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A Theoretical Analysis and Experimental Confirmation of the Optimally Loaded and Overdriven RF Power Amplifier

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

LINCOLN LABORATORY

A THEORETICAL ANALYSIS AND EXPERIMENTAL CONFIRMATION OF THE OPTIMALLY LOADED AND OVERDRIVEN RF POWER AMPLIFIER

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Group 63

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ABSTRACT

Although the "textbook" Class B approach to rf amplifier design yields high output power and reasonable collector efficiency (78.5 percent at maximum output power), neither the power nor the efficiency are optimum, and both are dependent on rf drive level. This report presents an analysis of appropriately selected collector voltage and current waveforms which determine the load impedance at the fundamental and harmonically related frequencies; these conditions define the Class B "optimum efficiency" case with 100 percent collector efficiency and 1.27 times the "textbook" Class B value of output power. If the rf drive level is increased and the collector voltage and current waveforms are appropriately selected so that the amplifier is overdriven, a different load impedance is determined; these conditions define the "optimum power" case with 1.46 times the "textbook" Class B value of output power and 88 percent collector efficiency. The "optimum power" case has the added advantage of resulting in an output power and collector frequency that are essentially constant over a predetermined range of drive level.

Finally, the theory is verified by the construction and testing of a UHF power amplifier having a power output of 46 watts and an overall dc to rf conversion efficiency of 65 percent with an output power insensitivity to rf drive of 1 db for 10.5 db.

Accepted for the Air Force
Franklin C. Hudson
Chief, Lincoln Laboratory Office

CONTENTS

	Abstract	iii
I.	Introduction	1
II.	The Optimum Efficiency Class B Tuned Power Amplifier	3
III.	The Optimum Power Class B Tuned Power Amplifier	5
IV.	Modified Class A Operation	7
V.	Computed Data and Design Procedure	9
VI.	Experimental Verification of Theory	9
VII.	Summary and Conclusion	14

A THEORETICAL ANALYSIS AND EXPERIMENTAL CONFIRMATION OF THE OPTIMALLY LOADED AND OVERDRIVEN RF POWER AMPLIFIER

I. INTRODUCTION

An improvement in both collector efficiency and output power over that described by "textbook" Class B* considerations can be realized if the load impedance at the fundamental and harmonically related frequencies presented to the output terminals of a tuned power amplifier stage are appropriately selected. Theoretical collector efficiencies of 100 percent at 1.27 times the textbook value of output power are possible. Furthermore, if the amplifier is overdriven, a different load impedance can be derived so that 1.46 times the textbook value of output power can be achieved with 88 percent collector efficiency. This technique has the added advantage of resulting in an output power and collector frequency that are essentially constant over a range of drive level.

To gain an intuitive understanding of the procedure, consider the textbook Class B waveforms shown in Fig. 1, where $I_c(\Theta)$ and $V_c(\Theta)$ have the arbitrary peak values I_s and V_{cc} respectively and Θ is in radians. Here, $2V_{cc}$ does not necessarily equal the device breakdown voltage (V_{br}) and I_s does not necessarily equal the device saturation current (I_{sat}). That is to say, the constraints on output power are not those imposed physically by the device (V_{br}, I_{sat}) but by the yet to be designed external circuit. Let the collector current waveform $I_c(\Theta)$ remain unchanged but select some new collector voltage waveform $V_c(\Theta)$ so that the fundamental component of the voltage waveform is greater than the textbook Class B value. If $V_c(\Theta)$ is symmetrical about V_{cc}, then the dc input power is the same as the Class B case, but the fundamental output power is increased. In particular, if $V_c(\Theta)$ is allowed to approach a square wave symmetrical about V_{cc} and a peak value V_{cc}, it will be shown that in the limit the collector efficiency approaches 100 percent. Since the collector voltage and current waveforms have been specified, the load impedance is determined. This is called the "optimum efficiency" case.

Next, the rf drive will be increased by some amount forcing $V_c(\Theta)$ and $I_c(\Theta)$ to be as shown in Fig. 2, determining a different load impedance. Note that the dc input power has increased, since I_{dc} of this new $I_c(\Theta)$ is greater than the textbook case. However, the collector efficiency increases faster than the dc input power. It will be shown that if the rf drive is increased by 5.2 db, an output power of 1.47 times the textbook Class B value is developed at 88 percent collector efficiency.

For the following analysis, an ideal device is assumed so that $V_{ce\ sat}$ equals 0 volts, h_{fe} = constant and so forth.

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*T. S. Gray, Applied Electronics (Wiley, New York, 1957), p. 403.

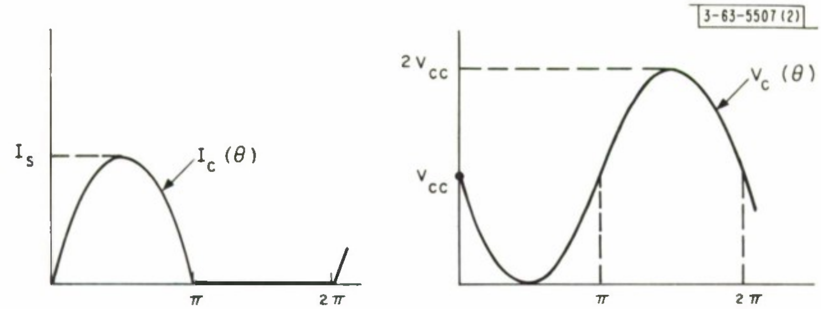

Fig. 1. Class B callectar current and valtage wavefarms.

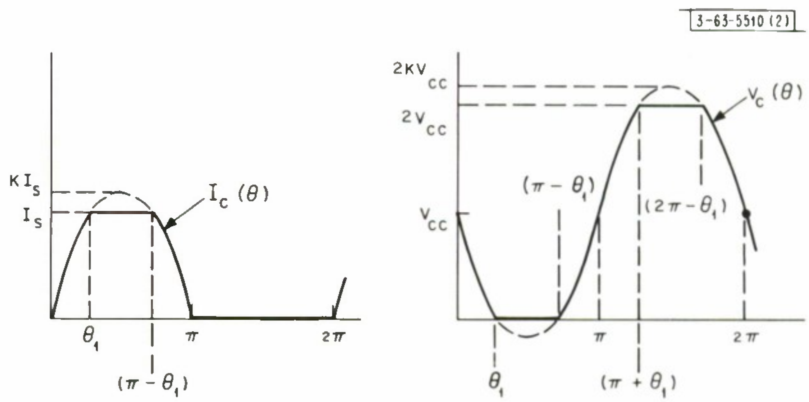

Fig. 2. Overdriven Class B callectar current and valtage wavefarms.

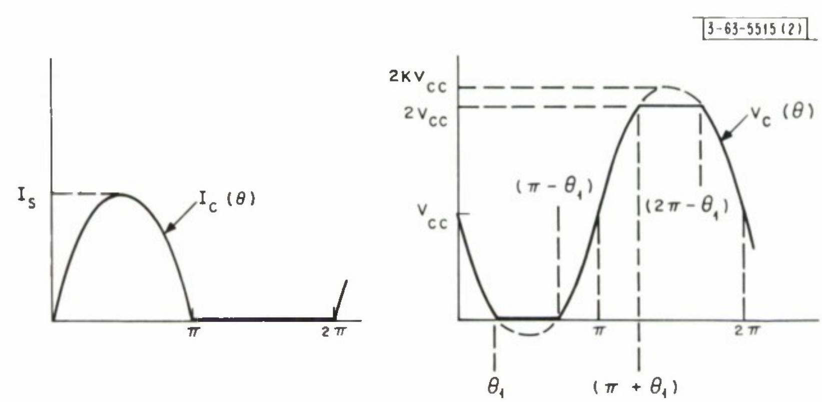

Fig. 3. Optimum efficiency Class B callectar current and voltage wavefarms.

II. THE OPTIMUM EFFICIENCY CLASS B TUNED POWER AMPLIFIER

The collector voltage and current waveforms for optimum efficiency Class B operation are shown in Fig. 3. Here the dc input power is held constant and only $V_c(\Theta)$ is allowed to change. A Fourier analysis* of $I_c(\Theta)$ and $V_c(\Theta)$ must be made to find the magnitudes and signs of the sine and cosinusoidal terms. The coefficients of the Fourier expansion of $I_c(\Theta)$ are

$$I_{A0} = \frac{1}{2\pi}\int_0^\pi I_s \sin\Theta \, d\Theta = \frac{I_s}{\pi} \tag{1}$$

where I_{A0} is the dc component of the collector current waveform and

$$I_{A1} = \frac{1}{\pi}\int_0^\pi I_s \sin\Theta \cos\Theta \, d\Theta = 0 \tag{2}$$

$$I_{AN} = \frac{1}{\pi}\int_0^\pi I_s \sin\Theta \cos\Theta n\Theta \, d\Theta \tag{3}$$

$$= \begin{cases} \frac{I_s}{\pi}\left(\frac{1}{1+n} + \frac{1}{1-n}\right) , & n \text{ even,} \\ 0 \quad , & n \text{ odd} \end{cases} \tag{4}$$

where I_{AN} is the peak value of the n^{th} harmonic cosinusoidal term of the Fourier expansion of $I_c(\Theta)$. Also

$$I_{B1} = \frac{1}{\pi}\int_0^\pi I_s \sin\Theta \sin\Theta \, d\Theta = \frac{I_s}{2} \tag{5}$$

where I_{B1} is the peak value of the fundamental component and

$$I_{BN} = \frac{1}{\pi}\int_0^\pi I_s \sin\Theta \sin n\Theta \, d\Theta = 0 \tag{6}$$

where I_{BN} is the peak value of the n^{th} harmonic sinusoidal term of the Fourier expansion of $I_c(\Theta)$. The coefficients of the expansion of $V_c(\Theta)$ are

$$V_{A0} = V_{cc} \tag{7}$$

where V_{A0} is the dc component of the collector voltage waveform and

$$V_{AN} = \frac{1}{\pi}\int_{0,\,(\pi-\Theta_1),\,(2\pi-\Theta_1)}^{\Theta_1,\,(\pi+\Theta_1),\,2\pi} KV_{cc} \sin\Theta \cos\Theta n\Theta \, d\Theta + \frac{1}{\pi}\int_{\Theta_1,\,(\pi+\Theta_1)}^{(\pi-\Theta_1),\,(2\pi-\Theta_1)} V_{cc} \cos n\Theta \, d\Theta \tag{8}$$

$$V_{AN} = 0 \quad , \quad \text{all } n \neq 0 \tag{9}$$

$$V_{BN} = \frac{1}{\pi}\int_{o,\,(\pi-\Theta_1),\,(2\pi-\Theta_1)}^{\Theta_1,\,(\pi+\Theta_1),\,2\pi} KV_{cc} \sin\Theta \sin n\Theta \, d\Theta + \frac{1}{\pi}\int_{\Theta_1,\,(\pi+\Theta_1)}^{(\pi-\Theta_1),\,(2\pi-\Theta_1)} V_{cc} \sin n\Theta \, d\Theta \tag{10}$$

$$V_{B1} = V_{cc}\left[\frac{2K\Theta}{\pi} - \frac{K \sin 2\Theta}{\pi} + \frac{4\cos\Theta}{\pi}\right] \tag{11}$$

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*F. B. Hildebrand, Advanced Calculus for Applications (Prentice-Hall, New Jersey, 1965), p.221.

where V_{B1} is the peak value of the fundamental component. Also

$$V_{BN}(\text{odd } n) = V_{cc}\left[\frac{2K\sin(\Theta - n\Theta)}{\pi} - \frac{2K\sin(\Theta + n\Theta)}{\pi} + \frac{4\cos n\Theta}{\pi}\right] \tag{12}$$

$$V_{BN}(\text{even } n) = 0 \tag{13}$$

where V_{BN} is the peak value of the n^{th} harmonic sinusoidal term of the Fourier expansion of $V_c(\Theta)$. Noticing that

$$K = \frac{1}{\sin\Theta_1} \tag{14}$$

as Θ_1 approaches zero $V_c(\Theta)$ approaches a square wave and the values of the fundamental components of the collector current and voltage are

$$I_{B1} = \frac{I_s}{2} \tag{15}$$

and

$$V_{B1} = \frac{4V_{cc}}{\pi} \tag{16}$$

giving an output power at the fundamental frequency of

$$P_{out}(rf) = \frac{V_{B1}}{\sqrt{2}}\frac{I_{B1}}{\sqrt{2}} = \frac{V_{cc}I_s}{\pi} \quad . \tag{17}$$

However, the dc input power is

$$P_{in}(dc) = V_{A0}I_{A0} = \frac{V_{cc}I_s}{\pi} \quad . \tag{18}$$

Therefore, the theoretical collector efficiency approaches 100 percent as $V_c(\Theta)$ approaches a square wave. The impedance conditions at the collector to common terminals (output) are necessarily

$$Z_1 = \frac{V_{B1}}{I_{B1}} = \frac{8}{\pi}\frac{V_{cc}}{I_s} \tag{19}$$

so that the fundamental load impedance is all real and

$$Z_n = \begin{cases} \dfrac{0}{I_{AN}} = 0 \quad , & n \text{ even} \quad (20) \\ \dfrac{V_{BN}}{0} = \infty \quad , & n \text{ odd} \quad . \quad (21) \end{cases}$$

Therefore, for 100 percent collector efficiency we must have a short circuit presented to the output terminals at the second harmonic frequency and alternating open and short circuits thereafter. Finally, the definition of R_L for the textbook Class B case is

$$R_L = \frac{2V_{cc}}{I_s} \quad . \tag{22}$$

Therefore,

$$Z_1 = R_1 = \frac{4}{\pi}R_L \quad . \tag{23}$$

III. THE OPTIMUM POWER CLASS B TUNED POWER AMPLIFIER

For the optimum power, or overdriven case, both the dc input power and the collector waveforms are allowed to change. However, for a fair comparison of Class B, optimum efficiency Class B and the overdriven case, the peak values of $V_c(\Theta)$ and $I_c(\Theta)$ must not exceed V_{cc} and I_s, respectively. The waveforms for this mode of operation have been shown in Fig. 2. The coefficients of the Fourier expansion of $V_c(\Theta)$ have already been derived in Eqs. 9 through 13 and are obviously a function of Θ_1 or K (overdrive). The coefficients of the expansion of $I_c(\Theta)$ that apply to this mode of operation have been derived in a similar fashion and are

$$I_{DC} = I_s \left[\frac{(\pi - \pi\Theta_1)}{2\pi} + \frac{K}{\pi} - \frac{K\cos\Theta_1}{\pi}\right] \tag{24}$$

$$I_{AN} = \begin{cases} 0 \quad , & n \text{ odd} \\ f(K, \Theta_1) \quad , & n \text{ even} \end{cases} \tag{25}$$

$$I_{B1} = \frac{I_s}{2}\left[\frac{2K\Theta_1}{\pi} - \frac{K\sin 2\Theta_1}{\pi} + \frac{4\cos\Theta_1}{\pi}\right] \tag{26}$$

$$I_{BN}(\text{even } n) = 0 \tag{27}$$

$$I_{BN}(\text{odd } n) = \frac{I_s}{2}\left[\frac{2K\sin(\Theta_1 - n\Theta_1)}{\pi(1-n)} - \frac{2K\sin(\Theta_1 + n\Theta_1)}{\pi(1+n)} + \frac{4\cos n\Theta_1}{n\pi}\right] \quad . \tag{28}$$

The function $f(K, \Theta_1)$ can be evaluated but is not needed for this analysis. The expression for rf output power at the fundamental frequency as a function of Θ_1 is therefore

$$P_{out}(rf) = \frac{V_{B1}}{\sqrt{2}}\frac{I_{B1}}{\sqrt{2}} = \frac{V_{cc}I_s}{4\pi^2}\left[2K\Theta_1 - K\sin 2\Theta_1 + 4\cos\Theta_1\right]^2 \quad . \tag{29}$$

The dc input power is also a function of Θ_1 so that

$$P_{in}(dc) = V_{A0}I_{A0} = \frac{V_{cc}I_s}{\pi}\left[\frac{(\pi - 2\Theta_1)}{2} + K - K\cos\Theta_1\right] \tag{30}$$

and the out-of-band impedances are simply

$$Z_n = \frac{V_{Bn}}{I_{Bn}} = \frac{2V_{cc}}{I_s} = R_L \tag{31}$$

$$Z_n = 0 \quad , \quad \text{even } n \quad . \tag{32}$$

Since a resistive load R_L must be presented to the device at the even harmonic frequencies, power will be dissipated at these frequencies so that

$$P_{out}(\text{odd } n) = \frac{V_{cc}I_s}{\pi^2}\left[\frac{K\sin(\Theta - n\Theta)}{(1-n)} - \frac{K\sin(\Theta + n\Theta)}{(1-n)} + \frac{2\cos n\Theta}{n\pi}\right]^2 \quad . \tag{33}$$

Although the output power obviously continues to increase with increasing K, the collector efficiency does not. Therefore, the "optimum output power" is defined as that power which corresponds to maximum collector efficiency. As mentioned before, that power is 1.47 times the textbook Class B value and occurs when K = 5.2 db, corresponding to a collector efficiency of 88 percent. Also, if the power gain G_o of any device is defined as the gain occurring when the device is

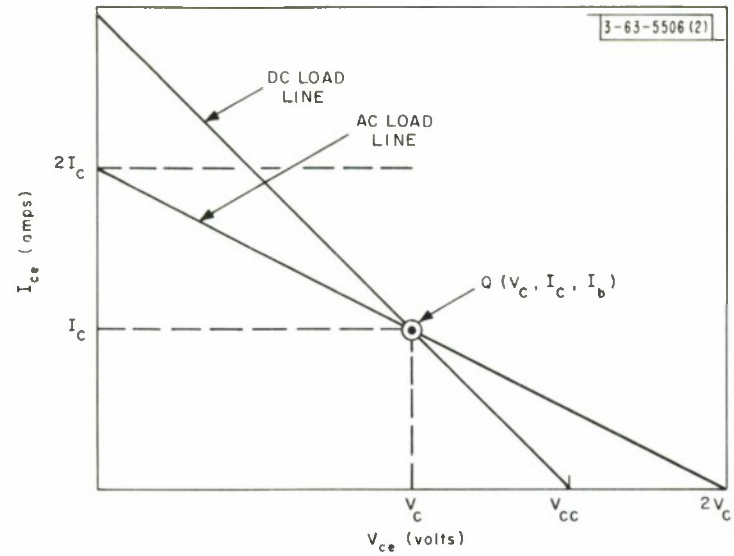

Fig. 4(a). Class A dc and ac load line and quiescent operating point.

