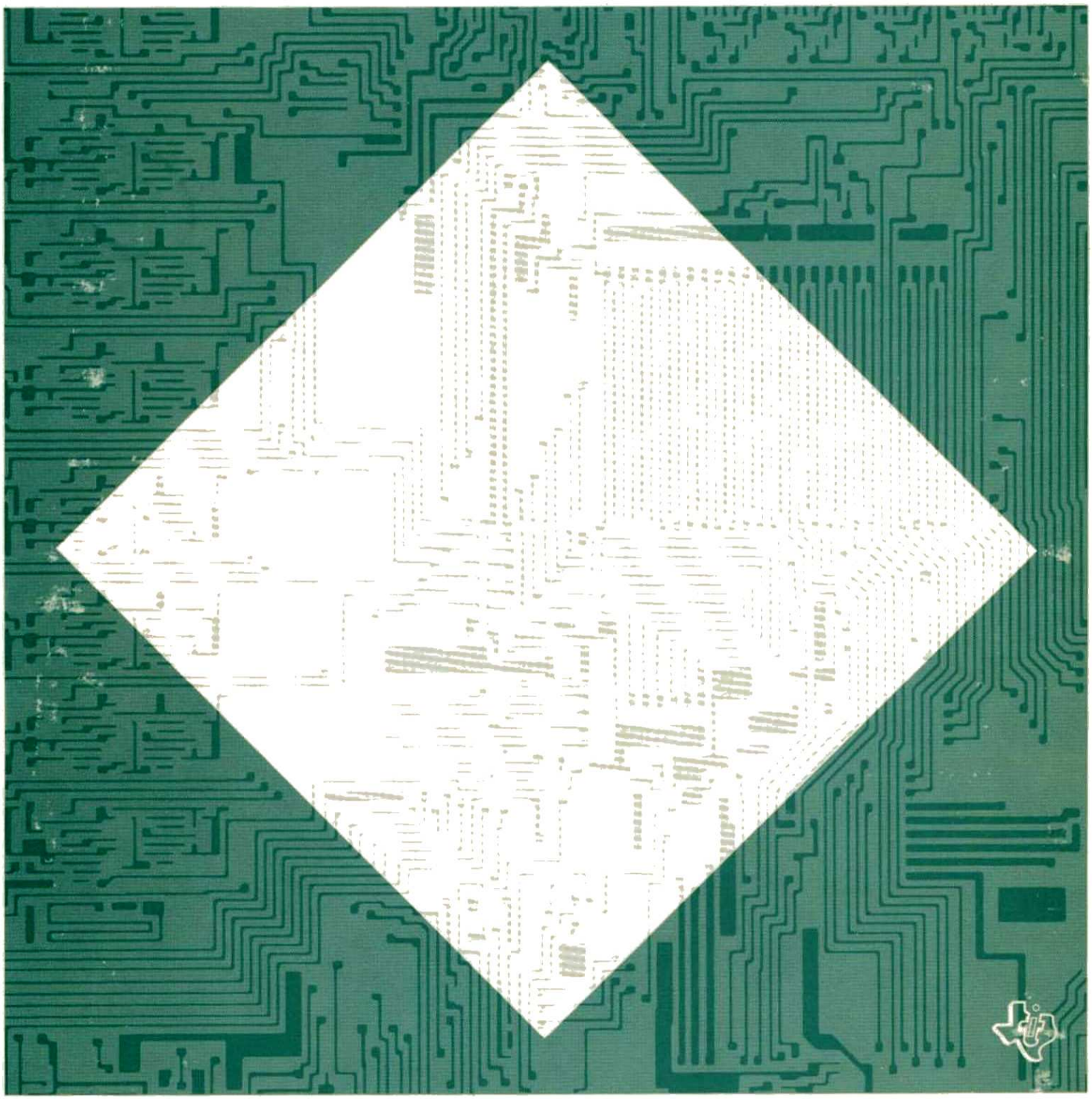
TI Programmable 58/59

Securities Analysis

Using the power of your *Solid State Software*™ module



ACKNOWLEDGEMENT

Texas Instruments expresses sincere gratitude to John P. Shelton, Professor of Finance, UCLA Graduate School of Management, for his contributions to the Securities Analysis Library.

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INTRODUCTION

The Securities Analysis Module places at your fingertips a library of programs designed to aid both financial professionals and individuals in the evaluation, selection, and management of investment portfolios. Within seconds you can install this *Solid State Software** module which tailors your calculator to solve problems related specifically to these professional fields. Your self-contained *Solid State Software* module provides easy-to-use calculating previously available only on large-scale computers.

USING THIS MANUAL

Following this brief introduction, you will find the description, principal equations, user instructions, and example problems for each of the 15 programs in the Securities Analysis Library. Each program is easily identified by the "SA" number in the upper corner of the page. This number corresponds with the call number you use to tell the calculator which program in the *Solid State Software* module you wish to use.

The primary reference point in this manual for each program is the User Instructions. These user instructions are also available for you in the handy pocket guide furnished with the library. The program description and sample problems should be used when you first run a program, to help you understand its full capabilities and limitations. Nonmagnetic label cards to identify the user-defined keys are also included in the library. Carefully remove the cards from the sheet and insert them in the card carrying case for convenient storage. Note that a special holder has been built into the case for storage of the library module.

When using the *Solid State Software* programs as subroutines to your own programs, you will also want to check Register Contents for the program and check Program Reference Data provided in Appendix C.

USING THE OPTIONAL PRINTER

If you have the optional PC-100A printer†, a printed record of entries and results is automatic. The User Instructions and example problems are marked to show exactly which values are printed in addition to being displayed.

Use the Calculator Mounting procedure in the PC-100A Owner's Manual to mount your calculator on the PC-100A. The switch called out in Step 2 should be set to "OTHER" for your calculator. Always turn the calculator and printer off before mounting or removing the calculator.

*Trademark of Texas Instruments

†Note: The TI Programmable 58 and TI Programmable 59 will not operate on the PC-100 print cradle.

INTRODUCTION

TIPS FOR RUNNING PROGRAMS

Before you begin using the *Solid State Software* programs on your own, here are a few things to keep clearly in mind until you become familiar with your calculator.

1. Press [CLR] before running a program if you are not sure of the status of the calculator. (To be completely sure of calculator status, turn it off and on again — but remember that this will clear the program memory.)

2. Some programs will leave the calculator in fix-decimal format (see Appendix C). In that event, you should press [INV] [2nd] [fix] before running another program if this format is not desired.

3. There is no visual indication of which *Solid State Software* program has been called. If you have any doubts, the safest method is to call the desired program with [2nd] [Pgm] mm, where mm is the two-digit program number. The calculator will remain at this program number until another program is called, [RST] is pressed or the calculator is turned off.

4. A flashing display normally indicates an improper key sequence or that a numerical limit has been exceeded. When this occurs, always repeat the program sequence and check that each step is performed as directed by the User Instructions. Any unusual limits of a program are given in the User Instructions or related notes. The In Case of Difficulty portion of Appendix A in *Personal Programming* may be helpful in isolating a problem.

5. Some of the *Solid State Software* programs may run for several minutes depending on input data. If you desire to halt a running program, press the [RST] key. This is considered as an emergency halt operation which returns control to the main memory. A program must be recalled to be run again.

USING *SOLID STATE SOFTWARE* PROGRAMS AS SUBROUTINES

Any of the *Solid State Software* programs may be called as a subroutine to your own program in the main memory. Either of two program sequences may be used: 1) [2nd] [Pgm] mm (User-Defined Key) or 2) [2nd] [Pgm] mm [SBR] (Common Label). Both will send the program control to program mm, run the subroutine sequence, and then automatically return to the main program without interruption. Following [2nd] [Pgm] mm with anything other than [SBR] or a user-defined key is not a valid key sequence and can cause unwanted results.

It is very important to consider the Program Reference Data in Appendix C for any program called as a subroutine. You must plan and write your own program such that the data registers, flags, subroutine levels, parentheses levels, T-register, angular mode, etc., used by the called subroutine are allowed for in your program. In addition, a Register Contents section of each program description provides a guide to determine where data is or must be located to run the program. A sample program that calls a *Solid State Software* program as a subroutine is provided in the PROGRAMMING CONSIDERATIONS section of *Personal Programming.*

If you need to examine and study the content of a *Solid State Software* program, you can download as described in the following paragraphs.

DOWNLOADING *SOLID STATE SOFTWARE* PROGRAMS

If you need to examine a *Solid State Software* program, it can be downloaded into the main program memory.* This will allow you to single step through a program in or out of the learn mode. It also allows using the program list or trace features of the optional printer. The only requirement for downloading a *Solid State Software* program is that the memory partition be set so there is sufficient space in the main program memory to receive the downloaded program. The key sequence to download a program is [2nd] [CP] [2nd] [Pgm] mm [2nd] [Op] 09, where mm is the program number to be downloaded. This procedure places the requested program into program memory beginning at program location 000. The downloaded program writes over any instructions previously stored in that part of program memory. Remember to press [RST] before running or tracing the downloaded program.

Please note that SA-04, SA-10, and SA-13 cannot be downloaded in the TI Programmable 58 due to the length of these programs. Also, the memory partition must be reset from the power-up condition in the TI-58 for programs SA-05, 06, 07, 08, 11, and 12. The key sequence to repartition the memory for SA-08 is 0 [2nd] [Op] 17. The sequence for SA-05, SA-06, SA-07, SA-11, and SA-12 is 1 [2nd] [Op] 17. Repartitioning must be performed before the downloading sequence.

The partition must be changed from the power-up condition in the TI Programmable 59 for SA-04, SA-10, and SA-13. The key sequence to repartition the memory for SA-04 is 3 [2nd] [Op] 17. The sequence for SA-10 and SA-13 is 5 [2nd] [Op] 17.

REMOVING AND INSTALLING MODULES

The Securities Analysis Module can easily be installed in the calculator or replaced with another. It is a good idea to leave the module in place in the calculator except when replacing it with another module. Be sure to follow these instructions when you need to remove or replace a module.

CAUTION

Be sure to touch some metal object before handling a module to prevent possible damage by static electricity.

1. **Turn the calculator OFF.** Loading or unloading the module with the calculator ON may cause the keyboard or display to lock out. Also, shorting the contacts can damage the module or calculator.

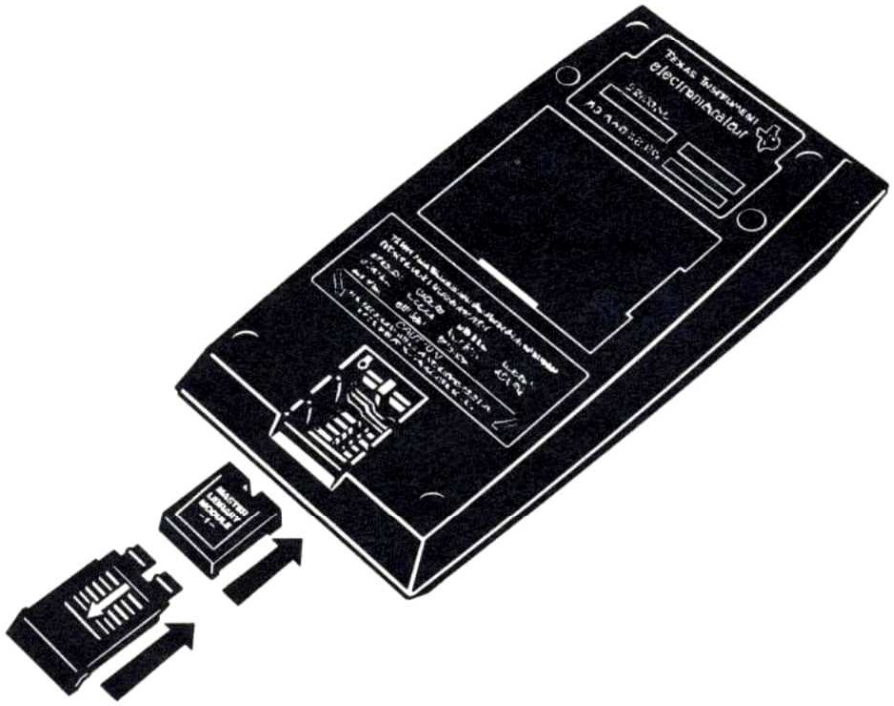
2. Slide out the small panel covering the module compartment at the bottom of the back of the calculator. (See Diagram on following page.)

3. Remove the module. You may turn the calculator over and let the module fall out into your hand.

*Unless the library is a protected special-purpose library.

4. Insert the module, notched end first with the labeled side up into the compartment. The module should slip into place effortlessly.

5. Replace the cover panel, securing the module against the contacts.



Don't touch the contacts inside the module compartment as damage can result.

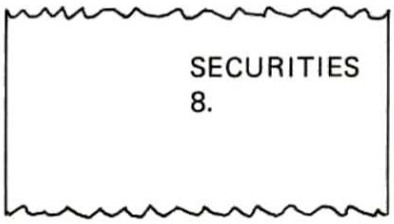
SECURITIES ANALYSIS LIBRARY DIAGNOSTIC

This program performs the following functions separately.

1. Diagnostic/Library Module Check
2. Linear Regression Initialization

Diagnostic/Library Module Check

This routine checks the operation of your calculator and most of its functions, including conversion and statistics functions that are preprogrammed in the calculator, trigonometric functions, data register operations, program transfers, and comparisons. It also uses other Securities Analysis Library programs to verify that the module is connected and operating correctly. If this diagnostic routine runs successfully, in approximately 15 seconds the number 8. will be displayed. If the calculator is attached to a PC-100A print cradle, the following will be printed:



If there is a malfunction in the calculator or the *Solid State Software* module, a flashing number will be displayed. Refer to Appendix A of the Owner's Manual for an explanation of the various procedures to be followed when you have difficulties.

When you simply want to know which of your *Solid State Software* modules is in the calculator without physically looking at it, you can call the Library Module Check portion of the routine directly. If the Securities Analysis Library Module is in the calculator, the number 8. will be displayed. This number is unique to the Securities Analysis Library (other optional libraries use other identifying digits).

Linear Regression Initialization

This routine initializes the calculator for linear regression by clearing data registers R_{01} through R_{06} and the T-register. It should be used whenever linear regression or other built-in statistics functions are to be started. You can also use the routine at any time to clear these registers selectively without disturbing any other registers.

USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
	Diagnostic/Module Check			
A1	Select Program		**[2nd] [Pgm] 01**	
A2	Run Diagnostic		**[SBR] [=]**	8.[1,2,3]
	or			
A3	Library Module Check		**[SBR] [2nd] [R/S]**	8.[2]
	Initialize Linear Regression			
B1	Select Program		**[2nd] [Pgm] 01**	
B2	Initialize Linear Regression		**[SBR] [CLR]**	0.

NOTES:

1. This output is obtained if the calculator is operating properly.
2. The number 8. indicates the Securities Analysis Library.
3. The display will flash if the display is in scientific notation, engineering notation, or fix decimal format when [SBR][=]is pressed. If in doubt, turn the calculator OFF and then ON before running the diagnostic.

Example 1: Diagnostic

PRESS	DISPLAY	PRINTOUT
[2nd] [Pgm] 01		
[SBR] [=]	8.	SECURITIES 8.

Example 2: Library Module Check

PRESS	DISPLAY	PRINTOUT
[2nd] [Pgm] 01		
[SBR] [2nd] [R/S]	8.	SECURITIES 8.

Example 3: Initialize Linear Regression

PRESS	DISPLAY	PRINTOUT
[2nd] [Pgm] 01		
[SBR] [CLR]	0.	

EARNINGS PER SHARE ESTIMATION

A key factor in valuing common stock is the estimation of future earnings per share (EPS). Such estimates are instrumental in determining future dividends and the price an investor might receive for the stock.

For example, a utility stock earning $6.00 per share might pay out 50% of its earnings ($3.00) as dividends and sell at a price/earnings ratio (P/E) of 7, or $42.00 per share.

Payout ratios are policy decisions and easily estimated from prior annual reports since they are usually stable over time unless a firm has serious cash flow problems. P/E ratios on the other hand vary with future economic conditions and the company's performance. Consequently, future P/E ratios can only be projected through an investor's expectations. This program projects future earnings per share by scaling current EPS up or down according to estimates of future trends made by the investor.

For example, all other things being equal, a 10% increase in sales increases earnings per share by 10%. A similar increase in profit margin has the same direct effect on EPS.

As a company expands, it must finance its growth by retaining and reinvesting its own profits, borrowing, and issuing new stock. So in addition to the above factors this program also determines the effect of altering the number of common shares outstanding and of changing dividend and borrowing policies.

If the projected growth can be funded entirely by retained earnings, or if borrowing or leverage is utilized, there is no need to issue new common stock and EPS rises in proportion to the company's growth. In fact, supplying funds through leverage can enhance EPS by raising the proportion of assets funded by debt. But this policy also increases the debt burden of the firm and the risk of bankruptcy. It is for this reason that bankers place limits on the use of leverage. Consequently, companies seldom change their debt/equity ratio dramatically without first trying to float additional stock.

If the company does issue new stock, there should be little change in EPS as long as the stock sells for a good price relative to its book value. If a poor price is received for the stock, then the company is forced to issue too many new shares, and EPS is diluted since the number of common shares outstanding increases faster than the growth in earnings.

The value of the approach presented by this program is that it permits the analyst to properly account for the effects of corporate performance (sales and profit margin), corporate policies (dividend payout ratio, leverage, etc.), market behavior, and the basic economics of corporate operations. Whether an investor uses a specific mathematical model such as this or reaches his decisions in less explicit ways, he should consider all of the factors mentioned above. In short, the questions the investor needs to answer in using this program are ones he should ask himself in any stock valuation exercise.

All of the information asked for in this model can be obtained from annual reports or easily estimated using sound judgment, except the ratio of the stock's book value to its market value (B/M). A reasonable estimate of the B/M ratio is its current value. However, since a company should never sell stock at less than book value, a realistic upper limit for this ratio should be no more than .95. Also, most companies are fortunate to have their stock sell for

twice book value indicating a lower bound of .5. But for an exceptionally attractive stock the B/M ratio could, optimistically, be as low as .3. As a general rule the B/M ratio should be fitted to the reported past growth of EPS. Note that although this expression is almost always utilized as a single ratio, the investor may redefine M as EPS X P/E.

One last point about this model concerns the difference between a company's growth and the portion of this growth that may be financed by retained earnings. If external financing is needed, the model assumes that the company sells additional common shares during the holding period. But if there is a surplus of retained earnings, the model assumes that the company uses the additional funds to repurchase its own stock. This activity decreases the number of shares outstanding and while it may happen, it is unusual enough that the investor should ensure that this is what he really expects. As a reminder, this difference is briefly displayed during the final EPS calculation. A negative value indicates a surplus of retained earnings.

Solid State Software TI ©1978				
EARNINGS PER SHARE ESTIMATION				SA-02
PNW; PNW_N	DPO; DPO_N	B/M		EPS; EPS_N
N	S; S_N	Π; Π_N	T; T_N	L; L_N

USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		[2nd] [Pgm] 02	
2	Initialize		[SBR] [CLR]	0.
3	Enter number of years stock is to be held	N	[A]	N
4a	Enter Current Sales	S	[B]	S
4b	Enter Expected Sales	S_N	[R/S]	S_N
5a	Enter Current Profit Margin	Π	[C]	Π
5b	Enter Expected Profit Margin	Π_N	[R/S]	Π_N
6a	Enter Current Turnover	T	[D]	T
6b	Enter Expected Turnover	T_N	[R/S]	T_N
7a	Enter Current Leverage	L	[E]	L
7b	Enter Expected Leverage	L_N	[R/S]	L_N
8a	Enter Current Profit on Net Worth	PNW	[2nd] [A′]	PNW
8b	Enter Expected Profit on Net Worth	PNW_N	[R/S]	PNW_N
9a	Enter Current Dividend Pay-Out Ratio	DPO	[2nd [B′]	DPO
9b	Enter Expected Dividend Pay-Out Ratio	DPO_N	[R/S]	DPO_N
10	Enter Book/Market Ratio	B/M	[2nd] [C′]	B/M
11	Enter Current EPS to find expected EPS	EPS	[2nd] [E′]	EPS_N

NOTES:

1. All input and output values are printed and labeled.
2. Profit on Net Worth (PNW) and Dividend Pay-Out Ratio must be entered as numbers less than 1.
3. The remaining variables may be entered in any order of magnitude if like variables are entered using the same magnitude, e.g., if S = $6,000,000 and S_N = 10,500,000, S may be entered as 6 provided S_N is entered as 10.5.
4. All entries are made on an annual basis. The first or "current" entries should be based on the present year. The "expected" entries should be based on the year the investor expects to sell the stock.

