1995 LOOS

E L E K T R . S T U E C K L I S T E

*RM: 1 EINHEIT = 2.54MM

ST.	BAUTEIL-BEZEICHNUNG	WERT/TYP	RM	HERSTELLER	LG-NR.	BEMERKUNGEN	AUFRUF-NAHME
2	R22,R31	196R 200R	5	10k?	~~10 071~~	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	196R*J5
1	R8	19K6 18k	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	19K6*J4
3	R6,R35,R40	1K0	4		10 047	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K0*J4
1	R3	1K0	5	10k?	~~10 071~~	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	1K0*J5
1	R36	1K3	4		10 050	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K3*J4
11	R4,R9,R11,R20,R23,R25	1K96 2k	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	1K96*J4
	R27,R28,R29,R30,R37						
1	R32	1K96 2k	5	10k?	~~10 071~~	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	1K96*J5
1	R17	261R 270R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	261R*J4
3	R5,R13,R15	2K87 3k	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	2K87*J4
1	R24	34K8 33k	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	34K8*J4
1	R12	511R 510R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	511R*J4
2	R14,R41	51R1 51R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	51R1*J4
2	R1,R39	68R1 68R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	68R1*J4
2	F1,F2	2N4416		MOTOROLA	APL-DL	JFET HIGH-FREQUENCY AMPLIFIER, N-FET TO-72 GEH.	2N4416
1	TP1	VERO12			16 082	VERO-FEDERPIN O/BOHR.1.2	VERO12
	~~SILBERDRAHT 1mm UND ISOLIERMAT. FÜR BRÜCKEN~~						
1	LEITERPLATTE	FG 447.100					
11	WIDERSTAND	0Ω				(BRÜCKEN)	
6	X20, X21, X22, X146,	VERO 12			16082		
	X152, X154						
8	SMD KONDENSATOR	100nF				(ÄNDERUNG)	

GSI DARMSTADT	BEZ.: SISU	NUMMER: FG 447.100	BEARB.: LOOS	DATUM 24.Oct.1995	BLATT 2 VON 2

E L E K T R . S T U E C K L I S T E

*RM: 1 EINHEIT = 2.54MM

ST.	BAUTEIL-BEZEICHNUNG	WERT/TYP	RM	HERSTELLER	LG-NR.	BEMERKUNGEN	AUFRUF-NAHME
5		DIP14*D1			13 322	CAB/DALEKTRON 110-91-314 DUAL-IN-LINE ZUM LOETEN	
4	BU1,BU2,BU3,BU4	BU594-211		ERNI	APL-DL	KOAXIALKONTAKT ABGEW., 5 LOETANSCHL, NR.: 594 211	BU594*D1
18	C1,C2,C3,C4,C6,C7	100N	1	UNION CARB	11 096	Union Carbide C320C104K1R5CA stehend Vielschicht-K	100N*A
	C8,C9,C10,C11,C12,C13						
	C15,C16,C17,C18,C19,C20						
5	CK1,CK2,CK4,CK5,CK6	1U0		UNION CARB	11 313	UNION CARBIDE C330C105K5R5CA STEHEND VIELSCHICHT-K	1U0*A
1	CK3	330N		UNION CARB	11 334	UNION CARBIDE C330C334K5R5CA STEHEND VIELSCHICHT-K	330N*A
2	C5,C14	47N	1	UNION CARB	11 309	Union Carbide C320C473K1R5CA stehend Vielschicht-K	47N*A
2	CT1,CT2	CT3P-12P 4-20P		BUERKLIN	APL	KER. SCHEIBENTRIMMER NR.:70D-163, TYP 10S-TRIKO 06	CT3P-12P*B1
5	MONTAGEMAT			AVANTEK	APL-DL	ACCESSORY-PACK, NR.: 330-006756-001	
5	HF1,HF2,HF3,HF4,HF5	GPD-462		AVANTEK	APL-DL	HF-VERSTAERKER	GPD-462
1	KURZSCHL.-BU			COMATEL	16 009	KURZSCHLUSSBUCHSE ISOLIERT MIT OEFFNUNG F. PRUEFCL	
	J1	WW-L. ZUSCHN	1		16 080	COMATEL 385.0358.120.400 WW-LEISTE ZUSCHN. 1X3PINS	JU1X3*B2
5	IN1,IN2,IN3,IN4,IN5	14UH	6		12101	INDUKTIVITAET 14UH RM=15.24MM	14UH
2	OP2,OP3	LM733		NATIONAL	APL-DL	LM733 DIFFERENTIAL AMPLIFIER	LM733
1	OP1	MC1495 1595		MOTOROLA	APL-DL	MC1495 WIDEBAND LINEAR 4-QUADRANT MULTIPLIER	MC1495
2	OP4,OP5	RC747		SIGNETICS	13 144	RC747 GENERAL PURPOSE OPERATIONAL AMPLIFIER	RC747
1	P1	10K			10 807	POTI-BECKMAN 66WR- 10K/0.10W/5%	P10K*66
1	R2	10K	4		10 071	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	10K*J4
1	R38	10K	5		10 071	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	10K*J5
2	R16,R18	12K1 12K	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	12K1*J4
1	R7	14K7 15K	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	14K7*J4
2	R10,R26	196K 180K	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	196K*J4
4	R19,R21,R33,R34	196R 200R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	196R*J4

GSI DARMSTADT	BEZ.: SISU	NUMMER: FG 447.100	BEARB.: LOOS	DATUM 24.Oct.1995	BLATT 1 VON 2

Bedarfsmeldung (BM)

Keine Bestellung für Lieferanten

GSI

1. FA
2. Einkauf:

№ 029708

Die stark umrandeten Felder werden vom FA bzw. EKF ausgefüllt.

Name des Anforderers:	Abt./Sekt.	Tel.	Anford.Kostenst.	Bedarfszeitpunkt	Tag
Loos, D	APL	2363	62100		13.10.95

Pos.	Menge	Einh.	Genaue Bezeichnung der zu beschaffenden Gegenstände: (gfls Verwendungszwecke [Betriebsverhältnisse] angeben)	Preise (soweit vorhanden)	Nr. (s.u.)	zu belastende Kostenstelle	FA Konto
1	25	Stück	Motorola JFET - 2N4416	2,10/Stck			
2	25	"	Multipliers MC1495	10,80/Stck			
					2	68370	

Der Bedarf kann aus vorhandenen Beständen — nicht — gedeckt werden.

Gesamtwert von Pos. 1 —

DM ca. 350,–

Abladestelle:	Lieferzeit:
Fracht:	Verp.:
Best. bei:	Z. b.
Nr.:	am:

1 = Neuteil zur Erweiterung einer bestehenden Anlage
2 = Neuteil zum Einbau in eine im Bau befindliche Anlage
3 = Ersatzteil
4 = neues selbstständig nutzbares Gerät
5 = Verbrauchsmaterial und Betriebsstoffe
6 = Reparatur
7 = Austauschgerät
8 = Leiharbeitnehmer

Bearbeitungsvermerke EKF

Lieferantenvorschlag: SPOERLE

Unterschrift des Anforderers: Loos	Sichtvermerk
genehmigt: [signature]	Datum 13.10.95

Form-Nr. 86/13-2
Lager-Nr. 82025

Bedarfsmeldung (BM)

Keine Bestellung für Lieferanten

No 029708

GSI

1. FA

2. Einkauf:

Die stark umrandeten Felder werden vom FA bzw. EKF ausgefüllt.

Name des Anforderers:	Abt./Sekt.	Tel.	Anford.Kostenst.	Bedarfszeitpunkt	Tag

Pos	Menge	Einh.	Genaue Bezeichnung der zu beschaffenden Gegenstände: (ggf. Verwendungszwecke / Betriebsverhältnisse angeben)	Preise (soweit vorhanden)	Nr. (s.u.)	zu belastende Kostenstelle	FA Konto

Der Bedarf kann aus vorhandenen Beständen — nicht — gedeckt werden.

Gesamtwert von Pos. 1 —

DM ca.

1 = Neuteil zur Erweiterung einer bestehenden Anlage
2 = Neuteil zum Einbau in eine im Bau befindliche Anlage
3 = Ersatzteil
4 = neues selbstständig nutzbares Gerät
5 = Verbrauchsmaterial und Betriebsstoffe
6 = Reparatur
7 = Austauschgerät
8 = Leiharbeitnehmer

Abladestelle:		Lieferzeit	
Fracht:		Verp.	
Best. bei:		Z. b.	
Nr		am:	

Bearbeitungsvermerke EKF

Lieferantenvorschlag:

Unterschrift des Anforderers

Sichtvermerk

genehmigt

Datum

Bedarfsmeldung (BM)
Keine Bestellung für Lieferanten

GSI

1. FA
2. Einkauf:

№ 029708

Die stark umrandeten Felder werden vom FA bzw. EKF ausgefüllt.

Name des Anforderers:	Abt./Sekt.	Tel.	Anford.Kostenst.	Bedarfszeitpunkt	Tag
Loos, D	APL	2363	62100		13.10.95

Pos.	Menge	Einh.	Genaue Bezeichnung der zu beschaffenden Gegenstände: (gfls Verwendungszwecke / Betriebsverhältnisse angeben)	Preise (soweit vorhanden)	Nr. (s.u.)	zu belastende Kostenstelle	FA Konto
1	25	Stück	Motorola JFET - 2N4416	2,10/Stck		1.97 Tel	1.55
2	25	"	Multipliers MC1495 L ↑ MC1595L	10,80/Stck	2	9.83 68370	
			Pos. 1 EBV			251	
			Pos 2 Spoerle	"		215	

Der Bedarf kann aus vorhandenen Beständen — nicht — gedeckt werden.

Gesamtwert von Pos. 1 —

DM ca. 350,–

Abladestelle:	Lieferzeit:
Fracht:	Verp.:
Best. bei:	Z. b.
Nr.:	am:

1 = Neuteil zur Erweiterung einer bestehenden Anlage
2 = Neuteil zum Einbau in eine im Bau befindliche Anlage
3 = Ersatzteil
4 = neues selbstständig nutzbares Gerät
5 = Verbrauchsmaterial und Betriebsstoffe
6 = Reparatur
7 = Austauschgerät
8 = Leiharbeitnehmer

Bearbeitungsvermerke EKF

Lieferantenvorschlag: SPOERLE

Unterschrift des Anforderers	Sichtvermerk
Loos	
genehmigt	Datum 13.10.95

Form-Nr. 86/13-2
Lager-Nr. 82025

GSI Gesellschaft für Schwerionenforschung mbH
Darmstadt

Anforderer

Ges. für Schwerionenforschung mbH · Postfach 11 05 52 · D-64220 Darmstadt

Planckstraße 1
D - 64291 Darmstadt
Telefon (0 61 51) 3 59 - 0
Durchwahl 359
Telefax (0 61 51) 3 59 - 27 85
Telex 04 19 593
Stückgut-Nr. 1471

Interne Vermerke

1 = Neuteil zur Erweiterung einer bestehenden Anlage
2 = Neuteil zum Einbau in eine im Bau befindliche Anlage
3 = Ersatzteil
4 = neues, selbständig nutzbares Gerät
5 = Verbrauchsmaterial und Betriebsstoffe
6 = Reparatur
9 = Austauschgerät

Ihre Zeichen: | Ihre Nachricht | Unsere Zeichen: Ekt | Tag:

Bitte auf Sendungen, Versandpapieren und in Korrespondenz stets angeben!

Abruf zur Bestellung Nr. .... interne Best.-Nr. .... vom .... Liefertermin ....

anfordernde Kostenstelle

Wir rufen aus unserer oben genannten Bestellung zur Lieferung ab:

Menge	Einh.		Preise	Nr. (s. o.)	zu belastende Kostenstelle bzw. Kostensammel-Nr.	F A Konto

Haus-/Lieferadresse: Planckstraße 1 · D - 64291 Darmstadt

Form-Nr. 86298 I
Lager-Nr. 65028

Gesellschaft für Schwerionenforschung mbH
Darmstadt

Anforderer

Ges. für Schwerionenforschung mbH · Postfach 11 05 52 · D-64220 Darmstadt

SPOERLE - ELEKTRONIK
POSTFACH 102 140
63261 DREIEICH

Planckstraße 1
D- 64291 Darmstadt
Telefon (0 61 51) 3 59 - 0
Druchwahl 359
Telefax (0 61 51) 3 59 - 27 85
Telex 04 19 593
Stückgut-Nr. 1471

Interne Vermerke

1 = Neuteil zur Erweiterung einer bestehenden Anlage
2 = Neuteil zum Einbau in eine im Bau befindliche Anlage
3 = Ersatzteil
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5 = Verbrauchsmaterial und Betriebsstoffe
6 = Reparatur
9 = Austauschgerät

Ihre Zeichen: Ihre Nachricht: Unsere Zeichen: Ekf. Tag:

81100
anfordernde Kostenstelle

Bitte auf Sendungen, Versandpapieren undr Korrespondenz stets angeben!

215 Abruf zur Bestellung Nr. 1/08641/95 interne Best.-Nr. vom 08.08.95 **Liefertermin** SOFORT

Wir rufen aus unserer oben genannten Bestellung zur Lieferung ab:

Menge	Einh.		Preise	Nr. (s.o.)	zu belastende Kostenstelle bzw. Kostensammel-Nr.	F A Konto
25	St	MC 1495 L	9,83 / St		68270	
		Gesamt	245.75			

Preis u Lieferzeit gem. Absprache mit Frau Endlich

Haus-/Lieferadresse: Planckstraße 1 · D - 64291 Darmstadt

Form-Nr. 86/24-1
Lager-Nr. 82053

Versand an

Rechnung von

SPOERLE ELECTRONIC

Handelsgesellschaft mbH & Co.
Max-Planck-Straße 1 - 3 D-63303 Dreieich
Postfach 10 21 40 D-63267 Dreieich

Telefon Verwaltung (06103) 304 - 8
Telefax Verwaltung (06103) 30 42 01
USt-IdNr.: DE113524852

Deutsche Bank Offenbach Nr. 072394000 BLZ 505 700 18
Volksbank Frankfurt Nr. 11810.9 BLZ 501 900 00
Postbank Frankfurt Nr. 93520601 BLZ 500 100 60

Datum: 16.10.95

Sachbearbeiter / Telefon: BETTINA ENDLICH 06103/304-349

VB. 1430

Ihre Bestelldaten: 08641/95

Bestelldatum: 13.10.95

Ihre Lieferantennummer

Kommissionsnummer: 1 . 14 . 8 8 7 4 4 9

Bitte bei Rückfragen angeben

SPOERLE ELECTRONIC ; Postfach 10 21 40 ; D-63267 Dreieich

Rechnung an

GSI Gesellschaft für
Schwerionenforschung mbH

Planckstr. 1

D 64291 Darmstadt

Auftrag an

SPOERLE ELECTRONIC
Bereich Frankfurt Süd

Im Gefierth 11A
D-63303 Dreieich
Telefon 06103/304-349
Telefax 06103/304360

SEITE 1

LIEFERSCHEIN

Belegnummer 1910591

Kundennummer 027004

Lieferungen und Leistungen erfolgen ausschliesslich zu unseren umseitigen Lieferungs- und Zahlungsbedingungen. Es gelten die jeweils gültigen Tagespreise.

Ihre Pos.	Liefermenge	Artikel-Nr.	Bezeichnung	Ihre Artikel-Nummer	EG	Bestellmenge	Restmenge
1	25	147120	MC 1595 L DIC14 MOT	68370	N	25	0

DUPLIKAT

Versandart

Neu im Lieferprogramm: FPGA's von ACTEL

19105911

GSI Gesellschaft für Schwerionenforschung mbH
Darmstadt

Anforderer

Ges. für Schwerionenforschung mbH · Postfach 11 05 52 · D-64220 Darmstadt

Planckstraße 1
D- 64291 Darmstadt
Telefon (0 61 51) 3 59 - 0
Durchwahl 359
Telefax (0 61 51) 3 59 - 27 85
Telex 04 19 593
Stückgut-Nr. 1471

Interne Vermerke

1 = Neuteil zur Erweiterung einer bestehenden Anlage
2 = Neuteil zum Einbau in eine im Bau befindliche Anlage
3 = Ersatzteil
4 = neues, selbständig nutzbares Gerät
5 = Verbrauchsmaterial und Betriebsstoffe
6 = Reparatur
9 = Austauschgerät

Ihre Zeichen: Ihre Nachricht: Unsere Zeichen: Ekt. Tag:

Bitte auf Sendungen, Versandpapieren und/Korrespondenz stets angeben!

Interne Best.-Nr.

Abruf zur Bestellung Nr. vom Liefertermin

anfordernde Kostenstelle

Wir rufen aus unserer oben genannten Bestellung zur Lieferung ab:

Menge	Einh.		Preise	Nr. (s. o.)	zu belastende Kostenstelle bzw. Kostensammel-Nr.	FA Konto

Haus-/Lieferadresse: Planckstraße 1 · D - 64291 Darmstadt

Form-Nr. 8824-1
Lager-Nr. 82053

GSI Gesellschaft für Schwerionenforschung mbH
Darmstadt

Anforderer

Ges. für Schwerionenforschung mbH · Postfach 11 05 52 · D-64220 Darmstadt

EBV-ELEKTRONIK
BURGSTR. 81-83
65817 EPPSTEIN/TS

Planckstraße 1
D- 64291 Darmstadt
Telefon (0 61 51) 3 59 - 0
Druchwahl 359
Telefax (0 61 51) 3 59 - 27 85
Telex 04 19 593
Stückgut-Nr. 1471

Interne Vermerke

1 = Neuteil zur Erweiterung einer bestehenden Anlage
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3 = Ersatzteil
4 = neues, selbständig nutzbares Gerät
5 = Verbrauchsmaterial und Betriebsstoffe
6 = Reparatur
9 = Austauschgerät

Ihre Zeichen: | Ihre Nachricht: | Unsere Zeichen: Ekf. Jr. Loos | Tag:

Bitte auf Sendungen, Versandpapieren undr Korrespondenz stets angeben!

25A Abruf zur Bestellung Nr. 1/71484/92 (interne Best.-Nr.) vom 22.10.92 **Liefertermin** SOFORT

8/100
anfordernde Kostenstelle

Wir rufen aus unserer oben genannten Bestellung zur Lieferung ab:

Menge	Einh.		Preise	Nr. (s.o.)	zu belastende Kostenstelle bzw. Kostensammel-Nr.	F A Konto
25	St	J FET - 2N 4416 MOTOROLA	1,55/St		68370	
					17. Cas	
		Preis gem. Absprache mit Jr. Schubert Gesamt	38,75			

Haus-/Lieferadresse: Planckstraße 1 · D - 64291 Darmstadt

Form-Nr. 86/24-1
Lager-Nr. 82053

EBV ELEKTRONIK
AUTORISIERTER VERTRAGSHÄNDLER FÜR HALBLEITER UND MICROSYSTEME

Centre Européen
Hans-Pinsel-Straße 4 · D-85540 Haar/München
Telefon (089) 45610-0 · Telefax (089) 46 44 88

Code 110227/ / +UA

Lieferanschrift

GESELLSCHAFT F.
SCHWERIONENFORSCHUNG *
PLANCKSTR. 1
64291 DARMSTADT

EBV ELEKTRONIK GmbH · Postfach 1109 · 85529 Haar

GESELLSCHAFT FUER P
SCHWERIONENFORSCHUNG MBH
PLANCKSTR. 1

64291 DARMSTADT

HAAR, den 16/10/95

Bei Zahlung bitte angeben
Rechnung Nr. 261181/129300

LIEFERSCHEIN Nr. 261181

Ihr Auftrag TEL.FR.LOOS vom 13/10/95

Wir liefern heute FOB zu unseren umseitigen Liefer und Zahlungsbedingungen, auf Ihre Rechnung und Gefahr.