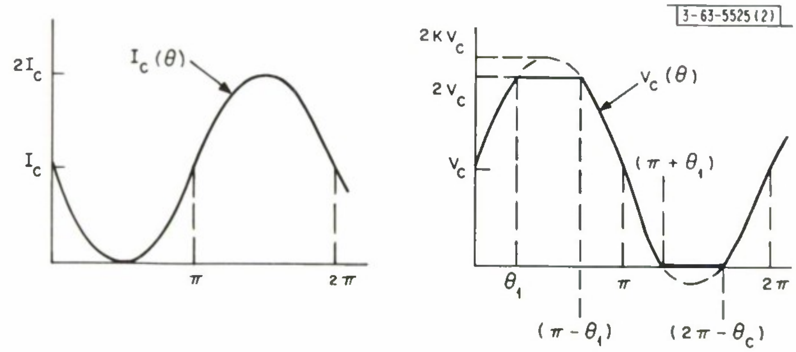

Fig. 4(b). Class A collector current and voltage waveforms for optimal loading only.

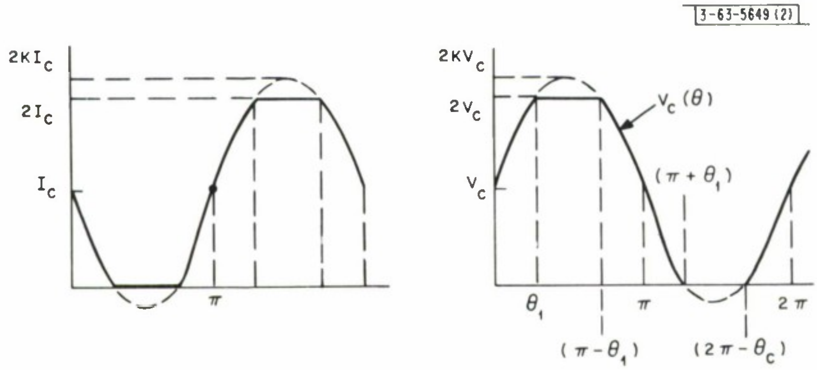

Fig. 5. Optimum efficiency and optimum power Class A collector current and voltage waveforms.

operated according to textbook Class B considerations with an output power P_o, then the new effective gain G_{eff} in the overdriven case is

$$G_{eff} = \frac{P_{out}}{K^2 \frac{P_o}{G_o}} = \frac{4G_o}{K^2 \pi} \left[\frac{2K\Theta_1}{\pi} - \frac{K \sin 2\Theta_1}{\pi} + \frac{4 \cos \Theta_1}{\pi}\right]^2 \quad . \tag{34}$$

Hence a theoretical insensitivity of rf output power of 0.5 db for a change in input drive power of 5.2 db is possible per stage. A computer program was written to solve Eqs. 29, 30, 33, and 34 for values of K ranging from 0 to 20 db (power) in 0.1 db steps. The results are discussed in Sec. V.

IV. MODIFIED CLASS A OPERATION

If the same technique is applied to a tuned Class A amplifier with the stipulation that the quiescent operating point must not change from the values determined by "textbook" Class A* definitions, then an improvement in output power is possible. Since the dc input power is fixed, the optimum power case is identically equal to the optimum efficiency case. According to the waveform analysis already completed, if the drive power to a Class A amplifier is fixed and only the load impedance presented to the output terminals (collector to common) is appropriately selected so that $V_c(\Theta)$ is allowed to approach a square wave symmetrical about V_c [Figs. 4(a) and (b)], then it is easily shown that the improvement in output power from the textbook value of $V_c I_c/2$ is

$$P_{out}(rf) = \frac{I_{B1}}{\sqrt{2}} \frac{V_{B1}}{\sqrt{2}} = V_c I_c \left(\frac{2}{\pi}\right) \tag{35}$$

if

$$Z(1) = \frac{V_{B1}}{I_{B1}} = \frac{V_c}{I_c} \left(\frac{4}{\pi}\right) \tag{36}$$

and

$$Z_n = \infty \quad , \quad n \text{ odd} \quad . \tag{37}$$

For the more interesting case (Fig. 5) where the rf drive level is also allowed to vary (the overdriven case) we have already performed the analysis necessary to write the design equations.

$$P_{out}(rf) = \frac{I_{B1}}{\sqrt{2}} \frac{V_{B1}}{\sqrt{2}} = \frac{V_c I_c}{2} \left[\frac{2K\Theta}{\pi} - \frac{K \sin 2\Theta}{\pi} + \frac{4 \cos \Theta}{\pi}\right]^2 \tag{38}$$

if

$$Z_1 = \frac{V_{B1}}{I_{B1}} = R_L = \frac{V_c}{I_c} \tag{39}$$

and

$$Z_n = R_L \quad , \quad n \text{ odd} \quad . \tag{40}$$

It should be noticed that, unlike the overdriven Class B case, here both the output power and collector efficiency continue to increase with overdrive (K) so that in the limit as

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* T. S. Gray, Applied Electronics (Wiley, New York, 1957), p. 403.

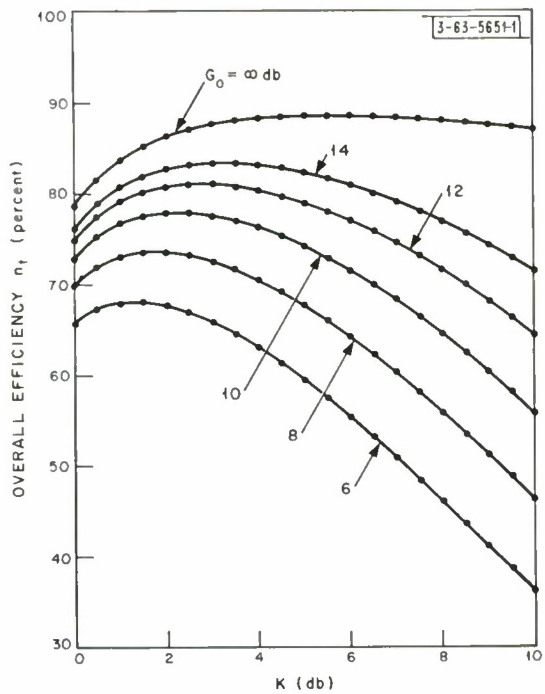


Fig. 6. Overdriven Class B operation. Overall efficiency versus K for different values of G_o.

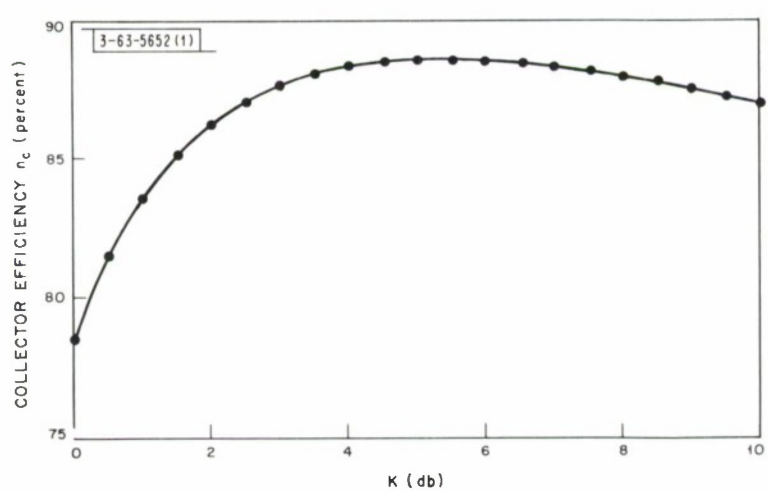


Fig. 7. Overdriven Class B operation. Collector efficiency versus K.

$$K \to \infty, \ \Theta_1 \to 0$$

$$P_{out}(rf) = \frac{V_c I_c}{2} \left[\frac{2}{\pi} - \frac{2}{\pi} + \frac{4}{\pi}\right]^2 = V_c I_c \left(\frac{8}{\pi^2}\right) \quad . \tag{41}$$

What is of interest, then, is where the overall efficiency of any stage is maximum for a given G_o. Here G_o is defined as that value of power gain that occurs when the stage is operated according to textbook Class A considerations. A computer program was written to solve for $P_{out}(rf)$, $P_{out}(n)$, G_{eff}, collector efficiency (n_c) and overall stage efficiency (n_t) for values of K ranging from 0 to 20 db in 0.1 db steps. These results are discussed in Sec. V.

V. COMPUTED DATA AND DESIGN PROCEDURE

To best explain the design procedure and computed curves of various amplifier stage characteristics for different values of K (Figs. 6 through 12), a typical transmitter design goal is specified.

rf output power $= P_{out}(rf) = 10$ watts

rf input power $= P_{in}(rf) = -10$ dbm

output frequency = 250 Mcps

Many devices are available which are capable of delivering 10 watts at 250 Mcps and a typical value for G_o at this level is 8 db. K can now be determined for the overdriven Class B case from Fig. 6.

$G_o = 8$ db

$n_t = 73.6$ percent

$K = 1.8$ db .

From Fig. 7

$$P_{out}(rf) = n_c \, [P_{in}(dc)]$$

and

$$P_{in}(dc) = 10 \text{ watts}/0.85 = 11.65 \text{ watts} \quad .$$

From Fig. 8

$$G_{eff} = 7.14 \text{ db} \quad , \qquad K = 1.8 \text{ db} \quad .$$

If we use this procedure down to a low rf drive level (say, 100 mw) where there is insufficient drive power for Class B operation, the overall dc to rf conversion efficiency so far will be approximately 70 percent. The rf input/output and efficiency characteristics for the power amplifier section of the transmitter can be calculated by using Figs. 6 through 9. The power dissipated at the third, fifth and seventh harmonic frequencies can be read directly from Fig. 13.

The curves shown in Figs. 8, 10, 11 and 12 can be used in a similar way to design an overdriven Class A preamplifier section. A typical value for G_o at these levels is 11 db.

VI. EXPERIMENTAL VERIFICATION OF THEORY

A power amplifier capable of delivering 46 watts at approximately 250 Mcps into a 50-ohm load was designed, constructed and tested for the space environment, according to the theory

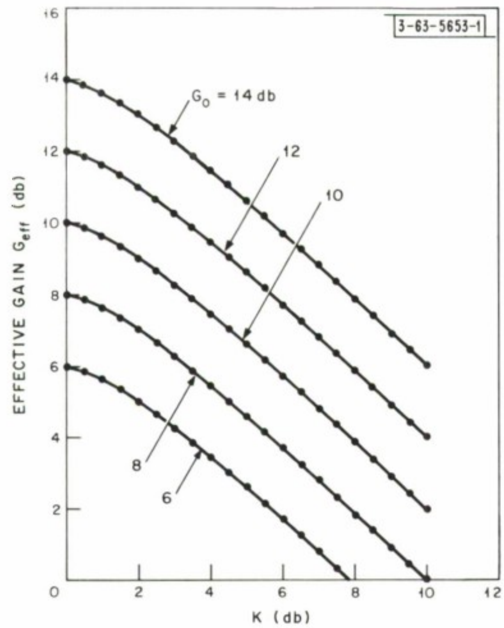


Fig. 8. Overdriven Closs A or Closs B operotion. Effective goin versus K for different volues of G_o.

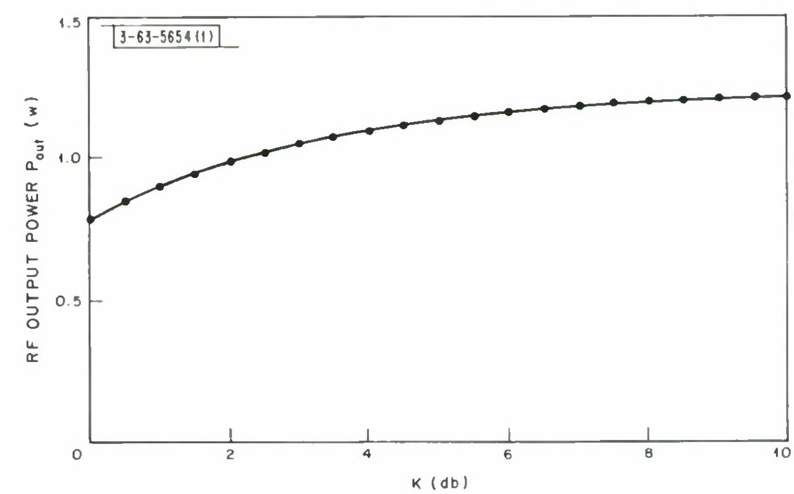
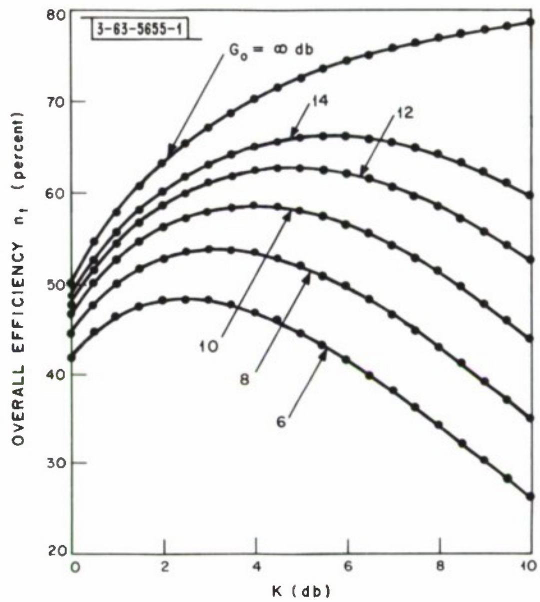


Fig. 9. Overdriven Closs B operation. Output power versus K.

Fig. 10. Overdriven Class A operation. Overall efficiency versus K for different values of G_o.



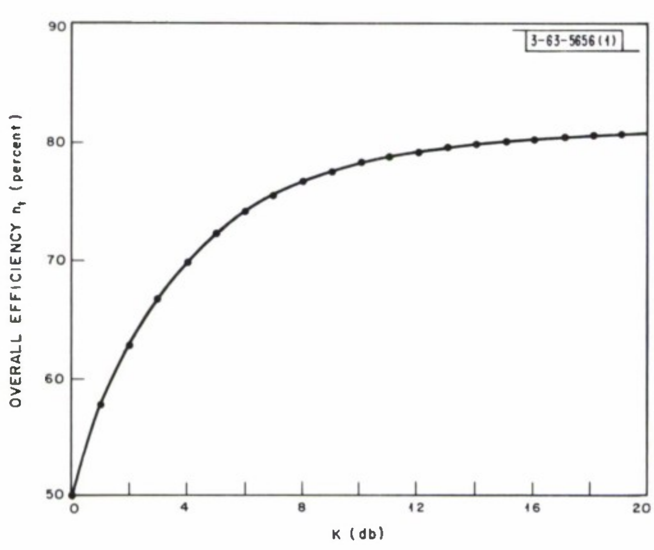


Fig. 11. Overdriven Class A operation. Overall efficiency versus K.

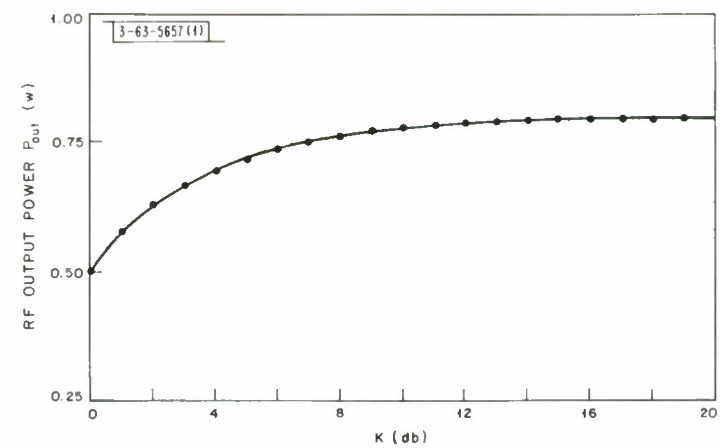


Fig. 12. Overdriven Class A operation. Output power versus K.

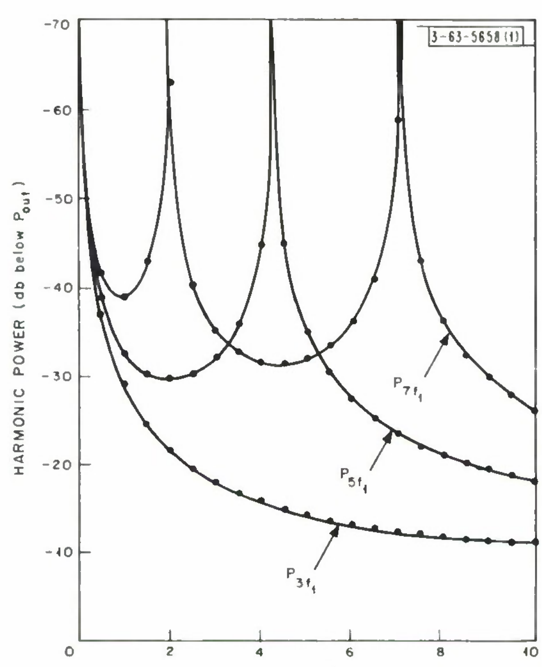


Fig. 13. Overdriven Class A or Class B operation. Harmonic output power versus K.

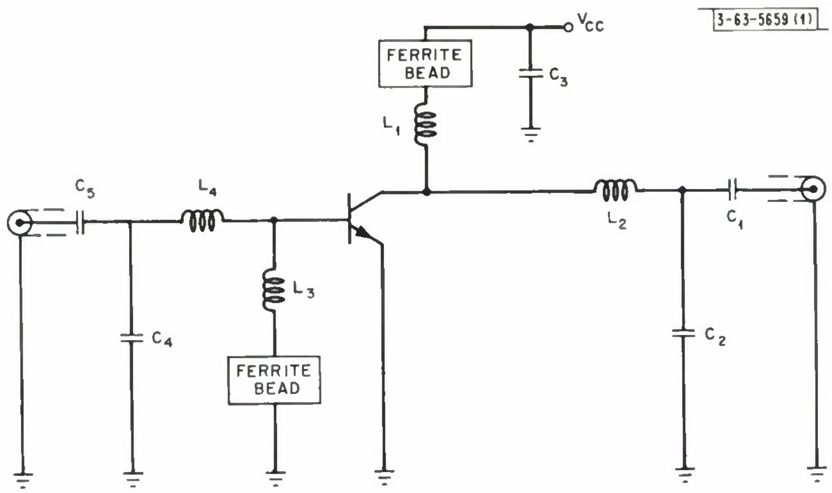


Fig. 14. Output stage amplifier schematic diagram.

developed. Four 11.50-watt power amplifiers were paralleled in the output stage using 3-db hybrids to develop this power reliably with commercially available devices. At center frequency the air-line hybrids have an insertion loss beyond 3 db of approximately 0.07 db.