SA-02

Example: If a company's current earnings per share is $3.21, find the expected EPS five years from now given the following information.

Sales

S = $7,450,000 S_N = $18,500,000

Profit Margin = Available for Common ÷ Sales
(Available for Common = Net Profit − Preferred Dividends

Π = .086 Π_N = .080

Turnover = Sales ÷ Assets

T = 1.83 T_N = 1.80

Leverage = Assets ÷ Common Stock Equity
(Common Stock Equity = Common Stock + Capital Surplus + Retained Earnings)

L = 1.82 L_N = 1.70

Profit on Net Worth = Available for Common ÷ Common Stock Equity

PNW = .242 PNW_N = .276

Dividend Payout Ratio = Dividends ÷ Available for Common

DPO = .18 DPO_N = .23

Book to Market Ratio

B/M = .7

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 02		Select program		
	[SBR] [CLR]	0.	Initialize		
5	[A]	5.	N	5.	N
7450000	[B]	7450000.00	S	7450000.00	S
18500000	[R/S]	18500000.00	S_N	18500000.00	
.086	[C]	0.09	Π	0.09	Π
.08	[R/S]	0.08	Π_N	0.08	
1.83	[D]	1.83	T	1.83	T
1.8	[R/S]	1.80	T_N	1.80	
1.82	[E]	1.82	L	1.82	L
1.7	[R/S]	1.70	L_N	1.70	
.242	[2nd] [A′]	0.24	PNW	0.24	PNW
.276	[R/S]	0.28	PNW_N	0.28	
.18	[2nd] [B′]	0.18	DPO	0.18	DPO
.23	[R/S]	0.23	DPO_N	0.23	
.7	[2nd] [C′]	0.70	B/M	0.70	B/M
3.21	[2nd] [E′]	"0.15"*	EPS	3.21	EPS
		6.70	EPS_N	6.70	

*Indicates that additional common shares are sold during the holding period.

Register Contents

R_{00}		R_{05}	L/L_N	R_{10}	R_{15}
R_{01}	N	R_{06}	PNW/PNW_N	R_{11}	R_{16}
R_{02}	S/S_N	R_{07}	DPO/DPO_N	R_{12}	R_{17}
R_{03}	Π/Π_N	R_{08}	B/M	R_{13}	R_{18}
R_{04}	T/T_N	R_{09}		R_{14}	R_{19}

SA-03

COMPOUND INTEREST

An essential element in understanding the investment process is to realize that the value of money depends not only on the quantity received, but also on when it is received. The simple fact that a dollar tomorrow is not worth a dollar today is crucial in understanding a vast array of financial instruments.

The basic concept is familiar to anyone who has put money in a savings account. If the money is earning 6% annual interest, then $1.00 deposited today is worth $1.06 in one year and $1.34 in five years. Note that in five years the dollar hasn't merely increased by 6 cents per year to a value of $1.30, but has grown another 4 cents. This is because the interest has earned interest, a concept known as "compounding".

The algebraic expression for this calculation is

$$FV = PV\ (1 + I/100)^N$$

This says that the future value (FV) of today's money (called the present value or PV) is equal to the present value of the money compounded for N periods at a periodic interest rate i. This program may be used to solve for any term in the above equation when the following circumstances prevail:

- The periods are of equal length.
- The interest earned is added to the principal at the end of each period.
- The interest rate is constant over each period.

The program can be used to solve compound interest problems using either the nominal annual rate method (U.S. method) or yearly effective rate method (European method). The two interest rates may be defined as follows:

$$\text{Nominal Annual Rate} = I \times N_c$$

$$1 + (YER/100) = 1(1 + I/100)^{N_c}$$

where

N_c is the number of compounding periods per year

YER is the yearly effective rate.

Given FV, PV, and N, the program solves for the periodic interest rate, I, which is the same for either method. The nominal annual rate is found by simple multiplication by the number of periods per year as shown. To find YER, the term 1 + (YER/100) is solved for using the program and YER is determined manually.

If the nominal annual interest rate is given, dividing this value by N_c provides I for input to the program. However, if the yearly effective interest rate is the known factor, the periodic rate I must be computed first using the program. This value can then be used without reentering in further calculations.

To simplify using the program for either method, two separate User Instructions are provided. Examples are given to demonstrate operation of the program for both methods.

Solid State Software TI ©1978				
COMPOUND INTEREST				SA-03
Cpt N	Cpt % I	Cpt FV	Cpt PV	
N	% I	FV	PV	

USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
	U.S. Method			
1	Select Program		[2nd] [Pgm] 03	
2	Initialize		[SBR] [CLR]	0.
3	Enter 3 of the following in any order			
	• Number of Periods	N	[A]	N
	• Interest Rate (% per period)	%I	[B]	%I
	• Future Value	FV	[C]	FV
	• Present Value	PV	[D]	PV
4	Find the missing term			
	• Number of Periods		[2nd] [A′]	N
	• Interest Rate (% per period)		[2nd] [B′]	%I
	• Future Value		[2nd] [C′]	FV
	• Present Value		[2nd] [D′]	PV

NOTES:
1. All input and output values are printed and labeled.
2. [SBR] [CLR] initializes PV and FV to $1.

SA-03

Example 1: Suppose that an investor wants to earn 14% annually on a stock he expects to hold for four years. If the stock pays no dividends and is currently selling for $15 per share, what must he sell the stock for at the end of the fourth year?

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 03		Select program		
	[SBR] [CLR]	0.	Initialize		
4	[A]	4.	N	4.	N
14	[B]	14.00	%I	14.00	%I
15	[D]	15.00	PV	15.00	PV
	[2nd] [C′]	25.33	FV	25.33	FV

Example 2: A stock recently sold for $125. If the stock was purchased at $85 per share and earned 9% per year, how long was the stock held? (Assume that no dividends were paid.)

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 03		Select program		
	[SBR] [CLR]	0.	Initialize		
9	[B]	9.00	%I	9.00	%I
125	[C]	125.00	FV	125.00	FV
85	[D]	85.00	PV	85.00	PV
	[2nd] [A′]	4.475200633	N	4.475200633	N

Example 3: Compare the investment of $1000 for one year at 5.75% compounded daily against the same amount invested at 6% compounded quarterly.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 03		Select program		
	[SBR] [CLR]	0.	Initialize		
1000	[D]	1000.00	PV	1000.00	PV
365	[A]	365.	N	365.	N
5.75	[÷]	5.75	Annual %I		
365	[=] [B]	0.02	Daily %I	0.02	%I
	[2nd] [C′]	1059.18	FV	1059.18	FV
4	[A]	4.	N	4.	N
6	[÷]	6.	Annual %I		
4	[=] [B]	1.50	Quarterly %I	1.50	%I
	[2nd] [C′]	1061.36	FV	1061.36	FV

Example 4: An investor bought a stock four years ago at $21.50 per share. He recently sold it for $30.00 per share. What was the annual rate of return? At this same rate of return how long would he have had to hold the stock for it to reach $35.00 a share?

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 03		Select program		
	[SBR] [CLR]	0.	Initialize		
4	**[A]**	4.	N	4.	N
30	**[C]**	30.00	FV	30.00	FV
21.5	**[D]**	21.50	PV	21.50	PV
	[2nd] [B′]	8.69	%I	8.69	%I
	[B]	8.69	See note below	8.69	%I
35	**[C]**	35.00	FV	35.00	FV
	[2nd] [A′]	5.850856965	N	5.850856965	N

NOTE: Simply press [B] to enter the interest rate. Do not enter 8.69 as this is a rounded value. The actual interest rate calculated is 8.68527527.

Register Contents

R_{00}	R_{05}	R_{10}	R_{15}
R_{01} N	R_{06}	R_{11}	R_{16}
R_{02} %I	R_{07}	R_{12}	R_{17}
R_{03} FV	R_{08}	R_{13}	R_{18}
R_{04} PV	R_{09}	R_{14}	R_{19}

SA-03

Solid State Software TI ©1978				
COMPOUND INTEREST				SA-03
Cpt N	Cpt % I	Cpt FV	Cpt PV	
N	%I	FV	PV	

USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
	European Method			
1	Select program		[2nd] [Pgm] 03	
2	Initialize		[SBR] [CLR]	0.
	If annual interest rate is known			
3	Solve for I_{eff} per period			
3A	Enter periods per year	N_c	[A]	N_c
3B	Enter 1 as PV	1	[D]	1.00
3C	Enter $(1 + I_{ann}/100)$ as FV	1 + I/100	[C]	FV
3D	Solve for I_{eff} per period		[2nd] [B′]	I_{eff}
3E	Enter I_{eff} per period		[B]	I_{eff}
4	Enter two of the following three variables in any order:			
	Number of periods	N	[A]	N
	Present value	PV	[D]	PV
	Future value	FV	[C]	FV
5	Calculate the remaining variable:			
	Number of periods		[2nd] [A′]	N
	Present value		[2nd] [D′]	PV
	Future value		[2nd] [C′]	FV
	To solve for I_{ann}, given PV, FV, N			
6	Number of periods	N	[A]	N
7	Present value	PV	[D]	PV
8	Future value	FV	[C]	FV
9A	Solve for I per period		[2nd] [B′]	I(period)
9B	Enter I per period		[B]	I(period)
10	Solve for annual interest rate (I_{ann})			
10A	Periods per year (N_c)	N_c	[A]	N_c
10B	Enter 1 for PV	1	[D]	1.00
10C	FV = $1 + I_{ann}/100$		[2nd] [D′]	$1 + I_{ann}/100$
10D	Subtract 1 and multiply by 100		[−]	
		1	[=] [×]	
		100	[=]	I_{ann}

Example 5: (European Method) What is the value of $500 after 24 months with interest compounded monthly, if the yearly effective interest rate is 5.75%?

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 03		Select program		
	[SBR] [CLR]	0.	Initialize		
12	**[A]**	12.00	N per yr for I_{eff}	12.	N
1	**[D]**	1.00	PV for I_{eff}	1.00	PV
1.0575	**[C]**	1.06	FV for I_{eff}	1.06	FV
	[2nd] [B′]	0.47	I_{eff}	0.47	%I
	[B]	0.47	I_{eff}	0.47	%I
24	**[A]**	24.00	N	24.	N
500	**[D]**	500.00	PV	500.00	PV
	[2nd] [C′]	559.15	FV	559.15	FV

Example 6: (European Method) What is the interest rate per period and the yearly effective interest rate for a savings account which increased in value from $1234.00 to $1300.00 in 13 months if the interest was compounded monthly?

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 03		Select program		
	[SBR] [CLR]	0.	Initialize		
13	**[A]**	13.00	N	13.	N
1234	**[D]**	1234.00	PV	1234.00	PV
1300	**[C]**	1300.00	FV	1300.00	FV
	[2nd] [B′]	0.40	I	0.40	%I
	[B]	0.40	I	0.40	%I
12	**[A]**	12.00	N per yr for I_{eff}	12.	N
1	**[D]**	1.00	PV for I_{eff}	1.00	PV
	[2nd] [C′] [−]	1.05	FV for I_{eff}	1.05	FV
1	[=] [×]	0.05			
100	[=]	4.93	I_{eff} (Annual)		

SA-04

ANNUITIES

The previous program answers investor's questions about the value of money when only one payment or injection of money into the future stream of funds occurs. But for many investments (e.g., savings accounts, bonds, dividend-paying stock) the future payments occur several times. How can these situations be analyzed? By placing two simplifying limitations on the future flow of funds, a wide range of practical investor applications can still be handled:

- The future cash flows must occur at regular intervals.
- The amount of each cash flow must be the same.

Extending the example used to describe the last program, consider an investor who deposits $1.00 per year in a savings account paying 6% annual interest for five years. How much is this account worth at the end of the fifth year? Assuming that each dollar is deposited at the beginning of the year, the future value of this stream of payments at the end of five years is $5.98. This says that the first dollar deposited grows for five years to a value of $1.34 (as in the last program), the second dollar grows for four years to $1.26, and so on, with the fifth dollar growing for one year to a value of $1.06. But what if the deposits are made at the end of each year? In this situation the future value is only $5.64 because each dollar has one year less in which to grow or collect interest.

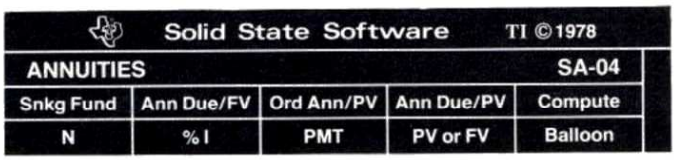
The above illustrates two types of annuity situations dealing with the calculation of the future value of a string of even payments. The first example, where payments are made at the beginning of each period, is known as an **annuity due/future value** situation. As shown in the example, this type of annuity is most easily described as the future value of a savings account with equal deposits made at the beginning of each period. Rent or lease agreements are examples of this type of annuity.

The second situation, where payments are made at the end of each period, is an **ordinary annuity/future value** (also called a **sinking fund**). A loan such as a home mortgage is a prime example of this type of an annuity, where a sum of money is repaid with interest by equal payments at the end of each period for a fixed period of time.

Though there are times when an investor wants to know the future value of a stream of equal, regular payments, it is much more common to be interested in the **present value** of those payments, or what they are worth today. For example, what is the present value of a lease involving fixed payments over a specified number of periods if the interest rate requirement is known?

There are also many annuity situations that involve not only a series of regular payments, but also require an additional payment at termination. These final cash flows are called **balloon payments.** For instance, if someone decides to pay off a loan early, the final payment is a balloon payment equal to the remaining principal balance at the time the loan is paid off. Or an investor sells a rental property from which he has received a steady flow of rent, thus producing a large impulse of income at the end of the investment. Bonds paying even coupon payments and then maturing at face value are another important example of an annuity with a balloon payment.

This program is designed to find any piece of information in any of the above annuity situations. Illustrations of their use are provided in the examples following the user instructions. See Appendix A for the equations employed by this program.



USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		[2nd] [Pgm] 04	
2	Initialize		[SBR] [CLR]	0.
3	Select type of problem			
	• Sinking Fund		[2nd] [A′]	0.
	• Annuity Due/FV		[2nd] [B′]	0.
	• Ordinary Annuity/PV		[2nd] [C′]	0.
	• Annuity Due/PV		[2nd] [D′]	0.
4	Enter known data in any order			
	• Number of Payments	N	[A]	N
	• Interest Rate (% per period)	%I	[B]	%I
	• Payment	PMT	[C]	PMT
	• Present Value or Future Value	PV or FV	[D]	PV or FV
	• Balloon Payment	BAL	[E]	BAL
5	Find the missing term			
	• Number of Payments		[2nd] [E′] [A]	N
	• Interest Rate (% per period)*		[2nd] [E′] [B]	%I
	• Payment		[2nd] [E′] [C]	PMT
	• Present Value or Future Value		[2nd] [E′] [D]	PV or FV
	• Balloon Payment		[2nd] [E′] [E]	BAL

NOTES:

1. All input and output values are printed and labeled.
2. [SBR] [CLR] initializes PV and FV to $1 and the Balloon Payment to 0.
3. Entering or computing a Balloon Payment for Sinking Fund and Annuity Due/FV calculations causes invalid results.
4. If bad data implying impossible situations is entered, the calculation of N may cause a flashing display

* Relatively long calculation time required.

SA-04

Example 1: An investor buys 30 shares of a stock at $70 per share and collects quarterly dividends of $1 per share. If he sells the stock for $78 per share one year later what is his annual yield?

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT
	[2nd] [Pgm] 04		Select program	
	[SBR] [CLR]	0.	Initialize	
	[2nd] [C′]	0.	Ord Ann/PV	
4	**[A]**	4.	N(quarters)	4. N
30	**[C]**	30.00	Total div./quart.	30.00 PMT
30	[×]	30.00	No. of shares	
70	[=] **[D]**	2100.00	Purchase price	2100.00 PV
30	[×]	30.00	No. of shares	
78	[=] **[E]**	2340.00	Sale Price	2340.00 BAL
	[2nd] [E′] [B]	4.12	I/Period	4.12 %I
	[×]	4.12		
4	[=]	16.46	I/Year	

Example 2: A 45-year-old man planning for retirement decides to put $100 into an account at the end of each month. The account pays 6% annual interest, compounded monthly. If he retires at age 65 how much will this account be worth? How long would it take him to save $50,000?

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT
	[2nd] [Pgm] 04		Select program	
	[SBR] [CLR]	0.	Initialize	
	[2nd] [A′]	0.	Sinking fund	
20	[×]	20.	No. years	
12	[=] **[A]**	240.	N(months)	240. N
6	[÷]	6.	%I/yr.	
12	[=] **[B]**	0.50	%I/mo.	0.50 %I
100	**[C]**	100.00	Payment	100.00 PMT
	[2nd] [E′] [D]	46204.09	Future value	46204.09 FV
50000	**[D]**	50000.00	Future value	50000.00 FV
	[2nd] [E′] [A]	251.1784545	No. months	251.1784545 N
	[÷]	251.1784545		
	[12] [=]	20.93153787	No. years	

Example 3: What is the present value of an investment that will pay $875 at the beginning of each month for the next 10 years if the discount rate is 11.5%?

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT
	[2nd] [Pgm] 04		Select program	
	[SBR] [CLR]	0.	Initialize	
	[2nd] [D′]	0.	Ann Due/PV	
10	[×]	10.	No. years	
12	[=] **[A]**	120.	No. months	120. N
11.5	[÷]	11.5	%I/yr.	
12	[=] **[B]**	0.96	%I/mo.	0.96 %I
875	**[C]**	875.00	Payment	875.00 PMT
	[2nd] [E′] [D]	62831.72	Present value	62831.72 PV

Example 4: If a workman invests $75 at the beginning of each month in a savings plan with a 7% annual return and his company adds another $50 a month to this plan, what would the account be worth at the end of 5 years?

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 04		Select program		
	[SBR] [CLR]	0.	Initialize		
	[2nd] [B′]	0.	Ann Due/FV		
5	[X]	5.	No. years		
12	[=] **[A]**	60.	No. months	60.	N
7	[÷]	7.	%I/yr.		
12	[=] **[B]**	0.58	%I/mo.	0.58	%I
125	**[C]**	125.00	Payment	125.00	PMT
	[2nd] [E′] [D]	9001.32	Future value	9001.32	FV

Register Contents

R_{00}	R_{05} Balloon	R_{10} Used	R_{15} Used*
R_{01} N	R_{06} Used	R_{11} Used	R_{16} Used*
R_{02} %I/100	R_{07}	R_{12} Used	R_{17} Used*
R_{03} PMT	R_{08} Used	R_{13} Used	R_{18} Used*
R_{04} PV or FV	R_{09} Used	R_{14} Used	R_{19} Used*

*Used only in conjunction with Pgm 10. R_{21} through R_{29} are also used with Pgm 10.

SA-05

UNEVEN CASH FLOWS

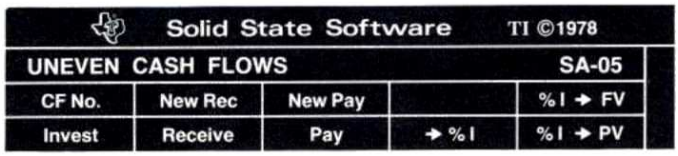
The preceding two programs have shown how money situations involving a single payment, or a stream of equal payments can be analyzed. But how can an investor analyze problems when future payments are unequal, as they frequently are in the real world? By making one simplifying assumption, that the payments occur at regular, periodic intervals, this program allows the analysis to be handled. Used properly, this program can accommodate up to 80 cash flows when used with the TI Programmable 59 and up to 40 cash flows with the TI Programmable 58. These cash flows are in addition to the initial investment.

Three calculations are performed by this program. Internal rate of return, which is a form of discounted cash flow analysis, is one of the most widely used measures of return in investments. Essentially, internal rate of return is compound interest in reverse; it is that interest rate that equates the present value of the expected cash flows to the initial investment. That is, the net present value of the investment must be zero.