Pos	Bezeichnung / Zolltarifnr.	Herstel./ECCN / AL.	Menge
1	2N4416 8541 2190 0	TMI21 /3A96G	25

25 DATECODE 9430
KOSTENLOSE MUSTER

DUPLIKAT

25

Zahlungsbedingungen
10 TAGE 2% SKONTO, 30 TAGE NETTO.
* 02/ 0 161046

EBV ELEKTRONIK Vertriebs GmbH · Amtsgericht München HRB 42104
Allein-Inhaber: Erich Fischer · Geschäftsführer: Erich Fischer, Peter Gürtler

UST-IDENT-Nr.: DE 129334372

Dresdner Bank München Kto.-Nr. 5 018 961
(BLZ 700 800 00)
Postbank München Kto.-Nr. 686 28-800
(BLZ 700 100 80)

ISO 9002 CERTIFIED

Bestellung bei Spoerle oder EBV für Kost.stelle 68370

25 x IC-MC1595L 15,56 DM/Stck

25 x μA 733 CN DIP 3,23 DM/Stck

Bestellung Fa. Bürklin für Kostenstelle: 68370

Metallschichtwiderstände 0,6W Typ. 0207

Stck	Wert		Best. Nr.	Preis	Betrag
100 x	51R1	Best. Nr.	30E168	0,08 DM/Stck	8,-
100 x	68R1	" "	30E180	0,08 "	8,-
100 x	196R	" "	30E224	0,08 "	8,-
100 x	261R	" "	30E236	0,08 "	8,-
100 x	511R	" "	30E264	0,08 "	8,-
100 x	1K0	" "	30E292	0,08 "	8,-
100 x	1K30	" "	30E303	0,08 "	8,-
200 x	1K96	" "	30E320	0,06 "	12,-
100 x	2K74	" "	30E334	0,08 "	8,-
100 x	2K87	" "	30E336	0,08 "	8,-
100 x	4K75	" "	30E358	0,08 "	8,-
100 x	10K0	" "	30E389	0,08 "	8,-
100 x	12K1	" "	30E397	0,08 "	8,-
100 x	14K7	" "	30E405	0,08 "	8,-
100 x	34K8	" "	30E441	0,08 "	8,-

SMD-Keramik-Vielschichtkondensatoren Typ Siemens

100 x	1µF	Best. Nr.	53D118	2,73 "	273,-
25 x	0,33µF	" "	53D109	1,09 "	
25. x	0,047µF		53D100	1,04 "	

Scheibentrimmer

25 x	1,8-15pF	Best. Nr.	70D270	1,41 "
25 x	2-6pF	" "	70D162	135 "

JFET-Transistoren

25 x	2N4416	Best Nr.	27S7700	1,96 "

BFI IBEXSA An AVNET Company

BFI IBEXSA Elektronik GmbH
Microwave Division

TELEFAX NACHRICHT

AN: Herrn Loos / GSI Darmstadt
VON: Sabine Peick / BFI IBEXSA Elektronik GmbH
UNSERE TEL. NO.: (089) 319767-17
UNSERE FAX NO.: (089) 3193510
BETR.: ANGEBOT NR. 960206
BEZ.: Ihre Anfrage von heute
DATUM: 2. Februar 1996

Sehr geehrter Herr Loos,

wir bedanken uns für Ihre Anfrage und unterbreiten Ihnen hierzu folgendes Angebot:

Pos.	Beschreibung	Menge	Preis DM/Stück
01	Modell GPD-464	50 St.	31,86

Zahlung:	30 Tage netto, Skonto wird nicht gewährt.
Preisstellung:	Die angegebenen Preise sind netto, verzollt, frei Verladestelle Dietzenbach und zuzügl. der gesetzl. Mehrwertsteuer gestellt.
Lieferzeit:	ca. 16-20 Wochen nach Auftragseingang
Gültigkeit:	Die Bindefrist für dieses Angebot beträgt 30 Tage.

Es gelten ausschließlich die o.g. Angebots-, Liefer- und Zahlungsbedingungen sowie unsere "Allgemeinen Geschäftsbedingungen für Lieferungen und Leistungen (AGL)".

Es würde uns freuen, wenn Ihnen unser Angebot zusagen sollte und verbleiben

mit freundlichen Grüßen
BFI IBEXSA Elektronik GmbH

Sabine Peick

Sabine Peick
Vertriebsassistentin

Bedarfsmeldung (BM)

Keine Bestellung für Lieferanten

GSI

1. FA

2. Einkauf:

№ 029713

Die stark umrandeten Felder werden vom FA bzw. EKF ausgefüllt.

Name des Anforderers:	Abt./Sekt.	Tel.	Anford.Kostenst.	Bedarfszeitpunkt	Tag
K. KOHL	APL	2388	62100		

Pos.	Menge	Einh.	Genaue Bezeichnung der zu beschaffenden Gegenstände: (gfls Verwendungszwecke [Betriebsverhältnisse] angeben)	Preise (soweit vorhanden)	Nr. (s.u.)	zu belastende Kostenstelle	FA Konto
			AVANTEK				
1	50	Stck	Amplifier Modul GPD-464	31,86/Stck	2		
			Preis lt. Angebot Nr. 960206 vom 02.02.96			68370	

Der Bedarf kann aus vorhandenen Beständen — nicht — gedeckt werden.

Gesamtwert von Pos. 1 —

DM ca.

1 = Neuteil zur Erweiterung einer bestehenden Anlage
2 = Neuteil zum Einbau in eine im Bau befindliche Anlage
3 = Ersatzteil
4 = neues selbstständig nutzbares Gerät
5 = Verbrauchsmaterial und Betriebsstoffe
6 = Reparatur
7 = Austauschgerät
8 = Leiharbeitnehmer

Abladestelle:	Lieferzeit:
Fracht:	Verp.:
Best. bei:	Z. b.
Nr.:	am:

Bearbeitungsvermerke EKF

Lieferantenvorschlag:
BFI IBEXSA
Eching

Unterschrift des Anforderers	Sichtvermerk
genehmigt	Datum

Form-Nr. 86/13-2
Lager-Nr. 82025

Spezial-Teile für COS-Suppressor / 1 Stück

Teil	Bemerkung	vorhanden	bestellen
2x 2N4416	JFET High-Freq. AMP	–	2 ✓
2x LM 733	Differenzial AMP	2	–
2x RC 747	OP LgNr. 13144	2	–
1x MC 1495	Linear 4 Quadr. Multplayer	–	2 ✓
5 Advantek GPD-462 ?	Verstärker	–	

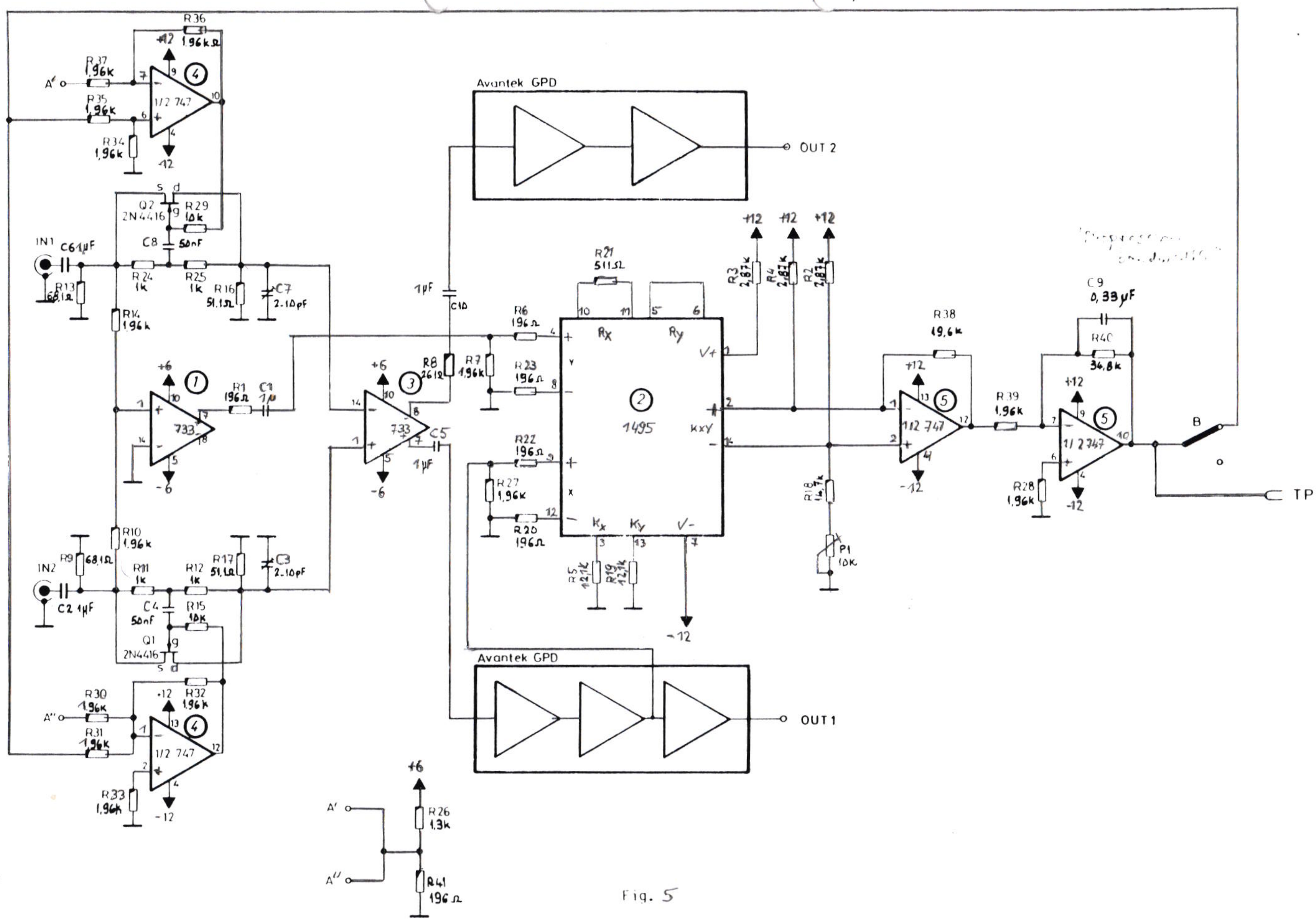

Avantek GPD
OUT 2
Avantek GPD
OUT 1
IN1
IN2
TP
B
1495
R36 1,96kΩ
R37 1,96k
R35 1,96k
R34 1,96k
1/2 747
Q2 2N4416
R29 10k
C8 50nF
C6 1µF
R13 68,1Ω
R24 1k
R25 1k
R16 51,1Ω
C7 2-10pF
R14 1,96k
733
R1 196Ω
C1 1µ
R10 1,96k
R9 68,1Ω
C2 1µF
R11 1k
R12 1k
R17 51,1Ω
C3 2-10pF
C4 50nF
R15 10k
Q1 2N4416
R30 1,96k
R31 1,96k
R32 1,96k
R33 1,96k
C10 1µF
R8 261Ω
R7 1,96k
C5 1µF
R6 196Ω
R23 196Ω
R22 196Ω
R27 1,96k
R20 196Ω
R21 511Ω
Rx
Ry
V+
V-
KXY
Kx
Ky
R5 12,1k
R19 12,1k
R3 2,87k
R4 2,87k
R2 2,87k
R18 14,7k
P1 10K
R38 19,6k
R39 1,96k
R28 1,96k
C9 0,33µF
R40 34,8k
R26 1,3k
R41 196Ω
A'
A''

Fig. 5

[Sabine . FG447.100] 61545.565

*RM: 1 EINHEIT = 2.54MM

ELEKTR. STUECKLISTE

ST.	BAUTEIL-BEZEICHNUNG	WERT/TYP	RM	HERSTELLER	LG-NR.	BEMERKUNGEN	AUFRUF-NAHME
2	R22,R31	196R 200R	5	10k 2	~~10 071~~	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	196R*J5
1	R8	19K6 18k	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	19K6*J4
3	R6,R35,R40	1K0	4		10 047	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K0*J4
1	R3	1K0	5	10k 2	~~10 071~~	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	1K0*J5
1	R36	1K3	4		10 050	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K3*J4
11	R4,R9,R11,R20,R23,R25 R27,R28,R29,R30,R37	1K96 2k	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	1K96*J4
1	R32	1K96 2k	5	10k 2	~~10 071~~	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	1K96*J5
1	R17 26.7 gewechselt	261R 270R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	261R*J4
3	R5,R13,R15	2K87 3k	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	2K87*J4
1	R24	34K8 33k	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	34K8*J4
1	R12	511R 510R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	511R*J4
2	R14,R41	51R1 51R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	51R1*J4
2	R1,R39	68R1 68R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	68R1*J4
2	F1,F2	2N4416		MOTOROLA	APL-DL	JFET HIGH-FREQUENCY AMPLIFIER, N-FET TO-72 GEH.	2N4416
1	TP1	VERO12			16 082	VERO-FEDERPIN O/BOHR.1.2	VERO12
	~~SILBERDRAHT 1mm UND ISOLIERMAT. FÜR BRÜCKEN~~						
1	LEITERPLATTE	FG 447.100					
11	WIDERSTAND	0 Ω				(BRÜCKEN)	
6	X20, X21, X22, X146, X152, X154	VERO 12			16082		
8	SMD KONDENSATOR	100nF				(ÄNDERUNG)	

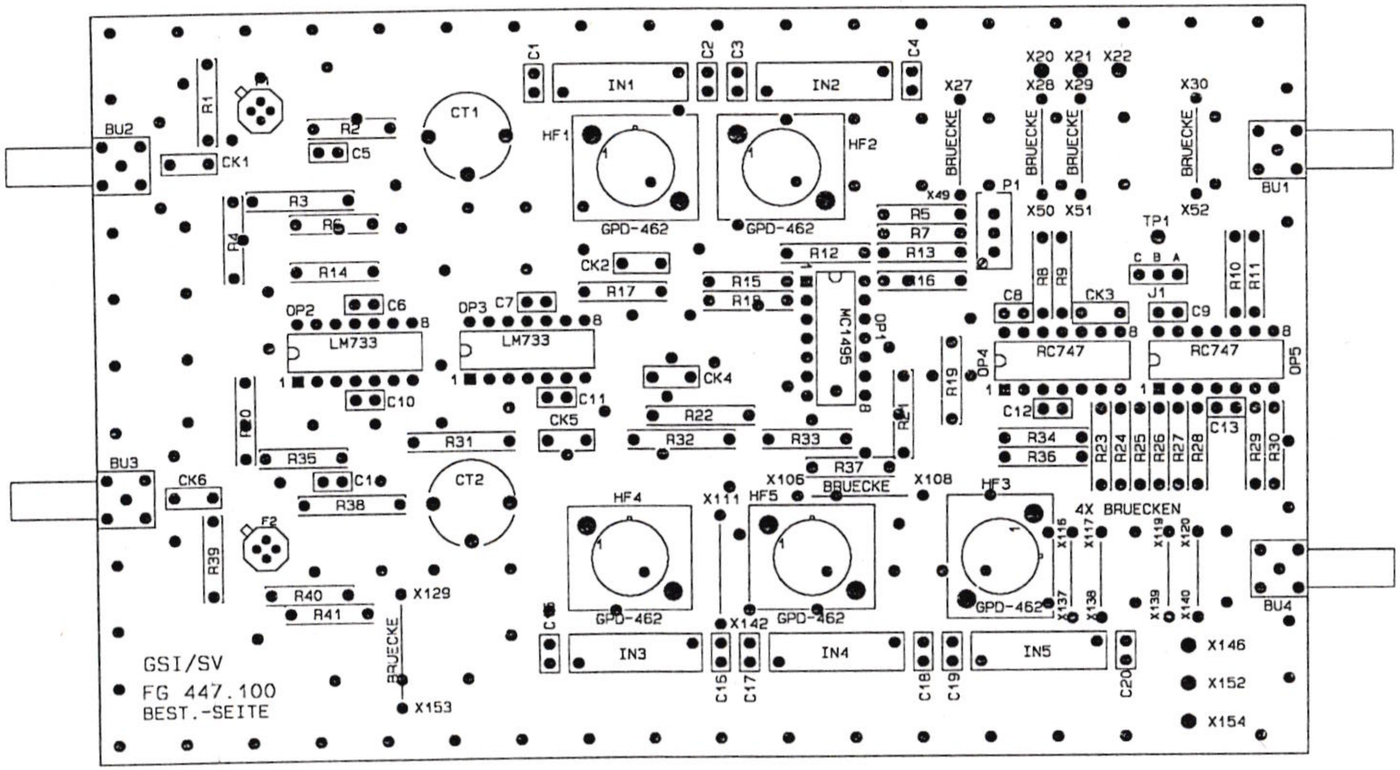
GSI DARMSTADT	BEZ.: SISU	NUMMER: FG 447.100	BEARB.: LOOS	DATUM 24.Oct.1995	BLATT 2 VON 2

E L E K T R . S T U E C K L I S T E

*RM: 1 EINHEIT = 2.54MM

ST.	BAUTEIL-BEZEICHNUNG	WERT/TYP	RM	HERSTELLER	LG-NR.	BEMERKUNGEN	AUFRUF-NAHME
5		DIP14*D1			13 322	CAB/DALEKTRON 110-91-314 DUAL-IN-LINE ZUM LOETEN	
4	BU1,BU2,BU3,BU4	BU594-211		ERNI	APL-DL	KOAXIALKONTAKT ABGEW., 5 LOETANSCHL, NR.: 594 211	BU594*D1
18	C1,C2,C3,C4,C6,C7	100N	1	UNION CARB	11 096	Union Carbide C320C104K1R5CA stehend Vielschicht-K	100N*A
	C8,C9,C10,C11,C12,C13						
	C15,C16,C17,C18,C19,C20						
5	CK1,CK2,CK4,CK5,CK6	1U0		UNION CARB	11 313	UNION CARBIDE C330C105K5R5CA STEHEND VIELSCHICHT-K	1U0*A
1	CK3	330N		UNION CARB	11 334	UNION CARBIDE C330C334K5R5CA STEHEND VIELSCHICHT-K	330N*A
2	C5,C14	47N	1	UNION CARB	11 309	Union Carbide C320C473K1R5CA stehend Vielschicht-K	47N*A
2	CT1,CT2	CT3P-12P 4-20P		BUERKLIN	APL	KER. SCHEIBENTRIMMER NR.:70D-163, TYP 10S-TRIKO 06	CT3P-12P*B1
5	MONTAGEMAT			AVANTEK	APL-DL	ACCESSORY-PACK, NR.: 330-006756-001	
5	HF1,HF2,HF3,HF4,HF5	GPD-462		AVANTEK	APL-DL	HF-VERSTAERKER	GPD-462
1	KURZSCHL.-BU			COMATEL	16 009	KURZSCHLUSSBUCHSE ISOLIERT MIT OEFFNUNG F. PRUEFCL	
	J1	WW-L. ZUSCHN	1		16 080	COMATEL 385.0358.120.400 WW-LEISTE ZUSCHN. 1X3PINS	JU1X3*B2
5	IN1,IN2,IN3,IN4,IN5	14UH	6		12101	INDUKTIVITAET 14UH RM=15.24MM	14UH
2	OP2,OP3	LM733		NATIONAL	APL-DL	LM733 DIFFERENTIAL AMPLIFIER	LM733
1	OP1	MC1495 1595		MOTOROLA	APL-DL	MC1495 WIDEBAND LINEAR 4-QUADRANT MULTIPLIER	MC1495
2	OP4,OP5	RC747		SIGNETICS	13 144	RC747 GENERAL PURPOSE OPERATIONAL AMPLIFIER	RC747
1	P1	10K			10 807	POTI-BECKMAN 66WR- 10K/0.10W/5%	P10K*66
1	R2	10K	4		10 071	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	10K*J4
1	R38	10K	5		10 071	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	10K*J5
2	R16,R18	12K1 12K	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	12K1*J4
1	R7	14K7 15K	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	14K7*J4
2	R10,R26 2K ! [illegible]	196K 180K	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	196K*J4
4	R19,R21,R33,R34	196R 200R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	196R*J4

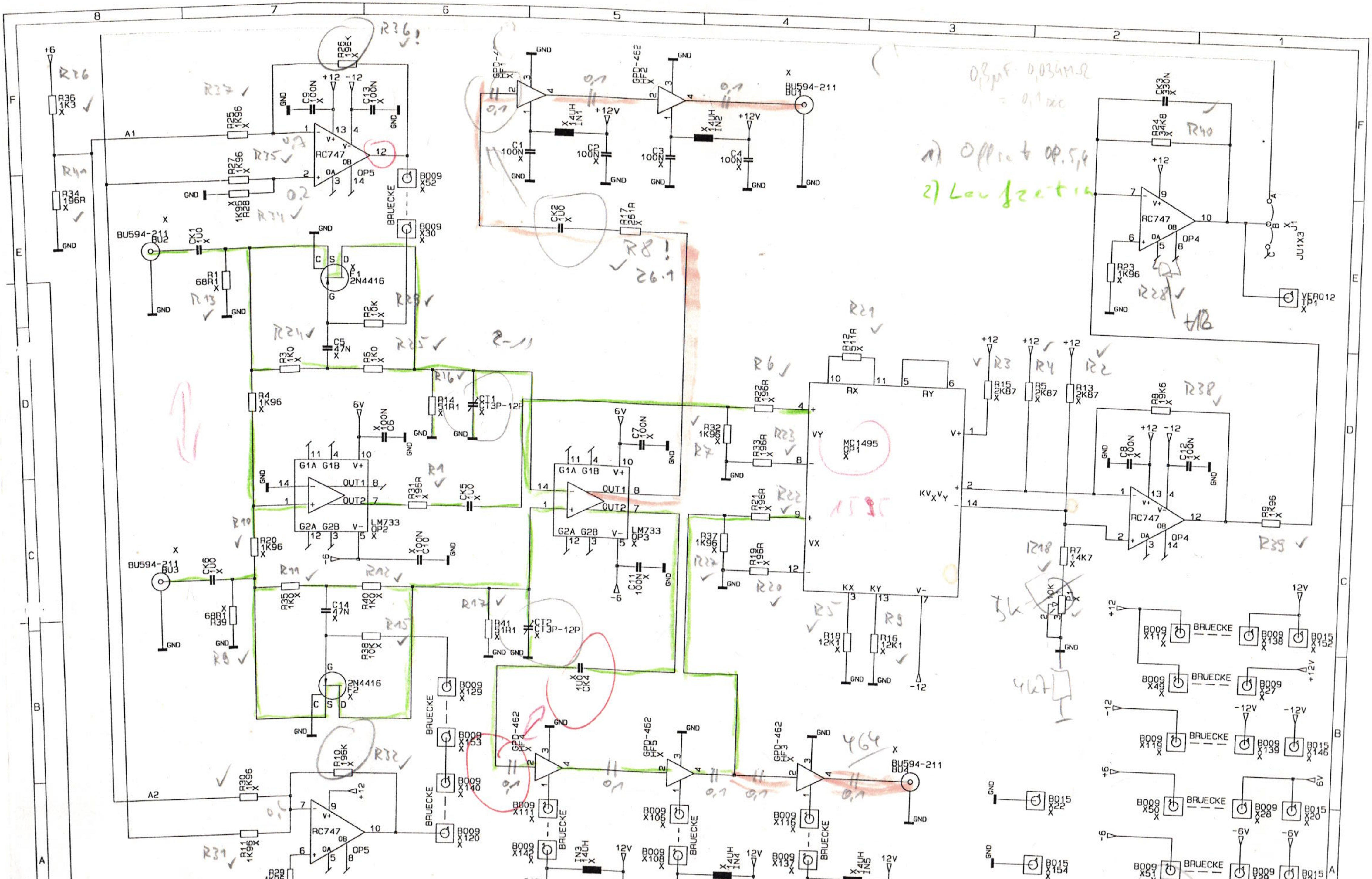
GSI DARMSTADT	BEZ.: SISU	NUMMER: FG 447.100	BEARB.: LOOS	DATUM 24.Oct.1995	BLATT 1 VON 2



GSI SISUKON1
25-OCT-1995 LOOS

SISU

FG 447.100



	NAME	DATUM
ENTW.	LOOS	27-Sep-95
BEARB.	VOLTZ	27.09.95
GEPR.		