An output stage amplifier schematic diagram is shown in Fig. 14. Since the input impedance is very low (typically 0.7 + j3) compared to the effective value of the collector to base capacity C_{ob}, C_{ob} is effectively from collector to ground. Therefore, at the operating frequency, C_{ob} cannot be neglected and is by design a component of the output matching network. The effective value of C_{ob} is approximately twice the minimum value. At the second harmonic, the design equations call for a short circuit from collector to ground. However, at this frequency $X_{C_{ob}}$ is essentially an rf short circuit, so that an external short need not be added. For this design, the higher order impedance terms were neglected. A comparison of the theoretical and measured performance of the amplifier is given in Fig. 15 and a photograph of the setup in Fig. 16.

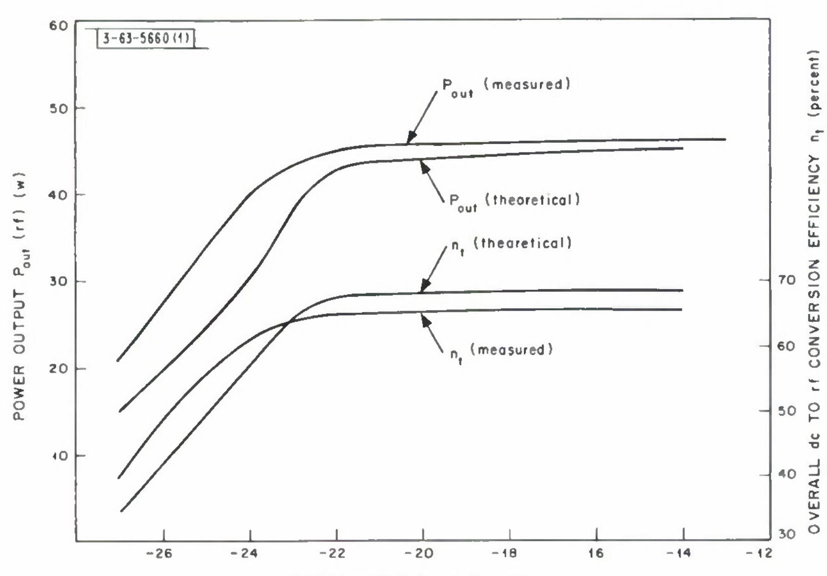


Fig. 15. Fundamental output power and overall efficiency versus rf drive (theoretical and measured curves).

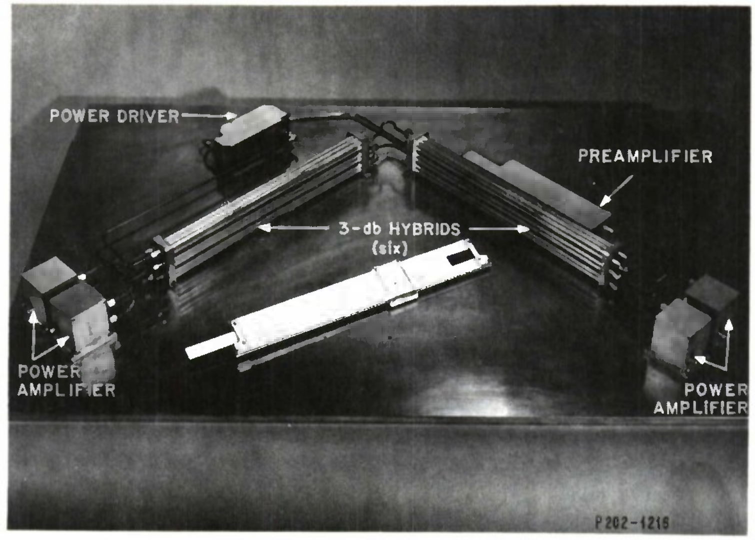


Fig. 16. 46-watt, 250-Mcps amplifier and preamplifier.

VII. SUMMARY AND CONCLUSION

An improvement in both efficiency and output power beyond the values described by textbook definitions can be realized by simply controlling the in and out of band load impedances presented to a device originally biased Class A or Class B. The effect on output power of variations of rf drive level with time, temperature, aging and radiation damage can be significantly reduced by controlling the harmonically related load impedances and overdriving. Finally, the theory has been verified by the construction and testing of a 46-watt, 250-Mcps amplifier which exhibited an insensitivity of output power to rf drive level within 1.2 db of the calculated theoretical value and an overall dc to rf conversion efficiency within 3 percent of the theoretical value.

A complete tabulation of the calculated design data and computer program is given in Appendix A.

ACKNOWLEDGMENT

The author gratefully acknowledges the many useful discussions with Dr. A. I. Grayzel and L. Hoffman of the MIT Lincoln Laboratory. He also wishes to thank R. E. Dolbec of Lincoln Laboratory for his assistance in the fabrication and testing of the experimental amplifier.

APPENDIX

COMPUTER PROGRAM AND CALCULATED DESIGN DATA

TABLE A-I

COMPUTER PROGRAM, CLASS B OVERDRIVEN

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                C      OPTIMUM EFFICIENCY DESIGN DATA FOR A SYMMETRICALLY OVERDRIVEN
                C      POWER AMPLIFIER, CLASS'B' OPERATION,SINGLE STAGE.
                C      THE FOLLOWING IS A LIST OF SYMBOLS USED IN THIS PROGRAM
                C      PIN(MK)=D.C. INPUT POWER TO THE DEVICE (WATTS).
                C      PD(MK)=POWER DISSIPATED BY THE DEVICE(WATTS).
                C      POUT(MK)=R.F. OUTPUT POWER (WATTS), AT THE FUNDAMENTAL FREQUENCY.
                C      EFFC(MK)=COLLECTOR EFFICIENCY (().
                C      EFFT(MK,NGC)=OVERALL AMPLIFIER EFFICIENCY (().
                C      K=THE INCREASE IN INPUT POWER (DB).
                C      THETA=TIME(RAD) TO FIRST SATURATE
                C      GO=AMPLIFIER STAGE POWER GAIN((),CLASSICAL CLASS 'B' OPERATION.
                C      G(MK,NGC)=EFFECTIVE GAIN OF STAGE .
                C      PN(MK,MN)=HARMONIC OUTPUT POWER (WATTS).
                C      ****************************************************************
ISN 0002               DIMENSION Q(250),PD(250),PIN(250),POUT(250),EFFC(250),
                      1EFFT(250,20),G(250,20),T(250),PN(250,20),PO(250,20),RATIO(250,20)
ISN 0003               REAL K
ISN 0004               REAL N
ISN 0005               DO 14C MK=2C,21C,1
ISN 0006               Q(MK)=(MK/2C.-1.)
ISN 0007               T(MK)=Q(MK)*2.
ISN 0008               S=Q(MK)/10.
ISN 0009               K=10.**S
ISN 0010               THETA=ARSIN(1./K)
ISN 0011               PD(MK)=K**2.*SIN(2.*THETA)/4.+K
                      1-K**2.*THETA/2.-K*COS(THETA)
ISN 0012               PIN(MK)=(3.141593-2.*THETA)/2.+K
                      1-K*COS(THETA)
ISN 0013               POUT(MK)=(2.*K*THETA/3.14)593-K*SIN(2.*THETA)/3.141593
                      1+4.*CCS(THETA)/3.141593)**2./4.*3.141593
ISN 0014               EFFC(MK)=POUT(MK)/PIN(MK)*10C.
ISN 0015               DO 110 MN=3,11,2
ISN 0016               N=MN
ISN 0017               PN(MK,MN)=(2.*K*SIN(THETA-N*THETA)/(1.-N)-2.*K*SIN(THETA+N*THETA)/
                      1(1.+N)+4.*CCS(N*THETA)/N)**2
ISN 0018               PO(MK,MN)=(2.*K*THETA-K*SIN(2.*THETA)+4.*COS(THETA))**2
ISN 0019               RATIO(MK,MN)=-1C.*ALOG10(ABS(PO(MK,MN)/PN(MK,MN)))
ISN 0020           110 CONTINUE
ISN 0021               DO 12C NGO=3,2C
ISN 0022               R=NGO/1C.
ISN 0023               GO=10.**R
```

TABLE A-I (Continued)

