

TDS

**Multi-Memory™ Card
User's Manual**

Tripod Data Systems, Inc.

TDS

Multi-MemoryTM

RAM Card

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1. INTRODUCTION

In this chapter, you will become familiar with the features of the TDS Multi-Memory™ RAM Card.

TDS MULTI-MEMORY™ RAM CARD

In 1990, Hewlett-Packard introduced the HP-48SX Scientific Expandable Calculator. Among the many advanced features of this product is its ability to expand the amount of Random Access Memory (RAM) that the calculator can use by inserting RAM memory integrated circuit (IC) cards into either or both of its card port slots. Hewlett-Packard has sold RAM memory cards for the HP-48SX in either of two sizes: 32k bytes and 128k bytes. This, coupled with the 32k bytes of RAM memory resident in the HP-48SX itself, allows the machine to be configured with up to 288k bytes of RAM (32k internal plus 128k in each port).

The operating system for the HP-48SX, which is built into its 256k bytes of system ROM, will permit the 48 to *address* only this 288k of RAM at any one time. However, by inserting and removing many different RAM cards into and from the machine, a HP-48SX user may, in effect, expand the amount of memory *accessed* by the 48 without limit. However, this technique of card swapping to expand the effective memory of the HP-48SX has three fundamental and/or practical limitations.

1) RAM cards plugged into the ports of the 48 may be configured either as *merged* memory or as *independent* memory. As the name implies, *merged* memory treats the memory plugged into the port(s) as a logical extension of the memory in the main machine. On the other hand, *independent* port memory is treated as a separate logical entity. In other words, individual

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objects stored in memory are not permitted to span the boundaries between different elements of independent memory. However, this is permitted for merged memory. A plug-in card which has been configured as *merged memory* may not be removed before it is *freed*. Thus, card swapping to expand memory requires that each of the swapped cards be configured as *independent* RAM.

2) Both the application program software and all of the data required to solve *any specific problem* must be contained in the memory that is currently resident in the machine. This limits the total memory available for *any specific problem* to the 288k bytes of logical memory.

3) Since a separate card must be purchased for each extra 128k of memory desired, using a card swapping technique to expand the effective memory of the machine is an expensive solution.

Multi-Memory RAM Cards from Tripod Data Systems address the latter two limitations in a significant way. These cards, available in either 256k or 512k byte sizes, represent an economical way of expanding the amount of RAM you may access by your 48 *without the necessity of performing a physical card swap*.

When a Multi-Memory RAM Card is plugged into one of the 48's ports, the 48 treats each 128k of the card as a separate logical entity. And, like physical card swaps, the 48 may only address 128k of this RAM at any time. However, each Multi-Memory RAM Card comes with several software library functions recorded in its RAM. Once downloaded to the 48's main memory, they will enable the 48 to swap *electronically* from one logical 128k bank to another. This process is known as "*bank switching*".

These functions are fully programmable. Thus, you may build these functions into your own software routines to perform the bank switching under control of *your* program. For example, if you are in the business of providing applications software for

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the HP-48SX, you may wish to include the bank switching capabilities within your application software. This will shield your end-users from the burden of bank switching management and present them with an integrated software package that takes full advantage of the memory capacities of Multi-Memory cards.



NOTE: The bank switching library software routines are protected by the copyright laws of the United States of America. If you are a supplier of application software for the HP-48SX and you would like to take advantage of the capabilities of TDS Multi-Memory Cards, you may apply for a license to use the bank-switching library routines within your application software. Please direct inquiries to:

