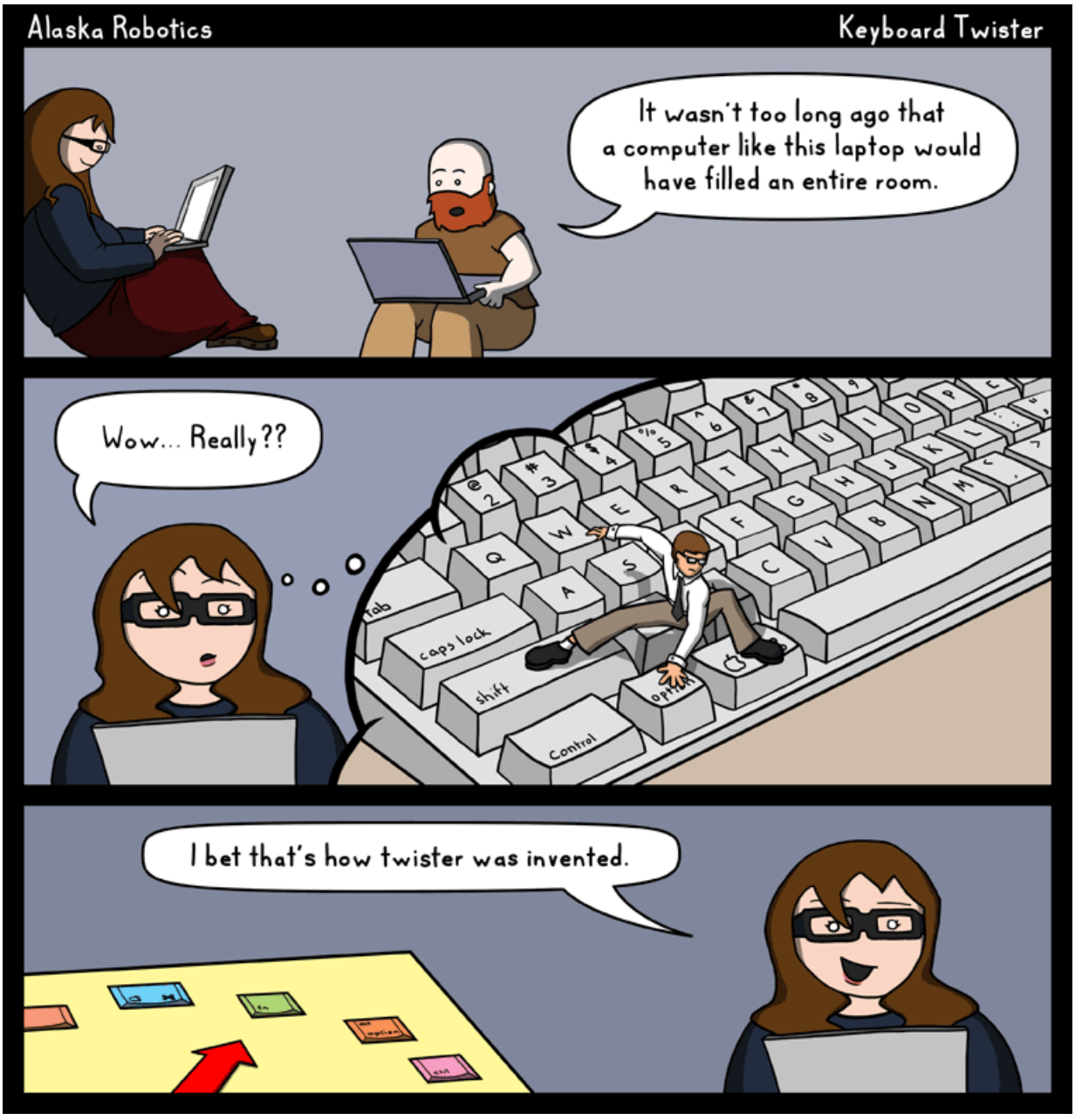
TI-83+ Z80 ASM for the Absolute Beginner

LESSON TWELVE:

- *Working with Key Presses*
- *Saving Register Values*

WORKING WITH KEY PRESSES



There was a time when computer programs could only run hard-coded numbers and instructions. You could not enter numbers, and you could not change what a program could do with key presses. Nowadays,

writing a calculator program without user key presses will easily put it at the bottom of the list at ticalc.org.