A word of warning about using the internal rate of return calculation. In some situations, a string of uneven cash flows may represent more than one internal rate of return. That is, whenever the cash flow changes from a payment (negative flow) to an income (positive flow) or vice versa, the possibility of an additional solution is added. This program finds the solution closest to zero, but the investor should be aware that other solutions may exist. Also, when using internal rate of return to compare alternative investments, the investments should be of similar capital outlays, duration, and risk. This factor provides a single measure for each which can be useful in comparing investments, but risk and other nonfinancial considerations should also be taken into account.

This program also finds the future value of a string of uneven cash flows. For example, if an investor deposits uneven amounts in a savings account for 12 months, this program can be used to determine the future value of that account at the end of the twelfth month when given the monthly interest rate.

A second result that may be calculated is the present value of a string of uneven cash flows. That is, given the periodic interest rate, an investor may use this program to determine today's value of an expected string of payments.



USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		[2nd] [Pgm] 05	
2	Initialize		[SBR] [CLR]	1.
3	Enter Cash Flows			
	• If received	CF	[B]	Next CF No.
	• If paid	CF	[C]	Next CF No.
	To Change or Correct a Cash Flow Entry			
	a) Enter Cash Flow Number	CF No.	[2nd] [A′]	CF No.
	b) Enter Cash Flow			
	• If received	CF	[2nd] [B′]	Next CF No.
	• If paid	CF	[2nd] [C′]	Next CF No.
4	Enter Investment	INV	[A]	INV
5	Compute Internal Rate of Return*		[D]	%I
6	Enter %I and compute Present Value	%I	[E]	PV
7	Enter %I and compute Future Value	%I	[2nd] [E′]	FV

NOTES:

1. Input and output values are printed and displayed.
2. Steps 5, 6, and 7 may be performed in any order.
3. 19+N registers are required for program use. (N is the number of cash flows.) Repartition if necessary.

* Relatively long calculation time required.

SA-05

Example 1: A land speculator purchased a parcel of 20 acres at $5,000 an acre. He paid $10,000 down and obtained a $90,000 mortgage at 8.5% interest for 25 years. Five years later, he sold the entire parcel for $170,000. If his annual taxes were $1,700, what was his IRR on the investment?

initial investment = $10,000

annual debt service on the mortgage = $725 × 12 = $8,700

taxes + annual debt service = cash flow = $10,400

balance on the mortgage at the time of sale = $83,542.36

YEAR	CASH FLOW
1	–$10,400
2	–$10,400
3	–$10,400
4	–$10,400
5	$170,000 – $10,400 – $83,542.36 = $76,057.64

Internal Rate of Return = 13.30

What if he had sold the land for $200,000?

YEAR	CASH FLOW
1	–$10,400
2	–$10,400
3	–$10,400
4	–$10,400
5	$200,000 – $10,400 – $83,542.36 = $106,057.64

Internal Rate of Return = 25.20

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 05		Call program		
	[SBR] [CLR]	1.	Initialize		
10400	**[C]**	2.00	1st cash flow	1. –10400.00	
10400	**[C]**	3.00	2nd cash flow	2. –10400.00	
10400	**[C]**	4.00	3rd cash flow	3. –10400.00	
10400	**[C]**	5.00	4th cash flow	4. –10400.00	
76057.64	**[B]**	6.00	5th cash flow	5. 76057.64	
10000	**[A]**		Initial investment	10000.00	INV
	[D]	13.30	Compute internal rate of return	13.30	%I
5	**[2nd] [A′]**	5.00	New reversion	5.00	
106057.64	**[2nd] [B′]**	6.00		106057.64	
	[D]	25.20	Compute internal rate of return	25.20	%I

Example 2: A 40-year-old man is planning for his retirement at age 65. Realizing that saving will be easier in future years when his children are grown he plans to put away $1,000 during each of the next five years, $2,000 a year for the next five years, $4,000 for each of the next ten years and $5,000 for each of the last five years. If he earns 6% annually on his savings what will his retirement fund be worth when he reaches age 65. For simplicity, assume that the full amount is deposited at the beginning of each year.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT
	[2nd] [Pgm] 05		Select program	
	[SBR] [CLR]	1.	Initialize	
1000	[C]	2.00	1st cash flow	1.
				−1000.00
1000	[C]	3.00	2nd cash flow	2.
				−1000.00
1000	[C]	4.00	3rd cash flow	3.
				−1000.00
1000	[C]	5.00	4th cash flow	4.
				−1000.00
1000	[C]	6.00	5th cash flow	5.
				−1000.00
2000	[C]	7.00	6th cash flow	6.
				−2000.00
2000	[C]	8.00	7th cash flow	7.
				−2000.00
2000	[C]	9.00	8th cash flow	8.
				−2000.00
2000	[C]	10.00	9th cash flow	9.
				−2000.00
2000	[C]	11.00	10th cash flow	10.
				−2000.00
4000	[C]	12.00	11th cash flow	11.
				−4000.00
4000	[C]	13.00	12th cash flow	12.
				−4000.00
4000	[C]	14.00	13th cash flow	13.
				−4000.00
4000	[C]	15.00	14th cash flow	14.
				−4000.00
4000	[C]	16.00	15th cash flow	15.
				−4000.00
4000	[C]	17.00	16th cash flow	16.
				−4000.00
4000	[C]	18.00	17th cash flow	17.
				−4000.00
4000	[C]	19.00	18th cash flow	18.
				−4000.00
4000	[C]	20.00	19th cash flow	19.
				−4000.00
4000	[C]	21.00	20th cash flow	20.
				−4000.00

SA-05

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
5000	[C]	22.00	21st cash flow	21.	
				−5000.00	
5000	[C]	23.00	22nd cash flow	22.	
				−5000.00	
5000	[C]	24.00	23rd cash flow	23.	
				−5000.00	
5000	[C]	25.00	24th cash flow	24.	
				−5000.00	
5000	[C]	26.00	25th cash flow	25.	
				−5000.00	
0	[A]	0.00	Initial investment	0.00	INV
6	[2nd] [E′]	−152469.48	%I → FV	6.00	%I
				−152469.48	FV

Example 3: An inventor sells one of his patent rights that has six years left before expiring to a corporation that agrees to pay him based upon profits attributed to the patent. If the inventor expects the following payments:

Year 1	$10,000
Year 2	$14,000
Year 3	$17,000
Year 4	$13,000
Year 5	$ 9,000
Year 6	$ 4,000

and if money is worth 12% annually to the inventor, what is the present value of his contract?

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 05		Select program		
	[SBR] [CLR]	1.	Initialize		
10000	[B]	2.00	1st cash flow	1.	
				10000.00	
14000	[B]	3.00	2nd cash flow	2.	
				14000.00	
17000	[B]	4.00	3rd cash flow	3.	
				17000.00	
13000	[B]	5.00	4th cash flow	4.	
				13000.00	
9000	[B]	6.00	5th cash flow	5.	
				9000.00	
4000	[B]	7.00	6th cash flow	6.	
				4000.00	
0	[A]	0.00	Initial investment	0.00	INV
12	[E]	47584.65	%I → PV	12.00	%I
				47584.65	PV

Example 4: You have an account worth $1000, and you make quarterly payments of $100, $200, and $100. If the account earns 5.25% annually, compounded quarterly, what is the value of your account at the end of the year?

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 05		Select program		
	[SBR] [CLR]	1.	Initialize		
100	**[C]**	2.00	CF_1	1.	
				−100.00	
200	**[C]**	3.00	CF_2	2.	
				−200.00	
100	**[C]**	4.00	CF_3	3.	
				−100.00	
1000	**[A]**	1000.00	Investment	1000.00	INV
5.25	**[÷]**	5.25	Annual %I		
4	**[=] [2nd] [E′]**	−1464.13	FV	1.31	%I
				−1464.13	FV

Register Contents

R_{00}	R_{05} $\Sigma(CF_N \times N)$	R_{10} Used	R_{15} Used
R_{01} Counter → N	R_{06} Used	R_{11} Used	R_{16} Used
R_{02} Used	R_{07} Used	R_{12} Investment	R_{17} Used
R_{03} Last CF	R_{08} Used	R_{13} Used	R_{18} Used
R_{04} ΣCF	R_{09} Pointer	R_{14} Used	R_{19} Used

R_{20} and above are used to store cash flow values.

SA-06

STOCK VALUATION

The ultimate question asked by any stock investor is "What is a share of stock worth?" The answer in a formal sense is that a share of stock, like any other economic asset, derives its value from the potential income it can provide for its owner. Since this income does not come all at once or in the very near future, this program adjusts future income to reflect its present value. This concept, known as "discounting," has been described and illustrated by programs SA-03, SA-04, and SA-05.

Bascially, given any two of the following, this program calculates the third.

- Buying Price (Net of Commission)
- Selling Price (Net of Commission)
- Interest Rate (per Dividend Period)

In addition to the above, the investor is required to enter the stock's dividend payments. If the stock pays no dividends, then the valuation simply reduces to a compound interest problem and may be more efficiently solved using SA-03. Two methods of entering dividends are provided. One technique requires the investor to enter each dividend payment separately. The other allows him to enter an initial dividend payment and a dividend growth rate. Additional payments are then entered automatically.

Optional entries include commission costs and tax rates. Note that if taxes are considered, they must be entered before dividends.

Solid State Software TI ©1978				
STOCK VALUATION				SA-06
Div No.	New Div	Growth	Div; N	Compute
Tax, CGT	Div	Buy; Com	Sell; Com	%I

USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		[2nd] [Pgm] 06	
2	Initialize		[SBR] [CLR]	1.
3a	Enter Personal Income Tax if desired	Tax	[A]	Tax
3b	Enter Capital Gains Tax if desired	CGT	[R/S]	CGT
4	Enter Dividend Payments using one of the following methods:			
	I. a) Enter Expected Growth Rate of Dividends	Growth	[2nd] [C′]	Growth
	b) Enter First Dividend Payment	Div	[2nd] [D′]	Div
	c) Enter Number of Dividend Payments	N	[R/S]	N + 1
	II. Enter Dividend Payment j (Repeat for j = 1 to N)	Div_j	[B]	j + 1
	To change or Correct a Dividend Entry			
	a) Enter Dividend Number	Div No.	[2nd] [A′]	Div No.
	b) Enter Dividend	Div	[2nd] [B′]	j + 1
5	Enter two of the following:			
	• Buying Price per Share	Buy	[C]	Buy
	and Commission per Share	Com	[R/S]	Buy + Com
	• Selling Price per Share and	Sell	[D]	Sell
	Commission per Share	Com	[R/S]	Sell − Com
	• Interest Rate per Dividend Period	%I	[E]	%I
6	Find the missing term:			
	• Buying Price (Net of Commission)		[2nd] [E′] [C]	Buy + Com
	• Selling Price (Net of Commission)		[2nd] [E′] [D]	Sell − Com
	• Interest Rate per Dividend Period		[2nd] [E′] [E]	%I

NOTES:

1. All input and output values are printed and labeled (Sell and Buy are printed Net of Commissions once entered).
2. If Taxes are to be considered they must be entered before dividends. The dividend payments are then printed net of taxes. (Note that CGT may be entered only after Tax is entered).
3. 19+N registers are required for program use. (N is the number of dividend payments.) Repartition if necessary.

SA-06

Example 1: A stock now selling for $63 a share, plus 75 cents commission, is paying dividends of $4.20 a year. If an 8% growth in dividends is assumed, how much will an investor have to sell this stock for (net of commission) in five years to realize an 11% after-tax return? Assume a personal income tax rate of 40% and a capital gains tax rate of 20%.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 06		Select program		
	[SBR] [CLR]	1.	Initialize		
40	**[A]**	40.00	Tax rate	40.00	TAX
20	**[R/S]**	20.00	CGT	20.00	CGT
8	**[2nd] [C′]**	8.00	GR	8.00	GR
4.2	**[2nd] [D′]**	4.20	1st Div.		
5	**[R/S]**	6.00	No. Div. PMTS	1.	
				2.52	
				2.	
				2.72	
				3.	
				2.94	
				4.	
				3.17	
				5.	
				3.43	
63	**[C]**	63.00	Buy		
.75	**[R/S]**	63.75	Buy + Com.	63.75	BUY
11	**[E]**	11.00	%I	11.00	%I
	[2nd] [E′] [D]	95.69	Sell	95.69	SELL

Example 2: An investor purchases a stock at $25 a share, plus 50 cents commission, and sells it one year later at $30 per share, minus 60 cents commission. If the stock paid quarterly dividends of 75 cents, 75 cents, 85 cents, and 90 cents, what was the after-tax return? Assume a personal income tax of 40% and a capital gains tax of 20%.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 06		Select program		
	[SBR] [CLR]	1.	Initialize		
40	**[A]**	40.00	Tax rate	40.00	TAX
20	**[R/S]**	20.00	CGT	20.00	CGT
.75	**[B]**	2.00	Div_1	1.	
				0.45	
.75	**[B]**	3.00	Div_2	2.	
				0.45	
.85	**[B]**	4.00	Div_3	3.	
				0.51	
.90	**[B]**	5.00	Div_4	4.	
				0.54	

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
25	[C]	25.00	Buy		
.5	[R/S]	25.50	Buy + Com.	25.50	BUY
30	[D]	30.00	Sell		
.6	[R/S]	29.40	Sell – Com.	29.40	SELL
	[2nd] [E′] [E]	4.75	Quarterly %I	4.75	%I
	[X]	4.75			
4	[=]	19.01	Annual %I		

Example 3: An investor believes that a stock will sell for $55 per share, less 70 cents commission, in two years. Meanwhile, he expects the stock to pay semiannual dividends of $1.75, $1.75, $2.00, and $2.00. How much can he afford to pay for the stock (net of commission) if he desires a 15% before-tax return?

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 06		Select program		
	[SBR] [CLR]	1.	Initialize		
1.75	[B]	2.00	Div_1	1. 1.75	
1.75	[B]	3.00	Div_2	2. 1.75	
2	[B]	4.00	Div_3	3. 2.00	
2	[B]	5.00	Div_4	4. 2.00	
55	[D]	55.00	Sell		
.7	[R/S]	54.30	Sell – Com.	54.30	SELL
15	[÷]	15.00	Annual %I		
2	[=] [E]	7.50	Periodic %I	7.50	%I
	[2nd] [E′] [C]	46.91	Buy	46.91	BUY

Register Contents

R_{00}	R_{05} $\Sigma(Div_N \times N)$	R_{10} Used	R_{15} Tax
R_{01} Counter → N	R_{06} Used	R_{11} Used	R_{16} CGT
R_{02} Used	R_{07} Used	R_{12} Buy + Com	R_{17} (1 + Growth/100)
R_{03} Last Div	R_{08} Used	R_{13} Sell – Com	R_{18} Div
R_{04} Σ Div	R_{09} Pointer	R_{14} %I	R_{19}

R_{20} and above are used to store dividend payments.

SA-07

OPTION VALUATION – BLACK SCHOLES MODEL

Investors not only have the opportunity to invest in corporate business directly by purchasing stock, but can also buy options, which are a vehicle for speculating on the price movement of certain common stocks over a fairly short horizon of up to nine months. An option is simply a security giving its owner the right to buy or sell a specified stock at a previously agreed upon "exercise" price at any time during the life of the contract.

If an investor feels that a stock is likely to go up in the next few months he may decide to buy a "call" contract entitling him to purchase 100 shares of the stock at the exercise price on demand. For example, if the current price of a stock is $39 and an investor expects its value to increase to $50, he may buy a call option giving him the right to purchase the stock at $40 a share within a specified period of time, say six months. This enables the investor to capture all the price appreciation of the stock over the life of the contract without being exposed to the risk of a drop in the price of the stock.

On the other side of the contract is an investor who has written the option. In the typical case, this investor owns the stock on which he writes the calls. So in effect, he has sold his prospects for price appreciation above the exercise price, but retains the risk of capital loss. The compensation an investor receives for taking this risk is the price that the buyer of the contract pays for the option.

The mirror image of a call is a "put" option. In this case an investor believes that the price of a stock is likely to fall in the near future. Consequently he may buy a "put" contract giving him the right to sell 100 shares of the stock to the writer of the contract at an agreed upon exercise price. For example, if the current price of a stock is $39 and an investor expects its value to decrease to $30, he might buy a put option with an exercise price of $35. Then if the price of the stock falls to a low enough value before the contract expires, he buys the stock at the lower price and sells it at the exercise price, realizing a gain. So the owner of a put profits only if the stock drops, just the reverse of a call owner's situation. Again, the compensation the writer of a put receives for the risk he is taking as standby purchaser is the price the buyer of the contract pays for the option.

The purpose of this program is to provide a widely-used method of determining fair prices for call and put options. In order to perform this evaluation, a few simplying assumptions are made by the model.

- The short-term interest rate is known and constant throughout the life of the contract.
- The stock price follows a random pattern with a variance rate proportional to the square of the stock price, indicating that the stock prices are lognormally distributed. The variance rate of return is constant.
- The option can be exercised only at the end of the contract period, or on its expiration date.
- There are no commissions involved in buying and selling the stock and the option.

- It is possible to borrow any fraction of the price of the security and to buy or hold the security at the short-term interest rate.

- There are no penalties for short selling.

- In its purest form this model assumes that the stock pays no dividends during the contract period. But the program makes an adjustment to accommodate this real-world aspect which is acceptable unless a dividend payment is unusually large.

One of the virtues of this model is that it requires inputs that, for the most part, are readily available. Contract dates and the current and exercise prices of the stock, for example, are specified when the option is written. An input that may be slightly difficult to obtain is the standard deviation of the stock price fluctuations, or "volatility." This value is supplied in some publications such as Standard and Poor's *Weekly Option Guide*. However, if the investor has to determine this value, he should remember that his calculator has the built-in capability of handling such calculations. (See Section V of your *Personal Programming* manual.) Another element required is an interest rate indicating a rate of return that an option writer could expect from a "well-hedged" position. Since this position should have only modest risk, the appropriate interest rate should not be much greater than the bank prime rate. A final note: the volatility of a stock and the interest rate mentioned above must both be entered in annual terms.

Another value obtained from this program is termed the "hedge ratio." By definition, the hedge ratio is the dollar amount the option value varies when there is a $1.00 change in share price. The use of the hedge ratio is explained in the next program.

SA-07

Solid State Software TI ©1978				
OPTION VALUATION — Black Scholes Model				SA-07
Today	Expire	Date; Val (D)		→ Val; HR (P)
Sh Price	Ex Price	Vol	%I	→ Val; HR (C)

USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		[2nd] [Pgm] 07	
2	Initialize		[SBR] [CLR]	0.
3	Enter Current Price of Stock per Share	Sh Price	[A]	Sh Price
4	Enter Exercise Price of Stock per Share	Ex Price	[B]	Ex Price
5	Enter Volatility	Vol	[C]	Vol
6	Enter Desired Yield	%I	[D]	%I
7	Enter Today's Date	MMDD.YYYY	[2nd] [A′]	MMDD.YYYY
8	Enter Expiration Date	MMDD.YYYY	[2nd] [B′]	MMDD.YYYY
9	If Dividends are to be considered: a) Enter Date of Dividend Payment b) Enter Dividend Payment per Share	 MMDD.YYYY Div	 [2nd] [C′] [R/S]	 MMDD.YYYY PV of Div
10	For Call Options a) Compute Value b) Compute Hedge Ratio		 [E] [R/S]	 Val HR
11	For Put Options a) Compute Value b) Compute Hedge Ratio		 [2nd] [E′] [R/S]	 Val HR

NOTES:

1. Input and output values are printed and labeled.
2. A 365 day year is assumed. If a 360 day year is desired, store 360 in R_5 after Step 2. It should be noted, however, that the calculations determine the actual number of days between dates and then divide by the 365 or 360 figure in transforming to annual terms.
3. Step 9 may be repeated for each dividend payment.