```
ISN 0024          Z=4.*GO*POUT(MK)/(3.141593*K**2.)
ISN 0025          G(MK,NGO)=10.*ALOG10(Z)
ISN 0026          EFFT(MK,NGO)=POUT(MK)/(PIN(MK)+K**2.*3.141593/(4.*GO))*100.
ISN 0027          DIFF=POUT(MK)-K/(4.*GO)
ISN 0028          IF(DIFF) 140,120,120
ISN 0029      120 CONTINUE
ISN 0030      140 CONTINUE
ISN 0031          WRITE(6,200)
ISN 0032          DO 300 MK=20,210,1
ISN 0033      300 WRITE(6,201)T(MK),PIN(MK),POUT(MK),EFFC(MK),PD(MK),(RATIO(MK,MN),M
                 1N=3,11,2)
ISN 0034      200 FORMAT('1','OPTIMUM EFFICIFNCY DESIGN DATA FOR AN OVERDRIVEN
                 1POWER AMPLIFIER'//1X,'K(DB)',3X,'PIN(MK)',3X,'POUT(MK)',3X,
                 2'EFFC(MK)',5X,'PD(MK)',3X,'HARMONIC CONTENT(DB BELOW POUT) VS. HAR
                 3MONIC NUMBER(N)'//1X,57X,'N=3',5X,'N=5',5X,'N=7',5X,'N=9',5X,'N=11
                 4'//)
ISN 0035      201 FORMAT(1X,F5.1,3X,F7.4,3X,F8.4,3X,F8.4,3X,F8.4,6X,F6.1,2X,F6.1,2X,
                 1F6.1,2X,F6.1,2X,F6.1)
ISN 0036          WRITE(6,202)
ISN 0037          DO 301 MK=20,210,1
ISN 0038      301 WRITE(6,203)T(MK),(G(MK,NGO),NGO=3,20,1)
ISN 0039      202 FORMAT('1',1X,'EFFECTIVE GAIN (G) VS K FOR DIFFERENT VALUES
                 1OF GO'//1X,'K(DB)',3X,'GO(DB) EQUALS',3X,'3',5X,'4',5X,'5',
                 25X,'6',5X,'7',5X,'8',5X,'9',4X,'10',4X,'11',4X,'12',4X,'13',
                 34X,'14',4X,'15',4X,'16',4X,'17',4X,'18',4X,'19',4X,'20'//)
ISN 0040      203 FORMAT(1X,F5.1,18X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,
                 11X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,
                 21X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2)
ISN 0041          WRITE(6,204)
ISN 0042          DO 302 MK=20,210,1
ISN 0043      302 WRITE(6,205)T(MK),(EFFT(MK,NGO),NGO=3,20,1)
ISN 0044      204 FORMAT('1',1X,'OVERALL FFFECIENCY VS K FOR DIFFERENT VALUES
                 1OF GO'//1X,'K(DB)',3X,'GO(DB) EQUALS',3X,'3',5X,'4',5X,'5',
                 25X,'6',5X,'7',5X,'8',5X,'9',4X,'10',4X,'11',4X,'12',4X,'13',
                 34X,'14',4X,'15',4X,'16',4X,'17',4X,'18',4X,'19',4X,'20'//)
ISN 0045      205 FORMAT(1X,F5.1,18X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,
                 11X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,
                 21X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2)
ISN 0046          RETURN
ISN 0047          END
```

TABLE A-II

OPTIMUM EFFICIENCY DESIGN DATA FOR AN OVERDRIVEN CLASS B POWER AMPLIFIER

(a) OUTPUT CHARACTERISTICS

K(DB)	PIN(MK)	POUT(MK)	EFFC(MK)	PD(MK)	HARMONIC CONTENT(DB BELOW POUT) VS. HARMONIC NUMBER(N) N=3	N=5	N=7	N=9	N=11
0.0	1.0000	0.7854	78.5358	0.2146					
0.1	1.0104	0.8013	79.3075	0.2091	-56.8	-57.1	-57.6	-58.3	-59.1
0.2	1.0200	0.8157	79.9654	0.2043	-48.0	-48.7	-49.7	-51.1	-52.9
0.3	1.0290	0.8290	80.5657	0.1999	-42.9	-43.9	-45.5	-47.7	-50.7
0.4	1.0377	0.8417	81.1112	0.1958	-39.4	-40.7	-42.8	-45.9	-50.5
0.5	1.0460	0.8537	81.6148	0.1919	-36.7	-38.4	-41.1	-45.2	-51.9
0.6	1.0540	0.8652	82.0822	0.1882	-34.5	-36.6	-39.9	-45.2	-55.4
0.7	1.0618	0.8762	82.5177	0.1848	-32.7	-35.1	-39.1	-45.9	-64.4
0.8	1.0694	0.8868	82.9247	0.1814	-31.2	-33.9	-38.6	-47.4	-64.1
0.9	1.0767	0.8970	83.3057	0.1782	-29.9	-32.9	-38.5	-49.8	-54.6
1.0	1.0839	0.9068	83.6630	0.1751	-28.7	-32.1	-38.5	-54.0	-50.3
1.1	1.0908	0.9163	83.9987	0.1722	-27.6	-31.5	-38.8	-64.5	-47.7
1.2	1.0976	0.9255	84.3143	0.1693	-26.7	-30.9	-39.3	-61.1	-46.1
1.3	1.1043	0.9344	84.6115	0.1665	-25.8	-30.5	-40.0	-52.4	-45.0
1.4	1.1108	0.9430	84.8910	0.1638	-25.0	-30.1	-41.1	-48.2	-44.4
1.5	1.1171	0.9513	85.1542	0.1612	-24.3	-29.8	-42.4	-45.5	-44.2
1.6	1.1234	0.9594	85.4021	0.1586	-23.6	-29.6	-44.3	-43.6	-44.3
1.7	1.1295	0.9672	85.6361	0.1562	-23.0	-29.4	-46.9	-42.1	-44.7
1.8	1.1354	0.9748	85.8561	0.1538	-22.5	-29.3	-51.0	-41.0	-45.5
1.9	1.1413	0.9822	86.0637	0.1514	-21.9	-29.2	-59.6	-40.1	-46.6
2.0	1.1470	0.9894	86.2590	0.1491	-21.4	-29.2	-62.1	-39.5	-48.3
2.1	1.1527	0.9964	86.4431	0.1469	-21.0	-29.2	-51.5	-39.1	-50.8
2.2	1.1582	1.0032	86.6163	0.1447	-20.5	-29.3	-46.9	-38.8	-54.8
2.3	1.1636	1.0098	86.7792	0.1426	-20.1	-29.4	-43.9	-38.6	-63.1
2.4	1.1690	1.0162	86.9326	0.1405	-19.7	-29.6	-41.6	-38.6	-66.6
2.5	1.1742	1.0225	87.0766	0.1385	-19.4	-29.8	-39.9	-38.7	-55.7
2.6	1.1794	1.0285	87.2118	0.1365	-19.0	-30.1	-38.5	-38.9	-51.0
2.7	1.1844	1.0345	87.3386	0.1346	-18.7	-30.4	-37.3	-39.2	-48.1
2.8	1.1894	1.0402	87.4573	0.1327	-18.4	-30.8	-36.3	-39.7	-46.0
2.9	1.1943	1.0458	87.5685	0.1308	-18.1	-31.2	-35.5	-40.4	-44.4
3.0	1.1991	1.0513	87.6724	0.1290	-17.8	-31.7	-34.7	-41.2	-43.1
3.1	1.2039	1.0566	87.7693	0.1272	-17.5	-32.2	-34.1	-42.2	-42.1
3.2	1.2085	1.0618	87.8598	0.1255	-17.2	-32.8	-33.5	-43.4	-41.4

TABLE A-II (Continued)

(a) OUTPUT CHARACTERISTICS (Continued)

K(DB)	PIN(MK)	POUT(MK)	EFFC(MK)	PD(MK)	HARMONIC CONTENT(DB BELOW POUT) VS. HARMONIC NUMBER(N) N=3	N=5	N=7	N=9	N=11
3.3	1.2131	1.0669	87.9440	0.1237	-17.0	-33.6	-33.0	-45.1	-40.8
3.4	1.2176	1.0718	88.0220	0.1221	-16.8	-34.4	-32.6	-47.2	-40.3
3.5	1.2221	1.0766	88.0941	0.1204	-16.5	-35.3	-32.3	-50.2	-40.0
3.6	1.2265	1.0813	88.1609	0.1188	-16.3	-36.4	-31.9	-55.0	-39.7
3.7	1.2308	1.0858	88.2224	0.1172	-16.1	-37.8	-31.7	-67.5	-39.6
3.8	1.2350	1.0903	88.2788	0.1156	-15.9	-39.4	-31.5	-60.3	-39.6
3.9	1.2392	1.0946	88.3304	0.1141	-15.7	-41.4	-31.3	-52.6	-39.7
4.0	1.2433	1.0988	88.3775	0.1126	-15.5	-44.2	-31.1	-48.5	-39.9
4.1	1.2474	1.1029	88.4200	0.1111	-15.3	-48.3	-31.0	-45.8	-40.2
4.2	1.2514	1.1069	88.4583	0.1096	-15.2	-56.8	-31.0	-43.7	-40.6
4.3	1.2553	1.1109	88.4925	0.1082	-15.0	-80.1	-30.9	-42.1	-41.1
4.4	1.2592	1.1147	88.5228	0.1068	-14.8	-49.2	-30.9	-40.7	-41.8
4.5	1.2630	1.1184	88.5495	0.1054	-14.7	-44.5	-31.0	-39.6	-42.6
4.6	1.2668	1.1221	88.5727	0.1040	-14.5	-41.4	-31.0	-38.6	-43.5
4.7	1.2705	1.1256	88.5925	0.1027	-14.4	-39.2	-31.1	-37.7	-44.7
4.8	1.2742	1.1291	88.6089	0.1013	-14.3	-37.3	-31.2	-37.0	-46.2
4.9	1.2778	1.1324	88.6222	0.1000	-14.1	-35.8	-31.4	-36.4	-48.2
5.0	1.2814	1.1357	88.6326	0.0988	-14.0	-34.5	-31.6	-35.8	-50.8
5.1	1.2849	1.1389	88.6400	0.0975	-13.9	-33.4	-31.8	-35.3	-54.7
5.2	1.2884	1.1421	88.6449	0.0963	-13.8	-32.4	-32.1	-34.8	-62.3
5.3	1.2918	1.1451	88.6470	0.0950	-13.6	-31.5	-32.3	-34.5	-69.5
5.4	1.2952	1.1481	88.6466	0.0938	-13.5	-30.7	-32.7	-34.1	-56.8
5.5	1.2985	1.1511	88.6438	0.0927	-13.4	-30.0	-33.0	-33.8	-51.8

TABLE A-II (Continued)

(b) EFFECTIVE GAIN VERSUS K FOR DIFFERENT VALUES OF G_o

K(DB) \ GO(DB) EQUALS	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0.0	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00
0.1	2.99	3.99	4.99	5.99	6.99	7.99	8.99	9.99	10.99	11.99	12.99	13.99	14.99	15.99	16.99	17.99	18.99	19.99
0.2	2.96	3.96	4.96	5.96	6.96	7.96	8.96	9.96	10.96	11.96	12.96	13.96	14.96	15.96	16.96	17.96	18.96	19.96
0.3	2.93	3.93	4.93	5.93	6.93	7.93	8.93	9.93	10.93	11.93	12.93	13.93	14.93	15.93	16.93	17.93	18.93	19.93
0.4	2.90	3.90	4.90	5.90	6.90	7.90	8.90	9.90	10.90	11.90	12.90	13.90	14.90	15.90	16.90	17.90	18.90	19.90
0.5	2.86	3.86	4.86	5.86	6.86	7.86	8.86	9.86	10.86	11.86	12.86	13.86	14.86	15.86	16.86	17.86	18.86	19.86
0.6	2.82	3.82	4.82	5.82	6.82	7.82	8.82	9.82	10.82	11.82	12.82	13.82	14.82	15.82	16.82	17.82	18.82	19.82
0.7	2.78	3.78	4.78	5.78	6.78	7.78	8.78	9.78	10.78	11.78	12.78	13.78	14.78	15.78	16.78	17.78	18.78	19.78
0.8	2.73	3.73	4.73	5.73	6.73	7.73	8.73	9.73	10.73	11.73	12.73	13.73	14.73	15.73	16.73	17.73	18.73	19.73
0.9	2.68	3.68	4.68	5.68	6.68	7.68	8.68	9.68	10.68	11.68	12.68	13.68	14.68	15.68	16.68	17.68	18.68	19.68
1.0	2.62	3.62	4.62	5.62	6.62	7.62	8.62	9.62	10.62	11.62	12.62	13.62	14.62	15.62	16.62	17.62	18.62	19.62
1.1	2.57	3.57	4.57	5.57	6.57	7.57	8.57	9.57	10.57	11.57	12.57	13.57	14.57	15.57	16.57	17.57	18.57	19.57
1.2	2.51	3.51	4.51	5.51	6.51	7.51	8.51	9.51	10.51	11.51	12.51	13.51	14.51	15.51	16.51	17.51	18.51	19.51
1.3	2.45	3.45	4.45	5.45	6.45	7.45	8.45	9.45	10.45	11.45	12.45	13.45	14.45	15.45	16.45	17.45	18.45	19.45
1.4	2.39	3.39	4.39	5.39	6.39	7.39	8.39	9.39	10.39	11.39	12.39	13.39	14.39	15.39	16.39	17.39	18.39	19.39
1.5	2.33	3.33	4.33	5.33	6.33	7.33	8.33	9.33	10.33	11.33	12.33	13.33	14.33	15.33	16.33	17.33	18.33	19.33
1.6	2.27	3.27	4.27	5.27	6.27	7.27	8.27	9.27	10.27	11.27	12.27	13.27	14.27	15.27	16.27	17.27	18.27	19.27
1.7	2.20	3.20	4.20	5.20	6.20	7.20	8.20	9.20	10.20	11.20	12.20	13.20	14.20	15.20	16.20	17.20	18.20	19.20
1.8	2.14	3.14	4.14	5.14	6.14	7.14	8.14	9.14	10.14	11.14	12.14	13.14	14.14	15.14	16.14	17.14	18.14	19.14
1.9	2.07	3.07	4.07	5.07	6.07	7.07	8.07	9.07	10.07	11.07	12.07	13.07	14.07	15.07	16.07	17.07	18.07	19.07
2.0	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00
2.1	1.93	2.93	3.93	4.93	5.93	6.93	7.93	8.93	9.93	10.93	11.93	12.93	13.93	14.93	15.93	16.93	17.93	18.93
2.2	1.86	2.86	3.86	4.86	5.86	6.86	7.86	8.86	9.86	10.86	11.86	12.86	13.86	14.86	15.86	16.86	17.86	18.86
2.3	1.79	2.79	3.79	4.79	5.79	6.79	7.79	8.79	9.79	10.79	11.79	12.79	13.79	14.79	15.79	16.79	17.79	18.79
2.4	1.72	2.72	3.72	4.72	5.72	6.72	7.72	8.72	9.72	10.72	11.72	12.72	13.72	14.72	15.72	16.72	17.72	18.72
2.5	1.65	2.65	3.65	4.65	5.65	6.65	7.65	8.65	9.65	10.65	11.65	12.65	13.65	14.65	15.65	16.65	17.65	18.65
2.6	1.57	2.57	3.57	4.57	5.57	6.57	7.57	8.57	9.57	10.57	11.57	12.57	13.57	14.57	15.57	16.57	17.57	18.57
2.7	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50	11.50	12.50	13.50	14.50	15.50	16.50	17.50	18.50
2.8	1.42	2.42	3.42	4.42	5.42	6.42	7.42	8.42	9.42	10.42	11.42	12.42	13.42	14.42	15.42	16.42	17.42	18.42
2.9	1.34	2.34	3.34	4.34	5.34	6.34	7.34	8.34	9.34	10.34	11.34	12.34	13.34	14.34	15.34	16.34	17.34	18.34
3.0	1.27	2.27	3.27	4.27	5.27	6.27	7.27	8.27	9.27	10.27	11.27	12.27	13.27	14.27	15.27	16.27	17.27	18.27
3.1	1.19	2.19	3.19	4.19	5.19	6.19	7.19	8.19	9.19	10.19	11.19	12.19	13.19	14.19	15.19	16.19	17.19	18.19
3.2	1.11	2.11	3.11	4.11	5.11	6.11	7.11	8.11	9.11	10.11	11.11	12.11	13.11	14.11	15.11	16.11	17.11	18.11
3.3	1.03	2.03	3.03	4.03	5.03	6.03	7.03	8.03	9.03	10.03	11.03	12.03	13.03	14.03	15.03	16.03	17.03	18.03
3.4	0.95	1.95	2.95	3.95	4.95	5.95	6.95	7.95	8.95	9.95	10.95	11.95	12.95	13.95	14.95	15.95	16.95	17.95
3.5	0.87	1.87	2.87	3.87	4.87	5.87	6.87	7.87	8.87	9.87	10.87	11.87	12.87	13.87	14.87	15.87	16.87	17.87
3.6	0.79	1.79	2.79	3.79	4.79	5.79	6.79	7.79	8.79	9.79	10.79	11.79	12.79	13.79	14.79	15.79	16.79	17.79
3.7	0.71	1.71	2.71	3.71	4.71	5.71	6.71	7.71	8.71	9.71	10.71	11.71	12.71	13.71	14.71	15.71	16.71	17.71

TABLE A-II (Continued)

(b) EFFECTIVE GAIN VERSUS K FOR DIFFERENT VALUES OF G_o (Continued)

K(DB)	GO(DB) EQUALS 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3.8	0.62	1.62	2.62	3.62	4.62	5.62	6.62	7.62	8.62	9.62	10.62	11.62	12.62	13.62	14.62	15.62	16.62	17.62
3.9	0.54	1.54	2.54	3.54	4.54	5.54	6.54	7.54	8.54	9.54	10.54	11.54	12.54	13.54	14.54	15.54	16.54	17.54
4.0	0.46	1.46	2.46	3.46	4.46	5.46	6.46	7.46	8.46	9.46	10.46	11.46	12.46	13.46	14.46	15.46	16.46	17.46
4.1	0.37	1.37	2.37	3.37	4.37	5.37	6.37	7.37	8.37	9.37	10.37	11.37	12.37	13.37	14.37	15.37	16.37	17.37
4.2	0.29	1.29	2.29	3.29	4.29	5.29	6.29	7.29	8.29	9.29	10.29	11.29	12.29	13.29	14.29	15.29	16.29	17.29
4.3	0.21	1.21	2.21	3.21	4.21	5.21	6.21	7.21	8.21	9.21	10.21	11.21	12.21	13.21	14.21	15.21	16.21	17.21
4.4	0.12	1.12	2.12	3.12	4.12	5.12	6.12	7.12	8.12	9.12	10.12	11.12	12.12	13.12	14.12	15.12	16.12	17.12
4.5	0.04	1.04	2.04	3.04	4.04	5.04	6.04	7.04	8.04	9.04	10.04	11.04	12.04	13.04	14.04	15.04	16.04	17.04
4.6	-0.05	0.95	1.95	2.95	3.95	4.95	5.95	6.95	7.95	8.95	9.95	10.95	11.95	12.95	13.95	14.95	15.95	16.95
4.7	-0.14	0.86	1.86	2.86	3.86	4.86	5.86	6.86	7.86	8.86	9.86	10.86	11.86	12.86	13.86	14.86	15.86	16.86
4.8	-0.22	0.78	1.78	2.78	3.78	4.78	5.78	6.78	7.78	8.78	9.78	10.78	11.78	12.78	13.78	14.78	15.78	16.78
4.9	-0.31	0.69	1.69	2.69	3.69	4.69	5.69	6.69	7.69	8.69	9.69	10.69	11.69	12.69	13.69	14.69	15.69	16.69
5.0	-0.40	0.60	1.60	2.60	3.60	4.60	5.60	6.60	7.60	8.60	9.60	10.60	11.60	12.60	13.60	14.60	15.60	16.60
5.1	-0.49	0.51	1.51	2.51	3.51	4.51	5.51	6.51	7.51	8.51	9.51	10.51	11.51	12.51	13.51	14.51	15.51	16.51
5.2	-0.57	0.43	1.43	2.43	3.43	4.43	5.43	6.43	7.43	8.43	9.43	10.43	11.43	12.43	13.43	14.43	15.43	16.43
5.3	-0.66	0.34	1.34	2.34	3.34	4.34	5.34	6.34	7.34	8.34	9.34	10.34	11.34	12.34	13.34	14.34	15.34	16.34
5.4	-0.75	0.25	1.25	2.25	3.25	4.25	5.25	6.25	7.25	8.25	9.25	10.25	11.25	12.25	13.25	14.25	15.25	16.25
5.5	-0.84	0.16	1.16	2.16	3.16	4.16	5.16	6.16	7.16	8.16	9.16	10.16	11.16	12.16	13.16	14.16	15.16	16.16
5.6	-0.93	0.07	1.07	2.07	3.07	4.07	5.07	6.07	7.07	8.07	9.07	10.07	11.07	12.07	13.07	14.07	15.07	16.07
5.7	-1.02	-0.02	0.98	1.98	2.98	3.98	4.98	5.98	6.98	7.98	8.98	9.98	10.98	11.98	12.98	13.98	14.98	15.98

TABLE A-II (Continued)

(c) OVERALL EFFICIENCY VERSUS K FOR DIFFERENT VALUES OF G_o

K(DB) GO(DB) EQUALS	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0.0	56.36	59.83	62.91	65.60	67.90	69.85	71.47	72.82	73.93	74.83	75.57	76.16	76.64	77.02	77.33	77.57	77.77	77.93
0.1	56.70	60.23	63.37	66.10	68.45	70.43	72.09	73.46	74.59	75.52	76.27	76.87	77.36	77.75	78.07	78.32	78.52	78.68
0.2	56.95	60.54	63.72	66.50	68.89	70.91	72.60	74.00	75.16	76.10	76.86	77.48	77.98	78.38	78.70	78.96	79.17	79.33
0.3	57.14	60.78	64.01	66.84	69.26	71.32	73.05	74.47	75.65	76.61	77.39	78.03	78.53	78.94	79.27	79.53	79.74	79.91
0.4	57.28	60.97	64.25	67.12	69.59	71.68	73.44	74.90	76.09	77.08	77.87	78.52	79.04	79.45	79.79	80.06	80.27	80.44
0.5	57.38	61.12	64.45	67.36	69.87	72.00	73.79	75.27	76.50	77.50	78.31	78.97	79.50	79.92	80.27	80.54	80.76	80.93
0.6	57.45	61.23	64.60	67.56	70.11	72.28	74.10	75.61	76.86	77.88	78.71	79.38	79.92	80.36	80.70	80.98	81.21	81.39
0.7	57.48	61.31	64.73	67.73	70.32	72.53	74.38	75.92	77.19	78.23	79.07	79.76	80.31	80.75	81.11	81.40	81.62	81.81
0.8	57.48	61.36	64.82	67.87	70.50	72.74	74.63	76.20	77.49	78.55	79.41	80.11	80.67	81.13	81.49	81.78	82.01	82.20
0.9	57.46	61.38	64.89	67.98	70.65	72.93	74.85	76.45	77.76	78.84	79.72	80.43	81.01	81.47	81.84	82.14	82.38	82.56
1.0	57.41	61.37	64.93	68.07	70.78	73.09	75.04	76.67	78.01	79.11	80.01	80.73	81.32	81.79	82.17	82.47	82.71	82.91
1.1	57.34	61.35	64.95	68.13	70.88	73.23	75.22	76.87	78.23	79.35	80.27	81.01	81.61	82.09	82.47	82.78	83.03	83.23
1.2	57.25	61.30	64.94	68.16	70.96	73.35	75.36	77.05	78.44	79.58	80.51	81.26	81.87	82.36	82.76	83.07	83.32	83.53
1.3	57.14	61.23	64.92	68.18	71.02	73.44	75.49	77.20	78.62	79.78	80.73	81.50	82.12	82.62	83.02	83.34	83.60	83.81
1.4	57.01	61.14	64.87	68.18	71.05	73.52	75.60	77.34	78.78	79.97	80.93	81.72	82.35	82.86	83.27	83.60	83.86	84.07
1.5	56.86	61.03	64.80	68.15	71.07	73.57	75.69	77.46	78.93	80.13	81.12	81.92	82.56	83.08	83.50	83.83	84.10	84.32
1.6	56.69	60.90	64.72	68.11	71.07	73.61	75.76	77.56	79.06	80.28	81.29	82.10	82.76	83.29	83.71	84.06	84.33	84.55
1.7	56.51	60.76	64.62	68.05	71.05	73.63	75.82	77.65	79.17	80.42	81.44	82.27	82.94	83.48	83.91	84.26	84.54	84.76
1.8	56.31	60.60	64.50	67.98	71.02	73.64	75.86	77.72	79.26	80.54	81.58	82.42	83.10	83.66	84.10	84.45	84.74	84.97
1.9	56.10	60.42	64.37	67.89	70.97	73.63	75.88	77.77	79.35	80.64	81.70	82.56	83.26	83.82	84.27	84.63	84.92	85.16
2.0	55.87	60.24	64.22	67.78	70.91	73.60	75.89	77.81	79.41	80.73	81.81	82.69	83.40	83.97	84.43	84.80	85.10	85.33
2.1	55.63	60.03	64.06	67.66	70.83	73.56	75.89	77.84	79.47	80.81	81.91	82.80	83.52	84.11	84.58	84.96	85.26	85.50
2.2	55.38	59.82	63.88	67.53	70.73	73.51	75.87	77.85	79.51	80.87	81.99	82.90	83.64	84.24	84.71	85.10	85.41	85.65
2.3	55.12	59.59	63.69	67.38	70.63	73.44	75.84	77.86	79.54	80.93	82.06	82.99	83.74	84.35	84.84	85.23	85.54	85.80
2.4	54.84	59.35	63.49	67.22	70.51	73.36	75.79	77.84	79.55	80.97	82.13	83.07	83.84	84.46	84.95	85.35	85.67	85.93
2.5	54.55	59.09	63.28	67.05	70.37	73.27	75.74	77.82	79.56	81.00	82.18	83.14	83.92	84.55	85.06	85.47	85.79	86.05
2.6	54.26	58.83	63.05	66.86	70.23	73.16	75.67	77.79	79.55	81.02	82.22	83.20	83.99	84.64	85.15	85.57	85.90	86.17
2.7	53.95	58.56	62.81	66.66	70.07	73.04	75.59	77.74	79.54	81.03	82.25	83.25	84.06	84.71	85.24	85.66	86.00	86.27
2.8	53.63	58.27	62.56	66.45	69.91	72.92	75.50	77.68	79.51	81.02	82.27	83.29	84.11	84.78	85.32	85.75	86.09	86.37
2.9	53.31	57.97	62.30	66.23	69.73	72.78	75.40	77.62	79.47	81.01	82.28	83.32	84.16	84.84	85.38	85.82	86.18	86.46
3.0	52.97	57.67	62.04	66.01	69.54	72.63	75.29	77.54	79.43	80.99	82.28	83.34	84.19	84.89	85.44	85.89	86.25	86.54
3.1	52.63	57.35	61.76	65.76	69.34	72.47	75.16	77.45	79.37	80.96	82.28	83.35	84.22	84.93	85.50	85.95	86.32	86.62
3.2	52.28	57.03	61.47	65.52	69.13	72.30	75.03	77.36	79.31	80.93	82.26	83.35	84.24	84.96	85.54	86.01	86.38	86.68
3.3	51.92	56.70	61.17	65.26	68.91	72.12	74.89	77.25	79.23	80.88	82.24	83.35	84.26	84.99	85.58	86.06	86.44	86.74
3.4	51.56	56.36	60.86	64.99	68.68	71.93	74.74	77.14	79.15	80.83	82.21	83.34	84.26	85.01	85.61	86.10	86.49	86.80
3.5	51.18	56.01	60.55	64.71	68.45	71.74	74.58	77.01	79.06	80.76	82.17	83.32	84.26	85.02	85.64	86.13	86.53	86.84
3.6	50.81	55.66	60.22	64.42	68.20	71.53	74.42	76.88	78.96	80.69	82.12	83.30	84.25	85.03	85.65	86.16	86.56	86.89

TABLE A-II (Continued)

(c) OVERALL EFFICIENCY VERSUS K FOR DIFFERENT VALUES OF G_o (Continued)

K(DB)	GO(DB) EQUALS 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3.7	50.42	55.29	59.89	64.13	67.94	71.31	74.24	76.74	78.85	80.61	82.07	83.26	84.24	85.03	85.67	86.18	86.59	86.92
3.8	50.03	54.92	59.55	63.82	67.68	71.09	74.06	76.59	78.74	80.53	82.01	83.22	84.22	85.02	85.67	86.19	86.62	86.95
3.9	49.63	54.55	59.20	63.51	67.41	70.86	73.86	76.44	78.62	80.43	81.94	83.18	84.19	85.01	85.67	86.20	86.63	86.98
4.0	49.23	54.16	58.85	63.19	67.13	70.62	73.66	76.27	78.49	80.33	81.87	83.13	84.15	84.99	85.67	86.21	86.65	87.00
4.1	48.82	53.77	58.49	62.86	66.84	70.37	73.45	76.10	78.35	80.23	81.79	83.07	84.12	84.97	85.65	86.21	86.65	87.01
4.2	48.41	53.38	58.12	62.53	66.54	70.11	73.24	75.92	78.20	80.11	81.70	83.00	84.07	84.94	85.64	86.20	86.66	87.02
4.3	47.99	52.98	57.74	62.19	66.24	69.85	73.01	75.74	78.05	79.99	81.61	82.93	84.02	84.90	85.62	86.19	86.66	87.03
4.4	47.57	52.57	57.36	61.84	65.93	69.58	72.78	75.55	77.89	79.87	81.51	82.86	83.96	84.86	85.59	86.18	86.65	87.03
4.5	47.14	52.16	56.97	61.48	65.61	69.30	72.54	75.34	77.73	79.73	81.40	82.77	83.90	84.82	85.56	86.16	86.64	87.02
4.6	46.71	51.74	56.58	61.12	65.28	69.01	72.30	75.14	77.56	79.59	81.29	82.69	83.83	84.77	85.52	86.13	86.62	87.02
4.7	46.28	51.32	56.18	60.75	64.95	68.72	72.05	74.92	77.38	79.45	81.17	82.59	83.76	84.71	85.48	86.10	86.60	87.01
4.8	45.84	50.89	55.78	60.38	64.61	68.42	71.79	74.70	77.19	79.30	81.05	82.50	83.68	84.65	85.44	86.07	86.58	86.99
4.9	45.40	50.46	55.37	60.00	64.27	68.12	71.52	74.48	77.00	79.14	80.92	82.39	83.60	84.59	85.39	86.03	86.55	86.97
5.0	44.96	50.03	54.95	59.61	63.91	67.80	71.25	74.24	76.81	78.97	80.78	82.28	83.51	84.52	85.33	85.99	86.52	86.95
5.1	44.51	49.59	54.53	59.22	63.56	67.48	70.97	74.00	76.60	78.81	80.65	82.17	83.42	84.44	85.27	85.95	86.49	86.92
5.2	44.07	49.15	54.11	58.82	63.19	67.16	70.68	73.76	76.40	78.63	80.50	82.05	83.33	84.37	85.21	85.90	86.45	86.89
5.3	43.61	48.70	53.68	58.42	62.82	66.83	70.39	73.50	76.18	78.45	80.35	81.93	83.23	84.29	85.15	85.84	86.41	86.86
5.4	43.16	48.25	53.24	58.01	62.45	66.49	70.09	73.25	75.96	78.26	80.20	81.80	83.12	84.20	85.08	85.79	86.36	86.82
5.5	42.71	47.80	52.81	57.60	62.07	66.15	69.79	72.98	75.73	78.07	80.04	81.67	83.01	84.11	85.00	85.73	86.31	86.78
5.6	42.25	47.35	52.37	57.18	61.68	65.80	69.48	72.71	75.50	77.88	79.87	81.53	82.90	84.02	84.93	85.66	86.26	86.74
5.7	41.79	46.89	51.92	56.75	61.29	65.44	69.16	72.44	75.26	77.67	79.70	81.39	82.78	83.92	84.85	85.60	86.20	86.69

TABLE A-III

COMPUTER PROGRAM, CLASS A OVERDRIVEN

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              C      OPTIMUM EFFICIENCY DESIGN DATA FOR A SYMMETRICALLY OVERDRIVEN
              C      POWER AMPLIFIER, CLASS'A' OPERATION,SINGLE STAGE.
              C      THE FOLLOWING IS A LIST OF SYMBOLS USED IN THIS PROGRAM
              C      PIN(MK)=D.C. INPUT POWER TO THE DEVICE (1 WATT,CONSTANT).
              C      PD(MK)=POWER DISSIPATED BY THE DEVICE(WATTS).
              C      POUT(MK)=R.F. OUTPUT POWER (WATTS), AT THE FUNDAMENTAL FREQUENCY.
              C      EFFC(MK)=COLLECTOR EFFICIENCY (().
              C      EFFT(MK,NGO)=OVERALL AMPLIFIER EFFICIENCY (().
              C      K=THE INCREASE IN INPUT POWER (DB).
              C      THETA=TIME(RAD) TO FIRST SATURATE
              C      GO=AMPLIFIER STAGE POWER GAIN((),CLASSICAL CLASS 'A' OPERATION.
              C      G(MK,NGO)=EFFECTIVE GAIN OF STAGE .
              C      PN(MK,MN)=HARMONIC OUTPUT POWER (WATTS).
              C      ******************************************************************
ISN 0002             DIMENSION Q(250),PD(250),PIN(250),POUT(250),EFFC(250),
                    1EFFT(250,20),G(250,20),T(250),PN(250,20),PO(250,20),RATIO(250,20)
ISN 0003             REAL K
ISN 0004             REAL N
ISN 0005             DO 140 MK=20,210,1
ISN 0006             Q(MK)=(MK/20.-1.)
ISN 0007             T(MK)=Q(MK)*2.
ISN 0008             S=Q(MK)/10.
ISN 0009             K=10.**S
              C      K IN 0.1 DB STEPS(POWER).
ISN 0010             THETA=ARSIN(1./K)
ISN 0011             PD(MK)=(2.*THETA/3.141593-K**2.*THETA/3.141593
                    1+K**2.*SIN(2.*THETA)/(2.*3.141593))
ISN 0012             PIN(MK)=1.
ISN 0013             POUT(MK)=(2.*K*THETA/3.141593-K*SIN(2.*THETA)/3.141593
                    1+4.*COS(THETA)/3.141593)**2./2.
ISN 0014             EFFC(MK)=POUT(MK)/PIN(MK)*100.
ISN 0015             DO 110 MN=3,11,2
ISN 0016             N=MN
ISN 0017             PN(MK,MN)=(2.*K*SIN(THETA-N*THETA)/(1.-N)-2.*K*SIN(THETA+N*THETA)/
                    1(1.+N)+4.*COS(N*THETA)/N)**2/(3.141593**2*2.)
ISN 0018             PO(MK,MN)=(2.*K*THETA/3.141593-K*SIN(2.*THETA)/3.141593
                    1+4.*COS(THETA)/3.141593)**2./2.
              C      FOR THE CLASS'A' PROGRAM, PO ‡ POUT ARE IDENTICAL.
ISN 0019             RATIO(MK,MN)=-10.*ALOG10(ABS(PO(MK,MN)/PN(MK,MN)))
ISN 0020         110 CONTINUE
ISN 0021             DO 120 NGO=3,20
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TABLE A-III (Continued)

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ISN 0022          R=NGO/10.
ISN 0023          GO=10.**R
ISN 0024          Z=4.*GO*POUT(MK)/(2.*K**2.)
ISN 0025          G(MK,NGO)=10.*ALOG10(Z)
ISN 0026          EFFT(MK,NGO)=POUT(MK)/(PIN(MK)+K**2.*3.141593/(4.*GO))*100.
ISN 0027          DIFF=POUT(MK)-K/(4.*GO)
ISN 0028          IF(DIFF) 140,120,120
ISN 0029      120 CONTINUE
ISN 0030      140 CONTINUE
ISN 0031          DO 160 MZ=1,10,1
ISN 0032          WRITE(6,200)
ISN 0033          DO 300 MK=20,210,1
ISN 0034      300 WRITE(6,201)T(MK),PIN(MK),POUT(MK),EFFC(MK),PD(MK),(RATIO(MK,MN),M
                 1N=3,11,2)
ISN 0035      200 FORMAT('1','OPTIMUM EFFICIENCY DESIGN DATA FOR AN OVERDRIVEN
                 1POWER AMPLIFIER'//1X,'K(DB)',3X,'PIN(MK)',3X,'POUT(MK)',3X,
                 2'EFFC(MK)',5X,'PD(MK)',3X,'HARMONIC CONTENT(DB BELOW POUT) VS. HAR
                 3MONIC NUMBER(N)'//1X,57X,'N=3',5X,'N=5',5X,'N=7',5X,'N=9',5X,'N=11
                 4'//)
ISN 0036      201 FORMAT(1X,F5.1,3X,F7.4,3X,F8.4,3X,F8.4,3X,F8.4,6X,F6.1,2X,F6.1,2X,
                 1F6.1,2X,F6.1,2X,F6.1)
ISN 0037          WRITE(6,202)
ISN 0038          DO 301 MK=20,210,1
ISN 0039      301 WRITE(6,203)T(MK),(G(MK,NGO),NGO=3,20,1)
ISN 0040      202 FORMAT('1',1X,'EFFECTIVE GAIN (G) VS K FOR DIFFERENT VALUES
                 1OF GO'//1X,'K(DB)',3X,'GO(DB) EQUALS',3X,'3',5X,'4',5X,'5',
                 25X,'6',5X,'7',5X,'8',5X,'9',4X,'10',4X,'11',4X,'12',4X,'13',
                 34X,'14',4X,'15',4X,'16',4X,'17',4X,'18',4X,'19',4X,'20'//)
ISN 0041      203 FORMAT(1X,F5.1,18X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,
                 11X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,
                 21X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2)
ISN 0042          WRITE(6,204)
ISN 0043          DO 302 MK=20,210,1
ISN 0044      302 WRITE(6,205)T(MK),(EFFT(MK,NGO),NGO=3,20,1)
ISN 0045      204 FORMAT('1',1X,'OVERALL EFFECIENCY VS K FOR DIFFERENT VALUES
                 1OF GO'//1X,'K(DB)',3X,'GO(DB) EQUALS',3X,'3',5X,'4',5X,'5',
                 25X,'6',5X,'7',5X,'8',5X,'9',4X,'10',4X,'11',4X,'12',4X,'13',
                 34X,'14',4X,'15',4X,'16',4X,'17',4X,'18',4X,'19',4X,'20'//)
ISN 0046      205 FORMAT(1X,F5.1,18X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,
                 11X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2,
                 21X,F5.2,1X,F5.2,1X,F5.2,1X,F5.2)
ISN 0047      160 CONTINUE
ISN 0048          RETURN
ISN 0049          END
```