There are three methods that will allow you to detect key presses in an ASM program. One method, which you have been using as _getKey, will wait for a keypress. The second method will only wait for a minuscule fraction of a second for a keypress, and then the program will keep running.

These two methods, however, are not flexible. First of all, it is difficult, if not impossible, to use these methods to allow continuous key detection. What happens when you press the down key—and hold it—in the catalog on the calculator? Assuming you are not running Omnicalc or a similar program, there is a brief pause before the menu keeps scrolling. This is definitely an annoyance if you are writing a game, such as a Mario game, where you need actions to happen constantly as the respective key is held.

Secondly, you can't detect multiply keys at once using this two methods. If you want to use the keys to move a ship and the second key to fire, you wouldn't be able fire and move at the same time.

The third method takes care of both these problems. Read Appendix C to learn about this. We DO NOT need this method for ASM Gorillas, and it requires an advanced knowledge of ASM to understand, so it will not be covered in the lesson itself. Rest assured, at the end of all the lessons, you will have the capability of understanding Appendix C.

Going back to _getKey, we know it waits for a key press. However, it will also tell you what key was pressed, by storing it into register A. Key presses, like most everything else, are numbers. During

_getKey, if you press the Up key, represented as the number 3, register A will hold the number 3.

But like everything else, we can use constants to make values easier to remember. In this case, kUp is a constant for the number three.

Key codes for _getKey are represented as hexadecimal numbers. In appendix G, as well as at the end of this lesson, you will find a table containing all the values for key presses, in hexadecimal. The dollar sign in front of the number means that the number is hexadecimal. When you are writing a program requiring hexadecimal numbers, you always put a $ in front of a number that you want to be hexadecimal.

Speaking of hexadecimal, since it is traditional to represent RAM addresses as hexadecimal numbers, we will use hexadecimal numbers for RAM addresses requiring numbers. For instance, we will stop using .org 40339 and use .org $9D93 instead, since $9D93 is hexadecimal for 40339.

On the next page is a program that will demonstrate the use of _getKey to either increase register B or decrease register B. In other words, we won't simply use _getKey just to wait for a key press.

```
#include “ti83plus.inc”
.org $9D93
.db    t2ByteTok, tAsmCmp

            B_CALL _ClrLCDFull
            ld b, 127
            jr     Display    ; Display initial value of B.
KeyLoop:
            B_CALL _getKey
            cp     kUp        ; If the up arrow key was pressed.
            jr     Z, Increase
            cp     kDown      ; If the down arrow key was pressed.
            jr     Z, Decrease
            cp     kClear     ; If the CLEAR key was pressed, quit the program
            ret    Z
            jr     KeyLoop    ; If any other key was pressed, redo _GetKey.
Increase:
            ld a, b
            cp    255   ; Don't increment B if it's at its maximum value.  That way it doesn’t reset to 0
            jr     Z, KeyLoop
            inc b
            jr     Display    ; Display new value of B.
Decrease:
            ld a, b
            cp     0          ; Don't decrement B if it's at its minimum value, so it doesn’t reset to 255.
            jr     Z, KeyLoop
            dec b   ;Since the next part of code run is display, we don’t need to jr there.
Display:
             ld a, 0       ; Reset cursor to top of screen.
            ld (curRow), a
            ld a,0
            ld (curCol),a
            ld h,0
            ld l, b
            b_call _DispHL
             jr     KeyLoop    ; Get another key.
```

The advantage to _getKey is that you can use it to detect when a key was pressed in conjunction with 2nd or Alpha. For instance, you can tell the calculator what to do when Alpha-1 is pressed, when 2nd-Math is pressed, etc. The only issue is that you cannot work with 2nd-Up, Alpha-Up, Alpha-Down and 2nd-Down with _getKey.