Example 1: On July 31, 1978, a particular stock is selling for $104-3/8. A dividend of 75 cents is to be paid on September 30, 1978. What is the value of the Z company call option with an exercise price of $110 and an expiration date of October 21, 1978? Assume a volatility of 27.5% and an interest rate (yield) of 6%.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 07		Select program		
	[SBR] [CLR]	0.	Initialize		
104.375	**[A]**	104.38	Current price	104.38	SH
110	**[B]**	110.00	Exercise price	110.00	EX
27.5	**[C]**	27.50	Volatility	27.50	VOL
6	**[D]**	6.00	%I	6.00	%I
731.1978	**[2nd] [A′]**	731.1978	Current date	731.1978	
1021.1978	**[2nd] [B′]**	1021.1978	Expiration date	1021.1978	
930.1978	**[2nd] [C′]**	930.1978	Dividend date	930.1978	
.75	**[R/S]**	0.74	Dividend	0.75	DIV
				0.74	
	[E]	3.41	Value	3.41	VAL
	[R/S]	0.39	Hedge ratio	0.39	HR

Example 2: On January 17, 1978, a stock with a volatility of 60% is selling for $52 a share. What is the value of a put option with an exercise price of $40 that expires on September 16, 1978? Use an interest rate of 10%.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 07		Select program		
	[SBR] [CLR]	0.	Initialize		
52	**[A]**	52.00	Current price	52.00	SH
40	**[B]**	40.00	Exercise price	40.00	EX
60	**[C]**	60.00	Volatility	60.00	VOL
10	**[D]**	10.00	%I	10.00	%I
117.1978	**[2nd] [A′]**	117.1978	Current date	117.1978	
916.1978	**[2nd] [B′]**	916.1978	Expiration date	916.1978	
	[2nd] [E′]	3.17	Value	3.17	VAL
	[R/S]	0.18	Hedge ratio	0.18	HR

Register Contents

R_{00}	R_{05} 365	R_{10} PV of Div	R_{15} Used
R_{01} SH price	R_{06} Date factor (Today)	R_{11} Used	R_{16} Used
R_{02} EX price	R_{07} Date factor (Expire)	R_{12} Used	R_{17} Used
R_{03} VOL	R_{08} Div. date	R_{13} Used	R_{18}
R_{04} %I	R_{09}	R_{14} Used	R_{19} Used

R_{21} through R_{23} are used.

SA-08

OPTION WRITING

Program SA-07 provides a means of establishing a fair price for an option contract. Given this information, this program goes a step further by determining the potential profit for the option writer.

Many investors who deal in options are content to write completely covered contracts. That is, the investor owns 100 shares of stock for each call contract or goes short 100 shares for each put contract he writes. (Puts and Calls are described in program SA-07.) On the other hand, investors with an adequate equity balance may want to use other option strategies. Brokerage firms normally require the investor who writes partially covered contracts to maintain a moderately large equity balance.

One of the more commonly used techniques is the writing of options that are only partially covered by stock, called "ratio writing." The idea in the case of a call writer is to hold enough shares in proportion to the number of calls written so that any small change in the price of the stock is neutralized by opposite changes in the call price. Regarding the writer of a put, the investor would go short the appropriate number of shares. This ratio of shares to calls or puts is the hedge ratio described in program SA-07. A hedge ratio of .3, for example, indicates that the investor should own 30 shares of stock for each 100-share call contract he writes (or go short 30 shares in the case of a put contract).

This might seem to be an exercise in futility since the perfectly-hedged option writer cannot expect to profit from stock and option price movements. But neither can he lose; so the position is riskless as far as price changes are concerned. And if the option premiums are large enough in relation to his investment, he can earn a reasonable return on a theoretically riskless position. In reality no ratio writer can hope to avoid all risk because to do so would require him to continuously alter his hedge ratio, and the resulting transaction costs would absorb his premium income. Nonetheless, a reasonably well-hedged ratio writer can expect to earn an adequate return.

To enable a ratio writer to analyze the potential return of such situations, this program provides the following information.

- The maximum dollar profit that may be realized.
- The dollar investment required.
- The maximum return on the investment.
- The range of stock prices within which the investment is profitable.

Because commissions are so significant in option trading, they are explicitly included in the calculations performed by this program. The exact amount of the commission on the options is known by the investor and this figure is entered directly into the program. However, since the commission on the stock may differ enough between the upper and lower break-even points to be significant, the investor is required to input stock commissions as a percentage of the share price. This program assumes that the investor closes out his position completely at the expiration of the option contract, incurring round-trip commissions. In practice, however, many ratio writers continue to write new contracts against the same stock. To a modest degree this practice reduces commission costs and increases potential profits.

Solid State Software TI ©1978				
OPTION WRITING				SA-08
N (Put)	Max	Inv; % I	U; L	Div; MNT
N (Call)	Opt; Com	Ex Price	N; Sh Price	% Com

USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		[2nd] [Pgm] 08	
2	Initialize		[SBR] [CLR]	0.
3	Enter Number of Options Sold • For Calls • For Puts	 N_{OPT} N_{OPT}	 [A] [2nd] [A′]	 N_{OPT} N_{OPT}
4a	Enter Price per Call or Put	Opt Price	[B]	Opt Price
4b	Enter Total Commission on Options in Dollars	Com	[R/S]	Com
5	Enter Exercise Price	Ex Price	[C]	Ex Price
6a	Enter Number of Shares Bought or Shorted	N_{sh}	[D]	N_{sh}
6b	Enter Current Price of Stock per Share	Sh Price	[R/S]	Sh Price
7	Enter Average Commission on One Share of Stock as a Percentage of the Share Price	% Com	[E]	% Com
8a	Enter Dividends per Share (Optional)	Div	[2nd] [E′]	Div
8b	Enter Maintenance Requirement (Optional)	MNT	[R/S]	MNT
9	Compute Maximum Profit		[2nd] [B′]	Max
10a	Compute Investment		[2nd] [C′]	Inv
10b	Compute Maximum Return		[R/S]	%I
11a	Compute Upper Break-Even Point		[2nd] [D′]	U
11b	Compute Lower Break-Even Point		[R/S]	L

NOTES:

1. Input and output values are printed and labeled.
2. Calculations are valid only when the number of shares bought or shorted is less than the number of puts or calls sold. (See note 3.)
3. The number of options sold is entered per 100 calls or puts (e.g., 1 option is 100 calls or puts).
4. If a maintenance requirement is to be entered when there are no dividends, enter zero for the dividend payment.

SA-08

Example 1: An investor sells two call options with an exercise price of $25 for $2.50 per call less a total commission of $34.00. If he also purchases 100 shares of the stock at $23.00 per share, determine his potential profit. Assume an average stock commission of 1.75% of the share price. Assume a dividend of 75 cents per share.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 08		Select program		
	[SBR] [CLR]	0.	Initialize		
2	[A]	2.	No. Call options	2.	N
2.5	[B]	2.50	Call price	2.50	CALL
34	[R/S]	34.00	Option commission	34.00	COM
25	[C]	25.00	Exercise price	25.00	EX
100	[D]	100.	No. Shares	100.	N
23	[R/S]	23.00	Share price	23.00	SH
1.75	[E]	1.75	Avg. commission	1.75	%C
.75	[2nd] [E′]	0.75	Dividend	0.75	DIV
	[2nd] [B′]	657.00	Max. profit	657.00	MAX
	[2nd] [C′]	1874.25	Investment	1874.25	INV
	[R/S]	35.05	Max. return	35.05	%I
	[2nd] [D′]	30.60	Upper breakeven	30.06	U
	[R/S]	18.31	Lower breakeven	18.31	L

Example 2: An investor sells three put options with an exercise price of $25.00 for $5.00 per put, less a total commission of $90.00. If he also shorts 100 shares of the stock at $23.00 per share, determine his potential profit. Assume an average stock commission of 1.75% of the share price, dividends of 75 cents per share and a $980.00 maintenance requirement.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 08		Select program		
	[SBR] [CLR]	0.	Initialize		
3	[2nd] [A′]	3.	No. put options	3.	N
5	[B]	5.00	Put price	5.00	PUT
90	[R/S]	90.00	Option commission	90.00	COM
25	[C]	25.00	Exercise price	25.00	EX
100	[D]	100.	No. shares	100.	N
23	[R/S]	23.00	Share price	23.00	SH
1.75	[E]	1.75	Avg. commission	1.75	%C
.75	[2nd] [E′]	0.75	Dividend	0.75	DIV
980	[R/S]	980.00	Maintenance	980.00	MNT
	[2nd] [B′]	1051.00	Max. profit	1051.00	MAX
	[2nd] [C′]	760.25	Investment	760.25	INV
	[R/S]	138.24	Max. return	138.24	%I
	[2nd] [D′]	35.33	Upper breakeven	35.33	U
	[R/S]	20.54	Lower breakeven	20.54	L

Register Contents

R_{00}	R_{05} Sh price	R_{10} MNT	R_{15} Used
R_{01} N_{OPT}	R_{06} % Com	R_{11} Used	R_{16}
R_{02} N_{OPT} Opt – Com	R_{07} Div	R_{12} Used	R_{17}
R_{03} Ex price	R_{08} 1 – % Com	R_{13} Used	R_{18}
R_{04} N_{SH}	R_{09} 1 + % Com	R_{14} Used	R_{19}

SA-09

WARRANT VALUATION

Investors who include warrants in their portfolios are just as interested in valuing these securities as any other. Although it is clear that warrant values are closely linked to such things as the current and exercise price of the stock, the time until expiration, the volatility, and the dividend pattern of the stock, this relationship is extremely complex. In an attempt to resolve these complexities, this program offers two models which are often used in approximating warrant values.

In many respects, warrants are very similar to call options. One difference is that warrants almost always have a life span of five years or longer. Another difference is that warrants may have an exercise price that is not constant, but increases at specified intervals. A typical warrant for example may offer its owner the opportunity to buy a stock at any time over the next three years at $30 a share, and then have the option of purchasing the stock for $35 during the next three years.

As with call options, a warrant investor can create a hedged position with stocks and calls. The first model presented here provides the investor with both the warrant value and the hedge ratio. Three entries are required by this model: the current and exercise prices of the stock and a variable called "C." This variable may be estimated by considering the following factors:

- The relationship between the exercise price and the current price of the stock – a greater difference between these prices means it is less likely that the stock price will exceed the exercise price. Thus, since the chance of realizing a profit is small, a lower value of C is indicated.

- The volatility of the stock price – a stock with a high volatility or standard deviation in its price stands a greater chance of exceeding the exercise price due to day-to-day fluctuations and requires a high value for C.

- The length of the warrant – a warrant with a long life provides the stock with a greater opportunity to exceed its exercise price and indicates that a high C is needed.

- The rate of growth of the stock price – naturally, a fast growing stock is more likely to exceed its exercise price and requires a higher value for C.

Through experience with this program the investor should be able to develop a feel for weighting the above factors in determining an appropriate value for C. As is illustrated above a higher C indicates a greater potential for profit and thus a more valuable warrant. Constraints on the model require C to be greater than 1, and practically speaking, virtually no warrant should be assigned a C value greater than 4.

The following graphs are provided as a guideline to help the investor choose C. Please note that the standard deviation (σ) and growth rate of the stock price must be "normalized" or adjusted to reflect the length of the warrants life before these graphs may be used. For example, if a stock is growing at 10% per year, then a warrant with a life span of 5 years would indicate a growth rate of 61% over the life of the warrant. This is found using the same method as in computing compound interest.

The equation is:

$$\text{Growth} = (1 + \text{Annual Growth})^N - 1$$

where N is the number of years and the growth rate is expressed as a decimal. In the above example:

$$0.61 = (1 + 0.1)^N - 1$$

The standard deviation of the stock price is adjusted by simply multiplying the annual standard deviation by the square root of the time period or number of years until expiration. For example, if a stock price has an annual standard deviation of 10%, then a warrant with a life span of 5 years would have an adjusted standard deviation of

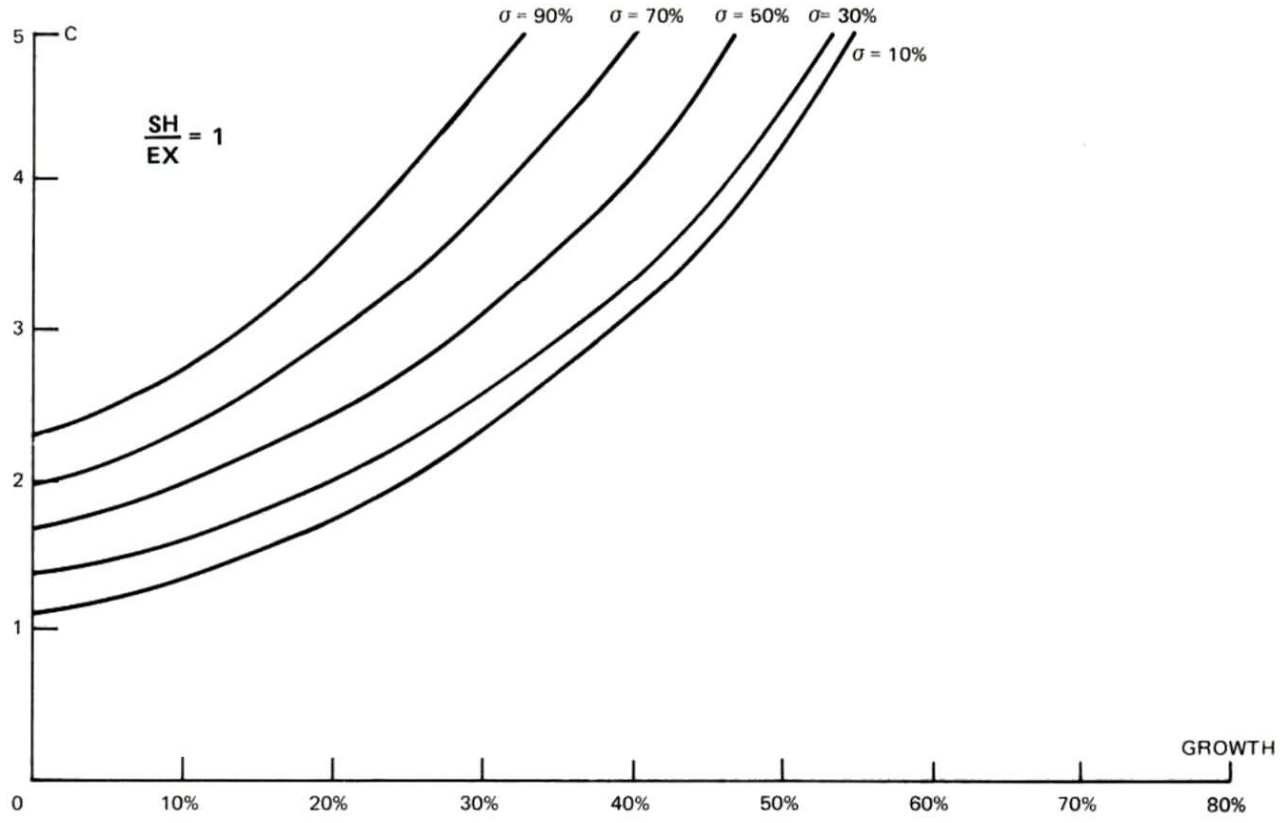
$$\sigma = 10\% \times \sqrt{5} = 22.4\%.$$

The second model is one that has long been used for valuing warrants whose stocks are fairly volatile and have an expiration date that is at least five years away. This model has more general appeal because it requires only two inputs: the current and exercise prices of the stock.

In most cases these models will produce different answers. This is a useful reminder that investors need to exercise their own judgment in interpreting these answers.

This program may also be used in analyzing convertible securities. A convertible security is a security such as a bond that may be converted to stock. The value of such a security is found by adding its value as a warrant to its "straight" value.

