i41CX+

The Premier Scientific/Engineering Calculator for iOS Devices

Mini-Manual

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Introduction

i41CX+ is an advanced programmable and expandable RPN scientific calculator with a virtual thermal printer/plotter that goes far beyond a mere replica of the original. In addition to being functionally equivalent to the world-renowned HP-41CX and providing access to its entire library of modules and programs, i41CX+ is enhanced with a workstation-class Computer Algebra System (CAS), iOS and hardware integration features, keyboard overlays, complete display color control, rich set of import and export capabilities, traditional and upbeat modern skins, and much more. This is the finest and most powerful scientific/engineering/financial/business calculator for iOS devices bar none.

Calculator Features
- RPN logic with a 4 element deep memory stack
- 319 main and 600 extended memory registers
- Over 400 built-in functions, including over 100 functions created specifically for i41CX+
- Time, calendar, alarm, and stopwatch functions
- Four module ports provide access to HP-41 expansion pacs
- Rich set of functions and algorithms: numerical, mathematical, statistical, complex, matrix, numerical integration, curve fitting, solutions to equations, and much more
- Powerful, flexible, and programmable Computer Algebra System (CAS) supporting symbolic, arbitrary precision, scalar, vector and matrix algebra calculations, 2D and 3D plotting, and much more
- Full-screen text editor with configurable font style, font size, color scheme, a user configurable macro keyboard, and a numerical keyboard. The text editor also provides the ability to view, delete, and mail CAS plots and render LaTeX documents
- Access to the entire HP-41 library of solutions for science, mathematics, statistics, engineering, business, financial, surveying, medicine, real estate, and many other domains
- Programmable - virtually unlimited number of lines
- User definable keyboard
- Ability to operate the calculator using a Bluetooth keyboard
- Device integration: external display mirroring, copy and paste, in-app mail, system keyboard, GPS, accelerometer, digital compass, time and date synchronization, AirPrint, and much more
- Notification Center widget
- Virtually unlimited storage capacity using the device's flash memory for local storage
- Import/export data, programs, overlays, modules, etc. via the web, email, and iTunes File Sharing
- 43 keyboard overlays and support for user created overlays
- Dynamic keyboard overlay switching
- Sound support including synthetic tones and interface sounds
- Support for calculator skins and optional mini stack display
- Adjustable calculator speed, sound volume, and display colors
- Searchable Usage & examples and quick reference guide tables of all built-in HP-41 and CAS functions
- Beautiful and clean user interface optimized for the portrait mode screen aspect ratio and to maximize the keypad area while still providing for a full featured scientific keypad

Printer Features
- Support for printing, plotting, graphics, and special characters
- User configurable and programmable print color
- Export printer output via email, clipboard, or AirPrint
- Ability to save a JPEG image of the paper roll to the device's photo album

i41CX+ Settings

i41CX+ is highly customizable. Like many iOS applications, its settings can be accessed in the global Settings application ( ) or by tapping the "gears" button above the "Clear Memory" button on the back view. The i41CX+ settings are described in the table below.

Setting	Description	Default Value
General		
Ignore Mute Switch	Specify whether to play sounds through the speaker regardless of the mute switch setting on iPhone devices.	OFF
Horizontal Swipes	Select action taken for horizontal swipe gestures.	Calc. ⇔ Printer
Vertical Swipes	Select action taken for vertical swipe gestures.	Front ⇔ Back
Mail Items To	Destination address when emailing data and programs.	to@address.com
Display Mirroring	Enable/display external display mirroring on devices that support external display mirroring.	OFF
Mirroring Scale To Fit	Specify whether to scale the mirrored output to fill the external display.	OFF
Calculator		
Skin	Select calculator skin.	Classic Rectangular
LCD Font	Select display character style.	Classic Regular
Stack Display	Show mini displays of Y, Z, T, and L registers (always disabled for the "Genuine" and "Classic (No Stack)" skins). This option is not available on iPad devices.	OFF
Lowercase Letters	Specify whether to enable display of the full set of lowercase letters.	OFF
Dynamic Overlay	Display selected overlay when USER mode is on, hide overlay when USER mode is off	OFF
Haptic Feedback	Set haptic feedback type on devices that support it	None
Key Press Glow	Show glow effect when pressing keys.	OFF
Key Click Sound Type	Select key click feedback sound.	New
Synchronize Time	Synchronize time & date with the device's system clock.	ON
Keep Time	Maintain time and date across application launches. Disabling "Synchronize Time" and enabling this option makes it possible to maintain a different time zone independent from the device system time.	ON
CV Calculator Mode	Function as HP-41CV rather than HP-41CX.	OFF
Widget Type	Select Notification Center widget type	Stack Registers
Disable I41CX Module	Disable built-in I41CX module.	OFF
Use Module Pages	Specify whether to load modules by ports or memory pages.	OFF
{ } Handling	Specify how to handle { } characters that are not available in the HP-41 character set.	Use [ ] instead of { }
Save Text Files In	Specify location for saving extended memory text files.	Text Files Directory

Setting	Description	Default Value
Line Numbers	Specify whether line numbers are used when importing or exporting programs in text format.	ON
Text Editor (`I41CXED`) and CAS		
Create New Files In	Specify the location for new files.	Extended Memory
Keyboard Configuration	Select which keyboards are active and their ordering	Numerical ⇔ System ⇔ Macro
Default Keyboard	Select the keyboard (system, macro, or numerical) first shown when the text area is tapped for editing.	System
Arrow Keys	Select whether to show arrow and other keys in i41CXED.	OFF
Auto Hide Macros	If enabled, the I41CXED macro keyboard is replaced by the standard keyboard after a macro button is pressed.	OFF
Return Shows Macros	If enabled, the I41CXED macro keyboard is shown whenever the "Return" key is pressed on the system keyboard.	OFF
Macro Insertion Point	Specify the location of the insertion point when a macro is inserted using the macro keyboard.	Context Dependent
Lowercase	Specify whether to use lowercase in CAS output.	OFF
Line Length Warning	Specify whether to set the text to a warning color when any line exceeds the maximum line character limit.	OFF
Create Fancy Output	If enabled, CAS output will be automatically generated in the fancy format that can be viewed in a more natural mathematical format with I41CXED. Enabling this option is equivalent to including "fancy_output;" at the beginning of CAS input files.	OFF
Auto Show Fancy	If enabled, I41CXED will automatically render fancy CAS output and LaTeX source when it first opens and when interactive CAS output generates fancy output. If disabled, rendering can be triggered by tapping the translucent button on the top right corner of the text window.	ON
Email Fancy Output As	Select fancy output email format.	Text and Image
Always Load gnuplot	If enabled, the gnuplot package is loaded every CAS session. Enabling this option is equivalent to including "load_package gnuplot;" at the beginning of CAS input files.	OFF
Auto Show Plots	If enabled, newly generated and updated plots are automatically shown during an interactive CAS session.	OFF
Overwrite Plots	If enabled, CAS will overwrite any existing plot(s) with the same name as plot(s) being generated. Otherwise, if a plot of the same name exists, it won't be overwritten and an error will be shown.	OFF
Default Plot Title	Set default title for CAS plots without specified plot titles.	i41CX+ Plot
Printer		
Appearance	Specifies the appearance of the printer covers	Normal
Power At Launch	Specify power state when app is launched	OFF
Start With New Roll	Printer starts with a new paper roll each time app is launched	OFF
Volume Control	Volume of printer sounds is controlled by the volume slider.	OFF

Setting	Description	Default Value
Printout Size Warning	Display warning when recommended printout size is exceeded. While there is no explicit limit for the number of printed lines, each printed line consumes memory and if you plan to save the printout as a JPEG photo, we recommend that the number of lines be not much more than 200 lines.	ON
Email Paper Roll As	Select format for emailing the paper roll.	Text and Image
iCloud		
Sync Preferences	Sync preferences.	OFF
Update Notifications	Display brief notification when there is iCloud activity.	OFF
About (In-App Settings Only)		
Version	Displays the app version.	App Version
Contact Support	Tap to email support.	

Calculator Front View
(La Pomme Mies Skin Shown)

Printer View

Historical Perspective

i41CX+ is functionally equivalent to the venerated, paradigm shifting HP-41CX programmable scientific calculator (or handheld computer, as HP marketed it). It includes functionalities beyond the equivalent of an HP-41CX system with magnetic card read/writer, tape printer, etc. with numerous additional features like OS and hardware integration features, CAS, application specific overlays, display control, a rich variety of skins, the ability to share data and programs with other users and devices, and much more. It is a sheer delight to use and beneath its simple looking interface lies an incredibly powerful mathematical system with capabilities that rival those of workstation-class applications like Mathematica and Maple.

The 41's initial arrival in 1979 on the scientific and engineering, financial, and computational scenes was awe inspiring and was the first HP calculator to offer alphanumeric capabilities which revolutionized the way a calculator could be used. It was a masterpiece of compact and powerful design. i41CX+ brings a modernized version of this powerful system to iOS devices giving them powerful computational capabilities.

This is one of the most sophisticated applications for Apple's iOS platform. It is an implementation of the universal Scientific Calculator with a programmable capability that made the 41, in reality, a powerful handheld programmable computer. It was astounding for what could be computed and a large body of work was assembled by the Personal Programmers Club (PPC) under the encouragement and nurturing of Richard Nelson of the Educalc Computer store in California. This work was continued and has been assembled by Warren Furlow who created the HP-41 Archive Website and who is the author of the "V41" emulator for the Windows environment.

Because i41CX+ is an elaborate extension of the extremely powerful and versatile HP-41CX, we created this mini manual to assist new users learn the enormous scope of the work, and quickly understand the essence of each aspect that is special to i41CX+ so that they can quickly delve more deeply into the workings of this very special computational system.

A rich and delightful world of computation awaits anyone interested in such necessities.

Memory

Computers depend upon memory to operate and provide answers. The basic element of memory in the HP-41CX is the register. Registers are like pigeon holes or mail slots behind the front desk of a hotel, or like cells in a spreadsheet. They can hold several types of elements such as numbers, alphanumeric text, key assignments, program steps, etc. They can even hold addresses of other registers. Registers can be stored or recalled upon the user's command.

RAM registers can hold numbers, key assignments, alphanumeric data (6 characters per register), or program steps. Programs are lists of steps of data and functions with defined names or labels and end points and may include branching commands based upon Boolean conditions. Developing a program on the HP-41CX is actually a simple process and with i41CX+, the program can be printed out on the built-in printer. This saves having to write them down. i41CX+ contains a total of 925 RAM registers (319 main memory, 600 extended memory, 5 stack, and the Alpha register). The Alpha register actually consists of 4 registers (one register can only hold 6 characters whereas the Alpha register can hold 24 characters),

so the true number is actually 928. This can be further extended with the HEPAX module which provides an additional 1304 registers bringing the total to 2,232 registers. And then there is the additional storage by being able to load/save data and programs from/to the device flash memory. The two layers of memory provide for virtually unlimited storage.