GSI - DARMSTADT

SISU

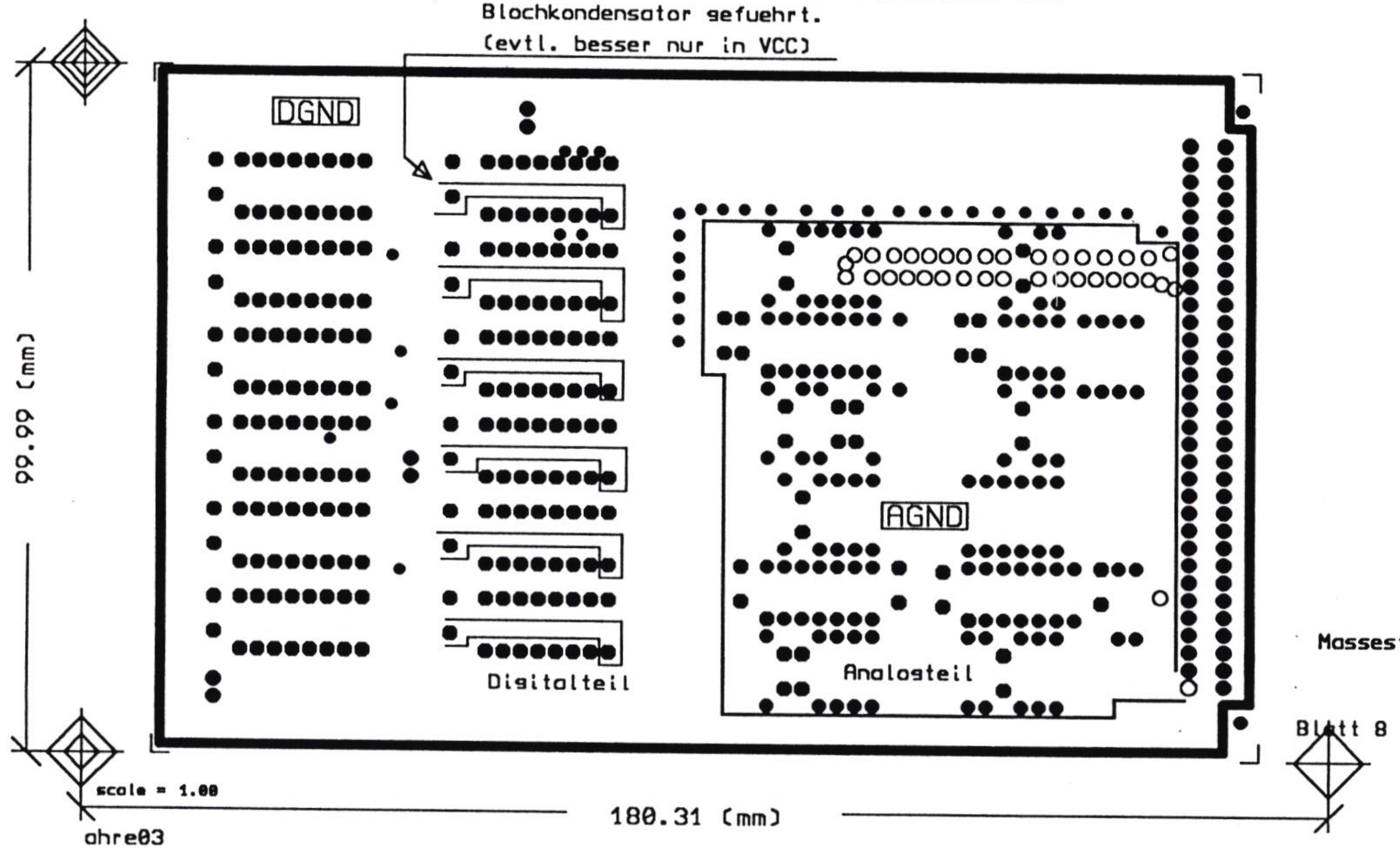
CLOSED-ORBIT SIGNAL SUPPRESSOR

VERS. FG 447.100

MASSTAB

BLATT 1 VON 1

Abschottung der Stromzufuehrung.
Hierdurch wird die Versorgung erst ueber den
Blochkondensator gefuehrt.
(evtl. besser nur in VCC)



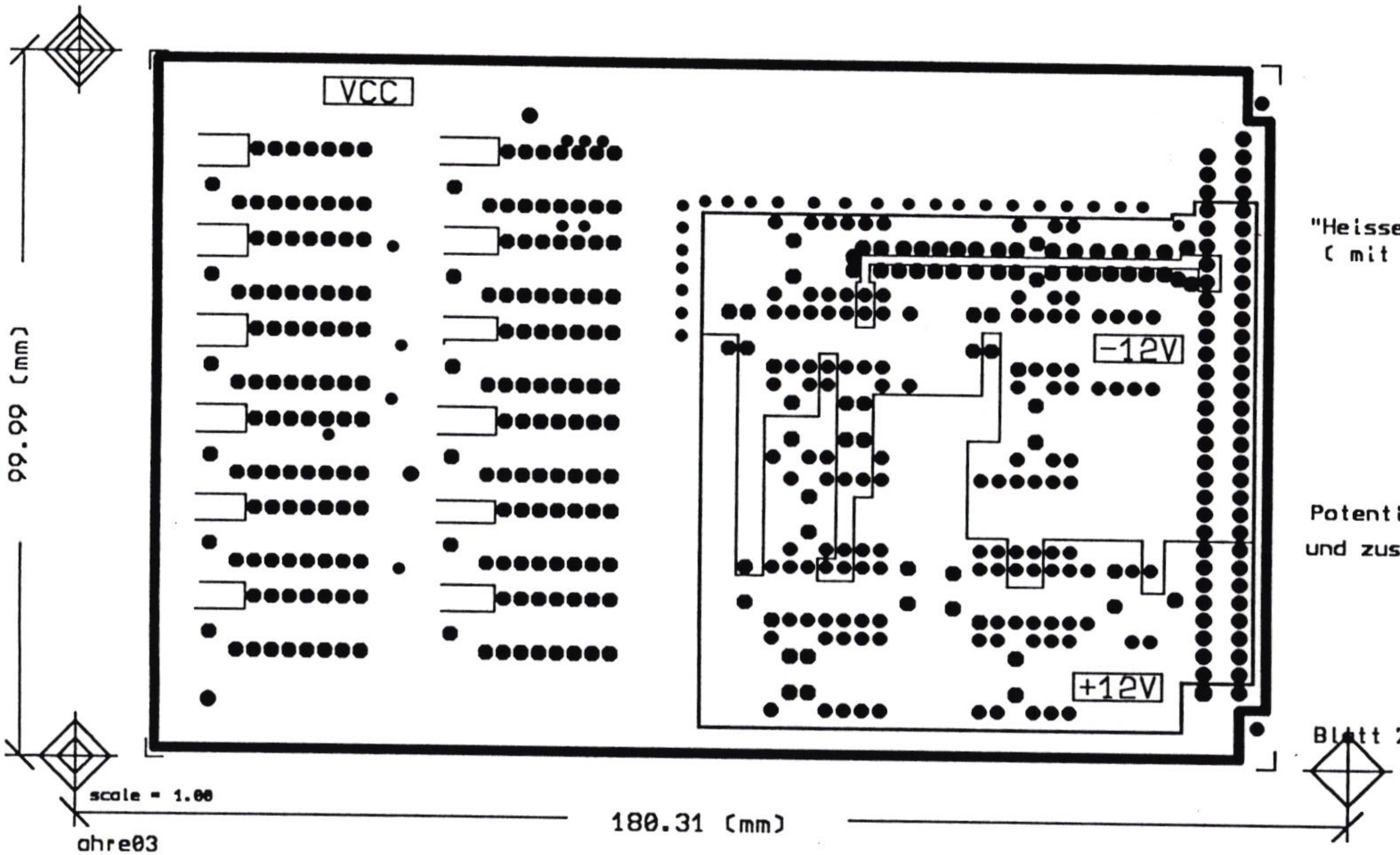
ahre03

01-Jun-94

SEG=2

RES=2

5071



"Heisse Leitung" zugenaeht
(mit Abdeckung)

Potentialgruppen bilden
und zusammen lassen.

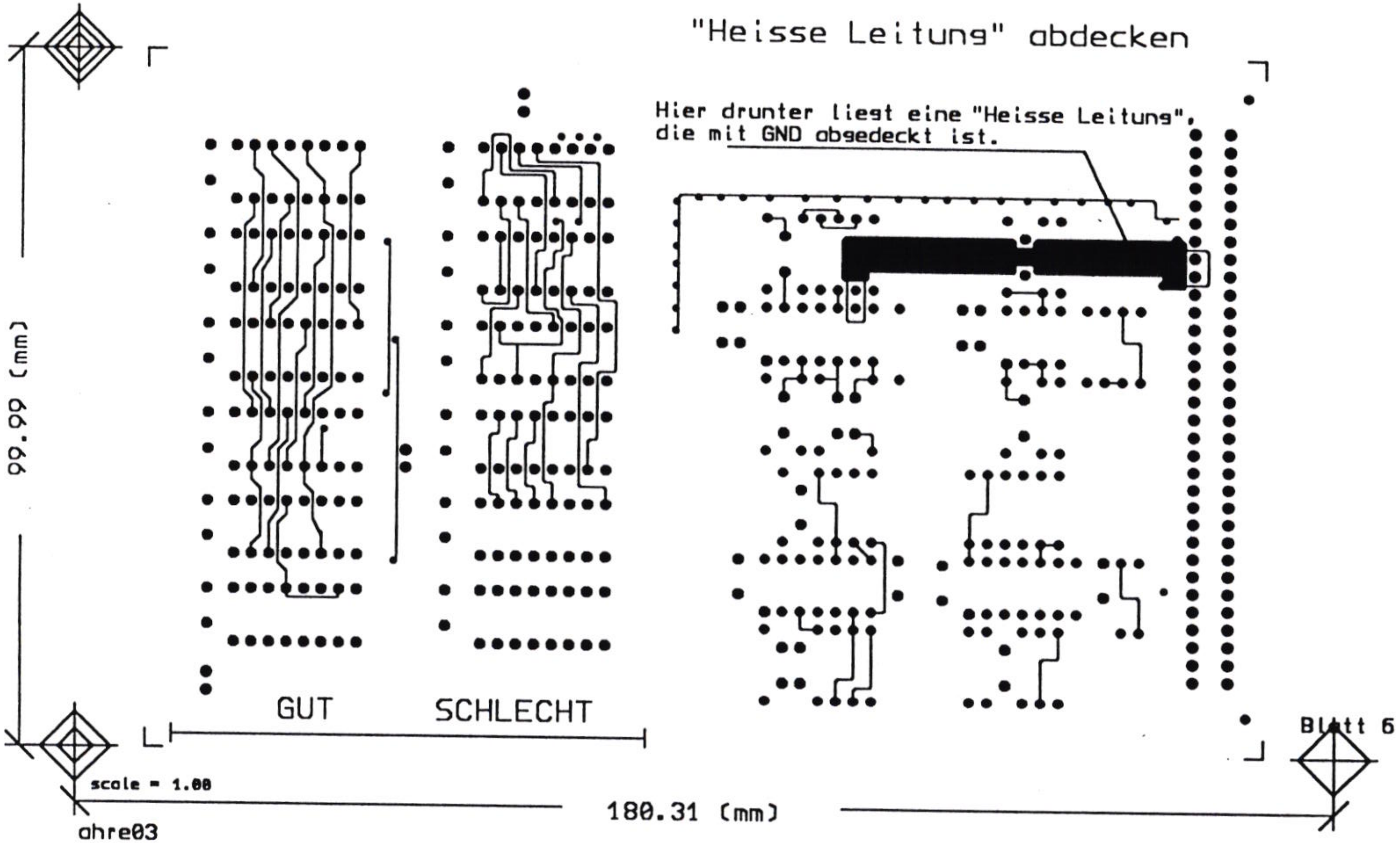
ahre03

01-Jun-94

SEG=3

RES=3

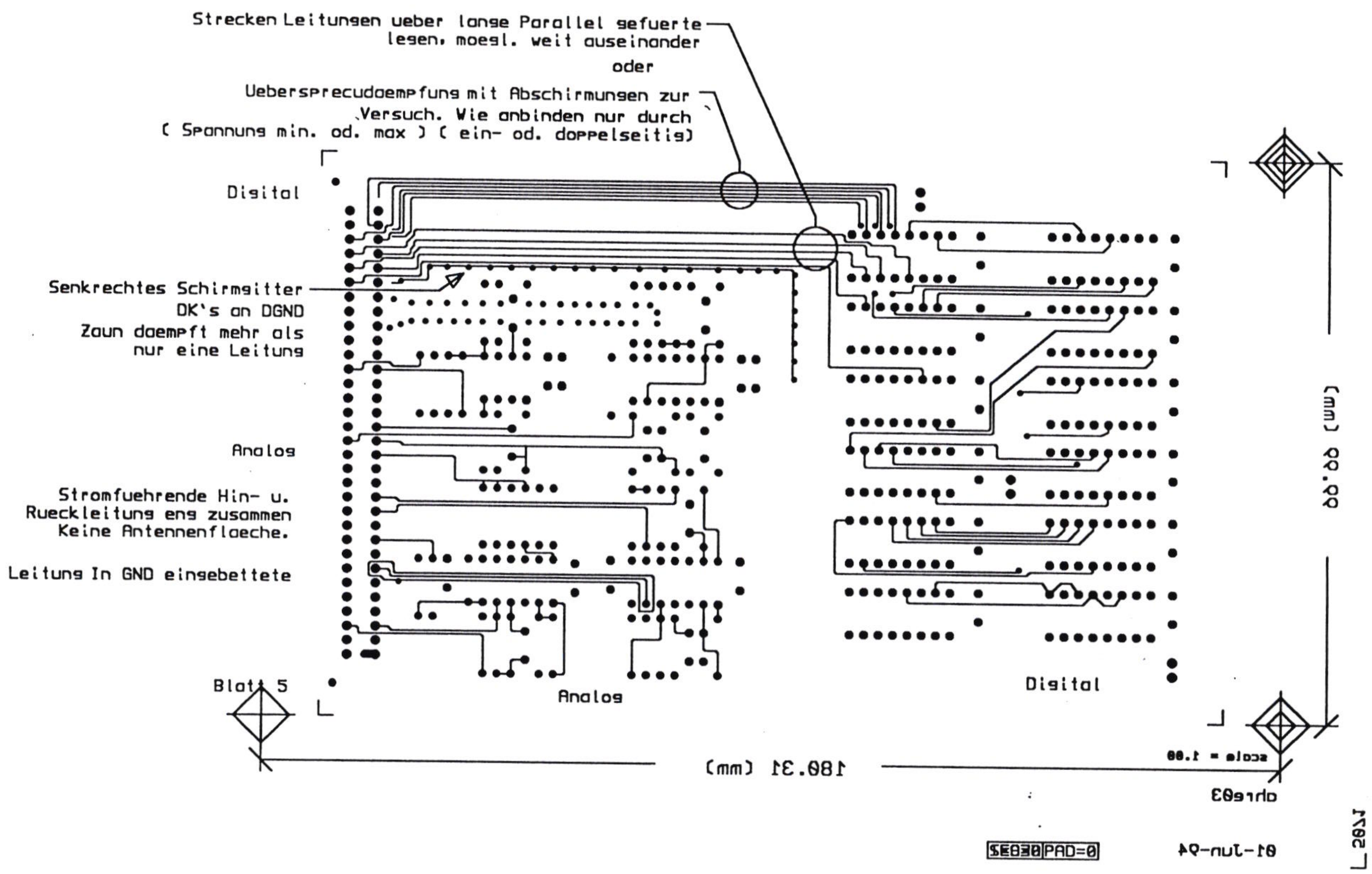
5071

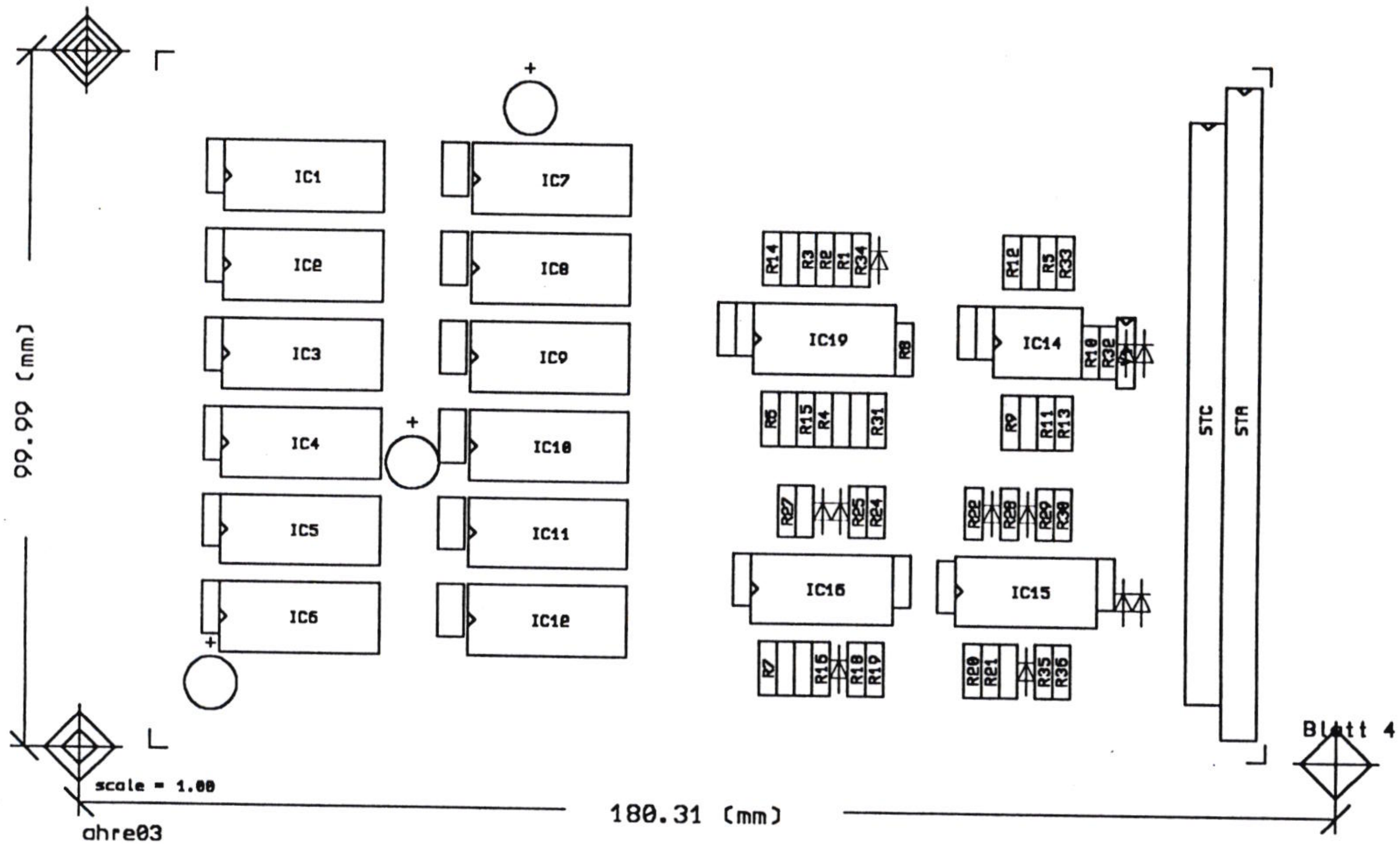


01-Jun-94

PAD=1 SEG=1

5071


Strecken Leitungen ueber lange Parallel gefuerte legen, moegl. weit auseinander
oder
Uebersprecudaempfung mit Abschirmungen zur Versuch. Wie anbinden nur durch (Spannung min. od. max) (ein- od. doppelseitig)
Digital
Senkrechtes Schirmgitter DK's an DGND
Zaun daempft mehr als nur eine Leitung
Analog
Stromfuehrende Hin- u. Rueckleitung eng zusammen Keine Antennenflaeche.
Leitung In GND eingebettete
Blatt 5
Analog
Digital