TABLE A-IV

OPTIMUM EFFICIENCY DESIGN DATA FOR AN OVERDRIVEN CLASS A POWER AMPLIFIER

(a) OUTPUT CHARACTERISTICS

K(DB)	PIN(MK)	POUT(MK)	EFFC(MK)	PD(MK)	HARMONIC CONTENT(DB BELOW POUT) VS. HARMONIC NUMBER(N) N=3	N=5	N=7	N=9	N=11
0.0	1.0000	0.5000	50.0000	0.5000	-162.6	-186.1	-166.7	-195.6	-125.0
0.1	1.0000	0.5101	51.0146	0.4898	-56.8	-57.1	-57.6	-58.3	-59.1
0.2	1.0000	0.5193	51.9270	0.4807	-48.0	-48.7	-49.7	-51.1	-52.9
0.3	1.0000	0.5278	52.7784	0.4721	-42.9	-43.9	-45.5	-47.7	-50.7
0.4	1.0000	0.5358	53.5827	0.4640	-39.4	-40.7	-42.8	-45.9	-50.5
0.5	1.0000	0.5435	54.3478	0.4563	-36.7	-38.4	-41.1	-45.2	-51.9
0.6	1.0000	0.5508	55.0790	0.4488	-34.5	-36.6	-39.9	-45.2	-55.4
0.7	1.0000	0.5578	55.7800	0.4416	-32.7	-35.1	-39.1	-45.9	-64.4
0.8	1.0000	0.5645	56.4539	0.4347	-31.2	-33.9	-38.6	-47.4	-64.1
0.9	1.0000	0.5710	57.1028	0.4280	-29.9	-32.9	-38.5	-49.8	-54.6
1.0	1.0000	0.5773	57.7286	0.4215	-28.7	-32.1	-38.5	-54.0	-50.3
1.1	1.0000	0.5833	58.3331	0.4151	-27.6	-31.5	-38.8	-64.5	-47.7
1.2	1.0000	0.5892	58.9175	0.4090	-26.7	-30.9	-39.3	-61.1	-46.1
1.3	1.0000	0.5948	59.4831	0.4030	-25.8	-30.5	-40.0	-52.4	-45.0
1.4	1.0000	0.6003	60.0308	0.3971	-25.0	-30.1	-41.1	-48.2	-44.4
1.5	1.0000	0.6056	60.5615	0.3914	-24.3	-29.8	-42.4	-45.5	-44.2
1.6	1.0000	0.6108	61.0762	0.3858	-23.6	-29.6	-44.3	-43.6	-44.3
1.7	1.0000	0.6158	61.5757	0.3804	-23.0	-29.4	-46.9	-42.1	-44.7
1.8	1.0000	0.6206	62.0604	0.3751	-22.5	-29.3	-51.0	-41.0	-45.5
1.9	1.0000	0.6253	62.5313	0.3698	-21.9	-29.2	-59.6	-40.1	-46.6
2.0	1.0000	0.6299	62.9887	0.3647	-21.4	-29.2	-62.1	-39.5	-48.3
2.1	1.0000	0.6343	63.4332	0.3597	-21.0	-29.2	-51.5	-39.1	-50.8
2.2	1.0000	0.6387	63.8654	0.3548	-20.5	-29.3	-46.9	-38.8	-54.8
2.3	1.0000	0.6429	64.2856	0.3500	-20.1	-29.4	-43.9	-38.6	-63.1
2.4	1.0000	0.6469	64.6944	0.3453	-19.7	-29.6	-41.6	-38.6	-66.6
2.5	1.0000	0.6509	65.0922	0.3407	-19.4	-29.8	-39.9	-38.7	-55.7
2.6	1.0000	0.6548	65.4792	0.3361	-19.0	-30.1	-38.5	-38.9	-51.0
2.7	1.0000	0.6586	65.8560	0.3317	-18.7	-30.4	-37.3	-39.2	-48.1
2.8	1.0000	0.6622	66.2227	0.3273	-18.4	-30.8	-36.3	-39.7	-46.0
2.9	1.0000	0.6658	66.5799	0.3230	-18.1	-31.2	-35.5	-40.4	-44.4
3.0	1.0000	0.6693	66.9278	0.3187	-17.8	-31.7	-34.7	-41.2	-43.1
3.1	1.0000	0.6727	67.2665	0.3146	-17.5	-32.2	-34.1	-42.2	-42.1
3.2	1.0000	0.6760	67.5966	0.3105	-17.2	-32.8	-33.5	-43.4	-41.4

TABLE A-IV (Continued)

(a) OUTPUT CHARACTERISTICS (Continued)

K(DB)	PIN(MK)	POUT(MK)	EFFC(MK)	PD(MK)	HARMONIC CONTENT(DB BELOW POUT) VS. HARMONIC NUMBER(N)				
					N=3	N=5	N=7	N=9	N=11
3.3	1.0000	0.6792	67.9182	0.3065	-17.0	-33.6	-33.0	-45.1	-40.8
3.4	1.0000	0.6823	68.2316	0.3025	-16.8	-34.4	-32.6	-47.2	-40.3
3.5	1.0000	0.6854	68.5369	0.2987	-16.5	-35.3	-32.3	-50.2	-40.0
3.6	1.0000	0.6883	68.8346	0.2948	-16.3	-36.4	-31.9	-55.0	-39.7
3.7	1.0000	0.6912	69.1248	0.2911	-16.1	-37.8	-31.7	-67.5	-39.6
3.8	1.0000	0.6941	69.4077	0.2874	-15.9	-39.4	-31.5	-60.3	-39.6
3.9	1.0000	0.6968	69.6835	0.2837	-15.7	-41.4	-31.3	-52.6	-39.7
4.0	1.0000	0.6995	69.9525	0.2801	-15.5	-44.2	-31.1	-48.5	-39.9
4.1	1.0000	0.7021	70.2147	0.2766	-15.3	-48.3	-31.0	-45.8	-40.2
4.2	1.0000	0.7047	70.4704	0.2731	-15.2	-56.8	-31.0	-43.7	-40.6
4.3	1.0000	0.7072	70.7198	0.2697	-15.0	-60.1	-30.9	-42.1	-41.1
4.4	1.0000	0.7096	70.9631	0.2663	-14.8	-49.2	-30.9	-40.7	-41.8
4.5	1.0000	0.7120	71.2004	0.2630	-14.7	-44.5	-31.0	-39.6	-42.6
4.6	1.0000	0.7143	71.4320	0.2597	-14.5	-41.4	-31.0	-38.6	-43.5
4.7	1.0000	0.7166	71.6578	0.2565	-14.4	-39.2	-31.1	-37.7	-44.7
4.8	1.0000	0.7188	71.8781	0.2533	-14.3	-37.3	-31.2	-37.0	-46.2
4.9	1.0000	0.7209	72.0931	0.2502	-14.1	-35.8	-31.4	-36.4	-48.2
5.0	1.0000	0.7230	72.3029	0.2471	-14.0	-34.5	-31.6	-35.8	-50.8
5.1	1.0000	0.7251	72.5076	0.2441	-13.9	-33.4	-31.8	-35.3	-54.7
5.2	1.0000	0.7271	72.7075	0.2411	-13.8	-32.4	-32.1	-34.8	-62.3
5.3	1.0000	0.7290	72.9024	0.2381	-13.6	-31.5	-32.3	-34.5	-69.5
5.4	1.0000	0.7309	73.0927	0.2352	-13.5	-30.7	-32.7	-34.1	-56.8
5.5	1.0000	0.7328	73.2783	0.2323	-13.4	-30.0	-33.0	-33.8	-51.8

TABLE A-IV (Continued)

(a) OUTPUT CHARACTERISTICS (Continued)