Replace cp kUp with cp kCapA, and replace cp kDown with cp kCapB. See what happens when you run the program. You can't change the value of register B with the regular up/down keys, but you can change the value either by pressing Alpha-Math or Alpha-APPS.

However, _getKey CANNOT be used to work with the 2nd key by itself. You cannot use it to work with the Alpha key by itself either. The 2nd and Alpha keys must be used in conjuction with other keys.

While _getKey waits for the user to press a key, _GetCSC does not. The user gets one shot at pressing a key, after which the program will continue. The advantage to _GetCSC is that a program can constantly be running without having to wait for a keypress. If the user does press a key, register A will contain the key pressed. If register A is equal to zero, no key was pressed.

There are some other differences between _GetCSC and _getKey. First of all, _GetCSC cannot directly access 2nd-Key and Alpha-Key functions, though it does allow you to use 2nd and Alpha keys by themselves. Also, _GetCSC uses different constants to represent key values. kUp and kDown will not work with _GetCSC.

The next page contains a program similar to the previous one. It uses _getCSC, meaning we have to make adjustments since _GetCSC waits only a fraction of a second for a keypress, and uses different constants. Pay special attention to the lines in blue.

```
#include “ti83plus.inc”
.org $9D93
.db    t2ByteTok, tAsmCmp

            B_CALL _ClrLCDFull
            ld b, 127
            jr     Display    ; Display initial value of B.
KeyLoop:
            B_CALL _GetCSC
            cp     skUp        ; If the up arrow key was pressed.
            jr     Z, Increase
            cp     skDown      ; If the down arrow key was pressed.
            jr     Z, Decrease
            cp    skClear     ; If the CLEAR key was pressed, quit the program
            ret    Z
            jr     KeyLoop    ; If any other key was pressed, or if no key was pressed, redo _GetCSC.
Increase:
            ld a, b
            cp    255   ; Don't increment B if it's at its maximum value.  That way it doesn’t reset to 0
            jr     Z, KeyLoop
            inc b
            jr     Display    ; Display new value of B.
Decrease:
            ld a, b
            cp     0          ; Don't decrement B if it's at its minimum value, so it doesn’t reset to 255.
            jr     Z, KeyLoop
            dec b   ;Since the next part of code run is display, we don’t need to jr there.
Display:
             ld a, 0       ; Reset cursor to top of screen.
            ld (curRow), a
            ld a,0
            ld (curCol),a
            ld h,0
            ld l, b
            b_call _DispHL
             jr     KeyLoop    ; Get another key.
```

SAVING REGISTER VALUES

So far, we've learned about saving registers by means of saving to other registers.

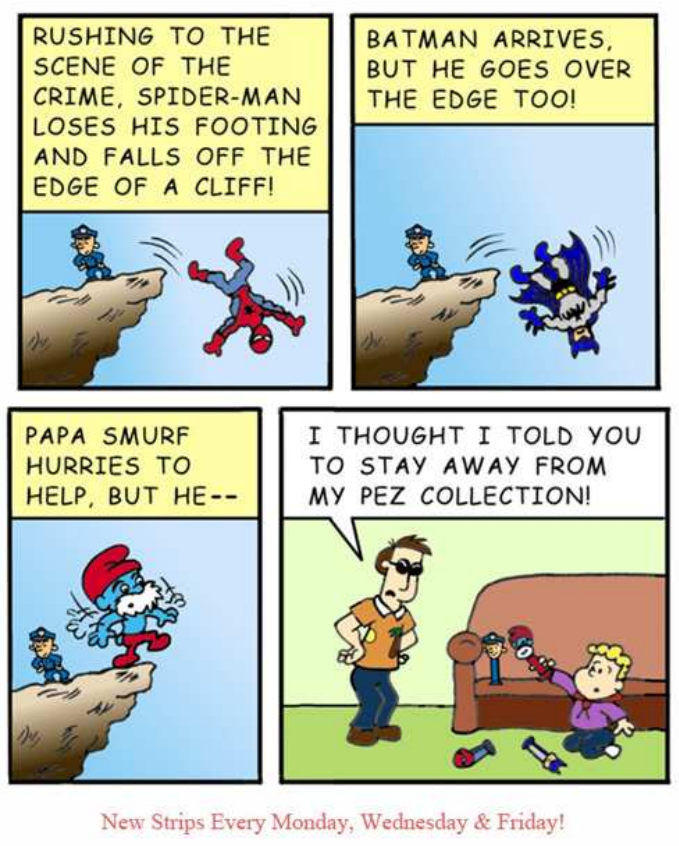
"It's the latest innovation in office safety.
When your computer crashes, an air bag is activated
so you won't bang your head in frustration."