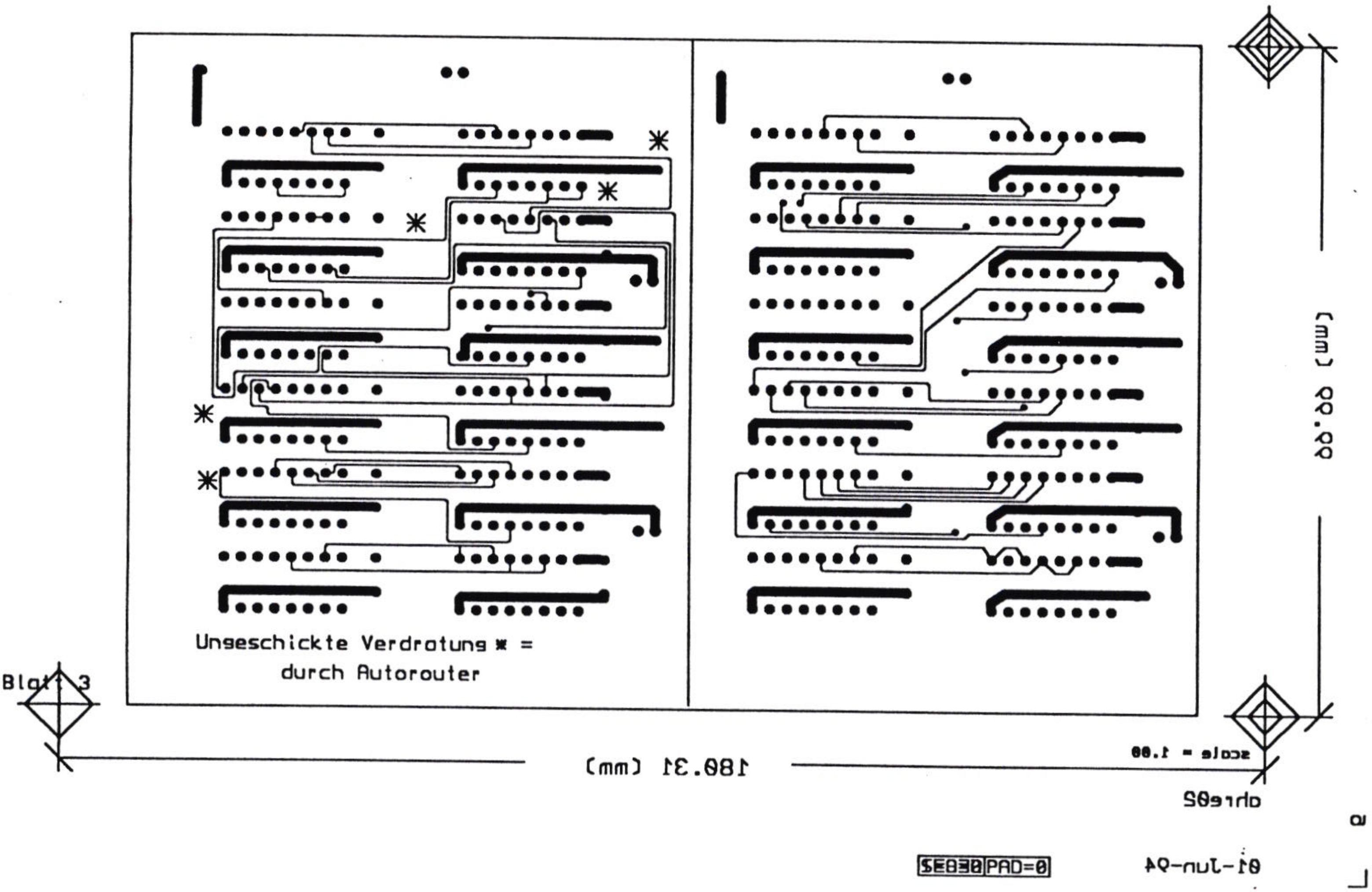


ahre03

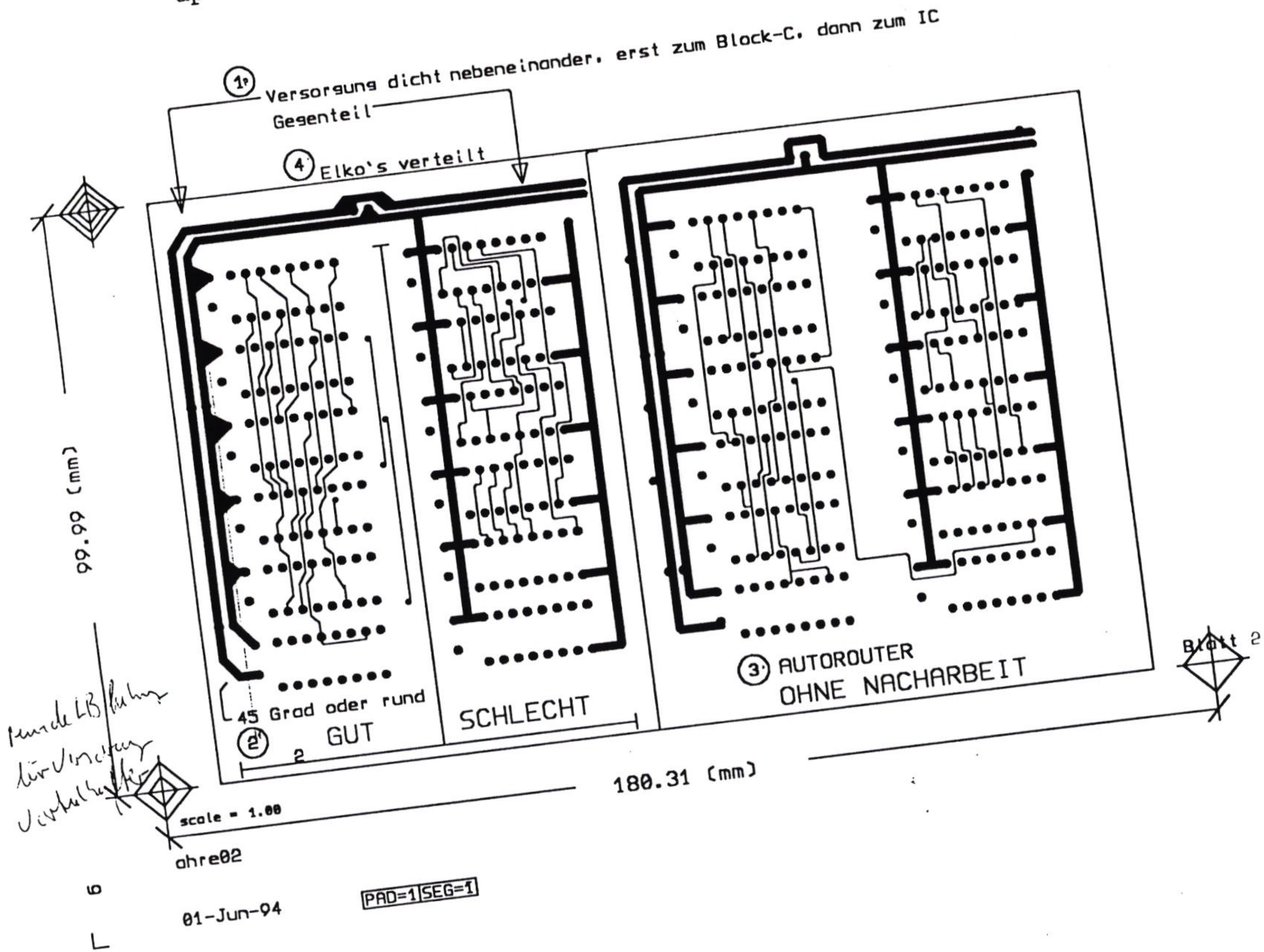
0

01-Jun-94 BPL=1 SEG=I

Thema Autorouter

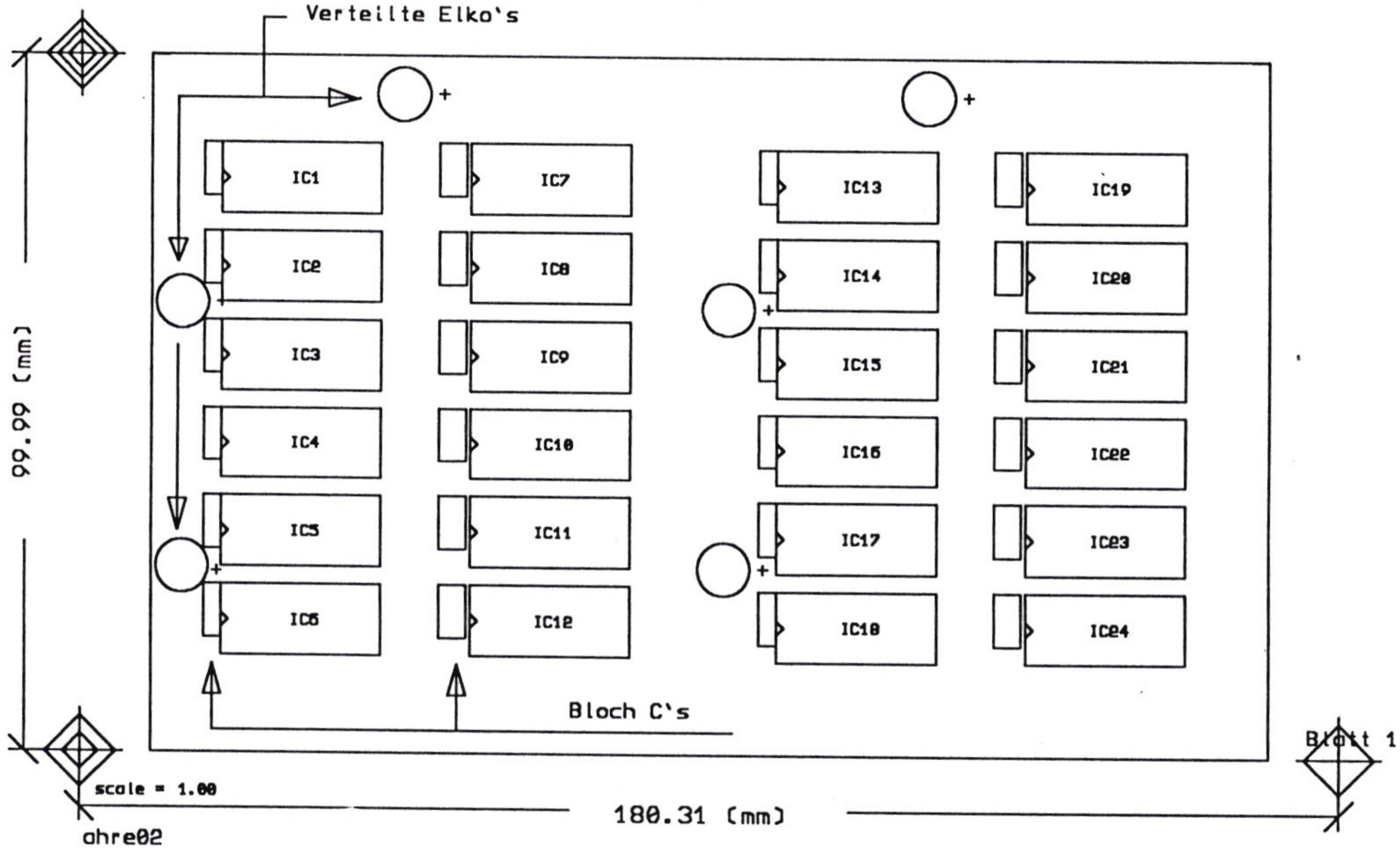


âp



1 Versorgung dicht nebeneinander, erst zum Block-C, dann zum IC
Gegenteil
4 Elko's verteilt
45 Grad oder rund
2 GUT
SCHLECHT
3 AUTOROUTER
OHNE NACHARBEIT
Blatt 2
99.99 (mm)
180.31 (mm)
scale = 1.00
ahre02
01-Jun-94
PAD=1 SEG=1

1.) Schaltung geht extrem mit ein
2.) Erdungskonzept
3.) Gehaeusefrage
4.) Multilayer erschlaegt 85% der Probleme
5.) Oder Masseflaechen gross halten



ahre02

01-Jun-94 BPL=1 SEG=I

Stk	Abk	Bauteilbezeichnung	Wert/Typ	Gehaeuse	RM	Hersteller	Lg.Nr.	Bemerkung	Soll	Ist
5		CAB/DALEKTRON 110-91-314 DUAL-IN-LINE ZUM LOETEN	DIP14*D1	DIP14		CAB/DALEKT	13 322			

GSI Darmstadt	Name: LOOS	Datum: 11.06.1996	Bestelliste Sockel zur Platine SISU1	Version: FG 447.100	Blatt: 1 von 1

Stk	Abk	Bauteilbezeichnung	Wert/Typ	Gehaeuse	RM	Hersteller	Lg.Nr.	Bemerkung	Soll	Ist
1	J	COMATEL 385.0358.120.400 WW-LEISTE ZUSCHN. 1X3PINS	JU1X3		1		16 080			

GSI Darmstadt	Name: LOOS	Datum: 11.06.1996	Bestelliste - Nachruestung Bauteile zur Platine SISU1	Version: FG 447.100	Blatt: 1 von 1

Lfn	Stk	Abk	Bauteilbezeichnung	Wert/Typ	Gehaeuse	RM	Hersteller	Lg.Nr.	Bemerkung	Soll	Ist
19	1	R	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	10K	MBB0207	4	BEYSCHLAG	10 071			
20	2	R	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	12K1		4	BEYSCHLAG				
21	2	R	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	68R1		4	BEYSCHLAG				
22	1	R	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	4K7		4		10 063			
23	1	R	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	511R		4	BEYSCHLAG				
24	1	R	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	14K7		4	BEYSCHLAG				
25	1	R	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	34K8		4	BEYSCHLAG				
26	4	R	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	196R		4	BEYSCHLAG				
27	3	R	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	2K87		4	BEYSCHLAG				
28	1	R	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	261R		4	BEYSCHLAG				
29	13	R	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	1K96		4	BEYSCHLAG				
30	1	R	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K3		4		10 050			
31	4	R	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K0	MBB0207	4	BEYSCHLAG	10 047			
32	2	ST	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	196R		5		10 071			
33	1	ST	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	10K		5		10 071			
34	1	ST	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	1K96		5		10 071			
35	1	TP	VERO-FEDERPIN O/BOHR.1.2	VERO12				16 082			

GSI Darmstadt	Name: LOOS	Datum: 11.06.1996	Bestelliste zur Platine SISU1	Version: FG 447.100	Blatt: 2 von 2

Lfn	Stk	Abk	Bauteilbezeichnung	Wert/Typ	Gehaeuse	RM	Hersteller	Lg.Nr.	Bemerkung	Soll	Ist
1	1		KURZSCHLUSSBUCHSE ISOLIERT MIT OEFFNUNG F. PRUEFCL	Sockel			COMATEL	16 009			
2	4	BU	KOAXIALKONTAKT ABGEW., 5 LOETANSCHL, NR.: 594 211	BU594-211			ERNI	APL-DL			
3	6	C	CHIP-KONDENSATOR 0805	100N	0805			EL-EX			
4	5	C	CHIP-KONDENSATOR 0805 FUER ABBLOCK	100N	A-0805			ELEX			
5	18	C	Union Carbide C320C104K1R5CA stehend Vielschicht-K	100N		1	UNION CARB	11 096			
6	2	C	Union Carbide C320C473K1R5CA stehend Vielschicht-K	47N		1	UNION CARB	11 309			
7	1	CK	UNION CARBIDE C330C334K5R5CA STEHEND VIELSCHICHT-K	330N			UNION CARB	11 334			
8	2	CT	KER. SCHEIBENTRIMMER NR.:70D-163, TYP 10S-TRIKO 06	CT3P-12P			BUERKLIN	APL			
9	2	F	JFET HIGH-FREQUENCY AMPLIFIER, N-FET TO-72 GEH.	2N4416	TO-72		MOTOROLA	APL-DL			
10	5	HF	HF-VERSTAERKER	GPD-462	TO-12		AVANTEK	APL-DL			
11	5	IN	INDUKTIVITAET 14UH RM=15.24MM	14UH		6					
12	2	OP	RC747 GENERAL PURPOSE OPERATIONAL AMPLIFIER	RC747	DIP14		SIGNETICS	13 144			
13	1	OP	MC1495 WIDEBAND LINEAR 4-QUADRANT MULTIPLIER	MC1495	DIP14		MOTOROLA	APL-DL			
14	2	OP	LM733 DIFFERENTIAL AMPLIFIER	LM733	DIP14		NATIONAL	APL-DL			
15	1	P	POTI-BECKMAN 66WR- 5K/0.10W/5%	5K				10 806			
16	1	P	POTI-BECKMAN 66WR- 10K/0.10W/5%	10K				10 807			
17	2	R	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	51R1		4	BEYSCHLAG				
18	1	R	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	19K6		4	BEYSCHLAG				

GSI Darmstadt	Name: LOOS	Datum: 11.06.1996	Bestelliste zur Platine SISU1	Version: FG 447.100	Blatt: 1 von 2

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                         W   W EEEEE RRRR  N   N EEEEE RRRR
                         W   W E     R   R N   N E     R   R
                         W   W E     R   R NN  N E     R   R
                         W   W EEEE  RRRR  N N N EEEE  RRRR
                         W W W E     R R   N  NN E     R R
                         WW WW E     R  R  N   N E     R  R
                         W   W EEEEE R   R N   N EEEEE R   R

  SSSSSSSS  IIIIII   SSSSSSSS UU      UU    11      GGGGGGGG   SSSSSSSS TTTTTTTTTT KK      KK
  SSSSSSSS  IIIIII   SSSSSSSS UU      UU    11      GGGGGGGG   SSSSSSSS TTTTTTTTTT KK      KK
SS            II   SS         UU      UU  1111    GG         SS             TT     KK      KK
SS            II   SS         UU      UU  1111    GG         SS             TT     KK      KK
SS            II   SS         UU      UU    11    GG         SS             TT     KK    KK
SS            II   SS         UU      UU    11    GG         SS             TT     KK    KK
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  SSSSSS      II     SSSSSS   UU      UU    11    GG           SSSSSS       TT     KKKKKK
        SS    II           SS UU      UU    11    GG  GGGGGG         SS     TT     KK    KK
        SS    II           SS UU      UU    11    GG  GGGGGG         SS     TT     KK    KK
        SS    II           SS UU      UU    11    GG      GG         SS     TT     KK      KK
        SS    II           SS UU      UU    11    GG      GG         SS     TT     KK      KK
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SSSSSSSS    IIIIII   SSSSSSSS   UUUUUUUUUU  111111    GGGGGG   SSSSSSSS     TT     KK      KK

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                  LL            IIIIII     SSSSSSSS    ;;;;      11
                  LL              II     SS            ;;;;    1111
                  LL              II     SS            ;;;;    1111
                  LL              II     SS                      11
                  LL              II     SS                      11
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                  LL              II       SSSSSS      ;;;;      11
                  LL              II             SS    ;;;;      11
                  LL              II             SS    ;;;;      11
          ....    LL              II             SS      ;;      11
          ....    LL              II             SS      ;;      11
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          ....    LLLLLLLLLL    IIIIII   SSSSSSSS      ;;      111111
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File _1DKA200:[CAD.CADE_JOB.SISU1.SISU11.SGSBLS]SISU1GSTK.LIS;1 (27615,66,0), last revised on 11-JUN-1996 09:09, is a 64 block sequential file owned by UIC [CAD,WERNER]. The records are variable length with implied (CR) carriage control. The longest record is 133 bytes.

Job SISU1APL (858) queued to P26GAS on 11-JUN-1996 13:32 by user WERNER, UIC [CAD,WERNER], under account ELEX at priority 100, started on printer LTA428: on 11-JUN-1996 13:34 from queue P26GAS.