SA-09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4
3
2
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SH/EX = 1
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σ = 70%
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GROWTH
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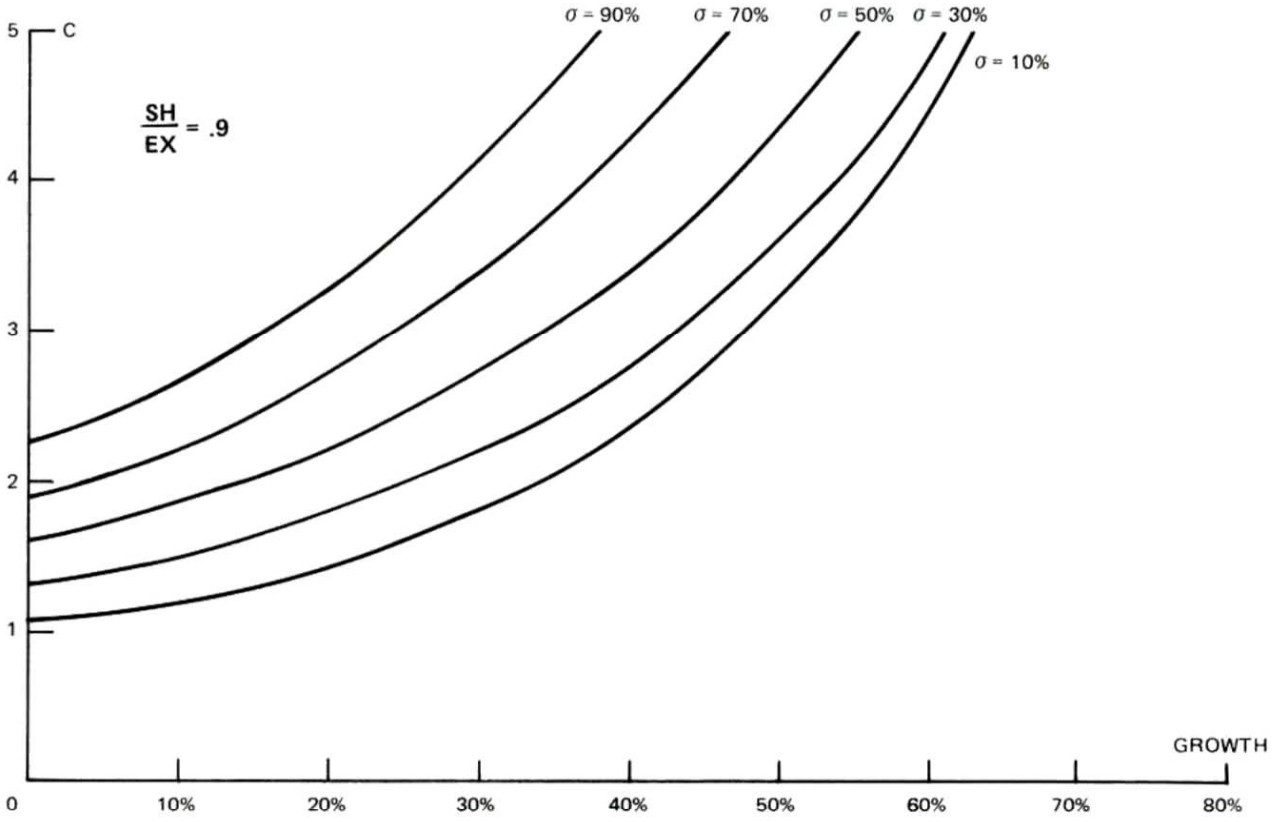
30%
40%
50%
60%
70%
80%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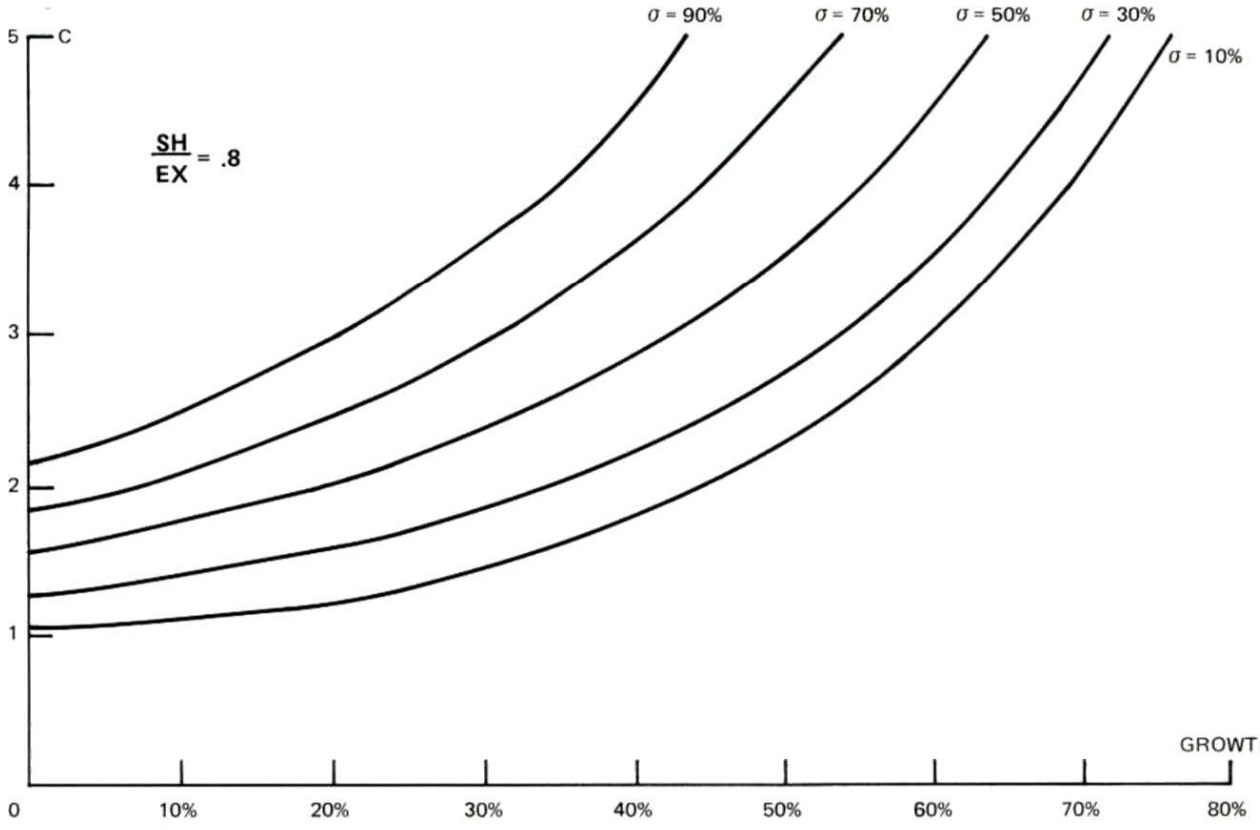
70%
80%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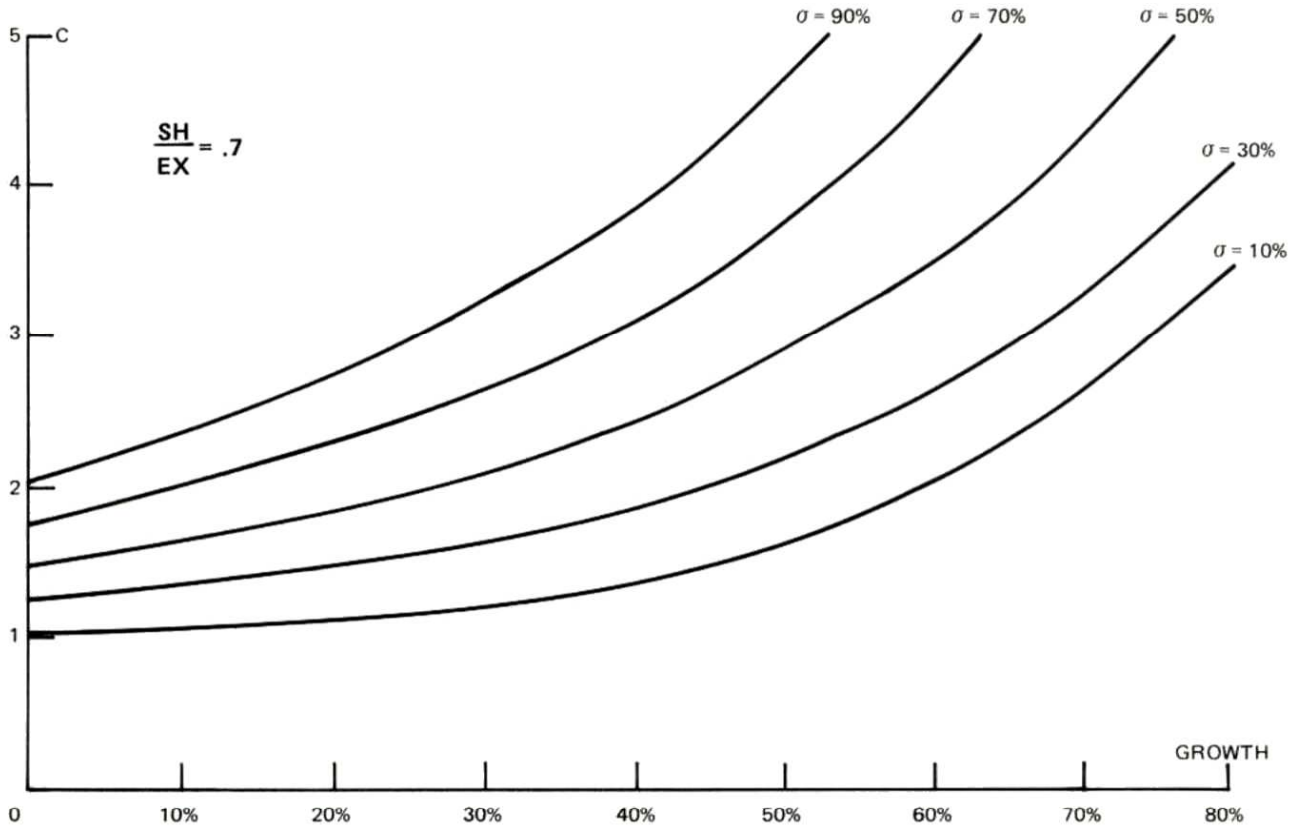
50%
60%
70%
80%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σ = 50%
σ = 30%
σ = 10%
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SH/EX = .7
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GROWTH
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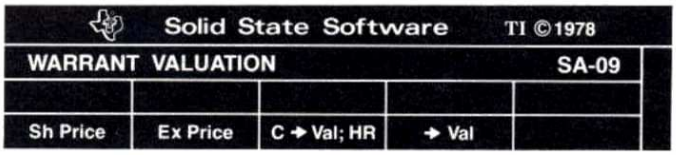
10%
20%
30%
40%
50%
60%
70%
80%

SA-09



USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		**[2nd] [Pgm] 09**	
2	Initialize		**[SBR] [CLR]**	0.
3	Enter Current Price of Stock per Share	Sh Price	**[A]**	Sh Price
4	Enter Exercise Price	Ex Price	**[B]**	Ex Price
	For Short-Term Warrants:			
5a	Enter C and compute value of warrant	C	**[C]**	Value
5b	Compute Hedge Ratio		**[R/S]**	HR
	For Long-Term Warrants:			
6	Compute Value of Warrant		**[D]**	Value

NOTES: 1. All input and output values are printed and labeled.

2. C must be greater than 1. (Display flashes invalid C.)

Example 1: Use both models to determine the value of a warrant given the following information:

Current Price	$40
Exercise Price	$50
Annual Growth Rate	6%
Annual Standard Deviation	26%
Time Until Expiration	5 Yrs

From the above:

Adjusted Growth Rate = $1.06^5 - 1 = .34$ or 34%
Adjusted Std. Dev. = $26\% \times \sqrt{5} = 58\%$

Now, referring to the graph for SH/EX = 40/50 = .8, C is found be approximately 2.8.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 09		Select program		
	[SBR] [CLR]	0.	Initialize		
40	**[A]**	40.00	Current Price	40.00	SH
50	**[B]**	50.00	Exercise Price	50.00	EX
2.8	**[C]**	12.82	C → Value	2.80	C
				12.82	VAL
	[R/S]	0.50	Hedge Ratio	0.50	HR
	[D]	14.03	Value	14.03	VAL

Example 2: Suppose that a convertible bond with a maturity value of $1000 can be converted to stock on the same terms as the warrant in Example 1. What is the value of this security assuming its value as a straight bond is still $1000. (Note that SA-10 could be used to determine its straight value if necessary.)

Since the maturity value of the bond is $1000 and the exercise price of the stock is $50, the bond may be converted into 1000/50 = 20 shares of stock. Therefore, the bond is worth its straight value of $1000 plus the value of 20 warrants as shown below.

Model 1 Value = $1000 + 20 × $12.82 = $1256.40

Model 2 Value = $1000 + 20 × $14.03 = $1280.60

SA-10

BOND VALUATION

A bond is a certificate of indebtedness indicating that the issuer of the bond has borrowed money from the certificate holder. Outlined on the certificate are the terms of the loan, such as interest payments, the time until maturity, and the face value of the bond.

A bond can actually provide its owner with two forms of income. One source is from fixed interest payments usually paid semiannually. A $1000 bond paying $85 in interest (coupon) payments each year, for example, is designated as an 8½% bond. However, the actual "yield to maturity" of the bond may differ from this 8½% figure.

Consider the case where a $1,000 bond is issued paying 8½%. Then suppose that interest rates increase and the same company issues another $1,000 bond paying 9%. Now if the holder of the first bond decides to sell, he won't be able to find a buyer at the $1,000 face value because the 9% bond will give him more for his money. In order to compensate for this, the holder of the 8½% bond would have to sell his bond at a discount, or at less than its face value. In this example the value of the bond would probably drop to around $944 because $85 a year is 9% of $944. But the investor purchasing the bond at a discount now has a second source of income, the capital gain he will receive when the bond reaches maturity. In practice, this capital gain is actually discounted back to its present value and included in the price of the bond when it is sold. In this example the 8½% bond would really yield more than 9% if it were sold at $944. Therefore, in order for the bond to yield a true 9%, the bond price is adjusted upward depending on how much time is left before maturity. If interest rates drop, on the other hand, the bond will sell at a premium, or above its $1,000 face value to compensate for market trends.

Basically, there are five elements involved in evaluating bonds.

- The length of time before maturity.
- The yield to maturity.
- The coupon interest rate.
- The current price of the bond.
- The maturity value of the bond.

Given any four of the above, this program can be used to find the fifth term. Optional entries include commission costs and taxes.

Another value that may be obtained using this program is the current yield of a bond. This value is simply defined as the annual interest payments divided by the initial investment. For example, if a $1,000 bond paying 8½% coupon interest is sold for $950, its current yield is 85/950 = .089, or 8.9%.

Solid State Software TI ©1978				
BOND VALUATION				SA-10
Settle	Redeem → N	→ CYLD	Tax; CGT	Compute
N	%I	%C	Buy; Com	MAT

USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		[2nd] [Pgm] 10	
2	Initialize		[SBR] [CLR]	0.
3	Enter any four of the following:			
	• Enter Number of Periods to Maturity	N	[A]	N
	OR			
	Enter Settlement Date and	MMDD.YYYY	[2nd] [A′]	MMDD.YYYY
	Enter Redemption Date	MMDD.YYYY	[2nd] [B′]	N
	• Enter Annual Yield to Maturity	%I	[B]	%I
	• Enter Annual Coupon Interest Rate	%C	[C]	%C
	• Enter Purchase Price (in points) and	Buy	[D]	Buy
	Enter Commission	Com	[R/S]	Com
	• Enter Maturity Value (in points)	MAT	[E]	MAT
4a	Enter Personal Income Tax if desired	Tax	[2nd] [D′]	Tax
4b	Enter Capital Gains Tax if desired	CGT	[R/S]	CGT
5	Find the missing term			
	• Number of periods to Maturity		[2nd] [E′] [A]	N
	• Annual Yield to Maturity		[2nd] [E′] [B]	%I
	• Annual Coupon Interest Rate		[2nd] [E′] [C]	%C
	• Purchase Price		[2nd] [E′] [D]	Buy
	• Maturity Value		[2nd] [E′] [E]	MAT
6	Find Current Yield (requires the entry of Annual Coupon Interest, Purchase Price, and Maturity Value in Step 3).		[2nd] [C′]	CYLD

NOTES:

1. Input and output values are printed and labeled.
2. All calculations are net of taxes and commissions.
3. Initialization assumes a 365 day year, semiannual coupon payments and that bond prices are entered in 10ths.

   To change to a 360 day year:
   Enter: 360
   Press: [STO] 25

   To change bond entry method to 32nds:
   Enter: 32
   Press: [STO] 27

   To change number of coupon payments per year:
   Enter: Number of Payments per Year
   Press: [STO] 26

   These changes must be made following Step 2 if desired. Note that if the actual dates are entered, the program computes the actual number of days between dates and then uses the 365 or 360 figure in transforming to annual terms.

SA-10

Example 1: A corporation sells a 20-year bond with an 8½% annual coupon. If the buyer wants to earn a 9% yield to maturity, how much can he afford to pay for the bond? If his personal income tax rate is 45% and his capital gains tax rate is 30%, what would his after-tax return be?

Note that in the following bond prices are entered and displayed in 10ths. Also note that the program assumes semiannual coupon payments unless told otherwise. This input is illustrated below.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 10		Select program		
	[SBR] [CLR]	0.	Initialize		
1	[STO] 26	1.	No. PMTS/Yr.		
20	[A]	20.	N	20.	N
9	[B]	9.00	%I	9.00	%I
8.5	[C]	8.50	Coupon %I	8.50	%C
100	[E]	100.00	Maturity value	100.00	MAT
	[2nd] [E′] [D]	95.44	Buy (net of com.)	95.44	BUY
	[D]	95.44	Enter buy price	95.44	BUY
45	[2nd] [D′]	45.00	Tax rate	45.00	TAX
30	[R/S]	30.00	CGT rate	30.00	CGT
	[2nd] [E′] [B]	5.00	%I	5.00	%I

Example 2: As of November 25, 1977, the U.S. Treasury 4's of February, 1993, are selling at 80-2/32. What is their yield to maturity?

Note that treasury bonds always mature on the 15th day of the designated month with coupon payments made every six months to coincide with the maturity date. In this case coupon payments of $20 (4% annual interest) are made each Feb. 15 and Aug. 15. Also observe that the value of this bond is quoted in 32nds. The program may be set up to accept the input in this form as illustrated below.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 10		Select program		
	[SBR] [CLR]	0.	Initialize		
32	[STO] 27	32.			
1125.1977	[2nd] [A′]	1125.1977	Current date	1125.1977	
215.1993	[2nd] [B′]	30.47123288	Mat. date → N	215.1993	
				30.47123288	N
4	[C]	4.00	Coupon %I	4.00	%C
80.02*	[D]	80.02	Buy	80.02	BUY
100	[E]	100.00	Maturity value	100.00	MAT
	[2nd] [E′] [B]	6.02	%I	6.02	%I

*Note that two digits are required for entry of 32nds.

Example 3: What is the current yield of a bond selling at $63.50 and paying semiannual coupons of $30 each (6% annual interest)?

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 10		Select program		
	[SBR] [CLR]	0.	Initialize		
6	**[C]**	6.00	Coupon rate	6.00	%C
63.5	**[D]**	63.50	Buy	63.50	BUY
100	**[E]**	100.00	Maturity value	100.00	MAT
	[2nd] [C′]	9.45	Current yield	9.45	CYLD

Note that the current yield calculation does not require N or %I.

Register Contents

R_{00}	R_{05} Used	R_{10} Used	R_{15} i	R_{20} Used	R_{25} 365
R_{01} N	R_{06} Used	R_{11} Used	R_{16} Used	R_{21} Used	R_{26} 2
R_{02} i	R_{07}	R_{12} Used	R_{17} %C	R_{22} Used	R_{27} 100
R_{03} Used	R_{08} Used	R_{13} Used	R_{18} Tax/100	R_{23} Used	R_{28} MAT
R_{04} Used	R_{09} (1 + i)	R_{14} Used	R_{19} CGT/100	R_{24} Used	R_{29} BUY+COM

SA-11

STOCK INDICATORS

In order to develop stock portfolios that minimize risk, it is necessary to know how individual stocks behave in relation to the movement of the entire market. One way to measure this behavior is to plot the percentage return of the stock (defined as the dividend income plus the increase in the value of the stock as a percentage of the stock price at the beginning of the period) against that which an investor would obtain if he held the mythical portfolio called the market. Then, by drawing a straight line through these points, several observations may be made. (Naturally, the line cannot be expected to hit all the points, but it should serve as a good approximation.)

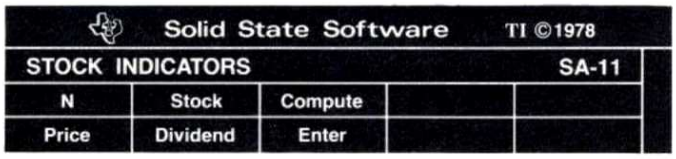
One piece of significant information is the slope of the line that best fits the above points. The slope or measure of incline of the line is known as the beta (β) of the stock, and reflects how responsive the stock is to the market. For example, a rather flat slope (β near zero) signifies a stock with a return that remains fairly constant independent of the market, while a slope of $\beta = 1$ indicates that the stock closely follows the market. On the other hand a steep slope ($\beta > 1$) is characteristic of a volatile stock that usually amplifies movement in the market, while a negative β is indicative of a stock moving opposite to the market.

The alpha (α) of a stock is also very important in portfolio analysis. This value represents the percentage return of the stock when the market earns no return as determined by the line that best fits the data.

This program can be used to calculate the above information as well as the expected return, and the variance and standard deviation of the return of each stock and a market index selected by the investor. Much of this information is used by program SA-12 in determining optimum portfolios.

To use this program, the investor simply enters the price and dividend history of a market index and the stocks he is interested in for a selected number of periods. Investors often disagree on the "best" interval to use in these calculations, but a widely used period is three months. Which stock index is best is usually answered by personal preference or by availability. Standard & Poors, Dow Jones, and the NYSE indexes are commonly available and should yield similar results in this program.

Another output of this program is a measure indicating how closely the data match the best-fit line found by the program. This value, known as the coefficient of determination (R^2), is described in Appendix B.



USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		**[2nd] [Pgm] 11**	
2	Initialize		**[SBR] [CLR]**	0.
3	Enter Number of Periods (N≥4)	N	**[2nd]** [A′]	N
4a	Enter Price Index for Period i	PI_i	[A]	PI_i
4b	Enter Dividend Index for Period i	DI_i	[B]	DI_i
4c	Ensure that entries made in 4a and 4b are correct and enter period (Repeat 4a-c for each period)		[C]	PI_i
5	Calculate Regression Data (Expected Return, Variance of Return, and Standard Deviation)		**[2nd]** [C′]	$\bar{x}$ERI* VARI* SDI
6	Enter Stock Number	Stock	**[2nd]** [B′]	Stock
7a	Enter Price for Period i	P_i	[A]	P_i
7b	Enter Dividend for Period i	D_i	[B]	D_i
7c	Ensure that entries made in 7a and 7b are correct and enter period (Repeat 7a-c for each period)		[C]	P_i
8	Calculate Regression Data (Alpha, Beta, Expected Return, Variance of Return, Standard Deviation, and Coefficient of Determination) (Repeat Steps 6, 7 and 8 for all stocks in the Portfolio)		**[2nd]** [C′]	A* B* ER* VAR* SD* R^2

NOTES:

1. All input and output values are printed and labeled.
2. Once [C] is pressed no changes may be made for that period. If an error is entered on key [C] while entering the market index, return to Step 2; while entering a stock, return to Step 6.
3. 26 + 2N registers are required for program use. Repartition if necessary.
4. Invalid results occur if N<4.

* Results are displayed for approximately 3 seconds and should be written down immediately if a PC-100A printer is not available.

SA-11

Example: Use the following data to calculate the required indicators.

		Periods									
		1	2	3	4	5	6	7	8	9	10
Market Index	P	74.17	83.96	91.63	81.33	95.30	106.50	91.11	90.05	99.17	117.50
	D	3.00	2.23	2.52	3.12	2.60	2.93	3.45	3.49	2.83	2.68
Stock A	P	28.50	28.50	34.40	52.40	62.30	64.50	68.50	57.50	72.00	93.20
	D	.20	.18	.24	.33	.57	.68	.79	.88	.76	.99
Stock B	P	57.70	77.20	91.20	65.50	67.40	72.40	65.40	59.40	73.30	71.20
	D	2.20	2.57	4.05	4.15	2.49	2.90	3.11	2.22	2.02	3.26
Stock C	P	79.70	105.50	105.10	112.70	141.30	224.00	233.30	175.00	226.50	265.30
	D	1.12	.99	1.65	1.77	1.96	2.94	6.45	8.96	7.28	9.78

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 11		Select program		
	[SBR] [CLR]	0.	Initialize		
10	**[2nd] [A′]**	10.	No. of Periods	10.	N
74.17	[A]	74.17	PI_1	74.17	P
3	[B]	3.00	DI_1	3.00	D
	[C]	74.17	Verify and enter		

Repeat the last three steps (4a-c) for each period.

117.50	[A]	117.50	PI_{10}	117.50	P
2.68	[B]	2.68	DI_{10}	2.68	D
	[C]	117.50	Verify and enter		

When all index data has been entered, go on to perform regression:

[2nd] [C′]	0.090688464*	$\bar{x}$ERI	0.090688464	$\bar{x}$ERI
	.0140477079*	VARI	.0140477079	VARI
	.1185230267	SDI	.1185230267	SDI

Now, enter data for Stock A.