Modules or Application Pacs contain register elements that are "burned" or locked in so that they cannot be modified. Just like the HP-41CX, i41CX+ contains 4 ports in which one can insert modules that contain programs and functions developed by experts in their various fields. They expand the capabilities of the calculator and are hence also called expansion pacs. There are a number of modules for a wide variety of applications and fields, many of which contain some fairly complex and sophisticated functions and programs.

Programming

Programming allows the creation of new functions and operations. These can be assigned to keys such that they can be executed at the press of a single key. Programs initiate the sequencing from the starting label through the list of data and functions placed in registers to various stop or end points, ultimately giving the desired answer.

The Chinese word for a computer derives from the word "thread". Metaphorically one starts from one end and work on down the thread until we reach the end.

All of the formulas that we learned in school or college can be placed into such programs and run on i41CX+. Quick answers, no point in being caught in the calculations. It actually is easy to operate them. However, we do have to know how they are set up so that we can run them. It is even possible to create interactive programs that request user input, whose execution continue by pressing the run stop (R/S) key so that interactive operations are simple and clear.

The memory in i41CX+ is more than adequate for most computations. In fact, in the early days of space exploration, the HP-41 was used to offload some of the computing load from the main Space Shuttle computer and served as an emergency backup for the highly accurate re-entry calculations in the event of a main computer failure.

The PPC had a member who discovered by accident that with a certain key sequence he could access the internal instructions of the machine that are normally not available to the user. The use of such instructions was called Synthetic Programming. i41CX+ provides access to these as well. These can be convenient to save program steps thereby saving execution time and program storage space as well as doing operations that are normally not possible through normal programming means.

Programs can be thought of as consisting of a sequence of key strokes. Thus, the simplest program consists of simply entering the normal calculation sequence in program mode and being able to execute it repeatedly thereafter. More complex programs can use looping, branching, subroutines, conditional execution, indirection, etc.

The Stack and RPN

The stack memory registers are labeled X, Y, Z , T and LastX and are unique to the HP calculators.

The LastX register always contains the last value of the X register. This can be helpful in spotting entry errors and for making corrections.

The X register is displayed in the main display and is the currently focused data.

The Y register contains the previously entered X value.

The Z register contains the previous Y value.

The T register contains the last Z value. This is the last register that data can be pushed into before running a repetitive calculation and because it is a sticky register, it has the handy property of down feeding the other registers as one progresses through a series of calculations. This makes it quick and easy to make a simple counter or to repeatedly perform calculations such as calculating % change for a number of iterations. The T register value sticks or remains until a new Z value is pushed into it.

Arithmetic operations use the data in the X and Y registers.

The stack makes if possible to quickly perform many operations using what is called RPN or Reverse Polish Notation. Mathematical operations are generally taught in infix notation, with the mathematical operators placed between the data that they operate on. For example, in the expression 2 + 3 = 5, the "+" operator is placed between the 2 and the 3. RPN, invented by the Polish Mathematician Jan Lukasiewicz in 1920, is a way of expressing mathematical operations in postfix notation. Using the previous example, 2 + 3 = 5 would be expressed as 2E 3+ 5, where E denotes the Enter operator. Thus, in RPN all operators follow each data item and hence the term postfix.

In the above example, the number of keystrokes is the same in both cases, four to obtain the answer 5. However, this is not always true. RPN makes it possible to enter data and operations without having to write down the intermediate answers or use parentheses.

For example, the infix notation expression (3 + 4) * 6 = 42 requires 8 keystrokes to obtain the answer. In RPN, this would be 3E 4+ 6* 42. That is a saving of 2 keystrokes for this very simple calculation. For more complex calculations, RPN can save a considerable number of keystrokes. In fact, RPN is never less efficient than infix notation so, in general, it can be said that RPN is more efficient.

Once you fully understand the logic of the Stack you are ready to calculate more efficiently than with algebraic or infix notation. Operators, such as the "+" operator used in the above example, operate on the values in the X and Y registers. Unary or single argument operators such as "SIN" operate on the value in the X register. There are many commands in i41CX+ that provide powerful and flexible ways to manipulate the stack registers , such as rolling the stack up or down, swapping registers, etc.

In addition to the stack registers, there is a special register, the A register, which can hold up to 24 alphanumeric characters for use in prompting, displaying messages, results, etc.

Functions and Commands

i41CX+ includes a rich and comprehensive set of functions.

The HP-41CX came with 244 functions accessible by the user. i41CX+ contains all the functions and operations that were supported by the HP-41CX and the HP82143A printer and over 100 new functions specific to i41CX+. These include functions that integrate device hardware and OS features such as access to accelerometer, GPS, and digital compass data, copy and paste support, import/export via the web and email, loading and saving data, programs, text files, etc. from/to the device's flash memory as well as very fast and full 10-

digit precision implementations of advanced mathematical functions such as the Gamma function, Lambert W function, prime number functions, Bessel functions, etc.

In total, i41CX+ has over 400 functions built in. All of the functions and commands can be listed using the Catalog (CAT) function that is executed by pressing SHIFT ENTER. Using the printer in TRACE mode, it is possible to get a paper print out of the catalog lists. Moreover, i41CX+ contains a Usage & Examples table with many usage tips and examples ranging from basic to advanced, a Quick Reference Guide with brief descriptions for all built-in functions and commands, as well as a CAS Quick Reference.

Like the HP-41CX, i41CX+ also includes the Time module which provides a comprehensive set of functions for performing time and date calculations. It also includes a clock, stopwatch, and alarms. These can be used to set alerts and even control programs. It is possible, for example, to run a specified program at preset times using alarms.
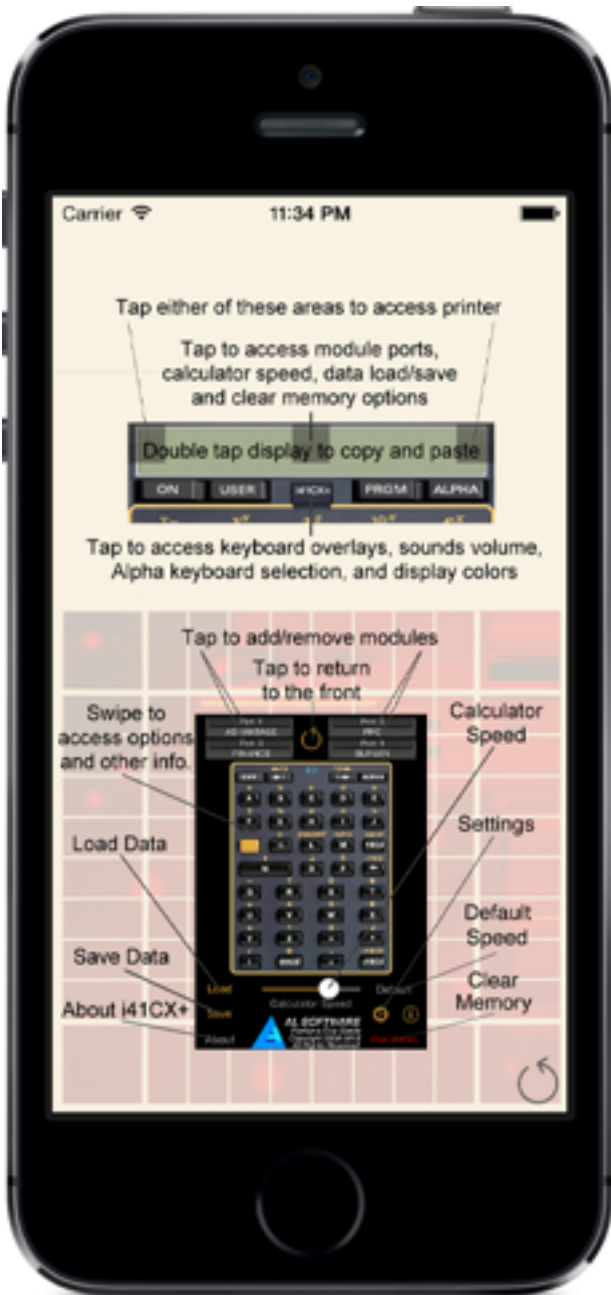
Keyboard or Front View

The primary means of interacting with the calculator is via the keyboard. The top 4 buttons are used to switch the calculator on/off, to enter and exit the USER defined keyboard mode, enter and exit program (PRGM) mode, and enter and exit Alphanumeric (ALPHA) entry mode.

There are a total of 35 keys, including 12 numeric and decimal point keys, 4 arithmetic operator keys, 10 keys for trigonometric and other common math functions, and 9 keys for program execution, register storage, entering values, etc. Furthermore, with the exception of the shift key, all keys have secondary functions (labelled in orange) that are accessed by pressing the shift key. This effectively doubles the total key count. The alphanumeric labels in blue denote the letters that are entered by pressing the keys in ALPHA mode. Taking the shifted alphanumeric characters into account brings the total number of items that can be entered directly from the keyboard to 142. Functions or commands that cannot be directly input by pressing a single key can be invoked either by pressing the execute (XEQ) key and then entering the name of the function or command or by using key assignments. One of the special capabilities of the HP-41 was that the user could customize the keyboard using the assign (ASN) function. This feature essentially allows the user to completely redefine the operations of all keys with the exception of the top row of keys, the shift key, and the number keys (the shifted number key operations can be re-assigned, however). Moreover, the top row of keys can be used to invoke labels 01 through 05 in program mode for quick program execution.

In addition to the HP-41CX keyboard, i41CX+ has special areas that when tapped perform operations such as switching between the various views, accessing overlays, modules, copy and paste, scrolling, displaying the system status bar (when the mini stack display is enabled), etc.

There are 3 primary views, the Calculator Front, the Calculator Back, the Printer that further contain numerous secondary views to access and configure features and settings. These are initially accessed through the front calculator and printer views.