La	Bez.	Wert/Typ	Gehaeuse	RM	Bemerkung	Aufruf-Name	Lg-Nr
B	OP1	Sockel	DIP14		CAB/DALEKTRON 110-91-314 DUAL-IN-LINE ZUM LOETEN	MC1495	13 322
B	OP2,OP3	Sockel	DIP14		CAB/DALEKTRON 110-91-314 DUAL-IN-LINE ZUM LOETEN	LM733	13 322
B	OP4,OP5	Sockel	DIP14		CAB/DALEKTRON 110-91-314 DUAL-IN-LINE ZUM LOETEN	RC747	13 322

<- B = Bauteilseite / L = Loetseite

GSI Darmstadt	Name: LOOS	Datum: 11.06.1996	Bestueckungsliste Sockel zur Platine SISU1	Version: FG 447.100	Blatt: 1 von 1

La	Bez.	Wert/Typ	Gehaeuse	RM	Bemerkung	Aufruf-Name	Lg-Nr
B	J1	JU1X3		1	COMATEL 385.0358.120.400 WW-LEISTE ZUSCHN. 1X3PINS	JU1X3*B2	16 080

<- B = Bauteilseite / L = Loetseite

GSI Darmstadt	Name: LOOS	Datum: 11.06.1996	Bestueckungsliste - Nachruestung Bauteile zur Platine SISU1	Version: FG 447.100	Blatt: 1 von 1

La	Bez.	Wert/Typ	Gehaeuse	RM	Bemerkung	Aufruf-Name	Lg-Nr
B	R36	1K3		4	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K3*J4	10 050
B	R37	1K96		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	1K96*J4	
B	R38	10K		5	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	10K*J5	10 071
B	R39	68R1		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	68R1*J4	
B	R40	1K0	MBB0207	4	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K0*J4	10 047
B	R41	51R1		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	51R1*J4	
B	R42	4K7		4	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	4K7*J	10 063
B	TP1	VERO12			VERO-FEDERPIN O/BOHR.1.2	VERO12	16 082
L	C21,C22,C23	100N	0805		CHIP-KONDENSATOR 0805	100N*0805	EL-EX
	C24,C25,C26						
L	C27,C28,C29	100N	A-0805		CHIP-KONDENSATOR 0805 FUER ABBLOCK	100N*0805A	ELEX
	C30,C31						

<- B = Bauteilseite / L = Loetseite

GSI Darmstadt	Name: LOOS	Datum: 11.06.1996	Bestueckungsliste zur Platine SISU1	Version: FG 447.100	Blatt: 3 von 3

La	Bez.	Wert/Typ	Gehaeuse	RM	Bemerkung	Aufruf-Name	Lg-Nr
B	R3	1K0	MBB0207	4	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K0*J4	10 047
B	R4	1K96		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	1K96*J4	
B	R5	2K87		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	2K87*J4	
B	R6	1K0	MBB0207	4	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K0*J4	10 047
B	R7	14K7		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	14K7*J4	
B	R8	19K6		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	19K6*J4	
B	R9,R10,R11	1K96		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	1K96*J4	
B	R12	511R		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	511R*J4	
B	R13	2K87		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	2K87*J4	
B	R14	51R1		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	51R1*J4	
B	R15	2K87		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	2K87*J4	
B	R16	12K1		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	12K1*J4	
B	R17	261R		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	261R*J4	
B	R18	12K1		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	12K1*J4	
B	R19	196R		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	196R*J4	
B	R20	1K96		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	1K96*J4	
B	R21	196R		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	196R*J4	
B	R22	196R		5	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	196R*J5	10 071
B	R23	1K96		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	1K96*J4	
B	R24	34K8		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	34K8*J4	
B	R25,R26,R27	1K96		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	1K96*J4	
	R28,R29,R30						
B	R31	196R		5	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	196R*J5	10 071
B	R32	1K96		5	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	1K96*J5	10 071
B	R33,R34	196R		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	196R*J4	
B	R35	1K0	MBB0207	4	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K0*J4	10 047

<- B = Bauteilseite / L = Loetseite

GSI Darmstadt	Name: LOOS	Datum: 11.06.1996	Bestueckungsliste zur Platine SISU1	Version: FG 447.100	Blatt: 2 von 3

La	Bez.	Wert/Typ	Gehaeuse	RM	Bemerkung	Aufruf-Name	Lg-Nr
B	BU1,BU2,BU3	BU594-211			KOAXIALKONTAKT ABGEW., 5 LOETANSCHL, NR.: 594 211	BU594*D1	APL-DL
	BU4						
B	C1,C2,C3	100N		1	Union Carbide C320C104K1R5CA stehend Vielschicht-K	100N*A	11 096
	C4						
B	C5	47N		1	Union Carbide C320C473K1R5CA stehend Vielschicht-K	47N*A	11 309
B	C6,C7,C8	100N		1	Union Carbide C320C104K1R5CA stehend Vielschicht-K	100N*A	11 096
	C9,C10,C11						
	C12,C13						
B	C14	47N		1	Union Carbide C320C473K1R5CA stehend Vielschicht-K	47N*A	11 309
B	C15,C16,C17	100N		1	Union Carbide C320C104K1R5CA stehend Vielschicht-K	100N*A	11 096
	C18,C19,C20						
B	CK3	330N			UNION CARBIDE C330C334K5R5CA STEHEND VIELSCHICHT-K	330N*A	11 334
B	CT1,CT2	CT3P-12P			KER. SCHEIBENTRIMMER NR.:70D-163, TYP 10S-TRIKO 06	CT3P-12P*B1	APL
B	F1,F2	2N4416	TO-72		JFET HIGH-FREQUENCY AMPLIFIER, N-FET TO-72 GEH.	2N4416	APL-DL
B	HF1,HF2,HF3	GPD-462	TO-12		HF-VERSTAERKER	GPD-462	APL-DL
	HF4,HF5						
B	IN1,IN2,IN3	14UH		6	INDUKTIVITAET 14UH RM=15.24MM	14UH	
	IN4,IN5						
B	J1	Sockel			KURZSCHLUSSBUCHSE ISOLIERT MIT OEFFNUNG F. PRUEFCL	JU1X3*B2	16 009
B	OP1	MC1495	DIP14		MC1495 WIDEBAND LINEAR 4-QUADRANT MULTIPLIER	MC1495	APL-DL
B	OP2,OP3	LM733	DIP14		LM733 DIFFERENTIAL AMPLIFIER	LM733	APL-DL
B	OP4,OP5	RC747	DIP14		RC747 GENERAL PURPOSE OPERATIONAL AMPLIFIER	RC747	13 144
B	P1	5K			POTI-BECKMAN 66WR- 5K/0.10W/5%	P5K*66	10 806
B	P2	10K			POTI-BECKMAN 66WR- 10K/0.10W/5%	P10K*66	10 807
B	R1	68R1		4	METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	68R1*J4	
B	R2	10K	MBB0207	4	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	10K*J4	10 071

<- B = Bauteilseite / L = Loetseite

GSI Darmstadt	Name: LOOS	Datum: 11.06.1996	Bestueckungsliste zur Platine SISU1	Version: FG 447.100	Blatt: 1 von 3

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DDDDDDDDDD    222222222222222222222222222222  DECprint Supervisor for OpenVMS (CADE)  222222222222222222222222222222    DDDDDDDDDD
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WW WW  E      R  R   N   N  E      R  R
W   W  EEEEE  R   R  N   N  EEEEE  R   R
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SS              II    SS          UU      UU   1111      BB      BB  SS             TT
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File _1DKA200:[CAD.CADE_JOB.SISU1.SISU11.SGSBLS]SISU1BST.LIS;1 (48946,95,0), last revised on 11-JUN-1996 09:09, is a 79 block sequential file owned by UIC [CAD,WERNER]. The records are variable length with implied (CR) carriage control. The longest record is 133 bytes.

Job SISU1APL (858) queued to P26GAS on 11-JUN-1996 13:32 by user WERNER, UIC [CAD,WERNER], under account ELEX at priority 100, started on printer LTA428: on 11-JUN-1996 13:33 from queue P26GAS.

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DDDDDDDDDD    2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222    DDDDDDDDDD
DDDDDDDDDD    2222222222222222222222  Digital Equipment Corporation - OpenVMS AXP Version V6.2  2222222222222222222222    DDDDDDDDDD
DDDDDDDDDD    2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222    DDDDDDDDDD
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E L E K T R . S T U E C K L I S T E

*RM: 1 EINHEIT = 2.54MM

ST.	BAUTEIL-BEZEICHNUNG	WERT/TYP	RM	HERSTELLER	LG-NR.	BEMERKUNGEN	AUFRUF-NAHME
1	R42	4K7	4		10 063	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	4K7*J
1	R12	511R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	511R*J4
2	R14,R41	51R1	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	51R1*J4
2	R1,R39	68R1	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	68R1*J4
2	F1,F2	2N4416		MOTOROLA	APL-DL	JFET HIGH-FREQUENCY AMPLIFIER, N-FET TO-72 GEH.	2N4416
1	TP1	VERO12			16 082	VERO-FEDERPIN O/BOHR.1.2	VERO12
1	LEITERPLATTE	FG 447.100					

GSI DARMSTADT	BEZ.: SISU1	NUMMER: FG 447.100 1	BEARB.: LOOS	DATUM 11.Jun.1996	BLATT 3 VON 3

E L E K T R .   S T U E C K L I S T E

*RM: 1 EINHEIT = 2.54MM

ST.	BAUTEIL-BEZEICHNUNG	WERT/TYP	RM	HERSTELLER	LG-NR.	BEMERKUNGEN	AUFRUF-NAHME
1	OP1	MC1495		MOTOROLA	APL-DL	MC1495 WIDEBAND LINEAR 4-QUADRANT MULTIPLIER	MC1495
2	OP4,OP5	RC747		SIGNETICS	13 144	RC747 GENERAL PURPOSE OPERATIONAL AMPLIFIER	RC747
1	P2	10K			10 807	POTI-BECKMAN 66WR- 10K/0.10W/5%	P10K*66
1	P1	5K			10 806	POTI-BECKMAN 66WR- 5K/0.10W/5%	P5K*66
1	R2	10K	4	BEYSCHLAG	10 071	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	10K*J4
1	R38	10K	5		10 071	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	10K*J5
2	R16,R18	12K1	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	12K1*J4
1	R7	14K7	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	14K7*J4
4	R19,R21,R33	196R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	196R*J4
	R34						
2	R22,R31	196R	5		10 071	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	196R*J5
1	R8	19K6	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	19K6*J4
4	R3,R6,R35	1K0	4	BEYSCHLAG	10 047	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K0*J4
	R40						
1	R36	1K3	4		10 050	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K3*J4
13	R4,R9,R10	1K96	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	1K96*J4
	R11,R20,R23						
	R25,R26,R27						
	R28,R29,R30						
	R37						
1	R32	1K96	5		10 071	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	1K96*J5
1	R17	261R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	261R*J4
3	R5,R13,R15	2K87	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	2K87*J4
1	R24	34K8	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	34K8*J4

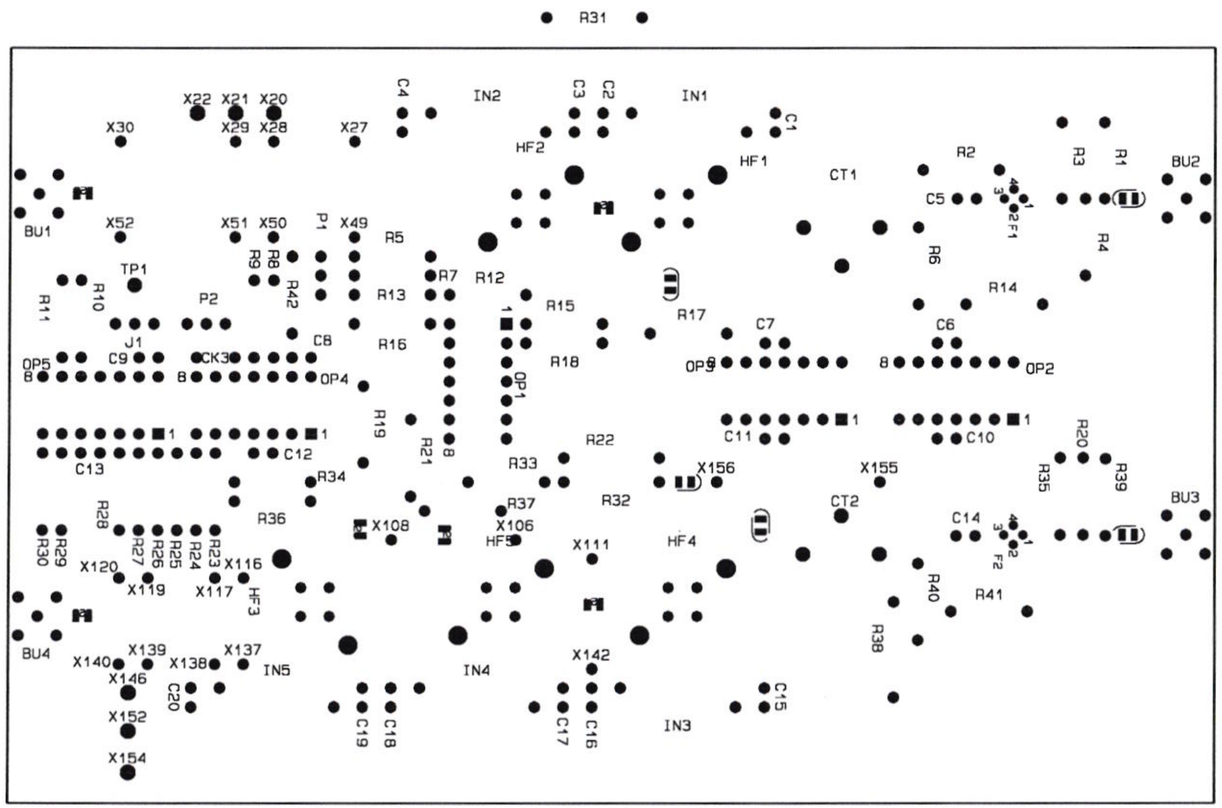
GSI DARMSTADT	BEZ.:	NUMMER:	BEARB.:	DATUM	BLATT
	SISU1	FG 447.100	LOOS	11.Jun.1996	2 VON 3

E L E K T R .   S T U E C K L I S T E

*RM: 1 EINHEIT = 2.54MM

ST.	BAUTEIL-BEZEICHNUNG	WERT/TYP	RM	HERSTELLER	LG-NR.	BEMERKUNGEN	AUFRUF-NAHME
5		DIP14*D1			13 322	CAB/DALEKTRON 110-91-314 DUAL-IN-LINE ZUM LOETEN	
4	BU1,BU2,BU3	BU594-211		ERNI	APL-DL	KOAXIALKONTAKT ABGEW., 5 LOETANSCHL, NR.: 594 211	BU594*D1
	BU4						
6	C21,C22,C23	100N			EL-EX	CHIP-KONDENSATOR 0805	100N*0805
	C24,C25,C26						
5	C27,C28,C29	100N			ELEX	CHIP-KONDENSATOR 0805 FUER ABBLOCK	100N*0805A
	C30,C31						
18	C1,C2,C3	100N	1	UNION CARB	11 096	Union Carbide C320C104K1R5CA stehend Vielschicht-K	100N*A
	C4,C6,C7						
	C8,C9,C10						
	C11,C12,C13						
	C15,C16,C17						
	C18,C19,C20						
1	CK3	330N		UNION CARB	11 334	UNION CARBIDE C330C334K5R5CA STEHEND VIELSCHICHT-K	330N*A
2	C5,C14	47N	1	UNION CARB	11 309	Union Carbide C320C473K1R5CA stehend Vielschicht-K	47N*A
2	CT1,CT2	CT3P-12P		BUERKLIN	APL	KER. SCHEIBENTRIMMER NR.:70D-163, TYP 10S-TRIKO 06	CT3P-12P*B1
5	MONTAGEMAT			AVANTEK	APL-DL	ACCESSORY-PACK, NR.: 330-006756-001	
5	HF1,HF2,HF3	GPD-462		AVANTEK	APL-DL	HF-VERSTAERKER	GPD-462
	HF4,HF5						
1	KURZSCHL.-BU			COMATEL	16 009	KURZSCHLUSSBUCHSE ISOLIERT MIT OEFFNUNG F. PRUEFCL	
	J1	WW-L. ZUSCHN	1		16 080	COMATEL 385.0358.120.400 WW-LEISTE ZUSCHN. 1X3PINS	JU1X3*B2
5	IN1,IN2,IN3	14UH	6			INDUKTIVITAET 14UH RM=15.24MM	14UH
	IN4,IN5						
2	OP2,OP3	LM733		NATIONAL	APL-DL	LM733 DIFFERENTIAL AMPLIFIER	LM733

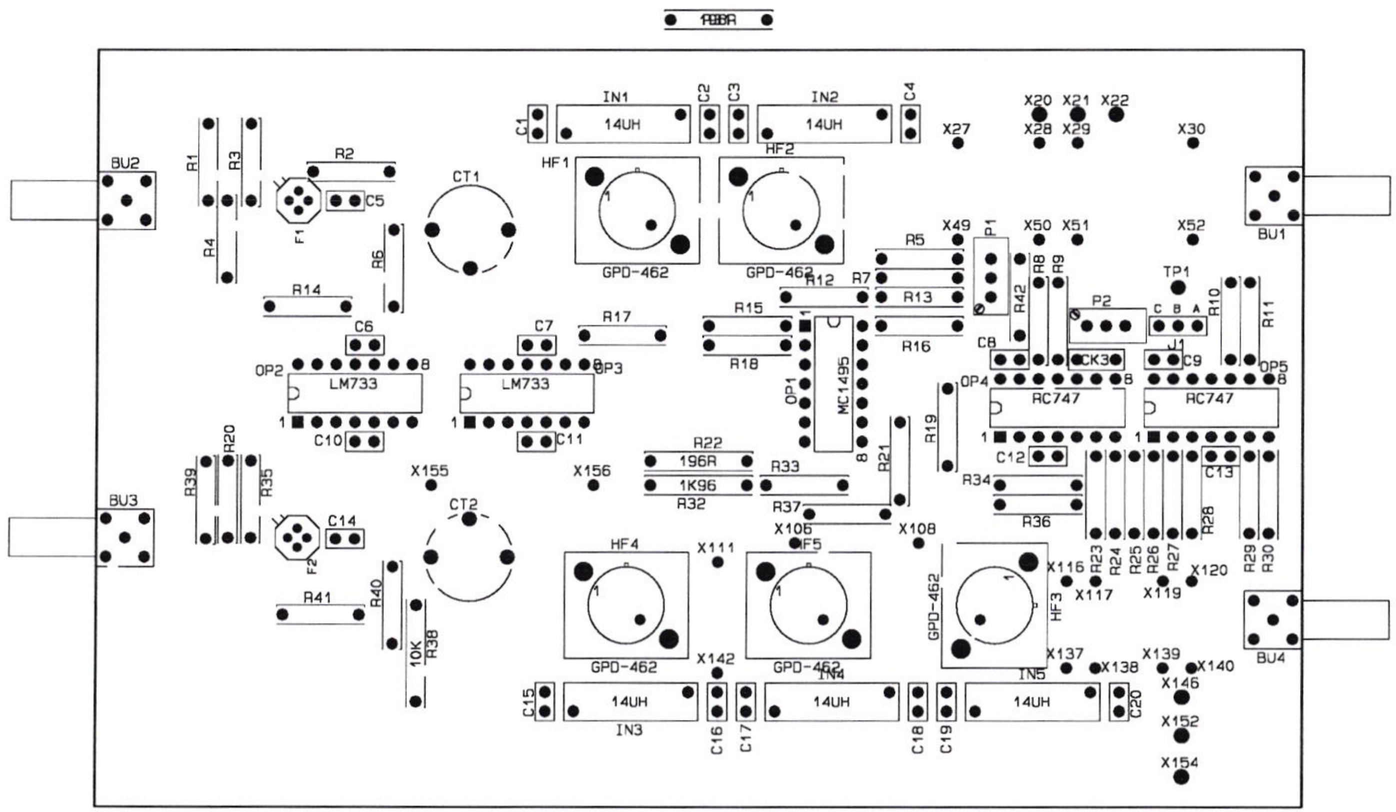
GSI DARMSTADT	BEZ.: SISU1	NUMMER: FG 447.100	BEARB.: LOOS	DATUM 11.Jun.1996	BLATT 1 VON 3



GSI SISU1KON2
11-JUN-1996 LOOS

SISU1

FG 447.101



GSI SISU1KON1
11-JUN-1996 LOOS

SISU1

FG 447.100 [handwritten correction: 1 over final digit]

Neu !