K(DB)	PIN(MK)	POUT(MK)	EFFC(MK)	PD(MK)	HARMONIC CONTENT(DB BELOW POUT) VS. HARMONIC NUMBER(N) N=3	N=5	N=7	N=9	N=11
5.6	1.0000	0.7346	73.4595	0.2295	-13.3	-29.3	-33.5	-33.6	-48.7
5.7	1.0000	0.7364	73.6364	0.2267	-13.2	-28.6	-33.9	-33.4	-46.4
5.8	1.0000	0.7381	73.8091	0.2239	-13.1	-28.0	-34.4	-33.2	-44.6
5.9	1.0000	0.7398	73.9776	0.2212	-13.0	-27.5	-35.0	-33.0	-43.1
6.0	1.0000	0.7414	74.1421	0.2185	-12.9	-27.0	-35.7	-32.9	-41.9
6.1	1.0000	0.7430	74.3028	0.2159	-12.8	-26.5	-36.4	-32.8	-40.9
6.2	1.0000	0.7446	74.4596	0.2133	-12.7	-26.1	-37.3	-32.8	-40.0
6.3	1.0000	0.7461	74.6126	0.2107	-12.7	-25.6	-38.2	-32.8	-39.2
6.4	1.0000	0.7476	74.7620	0.2082	-12.6	-25.2	-39.3	-32.8	-38.5
6.5	1.0000	0.7491	74.9078	0.2057	-12.5	-24.8	-40.6	-32.8	-37.9
6.6	1.0000	0.7505	75.0503	0.2032	-12.4	-24.5	-42.2	-32.9	-37.3
6.7	1.0000	0.7519	75.1893	0.2008	-12.4	-24.1	-44.2	-33.0	-36.9
6.8	1.0000	0.7533	75.3252	0.1983	-12.3	-23.8	-46.8	-33.1	-36.4
6.9	1.0000	0.7546	75.4577	0.1960	-12.2	-23.5	-50.7	-33.2	-36.1
7.0	1.0000	0.7559	75.5872	0.1936	-12.1	-23.2	-58.1	-33.4	-35.7
7.1	1.0000	0.7571	75.7135	0.1913	-12.1	-22.9	-66.9	-33.6	-35.5
7.2	1.0000	0.7584	75.8371	0.1890	-12.0	-22.6	-53.3	-33.8	-35.2
7.3	1.0000	0.7596	75.9576	0.1868	-11.9	-22.3	-48.2	-34.1	-35.0
7.4	1.0000	0.7608	76.0753	0.1846	-11.9	-22.1	-45.0	-34.4	-34.8
7.5	1.0000	0.7619	76.1903	0.1824	-11.8	-21.8	-42.6	-34.7	-34.7
7.6	1.0000	0.7630	76.3025	0.1802	-11.8	-21.6	-40.7	-35.1	-34.5
7.7	1.0000	0.7641	76.4121	0.1780	-11.7	-21.4	-39.2	-35.5	-34.5
7.8	1.0000	0.7652	76.5192	0.1759	-11.7	-21.2	-37.9	-35.9	-34.4
7.9	1.0000	0.7662	76.6238	0.1738	-11.6	-21.0	-36.7	-36.5	-34.4
8.0	1.0000	0.7673	76.7260	0.1718	-11.6	-20.8	-35.7	-37.0	-34.4
8.1	1.0000	0.7683	76.8257	0.1698	-11.5	-20.6	-34.8	-37.7	-34.4
8.2	1.0000	0.7692	76.9231	0.1677	-11.5	-20.4	-34.0	-38.4	-34.4
8.3	1.0000	0.7702	77.0182	0.1658	-11.4	-20.2	-33.2	-39.2	-34.5
8.4	1.0000	0.7711	77.1112	0.1638	-11.4	-20.0	-32.5	-40.1	-34.6
8.5	1.0000	0.7720	77.2019	0.1619	-11.3	-19.9	-31.9	-41.1	-34.7
8.6	1.0000	0.7729	77.2906	0.1600	-11.3	-19.7	-31.3	-42.4	-34.9
8.7	1.0000	0.7738	77.3772	0.1581	-11.2	-19.5	-30.8	-43.8	-35.0
8.8	1.0000	0.7746	77.4618	0.1562	-11.2	-19.4	-30.2	-45.7	-35.2
8.9	1.0000	0.7754	77.5444	0.1544	-11.1	-19.2	-29.8	-48.0	-35.5
9.0	1.0000	0.7763	77.6251	0.1526	-11.1	-19.1	-29.3	-51.3	-35.7
9.1	1.0000	0.7770	77.7039	0.1508	-11.1	-19.0	-28.9	-56.8	-36.0

TABLE A-IV (Continued)

(a) OUTPUT CHARACTERISTICS (Continued)

K(DB)	PIN(MK)	POUT(MK)	EFFC(MK)	PD(MK)	HARMONIC CONTENT(DB BELOW POUT) VS. HARMONIC NUMBER(N) N=3	N=5	N=7	N=9	N=11
9.2	1.0000	0.7778	77.7809	0.1490	-11.0	-18.8	-28.4	-76.8	-36.4
9.3	1.0000	0.7786	77.8560	0.1473	-11.0	-18.7	-28.1	-58.7	-36.7
9.4	1.0000	0.7793	77.9256	0.1455	-11.0	-18.6	-27.7	-52.1	-37.2
9.5	1.0000	0.7800	78.0014	0.1438	-10.9	-18.5	-27.3	-48.3	-37.6
9.6	1.0000	0.7807	78.0714	0.1421	-10.9	-18.3	-27.0	-45.7	-38.1
9.7	1.0000	0.7814	78.1400	0.1405	-10.9	-18.2	-26.7	-43.7	-38.7
9.8	1.0000	0.7821	78.2069	0.1388	-10.8	-18.1	-26.4	-42.0	-39.3
9.9	1.0000	0.7827	78.2721	0.1372	-10.8	-18.0	-26.1	-40.7	-40.0
10.0	1.0000	0.7834	78.3360	0.1356	-10.8	-17.9	-25.8	-39.4	-40.8
10.1	1.0000	0.7840	78.3985	0.1340	-10.7	-17.8	-25.5	-38.4	-41.7
10.2	1.0000	0.7846	78.4594	0.1324	-10.7	-17.7	-25.3	-37.4	-42.7
10.3	1.0000	0.7852	78.5189	0.1309	-10.7	-17.6	-25.0	-36.6	-43.9
10.4	1.0000	0.7858	78.5771	0.1294	-10.7	-17.5	-24.8	-35.8	-45.3
10.5	1.0000	0.7863	78.6339	0.1279	-10.6	-17.4	-24.6	-35.1	-47.1
10.6	1.0000	0.7869	78.6894	0.1264	-10.6	-17.3	-24.3	-34.4	-49.3
10.7	1.0000	0.7874	78.7436	0.1249	-10.6	-17.2	-24.1	-33.8	-52.3
10.8	1.0000	0.7880	78.7966	0.1234	-10.6	-17.2	-23.9	-33.3	-57.2
10.9	1.0000	0.7885	78.8484	0.1220	-10.5	-17.1	-23.7	-32.7	-69.6
11.0	1.0000	0.7890	78.8989	0.1206	-10.5	-17.0	-23.5	-32.2	-62.7
11.1	1.0000	0.7895	78.9483	0.1192	-10.5	-16.9	-23.3	-31.8	-54.9
11.2	1.0000	0.7900	78.9966	0.1178	-10.5	-16.9	-23.2	-31.3	-50.8
11.3	1.0000	0.7904	79.0435	0.1164	-10.4	-16.8	-23.0	-30.9	-48.0
11.4	1.0000	0.7909	79.0896	0.1151	-10.4	-16.7	-22.8	-30.5	-45.9
11.5	1.0000	0.7913	79.1347	0.1137	-10.4	-16.6	-22.7	-30.1	-44.2
11.6	1.0000	0.7918	79.1786	0.1124	-10.4	-16.6	-22.5	-29.8	-42.7
11.7	1.0000	0.7922	79.2217	0.1111	-10.4	-16.5	-22.4	-29.4	-41.5
11.8	1.0000	0.7926	79.2636	0.1098	-10.3	-16.5	-22.2	-29.1	-40.4
11.9	1.0000	0.7930	79.3046	0.1086	-10.3	-16.4	-22.1	-28.8	-39.4
12.0	1.0000	0.7934	79.3446	0.1073	-10.3	-16.3	-21.9	-28.5	-38.6

TABLE A-IV (Continued)

(b) EFFECTIVE GAIN VERSUS K FOR DIFFERENT VALUES OF G_o

K(DB)	GO(DB) EQUALS 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0.0	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00
0.1	2.99	3.99	4.99	5.99	6.99	7.99	8.99	9.99	10.99	11.99	12.99	13.99	14.99	15.99	16.99	17.99	18.99	19.99
0.2	2.96	3.96	4.96	5.96	6.96	7.96	8.96	9.96	10.96	11.96	12.96	13.96	14.96	15.96	16.96	17.96	18.96	19.96
0.3	2.93	3.93	4.93	5.93	6.93	7.93	8.93	9.93	10.93	11.93	12.93	13.93	14.93	15.93	16.93	17.93	18.93	19.93
0.4	2.90	3.90	4.90	5.90	6.90	7.90	8.90	9.90	10.90	11.90	12.90	13.90	14.90	15.90	16.90	17.90	18.90	19.90
0.5	2.86	3.86	4.86	5.86	6.86	7.86	8.86	9.86	10.86	11.86	12.86	13.86	14.86	15.86	16.86	17.86	18.86	19.86
0.6	2.82	3.82	4.82	5.82	6.82	7.82	8.82	9.82	10.82	11.82	12.82	13.82	14.82	15.82	16.82	17.82	18.82	19.82
0.7	2.78	3.78	4.78	5.78	6.78	7.78	8.78	9.78	10.78	11.78	12.78	13.78	14.78	15.78	16.78	17.78	18.78	19.78
0.8	2.73	3.73	4.73	5.73	6.73	7.73	8.73	9.73	10.73	11.73	12.73	13.73	14.73	15.73	16.73	17.73	18.73	19.73
0.9	2.68	3.68	4.68	5.68	6.68	7.68	8.68	9.68	10.68	11.68	12.68	13.68	14.68	15.68	16.68	17.68	18.68	19.68
1.0	2.62	3.62	4.62	5.62	6.62	7.62	8.62	9.62	10.62	11.62	12.62	13.62	14.62	15.62	16.62	17.62	18.62	19.62
1.1	2.57	3.57	4.57	5.57	6.57	7.57	8.57	9.57	10.57	11.57	12.57	13.57	14.57	15.57	16.57	17.57	18.57	19.57
1.2	2.51	3.51	4.51	5.51	6.51	7.51	8.51	9.51	10.51	11.51	12.51	13.51	14.51	15.51	16.51	17.51	18.51	19.51
1.3	2.45	3.45	4.45	5.45	6.45	7.45	8.45	9.45	10.45	11.45	12.45	13.45	14.45	15.45	16.45	17.45	18.45	19.45
1.4	2.39	3.39	4.39	5.39	6.39	7.39	8.39	9.39	10.39	11.39	12.39	13.39	14.39	15.39	16.39	17.39	18.39	19.39
1.5	2.33	3.33	4.33	5.33	6.33	7.33	8.33	9.33	10.33	11.33	12.33	13.33	14.33	15.33	16.33	17.33	18.33	19.33
1.6	2.27	3.27	4.27	5.27	6.27	7.27	8.27	9.27	10.27	11.27	12.27	13.27	14.27	15.27	16.27	17.27	18.27	19.27
1.7	2.20	3.20	4.20	5.20	6.20	7.20	8.20	9.20	10.20	11.20	12.20	13.20	14.20	15.20	16.20	17.20	18.20	19.20
1.8	2.14	3.14	4.14	5.14	6.14	7.14	8.14	9.14	10.14	11.14	12.14	13.14	14.14	15.14	16.14	17.14	18.14	19.14
1.9	2.07	3.07	4.07	5.07	6.07	7.07	8.07	9.07	10.07	11.07	12.07	13.07	14.07	15.07	16.07	17.07	18.07	19.07
2.0	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00
2.1	1.93	2.93	3.93	4.93	5.93	6.93	7.93	8.93	9.93	10.93	11.93	12.93	13.93	14.93	15.93	16.93	17.93	18.93
2.2	1.86	2.86	3.86	4.86	5.86	6.86	7.86	8.86	9.86	10.86	11.86	12.86	13.86	14.86	15.86	16.86	17.86	18.86
2.3	1.79	2.79	3.79	4.79	5.79	6.79	7.79	8.79	9.79	10.79	11.79	12.79	13.79	14.79	15.79	16.79	17.79	18.79
2.4	1.72	2.72	3.72	4.72	5.72	6.72	7.72	8.72	9.72	10.72	11.72	12.72	13.72	14.72	15.72	16.72	17.72	18.72
2.5	1.65	2.65	3.65	4.65	5.65	6.65	7.65	8.65	9.65	10.65	11.65	12.65	13.65	14.65	15.65	16.65	17.65	18.65
2.6	1.57	2.57	3.57	4.57	5.57	6.57	7.57	8.57	9.57	10.57	11.57	12.57	13.57	14.57	15.57	16.57	17.57	18.57
2.7	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50	11.50	12.50	13.50	14.50	15.50	16.50	17.50	18.50
2.8	1.42	2.42	3.42	4.42	5.42	6.42	7.42	8.42	9.42	10.42	11.42	12.42	13.42	14.42	15.42	16.42	17.42	18.42
2.9	1.34	2.34	3.34	4.34	5.34	6.34	7.34	8.34	9.34	10.34	11.34	12.34	13.34	14.34	15.34	16.34	17.34	18.34
3.0	1.27	2.27	3.27	4.27	5.27	6.27	7.27	8.27	9.27	10.27	11.27	12.27	13.27	14.27	15.27	16.27	17.27	18.27
3.1	1.19	2.19	3.19	4.19	5.19	6.19	7.19	8.19	9.19	10.19	11.19	12.19	13.19	14.19	15.19	16.19	17.19	18.19
3.2	1.11	2.11	3.11	4.11	5.11	6.11	7.11	8.11	9.11	10.11	11.11	12.11	13.11	14.11	15.11	16.11	17.11	18.11
3.3	1.03	2.03	3.03	4.03	5.03	6.03	7.03	8.03	9.03	10.03	11.03	12.03	13.03	14.03	15.03	16.03	17.03	18.03
3.4	0.95	1.95	2.95	3.95	4.95	5.95	6.95	7.95	8.95	9.95	10.95	11.95	12.95	13.95	14.95	15.95	16.95	17.95
3.5	0.87	1.87	2.87	3.87	4.87	5.87	6.87	7.87	8.87	9.87	10.87	11.87	12.87	13.87	14.87	15.87	16.87	17.87
3.6	0.79	1.79	2.79	3.79	4.79	5.79	6.79	7.79	8.79	9.79	10.79	11.79	12.79	13.79	14.79	15.79	16.79	17.79
3.7	0.71	1.71	2.71	3.71	4.71	5.71	6.71	7.71	8.71	9.71	10.71	11.71	12.71	13.71	14.71	15.71	16.71	17.71

TABLE A-IV (Continued)

(b) EFFECTIVE GAIN VERSUS K FOR DIFFERENT VALUES OF G_o (Continued)