The "i41CX+ Views" table lists the views that are used to access various features and to perform adjustments to settings in addition to the aforementioned Global settings.
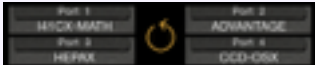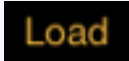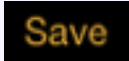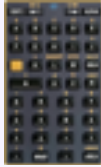
Calculator Information View
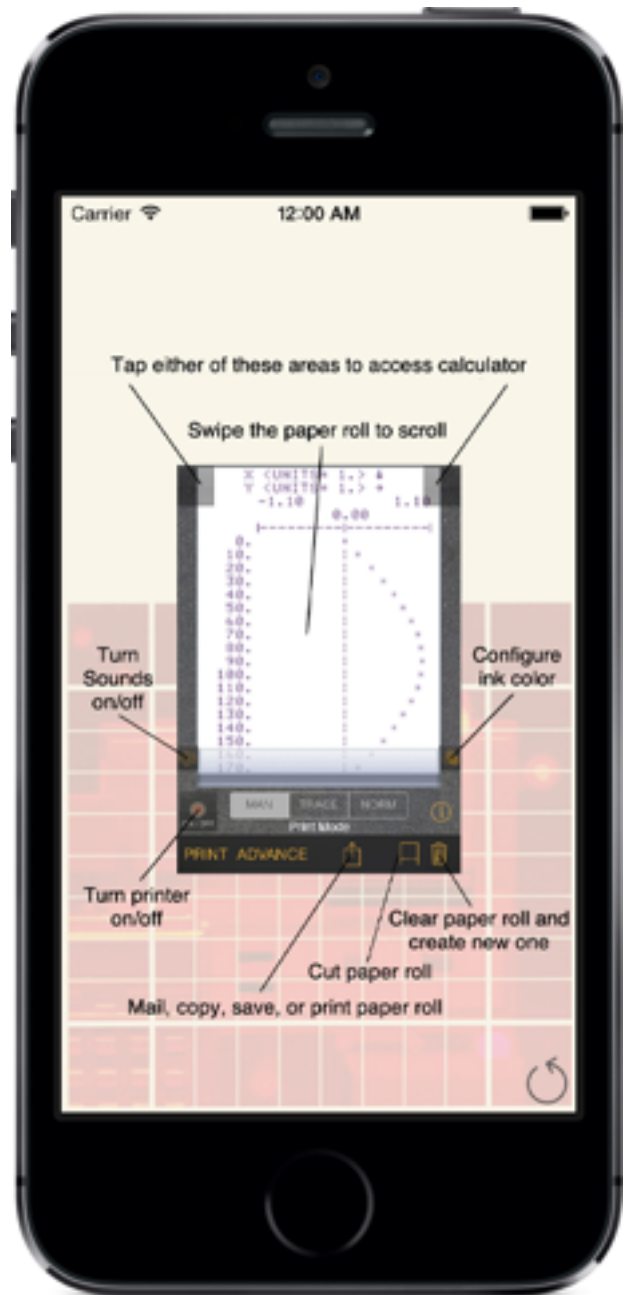
Printer Information View

i41CX+ Views

Views	Functions	How To Access
CALCULATOR FRONT	Perform calculations	Tap application icon
	Access other views	
	Copy/Paste	
Calculator Settings Picker	Select keyboard overlay	Tap overlay clip button
	Select calculator skin	
	Select display style	
	Change display colors	
	Set sounds volume	
	Select alphanumeric entry method (keypad or system keyboard)	
Display Color Controls	Set display foreground and background colors	
PRINTER	View printer output	Tap left or right edge of X register display or swipe horizontally (depending on global setting for horizontal swipe gestures action)
	Print current display contents	
	Create new paper roll	
	Advance paper roll	
	Select printer mode	
	Turn printer sounds on/off	
	Mail printout in text format	
	Save printout to Photos Album as JPG image	
Printer Color Controls	Set print color	Tap color settings button
	Enable/disable program control of print color	
Printer Information	View information about printer controls	Tap "i" button on bottom right of Printer view
CALCULATOR BACK	Load/unload modules	Tap center of X register display or swipe vertically (if vertical swipe gestures are enabled in the global settings)
	Load/Save data	
	View application information	
	Clear calculator memory	
	Set calculator speed	
	Revert calculator speed to default speed	
	Configure frequently used options	
	View and copy flags table	
	View and copy registers table	
	View/Search and copy Usage & Examples	
	View/Search Quick Reference Guide	
	View/Search CAS Quick Reference	
Module Picker	Load/unload modules	Tap a port in Back View
Load Picker	Download programs or data from the web	Tap "Load" button in Calculator Back View
	Import program or data from the clipboard	
	Load program file	
	Load register data file	

Views	Functions	How To Access
	Load HEPAX RAM file	
	Load flag data file	
	Load calculator state file	**Load**
	Load configuration file	
	Load text file	
	Load data file	
Save Picker	Save registers	Tap "Save" button in Calculator Back View
	Save flags	
	Save calculator state	
	Save HEPAX RAM	
	Save configuration	**Save**
	Save program	
	Save text file	
	Save data file	
ED Keyboard Map	ED keyboard map	Access Calculator Back View and swipe from left to right inside orange border until view is reached
Frequently Used Options	Configure frequently used options (Stack Display, Dynamic Overlay, etc.)	Swipe ED Keyboard Map from right to left
Flags Table	View and copy flags table	Swipe Frequently Used Options from right to left
Registers Table	View and copy registers table	Swipe Flags Table from right to left
Usage & Examples	View and search HP-41 and CAS usage and examples Copy items for use as templates	Swipe Registers Table from right to left

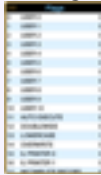| Views	Functions	How To Access
Quick Reference Guide	View and search descriptions of built-in functions and commands	Swipe Usage & Examples from right to left
CAS Quick Reference	View and search descriptions of CAS functions and optional packages	Swipe the Quick Reference Guide from right to left
Calculator Information	View information about calculator controls	Tap i button on bottom right of Calculator Back View
Settings	Access all app settings. Also available under the i41CX+ entry in the global Settings app.	Tap "Settings" button on bottom right of Calculator Back View
Mail	Send programs, data, printout, etc.	Tap the Mail button on the Save picker. Tap the mail icon on the Registers or Flags table. Execute any of the MAIL* commands.
i41CX+ Text Editor CAS Plot Viewer LaTeX Document Viewer		Execute I41CXED function
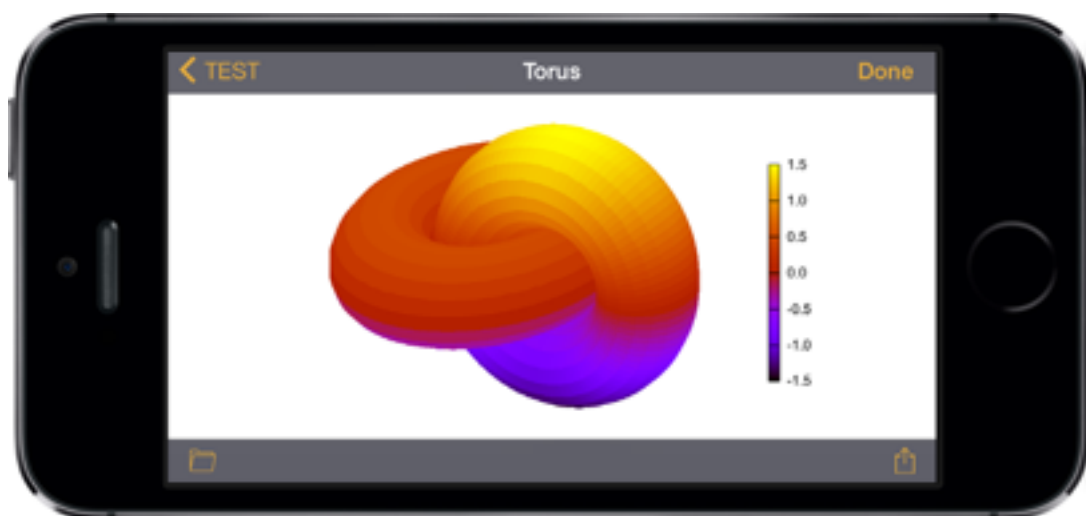
CAS Plot Viewer Screen
(Landscape Orientation Shown)

Expansion and Application Pacs

A vast number of application pacs or modules were developed for the HP-41. These were special purpose ROM chips that were inserted into the 4 ports at the top of the HP-41 and contained programs. They were expensive back in their day.

With i41CX+, these can be downloaded for free from HP41.org. The library of HP-41 application pacs is huge and there are still new modules being developed to this day. Just from HP alone, there were approximately 70 application pacs available. A list of these is included later in this manual, courtesy of HP41.org. These comprise applications from a wide range of disciplines such as Mechanical Engineering, Structural Engineering, Electrical Engineering, Business, Finance, Securities, Real Estate, Surveying, Physics, Mathematics, Medicine, Fluid Dynamics and the list goes on and on....

The PPC, the first club associated with the 41 also produced a famous module (PPC ROM) with 122 useful and powerful functions for a wide range of applications.

In the case of the HP-41, some modules were also memory expansion modules. i41CX+ includes the maximum possible memory configuration and thus memory expansion modules are not required and do not take up any ports.

Certain application pacs were for universal use such as the Math and Statistics Pac while some were of a very specialized nature, such as the SGS Redwood Gas Calculator Pac. The Financial Decisions Pac, for example, is a specialized module for financial and business users that gives the HP-41CX a superset of the capabilities of an HP-12C.

Installing virtually all available HP-41 modules into i41CX+ is as easy as follows.

1. Access the calculator's back view.
2. Tap one of the module ports.
3. Select the "Download from URL..." picker item.
4. Tap the "Download" button to accept the pre-entered hp41.org/mod URL which points to the i41CX+ module repository kindly hosted by hp41.org.

All modules available at hp41.org are now available for use in i41CX+! Of course, if you have your own modules, it's a simple matter of placing the modules on a directory accessible via the web and entering the URL into the "Download from URL..." dialog. Alternatively, you can use the iTunes File Sharing feature to install modules.

Hierarchy of Storage

i41CX+ provides access to three layers of storage via its "Load" and "Save" features as illustrated below.

Load: web/external/clipboard -> Device flash memory -> HP-41CX memory
Save: HP-41CX memory -> Device flash memory -> web/external (iCloud, Mail, File Sharing)

This hierarchy provides for virtually unlimited storage of data and programs.

Hardware and OS Integration Module

i41CX+ includes a built-in custom module (I41CX) with 59 functions to 1) take advantage of available hardware and OS features such as the accelerometer, GPS, copy and paste, email, etc., 2) provide programmatic access to i41CX+ GUI functionality such as showing the printer view, setting the calculator speed, etc., and 3) control graphics mode which provides full control over the calculator displays. The functions are described below.

- Calculator Speed
  - GETCSPD: Get the calculator speed factor and place it in X.
  - SETCSPD: Set calculator speed using the value in the X register. Valid values are between 0.35 and 50.0 with 1.0 corresponding to the default speed. Values outside this range are rounded up/down to the closest values within the valid range. This function is useful for speeding up calculation intensive portions of programs and running interactive display intensive portions at the default (or lower) speed.

    NOTE: The maximum allowed limit of the SETCSPD command applies when executed in a program. If set beyond the normal valid maximum limit (4.0), the calculator speed will revert back to the normal valid maximum limit when the program stops running. This allows faster program execution.