However, as you might expect, this can be a problem if other registers you can save to are tied up with values you need. Furthermore, did you see any instructions that allow you to, for example, "LD HL, DE?" Nope, they don't exist. So while you can save the value of two byte registers by, say, "LD H, D LD L, E", this can be an inconvenient, and in some cases, impossible. (It would have been awesome if Zilog could have made 150 registers to solve the problem of saving registers like this, but that would have been expensive at the time the processor was invented.)

What about saving the values of registers to RAM? Not a bad idea, but then register A would have to be free so you could store the value of the register in A and save it to RAM. This method is also not very optimized, and in a processor-intensive game, every second counts.

Did I just say register A would have to be free? Well, I'm mistaken, but nobody's perfect. You can save the values of registers to RAM in one simple instruction, PUSH. Then you recall it by POP.

Think of this process as a PEZ dispenser. I'm hoping you know what PEZ in. It's a very tasty, but tiny, square candy that will have little ones eating out of your hand in mere moments. What's more fun is the way you get that candy. You have a PEZ dispenser with someone's head at the top—Charlie Brown, Pluto the Dog, Chuck Norris, etc. To get candy out of the dispenser, you move the head back, and out comes the candy! The greatest thing since sliced bread.

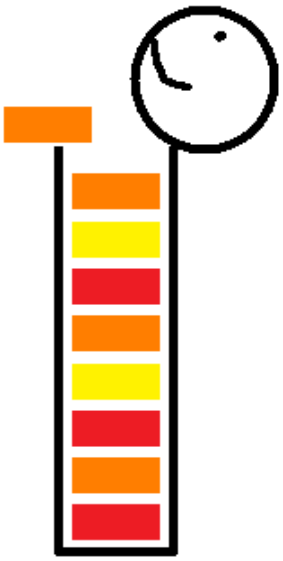


Now, does that candy come magically? Of course not, even though as a three-year-old you might have thought that. You have to put candy inside of the dispenser to fill it, and then you take candy out to eat it.

You refill the PEZ dispenser by pushing candy in. To stick a piece of candy in, it must be "pushed" on top of the other pieces of candy.

The reason you have to push the candy is because all the candy you stored in the dispenser stays toward the top. It won't go down unless you force it down, that is, unless you push it down.