E L E K T R .   S T U E C K L I S T E

*RM: 1 EINHEIT = 2.54MM

ST.	BAUTEIL-BEZEICHNUNG	WERT/TYP	RM	HERSTELLER	LG-NR.	BEMERKUNGEN	AUFRUF-NAHME
1	R42	4K75	4		10 063	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	4K7*J
1	R12	511R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	511R*J4
2	R14,R41	51R1	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	51R1*J4
2	R1,R39	68R1	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	68R1*J4
2	F1,F2	2N4416		MOTOROLA	APL-DL	JFET HIGH-FREQUENCY AMPLIFIER, N-FET TO-72 GEH.	2N4416
1	TP1	VERO12			16 082	VERO-FEDERPIN O/BOHR.1.2	VERO12
1	LEITERPLATTE	FG 447.100					

GSI DARMSTADT	BEZ.: SISU1	NUMMER: FG 447.101	BEARB.: LOOS	DATUM 11.Jun.1996	BLATT 3 VON 3

E L E K T R . S T U E C K L I S T E

*RM: 1 EINHEIT = 2.54MM

ST.	BAUTEIL-BEZEICHNUNG	WERT/TYP	RM	HERSTELLER	LG-NR.	BEMERKUNGEN	AUFRUF-NAHME
1	OP1	MC1495		MOTOROLA	APL-DL	MC1495 WIDEBAND LINEAR 4-QUADRANT MULTIPLIER	MC1495
2	OP4,OP5	RC747		SIGNETICS	13 144	RC747 GENERAL PURPOSE OPERATIONAL AMPLIFIER	RC747
1	P2	10K			10 807	POTI-BECKMAN 66WR- 10K/0.10W/5%	P10K*66
1	P1	5K			10 806	POTI-BECKMAN 66WR- 5K/0.10W/5%	P5K*66
1	R2	10K	4	BEYSCHLAG	10 071	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	10K*J4
1	R38	10K	5		10 071	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	10K*J5
2	R16,R18	12K1	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	12K1*J4
1	R7	14K7	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	14K7*J4
4	R19,R21,R33	196R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	196R*J4
	R34						
2	R22,R31 ?	196R	5		10 071	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	196R*J5
1	R8	19K6 (20k)	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	19K6*J4
4	R3,R6,R35	1K0	4	BEYSCHLAG	10 047	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K0*J4
	R40						
1	R36	1K3	4		10 050	METALLSCHICHTWIDERSTAND, 0.6W/1% RASTER=4	1K3*J4
13	R4,R9,R10	1K96	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	1K96*J4
	R11,R20,R23						
	R25,R26,R27						
	R28,R29,R30						
	R37						
1	R32	1K96	5		10 071	METALLSCHICHTWIDERSTAND 0.6W/1% RASTER=5	1K96*J5
1	R17	261R	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	261R*J4
3	R5,R13,R15	2K87	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	2K87*J4
1	R24	34K8	4	BEYSCHLAG		METALLSCHICHT-R 0.6W/1%, MBB0207-50BX (E96), RM=4	34K8*J4

GSI DARMSTADT	BEZ.: SISU1	NUMMER: FG 447.100	BEARB.: LOOS	DATUM 11.Jun.1996	BLATT 2 VON 3

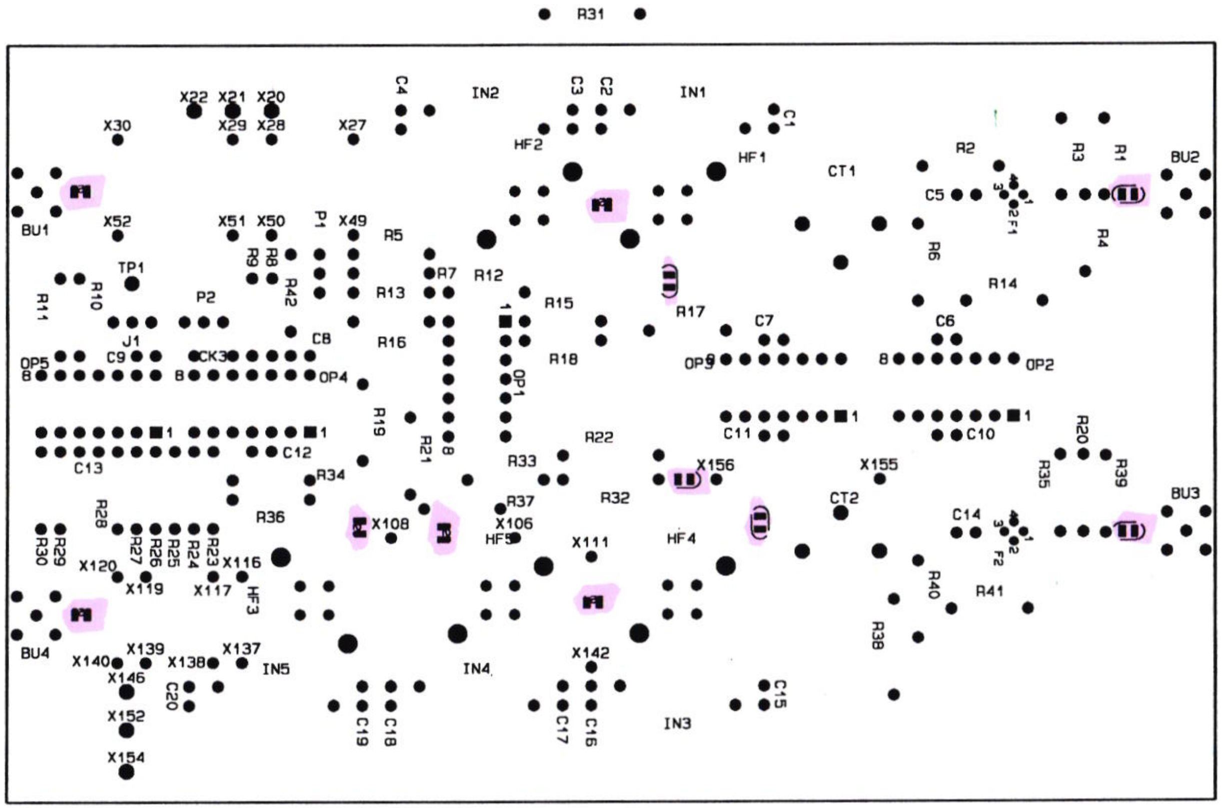
2.

E L E K T R . S T U E C K L I S T E

*RM: 1 EINHEIT = 2.54MM

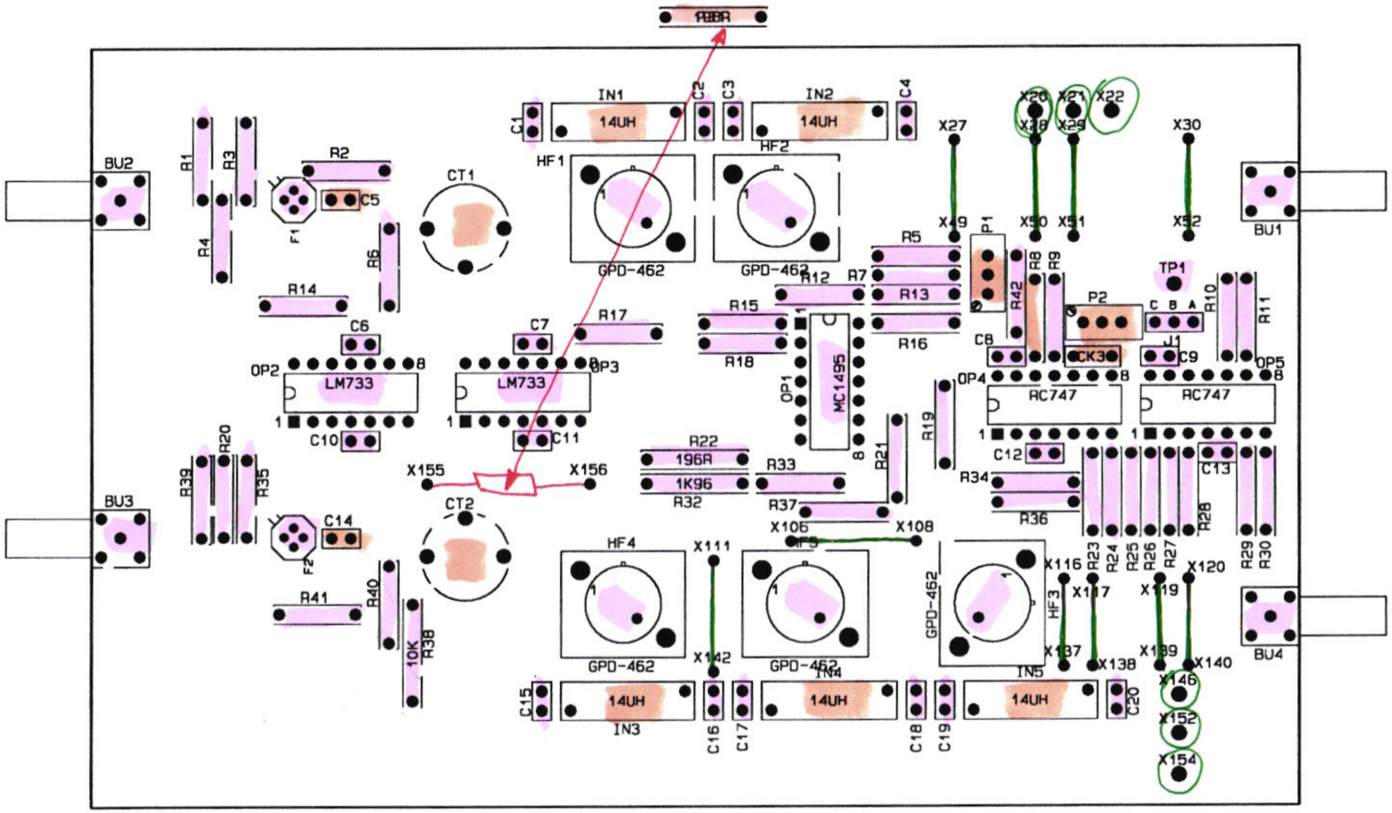
ST.	BAUTEIL-BEZEICHNUNG	WERT/TYP	RM	HERSTELLER	LG-NR.	BEMERKUNGEN	AUFRUF-NAHME
5		DIP14*D1			13 322	CAB/DALEKTRON 110-91-314 DUAL-IN-LINE ZUM LOETEN	
4	BU1,BU2,BU3	BU594-211		ERNI	APL-DL	KOAXIALKONTAKT ABGEW., 5 LOETANSCHL, NR.: 594 211	BU594*D1
	BU4						
6	C21,C22,C23	100N			EL-EX	CHIP-KONDENSATOR 0805	100N*0805
	C24,C25,C26						
5	C27,C28,C29	100N			ELEX	CHIP-KONDENSATOR 0805 FUER ABBLOCK	100N*0805A
	C30,C31						
18	C1,C2,C3	100N	1	UNION CARB	11 096	Union Carbide C320C104K1R5CA stehend Vielschicht-K	100N*A
	C4,C6,C7						
	C8,C9,C10						
	C11,C12,C13						
	C15,C16,C17						
	C18,C19,C20						
1	CK3	330N		UNION CARB	11 334	UNION CARBIDE C330C334K5R5CA STEHEND VIELSCHICHT-K	330N*A
2	C5,C14	47N	1	UNION CARB	11 309	Union Carbide C320C473K1R5CA stehend Vielschicht-K	47N*A
2	CT1,CT2	CT3P-12P		BUERKLIN	APL	KER. SCHEIBENTRIMMER NR.:70D-163, TYP 10S-TRIKO 06	CT3P-12P*B1
5	MONTAGEMAT			AVANTEK	APL-DL	ACCESSORY-PACK, NR.: 330-006756-001	
5	HF1,HF2,HF3	GPD-462 4		AVANTEK	APL-DL	HF-VERSTAERKER	GPD-462
	HF4,HF5						
1	KURZSCHL.-BU			COMATEL	16 009	KURZSCHLUSSBUCHSE ISOLIERT MIT OEFFNUNG F. PRUEFCL	
	J1	WW-L. ZUSCHN	1		16 080	COMATEL 385.0358.120.400 WW-LEISTE ZUSCHN. 1X3PINS	JU1X3*B2
5	IN1,IN2,IN3	14UH	6			INDUKTIVITAET 14UH RM=15.24MM	14UH
	IN4,IN5						
2	OP2,OP3	LM733		NATIONAL	APL-DL	LM733 DIFFERENTIAL AMPLIFIER	LM733

GSI DARMSTADT	BEZ.: SISU1	NUMMER: FG 447.100 1	BEARB.: LOOS	DATUM 11.Jun.1996	BLATT 1 VON 3



GSI SISU1KON2 SISU1 FG 447.100 / 1

11-JUN-1996 LOOS

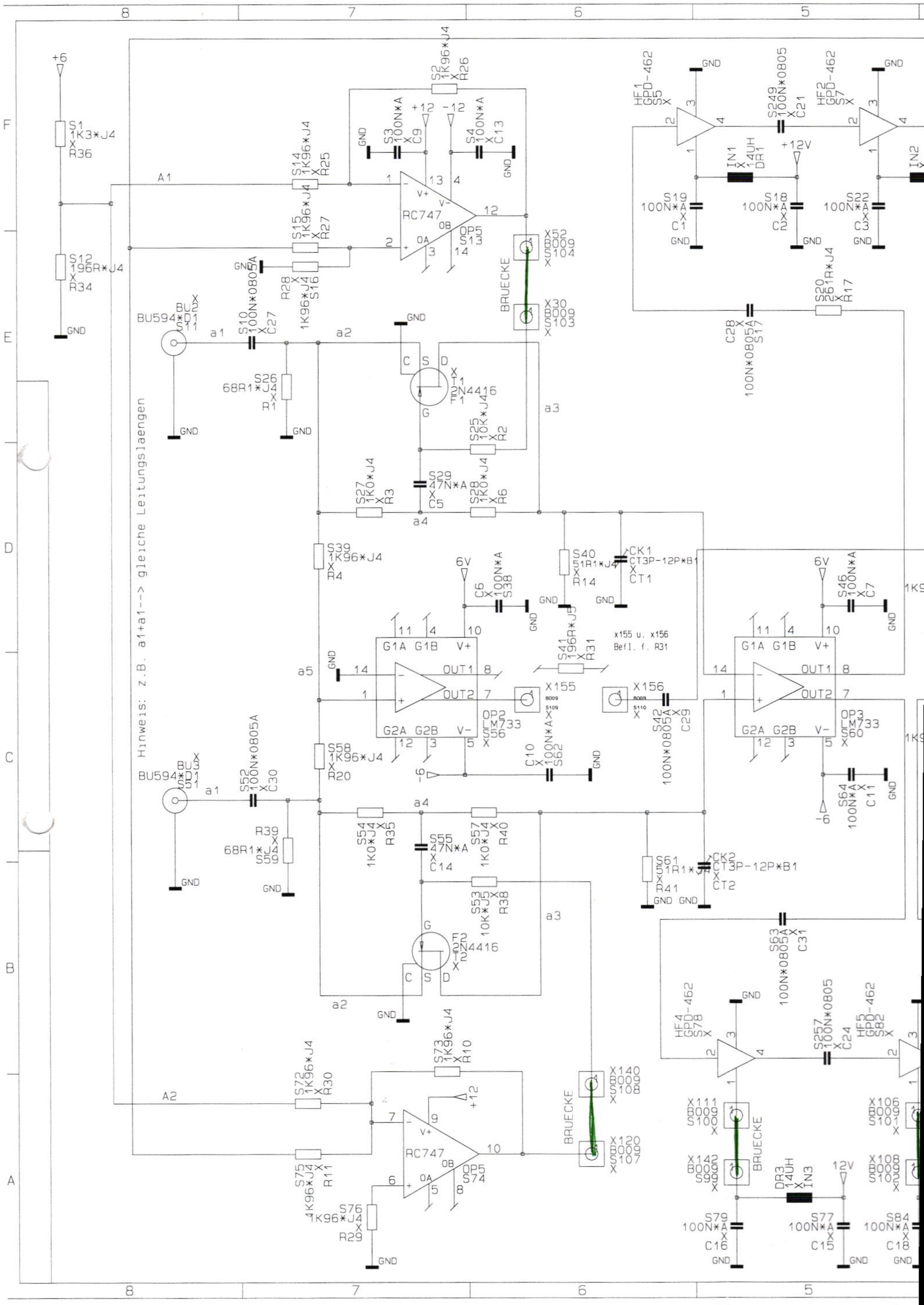


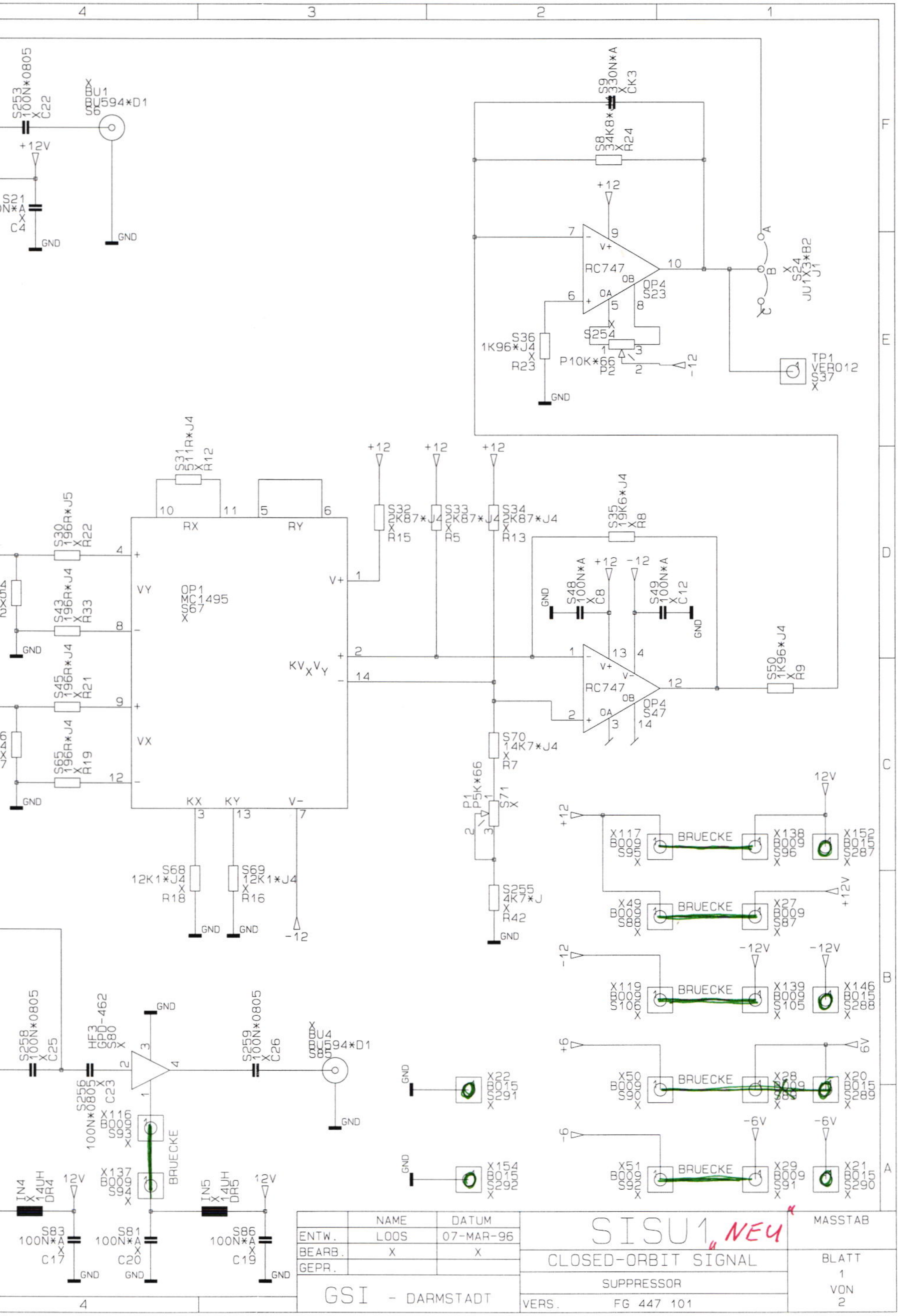
GSI SISU1KON1 SISU1 FG 447.10~~0~~

11-JUN-1996 LOOS

Neu!

68370


RC747
LM733
2N4416
BRUECKE
Hinweis: z.B. a1+a1--> gleiche Leitungslaengen
x155 u. x156
Befl. f. R31
BU594*D1
GPD-462


SISU1 „NEU"
CLOSED-ORBIT SIGNAL
SUPPRESSOR
GSI - DARMSTADT
VERS. FG 447 101
ENTW. LOOS 07-MAR-96
BEARB. X X
GEPR.
NAME DATUM
MASSTAB
BLATT 1 VON 2
OP1 MC1495 S67
RC747 OP4 S47
RC747 OP4 S23
BRUECKE
TP1 VERO12 S37
S24 JU1X3*B2 J1
BU1 BU594*D1 S6
BU4 BU594*D1 S85
HF3 GPD-462 S80
GND
+12
-12
Prototyp !