- Copy and Paste
  - COPYA: Copy the contents of the Alpha register into the clipboard.
  - COPYFLG: Copy the flags table in text format into the clipboard.
  - COPYPRT: Copy the printout as text into the clipboard.
  - COPYR: Copy the contents of the specified register (all if none is specified) into the clipboard. Valid arguments are X, Y, Z, T, LASTX, A, Rnnn, and b.e.
  - COPYSTK: Copy the contents of the stack (X, Y, Z, T, and LastX) into the clipboard.
  - COPYTXT: Copy the contents of the specified extended memory text file into the clipboard.
  - COPYX: Copy the contents of the X register into the clipboard.
  - PASTEA: Paste the contents of the clipboard into the Alpha register.
  - PASTER: Paste the contents of the clipboard into the specified register. If no argument is specified, the contents will be pasted into the X register.
  - PASTEX: Paste the contents of the clipboard into the X register.
  - PASTSTK: Paste the contents of the clipboard into the stack (X, Y, Z, T, and LastX). The following two clipboard content formats are recognized.
      <Register Name> <Register Value>
      <X Value> <Y Value> ... <LastX Value>
    In both cases, only the provided values are pasted into the stack. For example, if the clipboard contains "Y 10" only the Y register's contents are replaced and all other stack registers remain unaffected.
  - PASTTXT: Paste clipboard contents to the extended memory file specified in the Alpha register. If the specified file does not exist, a new file is created with the contents of the clipboard. If the specified file exists, the contents of the clipboard are appended to the end of the file.

- Graphics Mode
  - GSCRON: Enable graphics screen mode.
  - GSCROFF: Disable graphics screen mode.
  - GSCRCLR: Clear graphics screen.

- – `GSETSEG`: Set graphics segments at position specified in X to value specified in Y.
- – `GGETSEG`: Get the value of segments at position specified in X.
- – `GSETSTY`: Set "stack Y" mini-screen contents to specified characters in A.
- – `GSETSTZ`: Set "stack Z" mini-screen contents to specified characters in A.
- – `GSETSTT`: Set "stack T" mini-screen contents to specified characters in A.
- – `GSETSTL`: Set "stack L" mini-screen contents to specified characters in A.
- – `GGETSTY`: Get "stack Y" mini-screen contents and place them in A.
- – `GGETSTZ`: Get "stack Z" mini-screen contents and place them in A.
- – `GGETSTT`: Get "stack T" mini-screen contents and place them in A.
- – `GGETSTL`: Get "stack L" mini-screen contents and place them in A.

  NOTE: Graphics mode is described in more detail later in this manual.
- Hardware and OS Features
  - – `ACCXYZ`: Obtain the 3D accelerometer values and place them in the X, Y, and Z registers. The accelerometer values are in units of g, the acceleration constant of 9.80665 m/s^2.
  - – `RANDOM`: Obtain cryptographically secure random number in the range [0,1] and place it in the X register.
  - – `TIMZONE`: Get system time zone information: abbreviated time zone name in Alpha register, offset from GMT (without DST) in X, and DST offset in Y.
- I/O
  - – `DWNLOAD`: Download data using the first record in the specified ASCII file as the download URL; same as selecting the "Download from URL..." Load picker item and entering the first record of the specified extended memory ASCII file as the URL.

    NOTE: Use the "Sigma" character (SHIFT F) for "~" in URLs.
  - – `LOADFLG`: Load flags using filename specified in the Alpha register; same as selecting the filename FLG Load picker item.
  - – `LOADREG`: Load registers using filename specified in the Alpha register; same as selecting the filename REG Load picker item.
  - – `LOADOVL`: Load keyboard overlay specified in the Alpha register.
  - – `LOADTXT`: Load text file specified in the Alpha register.
  - – `SAVFLG`: Save flags using filename specified in the Alpha register; same as selecting the "Save Flags..." Save picker item and entering the filename into the dialog.
  - – `SAVREG`: Save registers using filename specified in the Alpha register; same as selecting the "Save Registers..." Save picker item and entering the filename into the dialog.
  - – `SAVTXT`: Save text file specified in the Alpha register.
- Location Services (i.e. GPS and digital compass)
  - – `COMPASS`: Obtain the magnetic heading and place it in the X register. The heading is the angle starting at due north and continuing clockwise around the compass (0 = north, 90 = east, etc. when in degrees). The calculator's mode determines the units used for the heading (degrees, radians, or gradients). The accuracy (in the same units as the heading) is stored in the Y register.
  - – `CURRALT`: Obtain the current altitude and place it in the X register. Altitude is given in units of meters above (positive) or below (negative) sea level. The accuracy of the altitude value, measured in meters, is placed in the Y register.
  - – `CURRHDG`: Obtain the current heading and place it in the X register. The heading is the angle starting at due north and continuing clockwise around the compass (0 = north, 90

= east, etc. when in degrees mode). The calculator's mode determines the units used for the heading (degrees, radians, or gradients).

- CURRLOC: Obtain the current latitude and longitude coordinates and place them in the X and Y registers, respectively. The calculator's mode determines the units used for the coordinates (degrees, radians, or gradients). The radius of uncertainty for the location, measured in meters, is placed in the Z register.
- CURRSPD: Obtain the current speed and place it in the X register. The speed is given in units of m/s.

- Mail
  - MAILA: Mail A register.
  - MAILCFG: Mail current configuration.
  - MAILFLG: Mail flags; same as pressing the mail button in the flags table.
  - MAILHEP: Mail HEPAX RAM contents.
  - MAILMOD: Mail specified module file.
  - MAILOVL: Mail current overlay file.
  - MAILPRG: Mail user program whose name is specified in the Alpha register.
  - MAILPRT: Mail printer output in text format.
  - MAILREG: Mail registers; same as pressing the mail button in the registers table. The function accepts an optional argument in the Alpha register specifying the register to mail. If no argument is specified, the behavior is to mail all allocated registers. Valid arguments are X, Y, Z, T, LASTX, A, Rnnn, and b.e.
  - MAILSTA: Mail current calculator state.
  - MAILSTK: Mail stack registers (X, Y, Z, T, and Last X).
  - MAILTXT: Mail specified text file.
  - MAILX: Mail X register.

- Printer
  - SAVROLL: Save printer paper roll; same as selecting the "Save to Photos Album" action in the printer. This function has no effect if the paper roll is empty.
  - SHOWPRT: Switch to the printer view. This is useful to signal either the end of a plotting/printing program run or for a program to require the user's inspection of the printer output.
  - NEWROLL: Clear paper roll; same as pressing the New Roll button in the printer.

- Text Editor, CAS Plot Viewer, and LaTeX Document Viewer

  I41CXED: Edit/view text file specified in the Alpha register. I41CXED also provides access to view, mail, and delete CAS plots and can also be used to render and view simple LaTeX documents.

HP-41 Library of Expansion Pacs, Manuals, and Overlays

Courtesy of HP41.org

Title	Date	Author
Advantage Pac		Hewlett-Packard
Advantage Pac Manual	Jul 1985	Hewlett-Packard
Aviation Pac		Hewlett-Packard
Aviation Pac Manual		Hewlett-Packard
Circuit Analysis Pac		Hewlett-Packard
Circuit Analysis Pac Manual	Aug 1984	Hewlett-Packard
Circuit Analysis Pac Overlay		Hewlett-Packard
Clinical Lab and Nuclear Medicine Pac		Hewlett-Packard
Clinical Lab and Nuclear Medicine Pac Manual		Hewlett-Packard
Clinical Lab and Nuclear Medicine Pac Overlay		Hewlett-Packard
Clinical Lab and Nuclear Medicine Pac Quick Ref	1979	Hewlett-Packard
ELI-41 & Electrical Engineering Solutions 2.21 (Eclipse Logic, Inc.)		Tacit Logic Systems, Inc.
Financial Decisions Pac		Hewlett-Packard
Financial Decisions Pac Manual	Aug 1984	Hewlett-Packard
Financial Decisions Pac Overlays		Hewlett-Packard
Financial Decisions Pac Quick Ref	Jul 1979	Hewlett-Packard
Games Pac		Hewlett-Packard
Games Pac Manual	July 1980	Hewlett-Packard
Games Pac Overlays		Hewlett-Packard
Home Management Pac		Hewlett-Packard
Home Management Pac Manual	Aug 1984	Hewlett-Packard
Home Management Pac Overlays		Hewlett-Packard
Home Management Pac Quick Ref		Hewlett-Packard
HYDRACOMP Module	1982	Paul-Munroe Hydraulics, Inc.
Keys Surveying Module Manual	Sep 1987	Fred McMichael
LINK PLUS for HP-IL 2.06	Jul 1990	Southern Software
Machine Design Pac		Hewlett-Packard
Machine Design Pac Manual		Hewlett-Packard
Math Pac		Hewlett-Packard
Math Pac Manual (Spanish)		Hewlett-Packard
Math Pac Manual	Feb 1984	Hewlett-Packard
Math Pac Overlays		Hewlett-Packard
Math Pac Quick Ref(Spanish)		Hewlett-Packard
Math Pac Quick Ref	Feb 1979	Hewlett-Packard
Math/Stat Pac		Hewlett-Packard
Navigation Pac		Hewlett-Packard
Navigation Pac Manual	Aug 1984	Hewlett-Packard
Petroleum Fluids Pac		Hewlett-Packard

Petroleum Fluids Pac Manual		Hewlett-Packard
Petroleum Fluids Pac Quick Ref	May 1982	Hewlett-Packard
Plot of 2-3 Functions on One Graph		John L. Gilby
Real Estate Pac		Hewlett-Packard
Real Estate Pac Manual	Sep 1983	Hewlett-Packard
Real Estate Pac Overlay		Hewlett-Packard
Real Estate Pac Quick Reference	Aug 1980	Hewlett-Packard
SDK41 ManualR6	Apr 2008	Warren Furlow
Securities Pac		Hewlett-Packard
Securities Pac Manual	Aug 1984	Hewlett-Packard
Securities Pac Overlays		Hewlett-Packard
Securities Pac Quick Ref		Hewlett-Packard
Standard Applications Pac		Hewlett-Packard
Standard Applications Pac Manual	Aug 1980	Hewlett-Packard
Standard Applications Pac Manual(Spanish)	Jul 1979	Hewlett-Packard
Stat Pac		Hewlett-Packard
Stat Pac Manual	Aug 1984	Hewlett-Packard
Stat Pac Manual(Spanish)		Hewlett-Packard
Stat Pac Quick Ref	Jun 1979	Hewlett-Packard
Stat Pac Quick Ref(Spanish)	Apr 1980	Hewlett-Packard
Stress Analysis Pac		Hewlett-Packard
Stress Analysis Pac Manual	Aug 1984	Hewlett-Packard
Stress Analysis Pac Overlays		Hewlett-Packard
Structural Analysis Pac		Hewlett-Packard
Structural Analysis Pac Manual	Aug 1984	Hewlett-Packard
Structural Analysis Pac Overlays		Hewlett-Packard
Surveying Pac		Hewlett-Packard
Surveying Pac Manual	Aug 1984	Hewlett-Packard
Surveying Pac Overlays		Hewlett-Packard
Surveying Pac Quick Ref	May 1979	Hewlett-Packard
Thermal & Transport Science Pac		Hewlett-Packard
Thermal & Transport Science Pac Manual	Aug 1984	Hewlett-Packard

As mentioned earlier, this is just the list of items that HP developed but there are many many more third-party modules, manuals, and overlays, the vast majority of which are available from HP41.org. With the exception of modules that rely on special hardware (e.g. Wand, IR-PRINT, etc.), all of them are compatible with i41CX+.