Tripod Data Systems
P.O. Box 947
Corvallis, OR 97339

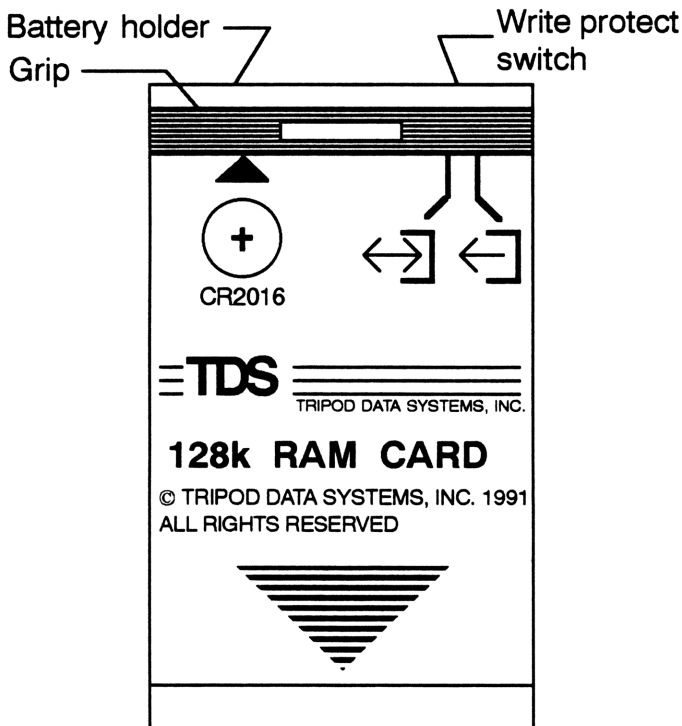
When granted, a license to use the bank-switching software library routines will be provided to you on a royalty-free basis without charge.

2. GETTING STARTED

In this chapter, you will learn how to install your Multi-Memory Card and how to download the Bank Switching Library to the main memory of your HP-48SX.

INSTALLING AND REMOVING YOUR MULTI-MEMORY CARD

The figure below shows your TDS Multi-Memory Card as it is removed from its box:



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The card comes with its own protective case. Your Multi-Memory card has been engineered to withstand normal handling and use. However, as an extra precaution, you should use the case to help protect the card when it is not in use.

The card also comes with its lithium backup battery installed. The use of the protective case will also prolong the life of the backup lithium battery when the card is removed from the HP-48SX.

⇒ **NOTE:** Do not remove this battery except to replace it; and then, only when the card has been installed in your HP-48SX with the power ON. [See specific instructions for replacing your lithium backup battery later in this chapter.]

Card installation procedure:

- 1) To install the card, make sure that your HP-48SX has been turned OFF.
- 2) Turn the unit over and remove the port cover.
- 3) Choose an empty port for your card. Either port may be used.

⇒ **NOTE:** The application software that you intend to use with your card may specify into which port the Multi-Memory Card must be installed. Consult the documentation that accompanied your application software for specific instructions.

- 4) Remove the card from its protective case. Store the case in a safe place so that it may be used with the card when you remove it later.

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5) Position the card in the slot with the triangular arrow showing and its end of the card inserted first. Be certain that both edges of the card are in the same port slot.

6) Slide the card firmly into place until it stops. When you first feel resistance, it still has 6 mm (about 1/4") to go before it is fully seated.

If desired, another card may be inserted in the other port.

7) Replace the port cover.

Card removal procedure:

1) Turn the HP-48SX OFF.

2) Turn the unit over and remove the port cover.

3) Press your thumbnail against the grip and slide the card out of the port.

4) Replace the card in its protective case.

5) Replace the port cover.

WRITE PROTECTING YOUR TDS MULTI-MEMORY CARD

Each TDS Multi-Memory Card has a small, two-position switch along the top edge of the card. By placing this switch in the "write protect" (read only) position, the contents of *all of the banks of memory* of the card are protected against being overwritten or accidental erasure by the HP-48SX. The write protect position is the one that is closest to the edge of the card. To enable the card for being written as well as being read, move the switch to the "read/write" position. The "read/write"

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position is the one that is closest to the center of the card.

DOWNLOADING THE BANK SWITCHING SOFTWARE TO YOUR HP-48SX'S MAIN MEMORY

Each TDS Multi-Memory Card comes with several software bank switching routines recorded in the first bank of RAM. These routines will enable you to take full advantage of the memory of the card. However, before they can be used, they must be downloaded from the Multi-Memory Card's memory to the 48's main system memory. [If the routines were left in one of the banks of the Multi-Memory Card and that particular bank were switched "OFF", the routines could not be accessed by the 48's operating system.]

There are two sources of the Bank Switching Software. These routines are loaded in Bank 1 of your Multi-Memory Card when it is shipped from the factory. These routines are also loaded on the floppy disk that was shipped with your Multi-Memory Card.