1	**[2nd] [B′]**	1.	Stock A	1.	S
28.50	[A]	28.50	P_1	28.50	P
.2	[B]	0.20	D_1	0.20	D
	[C]	28.50	Verify and enter		

Repeat last three steps (7a-c) for each period.

93.2	[A]	93.20	P_{10}	93.20	P
.99	[B]	.99	D_{10}	0.99	D
	[C]	93.20	Verify and enter		

*Displayed approximately 3 seconds

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
When periodic data for Stock A has been entered, calculate regression data:					
	[2nd] [C′]	.1787537195*	Alpha	.1787537195	A
		−.1323592021*	Beta	−.1323592021	B
		.1667502668*	ER	.1667502668	ER
		.0449575777*	Variance	.0449575777	VAR
		.2120320205*	S. Deviation	.2120320205	SD
		.0062511987	R^2	.0062511987	R^2

*Displayed approximately 3 seconds.

Enter the periodic data and repeat the above procedure for Stocks B and C. (User Instruction Steps 6, 7, and 8.)

The following information will be generated:

Market

$\bar{x}$ERI = .090688464
VARI = .0140477079
SDI = .1185230267

	Stock A	Stock B	Stock C
ALPHA	.1787537195	−.0121867206	.0993392983
BETA	−.1323592021	1.036804125	1.016329395
ER	.1667502668	.081839453	.1915086501
VAR	.0449575777	.0397090787	.0608353289
SD	.2120320205	.1992713694	.2466481886
R^2	.0062511987	.4122170478	.263608247

Register Contents

R_{00} Stock Pointer	R_{05}	R_{10}	R_{15}	R_{20} N
R_{01}	R_{06}	R_{11}	R_{16} VARI	R_{21} Alpha
R_{02}	R_{07} Index Pointer	R_{12} P_i	R_{17} S^2	R_{22} Beta
R_{03}	R_{08} Used	R_{13} D_i	R_{18} ER	R_{23}
R_{04}	R_{09}	R_{14} P_{i-1}	R_{19} VAR	R_{24} SDI
				R_{25} SD

Registers R_{26} and above are used for storing yield data.

SA-12

PORTFOLIO SELECTION – SHARPE'S MODEL

Investors universally agree that a stock or any other asset should be evaluated in terms of its expected return and its risk. But unless an investor only owns one stock (which exposes him to unnecessary risk), he should be concerned with the total return and the collective risk of his entire portfolio. Though the return of a portfolio is nothing more than the sum of the returns of the individual securities, its risk is not so easily related to the individual risks. This means that the selection of a portfolio that minimizes risk without sacrificing too much return is not immediately obvious.

This program provides a method of selecting an optimum portfolio by determining the proportion of available funds that should be devoted to each security in a portfolio. Calculations are performed by comparing the interrelationships between the securities the investor would like to include in his portfolio and a market index. Inputs required for the market index include its expected return and the variance of that return. The investor is also asked to supply certain "stock indicators" (the alphas and betas described in SA-11 and the variance of the stock's return) for each stock he is considering in his analysis.

These indicators may be obtained by several means. One method is to use program SA-11 to compute these values based on historical data. The investor may use these values directly or modify them if he feels that future trends may differ from the past. Estimating these indicators without analyzing past data is not recommended, as it is very difficult to have a feel for these statistics based solely on observation.

One of the best ways to obtain this data is from statistical information developed and published by stock analysis firms. Beta values (β), for example, are included in Standard and Poor's *"Weekly Option Guide."* Assuming that the investor knows the expected returns of the stock (ER) and the market index (ERI), he can compute alpha (α) as

$$\alpha = ER - \beta(ERI).$$

Another way of expressing this relationship is

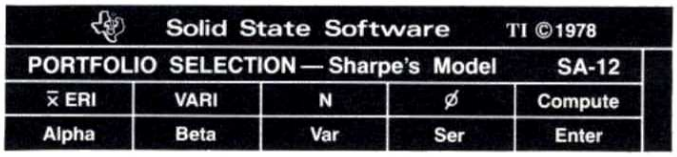
$$\beta = (ER - \alpha)/ERI.$$

Note that this program allows the investor to input either the variance or the standard deviation of a security's return. This input may be obtained by using SA-11 to compute the variance or by going to a brokerage publication. Most publications provide the standard deviation of the return, though it is often called volatility or standard error.

As a final input the investor must express his willingness to accept risk in order to obtain a larger return. This risk factor, denoted ϕ (phi), is entirely up to the investor. In theory, ϕ may range from zero to infinity with a higher value of ϕ causing the program to assign a greater proportion of available funds to the risky security with a high return. But in practice, an aggressive investor seldom chooses a ϕ larger than 3 or 4.

Specifically, ϕ is the weight attached to a unit of risk relative to a unit of return, or the increase in percentage variance of return in proportion to the increase in percentage return that is considered optimum for the investor. If $\phi = 2$, for example, then the investor is saying that he is willing to accept two units of risk for one unit of return, and if $\phi = \frac{1}{2}$ the investor wants two units of return for every unit of risk he takes.

As mentioned above, the final output of this program provides the investor with the optimum weight of each security in his portfolio. However, the constraint that the sum of the weights total 1, or 100%, does not prevent a security from being assigned a negative weight. The stocks in a two-stock portfolio, for example, might be assigned weights of −1.3 and 2.3, the sum of which is 1. In such circumstances, the investor should remove any security assigned a negative weight from his portfolio and run the program again.



USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		**[2nd] [Pgm] 12**	
2	Initialize		**[SBR] [CLR]**	0.
3	Enter Expected Return of the Index	$\bar{x}$ERI	**[2nd] [A′]**	$\bar{x}$ERI
4	Enter Variance of Return of the Index	VARI	**[2nd] [B′]**	VARI
5	Enter Number of Stocks in Portfolio	N	**[2nd] [C′]**	N
6	Enter Risk Factor ($\phi \geq 0$)	ϕ	**[2nd] [D′]**	ϕ
7a	Enter Alpha for Stock i	α	**[A]**	α
7b	Enter Beta for Stock i	β	**[B]**	β
7c	Enter Variance of Return for Stock i	Var	**[C]**	Var
	OR			
	Enter Standard Error of Estimate for Stock i	SER	**[D]**	SER
7d	Ensure that entries made in 7a-c are correct and enter stock (Repeat Step 7 for each stock)		**[E]**	No Change
8	Compute Weights of Individual Stocks		**[2nd] [E′]**	WGTS*

NOTES:

1. Input and output values are printed and labeled.
2. Once [E] is pressed, no changes may be made for that stock. If an error is discovered, return to Step 2.
3. 26 + 3N registers are required for program use. Repartition if necessary.

* The weights are displayed in order for about 3 seconds.

SA-12

Example 1: Use the regression data obtained in Program 11 to find the optimum weights of each stock in the portfolio. Use ϕ's of 0 and 0.05.

	Stock A	Stock B	Stock C	Index
α	.179	−.012	.099	$\bar{x}$ERI = .091
β	−.133	1.037	1.016	VARS = .014
VAR	.045	.040	.061	

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 12		Select program		
	[SBR] [CLR]	0.	Initialize		
.091	[2nd] [A′]	0.091	$\bar{x}$ERI	0.091	$\bar{x}$ERI
.014	[2nd] [B′]	0.014	Var. of index	0.014	VARI
3	[2nd] [C′]	3.	No. stocks	3.	N
0	[2nd] [D′]	0.	Risk factor	0.	PHI
.179	[A]	0.179	α – Stock A	1.	
				0.179	A
.133	[+/–] [B]	−0.133	β – Stock A	−0.133	B
.045	[C]	0.045	Var. – Stock A	0.045	VAR
	[E]	0.045	Verify and enter		
.012	[+/–] [A]	−0.012	α – Stock B	2.	
				−0.012	A
1.037	[B]	1.037	β – Stock B	1.037	B
.04	[C]	0.04	Var. – Stock B	0.04	VAR
	[E]	0.04	Verify and enter		
.099	[A]	0.099	α – Stock C	3.	
				0.099	A
1.016	[B]	1.016	β – Stock C	1.016	B
.061	[C]	0.061	Var. – Stock C	0.061	VAR
	[E]	0.061	Verify and enter		
	[2nd] [E′]	1.*	Find weights	1.	
		.4643642967*		.4643642967	WGT
		2.*		2.	
		.3220787171*		.3220787171	
		3.*		3.	
		.2135569861		.2135569861	WGT
.05	[2nd] [D′]	.05	New risk factor	0.05	PHI
	[2nd] [E′]	1.*	Find weights	1.	
		.4759933138*		.4759933138	WGT
		2.*		2.	
		.2880939957*		.2880939957	WGT
		3.*		3.	
		.2359126905		.2359126905	WGT

*Displayed for approximately 3 seconds.

Example 2: Find the optimum weights for each stock in a two-stock portfolio, given the following data:

	Stock 1	Stock 2	Index
α	.05	.15	$\bar{x}$ERI = .1
β	0	0	VARI = .1
SER	.2	.4	

Use ϕ's of 0 and 1.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 12		Select program		
	[SBR] [CLR]	0.	Initialize		
.1	**[2nd] [A′]**	0.1	$\bar{x}$ERI	0.1	$\bar{x}$ERI
.1	**[2nd] [B′]**	0.1	Var. of index	0.1	VARI
2	**[2nd] [C′]**	2.	No. of stocks	2.	N
0	**[2nd] [D′]**	0.	Risk factor	0.	PHI
.05	**[A]**	0.05	α for Stock 1	1.	
				0.05	A
0	**[B]**	0.	β for Stock 1	0.	B
.2	**[D]**	0.2	SER for Stock 1	0.2	SER
	[E]	0.2	Verify and enter		
.15	**[A]**	0.15	α for Stock 2	2.	
				0.15	A
0	**[B]**		β for Stock 2	0.	B
.4	**[D]**	0.4	SER for Stock 2	0.4	SER
	[E]	0.4	Verify and enter		
	[2nd] [E′]	1.*		1.	
		0.8*		0.8	WGT
		2.*		2.	
		0.2		0.2	WGT
1	**[2nd] [D′]**	1.	New risk factor	1.	PHI
	[2nd] [E′]	1.*		1.	
		0.55*		0.55	WGT
		2.*		2.	
		0.45		0.45	WGT

*Displayed for approximately 3 seconds.

Register Contents

R_{00} α Pointer	R_{05} Used	R_{10}	R_{15}	R_{20} SER
R_{01} N	R_{06} $\Sigma\beta/-2$ Var.	R_{11} ½ VARI	R_{16}	R_{21}
R_{02}	R_{07} $\Sigma\beta^2/-2$ Var.	R_{12} λ_2	R_{17} $\Sigma\alpha\beta\phi/2$ Var.	R_{22}
R_{03} Σ 1/−2 Var.	R_{08} β Pointer	R_{13} λ_1	R_{18} ϕ	R_{23} $\bar{x}$ERI
R_{04} $\Sigma\alpha\phi/2$ Var.	R_{09} Var. Pointer	R_{14}	R_{19}	R_{24} VARI

R_{25} is used. R_{26} and above are used to store the stock data.

SA-13

PORTFOLIO BOOKKEEPING

Every investor should have a clear, updated picture of the value of his securities portfolio and related information such as profitability, dividend yield, and rate of return. This program provides a quick and easy way to perform these essential but tedious calculations.

The information required by this program (dates, initial cost and current value of the securities, and income from the securities) is readily available to the investor. However, one point to be remembered is that the number of shares and their cost basis should be the same as those used the last time the portfolio was evaluated, unless a stock split has occurred. When this happens, the investor should increase the number of shares to reflect the current number owned, and adjust the original purchase price per share downward proportionately.

Once the data for an individual security is entered, the following information is calculated for that security:

- Total Cost
- Total Market Value
- Annual Income
- Gain/Loss
- Yield
- Annualized Growth
- Total Yield

The portfolio totals may also be displayed at any time the investor asks for them.

This program actually has two uses. The above describes how an investor may determine unrealized gains by evaluating securities he currently holds in his portfolio. To determine realized gains the investor simply performs this same evaluation on securities he has removed from his portfolio during the last calendar year. The only difference is that he enters the date on which he sold the security instead of the present date as described in the user instructions. For tax purposes the investor may choose to perform this evaluation in two parts since he must pay income tax on securities held less than six months and capital gains tax on those held for a longer period of time.

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PORTFOLIO BOOKKEEPING				SA-13
Buy	Current	Sell	Portfolio	
N	Cost	MP	INC	Total

USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		[2nd] [Pgm] 13	
2	Initialize		[SBR] [CLR]	0.
3	Enter Date Bought	MMDD.YYYY	[2nd] [A′]	BD
4	Enter Present Date	MMDD.YYYY	[2nd] [B′]	PD
5	Enter Date to be Sold	MMDD.YYYY	[2nd] [C′]	SD
6	Enter Number of Securities or Contracts Bought or Sold	N	[A]	N
7	Enter Cost of Purchase of Security or Contract	Cost	[B]	Cost
8	Enter Current Market Price of Security or Contract Purchased	MP	[C]	MP
9	Enter Annual Dividends per Share (or Coupon Payments per Bond) of Purchased Security	INC	[D]	INC
10	Calculate: Total Cost Market Value Annual Income Gain/Loss Yield Annualized Growth Total Yield		[E]	TC* MV* AI* G/L* %Y* %AG* %TY
	(Repeat Steps 3-10 for each Security or Contract in the Portfolio)			
11	Display Portfolio Totals (may be performed at any time): Total Cost Market Value Annual Income Gain/Loss Yield Annualized Growth Total Yield		[2nd] [D′]	ΣTC* ΣMV* ΣAI* ΣG/L* P%Y* P%AG* P%TY*

NOTE: * Displayed for approximately three seconds.

SA-13

Example 1: Evaluate the following portfolio for unrealized gains. Use October 31, 1977, as the present date.

	Number of Securities or Contracts	Cost/Share	Market Price	Div/Share	Purchase Date
Stock 1	3400	21.17	57.00	2.00	10-31-76
Stock 2 (Calls-Bought)	300	.93	.75	–†	10-31-76
Stock 3	10	755.00	800.00	60.00	10-31-76

†Enter zero

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 13		Select program		
	[SBR] [CLR]	0.	Initialize		
1031.1976	[2nd] [A′]	1031.1976	Purchase date	1031.1976	BD
1031.1977	[2nd] [B′]	1031.1977	Present date	1031.1977	PD
3400	[A]	3400.	No. of shares	3400.	N
21.17	[B]	21.17	Cost/share	21.17	COST
57	[C]	57.00	Market price	57.00	MP
2	[D]	2.00	Div/share	2.00	INC
	[E]	71978.00*	Total cost	71978.00	TC
		193800.00*	Market value	193800.00	MV
		6800.00*	Annual income	6800.00	AI
		121822.00*	Gain/loss	121822.00	G/L
		9.45*	Yield	9.45	%Y
		169.25*	Annualized growth	169.25	%AG
		178.70	Total yield	178.70	%TY

Repeat above steps for each security or contract in the portfolio. Do not press [SBR] [CLR]. Dates need not be reentered if they remain the same. When all data is entered, find the portfolio totals:

[2nd] [D′]	79807.00*	Total cost	79807.00	ΣTC
	202025.00*	Market value	202025.00	ΣMV
	7400.00*	Annual income	7400.00	ΣAI
	122218.00*	Gain/loss	122218.00	ΣG/L
	9.27*	Yield	9.27	P%Y
	153.14*	Annualized growth	153.14	P%AG
	162.41	Total yield	162.41	P%TY

*Displayed for approximately 3 seconds.

You will have generated the following information:

	Total Cost	Market Value	Annual Income	Gains/Loss	Yield	Annualized Growth	Total Yield
Stock 1	71978.00	193800.00	6800.00	121822.00	9.45	169.25	178.70
Stock 2	279.00	225.00	–	–54.00	–	–19.35	–19.35
Stock 3	7550.00	8000.00	600.00	450.00	7.95	5.96	13.91
Portfolio	79807.00	202025.00	7400.00	122218.00	9.27	153.14	162.41

Example 2: Evaluate the following portfolio for realized gains (selling date: October 30, 1977) for tax purposes. Taxes may be computed by applying income tax rates to securities held less than six months and capital gains tax rates otherwise.

	Number of Shares	Cost/Share	Market Price	Div/Share	Purchase Date
Stock 1	1000	42.00	50.00	3.00	8-31-77
Stock 2	500	30.00	34.00	2.00	8-31-77
Stock 3	250	15.00	20.00	1.00	10-31-75
Stock 4	2000	72.00	80.00	5.00	10-31-75

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 13		Select program		
	[SBR] [CLR]	0.	Initialize		
831.1977	[2nd] [A′]	831.1977	Purchase date	831.1977	BD
1030.1977	[2nd] [C′]	1030.1977	Selling date	1030.1977	SD
1000	[A]	1000.	No. of shares	1000.	N
42	[B]	42.00	Cost/share	42.00	COST
50	[C]	50.00	Market price	50.00	MP
3	[D]	3.00	Div/share	3.00	INC
	[E]	42000.00*	Total cost	42000.00	TC
		50000.00*	Market value	50000.00	MV
		3000.00*	Annual income	3000.00	AI
		8000.00*	Gain/loss	8000.00	G/L
		7.14*	Yield	7.14	%Y
		188.82*	Annualized growth	188.82	%AG
		195.97	% Total yield	195.97	%TY

Repeat above procedure for stock 2. Do not press [SBR] [CLR]. Dates need not be entered if they remain the same. Then compute portfolio data for these two stocks held less than six months.

*Displayed approximately 3 seconds.

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ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [D′]	57000.00*	Portfolio cost	57000.00	ΣTC
		67000.00*	Portfolio MV	67000.00	ΣMV
		4000.00*	Portfolio AI	4000.00	ΣAI
		10000.00*	Portfolio G/L	10000.00	ΣG/L
		7.02*	Portfolio yield	7.02	P%Y
		169.17*	Portfolio AG	169.17	P%AG
		176.19	Portfolio TY	176.19	P%TY

*Displayed approximately 3 seconds.

Reinitialize and repeat procedure for the two stocks purchased October 31, 1975. The complete portfolio data will be as follows:

	Total Cost	Market Value	Annual Income	Gains/Loss	Yield	Annualized Growth	Total Yield
Stock 1	42000.00	50000.00	3000.00	8000.00	7.14	188.82	195.97
Stock 2	15000.00	17000.00	1000.00	2000.00	6.67	114.13	120.80
Portfolio (less than 6 months)	57000.00	67000.00	4000.00	10000.00	7.02	169.17	176.19
Stock 3	3750.00	5000.00	250.00	1250.00	6.67	15.47	22.14
Stock 4	144000.00	160000.00	10000.00	16000.00	6.94	5.41	12.35
Portfolio (more than 6 months)	147750.00	165000.00	10250.00	17250.00	6.94	5.66	12.60

Register Contents

R_{00}	R_{06} (PD−BD)/365	R_{12} AI	R_{18} ΣAI	R_{24} %Y/100
R_{01} Used	R_{07} (SD−BD)/365	R_{13} P%Y	R_{19}	R_{25} %AG/100
R_{02}	R_{08}	R_{14} P%AC	R_{20} N	R_{26} %TY
R_{03} MV	R_{09}	R_{15} ΣTC	R_{21} Used	R_{27} Cost
R_{04} TC	R_{10} ΣTC(%Y)/100	R_{16} ΣMV	R_{22} Used	R_{28} MP
R_{05} BD Factor	R_{11} ΣTC(%Y)/100	R_{17} ΣG/L	R_{23} Used	R_{29} INC

CAPITAL ACCUMULATION PLANNING

In economics and business it is common to use financial models in planning for the future. Naturally, some simplifying assumptions must be made, but these techniques do allow one to arrive at a reasonably intelligent estimate of the situation by highlighting critical elements.

The model presented by this program can be used to forecast the future net worth of businesses and individuals alike. The basic inputs are present net worth and annual income after taxes. The following assumptions must also be made:

- A constant proportion of after-tax income is saved and invested at a constant rate of return.
- Annual income increases by the same percentage each year.

Once the future net worth is calculated, its present value may be found by assuming a constant rate of inflation.