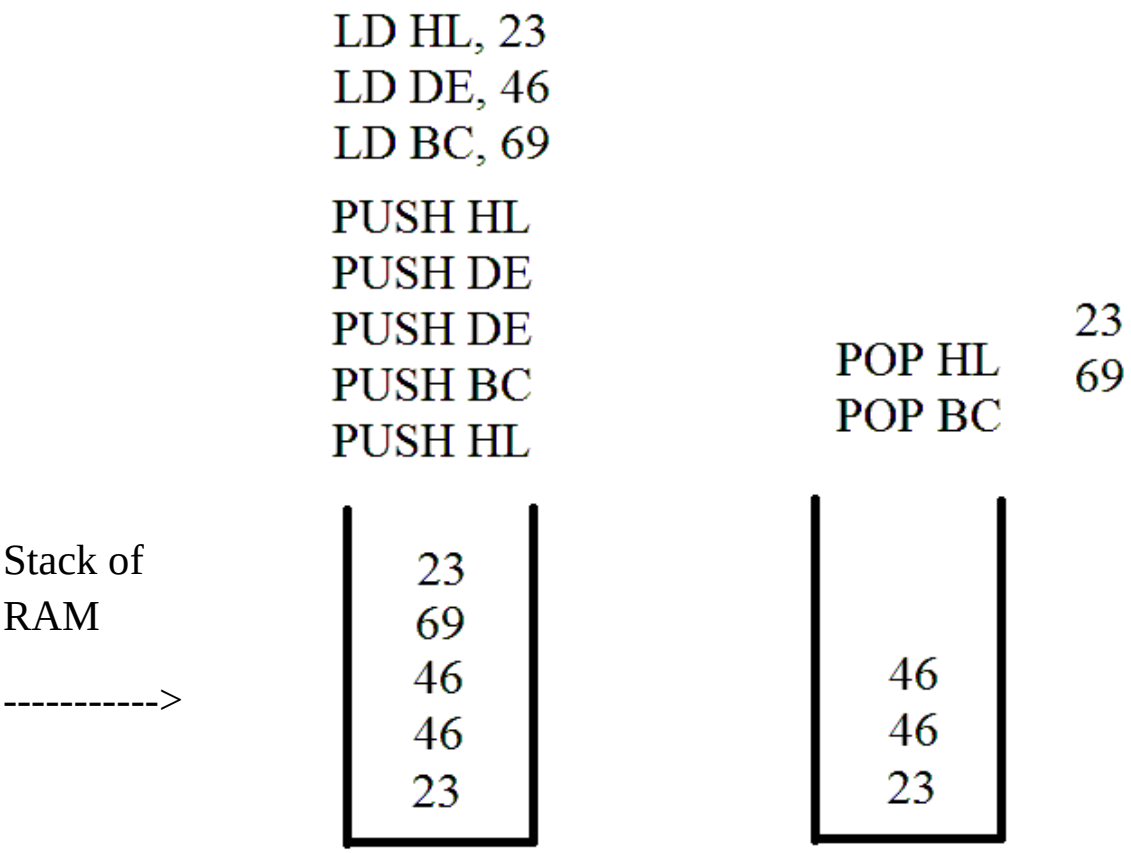
To get a piece of candy from your PEZ dispenser to eat it, you "pop" a piece of candy from the dispenser. By pushing the head of the dispenser back, a piece of candy "pops" out



I think you can tell that when you put candy inside the dispenser, it always comes out in the opposite order you put it in. If you put in red, yellow, orange, orange, and yellow, you will eat yellow, orange, orange, yellow and red.

So when you use PUSH for saving the value of a register, you save it in RAM. When you POP it, the last value you pushed is POPed. It always goes in order, just like PEZ candy. If you push HL = 10, and then push HL = 11, the first value that is popped will be 11. By the way,

our “RAM Dispenser” for pushing and popping values is called a **stack.** Think of it as a stack of candy, or a stack of values.



You can only push and pop 2 Byte registers. Therefore, you can push and pop HL, DE, BC and AF. You cannot push A, B, C, D, E, F, H, or L by themselves.

HOWEVER, if you push HL, you don’t have to pop HL. If you push in a piece of PEZ candy that belongs to you, do you have to eat it when you pop out that piece of candy? NO! You can eat it, or you can give it to a friend or your little sister (now, let’s not be selfish here). Let’s say you need to save the value of HL = 10. So you push it. If DE needs that value later, you can use POP DE, and DE will equal 10. Be aware that once you pop a value, it disappears from the stack. A piece

of PEZ candy popped from the dispenser can only appear again if you put it back inside the dispenser.

Pushing and poping is a very effective method for saving the values of registers. But be sure that your stack of values is empty before you exit your program. (In other words, each and every "push" should have a "pop" somewhere in the program.) Otherwise, you will have an error, possibly a crash. This will be explained in Appendix F.

We'll use what we learned in this chapter in the next lesson when we do more work with ASM Gorillas. Then, we'll start looking at…(drumroll)…graphics! Don't forget that there are tables for keypress values on the next pages, courtesy of Sean McLaughlin.

Key Codes (For _getKey)

These are the codes returned from the `GetKey` routine. They are grouped into four categories:

- Primary-Function Keys (press the key)
- 2nd-Function Keys (press [2nd])
- Alpha-Function Keys (press [ALPHA])
- Alpha-Alpha-Function Keys (press [ALPHA] twice)

There are no codes for 2nd+Up or 2nd+Down, they always change the contrast.