If your Multi-Memory Card is new, you may follow the instructions in the next section. If you have used your Multi-Memory Card with the TDS-48 Surveying Card, you must download the bank switching routines from the floppy disk using your PC. Instructions for doing this follow the next set of instructions.

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⇒ **NOTE:** Throughout this manual, keystrokes to use in implementing the various procedures are shown in **BOLDFACE**. **BOLDFACE** enclosed in brackets [] indicates actual keys on the HP-48SX. These may be either printed directly on a keytop or temporarily shown in the bottom line of the display as a "softkey" label. **BOLDFACE** enclosed in brackets [] and preceded by either a [↶] or a [↷] indicates that the named function is a "left"- or "right"-shifted function and that name may be found printed on the keyboard above one of the keytops. **BOLDFACE** that is not enclosed in brackets indicates that the boldface message should be keyed into the command line of the 48 as an alpha string, preceded by the usual [α] [α] alpha-lock keystrokes. Lower case **boldface** that is enclosed in braces { } indicates that the value to be keyed in may vary depending on your unique situation. A further explanation of what is required is provided in braces { } on the appropriate line in the manual.

Downloading procedure from the Multi-Memory Card

- 1) Make sure that the write protect switch at the top edge of your card is set to the "Read/Write" position (the position that is nearest the center of the card).
- 2) Press [↶] [LIBRARY]. This will present you with the port numbers in the softkey labels.
- 3) Press either [PORT 1] OR [PORT 2] [Depending on which of the ports contains your Multi-Memory Card]. The number [803] will appear in the left-most softkey label.
- 4) Press [↷] [803]. The display will now read "Library 803: SWITCH".
- 5) Press [0] [STO].

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⇒ **NOTE:** If **[803]** is not displayed after step 4, you should do the following:
Press **[1]**
Type **BS1 [ENTER]** or **BS2 [ENTER]**, depending on whether you have plugged the card into port 1 or port 2.
Return to step 2 above.

The bank switching software library has now been installed in the Main Memory of your 48 (port 0). It is necessary to perform this operation only once no matter how many Multi-Memory cards you intend to use or into which ports you intend to install them. Once installed, this software will remain in your system's main memory either until you intentionally purge it or until you experience a Memory Loss in your HP-48SX.

Once the bank switching software has been loaded into the main system memory (port 0), you should delete the bank switching software from the card so that you can free up its space for other uses and prevent it from ever being executed in the independent memory. This may be done as follows:

- 1) Press **[→] [::] {x}** {where x is the port number into which you have plugged the card}.
- 2) Press **[▶] 803 [ENTER] [ENTER]** The screen will now display 1:803 on both lines 1 and 2 of the stack.
- 3) Press **[←] [MEMORY] [NXT] [DETACH]**.
- 4) Press **[←] [PURGE]**. The bank switching software has now been purged from the card.

Downloading procedure from the floppy disk.

- 1) Insert the floppy disk in your floppy drive and at the DOS

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prompt, type [A] [:] [RETURN].

2) Plug in your HP-48SX into either Port 1 or Port 2 of your PC.

Next, you need to set up your HP-48SX to receive the software from your PC with the proper communication parameters.

3) Press [←] [I/O]. Then press [SETUP]. The screen will appear as:

I/O setup menu					
IR / wire :	wire				
ASCII / binary :	binary				
baud :	9600				
parity :	none 0				
checksum type :	3				
translate code :	1				
IR/W	ASCII	BAUD	PARIT	CHSM	TRAN

If the values of the parameters in the screen are not as shown on the right hand side of the illustration above, you should press the softkeys associated with the parameters for which the values are different than those shown. This will allow you to scroll through the various choices until the values match those as shown above. For example, if the baud is shown as 1200, pressing the [BAUD] softkey three times will set the baud to 2400, 4800, and finally 9600 in turn.

4) On your PC, type **KERMIT** [RETURN]. The prompt will be Kermit-MS>.

5) On your PC, type **SET BAUD 9600** [RETURN].

6) On your PC, type **SET PORT 1** (or 2 depending on the port

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on your PC in which you have your cable connected)
[RETURN].