Of particular interest to individuals is retirement planning. Once this program is used to determine an individual's future net worth, he may use SA-04 to find his retirement income depending on how long he expects to live. (See the examples accompanying this program and SA-04.) The following mortality tables can be used as a guide in determining the number of years an individual should expect to live after retiring.

SA-14

COMMISSIONERS 1958 STANDARD ORDINARY MORTALITY TABLE*

Age x	Number Living lx	Number Dying dx	Deaths per 1,000	Age x	Number Living lx	Number Dying dx	Deaths per 1,000
0	10,000,000	70,800	7.08	**50**	8,762,306	72,902	8.32
1	9,929,200	17,475	1.76	51	8,689,404	79,160	9.11
2	9,911,725	15,066	1.52	52	8,610,244	85,758	9.96
3	9,896,659	14,449	1.46	53	8,524,486	92,832	10.89
4	9,882,210	13,835	1.40	54	8,431,654	100,337	11.90
5	9,868,375	13,322	1.35	**55**	8,331,317	108,307	13.00
6	9,855,053	12,812	1.30	56	8,223,010	116,849	14.21
7	9,842,241	12,401	1.26	57	8,106,161	125,970	15.54
8	9,829,840	12,091	1.23	58	7,980,191	135,663	17.00
9	9,817,749	11,879	1.21	59	7,844,528	145,830	18.59
10	9,805,870	11,865	1.21	**60**	7,698,698	156,592	20.34
11	9,794,005	12,047	1.23	61	7,542,106	167,736	22.24
12	9,781,958	12,325	1.26	62	7,374,370	179,271	24.31
13	9,769,633	12,896	1.32	63	7,195,099	191,174	26.57
14	9,756,737	13,562	1.39	64	7,003,925	203,394	29.04
15	9,743,175	14,225	1.46	**65**	6,800,531	215,917	31.75
16	9,728,950	14,983	1.54	66	6,584,614	228,749	34.74
17	9,713,967	15,737	1.62	67	6,355,865	241,777	38.04
18	9,698,230	16,390	1.69	68	6,114,088	254,835	41.68
19	9,681,840	16,846	1.74	69	5,859,253	267,241	45.61
20	9,664,994	17,300	1.79	**70**	5,592,012	278,426	49.79
21	9,647,694	17,655	1.83	71	5,313,586	287,731	54.15
22	9,630,039	17,912	1.86	72	5,025,855	294,766	58.65
23	9,612,127	18,167	1.89	73	4,731,089	299,289	63.26
24	9,593,960	18,324	1.91	74	4,431,800	301,894	68.12
25	9,575,636	18,481	1.93	**75**	4,129,906	303,011	73.37
26	9,557,155	18,732	1.96	76	3,826,895	303,014	79.18
27	9,538,423	18,981	1.99	77	3,523,881	301,997	85.70
28	9,519,442	19,324	2.03	78	3,221,884	299,829	93.06
29	9,500,118	19,760	2.08	79	2,922,055	295,683	101.19
30	9,480,358	20,193	2.13	**80**	2,626,372	288,848	109.98
31	9,460,165	20,718	2.19	81	2,337,524	278,983	119.35
32	9,439,447	21,239	2.25	82	2,058,541	265,902	129.17
33	9,418,208	21,850	2.32	83	1,792,639	249,858	139.38
34	9,396,358	22,551	2.40	84	1,542,781	231,433	150.01
35	9,373,807	23,528	2.51	**85**	1,311,348	211,311	161.14
36	9,350,279	24,685	2.64	86	1,100,037	190,108	172.82
37	9,325,594	26,112	2.80	87	909,929	168,455	185.13
38	9,299,482	27,991	3.01	88	741,474	146,997	198.25
39	9,271,491	30,132	3.25	89	594,477	126,303	212.46
40	9,241,359	32,622	3.53	**90**	468,174	106,809	228.14
41	9,208,737	35,362	3.84	91	361,365	88,813	245.77
42	9,173,375	38,253	4.17	92	272,552	72,480	265.93
43	9,135,122	41,382	4.53	93	200,072	57,881	289.30
44	9,093,740	44,741	4.92	94	142,191	45,026	316.66
45	9,048,999	48,412	5.35	**95**	97,165	34,128	351.24
46	9,000,587	52,473	5.83	96	63,037	25,250	400.56
47	8,948,114	56,910	6.36	97	37,787	18,456	488.42
48	8,891,204	61,794	6.95	98	19,331	12,916	668.15
49	8,829,410	67,104	7.60	99	6,415	6,415	1,000.00

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USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		[2nd] [Pgm] 14	
2	Initialize		[SBR] [CLR]	0.
3	Enter Present Year	Present	[A]	Present
4	Enter Future Year	Future	[2nd] [A′]	Future
5	Enter Present Net Worth	PNW	[B]	PNW
6	Enter After-Tax Income	INC	[C]	INC
7	Enter Percent of Income Invested	INV	[2nd] [C′]	INV
8	Enter Annual Return on Investments	%I	[D]	%I
9	Enter Growth in After-Tax Income	%G	[E]	%G
10	Compute Future Net Worth		[2nd] [B′]	FNW
11	Enter Inflation Rate and Calculate Present Value of Future Net Worth	IR	[2nd] [D′]	PV

NOTES:

1. Input and output values are printed and labeled. (Steps 3 and 4 are not labeled allowing the user to enter "years" for businesses and "ages" for individuals. Entries must be compatible.)
2. The PNW entered in Step 5 must be positive.

SA-14

Example 1: Compute the future net worth of an individual at age 65 given the following information: present age, 30; PNW, $4,000; after-tax income, $10,000; percentage of income invested, 10%; return on investments, 5%; estimated growth in after-tax salary, 4%. Then assume a constant inflation rate of 6% and find the present value of his future net worth.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 14		Select program		
	[SBR] [CLR]	0.	Initialize		
30	[A]	30.	Present age	30.	
65	[2nd] [A′]	65.	Future age	65.	
4000	[B]	4000.00	PNW	4000.00	PNW
10000	[C]	10000.00	After-tax income	10000.00	EARN
10	[2nd] [C′]	10.00	% income invested	10.00	INV
5	[D]	5.00	Return on inv.	5.00	%I
4	[E]	4.00	Income growth rate	4.00	%G
	[2nd] [B′]	179056.70	FNW	179056.70	FNW
6	[2nd] [D′]	23296.21	Discounted PV	6.00	IR
				23296.21	PV

Example 2: A 40-year-old worker is planning for his retirement. His current income is $25,000 after taxes, and he expects it to grow at an average rate of 5% per year. He believes that he can live on half his final income and wants sufficient funds to last until age 80 assuming that social security will account for 50% of his retirement income. If his investments earn an average of 10% per year, what percentage of his income should he invest each year?

Step 1 Compute his income at age 65 using SA-03.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 03		Select program		
	[SBR] [CLR]	0.	Initialize		
25	[A]	25.	Years to age 65	25.	N
5	[B]	5.00	Income growth rate	5.00	%I
25000	[D]	25000.00	PV	25000.00	PV
	[2nd] [C′]	84658.87	FV	84658.87	FV

Step 2 Compute retirement income needed as 25% of income at age 65. (Social Security supplies the other 25%.)

	[×]	84658.87	
.25	[=]	21164.72	Required income

Step 3 Compute net worth needed at age 65 to provide the above income, using the ordinary annuity calculation in SA-04.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 04		Select program		
	[SBR] [CLR]	0.	Initialize		
	[2nd] [C′]	0.	Select ordinary annuity routine		
80	[–]	80.			
65	[=] [A]	15.	N	15.	N
10	[B]	10.00	Return on inv.	10.00	%I
21164.72	[C]	21164.72	PMT	21164.72	PMT
	[2nd] [E′] [D]	160980.54	FNW at age 65	160980.54	PV

Step 4 Now solve for the necessary saving rate using SA-14. Use a present net worth of $5000. Note that this value excludes property, such as the worker's house, which he would not turn into capital at retirement.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
	[2nd] [Pgm] 14		Select program		
	[SBR] [CLR]	0.	Initialize		
40	[A]	40.	Present age	40.	
65	[2nd] [A′]	65.	Future age	65.	
5000	[B]	5000.00	PNW	5000.00	PNW
25000	[C]	25000.00	After-tax income	25000.00	EARN
10	[D]	10.00	Return on inv.	10.00	%I
5	[E]	5.00	Income growth rate	5.00	%G
5	[2nd] [C′]	5.00	% income invested	5.00	INV
	[2nd] [B′]	240382.30	FNW	240382.30	FNW
3	[2nd] [C′]	3.00	% income invested	3.00	INV
	[2nd] [B′]	165898.79	FNW	165898.79	FNW
2.5	[2nd] [C′]	2.50	% income invested	2.50	INV
	[2nd] [B′]	147277.92	FNW	147277.92	FNW
2.8	[2nd] [C′]	2.80	% income invested	2.80	INV
	[2nd] [B′]	158450.44	FNW	158450.44	FNW
2.9	[2nd] [C′]	2.90	% income invested	2.90	INV
	[2nd] [B′]	162174.62	FNW	162174.62	FNW
2.85	[2nd] [C′]	2.85	% income invested	2.85	INV
	[2nd] [B′]	160312.53	FNW	160312.53	FNW

Note that an iterative procedure is used to determine the percentage of income that must be invested to achieve the desired future net worth at age 65. In this example, just over 2.85% of his income to achieve his goal of a net worth of $160,980 at his retirement.

Example 3: Suppose that the man in the last example became concerned that he might deplete his retirement investments by living more than 80 years. The solution to this problem is to go to an insurance company and buy a "lifetime annuity" guaranteed to pay him for as long as he lives. But how much would an insurance company charge for this annuity?

The insurance company must make a profit on its investments and is required to put its customer's money in relatively safe, but low yield securities and other properties. Therefore, the rate of return it can offer on the annuities it sells is low, say 4%, compared to the 10% previously used in computing the cost of his own self-funded annuity.

In exchange for the lower interest rate, the insurance company offers to pay indefinitely. But due to the mortality rate, the number of annuities it must pay on decreases each year (excluding new annuities that the company sells). For example, the mortality tables presented in this section indicate that a 65-year-old man only has a 39% chance of reaching age 80 (ℓ_{80}/ℓ_{65} = number living at 80/number living at 65 = 2,626,372/6,800,531).

The insurance company determines the value of the annuity by finding the average number of payments it expects to make. This is done by multiplying the payment by the "chance" or probability that the buyer of the annuity will live to collect the payment. These "expected payments" may then be entered into the Uneven Cash Flows program, SA-05, and discounted at the agreed upon interest rate to their present value.

Note that the probability that the buyer of the annuity will live to collect a given payment is found by dividing the number of people living at that age (ℓ_x) by the number living at age 65 (ℓ_{65}).

Age x	ℓ_x	ℓ_x/ℓ_{65}	× $21,164.72 = Expected Payment
66	6,584,614	.968	$20,493
67	6,355,865	.935	19,781
68	6,114,088	.899	19,028
69	5,859,253	.862	18,235
70	5,592,021	.822	17,404
71	5,313,586	.781	16,537
72	5,025,855	.739	15,642
73	4,731,089	.696	14,724
74	4,431,800	.652	13,792
75	4,129,906	.607	12,853
76	3,826,895	.563	11,910
77	3,523,881	.518	10,967
78	3,221,884	.474	10,027
79	2,922,055	.430	9,094
80	2,626,372	.386	8,174
81	2,337,524	.344	7,275
82	2,058,541	.303	6,407
83	1,792,639	.264	5,579
84	1,542,781	.227	4,801
85	1,311,348	.193	4,081
86	1,100,037	.162	3,424
87	909,929	.134	2,832
88	741,474	.109	2,308
89	594,477	.087	1,850
90	468,174	.069	1,457

For complete accuracy, this calculation should be continued until $\ell_x = 0$, but the values are now small enough that additional calculation should have little impact on the final answer. It is now time to use SA-05 to determine the present value of the annuity. Use the above expected payments and an interest rate of 4%.

TI-58's must be repartitioned by pressing 5 [2nd] [Op] 17 before running the example.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT
	[2nd] [Pgm] 05		Select program	
	[SBR] [CLR]	1.	Initialize	
20493	[C]	2.00	Expected PMT_1	1.
				−20493.00
19781	[C]	3.00	PMT_2	2.
				−19781.00
19028	[C]	4.00	PMT_3	3.
				−19028.00
18235	[C]	5.00	PMT_4	4.
				−18235.00
17404	[C]	6.00	PMT_5	5.
				−17404.00
16537	[C]	7.00	PMT_6	6.
				−16537.00
15642	[C]	8.00	PMT_7	7.
				−15642.00
14724	[C]	9.00	PMT_8	8.
				−14724.00
13792	[C]	10.00	PMT_9	9.
				−13792.00
12853	[C]	11.00	PMT_{10}	10.
				−12853.00
11910	[C]	12.00	PMT_{11}	11.
				−11910.00
10967	[C]	13.00	PMT_{12}	12.
				−10967.00
10027	[C]	14.00	PMT_{13}	13.
				−10027.00
9094	[C]	15.00	PMT_{14}	14.
				−9094.99
8174	[C]	16.00	PMT_{15}	15.
				−8174.00
7275	[C]	17.00	PMT_{16}	16.
				−7275.00
6407	[C]	18.00	PMT_{17}	17.
				−6407.00
5579	[C]	19.00	PMT_{18}	18.
				−5579.00
4801	[C]	20.00	PMT_{19}	19.
				−4801.00
4081	[C]	21.00	PMT_{20}	20.
				−4081.00
3424	[C]	22.00	PMT_{21}	21.
				−3424.00

SA-14

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT	
2832	[C]	23.00	PMT_{22}	22.	
				−2832.00	
2308	[C]	24.00	PMT_{23}	23.	
				−2308.00	
1850	[C]	25.00	PMT_{24}	24.	
				−1850.00	
1457	[C]	26.00	PMT_{25}	25.	
				−1457.00	
0	[A]	0.00		0.00	INV
4	[E]	−188258.83	PV	4.00	%I
				−188258.83	PV

This means that the worker would have to pay $188,259 for an annuity that would give him a guaranteed annual income of $21,165 for the remainder of his life.

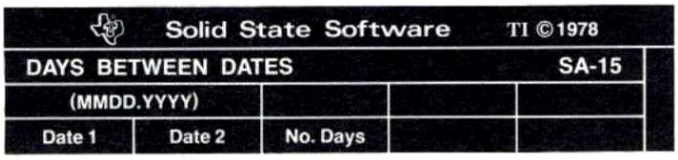
Register Contents

R_{00}	R_{05} %I/100	R_{10} Present Age	R_{15} (%I/100 + 1)
R_{01}	R_{06} %G/100	R_{11} Future Age	R_{16} (%G/100 + 1)
R_{02}	R_{07} (1 + %I/100)	R_{12} PNW	R_{17} Future − Present Age
R_{03}	R_{08}	R_{13} Income	R_{18} FNW
R_{04}	R_{09}	R_{14} INV/100	R_{19}

DAYS BETWEEN DATES

This program calculates the number of days between any two calendar dates after the year 1582 (1752 in the United States and England). The calculations are based on the Gregorian calendar.

Note that the dates are entered in the order: month, day, year using the format MMDD.YYYY.



USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select Program		[2nd] [Pgm] 15	
2	Initialize		[SBR] [CLR]	
3	Enter First Date	MMDD.YYYY	[A]	MMDD.YYYY
4	Enter Second Date	MMDD.YYYY	[B]	MMDD.YYYY
5	Find Number of Days Between Dates		[C]	No. Days

NOTES:

1. Calculations are valid only after 1582.
2. Erroneous entries such as Feb. 30 yield incorrect results without any warnings.
3. The date factor (see Appendix A) may be obtained by entering the date and pressing [2nd] [A′].

SA-15

Example: Find the number of days between:

1. January 1, 1976, and January 1, 1977.
2. January 1, 1977, and January 1, 1978.

ENTER	PRESS	DISPLAY	COMMENTS	PRINTOUT
	[2nd] [Pgm] 15		Select program	
	[SBR] [CLR]	0.	Initialize	
101.1976	[A]	101.1976	First date	
101.1977	[B]	101.1977	Second date	
	[C]	366.	Number of days	
101.1977	[A]	101.1977	First date	
101.1978	[B]	101.1978	Second date	
	[C]	365.	Number of days	

Register Contents

R_{20} Date factor 2
R_{21} Used
R_{22} Used
R_{23} Used
R_{24} Date factor 1

APPENDIX A – EQUATIONS

SA-02 Earnings Per Share Estimation

This equation used to estimate earnings per share after N periods (EPS_N) is:

$$EPS_N = EPS \frac{(S_N/S)(\Pi_N/\Pi)}{\left\{(S_N/S)(T/T_N)(L/L_N) - [1 + \overline{PNW}\,(1 - \overline{DPO})]^N\right\}\left(\frac{B}{M}\right) + 1}$$

where

S = Sales
Π = Profit Margin = Available for Common/Sales
(Available for Common = Net Profit – Preferred Dividends
T = Turnover = Sales/Assets
L = Leverage = Assets/Common Stock Equity
(Common Stock Equity = Common Stock + Capital Surplus + Retained Earnings)
PNW = Profit on Net Worth = Available for Common/Common Stock Equity
DPO = Dividend Pay-out Ratio = Dividends/Available for Common
B/M = Book/Market Ratio

SA-04 Annuities

1. Sinking Fund

$$FV = PMT \frac{(1+i)^N - 1}{i}$$

2. Annuity Due/FV

$$FV = PMT\,(1+i)\frac{(1+i)^N - 1}{i}$$

3. Ordinary Annuity/PV

$$PV = PMT\left[\frac{1-(1+i)^{-N}}{i}\right] + BAL(1+i)^{-N}$$

4. Annuity Due/PV

$$PV = PMT\,(1+i)\left[\frac{1-(1+i)^{-N}}{i}\right] + BAL(1+i)^{-N}$$

APPENDIX A

where

N = Number of Payment Periods
PV = Present Value
FV = Future Value
BAL = Balloon Payment
i = Periodic Interest (decimal)

Note: i is determined by the Newton-Raphson Method.

SA-05 Uneven Cash Flows

The internal rate of return is found using sophisticated numerical techniques, based on a method by E. Schroder. Reference: *Numerical Methods*; Dahlquist, Bjork, Anderson; pp 222-6, 237; Prentice-Hall, 1974.

The Compound Interest Program (SA-03) is used to compute PV as:

$$PV = FV/(1 + k)^N$$

The Future Value is found as:

$$FV = \sum_{j=0}^{N} CF_j(1 + i)^{N+1-j}$$

where CF_0 = Investment

SA-06 Stock Valuation

Calculations are based on the following equation:

$$BUY + COM_{BUY} = (1 - TAX) \sum_{j=1}^{N} DIV_j/(1 + i)^j + \frac{(SELL - COM_{SELL}) - [(SELL - COM_{SELL}) - (BUY + COM_{BUY})]\,CGT}{(1 + i)^N}$$

where

BUY = Purchase Price of Stock per Share
COM_{BUY} = Commission per Share at Purchase
SELL = Selling Price of Stock per Share
COM_{SELL} = Commission per Share at Sale
DIV_j = Dividend Payment
i = Yield
TAX = Income Tax Rate (in decimal form)
CGT = Capital Gains Tax (in decimal form)

APPENDIX A

SA-07 Option Valuation — Black-Scholes Model

The value of a Call Option at time t is found as:

$$w(x,t) = xN(d_1) - ce^{-r\Delta t}\, N(-d_2)$$

and the value of a Put Option is:

$$u(x,t) = -xN(-d_1) + ce^{-r\Delta t}\, N(-d_2)$$

for $$d_1, d_2 = [\ln(x/c) + (r \pm \nu^2/2)\Delta t]/\nu\sqrt{\Delta t}$$

where

x = Share Price
c = Exercise Price
Δt = Days Until Expiration/365
ν = Volatility (Std. Dev. of Return)
r = Annual Yield
$N(d)$ = Cumulative Normal Density Function

The Hedge Ratio is $N(d_1)$ for a Call Option and $N(-d_1)$ for a Put Option.

Reference: Fischer Black and Myron Scholes, *Journal of Political Economy*, May/June 1973, pp 637-654.