Financial Decisions Pac: Turn i41CX+ into an HP-12C

Need to solve for any of the five standard compound interest variables (N, I, PV, PMT, and FV)? Calculate the internal rate of return of a series of unequal or equal cash flows? Need to solve the internal rate of return using a modified IRR technique? Calculate the net present value? Calculate amortization schedules? Calculate sum of the years' digits depreciation schedule? Calculate before- and after-tax price or yield for semi-annual or annual coupon securities? All of these and more are possible with the Financial Decisions Pac. The HP-12C is essentially dedicated to perform these types of calculations but in two easy steps, i41CX+ can perform all of these tasks and more!

1. Download the Financial Decisions Pac, if you haven't already done so.
2. Tap one of the module ports and select the FINANCE module.

Furthermore, using the configurable USER mode keyboard and keyboard overlays such as the "Financial MONEY" overlay shown below, the user can quite literally convert the i41CX+ keyboard into a keyboard with similar functions as the HP-12C. Best of all, all built-in functions are unaffected by the inserted module and going back to the standard keyboard is a simple matter of either selecting "No Overlay" in the overlay picker or, better yet, use the "Dynamic Overlay" option. When the "Dynamic Overlay" option is enabled, the selected overlay is automatically displayed when in USER mode and hidden when in normal mode. Thus, hiding and showing the overlay is a simple matter of pressing the USER button. In this example, it's almost like having a virtual HP-12C in USER mode!

Advantage Pac: Turn i41CX+ into an HP-15C and HP-16C

Need to perform real or complex matrix operations and functions? Need to find the roots of an equation? Need to solve or evaluate polynomials? Need to perform numerical integration? Need to solve first- or second-order differential equations? Need to perform complex number operations and functions? Need to perform vector operations? Coordinate transformations? Number conversions and Boolean logic? Curve fitting? Solve time value of money problems? These are essentially the problems for which the HP-15C and HP-16C were developed. The Advantage Pac provides these capabilities to the HP-41CX. Thus, by loading the Advantage Pac and creating the appropriate key assignments, you can turn i41CX+ into a virtual HP-15C or HP-16C!

I41CX-MATH Module: Fast and Full Precision Math Functions and CAS

You can go far beyond the capabilities of these other fine HP calculators, however. i41CX+ contains a custom developed I41CX-MATH module that contains the following advanced mathematic functions that execute much faster than traditional HP-41 modules and with full 10 digit precision (they are internally computed with 15 digits of precision).

- Base 2 powers: 2^x, $\log_2 x$
- Hyperbolic functions: $\cosh$, $\sinh$, $\tanh$, $\cosh^{-1}$, $\sinh^{-1}$, $\tanh^{-1}$
- Bessel functions: $J_0, J_1, J_n, Y_0, Y_1, Y_n$
- Combinatorics: $_nC_r$, $_nP_r$, $(x)_n$
- Error functions: erf, erfc
- Gamma functions: $\Gamma(x)$, $\ln \Gamma(x)$, $\Gamma(s,x)$, $\gamma(s,x)$, $P(s,x)$, $Q(s,x)$
- Greatest common divisor (GCD) and least common multiple (LCM)
- Lambert W function: $W_0(x)$, $W_{-1}(x)$
- Prime number functions: primality test, next prime, Euler's totient function $\varphi(n)$
- Two argument arctan function $\mathrm{atan2}(y, x)$
- Beta functions: $\mathrm{B}(x,y)$, $\mathrm{B}(x; a, b)$, $I_x(a, b)$
- Digamma function $\psi(x)$
- Exponential integral functions: $E_1(x)$, $E_i(x)$, $E_n(x)$
- Logarithmic integration function $\mathrm{li}(x)$

In addition to these advanced numerical functions, i41CX+ contains a very powerful and flexible computer algebra system (CAS) function. The CAS function is based on REDUCE, a system for doing scalar, vector and matrix algebra, and arbitrary precision numerical calculations. The capabilities of the system include, but are not limited, to the following.

- Expansion and ordering of polynomials and rational functions
- Substitutions and pattern matching in a wide variety of forms
- Automatic and user controlled simplification of expressions
- Calculations with symbolic matrices
- Arbitrary precision integer and real arithmetic
- Facilities for defining new functions
- Analytic differentiation and integration
- Factorization of polynomials
- Solving a variety of algebraic equations
- Facilities for the output of expressions in a variety of formats
- 2D and 3D plotting

Ironically, the embedded CAS is actually more powerful than the HP-41CX and is even programmable! The i41CX+ CAS uses text files as mini notebooks, similar to Mathematica. CAS performs the operations in the input text file whose file name is specified in the Alpha register. Upon completion, the results are appended to the text file. To specify separate

input and output files, enter the input and output file names separated by a comma into the Alpha register (e.g. `"CASIN,CASOUT"` without the quotes). To ignore the CAS output, specify an empty output file (e.g. `"CASIN,"` without the quotes). This is useful for cases where the CAS operations manipulate and place the result(s) in calculator registers. Finally, it is also possible to run CAS interactively by specifying a text file followed by two commas in the Alpha register (e.g. `"CASFILE,,"` without the quotes).

By default, the CAS output is converted into uppercase letters to allow it to be viewed in the i41CX+ calculator display (using `ED`, for example). The conversion to uppercase can be disabled by setting flag 13 or by enabling the "Lowercase" global setting. In either case, the CAS output is best viewed using the `I41CXED` text editor function or emailed using the `MAILTXT` function since the vast majority of cases will involve long output strings and in many cases spanning multiple lines that are difficult to view using the 12 character calculator display. Note that both I41CXED and the MAIL* composition windows support device rotation so the contents can be viewed in landscape.

The i41CX+ CAS environment provides complete access to the calculator registers and flags. They can be accessed within the CAS environment using the following variables.

- Stack Registers: `x_reg, y_reg, z_reg, t_reg, l_reg`
- Alpha register: `a_reg`
- Data Register nnn: `data_reg(nnn)`
- Flag n: `flag_reg(n)`

Any changes made to these variables in the CAS environment are reflected in the calculator registers upon completion of the CAS operations. To maintain data typing intact between the calculator internal registers and the CAS environment, strings in the calculator register variables in the CAS environment need to be surrounded with double quotes (e.g. if a register contains the string `ABC` the corresponding variable will contain `"ABC"` instead of just `ABC`) and non-normalized numbers (NNN) are treated as strings (e.g. if a register contains `0xaabbccddeeff`, the corresponding variable will contain `"0xaabbccddeeff"`).

Upon completion, the values of the calculator registers are updated based on the values of the variables in the CAS environment. Therefore, to write a string to a calculator register in the CAS environment, include the surrounding double quotes as part of the string (e.g. to write the string `FOO`, assign the corresponding variable in the CAS environment with `"""FOO"""` so that the CAS variable contains the string `"FOO"`) and if you wish to assign a NNN to a calculator register in the CAS environment, assign it as a string (e.g. to write `0x77665544332211` into a register, assign the corresponding variable in the CAS environment with `"0x77665544332211"`).

The following are just some simple examples to illustrate the capabilities of the i41CX+ CAS.

- Arbitrary precision, including complex numbers
  Input: `precision 20; 2.3^(5.6i);`
  Output: `−0.048079349091427726016−0.99884351937175055583*I`
- Solve algebraic equation
  Input: `solve(x^2+8x+15=0,x);`
  Output: `[X=−3,X=−5]`
- Solve simultaneous equations

Input: `solve([x+3y=7, y-x=1],[x,y]);`

Output: [[X=1,Y=2]]

- Differentiate a function

  Input: `i=sqrt(-1); u:=(x*exp(i*y)*log(z)); df(u,x,1,y,2,z,1);`

  Output:
  ```
           i*y
      - e
     ---------
         z
  ```

- Integrate a function

  Input: `f:=x*exp(x); int(f,x);`

  Output:
  ```
    x
   e *(x - 1)
  ```

- Matrix operations

  Input: `m:=mat((a,b),(c,d)); det(m);`

  Output: `a*d - b*c`

- Special functions

  Input: `load specfn; on rounded; zeta(4);`

  Output: `1.08232323371`

- Plot the sine function

  Input: `load_package gnuplot; plot(sin(x));`

  Output: `CASPlot` SVG file (view, email, or delete using I41CXED)

- Plot a surface

  Input: `load_package gnuplot; plot (cos sqrt(x**2+y**2),`

  `x=(-10 .. 10), y=(-10 .. 10), hidden3d, output="3D Plot");`

  Output: `3D Plot` SVG file (view, email, or delete using I41CXED)

For more details on the i41CX+ CAS please see the REDUCE User's Manual. Because the HP-41CX character set does not include curly braces ("{" and "}"), these are by default substituted by square brackets ("[" and "]") in the i41CX+ CAS for both input and output. However, the "{} Handling" global option can be configured to specify the use of curly braces and thus achieve seamless compatibility between REDUCE and the i41CX+ CAS.

The Financial Decisions Pac, Advantage Pac, and I41CX-MATH module are just three examples of the powerful capabilities enabled by the use of expansion pacs. And there are over 100 such expansion pacs available! The combination of i41CX+ and expansion modules comprise a very powerful small package. Combined with programmability, there is virtually no calculation application beyond the reach of i41CX+!

Exchanging data and programs

The 41 was so loved by the user community that people were doubling the clock speed and adding all kinds of peripherals and memory. Using the HP-IL interface, the HP-41 could drive any number of peripherals from line printers, to monitors, to tape printers, card readers, barcode wands, tape memory cartridges and other custom devices. There seemed to be no end to the number of riggings and devices associated with the little hand held computer.

Today, with iOS devices, in an even smaller format much of that capability can still be realized. i41CX+ supports an adjustable calculator speed and it has flexible and extensive support for exchanging information with other users and devices. It is possible to send and receive emails with data or programs, transfer the printouts to a computer to create actual paper printouts, download data, programs, overlays, modules, etc. from the web and even import data and programs from the system clipboard or using the iTunes file sharing feature.

The ability to share data and programs via email would be extremely useful in a classroom setting whereby the teacher could email the students some data and/or programs or vice versa for handing in work. Of course, this could also become a conduit for cheating but that's true of any modern device with communication capabilities... For example, let's suppose that you have a program entered into the calculator and wish to send it to another i41CX+ user. This is very simple with i41CX+. Just go to the back of the calculator and tap the "Save" button. Scroll down to the label of the program that you wish to share and tap the "Mail" button. A mail window with the program will pop up. Enter the destination email address and send it.