7) On your PC, type **SET PARITY NONE** [RETURN].

8) On your 48, press [↵] [I/O]. Then press [RECV].

9) On your PC, type **SEND SWITCH** [ENTER].

10) Once the transfer is complete, on your 48 press [VAR].
The [SWITC]H variable should appear as a softkey.

11) Press [SWITC].

12) Press [0] [STO]. The software has now been restored into port 0.

13) The variable "SWITCH" is no longer needed in your 48. To free up memory, you should delete it. Press [VAR] ['] [SWITC] [↵] [PURGE].

14) To confirm that the routines have been loaded into main memory, press [↵] [LIBRARY] [PORT0]. [803] will appear as a softkey.

REPLACING THE BACK-UP LITHIUM BATTERY IN YOUR MULTI-MEMORY CARD

Multi-Memory Cards come with a back-up lithium battery installed to maintain the bank switching software in the card. This battery should be replaced once a year *whether or not the card has been installed in your 48.*

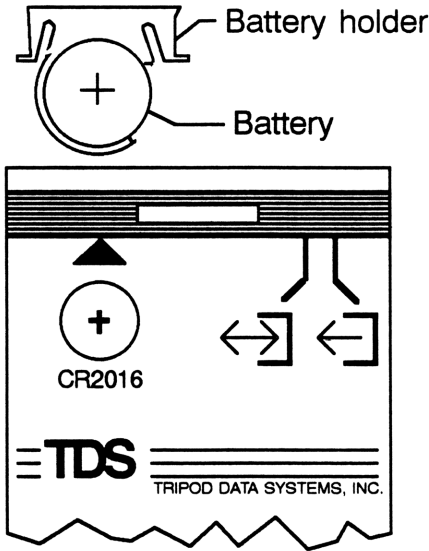
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⇒ **NOTE:** To prolong the life of your back-up lithium battery, you should use the protective case that came with your card whenever the card is removed from the HP-48SX48.

⇒ **NOTE:** Never remove the back-up battery unless the card has been installed in your HP-48SX and the power is ON. Removing the battery in any other way will cause the contents of the memory to be lost.

- 1) With the card installed in either Port 1 or Port 2 of the calculator, turn the power ON.
- 2) Turn the calculator over and remove the port cover.
- 3) Place the index finger of one hand on the card grip to prevent the removal of the card during the removal of the back-up battery.
- 4) Use the thumbnail of your free hand to grip the plastic at the nail grip on the left side of the exposed end of the card. Pull the battery holder and battery out of the card.
- 5) Remove the old battery from the battery holder.
- 6) Install a fresh CR2016 3-volt coin cell into the battery holder. Be certain that the orientation of the battery and the battery holder are as shown in the figure below.

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7) Replace the battery and battery holder in the card.

8) Replace the port cover.



NOTE: If you inadvertently lose your card memory, you will have to execute the the BS1 or the BS2 function after you reinstall the card into the 48 before you can access the various memory banks of the card. (See the next chapter of this manual "Using Your TDS Multi-Memory Card".)

3. USING YOUR TDS MULTI-MEMORY CARD

In this chapter, you will learn how to use your TDS Multi-Memory Card in your own work.

USING THE BANK SWITCHING LIBRARY ROUTINES

Before using the Multi-Memory Card, you must first install it and download the bank switching library software routines to the main system memory of your TDS-48SX. Instructions for doing this are given in the previous chapter of this manual: "Getting Started".

⇒ **NOTE:** Some application software written for the HP-48SX may already allow for the use of Multi-Memory cards. Such software has the bank switching routines built into it; and, it performs the bank switching in such a way that the product appears to the user to be either 256k or 512k of contiguous memory plugged into a single 48 port. For example, the TDS-48 Surveying Card (Version 3.0 or higher) has been developed in this way. Users of such application software need only to install the card and use it as described in their application software manual.

Once the bank switching library routines have been downloaded to your 48's main system memory, you have at your disposal four new functions that operate on the operational stack. These functions possess all of the properties of other HP-48SX functions e.g., they may be executed from the keyboard; they may be included in user programs; they may be assigned as

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variables to softkeys; etc.