Bestellung bei Spoerle oder E3V für Kost. stelle

25 x IC - MC 1595L 15,56 DM/Stck

25 x µA 733 CN DIP 3,23 DM/Stck

Typ → 19K6 fehlt

Bestellung Fa. Bürklin für Kostenstelle: 68370

Metallschichtwiderstände 0,6W Typ. 0207

Stck	Wert				
100×	51R1	Best. Nr.	30E168	0,08 DM/Stck	8,–
100×	68R1	" "	30E180	0,08 "	8,–
100×	196R	" "	30E224	0,08 "	8,–
100×	261R	" "	30E236	0,08 "	8,–
100×	511R	" "	30E264	0,08 "	8,–
100×	1K0	" "	30E292	0,08 "	8,–
100×	1K30	" "	30E303	0,08 "	8,–
200×	1K96	" "	30E320	0,06 "	12,–
100×	2K74	" "	30E334	0,08 "	8,–
100×	2K87	" "	30E336	0,08 "	8,–
100×	4K75	" "	30E358	0,08 "	8,–
100×	10K0	" "	30E389	0,08 "	8,–
100×	12K1	" "	30E397	0,08 "	8,–
100×	14K7	" "	30E405	0,08 "	8,–
100×	34K8	" "	30E441	0,08 "	8,–

SMD-Keramik-Vielschichtkondensatoren Typ Siemens

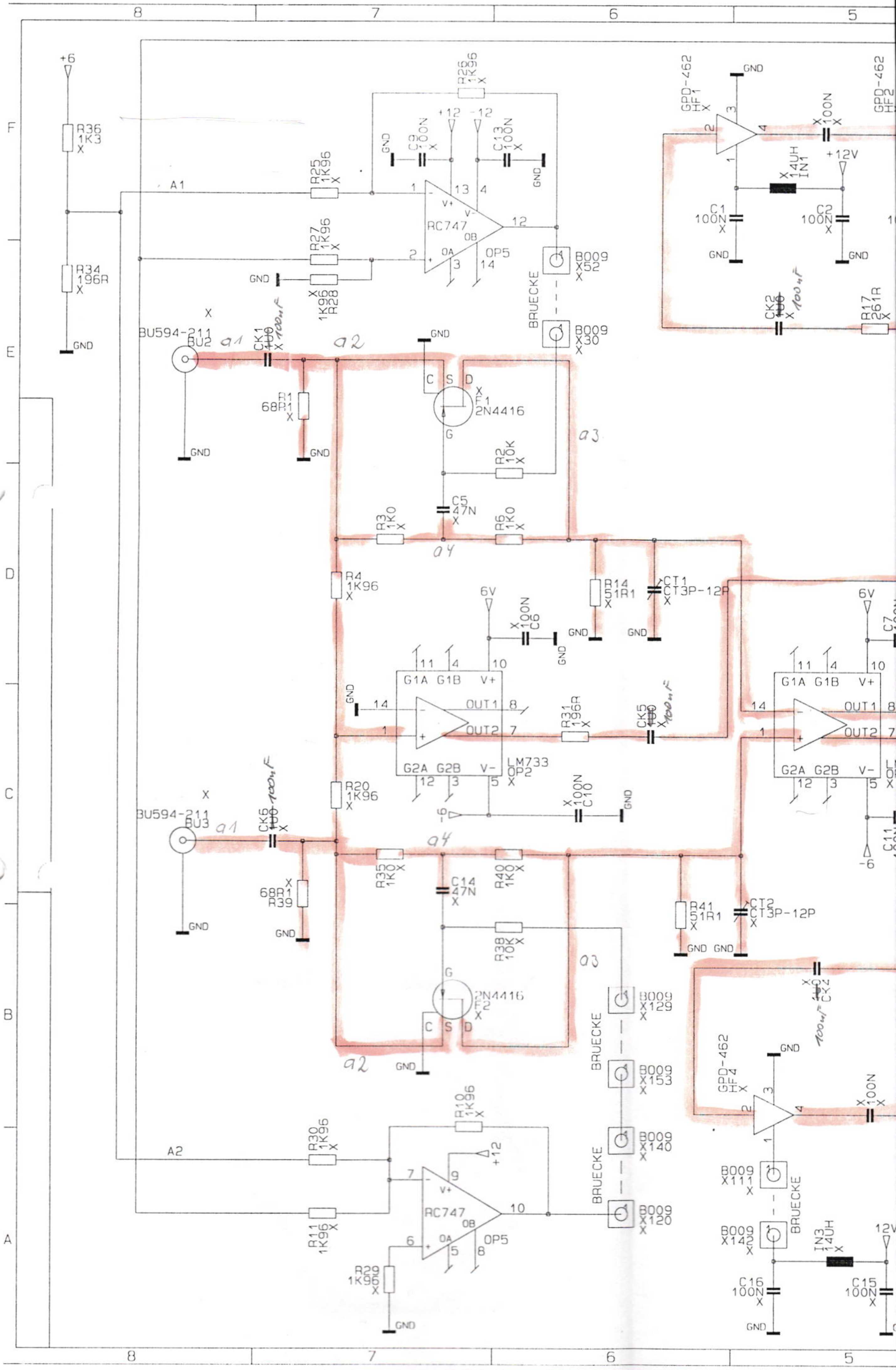
100×	1µF	Best. Nr.	53D118	2,73 "	273,–
25×	0,33µF	" "	53D109	1,09 "	
25×	0,047µF		53D100	1,04 "	

Scheibentrimmer

25×	1,8-15pF	Best. Nr.	70D270	1,41 "
25×	2-6pF	" "	70D162	1,35 "

JFET-Transistoren

25×	2N4416	Best. Nr.	27S7700	1,96 "


8
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R36
1K3
R34
196R
GND
A1
R25
1K96
R27
1K96
R28
1K96
R26
1K96
+12
-12
C9
100N
C13
100N
RC747
OP5
B009
X52
X30
BRUECKE
BU594-211
BU2
BU3
CK1
R1
68R1
a1
a2
a3
a4
F1
2N4416
F2
R2
10K
C5
47N
R3
1K0
R6
1K0
R4
1K96
R14
51R1
CT1
CT3P-12P
6V
C6
100N
G1A
G1B
V+
OUT1
OUT2
G2A
G2B
V-
R31
196R
CK5
LM733
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CK6
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R40
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51R1
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C2
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14UH
IN1
IN3
+12V
12V
CK2
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261R
C7
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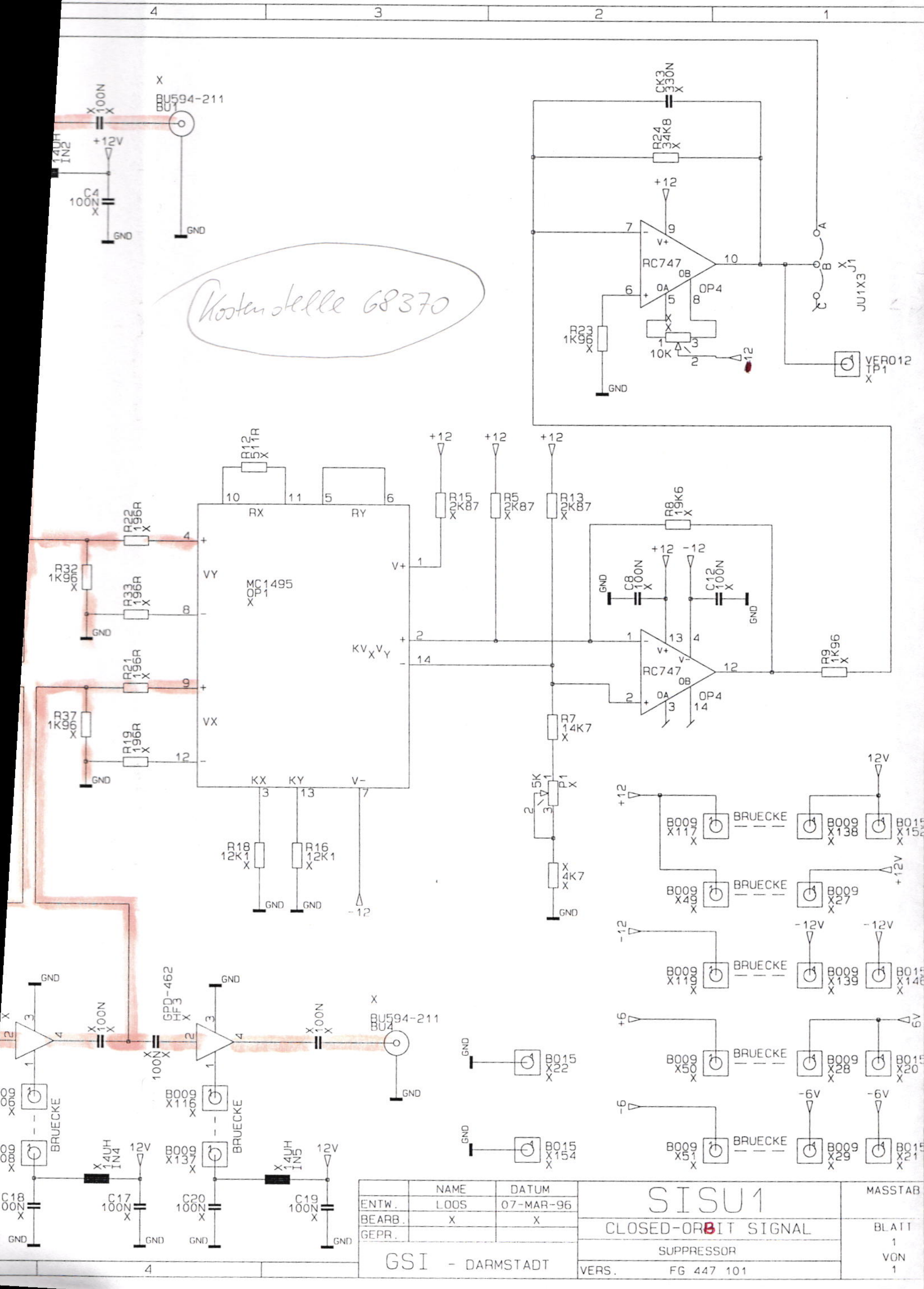
C15
100N
C16
100N
CK4
100nF


SISU1
CLOSED-ORBIT SIGNAL
SUPPRESSOR
GSI - DARMSTADT
ENTW. LOOS 07-MAR-96
BEARB. X X
GEPR.
NAME
DATUM
VERS. FG 447 101
MASSTAB
BLATT 1 VON 1
Kostenstelle 68370
MC1495
OP1
RC747
OP4
BU594-211
BU1
BU4
GPD-462
HF3
BRUECKE
VERO12
TP1
JU1X3
J1
R24 34K8
CK3 330N
R23 1K96
R12 511R
R15 2K87
R5 2K87
R13 2K87
R8 19K6
R9 1K96
R7 14K7
P1 5K
R18 12K1
R16 12K1
R22 196R
R33 196R
R21 196R
R19 196R
R32 1K96
R37 1K96
C8 100N
C12 100N
C4 100N
C17 100N
C18 100N
C19 100N
C20 100N
IN2 14UH
IN4 14UH
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B015
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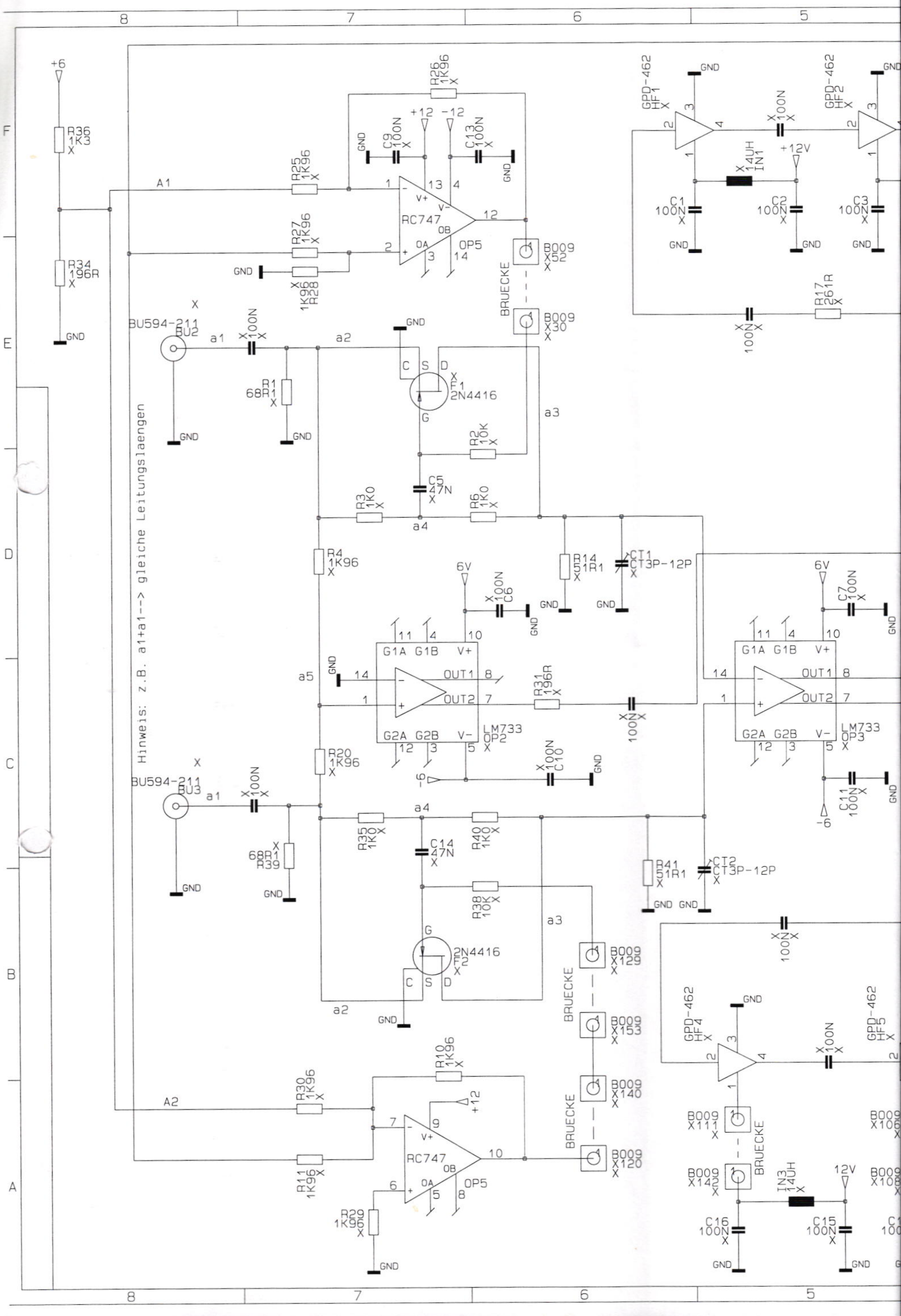
+12V
12V
-12V
-6V
6V



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196R
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100N
C13
100N
GND
RC747
OP5
V+
V-
0A
0B
BOO9
X52
X30
BRUECKE
BU594-211
BU2
BU3
a1
a2
a3
a4
a5
100N
R1
68R1
C
S
D
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T1
2N4416
R2
10K
C5
47N
R3
1K0
R6
1K0
R4
1K96
R14
51R1
CT1
CT3P-12P
6V
C6
100N
G1A
G1B
OUT1
OUT2
G2A
G2B
LM733
OP2
R31
196R
R20
1K96
C10
100N
-6
Hinweis: z.B. a1+a1--> gleiche Leitungslaengen
R39
68R1
R35
1K0
R40
1K0
C14
47N
R38
10K
R41
51R1
CT2
CT3P-12P
T2
2N4416
BOO9
X129
X153
X140
X120
R30
1K96
R10
1K96
R11
1K96
R29
1K96
GPD-462
HF1
HF2
HF4
HF5
14UH
IN1
+12V
C1
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C2
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C3
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R17
261R
C7
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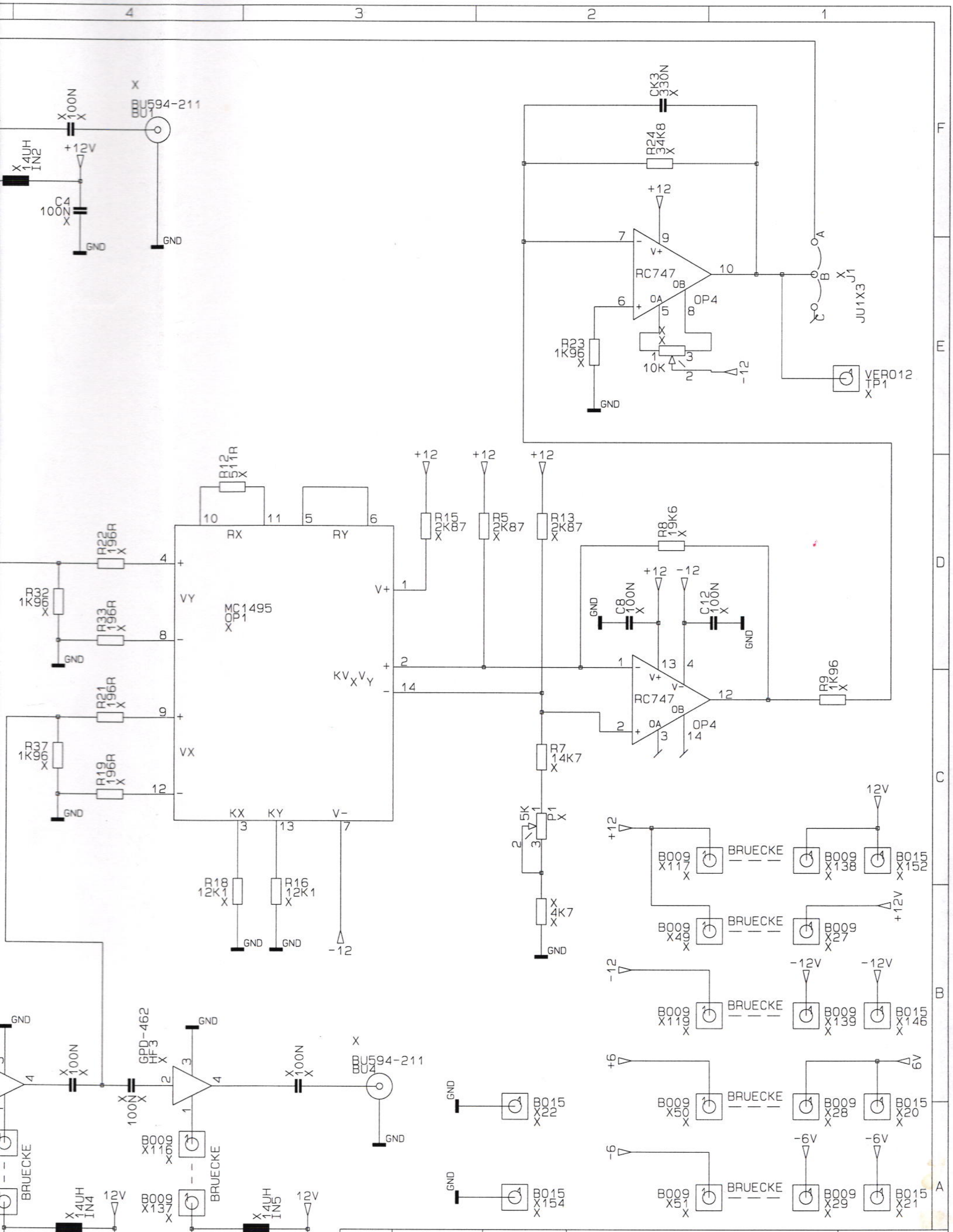
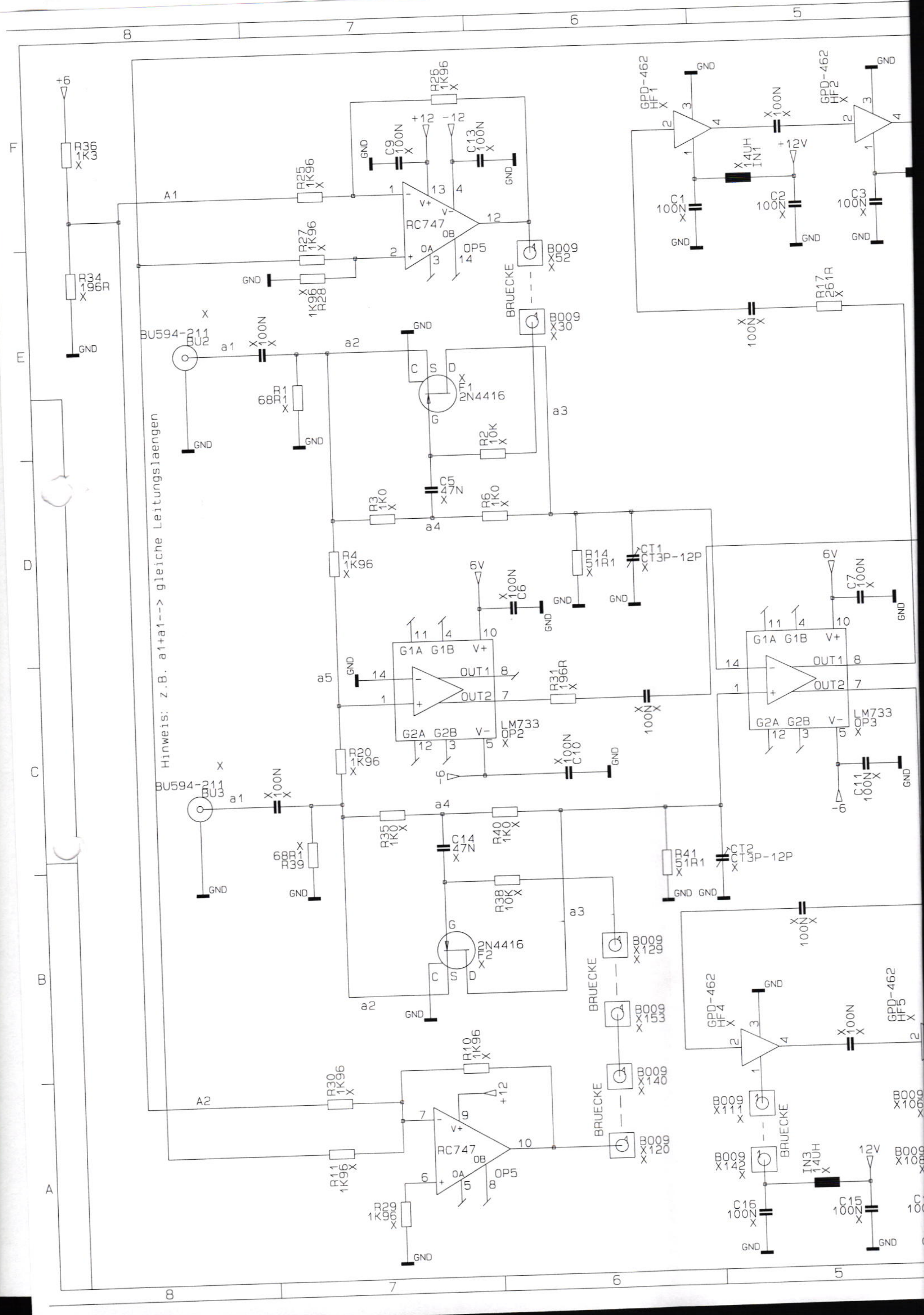