Receiving data and programs from other users is even simpler. Suppose that you received an email with i41CX+ data or program. Open the email that you received with the iOS Mail application and scroll down to the bottom and tap the attachment and then select to open it with i41CX+. This will launch i41CX+ and you'll be asked to confirm saving the program. If confirmed, it will show up in the "Load" picker from where it can be loaded into the calculator's memory. An alternative way to accomplish this is to email the program or data in an email, copy the program or data in the email on your device, and use the "Import from clipboard..." item in the "Load" picker to save the clipboard contents as a program or data file that you can then load into the calculator's memory. This is useful to exchange data or programs with non-i41CX+ users or desktop programs. Overlays can be imported in a similar fashion.

Of course, i41CX+ also supports copy and paste of stack registers, Alpha register, printer output, flags table, and registers table contents. Double tapping the main display provides access to copy/paste operations from/to the X and Alpha registers depending on the status of Alpha mode. Double tapping the printer paper roll, flags table, or registers table provides the option to copy their contents. Double tapping the mini stack area provides access to copypaste operations from/to the stack registers. Copy and paste operations are also programmatically supported via the `COPYA, COPYFLG, COPYPRT, COPYSTK, COPYX,` `PASTEA, PASTER,` and `PASTEX` functions.

All in all the i41CX+ elevates iOS devices into serious calculating machines capable of performing a virtually unlimited number of calculation tasks. Imagine going through school and generating programs of each and every formula that is of importance as you progress though your courses. They will always be available to you in the future.

Sounds

i41CX+ includes a rich set of interface sounds to provide auditory feedback and provide an immersive experience as close as possible to that of the real HP-41CX and printer. It also supports the HP-41CX sounds (BEEP and TONE) that can be used in programs and for audible alarms. Some HP-41CX users have gone as far as creating programs that play famous musical scores using the available tones (10 normal and a large number of synthetic ones). The standard sounds supported by i41CX+ are listed below.

- 11 calculator sounds (TONE 0-9 + BEEP)
- 3 types of key click sounds (New, Old, System)
- scroll click sound
- printer paper advance sound
- printer paper roll tear sound
- printer image save sound (camera capture/shutter sound)
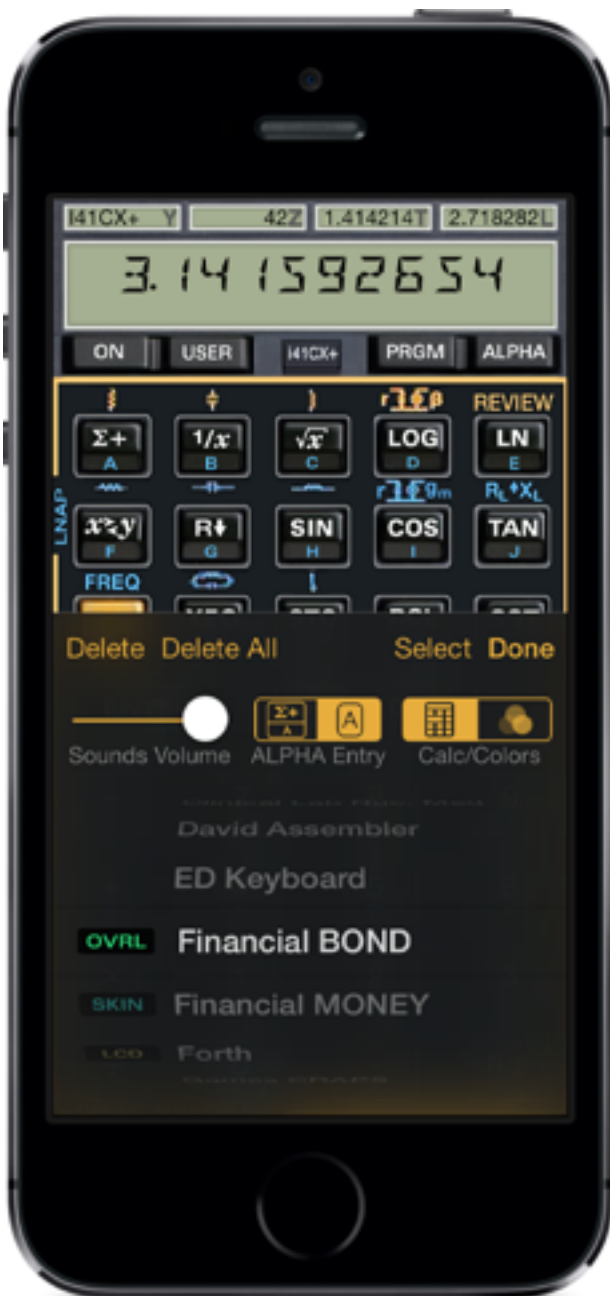
Keyboard Overlay Picker   **Calculator Back View**

Graphics Mode

i41CX+ supports a special graphics mode that provides full control over the display (main and stack display if stack display is visible) when running programs. This enables the display of custom characters and shapes that are otherwise not possible with traditional means. In graphics mode, all individual segments of the main display become independently controllable as are the contents of the stack displays. As shown in the diagram below, the i41CX+ main display consists of 12 characters, each containing 17 segments, including the segments used to display the period, comma, and colon. Incidentally, it was not normally possible to display a semicolon on an HP-41 but this is just one of the new possibilities with graphics mode.
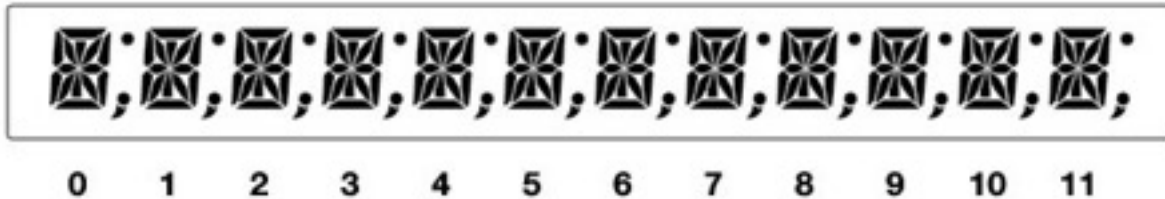
Each segment of a character corresponds to a power of 2 with the powers shown in the following diagram.
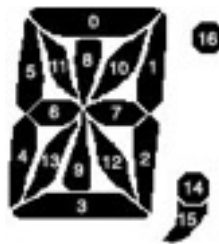
For example, a capital letter O is displayed by turning on segments 0, 1, 2, 3, 4, and 5 and turning off all other segments. Thus, setting the segments value for a character on the display to $2^0 + 2^1 + 2^2 + 2^3 + 2^4 + 2^5 = 0x3F = 63$ would display the capital letter O. As another example, a semicolon could be displayed by setting the segments value of a character to $2^{14} + 2^{15} + 2^{16} = 0x1C000 = 114688$.

GSCRON enables graphics mode and GSCROFF disables graphics mode. The graphics display buffer can be cleared using the GSCRCLR function. Graphics mode uses a dedicated main display buffer that is independent from the normal display and its contents are retained until the application is quit. Therefore, clearing the graphics screen has no effect on the contents of the normal mode display. Each character's segments can be set to the desired value using the GSETSEG function which takes two arguments. The value in the X register specifies the character location (0-11) and the value in the Y register specifies the segments value for the character. The current value of the segments for a given character can be obtained using the GGETSEG function which takes the character position (0-11) argument from the X register. The stack displays (Y, Z, T, and L) can be controlled in a similar fashion. The GSETST{Y, Z, T, L} functions set the contents of the corresponding display to the contents of the Alpha register (up to a maximum of 6 characters) and GGETST{Y, Z, T, L} copies the contents of the corresponding display into the Alpha register.

Tips and Tricks

As must be obvious from this mini manual which provides only a cursory overview, i41CX+ is a very sophisticated application. There are many features and capabilities that many users may not be aware of. We will briefly mention some of them below.

- Display Status Bar

  To display the system status bar when the mini stack display is enabled, simply tap the mini stack display area (the area that the status bar normally occupies). The status bar will be shown for a few seconds and then it will automatically disappear.

- Display Clock

  Pressing SHIFT ON places the calculator in clock display mode. By default, the displayed clock is a 12-hour h:mm:ss format. This can be changed to display the time and date using the CLKTD function which will configure the clock display mode to show the time and date in 12-hour h:mm MM/DD format. To configure the clock to display only the time, use the CLKT function. To switch between 12-hour and 24-hour formats, use the CLK12 and CLK24 functions. To return to the calculator, press any key. For more details on the Time module, please see the HP-41CX manual.

- Use the Stopwatch

  Executing the SW function places the calculator in stopwatch mode. The stopwatch can be started and stopped using the R/S (Run/Stop) key and cleared using the delete/backspace key. The stopwatch supports splits, storing and recalling times, etc. The included "Stop Watch" keyboard overlay comes in handy when using the stopwatch. To return to the calculator, press SHIFT delete/backspace.

- Copy and Paste Data

  i41CX+ has comprehensive and flexible support for copy and paste operations. Double tapping the main display allows copy and paste operations from/to the X register or A register, depending on the state of ALPHA mode. If the mini stack display is enabled, double tapping the mini stack area (the area that the system status bar normally occupies) allows copy and paste operations from/to the stack registers (X, Y, Z, T, and LastX). Double tapping the paper roll allows copying the printout in text format. Double tapping the Flags or Registers table allows copying the table contents in space delimited format. These operations can also be performed using the COPYA, COPYFLG, COPYPRT, COPYR, COPYSTK, and COPYX functions.

- Turbo Program Execution Mode

  i41CX+ supports a configurable speed that is normally controlled via the "Calculator Speed" slider on the back view of the calculator or programmatically via the SETCSPD function and that allows for a maximum speed of 4x the normal HP-41CX operating speed. When running a program, however, the SETCSPD function's 4x limit is raised to 40x. The calculator speed will revert back to the normal valid maximum limit when the program stops running. This allows for faster program execution.

- Navigate the Flags, Registers, Usage & Examples, and Quick Reference Tables

  Tapping the right edge of these tables will jump to the proportionate location in the table (e.g. tapping the middle of the right edge will jump to the middle, tapping the bottom of the right edge will jump to the bottom, etc.), similar to the way that tapping a letter in the built-in address book works. Furthermore, tapping the title area of these tables will jump back to the top of the table, similar to the way that tapping the status bar in Safari jumps back to the top of the web page.

- Quickly Switch Module Port Pickers

  It is not necessary to close a module port picker to access a different one. It is possible to switch between different module port pickers by simply tapping a different port even while the module port picker is visible.

Tips and Tricks (Continued)

- Revert Display Colors, Printer Ink Color, and Calculator Speed and Quickly Remove Active Overlay or Module

  i41CX+ supports the shake gesture to revert display color settings, printer colors, and calculator speed back to default settings as well as to select the "No Overlay" and "No Module" items in the overlay and module pickers. The shake gesture is not only useful for recovering from inadvertently setting psychedelic display colors but can also be used to quickly switch back and forth between different skin display color schemes because the color restore is skin context sensitive. If a traditional skin is active, the display colors will reset to black characters and light green background whereas if a non-traditional skin (e.g. Bauhaus) is active, the display colors will reset to the recommended display settings for that skin. In the case of the overlay and module pickers, the shake gesture saves the need to scroll the picker wheel back to the "No Overlay" and "No Module" items.