Fundamentally, the TDS Multi-Memory Card may be used in the same way that the HP-82215A 128k-byte RAM Card may be used. The difference is that the Multi-Memory Card contains additional "banks" of 128k bytes of memory (1 additional bank for the 256k version and 3 additional banks for the 512k version). Switching a "bank" is logically equivalent to removing a 128k card from one of the ports and replacing it with another. Thus, these instructions only deal with how to accomplish the bank switching function. For more information on the general use of RAM cards in the 48, consult your HP-48SX Owner's Manual, Vol. II, "Using Plug-in Cards and Libraries", pp. 635-653.

The HP-48SX has two ports for plug-in cards, port 1 and port 2. There is a graphic on the back case of the 48 to indicate which port is which. TDS Multi-Memory cards may be inserted into either one or both of these ports. When you want to use the memory in one of the banks of a Multi-Memory card in an operation or calculation in your 48, you need to be certain that the particular bank that you want to use is the "active" bank in that port. **There can be only one 128k bank of a Multi-Memory card active in one port at any one time.** However, if you have a Multi-Memory card plugged into both ports, you may have a differently numbered port active for each of these cards.

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NOTE: The identity of the number of the currently active bank remains with the card when it is removed from your 48. When that card is reinstalled into the 48, the bank that was active when it was removed becomes the active bank again irrespective of which port you install it or which banks of other cards have been activated in the interim. *New cards are shipped from the TDS factory with bank 1 active in all cases.* This is important, because the bank switching software is installed in bank 1 and it must be downloaded into your HP-48SX's main memory before you can access any of the other banks of RAM.

Activating a bank is no more difficult than telling the 48 which port number and which bank number within that port are those which you want to activate. The functions that do this are BS1, BS2, and BANKN.

THE "BS1" and "BS2" FUNCTIONS

The BS1 function will allow you to activate a bank of memory in a Multi-Memory Card plugged into port 1. The BS2 function will allow your to activate a bank of memory in a Multi-Memory Card plugged into port 2.

To use either the BS1 or BS2 functions, you must first key the appropriate bank number into the first line of the stack. The PORT NUMBER is embedded into the command:

- 1) Press {x} [ENTER] {where x is the desired bank number}.
- 2) Press BS1 [ENTER] (for port 1) OR BS2 [ENTER] (for port 2). Remember to use the alpha-lock sequence [α] [α] before keying in the strings BS1 or BS2.

The specified bank in the designated port has now been activated. This command will not affect the active bank in the

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other port.

⇒ **NOTE:** Banks within a card are numbered beginning with 1 (1 and 2 for the 256k card and 1, 2, 3 and 4 for the 512k card).

Like physically swapping RAM cards, the BS1 and BS2 library functions will perform an automatic "warm start" of your HP-48SX. [See the section entitled "An Important Consideration for Bank Switching" later in this chapter of the manual.]

THE "BANKN" FUNCTION

The BANKN function will allow you to activate a bank of memory for a Multi-Memory Card plugged into either port 1 or port2.

To use the BANKN function, you must first key the appropriate port number and bank number into the first two lines of the stack.

1) Press {**n**} [ENTER] {where n is the desired port number}.

1) Press {**x**} [ENTER] {where x is the desired bank number}.

2) Press **BANKN** [ENTER]. Remember to use the alpha-lock sequence [**α**] [**α**] before keying in the string **BANKN**.

The specified bank in the designated port has now been activated. This command will not affect the active bank in the other port.

⇒ **NOTE:** Banks within a card are numbered beginning with 1 (1 and 2 for the 256k card and 1, 2, 3 and 4 for the 512k card).

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Unlike physically swapping RAM cards, the BANKN library function will not perform an automatic "warm start" of your HP-48SX. [See the section entitled "An Important Consideration for Bank Switching" later in this chapter of the manual.]

THE "SEARCH" FUNCTION

The "SEARCH" function will search through the entire memory of a Multi-Memory Card plugged into either port of the 48 and will return the bank number in which a named object is found.

To use the "SEARCH" function, key in the name of the object to be found as an alpha string into level 2 of the stack; key in the port number to be used in the search into level 1 of the stack; and, execute SEARCH.