K(DB)	GO(DB) EQUALS 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3.8	0.62	1.62	2.62	3.62	4.62	5.62	6.62	7.62	8.62	9.62	10.62	11.62	12.62	13.62	14.62	15.62	16.62	17.62
3.9	0.54	1.54	2.54	3.54	4.54	5.54	6.54	7.54	8.54	9.54	10.54	11.54	12.54	13.54	14.54	15.54	16.54	17.54
4.0	0.46	1.46	2.46	3.46	4.46	5.46	6.46	7.46	8.46	9.46	10.46	11.46	12.46	13.46	14.46	15.46	16.46	17.46
4.1	0.37	1.37	2.37	3.37	4.37	5.37	6.37	7.37	8.37	9.37	10.37	11.37	12.37	13.37	14.37	15.37	16.37	17.37
4.2	0.29	1.29	2.29	3.29	4.29	5.29	6.29	7.29	8.29	9.29	10.29	11.29	12.29	13.29	14.29	15.29	16.29	17.29
4.3	0.21	1.21	2.21	3.21	4.21	5.21	6.21	7.21	8.21	9.21	10.21	11.21	12.21	13.21	14.21	15.21	16.21	17.21
4.4	0.12	1.12	2.12	3.12	4.12	5.12	6.12	7.12	8.12	9.12	10.12	11.12	12.12	13.12	14.12	15.12	16.12	17.12
4.5	0.04	1.04	2.04	3.04	4.04	5.04	6.04	7.04	8.04	9.04	10.04	11.04	12.04	13.04	14.04	15.04	16.04	17.04
4.6	-0.05	0.95	1.95	2.95	3.95	4.95	5.95	6.95	7.95	8.95	9.95	10.95	11.95	12.95	13.95	14.95	15.95	16.95
4.7	-0.14	0.86	1.86	2.86	3.86	4.86	5.86	6.86	7.86	8.86	9.86	10.86	11.86	12.86	13.86	14.86	15.86	16.86
4.8	-0.22	0.78	1.78	2.78	3.78	4.78	5.78	6.78	7.78	8.78	9.78	10.78	11.78	12.78	13.78	14.78	15.78	16.78
4.9	-0.31	0.69	1.69	2.69	3.69	4.69	5.69	6.69	7.69	8.69	9.69	10.69	11.69	12.69	13.69	14.69	15.69	16.69
5.0	-0.40	0.60	1.60	2.60	3.60	4.60	5.60	6.60	7.60	8.60	9.60	10.60	11.60	12.60	13.60	14.60	15.60	16.60
5.1	-0.49	0.51	1.51	2.51	3.51	4.51	5.51	6.51	7.51	8.51	9.51	10.51	11.51	12.51	13.51	14.51	15.51	16.51
5.2	-0.57	0.43	1.43	2.43	3.43	4.43	5.43	6.43	7.43	8.43	9.43	10.43	11.43	12.43	13.43	14.43	15.43	16.43
5.3	-0.66	0.34	1.34	2.34	3.34	4.34	5.34	6.34	7.34	8.34	9.34	10.34	11.34	12.34	13.34	14.34	15.34	16.34
5.4	-0.75	0.25	1.25	2.25	3.25	4.25	5.25	6.25	7.25	8.25	9.25	10.25	11.25	12.25	13.25	14.25	15.25	16.25
5.5	-0.84	0.16	1.16	2.16	3.16	4.16	5.16	6.16	7.16	8.16	9.16	10.16	11.16	12.16	13.16	14.16	15.16	16.16
5.6	-0.93	0.07	1.07	2.07	3.07	4.07	5.07	6.07	7.07	8.07	9.07	10.07	11.07	12.07	13.07	14.07	15.07	16.07
5.7	-1.02	-0.02	0.98	1.98	2.98	3.98	4.98	5.98	6.98	7.98	8.98	9.98	10.98	11.98	12.98	13.98	14.98	15.98
5.8	-1.11	-0.11	0.89	1.89	2.89	3.89	4.89	5.89	6.89	7.89	8.89	9.89	10.89	11.89	12.89	13.89	14.89	15.89
5.9	-1.20	-0.20	0.80	1.80	2.80	3.80	4.80	5.80	6.80	7.80	8.80	9.80	10.80	11.80	12.80	13.80	14.80	15.80
6.0	-1.29	-0.29	0.71	1.71	2.71	3.71	4.71	5.71	6.71	7.71	8.71	9.71	10.71	11.71	12.71	13.71	14.71	15.71
6.1	-1.38	-0.38	0.62	1.62	2.62	3.62	4.62	5.62	6.62	7.62	8.62	9.62	10.62	11.62	12.62	13.62	14.62	15.62
6.2	-1.47	-0.47	0.53	1.53	2.53	3.53	4.53	5.53	6.53	7.53	8.53	9.53	10.53	11.53	12.53	13.53	14.53	15.53
6.3	-1.56	-0.56	0.44	1.44	2.44	3.44	4.44	5.44	6.44	7.44	8.44	9.44	10.44	11.44	12.44	13.44	14.44	15.44
6.4	-1.65	-0.65	0.35	1.35	2.35	3.35	4.35	5.35	6.35	7.35	8.35	9.35	10.35	11.35	12.35	13.35	14.35	15.35
6.5	-1.74	-0.74	0.26	1.26	2.26	3.26	4.26	5.26	6.26	7.26	8.26	9.26	10.26	11.26	12.26	13.26	14.26	15.26
6.6	-1.84	-0.84	0.16	1.16	2.16	3.16	4.16	5.16	6.16	7.16	8.16	9.16	10.16	11.16	12.16	13.16	14.16	15.16
6.7	-1.93	-0.93	0.07	1.07	2.07	3.07	4.07	5.07	6.07	7.07	8.07	9.07	10.07	11.07	12.07	13.07	14.07	15.07
6.8	-2.02	-1.02	-0.02	0.98	1.98	2.98	3.98	4.98	5.98	6.98	7.98	8.98	9.98	10.98	11.98	12.98	13.98	14.98
6.9	-2.11	-1.11	-0.11	0.89	1.89	2.89	3.89	4.89	5.89	6.89	7.89	8.89	9.89	10.89	11.89	12.89	13.89	14.89
7.0	-2.21	-1.21	-0.21	0.79	1.79	2.79	3.79	4.79	5.79	6.79	7.79	8.79	9.79	10.79	11.79	12.79	13.79	14.79
7.1	-2.30	-1.30	-0.30	0.70	1.70	2.70	3.70	4.70	5.70	6.70	7.70	8.70	9.70	10.70	11.70	12.70	13.70	14.70
7.2	-2.39	-1.39	-0.39	0.61	1.61	2.61	3.61	4.61	5.61	6.61	7.61	8.61	9.61	10.61	11.61	12.61	13.61	14.61
7.3	-2.48	-1.48	-0.48	0.52	1.52	2.52	3.52	4.52	5.52	6.52	7.52	8.52	9.52	10.52	11.52	12.52	13.52	14.52
7.4	-2.58	-1.58	-0.58	0.42	1.42	2.42	3.42	4.42	5.42	6.42	7.42	8.42	9.42	10.42	11.42	12.42	13.42	14.42
7.5	-2.67	-1.67	-0.67	0.33	1.33	2.33	3.33	4.33	5.33	6.33	7.33	8.33	9.33	10.33	11.33	12.33	13.33	14.33
7.6	-2.76	-1.76	-0.76	0.24	1.24	2.24	3.24	4.24	5.24	6.24	7.24	8.24	9.24	10.24	11.24	12.24	13.24	14.24
7.7	-2.86	-1.86	-0.86	0.14	1.14	2.14	3.14	4.14	5.14	6.14	7.14	8.14	9.14	10.14	11.14	12.14	13.14	14.14
7.8	-2.95	-1.95	-0.95	0.05	1.05	2.05	3.05	4.05	5.05	6.05	7.05	8.05	9.05	10.05	11.05	12.05	13.05	14.05

TABLE A-IV (Continued)

(b) EFFECTIVE GAIN VERSUS K FOR DIFFERENT VALUES OF G_o (Continued)

K(DB) GO(DB) EQUALS	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
7.9	-3.05	-2.05	-1.05	-0.05	0.95	1.95	2.95	3.95	4.95	5.95	6.95	7.95	8.95	9.95	10.95	11.95	12.95	13.95
8.0	-3.14	-2.14	-1.14	-0.14	0.86	1.86	2.86	3.86	4.86	5.86	6.86	7.86	8.86	9.86	10.86	11.86	12.86	13.86
8.1	-3.23	-2.23	-1.23	-0.23	0.77	1.77	2.77	3.77	4.77	5.77	6.77	7.77	8.77	9.77	10.77	11.77	12.77	13.77
8.2	-3.33	-2.33	-1.33	-0.33	0.67	1.67	2.67	3.67	4.67	5.67	6.67	7.67	8.67	9.67	10.67	11.67	12.67	13.67
8.3	-3.42	-2.42	-1.42	-0.42	0.58	1.58	2.58	3.58	4.58	5.58	6.58	7.58	8.58	9.58	10.58	11.58	12.58	13.58
8.4	-3.52	-2.52	-1.52	-0.52	0.48	1.48	2.48	3.48	4.48	5.48	6.48	7.48	8.48	9.48	10.48	11.48	12.48	13.48
8.5	-3.61	-2.61	-1.61	-0.61	0.39	1.39	2.39	3.39	4.39	5.39	6.39	7.39	8.39	9.39	10.39	11.39	12.39	13.39
8.6	-3.71	-2.71	-1.71	-0.71	0.29	1.29	2.29	3.29	4.29	5.29	6.29	7.29	8.29	9.29	10.29	11.29	12.29	13.29
8.7	-3.80	-2.80	-1.80	-0.80	0.20	1.20	2.20	3.20	4.20	5.20	6.20	7.20	8.20	9.20	10.20	11.20	12.20	13.20
8.8	-3.90	-2.90	-1.90	-0.90	0.10	1.10	2.10	3.10	4.10	5.10	6.10	7.10	8.10	9.10	10.10	11.10	12.10	13.10
8.9	-3.99	-2.99	-1.99	-0.99	0.01	1.01	2.01	3.01	4.01	5.01	6.01	7.01	8.01	9.01	10.01	11.01	12.01	13.01
9.0	-4.09	-3.09	-2.09	-1.09	-0.09	0.91	1.91	2.91	3.91	4.91	5.91	6.91	7.91	8.91	9.91	10.91	11.91	12.91
9.1	-4.19	-3.19	-2.19	-1.19	-0.19	0.81	1.81	2.81	3.81	4.81	5.81	6.81	7.81	8.81	9.81	10.81	11.81	12.81
9.2	-4.28	-3.28	-2.28	-1.28	-0.28	0.72	1.72	2.72	3.72	4.72	5.72	6.72	7.72	8.72	9.72	10.72	11.72	12.72
9.3	-4.38	-3.38	-2.38	-1.38	-0.38	0.62	1.62	2.62	3.62	4.62	5.62	6.62	7.62	8.62	9.62	10.62	11.62	12.62
9.4	-4.47	-3.47	-2.47	-1.47	-0.47	0.53	1.53	2.53	3.53	4.53	5.53	6.53	7.53	8.53	9.53	10.53	11.53	12.53
9.5	-4.57	-3.57	-2.57	-1.57	-0.57	0.43	1.43	2.43	3.43	4.43	5.43	6.43	7.43	8.43	9.43	10.43	11.43	12.43
9.6	-4.66	-3.66	-2.66	-1.66	-0.66	0.34	1.34	2.34	3.34	4.34	5.34	6.34	7.34	8.34	9.34	10.34	11.34	12.34
9.7	-4.76	-3.76	-2.76	-1.76	-0.76	0.24	1.24	2.24	3.24	4.24	5.24	6.24	7.24	8.24	9.24	10.24	11.24	12.24
9.8	-4.86	-3.86	-2.86	-1.86	-0.86	0.14	1.14	2.14	3.14	4.14	5.14	6.14	7.14	8.14	9.14	10.14	11.14	12.14
9.9	-4.95	-3.95	-2.95	-1.95	-0.95	0.05	1.05	2.05	3.05	4.05	5.05	6.05	7.05	8.05	9.05	10.05	11.05	12.05
10.0	-5.05	-4.05	-3.05	-2.05	-1.05	-0.05	0.95	1.95	2.95	3.95	4.95	5.95	6.95	7.95	8.95	9.95	10.95	11.95
10.1	-5.15	-4.15	-3.15	-2.15	-1.15	-0.15	0.85	1.85	2.85	3.85	4.85	5.85	6.85	7.85	8.85	9.85	10.85	11.85
10.2	-5.24	-4.24	-3.24	-2.24	-1.24	-0.24	0.76	1.76	2.76	3.76	4.76	5.76	6.76	7.76	8.76	9.76	10.76	11.76
10.3	-5.34	-4.34	-3.34	-2.34	-1.34	-0.34	0.66	1.66	2.66	3.66	4.66	5.66	6.66	7.66	8.66	9.66	10.66	11.66
10.4	-5.44	-4.44	-3.44	-2.44	-1.44	-0.44	0.56	1.56	2.56	3.56	4.56	5.56	6.56	7.56	8.56	9.56	10.56	11.56
10.5	-5.53	-4.53	-3.53	-2.53	-1.53	-0.53	0.47	1.47	2.47	3.47	4.47	5.47	6.47	7.47	8.47	9.47	10.47	11.47
10.6	-5.63	-4.63	-3.63	-2.63	-1.63	-0.63	0.37	1.37	2.37	3.37	4.37	5.37	6.37	7.37	8.37	9.37	10.37	11.37
10.7	-5.73	-4.73	-3.73	-2.73	-1.73	-0.73	0.27	1.27	2.27	3.27	4.27	5.27	6.27	7.27	8.27	9.27	10.27	11.27
10.8	-5.82	-4.82	-3.82	-2.82	-1.82	-0.82	0.18	1.18	2.18	3.18	4.18	5.18	6.18	7.18	8.18	9.18	10.18	11.18
10.9	-5.92	-4.92	-3.92	-2.92	-1.92	-0.92	0.08	1.08	2.08	3.08	4.08	5.08	6.08	7.08	8.08	9.08	10.08	11.08
11.0	-6.02	-5.02	-4.02	-3.02	-2.02	-1.02	-0.02	0.98	1.98	2.98	3.98	4.98	5.98	6.98	7.98	8.98	9.98	10.98
11.1	-6.12	-5.12	-4.12	-3.12	-2.12	-1.12	-0.12	0.88	1.88	2.88	3.88	4.88	5.88	6.88	7.88	8.88	9.88	10.88
11.2	-6.21	-5.21	-4.21	-3.21	-2.21	-1.21	-0.21	0.79	1.79	2.79	3.79	4.79	5.79	6.79	7.79	8.79	9.79	10.79
11.3	-6.31	-5.31	-4.31	-3.31	-2.31	-1.31	-0.31	0.69	1.69	2.69	3.69	4.69	5.69	6.69	7.69	8.69	9.69	10.69
11.4	-6.41	-5.41	-4.41	-3.41	-2.41	-1.41	-0.41	0.59	1.59	2.59	3.59	4.59	5.59	6.59	7.59	8.59	9.59	10.59
11.5	-6.51	-5.51	-4.51	-3.51	-2.51	-1.51	-0.51	0.49	1.49	2.49	3.49	4.49	5.49	6.49	7.49	8.49	9.49	10.49
11.6	-6.60	-5.60	-4.60	-3.60	-2.60	-1.60	-0.60	0.40	1.40	2.40	3.40	4.40	5.40	6.40	7.40	8.40	9.40	10.40
11.7	-6.70	-5.70	-4.70	-3.70	-2.70	-1.70	-0.70	0.30	1.30	2.30	3.30	4.30	5.30	6.30	7.30	8.30	9.30	10.30
11.8	-6.80	-5.80	-4.80	-3.80	-2.80	-1.80	-0.80	0.20	1.20	2.20	3.20	4.20	5.20	6.20	7.20	8.20	9.20	10.20
11.9	-6.90	-5.90	-4.90	-3.90	-2.90	-1.90	-0.90	0.10	1.10	2.10	3.10	4.10	5.10	6.10	7.10	8.10	9.10	10.10
12.0	-6.99	-5.99	-4.99	-3.99	-2.99	-1.99	-0.99	0.01	1.01	2.01	3.01	4.01	5.01	6.01	7.01	8.01	9.01	10.01

TABLE A-IV (Continued)

(c) OVERALL EFFICIENCY VERSUS K FOR DIFFERENT VALUES OF G_o

K(DB) GO(DB) EQUALS	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0.0	35.88	38.09	40.05	41.76	43.23	44.47	45.50	46.36	47.06	47.64	48.11	48.48	48.79	49.03	49.23	49.39	49.51	49.61
0.1	36.37	38.65	40.68	42.45	43.96	45.25	46.33	47.22	47.95	48.55	49.04	49.43	49.75	50.01	50.21	50.37	50.50	50.61
0.2	36.77	39.12	41.21	43.04	44.61	45.94	47.06	47.98	48.74	49.37	49.87	50.28	50.61	50.88	51.09	51.26	51.39	51.50
0.3	37.12	39.53	41.68	43.57	45.19	46.57	47.72	48.68	49.47	50.12	50.64	51.07	51.41	51.69	51.91	52.08	52.23	52.34
0.4	37.43	39.90	42.11	44.05	45.73	47.15	48.34	49.33	50.15	50.82	51.37	51.81	52.16	52.45	52.68	52.86	53.01	53.17
0.5	37.70	40.23	42.50	44.50	46.22	47.69	48.92	49.95	50.79	51.49	52.05	52.51	52.87	53.17	53.41	53.60	53.75	53.87
0.6	37.93	40.53	42.86	44.91	46.68	48.19	49.46	50.52	51.40	52.11	52.70	53.17	53.55	53.86	54.11	54.30	54.46	54.59
0.7	38.14	40.79	43.18	45.28	47.11	48.66	49.97	51.07	51.97	52.71	53.31	53.80	54.20	54.52	54.77	54.98	55.14	55.27
0.8	38.32	41.03	43.47	45.63	47.50	49.11	50.46	51.58	52.52	53.28	53.90	54.41	54.82	55.15	55.41	55.62	55.79	55.93
0.9	38.47	41.24	43.74	45.95	47.87	49.52	50.91	52.07	53.03	53.82	54.47	54.99	55.41	55.75	56.02	56.24	56.42	56.56
1.0	38.60	41.42	43.98	46.24	48.22	49.91	51.34	52.53	53.52	54.34	55.00	55.54	55.98	56.33	56.61	56.84	57.02	57.16
1.1	38.71	41.58	44.19	46.51	48.53	50.27	51.74	52.97	53.99	54.83	55.52	56.07	56.52	56.89	57.18	57.41	57.60	57.75
1.2	38.79	41.72	44.39	46.76	48.83	50.61	52.12	53.39	54.44	55.30	56.01	56.59	57.05	57.42	57.73	57.97	58.16	58.31
1.3	38.85	41.84	44.56	46.98	49.10	50.93	52.48	53.78	54.87	55.76	56.48	57.08	57.55	57.94	58.25	58.50	58.70	58.86
1.4	38.90	41.93	44.70	47.18	49.35	51.23	52.82	54.16	55.27	56.19	56.94	57.55	58.04	58.44	58.76	59.02	59.22	59.39
1.5	38.92	42.01	44.83	47.36	49.59	51.51	53.14	54.51	55.66	56.60	57.37	58.00	58.51	58.92	59.25	59.52	59.73	59.90
1.6	38.93	42.06	44.94	47.52	49.80	51.76	53.44	54.85	56.02	56.99	57.79	58.44	58.96	59.38	59.72	60.00	60.22	60.39
1.7	38.92	42.10	45.03	47.67	49.99	52.00	53.72	55.17	56.37	57.37	58.19	58.85	59.39	59.83	60.18	60.46	60.69	60.87
1.8	38.89	42.12	45.10	47.79	50.16	52.22	53.98	55.47	56.71	57.73	58.57	59.26	59.81	60.26	60.62	60.91	61.15	61.33
1.9	38.85	42.13	45.16	47.90	50.32	52.42	54.23	55.75	57.02	58.07	58.94	59.64	60.22	60.68	61.05	61.35	61.59	61.78
2.0	38.79	42.12	45.20	47.99	50.46	52.61	54.46	56.02	57.32	58.40	59.29	60.01	60.60	61.08	61.46	61.77	62.02	62.21
2.1	38.72	42.09	45.22	48.06	50.58	52.78	54.67	56.27	57.60	58.71	59.63	60.37	60.98	61.47	61.86	62.18	62.43	62.64
2.2	38.63	42.05	45.22	48.11	50.68	52.93	54.86	56.50	57.87	59.01	59.95	60.71	61.34	61.84	62.25	62.57	62.83	63.04
2.3	38.53	41.99	45.21	48.15	50.77	53.07	55.04	56.72	58.13	59.30	60.26	61.04	61.68	62.20	62.62	62.95	63.22	63.44
2.4	38.42	41.92	45.19	48.18	50.85	53.19	55.21	56.92	58.37	59.56	60.55	61.36	62.02	62.55	62.98	63.32	63.60	63.82
2.5	38.29	41.83	45.15	48.19	50.91	53.30	55.36	57.12	58.59	59.82	60.83	61.66	62.34	62.89	63.33	63.68	63.97	64.20
2.6	38.15	41.73	45.10	48.18	50.95	53.39	55.49	57.29	58.80	60.06	61.10	61.95	62.65	63.21	63.66	64.03	64.32	64.56
2.7	38.00	41.62	45.03	48.16	50.98	53.46	55.62	57.45	59.00	60.29	61.36	62.23	62.94	63.52	63.99	64.36	64.67	64.91
2.8	37.84	41.50	44.95	48.13	51.00	53.53	55.72	57.60	59.19	60.51	61.60	62.50	63.23	63.82	64.30	64.69	65.00	65.25
2.9	37.67	41.36	44.86	48.08	51.00	53.58	55.82	57.74	59.36	60.71	61.83	62.75	63.50	64.11	64.61	65.00	65.32	65.58
3.0	37.49	41.22	44.75	48.02	50.99	53.61	55.90	57.86	59.52	60.91	62.05	63.00	63.77	64.39	64.90	65.31	65.63	65.90
3.1	37.29	41.06	44.63	47.95	50.96	53.64	55.97	57.97	59.67	61.09	62.26	63.23	64.02	64.66	65.18	65.60	65.94	66.20
3.2	37.09	40.89	44.50	47.87	50.92	53.65	56.02	58.07	59.80	61.25	62.46	63.45	64.26	64.92	65.45	65.88	66.23	66.51
3.3	36.88	40.71	44.36	47.77	50.87	53.64	56.07	58.15	59.93	61.41	62.65	63.66	64.49	65.17	65.72	66.16	66.51	66.80
3.4	36.66	40.52	44.21	47.66	50.81	53.63	56.10	58.23	60.04	61.56	62.82	63.86	64.72	65.41	65.97	66.42	66.79	67.08
3.5	36.43	40.32	44.05	47.54	50.74	53.60	56.12	58.29	60.14	61.69	62.99	64.05	64.93	65.64	66.21	66.68	67.05	67.35
3.6	36.20	40.11	43.87	47.41	50.65	53.56	56.12	58.34	60.23	61.82	63.14	64.23	65.13	65.86	66.45	66.93	67.31	67.62
3.7	35.95	39.89	43.69	47.27	50.55	53.51	56.12	58.38	60.31	61.93	63.29	64.40	65.32	66.07	66.68	67.16	67.56	67.88