The Standard Normal Function is determined by finding the right tail area of the function, Q(x), where:

$$Q(x) = \frac{1}{\sqrt{2\pi}}\, e^{-x^2/2}\,(b_1\, t + b_2\, t^2 + b_3\, t^3 + b_4\, t^4 + b_5\, t^5) + \epsilon(x)$$

In the above:

$t = 1/1 + px$
$p = .2316419$
$b_1 = .319381530$
$b_2 = -.356563782$
$b_3 = 1.781477937$
$b_4 = -1.821255978$
$b_5 = 1.330274429$
$|\epsilon(x)| = <7.5 \times 10^{-8}$

SA-08 Option Writing

CALL OPTIONS

Maximum Profit (occurs at exercise price)

$$Max = N_{OPT} \times 100 \times P_{OPT} - Com + N_{Sh}\,[P_{EX}(1 - \%C) - P_{Sh}(1 + \%C) + Div]$$

Initial Investment

$$Inv = N_{Sh}\, P_{Sh}\, (1 + \%C) - [N_{OPT} \times 100 \times P_{OPT} - Com] + MNT$$

APPENDIX A

Upper Break-Even Point (option exercised)

$$U = [Max + (N_{OPT} - N_{Sh})\, P_{EX}(1 - \%C)]/(N_{OPT} - N_{Sh})(1 + \%C)$$

Lower Break-Even Point (option not exercised)

$$L = [Max - N_{Sh} \times P_{EX}\ (1 - \%C)]/-N_{Sh}\ (1 - \%C)$$

PUT OPTIONS

Maximum Profit (occurs at exercise price)

$$Max = N_{OPT} \times 100 \times P_{OPT} - Com + N_{Sh}\,[P_{Sh}(1 - \%C) - P_{EX}(1 + \%C) - Div]$$

Initial Investment

$$Inv = N_{Sh} \times P_{Sh}/2 + N_{Sh} \times P_{Sh} \times \%C - (N_{OPT} \times 100 \times P_{OPT} - Com) + MNT$$

Upper Break-Even Point (option not exercised)

$$U = [Max + N_{Sh}\ P_{EX}\ (1 + \%C)]/N_{Sh}\ (1 + \%C)$$

Lower Break-Even Point (option exercised)

$$L = [Max - (N_{OPT} - N_{Sh})\, P_{EX}\ (1 + \%C)]/-(N_{OPT} - N_{Sh})(1 - \%C)$$

where:

%C	= Average commission per share as a percentage of share price
Com	= Total commission on options in dollars
Div	= Dividends per share
Max	= Maximum Profit
MNT	= Maintenance Requirement
N_{OPT}	= Number of Options Sold
N_{Sh}	= Number of Shares Bought or Shorted
P_{EX}	= Exercise Price
P_{OPT}	= Price per Call or Put
P_{Sh}	= Current per share price of stock

APPENDIX A

SA-09 Warrant Valuation

For short-term warrants (C>1):

$$Val = Ex(C-1)\left[\frac{Sh/Ex}{C}\right]^{C/(C-1)} \qquad \text{where } C \geqslant (Sh/Ex)$$

$$Val = Ex[(Sh/Ex) - 1] \qquad \text{where } C < (Sh/Ex)$$

$$HR = \left[\frac{(Sh/Ex)}{C}\right]^{1/(C-1)} \qquad \text{where } C \geqslant (Sh/Ex)$$

$$HR = 1 \qquad \text{where } C < (Sh/Ex)$$

For long-term warrants:

$$Val = \sqrt{Ex^2 + Sh^2} - Ex$$

where:

C = "Risk" Factor
Ex = Exercise Price
HR = Hedge Ratio
Sh = Current per share price of stock
Val = Value of Warrant

Reference: Paul Samuelson, "Rational Theory of Warrant Pricing," *Industrial Management Review,* Vol. 6, No. 2, Spring 1965, pp 13-39.

SA-10 Bond Valuation

Most calculations are performed by the Annuities Program (SA-04). The following equation is used:

$$Buy + Com = \%C \times Mat(1 - Tax)\left[\frac{(1+i)^j - (1+i)^{-N}}{i}\right] + (Mat - [Mat - (Buy + Com)]\ CGT)/(1+i)^N - j \times \%C \times Mat(1 - Tax)$$

where:

Buy = Purchase Price
%C = Annual Coupon Interest Rate
Com = Commission
CGT = Capital Gains Tax Rate
i = Annual yield to maturity
j = 1 − [INV] [INT] N, e.g., N = 12.6, j = .4
Mat = Maturity Value
N = Number of periods to maturity
Tax = Personal Income Tax Rate

APPENDIX A

SA-11 Stock Indicators

For the Market Index, the yield for each period is found as:

$$YI_i = (PI_{i+1} - PI_i + DI_{i+1})/PI_i$$

Then, using the built-in calculator functions, [2nd] [$\bar{x}$] and [INV] [2nd] [$\bar{x}$]:

$$\bar{x}ERI = \frac{1}{N-1} \sum_{i=1}^{N-1} YI_i$$

$$SDI = \left[\left(\sum_{i=1}^{N-1} YI_i - \bar{x}ERI \right) / (N-2) \right]^{1/2}$$

$$VARI = SDI^2$$

For the Individual Stocks, the yield for each period is found as:

$$Y_i = (P_{i+1} - P_i + D_{i+1})/P_i$$

Then, using the linear regression feature [2nd] [Op] 12, α and β are found such that

$$Y_i \approx \alpha + \beta\, YI_i$$

The expected return is evaluated as:

$$ER = \alpha + \beta\, (\bar{x}ERI)$$

and the variance of the return is found as

$$VAR = \beta^2\, (VARI) + S^2$$

where

$$S^2 = \left(\sum_{i=1}^{N-1} Y_i^2 - \alpha \sum_{i=1}^{N-1} Y_i - \beta \sum_{i=1}^{N-1} YI_i\, Y_i \right) / (N-3)$$

Then,

$$SD = \sqrt{VAR}$$

Finally, the coefficient of determination is found using [2nd] [Op] 13.

Note: YI_i and Y_i are computed for i = 1 to (N−1).

APPENDIX A

SA-12 Portfolio Selection – Sharpe's Model

Sharpe's Single-Index Model is represented by the following system of linear equations:

$$\begin{bmatrix} -2\,\mathrm{Var}_1 & 0 & 0 & \cdots & 0 & 0 & 1 & \beta_1 \\ 0 & -2\,\mathrm{Var}_2 & 0 & \cdots & 0 & 0 & 1 & \beta_2 \\ 0 & 0 & -2\,\mathrm{Var}_3 & \cdots & 0 & 0 & 1 & \beta_3 \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & & -2\,\mathrm{Var}_n & 0 & 1 & \beta_n \\ 0 & 0 & 0 & \cdots & 0 & -2\,\mathrm{Var}_I & 0 & -1 \\ 1 & 1 & 1 & \cdots & 1 & 0 & 0 & 0 \\ \beta_1 & \beta_2 & \beta_3 & \cdots & \beta_n & -1 & 0 & 0 \end{bmatrix}$$

$$\times \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ \cdot \\ \cdot \\ \cdot \\ w_n \\ w_I \\ \lambda_1 \\ \lambda_2 \end{bmatrix} = \begin{bmatrix} -\phi\alpha_1 \\ -\phi\alpha_2 \\ -\phi\alpha_3 \\ \cdot \\ \cdot \\ \cdot \\ -\phi\alpha_n \\ -\phi\alpha_I \\ 1 \\ 0 \end{bmatrix}$$

This system is solved for the weights (w_i) by Gauss-Jordan Elimination.

Reference: *Portfolio Analysis*, Jack Clark Francis and Stephen H. Archer, pp 96-103, Prentice-Hall, 1971.

SA-13 Portfolio Bookkeeping

TC = Cost × N
MV = (MP) × N
AI = INC × N
G/L = MV − TC
%Y = (AI/TC) × 100
%AG = $(\sqrt[n]{MV/TC} - 1) \times 100$
where n = No. Days/365
%TY = %Y + %AG
P%Y = $\Sigma(TC \times \%Y)/\Sigma TC$
P%AG = $\Sigma(TC - \%AG)/\Sigma TC$
P%TY = P%YD + P%AG

APPENDIX A

SA-14 Capital Accumulation Planning

Calculations are performed as follows:

$$FNW = PNW\ (1 + i)^N + \left[\frac{(1 + i)^N - (1 + g)^N}{i - g}\right]\ (INC \times INV)$$

where $i \neq g$

$$FNW = PNW\ (1 + i)^N + N\ (1 + i)^{(N-1)}\ (INC \times INV)$$

where $i = g$

where

N	=	Number of Periods
FNW	=	Future Net Worth
PNW	=	Present Net Worth
i	=	%I/100
g	=	%G/100
INC	=	After Tax Income
INV	=	Percent of Income Invested

$$PV = FNW/(1 + IR)^N$$

where

PV	=	Present Value
IR	=	Inflation Rate

SA-15 Days Between Dates

The number of days between dates is found by calculating a "factor" for each date and then finding the difference between the factors.

The factor is evaluated as:

$$Factor = 365 \times Year + Day + (Month - 1)31 + Int[(Year - 1)/4] - Int\left\{\frac{3}{4}\left(Int[(Year - 1)/100] + 1\right)\right\}$$

for Month < 3

$$Factor = 365 \times Year + Day + (Month - 1)31 - Int\ (Month \times .4 + 2.3) + Int(Year/4) - Int\left\{\frac{3}{4}\ [Int\ (Year/100) + 1]\right\}$$

for Month $\geqslant 3$

APPENDIX B – FORECASTING METHODS

Knowledge about past and present trends and future probabilities is an important aspect of investing. And knowing how well one variable relates to another can help an investor make better decisions. Using the linear regression features on the TI 58/59, an investor can take information about past performance or relationships and use it to make forecasts of future performance.

In the linear regression situation, an investor usually has data expressed as pairs of variables that could be plotted on a graph. Such pairs of points are commonly labeled (x, y) (e.g., x may be dollars in advertising while y is unit sales). Once the plot is made, the investor can predict new points from the historical data. The linear regression feature of the TI 58/59 mathematically draws the "best straight line" through the data points. Just follow the simple steps outlined below.

1. First press [2nd] [Pgm] 01 [SBR] [CLR] to initialize the calculation. When "0." appears in the display press [RST] to return from program 01.

2. Enter an "x" value and press [x ≷ t].

3. Enter the corresponding "y" value and press [2nd] [Σ+].

4. Repeat steps 2 and 3 until all data pairs are entered.

5. To find y for a given x, enter x and press [2nd] [Op] 14.

6. To find x for a given y, enter y and press [2nd] [Op] 15.

Slope and Intercept

The calculator also provides the investor with two more pieces of information about the line it has drawn through his data points. Pressing [2nd] [Op] 12 displays the "y-intercept" and places the "slope" in the T-register (press [x ≷ t] to see the slope).

The y-intercept (b) is simply the value of y at x = 0. The slope (m) of the line is the ratio of its "rise" to its "run". Any straight line may be expressed as an equation written in the form:

$$y = b + mx.$$

About the Correlation Coefficient

Pressing [2nd] [Op] 13 displays the correlation coefficient (r) of the two sets of data (x's and y's). A value close to plus 1 indicates a high positive correlation, and a value close to minus 1 indicates a high negative correlation. A value of about zero indicates that the two sets of data are not related.

For example, suppose that a company gives two tests to new employees, Test A and Test B. If there is a high positive correlation between the tests, then an employee scoring high on Test A should also score high on Test B. On the other hand, a high negative correlation says

that an employee scoring high on Test A should score low on Test B. If there is no correlation (r is near zero), then nothing can be said about how an employee's performance on one test relates to his performance on the other.

Note: If the straight line best fitting the data points is perfectly vertical or horizontal, some of the above calculations are invalid. This situation is indicated by a flashing display. See Section V of your "Personal Programming" manual for further instructions.

Example: Suppose that there seems to be a fairly good relationship between a company's annual sales volume (x) and the gross national product (y). Use the following data to determine the expected sales of the company when the gross national product (GNP) reaches $2 trillion.

GNP (billions) (x)	Annual Sales Volume (y)
$ 700	$101,000
800	116,000
900	165,000
1100	209,000
1300	264,000
2000	???

ENTER	PRESS	DISPLAY	COMMENTS
	[2nd] [Pgm] 01		Select Diagnostic Program
	[SBR] [CLR]	0.	Initialize Linear Regression Data Registers
	[RST]	0.	Return from Program 01
700	[x ≷ t]	0.	x_1
101000	[2nd] [Σ+]	1.	y_1
800	[x ≷ t]	701.	x_2
116000	[2nd] [Σ+]	2.	y_2
900	[x ≷ t]	801.	x_3
165000	[2nd] [Σ+]	3.	y_3
1100	[x ≷ t]	901.	x_4
209000	[2nd] [Σ+]	4.	y_4
1300	[x ≷ t]	1101.	x_5
264000	[2nd] [Σ+]	5.	y_5
2000	[2nd] [Op] 14	459241.3793	$x \rightarrow y'$
	[2nd] [Op] 12	−95068.96552	b
	[x ≷ t]	277.1551724	m
	[2nd] [Op] 13	.9935283439	r

APPENDIX B

Nonlinear Models

It should be clear that a straight-line model is not applicable in all situations. Sales, for example, often grow exponentially. This model may be expressed as

$$y = b\, e^{mx}$$

where y represents sales and x represents time. The values b and m are constants that are determined by the curved line which best fits the data points, and e is a value such that ln e = 1. In order to use the built-in linear regression features to fit an exponential curve to a set of data points, the investor must first convert the above to the linear equation

$$\ln y = \ln b + mx.$$

Now instead of entering x and y, the investor simply enters x and ln y. He may then find new values for y by entering x and pressing [2nd] [Op] 14 [INV] [ln x]. (Op 14 actually calculates ln y.) Similarly, entering a y value and pressing [ln x] [2nd] [Op] 15 calculates the corresponding x value.

The following curves should handle most situations encountered by investors.

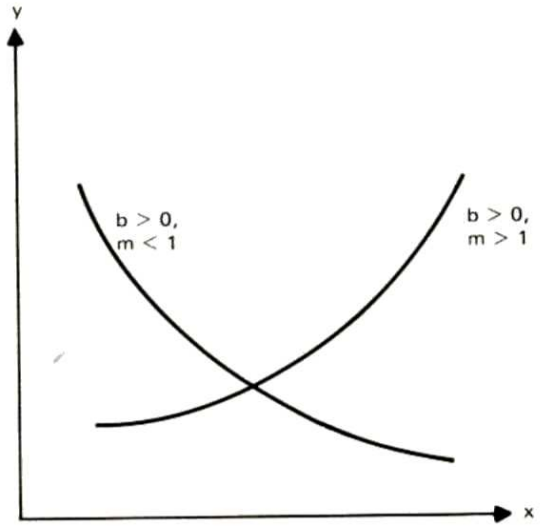


Figure B-1 — Exponential Curves

$y = b\, e^{mx}$
$\ln y = \ln b + mx$

Enter: x Press: [x ≷ t]
Enter: y Press: [ln x] [2nd] [Σ+]

To find new y value
Enter: x Press: [2nd] [OP] 14
[INV] [ln x]

To find new x value
Enter: y Press: [ln x] [2nd] [Op] 15

To find b and m
Press: [2nd] [Op] 12 Display: b
[INV] [ln x]
Press: [x ≷ t] Display: m

APPENDIX B

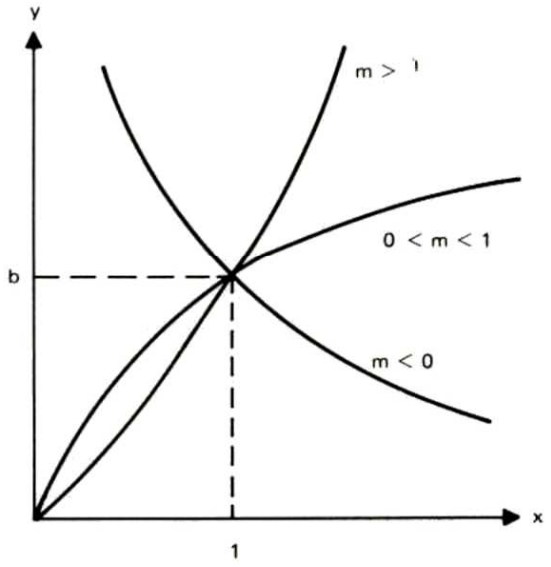


Figure B-2 — Power Curves

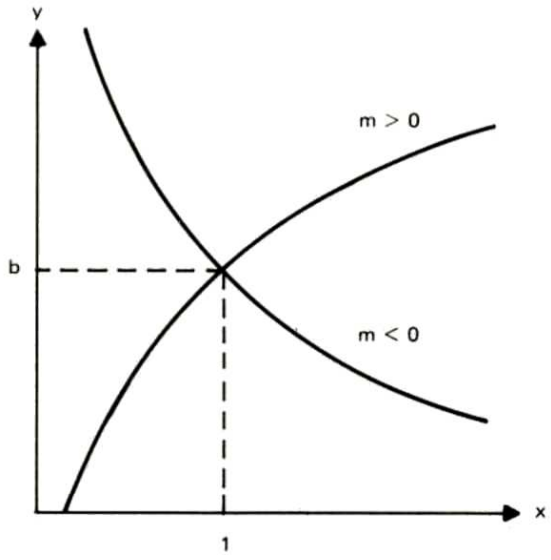


Figure B-3 — Logarithmic Curves

$$y = bx^m$$
$$\ln y = \ln b + m \ln x$$

Enter: x — Press: [ln x] [x ≷ t]
Enter: y — Press: [ln x] [2nd] [Σ+]

To find new y value

Enter: x — Press: [ln x] [2nd] [Op] 14 [INV] [ln x]

To find new x value

Enter: y — Press: [ln x] [2nd] [Op] 15 [INV] [ln x]

To find b and m

Press: [2nd] [Op] 12 [INV] [ln x] — Display: b
Press: [x ≷ t] — Display: m

$$y = b + m \ln x$$

Enter: x — Press: [ln x] [x ≷ t]
Enter: y — Press: [2nd] [Σ+]

To find new y value

Enter: x — Press: [ln x] [2nd] [Op] 14

To find new x value

Enter: y — Press: [2nd] [Op] 15 [INV] [ln x]

To find b and m

Press: [2nd] [Op] 12 — Display: b
Press: [x ≷ t] — Display: m

APPENDIX C: PROGRAM REFERENCE DATA

Program Number	Title	No. of Steps	Data Reg. Used	Flags Used	SBR Levels	Paren. Levels	Calls Pgm.	Special Functions Used	x ≷ t	ABS Address	Fix Decimal Format	Program Number
01	Diagnostic	107	1-6, 22-24		1	4	15	N/A	X	X	9	01
02	Earnings per Share	196	1-8	5	2	5	9		X	X	2, 9	02
03	Compound Interest	147	1-4	5	2	3	2, 9		X	X	2, 9	03
04	Annuities	698	1-6, 8-14, 21-23	1-6	2	4	2, 3, 9		X	X	2, 9	04
05	Uneven Cash Flows	359	1-12, 20+	2,5	2	3	3, 9		X	X	2, 9	05
06	Stock Valuation	348	1-18, 20+	2,5	3	4	3, 5, 9		X	X	2, 9	06
07	Black – Scholes Model	395	1-9, 10-17, 19, 21-23	1,5	2	4	9, 15		X	X	2, 4	07
08	Option Writing	405	1-13	1,5	2	3	2, 3, 9		X	X	2, 9	08
09	Warrant Valuation	184	1-5	5	1	3			X	X	2	09
10	Bond Valuation*	546	1-6, 8-19, 21-29	0-6	3	6	2-4, 6 9, 15		X	X	2, 4, 9	10
11	Stock Indicators	329	0, 7, 8, 12-14, 16-22, 24+	1,5	3	2	1, 2, 9	$\Sigma+$, $\bar{x}$ Op 13	X	X	9	11
12	Sharpe's Model	376	0, 1, 3-9, 11-13, 17, 18	5	2	3	2, 9, 11		X	X	9	12
13	Portfolio Bookkeeping	481	1, 3-7, 10-18, 20-29	5	2	4	11, 15	Op 10	X	X	2, 4, 9	13
14	Capital Accumulation	233	5-7, 10-18	5	2	3	3, 9		X	X	2, 9	14
15	Days Between Dates	160	20-24		1	3			X	X	4, 9	15
	Pointers and Counters	36										

*Does not run in ENG mode

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