  To prevent distracting the user with unnecessary confirmation dialogs due to inadvertent shaking motion, shake gestures are only detected if the display color settings picker, printer color picker, calculator speed slider, overlay picker, or module picker is visible.

- Automatically Display Keyboard Overlay

  The "Dynamic Overlay" option available in the global Settings application and in the calculator back view can be used to automatically display the selected keyboard overlay only when USER mode is active. This allows for quick and easy switching between the standard keyboard and the selected keyboard overlay without having to manually select and deselect the keyboard overlay using the overlay picker.

- Use the HP-41CX Text Editor

  The HP-41CX came with a built-in text editor for use with extended memory text files. To invoke the text editor, place the name of the extended memory text file in the Alpha register and then execute the ED function.

- Use the Mail Composition Window as a General Purpose Editor

  While ED is neat and was useful on the HP-41CX, i41CX+ users have a superior alternative to create and edit not just text files but also data and programs. Because i41CX+ supports importing registers, flags, program, and text file data from the clipboard, this can be used in conjunction with the in-app mail composition window as a general purpose editor environment.

  For example, to create a program, execute any of the mail functions (MAILA will do) or use any of the GUI based mail features ("Mail" button on the printer, mail icons in the flags and registers tables, or the "Mail" button in the "Save" picker) to open a mail composition window. Select all of the text and delete it. Now enter the program. When done entering the program, select all of the text and copy it. Tap the "Cancel" button to return to i41CX+ and select the "Load" picker's "Import from clipboard..." item to save your program to a file in i41CX+ that you can then load into memory. The same process can be used to edit content in i41CX+ by first generating a mail containing the content you wish to edit. After editing it, copy it, return to i41CX+ and save it to a file that you can then load to replace the previous content.

- Expand the available memory and program in MCODE

  As mentioned earlier, i41CX+ is compatible with the HEPAX module. The HEPAX module provides an additional 1304 registers that can be used to store data, text, programs, and even copies of main memory or other module contents. This provides an easy and readily accessible alternative to store large numbers of files in addition to the i41CX+ Load/Save facilities. The HEPAX module also provides facilities for MCODE programming.

Tips and Tricks (Continued)

- Unit conversions

  The Petroleum Fluids and Machine Design Pacs support extremely flexible and powerful unit conversion systems. In both cases, the conversion is performed by entering a unit conversion "equation" into the Alpha register and then using forward and backward conversion functions. Below are some examples using the Machine Design Pac that illustrate the simplicity and flexibility of these unit conversion systems.

    - Convert 212°F to kelvins.

      1. Enter F-K into the Alpha register. This specifies the conversion units and the direction (forward being F to K and backward being K to F).

      2. Enter 212 and execute the `FCON` (Forward CONversion) function.

      3. The result will be 373.15 (°K).

    - Convert 88 feet per second to kilometers per hour. Convert 100 kilometers per hour back to feet per second.

      4. Enter FT/S-KM/HR into the Alpha register.

      5. Enter 88 and execute the `FCON` function.

      6. The result will be 96.5606 (KM/HR).

      7. Enter 100 and execute the `BCON` (Backward CONversion) function.

      8. The result will be 91.1344 (FT/S).

    - Convert 20 $(btu \cdot in)/(°F \cdot ft^3 \cdot s)$ to $W/(in^2 \cdot °C)$.

      9. Enter BTU*IN/F*FT3*S-W/IN2*C into the Alpha register.

      10. Enter 20 and execute the `FCON` function.

      11. The result will be 21.9803 $(W/in^2 \cdot °C)$.

  The Petroleum Fluids Pac unit conversion system functions similarly but supports a slightly different set of units and the forward and backward functions are named `CON` (forward CONversion) and `INCON` (INverse CONversion), respectively.

- Take advantage of i41CX+'s non-modal design

  i41CX+ is designed to be non-modal. That is, there is no need to dismiss picker views, etc. to perform other operations. For example, it is possible to switch between the printer, front, and back views, even if the system keyboard is displayed in the front view. The keyboard will automatically hide itself when switching to the printer or back views and will reappear when returning to the front view.   The same applies to picker views. They don't prevent transitions between the front, back, and printer views. As another example, it is possible to switch between keypad and system keyboard ALPHA entry modes without having to first dismiss the system keyboard (e.g. by tapping the ALPHA key). With the system keyboard displayed, tapping the overlay clip button will reveal the ALPHA entry button which can then be toggled to select the keypad for ALPHA input.

- i41CX+ Text Editor, CAS Plot Viewer, and LaTeX Document Viewer (`I41CXED`)

    - The keyboard can be hidden by tapping the filename being edited that is shown at the top center of the window. This provides access to the font style, font size, color, plots, and mail buttons that are otherwise hidden when the keyboard is visible.

    - If a specified file doesn't exist in extended memory but matches the name of a saved text file, the saved file is automatically accessed. This allows files that are too large to fit into extended memory to be edited and used for CAS input/output. Setting flag 10 or 14 allows saved files to be overwritten so it is even possible to clear them.

Tips and Tricks (Continued)

- `I41CXED` accepts arguments in the "file1,file2" format. If a comma is present in the Alpha register, `I41CXED` uses the string up to the comma as the file name (i.e. open the first filename). This simplifies using `I41CXED` in conjunction with `CAS` which accepts separate input and output files separated by a comma.

- `I41CXED` automatically detects fancy format CAS output. If the "Show Fancy Source" global setting is enabled, `I41CXED` will automatically display fancy output in a natural mathematical format. Otherwise, it displays a translucent button on the top right corner of the text window when it detects the fancy format. Tapping the button displays the output in a more natural mathematical format. The displayed fancy output can also be mailed in LaTeX format.

- If the text contains "\begin{document} ... \end{document}" (without the quotes), `I41CXED` displays a translucent button on the top right corner of the text window that can be tapped to render and view the LaTeX content.
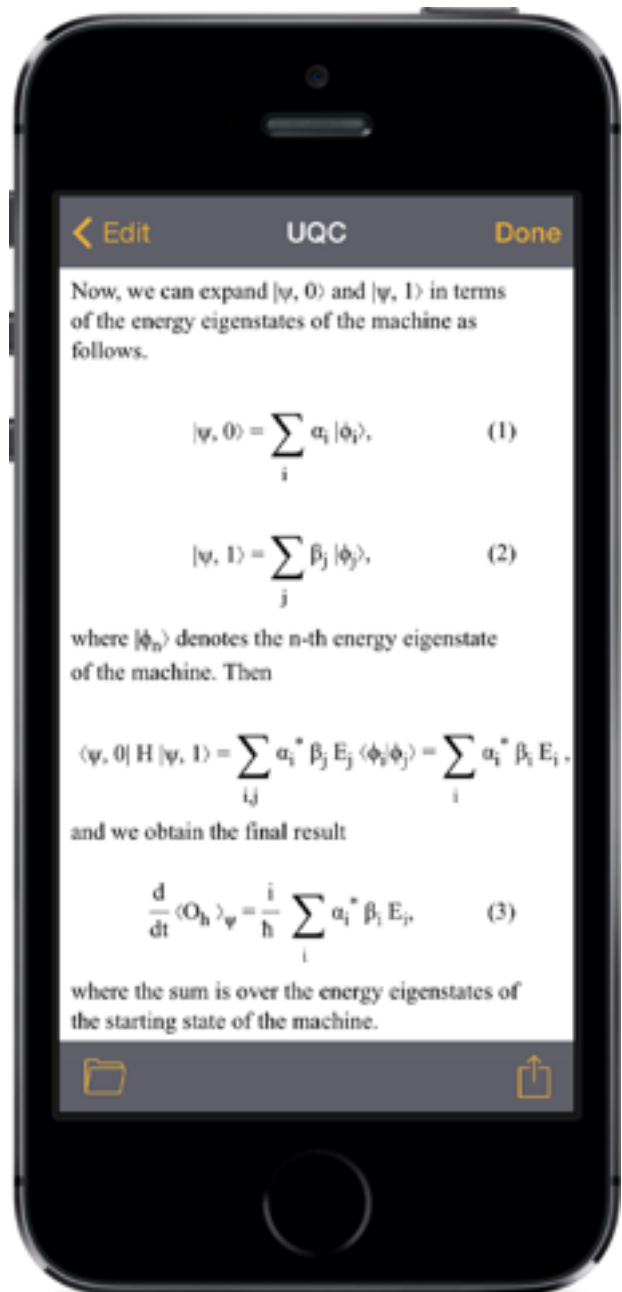
I41CXED Text Editor   **LaTeX Viewer Screen**

Tips and Tricks (Continued)

- I41CXED Macro Keyboard and Numerical Keyboard
  - Switch between the enabled keyboards with horizontal swipes in the text area.
  - To edit the contents of a macro, tap and hold the button down for 1 second or longer.
  - Instances of \n in macros are automatically converted into new lines. This makes it possible to create macros with text spanning multiple lines and to create a Return key.
  - Assign \b to a button to create a backspace/delete key.
  - Assign \c to a button to create a clear key.
  - Assign \cb to a button to create a key that clears batch CAS output.
  - Assign \r to a button to create a "silent" return key that doesn't invoke CAS execution in interactive CAS sessions.
  - Text surrounded by # characters is used as the label for the button. For example, if a macro button contains #LABEL#, the button will display LABEL in a larger font instead of the actual contents of the macro. Special labels (DF, E, I, INFINITY, INT, PI, PROD, SUM) are automatically displayed with the corresponding mathematical symbol.
  - The insertion point after tapping a macro button can be specified in the macro itself using \^. If a specific insertion point location is not specified, the insertion point is placed after the first "(", first space, first newline, or at the end of the macro, in that order.
  - Set the "Default Keyboard" option to "Macro" and enable the "Auto Hide Macros" and "Return Shows Macros" options to make the macro keyboard the primary keyboard.

I41CXED Macro Keyboard   **Editing a Macro**

Tips and Tricks (Continued)

- Quickly Perform CAS operations

  CAS can be run interactively by specifying a text file followed by two commas in the Alpha register (e.g. `CASFILE,,`). When CAS is executed in this way, it will automatically pop up a `I41CXED` full-screen text editor window. Pressing return at the end of a line causes immediate execution of that line and the output is inserted at the current insertion point (i.e. immediately following the input line).

  Alternatively, an interactive session can be initiated by assigning #CAS# to a button of the macro keyboard and using that button to start CAS after opening a file with `I41CXED`. Once an interactive CAS session is active, the #CAS# macro can be used to batch process the contents of the file with CAS.

  Interactive CAS sessions remain active until either the `I41CXED` window is closed with the "Done" button or explicitly quit using the various CAS termination commands (e.g. sync_and_quit, quit_with_error, etc.).