Alpha-Alpha keys must be enabled with

```
SET     LwrCaseActive,(IY+AppLwrCaseFlag)
```

kExtendEcho2 ($FC) is always returned in A. (KeyExtend) holds the keycode.

Primary-Function Keys

Key	Equate	Value	Key	Equate	Value	Key	Equate	Value
[Y=]	kYEqu	$49	[MODE]	kMode	$45	[X,T,θ,*n*]	kVarX	$B4
[WINDOW]	kWindow	$48	[DEL]	kDel	$0A	[STAT]	kStat	$31
[ZOOM]	kZoom	$2E	<	kLeft	$02	V	kDown	$04
[TRACE]	kTrace	$5A	Λ	kUp	$03			
[GRAPH]	kGraph	$44	>	kRight	$01			
[MATH]	kMath	$32	[x^{-1}]	kInv	$86	[x^2]	kSquare	$BD
[APPS]	kAppsMenu	$2C	[SIN]	kSin	$B7	[,]	kComma	$8B
[PRGM]	kPrgm	$2D	[COS]	kCos	$B9	[(]	kLParen	$85
[VARS]	kVars	$35	[TAN]	kTan	$BB	[)]	kRParen	$86
[CLEAR]	kClear	$09	[^]	kExpon	84	[÷]	kDiv	$83

[LOG]	kLog	$C1	[LN]	kLn	$BF	[STO=>]	kStore	$8A
[7]	k7	$95	[4]	k4	$92	[1]	k1	$8F
[8]	k8	$96	[5]	k5	$93	[2]	k2	$90
[9]	k9	$97	[6]	k6	$94	[3]	k3	$91
[×]	kMul	$82	[-]	kSub	$81	[+]	kAdd	$80
[0]	k0	$8E						
[.]	kDecPnt	$8D						
[(-)]	kChs	$8C						
[ENTER]	kEnter	$05						

Second-Function Keys

Key	Equate	Value	Key	Equate	Value	Key	Equate	Value
[STAT PLOT]	kStatEd	$43	[QUIT]	kQuit	$40	[LINK]	kLinkIO	$41
[TBLSET]	kTblSet	$4B	[INS]	kIns	$0B	[LIST]	kList	$3A
[FORMAT]	kFormat	$57	[2nd] + <	kBOL	$0E			
[CALC]	kCalc	$3B	[2nd] + >	kEOL	$0F			
[TABLE]	kTable	$4A						
[TEST]	kTest	$33	[MATRX]	kMatrix	$37	[$\sqrt{\ }$]	kSqrt	$BE
[ANGLE]	kAngle	$39	[SIN^{-1}]	kASin	$B8	[EE]	kEE	$98
[DRAW]	kDraw	$2F	[COS^{-1}]	kACos	$BA	[{]	kLBrace	$EC
[DISTR]	kDist	$38	[TAN^{-1}]	kATan	$BC	[}]	kRBrace	$ED
			[π]	kPi	$B5	[e]	kCONSTeA	$EF

[10^x]	kALog	$C2	[e^x]	kExp	$C0	[RCL]	kRecall	$0C
[u]	kUnA	$F9	[L4]	kL4A	$F6	[L1]	kL1A	$F3
[v]	kVnA	$FA	[L5]	kL5A	$F7	[L2]	kL2A	$F4
[w]	kWnA	$FB	[L6]	kL6A	$F8	[L3]	kL3A	$F5
[**[**]	kLBrack	$87	[**]**]	kRBrack	$88	[MEM]	kMem	$36
[OFF]	kOff	$3F						
[CATALOG]	kCatalog	$3E						
[*i*]	kI	$EE						
[ANS]	kAns	$C5						
[ENTRY]	kLastEnt	$0D						