- 1) Press **[→] [" "] [α] [α] {xxx} [ENTER]** {where xxx is the name of the object of the search}.
- 2) Press **{n} [ENTER]** {where n is the number of the port to be searched}.
- 3) Press **[α] [α] SEARCH [ENTER]**.

The "SEARCH" function will search each bank of memory in turn. It will return the bank number of the first occurrence of an object with the specified name to level 1 of the stack. If no object with the specified name is found in memory contained in the specified port, then the "SEARCH" function will return the value 0 to level 1 of the stack.

MERGED VS INDEPENDENT MEMORY

The TDS Multi-Memory Card does not actually extend the as-built, total memory limitation of the HP-48SX; that limit is 288k bytes of memory. The Multi-Memory Card increases memory

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usage capacity by switching use of different memory banks. An important restriction in use of the card is that, once one of its banks is merged into the main memory of the HP-48 SX, it cannot be simply switched out at will. If that were attempted, the result would be a MEMORY-LOSS in the HP-48 SX. The Bank-Switching Program checks for this automatically and will not allow an attempt to switch a bank from the main memory without first freeing merged memory. If you do not first free merged memory, the program will display :

"ILLEGAL BANK SWITCHING" Error

Therefore, to switch a merged bank out of the main memory, you must first free the merged memory. To free a relatively unused merged memory :

Press **[←] [{}]** **[ENTER]**.

Press **{n}** {where n represents number of the port into which the card has been installed}.

Press **[←] [MEMORY]**

Press **[NXT] [NXT] [FREE]**.

For more complete information regarding use of the **[FREE]** Command, consult the HP-48 SX Owner's Manual, Vol. II, Section 34: "Freeing Merged Memory," pp. 649-650.

AN IMPORTANT CONSIDERATION FOR BANK SWITCHING

Whenever you physically remove a card from or install a card into your HP-48SX, the next time that you turn the calculator ON, it will reset itself with a "warm start". During a "warm start", the 48 will clear the stack, all local variables, the LAST stack; and, it will display the MATH menu. However, you may or may not want to "warm start" your 48 when you electronically bank switch within a Multi-Memory card from one 128k bank of memory to another. In this regard the BS1, BS2,

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and BANKN functions operate differently. The functions BS1 and BS2 will perform a "warm start" each time one of them is executed. In addition to the clearing operations listed above, a "warm start" will also halt the execution of a running program. If you do not want to do a "warm start" or halt your running program, you should use the BANKN function. Of course you can always do a "warm start" manually from the keyboard. Just press the [ON] key and, while holding it down, press and release the [C] key.

However, if you choose not to "warm start", you should be aware of the fact that objects that appear to the user to be in the main system memory may indeed be physically located in the card memory and accessed by reference to the object's *address* within the card. For example, if you recall an object from the card's memory to the stack, the object is not copied from the card to the stack in the main memory. Instead, the main memory records the address (location within the card) of the object. Then, if you bank switch to another bank of memory within a Multi-Memory card and subsequently try to perform an operation on the object in the stack, the 48 will perform the operation using whatever happens to be located in the proper address but in a *different bank* of memory. The results of this will be unpredictable at best. To guard against such results, if you choose to use the BANKN function and not warm start, you may want to save the stack as a named list object in main memory before the bank switch and, then restore the list object to the stack after the bank switch.

To store the stack:

Press [PRG] [STK] [DEPTH].

Press [PRG] [OBJ] [->LIST].

Press ['] [α] [α] {xxx} [ENTER] [STO] {where xxx is the name that you want to use for the list object.}.

The stack has now been stored as a named list object, and you

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may now do a bank switch using the BANKN function safely.

To recall the list object to the stack:

Press ['] [α] [α] {xxx} [ENTER] [→] [RCL] {where xxx is the name you chose for the list object}.

Press [PRG] [OBJ] [OBJ->] [←]

The stack has now been restored to the state that it was in before the bank switch, with actual values in its contents rather than addressed references to data contents which may have been switched out of memory.

The background of the entire page is composed of several parallel diagonal lines in white and dark blue, creating a sense of motion and depth. The letters 'TDS' are prominently displayed in a bold, black, sans-serif font, positioned in the upper left quadrant of the page.

TDS

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