	NAME	DATUM	SISU1	MASSTAB
ENTW.	LOOS	07-MAR-96	CLOSED-ORBIT SIGNAL	BLATT 1 VON 2
BEARB.	X	X	SUPPRESSOR	
GEPR.			VERS. FG 447 101	
GSI - DARMSTADT				



8
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E
D
C
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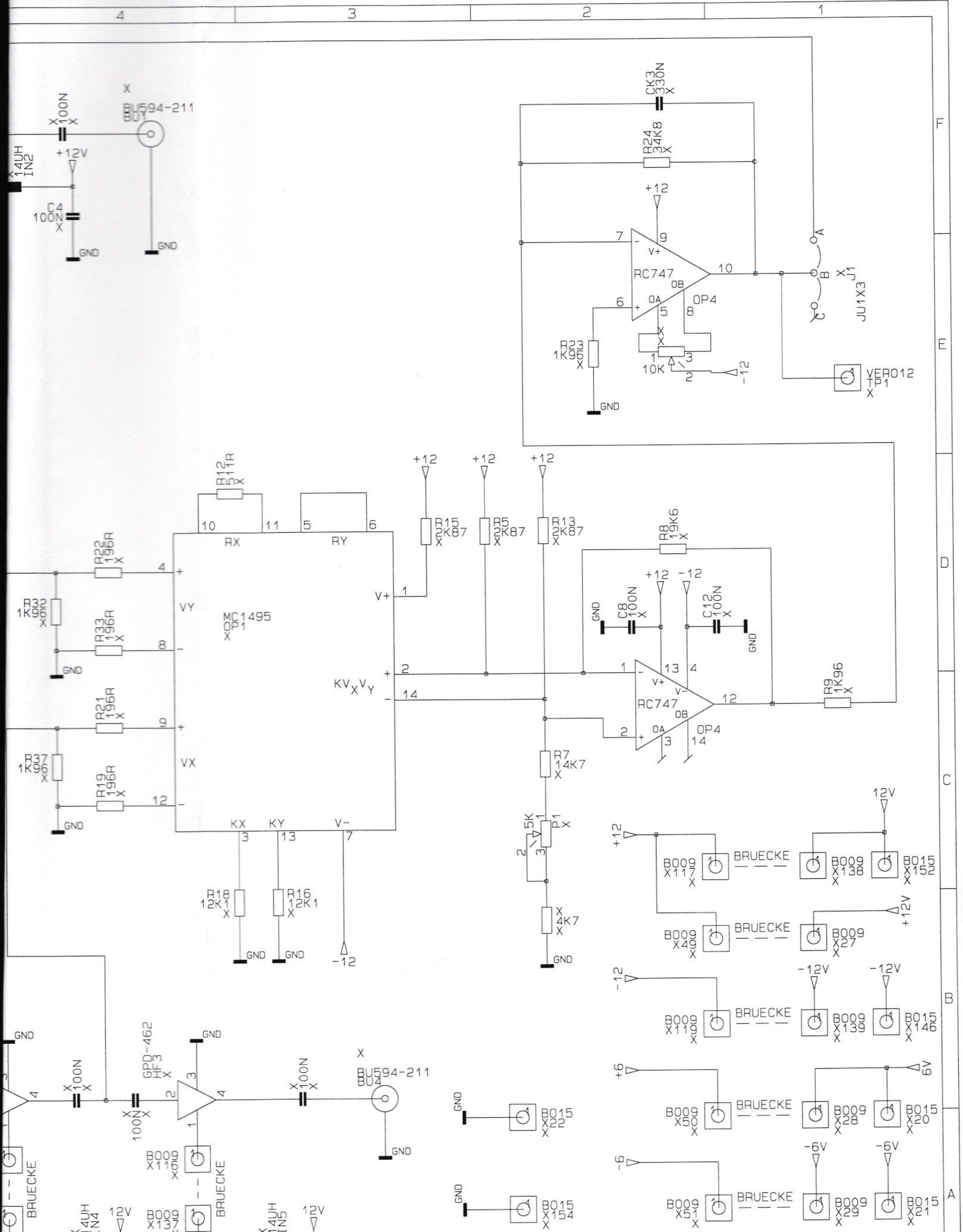
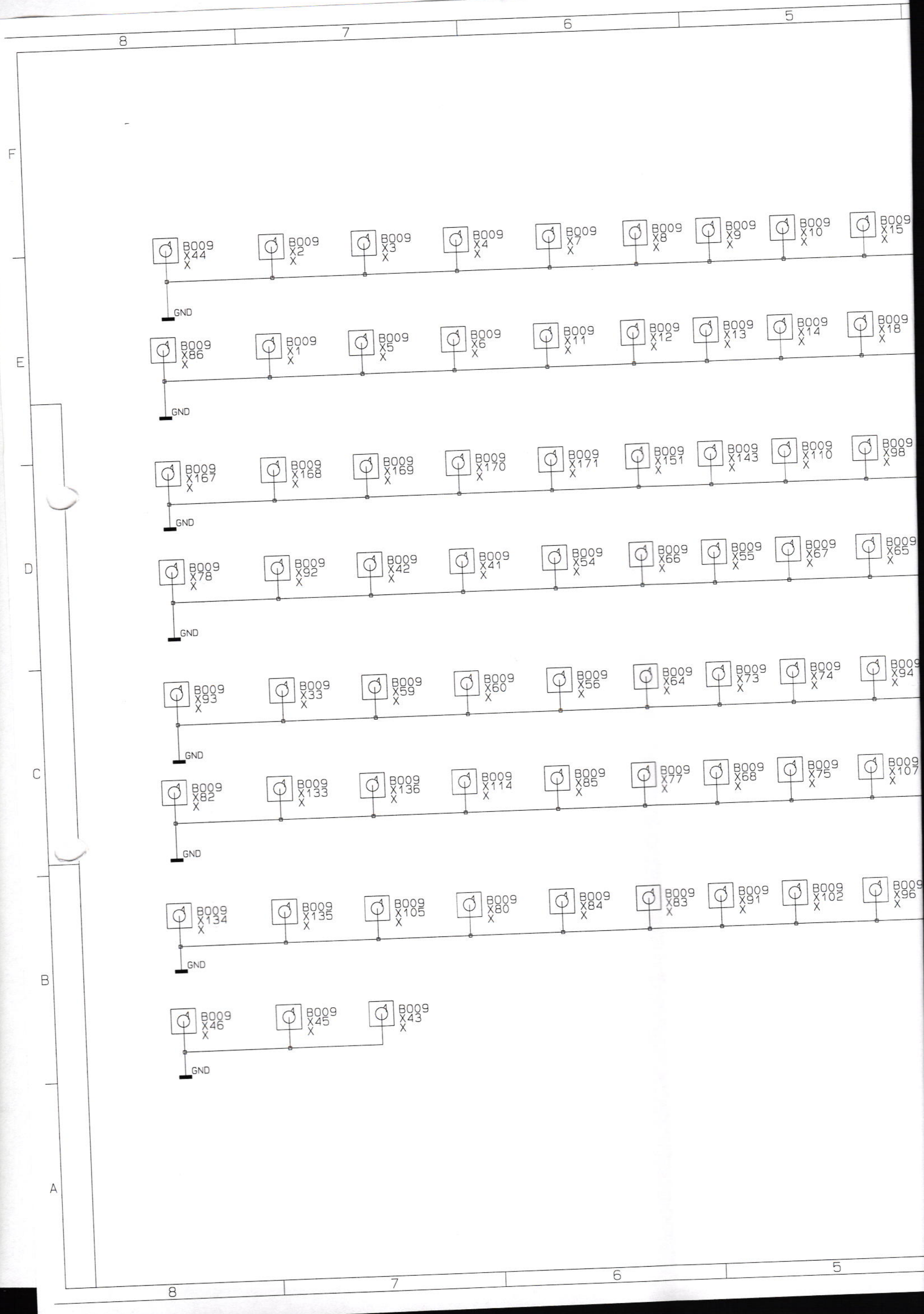
+6
R36
1K3
R34
196R
GND
A1
A2
R25
1K96
R26
1K96
R27
1K96
R28
1K96
+12
-12
C9
100N
C13
100N
RC747
OP5
B009
X52
X30
BRUECKE
BU594-211
BU2
BU3
a1
a2
a3
a4
a5
R1
68R1
F1
2N4416
R2
10K
C5
47N
R3
1K0
R6
1K0
R4
1K96
R14
51R1
CT1
CT3P-12P
6V
C6
100N
G1A
G1B
V+
OUT1
OUT2
G2A
G2B
V-
LM733
OP2
OP3
R31
196R
R20
1K96
C10
100N
-6
R35
1K0
R40
1K0
C14
47N
R39
68R1
R41
51R1
CT2
R38
10K
F2
X129
X153
X140
X120
R10
1K96
R30
1K96
R11
1K96
R29
1K96
GPD-462
HF1
HF2
HF4
HF5
14UH
IN1
IN3
+12V
12V
C1
C2
C3
C7
C11
C15
C16
100N
R17
261R
X111
X142
X106
X108
Hinweis: z.B. a1+a1--> gleiche Leitungslaengen

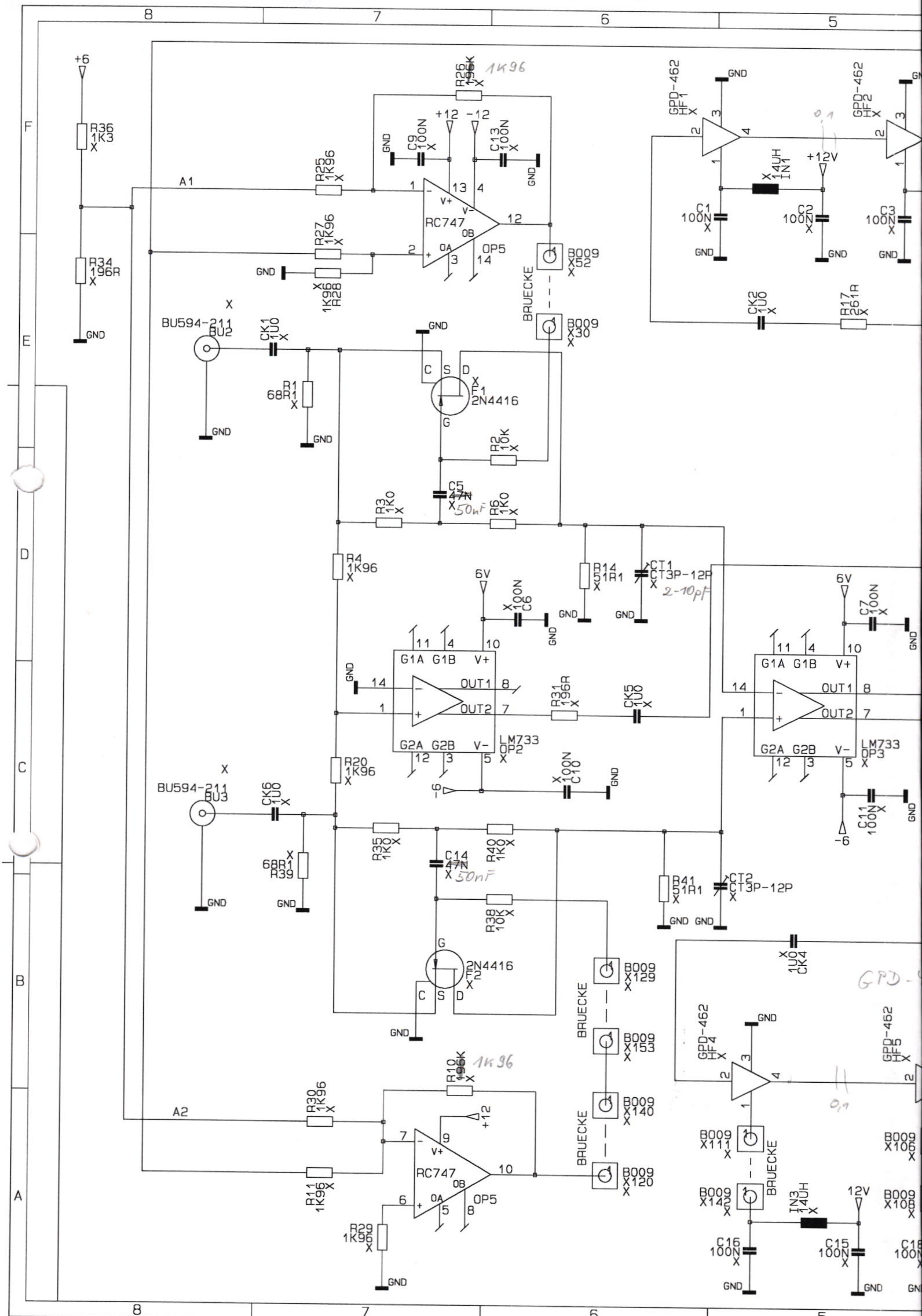


	NAME	DATUM	SISU1	MASSTAB
ENTW.	LOOS	07-MAR-96	CLOSED-ORBIT SIGNAL	BLATT 1 VON 2
BEARB.	X	X	SUPPRESSOR	
GEPR.				
GSI - DARMSTADT			VERS. FG 447 101	



8
7
6
5
F
E
D
C
B
A
B009 X44 X
B009 X2 X
B009 X3 X
B009 X4 X
B009 X7 X
B009 X8 X
B009 X9 X
B009 X10 X
B009 X15 X
GND
B009 X86 X
B009 X1 X
B009 X5 X
B009 X6 X
B009 X11 X
B009 X12 X
B009 X13 X
B009 X14 X
B009 X18 X
GND
B009 X167 X
B009 X168 X
B009 X169 X
B009 X170 X
B009 X171 X
B009 X151 X
B009 X143 X
B009 X110 X
B009 X98 X
GND
B009 X78 X
B009 X92 X
B009 X42 X
B009 X41 X
B009 X54 X
B009 X66 X
B009 X55 X
B009 X67 X
B009 X65 X
GND
B009 X93 X
B009 X33 X
B009 X59 X
B009 X60 X
B009 X56 X
B009 X64 X
B009 X73 X
B009 X74 X
B009 X94 X
GND
B009 X82 X
B009 X133 X
B009 X136 X
B009 X114 X
B009 X85 X
B009 X77 X
B009 X68 X
B009 X75 X
B009 X107 X
GND
B009 X134 X
B009 X135 X
B009 X105 X
B009 X80 X
B009 X84 X
B009 X83 X
B009 X91 X
B009 X102 X
B009 X96 X
GND
B009 X46 X
B009 X45 X
B009 X43 X
GND

	NAME	DATUM	SISU1	MASSTAB
ENTW.	LOOS	27-Sep-95	CLOSED-ORBIT SIGNAL	BLATT 2 VON 2
BEARB.	VOLTZ	27.09.95		
GEPR.				
GSI - DARMSTADT			VERS. FG 447 101	



8
7
6
5
F
E
D
C
B
A
+6
R36
1K3
R34
196R
GND
A1
A2
R25
1K96
R27
1K96
R28
1K96
R26
196K
1K96
C9
100N
C13
100N
+12
-12
RC747
OP5
B009
X52
X30
BRUECKE
BU594-211
BU2
BU3
CK1
1U0
R1
68R1
F1
2N4416
F2
R2
10K
C5
47N
50nF
R3
1K0
R6
1K0
R4
1K96
R14
51R1
CT1
CT3P-12P
2-10pF
6V
C6
100N
LM733
OP2
OP3
G1A
G1B
G2A
G2B
OUT1
OUT2
V+
V-
R31
196R
CK5
1U0
C10
100N
R20
1K96
CK6
1U0
R39
68R1
R35
1K0
R40
1K0
C14
47N
50nF
R38
10K
R41
51R1
CT2
CT3P-12P
B009
X129
X153
X140
X120
R10
196K
1K96
R30
1K96
R11
1K96
R29
1K96
GPD-462
HF1
HF2
HF4
HF5
+12V
IN1
14UH
C1
100N
C2
100N
C3
100N
CK2
1U0
R17
261R
0,1
C7
100N
C11
100N
-6
CK4
1U0
GPD-
B009
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X108
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12V
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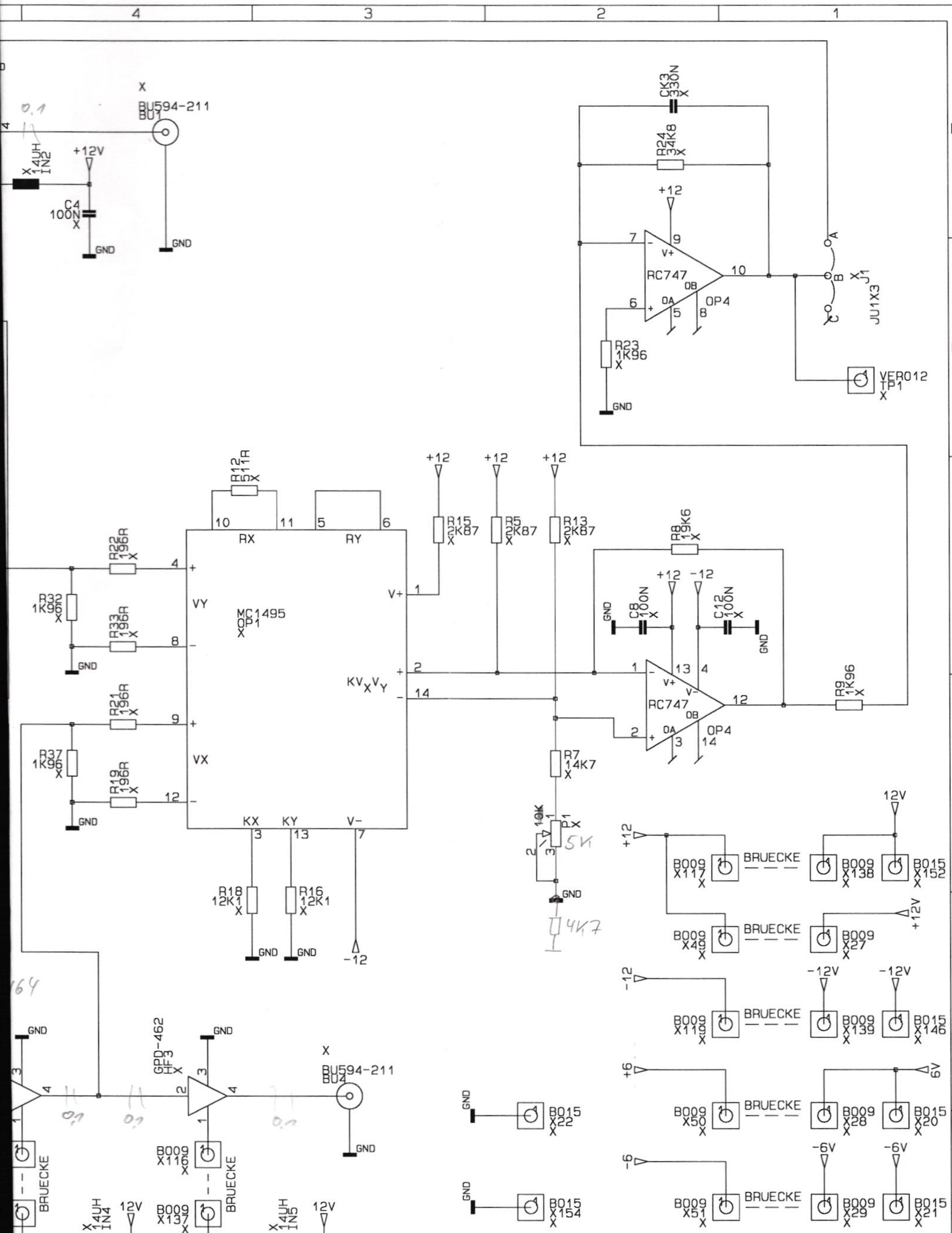
100N
C15
100N
C18
100N
GND



	NAME	DATUM	SISU	MASSTAB
ENTW.	LOOS	27-Sep-95	CLOSED-ORDIT SIGNAL	BLATT 1 VON 1
BEARB.	VOLTZ	27.09.95	SUPPRESSOR	
GEPR.			VERS. FG 447.100	
GSI - DARMSTADT				