Alpha-Function Keys

Key	Equate	Value	Key	Equate	Value	Key	Equate	Value
Page Up	kAlphaUp	$07	[A]	kCapA	$9A	[D]	kCapD	$9D
Page Down	kAlphaDown	$08	[B]	kCapB	$9B	[E]	kCapE	$9E
			[C]	kCapC	$9C	[F]	kCapF	$9F
						[G]	kCapG	$A0
						[H]	kCapH	$A1
[I]	kCapI	$A2	[N]	kCapN	$A7	[S]	kCapS	$AC
[J]	kCapJ	$A3	[O]	kCapO	$A8	[T]	kCapT	$AD
[K]	kCapK	$A4	[P]	kCapP	$A9	[U]	kCapU	$AE
[L]	kCapL	$A5	[Q]	kCapQ	$AA	[V]	kCapV	$AF

[M]	kCapM	$A6	[R]	kCapR	$AB	[W]	kCapW	$B0
[X]	kCapX	$B1						
[Y]	kCapY	$B2	[_]	kSpace	$99			
[Z]	kCapZ	$B3	[:]	kColon	$C6			
[θ]	kThetA	$CC	[?]	kQuest	$CA			
["]	kQuotE	$CB	[SOLVE]	kAlphaEnter	$06			

Alpha-Alpha-Function Keys

Key	Equate	Value	Key	Equate	Value	Key	Equate	Value
[a]	kLa	$E2	[d]	kLd	$E5	[i]	kLi	$EA
[b]	kLb	$E3	[e]	kLe	$E6	[j]	kLj	$EB
[c]	kLc	$E4	[f]	kLf	$E7	[k]	kLk	$EC
			[g]	kLg	$E8	[l]	kLl	$ED
			[h]	kLh	$E9	[m]	kLm	$EE
[n]	kLSmalln	$EF	[s]	kLs	$F4	[x]	kLx	$F9
[o]	kLo	$F0	[t]	kLt	$F5	[y]	kLy	$FA
[p]	kLp	$F1	[u]	kLu	$F6	[z]	kLz	$FB
[q]	kLq	$F2	[v]	kLv	$F7			
[r]	kLSmallr	$F3	[w]	kLw	$F8			

Scan Codes (For _GetCSC)

These are the codes returned from the `GetCSC` routine.

The [APPS] key is equated to `skMatrix` for portability to the TI-83. You may want to re-equate it in your programs if it's confusing.

Key	Equate	Value	Key	Equate	Value	Key	Equate	Value
[Y=]	`skYEqu`	$35	[2nd]	`sk2nd`	$36	[ALPHA]	`skAlpha`	$30
[WINDOW]	`skWindow`	$34	[MODE]	`skMode`	$37	[X,T,θ,*n*]	`skGraphVar`	$28
[ZOOM]	`skZoom`	$33	[DEL]	`skDel`	$38	[STAT]	`skStat`	$20
[TRACE]	`skTrace`	$32	<	`skLeft`	$02	V	`skDown`	$01
[GRAPH]	`skGraph`	$31	Λ	`skUp`	$04	>	`skRight`	$03
[MATH]	`skMath`	$2F	[x^{-1}]	`skRecip`	$2E	[x^2]	`skSquare`	$2D
[APPS]	`skMatrix`	$27	[SIN]	`skSin`	$26	[,]	`skComma`	$25
[PRGM]	`skPrgm`	$1F	[COS]	`skCos`	$1E	[(]	`skLParen`	$1D
[VARS]	`skVars`	$17	[TAN]	`skTan`	$16	[)]	`skRParen`	$15
[CLEAR]	`skClear`	$0F	[^]	`skPower`	$0E	[÷]	`skDiv`	$0D
[LOG]	`skLog`	$2C	[LN]	`skLn`	$2B	[STO=>]	`skStore`	$2A
[7]	`sk7`	$24	[4]	`sk4`	$23	[1]	`sk1`	$22
[8]	`sk8`	$1C	[5]	`sk5`	$1B	[2]	`sk2`	$1A
[9]	`sk9`	$14	[6]	`sk6`	$13	[3]	`sk3`	$12
[×]	`skMul`	$0C	[-]	`skSub`	$0B	[+]	`skAdd`	$0A
[0]	`sk0`	$21						
[.]	`skDecPnt`	$19						
[(-)]	`skChs`	$11						
[ENTER]	`skEnter`	$09						