TABLE A-IV (Continued)

(c) OVERALL EFFICIENCY VERSUS K FOR DIFFERENT VALUES OF G_o (Continued)

K(DB)	GO(DB) EQUALS	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3.8		35.70	39.66	43.49	47.11	50.44	53.45	56.10	58.40	60.37	62.03	63.42	64.57	65.51	66.27	66.89	67.40	67.80	68.12
3.9		35.44	39.42	43.29	46.95	50.32	53.37	56.07	58.42	60.43	62.13	63.54	64.72	65.68	66.46	67.10	67.62	68.03	68.37
4.0		35.17	39.18	43.08	46.77	50.19	53.29	56.04	58.43	60.48	62.21	63.66	64.86	65.84	66.65	67.30	67.83	68.26	68.60
4.1		34.90	38.93	42.86	46.59	50.05	53.19	55.99	58.42	60.51	62.28	63.76	64.99	66.00	66.83	67.50	68.04	68.47	68.83
4.2		34.62	38.67	42.62	46.40	49.90	53.09	55.93	58.41	60.54	62.34	63.86	65.12	66.15	66.99	67.68	68.24	68.68	69.04
4.3		34.34	38.40	42.39	46.19	49.74	52.97	55.86	58.38	60.55	62.40	63.95	65.23	66.29	67.15	67.86	68.43	68.89	69.26
4.4		34.05	38.13	42.14	45.98	49.57	52.85	55.77	58.34	60.56	62.44	64.02	65.34	66.42	67.31	68.03	68.61	69.08	69.46
4.5		33.75	37.85	41.88	45.76	49.39	52.71	55.68	58.30	60.55	62.47	64.09	65.43	66.54	67.45	68.19	68.79	69.27	69.66
4.6		33.45	37.56	41.62	45.53	49.20	52.56	55.58	58.24	60.54	62.50	64.15	65.52	66.66	67.59	68.34	68.96	69.45	69.85
4.7		33.15	37.27	41.35	45.29	49.00	52.41	55.47	58.17	60.52	62.52	64.20	65.60	66.76	67.72	68.49	69.12	69.63	70.03
4.8		32.84	36.97	41.07	45.04	48.79	52.24	55.35	58.10	60.48	62.52	64.24	65.68	66.86	67.84	68.63	69.27	69.79	70.21
4.9		32.53	36.67	40.79	44.79	48.57	52.07	55.22	58.01	60.44	62.52	64.27	65.74	66.95	67.95	68.76	69.42	69.96	70.38
5.0		32.21	36.36	40.50	44.53	48.35	51.88	55.08	57.92	60.39	62.51	64.30	65.80	67.04	68.06	68.89	69.56	70.11	70.55
5.1		31.89	36.04	40.20	44.26	48.11	51.69	54.93	57.81	60.33	62.49	64.32	65.85	67.11	68.16	69.01	69.70	70.26	70.71
5.2		31.56	35.72	39.90	43.98	47.87	51.49	54.77	57.70	60.26	62.46	64.32	65.89	67.18	68.25	69.12	69.83	70.40	70.86
5.3		31.24	35.40	39.59	43.69	47.62	51.28	54.61	57.58	60.18	62.42	64.32	65.92	67.24	68.33	69.23	69.95	70.54	71.01
5.4		30.91	35.07	39.27	43.40	47.36	51.06	54.43	57.45	60.09	62.37	64.31	65.94	67.30	68.41	69.33	70.07	70.67	71.15
5.5		30.58	34.74	38.95	43.11	47.09	50.83	54.25	57.31	60.00	62.32	64.30	65.96	67.34	68.48	69.42	70.18	70.79	71.29
5.6		30.24	34.40	38.63	42.80	46.82	50.59	54.05	57.16	59.89	62.26	64.27	65.97	67.38	68.55	69.50	70.28	70.91	71.42
5.7		29.90	34.06	38.30	42.49	46.54	50.35	53.85	57.00	59.78	62.19	64.24	65.97	67.42	68.61	69.59	70.38	71.03	71.55
5.8		29.56	33.72	37.96	42.18	46.25	50.10	53.64	56.84	59.66	62.11	64.20	65.97	67.44	68.66	69.66	70.47	71.14	71.67
5.9		29.22	33.38	37.62	41.85	45.96	49.84	53.43	56.66	59.53	62.02	64.15	65.95	67.46	68.70	69.73	70.56	71.24	71.78
6.0		28.88	33.03	37.28	41.53	45.66	49.58	53.20	56.48	59.39	61.93	64.10	65.93	67.47	68.74	69.79	70.64	71.33	71.89
6.1		28.54	32.68	36.93	41.19	45.35	49.30	52.97	56.29	59.25	61.82	64.03	65.91	67.48	68.78	69.84	70.72	71.43	72.00
6.2		28.19	32.33	36.58	40.86	45.04	49.02	52.73	56.09	59.09	61.71	63.96	65.87	67.47	68.80	69.89	70.79	71.51	72.10
6.3		27.85	31.97	36.23	40.52	44.72	48.73	52.48	55.89	58.93	61.59	63.89	65.83	67.46	68.82	69.94	70.85	71.59	72.19
6.4		27.50	31.61	35.87	40.17	44.39	48.44	52.22	55.67	58.76	61.47	63.80	65.78	67.45	68.83	69.98	70.91	71.67	72.28
6.5		27.16	31.26	35.51	39.82	44.06	48.14	51.96	55.45	58.58	61.33	63.71	65.73	67.43	68.84	70.01	70.96	71.74	72.37
6.6		26.81	30.90	35.15	39.46	43.73	47.83	51.69	55.22	58.40	61.19	63.61	65.67	67.40	68.84	70.03	71.01	71.81	72.45
6.7		26.46	30.53	34.78	39.10	43.39	47.52	51.41	54.99	58.20	61.04	63.50	65.60	67.36	68.84	70.05	71.05	71.87	72.53
6.8		26.12	30.17	34.41	38.74	43.04	47.20	51.13	54.75	58.00	60.88	63.38	65.52	67.32	68.83	70.07	71.09	71.92	72.60
6.9		25.77	29.81	34.04	38.38	42.69	46.88	50.84	54.50	57.80	60.72	63.26	65.44	67.27	68.81	70.08	71.12	71.97	72.66
7.0		25.43	29.44	33.67	38.01	42.34	46.55	50.54	54.24	57.58	60.55	63.13	65.35	67.22	68.79	70.08	71.15	72.02	72.72
7.1		25.08	29.08	33.30	37.63	41.98	46.21	50.24	53.97	57.36	60.37	63.00	65.25	67.16	68.76	70.08	71.17	72.06	72.78
7.2		24.74	28.72	32.92	37.26	41.61	45.87	49.93	53.70	57.13	60.18	62.85	65.15	67.09	68.72	70.07	71.19	72.10	72.83
7.3		24.39	28.35	32.55	36.88	41.25	45.52	49.61	53.42	56.90	59.99	62.70	65.04	67.02	68.68	70.06	71.20	72.13	72.88
7.4		24.05	27.99	32.17	36.50	40.87	45.17	49.29	53.14	56.65	59.79	62.55	64.92	66.94	68.63	70.04	71.20	72.15	72.93
7.5		23.71	27.62	31.79	36.12	40.50	44.82	48.96	52.85	56.40	59.59	62.38	64.80	66.85	68.58	70.02	71.21	72.18	72.97
7.6		23.37	27.26	31.41	35.73	40.12	44.46	48.63	52.55	56.15	59.37	62.21	64.67	66.76	68.52	69.99	71.20	72.19	73.00
7.7		23.03	26.89	31.03	35.35	39.74	44.09	48.29	52.25	55.88	59.15	62.03	64.53	66.66	68.46	69.96	71.19	72.21	73.03

TABLE A-IV (Continued)

(c) OVERALL EFFICIENCY VERSUS K FOR DIFFERENT VALUES OF G_o (Continued)

K(DB)	GO(DB) EQUALS 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
7.8	22.69	26.53	30.65	34.96	39.36	43.72	47.95	51.94	55.61	58.92	61.85	64.39	66.56	68.39	69.92	71.18	72.22	73.06
7.9	22.36	26.17	30.27	34.57	38.97	43.35	47.60	51.62	55.34	58.69	61.66	64.24	66.45	68.31	69.87	71.16	72.22	73.08
8.0	22.02	25.81	29.89	34.18	38.58	42.97	47.25	51.30	55.05	58.45	61.46	64.08	66.33	68.23	69.82	71.14	72.22	73.10
8.1	21.69	25.45	29.51	33.79	38.19	42.59	46.89	50.98	54.77	58.20	61.26	63.92	66.21	68.15	69.77	71.11	72.22	73.12
8.2	21.36	25.09	29.13	33.39	37.79	42.21	46.53	50.64	54.47	57.95	61.05	63.75	66.08	68.05	69.71	71.08	72.21	73.13
8.3	21.04	24.73	28.75	33.00	37.40	41.82	46.16	50.31	54.17	57.69	60.83	63.58	65.95	67.95	69.64	71.04	72.19	73.13
8.4	20.71	24.38	28.37	32.61	37.00	41.43	45.79	49.96	53.86	57.42	60.61	63.40	65.80	67.85	69.57	71.00	72.17	73.14
8.5	20.39	24.02	27.99	32.21	36.60	41.04	45.41	49.62	53.55	57.15	60.38	63.21	65.66	67.74	69.49	70.95	72.15	73.14
8.6	20.07	23.67	27.61	31.82	36.20	40.64	45.03	49.26	53.23	56.87	60.14	63.02	65.50	67.63	69.41	70.90	72.12	73.13
8.7	19.75	23.32	27.23	31.42	35.79	40.24	44.65	48.90	52.91	56.59	59.90	62.82	65.35	67.50	69.32	70.84	72.09	73.12
8.8	19.43	22.97	26.86	31.03	35.39	39.84	44.26	48.54	52.58	56.30	59.65	62.61	65.18	67.38	69.23	70.78	72.06	73.11
8.9	19.12	22.63	26.48	30.63	34.99	39.44	43.87	48.17	52.24	56.00	59.40	62.40	65.01	67.25	69.13	70.71	72.02	73.09
9.0	18.81	22.28	26.11	30.24	34.58	39.03	43.48	47.80	51.90	55.70	59.14	62.18	64.83	67.11	69.03	70.64	71.97	73.07
9.1	18.50	21.94	25.74	29.85	34.17	38.62	43.08	47.43	51.56	55.39	58.87	61.96	64.65	66.97	68.92	70.56	71.92	73.04
9.2	18.20	21.60	25.37	29.45	33.77	38.21	42.68	47.05	51.21	55.08	58.60	61.73	64.46	66.82	68.81	70.48	71.87	73.01
9.3	17.90	21.26	25.00	29.06	33.36	37.80	42.28	46.66	50.85	54.76	58.32	61.49	64.27	66.66	68.69	70.40	71.81	72.98
9.4	17.60	20.93	24.64	28.67	32.95	37.39	41.87	46.28	50.49	54.43	58.03	61.25	64.07	66.50	68.57	70.31	71.75	72.94
9.5	17.30	20.60	24.27	28.28	32.55	36.98	41.46	45.88	50.13	54.11	57.74	61.00	63.86	66.34	68.44	70.21	71.68	72.90
9.6	17.01	20.27	23.91	27.89	32.14	36.56	41.05	45.49	49.76	53.77	57.45	60.75	63.65	66.17	68.31	70.11	71.61	72.85
9.7	16.72	19.94	23.55	27.50	31.73	36.15	40.64	45.09	49.39	53.43	57.15	60.49	63.44	65.99	68.17	70.01	71.54	72.80
9.8	16.43	19.62	23.19	27.12	31.33	35.73	40.22	44.69	49.01	53.08	56.84	60.22	63.21	65.81	68.03	69.90	71.46	72.75
9.9	16.15	19.30	22.84	26.73	30.92	35.31	39.81	44.28	48.63	52.73	56.53	59.95	62.98	65.62	67.88	69.78	71.38	72.69
10.0	15.87	18.98	22.49	26.35	30.52	34.90	39.39	43.88	48.24	52.38	56.21	59.68	62.75	65.43	67.72	69.66	71.29	72.63
10.1	15.59	18.67	22.14	25.97	30.11	34.48	38.97	43.47	47.85	52.02	55.89	59.39	62.51	65.23	67.56	69.54	71.20	72.57
10.2	15.32	18.36	21.79	25.59	29.71	34.06	38.55	43.05	47.46	51.66	55.56	59.11	62.27	65.03	67.40	69.41	71.10	72.50
10.3	15.05	18.05	21.45	25.22	29.31	33.64	38.13	42.64	47.06	51.29	55.23	58.81	62.02	64.82	67.23	69.28	71.00	72.42
10.4	14.78	17.74	21.10	24.84	28.91	33.23	37.70	42.22	46.66	50.91	54.89	58.52	61.76	64.60	67.06	69.14	70.89	72.35
10.5	14.52	17.44	20.77	24.47	28.51	32.81	37.28	41.80	46.26	50.54	54.54	58.21	61.50	64.38	66.88	69.00	70.78	72.27
10.6	14.26	17.14	20.43	24.10	28.11	32.39	36.85	41.38	45.85	50.15	54.20	57.90	61.23	64.16	66.69	68.85	70.67	72.18
10.7	14.00	16.85	20.10	23.73	27.72	31.98	36.43	40.95	45.44	49.77	53.84	57.59	60.96	63.93	66.50	68.70	70.55	72.09
10.8	13.75	16.56	19.77	23.37	27.32	31.56	36.00	40.53	45.03	49.38	53.48	57.27	60.68	63.69	66.30	68.54	70.42	72.00
10.9	13.50	16.27	19.44	23.01	26.93	31.15	35.57	40.10	44.61	48.98	53.12	56.94	60.39	63.45	66.10	68.38	70.30	71.90
11.0	13.25	15.98	19.12	22.65	26.54	30.73	35.15	39.67	44.19	48.59	52.76	56.61	60.11	63.20	65.90	68.21	70.16	71.80
11.1	13.00	15.70	18.80	22.29	26.15	30.32	34.72	39.24	43.77	48.19	52.38	56.28	59.81	62.95	65.69	68.04	70.03	71.69
11.2	12.76	15.42	18.48	21.94	25.77	29.91	34.30	38.81	43.35	47.78	52.01	55.94	59.51	62.69	65.47	67.86	69.89	71.59
11.3	12.53	15.15	18.17	21.59	25.38	29.50	33.87	38.38	42.92	47.37	51.63	55.59	59.21	62.43	65.25	67.68	69.74	71.47
11.4	12.29	14.88	17.86	21.24	25.00	29.10	33.44	37.95	42.49	46.96	51.24	55.25	58.90	62.16	65.02	67.49	69.59	71.35
11.5	12.06	14.61	17.55	20.90	24.63	28.69	33.02	37.52	42.07	46.55	50.86	54.89	58.58	61.89	64.79	67.30	69.44	71.23
11.6	11.84	14.35	17.25	20.56	24.25	28.29	32.59	37.08	41.63	46.13	50.47	54.53	58.26	61.61	64.56	67.10	69.28	71.11
11.7	11.61	14.08	16.95	20.22	23.88	27.88	32.17	36.65	41.20	45.71	50.07	54.17	57.94	61.33	64.31	66.90	69.11	70.98
11.8	11.39	13.83	16.65	19.89	23.51	27.48	31.75	36.21	40.77	45.29	49.67	53.80	57.61	61.04	64.07	66.70	68.95	70.84
11.9	11.17	13.57	16.36	19.55	23.14	27.09	31.33	35.78	40.33	44.87	49.27	53.43	57.27	60.74	63.82	66.49	68.77	70.70
12.0	10.96	13.32	16.07	19.23	22.78	26.69	30.91	35.35	39.90	44.44	48.86	53.05	56.93	60.45	63.56	66.27	68.60	70.56

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13. ABSTRACT

Although the "textbook" Class B approach to rf amplifier design yields high output power and reasonable collector efficiency (78.5 percent at maximum output power), neither the power nor the efficiency are optimum, and both are dependent on rf drive level. This report presents an analysis of appropriately selected collector voltage and current waveforms which determine the load impedance at the fundamental and harmonically related frequencies; these conditions define the Class B "optimum efficiency" case with 100 percent collector efficiency and 1.27 times the "textbook" Class B value of output power. If the rf drive level is increased and the collector voltage and current waveforms are appropriately selected so that the amplifier is overdriven, a different load impedance is determined; these conditions define the "optimum power" case with 1.46 times the "textbook" Class B value of output power and 88 percent collector efficiency. The "optimum power" case has the added advantage of resulting in an output power and collector frequency that are essentially constant over a predetermined range of drive level.

Finally, the theory is verified by the construction and testing of a UHF power amplifier having a power output of 46watts and an overall dc to rf conversion efficiency of 65 percent with an output power insensitivity to rf drive of 1 db for 10.5db.

14. KEY WORDS

UHF power amplifier
overdriven rf amplifier
rf drive level