  Yet another alternative quick and efficient way to perform CAS operations is to use `I41CXED` to pop up a text editor window, use it to write/edit the CAS input, save the text file, execute the CAS function, and use `I41CXED` again to view the results. The following is a short program that can be used for this purpose. Note that this program uses separate CAS input and output files.

  ```
  01 LBL "DOCAS"
  02 SF 25              ; Set flag 25 in case CASOUT does not exist
  03 "CASOUT"           ; CAS output file
  04 PURFL              ; Delete CAS output file if it exists
  05 CF 25              ; Clear flag 25
  06 "CASIN,CASOUT"     ; Specify CAS input and output files
  07 I41CXED            ; Open text editor
  08 CAS                ; Execute CAS
  09 "CASOUT"           ; CAS output file
  10 I41CXED            ; View CAS output results with text editor
  11 END
  ```

- Change CAS output line width

  The default CAS output line width is set for optimal viewing with `I41CXED` based on the set font size. The default output line width can be overridden using the linelength operator. For example, "linelength 72$" sets the output line width to 72 characters.

- Restrict CAS output to only the results of interest

  CAS output can be suppressed by using "$" instead of ";" to terminate each operation. Thus, we recommend using "$" to terminate intermediate operations and only use ";" to produce the results of interest.

- Optimal way to view long CAS output

  Open the CAS output file with `I41CXED` or with `MAILTXT` and turn your device sideways to better view long CAS output in landscape mode.

- Copy sample programs or CAS examples from the Usage & Examples table

  The contents of the Usage & Examples table can be copied by tapping the cell to select it and then tapping the Copy button that appears. The contents can then be pasted into `I41CXED` or imported as a program or text file using the Load picker's "Import from clipboard..." item.

- Seamless compatibility with REDUCE source code

Specifying the "Use { }" option for the "{ } Handling" global setting achieves full and complete REDUCE and gnuplot source code compatibility.

- Specify a range of registers to copy or email with the `COPYR` and `MAILREG` functions

  Placing `b.e` in the Alpha register when executing the `COPYR` or `MAILREG` causes the value in the X register to be interpreted in the traditional bbb.eee format (e.g. 1.042 specifies registers 1 through 42). Note that when using "b.e", the register name labels are NOT included in the generated text to make it easier to transfer the values into a spreadsheet, for example.Tips and Tricks (Continued)

- Take advantage of iPad specific features
  - Portrait orientations works in the same way as on the iPhone but with the ability to swipe in the black area surrounding the calculator view to switch to the printer (horizontal swipe) and back views (vertical swipe).

    In landscape orientation, both printer and calculator are shown. To switch to the back view, use a vertical swipe gesture in the calculator display or tap the center of the calculator display as in the iPhone version. The printer and calculator locations can be switched by swiping horizontally in the calculator display or in the inactive printer area. The locations are remembered across rotation changes and subsequent app launches.

  - Tapping the top of the screen reveals the status bar and a menu toolbar for a few seconds, providing access to nearly all of the back view functionality (module ports, load and save data, flags, registers, etc.). Hence, the back view is only necessary for the "About", "Clear Memory", and "Speed Slider" features.
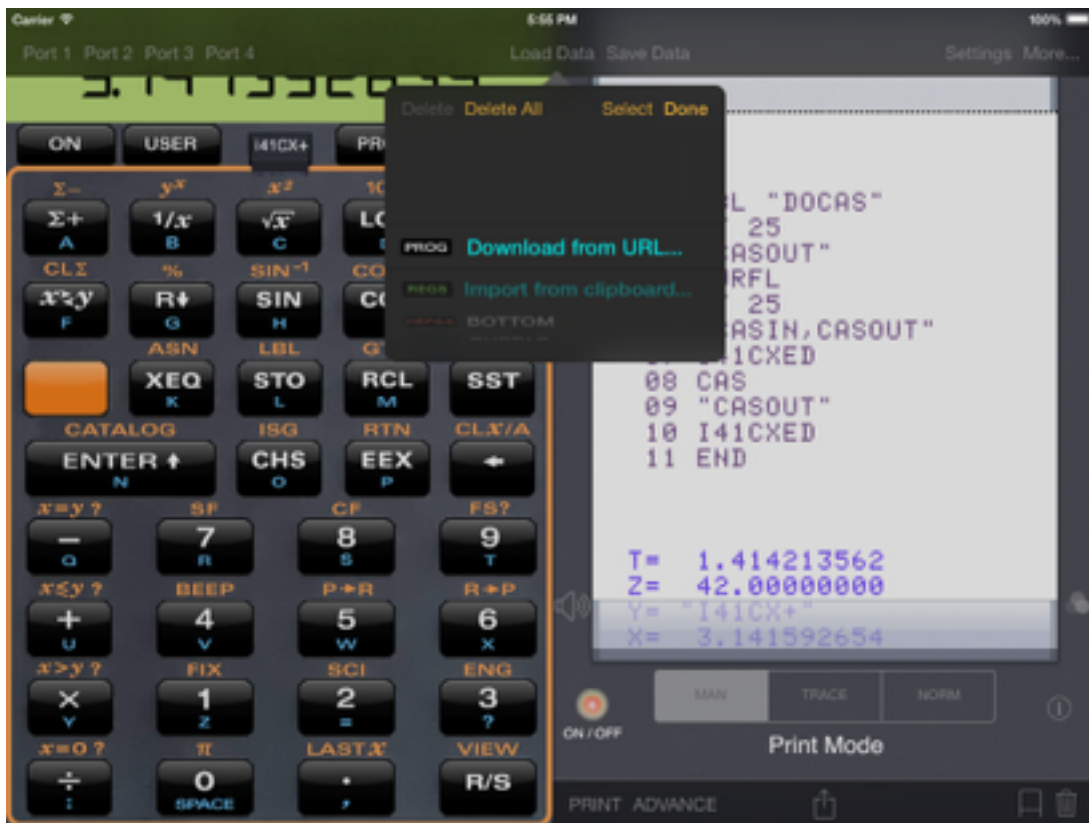
  - The iPad `I41CXED` macro keyboard supports 24-button user configurable buttons.

Tips and Tricks (Continued)

- Notification Center widget
  Your favorite calculator is just a down swipe away from anywhere so you can view and copy the most recent stack register values, perform simple RPN calculations, or use the full calculator without having to open the app! Best of all, the widget and the app share the same data and settings so the two are always in sync.

- Take advantage of 4" Retina screen devices
  i41CX+ supports the option to use the extra screen real-estate on 4" Retina screen devices as a new scrollable mini controls view above a legacy sized calculator view. The mini controls provide quick access to module ports, "Load" and "Save" buttons, and calculator speed settings. They are essentially a simplified version of the most frequently used controls on the back view of the calculator. The mini controls can be enabled using the "Mini Controls" toggle switch in the "Frequently Used Options" section of the back view.

Mini Controls
(Module Ports Shown)

Notification Center Widget
(Simple Calculator Widget Shown)

Tips and Tricks (Continued)

- Easily import/export files using iTunes File Sharing

  i41CX+ files can be accessed using the iTunes File Sharing feature. Moreover, i41CX+ works around the iTunes inability to handle subdirectories by moving any items placed at the top level of the iTunes file sharing pane into the appropriate locations after you sync your device. i41CX+ determines file types using the file extensions. The following is the list of extensions for each file type. File extensions are case insensitive.

Overlay: PNG	Program: RAW or TXT	Text File: TXT
Data File: DAT	Module: MOD	Registers: REG
Flags: FLG	HEPAX RAM: RAM	Configuration: CFG
State File: SAVE	Plot: SVG	Macro Keyboard: KBD

- Have Some Fun ;-)
  - The printer ink color can be changed while printing is in progress. Varying the printer ink color can make for some funky looking rainbow printouts!
  - If you were/are a fan of text based adventure/D&D games, try the DUNGEON-41CX game that can be downloaded from here.

References and Resources

The following are some links to information and resources.

- HP-41CX Related

  - Warren Furlow's comprehensive "The HP-41 Archive Website": http://www.hp41.org
  - Online HP-41 Manual: http://www.greendyk.nl/HP-41c-manual/index.html
  - PDF Versions of the HP-41CX Manuals
  - i41CX+ FAQ

  And, of course, a Google search for HP-41 will reveal many more.

- REDUCE (CAS) Related

  - Online REDUCE User's Manual (also available for download in PDF format here)
  - Documentation for packages and more is available at the REDUCE Documentation Page

Skins Collection

Aluminum

Dark Metal

Skins Collection (Continued)

Bauhaus

Bauhaus Mies

Skins Collection (Continued)

Classic

Classic Rectangular

Skins Collection (Continued)

Classic Naked

Genuine (best on iPhone 5)

Skins Collection (Continued)

High Tech

High Tech Black

High Tech Oblique

La Pomme

La Pomme Mies

Skins Collection (Continued)

LED Blue

LED Green

Skins Collection (Continued)

LED Grey

LED Magenta

Skins Collection (Continued)

LED Red

Skins Collection (Continued)

Gris

Gris Naked

Skins Collection (Continued)

Noir

Noir Naked

Skins Collection (Continued)

Skinny

Skinny Rectangular

Skinny Naked

Vintage

Acknowledgements

i41CX+ is literally built upon the shoulders of giants. The HP-41's success and popularity was in large part due to its active and avid user community. The PPC run by Richard Nelson in the 1980's and 90's published newsletters containing programs submitted by users. At one time, the club had over 10,000 members. Some of the work he collated into the PPC ROM whose programs are still relevant today and also serve as great reference material. The commitment and dedication of the user community made the HP-41 one of the greatest and most popular hand-held computers/calculators ever made. i41CX+ users become part of the global HP-41 user community that continues to thrive, use, and enjoy the wonders of this little machine to this day.

Much of this early work created back in the days of physical media would have been lost and become inaccessible by current and future generations were it not for the monumental efforts of people like Warren Furlow and contributors who compiled the vast library of HP-41 publications, modules, user library programs, references, etc. and made them all available for free to the community at the HP-41 Archive Website (hp41.org). Warren also kindly hosts a dedicated repository of modules and programs specifically for i41CX+ users at hp41.org. Many thanks to Warren.

In a similar vein, i41CX+ is what it is today as a result of the numerous suggestions and feedback that we receive from users and friends. We would like to thank those of you that have contributed your ideas and feedback and hope that you will continue to do so in the future.

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 * distribute the complete modified source code. Modifications are to
 * be distributed as patches to the released version. Permission to
 * distribute binaries produced by compiling modified sources is granted,
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```
 *    1. distribute the corresponding source modifications from the
 *      released version in the form of a patch file along with the binaries,
 *    2. add special version identification to distinguish your version
 *      in addition to the base release version number,
 *    3. provide your name and address as the primary contact for the
 *      support of your modified version, and
 *    4. retain our contact information in regard to use of the base
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```