# TRIANGULAR µOS 1.31/C128

## for

**C= COMMODORE 128**
PERSONAL COMPUTER

## Programmers Reference Guide

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# Contents:

# A. Introduction

Programmer's Reference Guide for TRIANGULAR μOS 1.31/C128 SDK (Software Development Kit) explains aspects of TRIANGULAR μOS, a GUI (graphic user interface) operating system for 8-bit Commodore computers.

Goal of creating this system was to develop GUI for 8-bit Commodore computers with lowest amount of memory: that is Commodore PET with at least 4 KB of memory. Next it was expanded for Commodore VIC-20 with standard 5 KB of memory or later with more amount of expansion RAM was required. And in later versions of μOS was adapted for Commodore 64. This iteration of TRIANGULAR μOS (1.31/C128) is designed to run on Commodore 128.

This software was written in Commodore BASIC language (port of Microsoft BASIC) using CBM prg Studio 4.01, and is designed to run on Commodore 128 in its standard C128 40-column mode. This version of TRIANGULAR μOS is designed to support BASIC 7.0 and works in color text mode. Commodore BASIC (a runtime interpreted language similar in basic concept to JAVA RTM or C# CLI) is default language used in 8-bit Commodore computers and also functions as their OS and user interface. In similar fashion to early Microsoft Windows (1.0 to 3.11), μOS sits atop of BASIC and KERNAL (Commodore's kernel) and Commodore DOS, which is implemented in every Commodore disk drives or 3rd party solutions in order to load μOS modules, load/save settings and documents, perform operations on floppy disks and communicate with disk drive(s).

**Package contains files:**

- *TRIANGULAR uOS 1.31-C128 for Commodore 128 Programmer's Reference Guide.pdf* – this document
- Source Code folder with 3 files: UOS.bas (source code of UOS program), GUI.bas (source code of GUI program) and uos-cfg.seq (default configuration file)
- *TRIANGULAR uOS 1.31-C128 for Commodore 128 Memory Map.xlsx* – spreadsheet which details usage of variable stored in memory by TRIANGULAR μOS 1.31/C128
- *TRIANGULAR uOS 1.31-C128 for Commodore 128 Variables* – spreadsheet which details BASIC variables used by TRIANGULAR μOS 1.31/C128
  *TRIANGULAR uOS 1.31-C128 for Commodore 128 System Disk Content* – a spreadsheet which presents file structure of System Disk of TRIANGULAR μOS
- *TRIANGULAR uOS 1.31-C128.d81* – empty, preformatted System Disk
- *TRIANGULAR uOS 1.31-C128 Documents.d81* – empty, preformatted Documents Disk

# B. What you need

In order to change and/or compile TRIANGULAR µOS 1.31/C128 you need to do this using external program like CBM prg Studio 4.0.1 (which was used in development and for compilation of .prg files). Using BASIC 7.0 on real hardware or emulator is out of question, since source code uses extensive line concatenation (up to 255 bytes long lines). Standard BASIC won't present program lines properly (especially print statements) and its screen/program editor won't be able alter those lines. Download CBM prg Studio here: https://www.ajordison.co.uk

For fast creation and modification disk content I recommend DirMaster. I formatted my disk with custom PETSCII characters in Disk name and Disk ID using DirMaster.
Download DirMaster here: https://style64.org/dirmaster

For testing and debugging use real Commodore 128 or emulator (I used freeware VICE emulator). Download VICE emulator here: https://vice-emu.sourceforge.io

Commodore 128 emulator VICE must be configured with enabled disk drive that can read 800KB 3.5¨ diskette (.d81 file): recommended CBM 1581*. Also, you should enable joystick. You can easily configure it as Numpad keys:

- Up (8), Down (2), Left (4), Right (6)
- You can move diagonally e.g., Up-Left (7)
- 0 or right Ctrl: Fire (click/select)

You can also enable printer in in VICE emulator. Do this in:
Settings -> Peripheral devices -> Printers or similar options. You can choose printer as device #4 - #7, although #4 is standard and recommended.

*Using 5.25" disk drive: 1571 (default), alternatively 1541 type drive (1541-II) is possible, but System Disk and Documents disk images first must be converted to .d71 or .d64 file in external program (e.g DirMaster). Additionally using 1571 disk drive amounts to over twice disks drive speed reduction, while 1541 type drive bring speed to default Commodore 64 levels (~10 times slower than 1581) thus only 1581 type drive type is officially supported.

# C. How to compile TRIANGULAR µOS 1.31/C128

Source code of UOS and GUI programs is stored in UOS.bas and GUI.bas files. Segments of programs are commented with simple descriptive caption-like comments: !- characters are used to mark comment in CBM prg Studio.

After compiling those files UOS.prg and GUI.prg add them to System Disk. File names on disk should always be UOS and GUI (in upper case/graphic mode) or uos and gui (in lower case mode). Remember to put UOS file first (to properly load system with LOAD "*",8 command).

Add uos-cfg.seq file and change its name to UOS>CFG (it should have SEQ property) and place it in the middle of UOS and GUI (that's my convention).

You can use empty, preformatted System Disk file to speed up process (*TRIANGULAR uOS 1.31-C128.d81* file).

# D. Troubleshooting

Loading of module of TRIANGULAR μOS can "freeze" in process of inter-loading next μOS module or disk program (a very rare occurrence). This happens when loading screen do not proceed to next module for over 1 minute for μOS. When loading screen is not responsive for longer time, it can mean error in inter-loading procedure, most probably keyboard buffer was not filled with key properly. To see what really happened change color of cursor to blue (press Control + 7) and enter command POKE 53281,1 and hit Return key. This should change background color to white which will show underlying black text of loading sequence message. If computer doesn't change cursor or background color try again. If still there is no effect it might be real freeze. If color change procedure succeeds, try using RUN command to see if program will start or go to top of screen (Home key) and press Return in order try to reload program. If it will loads successfully enter RUN command. If that not work check if load command is correct. It should have format: LOAD "[filename]", [device # (1 or 8 - 11)] like in e.g.: LOAD "GUI", 8. If none of it works then start system anew. To prevent this kind of freeze, try not to use keyboard when inter-loading procedure is performed (it can slip improper key into keyboard buffer, which most often leads to this error).

# E. BASICALLY

Below are listed function of BASICALLY API of TRANGULAR μOS 1.31/C128.

1. Window generator: draws empty window based on data in variable arguments. Before evoking this function assign desired values to those variables:
   w1 - window top-left vertical position
   w2 - window top-left horizontal position
   w3 - window bottom-right vertical position
   w4- window bottom-right horizontal position
   wn$ - window name which will be displayed on title bar and on task bar

   Next evoke this function with gosub49

   This function also generates w1$ string variable (vertical start of window) and w2$ (horizontal start of window) that can be used in further alignment of windows elements
   Caution: variable j is used in for-to:next loops.

2. left$(s$,x) – will display x number of spaces (max x = 39)

3. left$(v$,x) – will display x number of cursor down {down} (max x = 23)

4. left$(h$,x) – will display x number of cursor right {right} (max x = 39)

# F. Support

For more information, to report bug or to get help go to links listed below.

TRANGULAR µOS for Commodore 128 on Commodore 128 forum:https://c-128.freeforums.net/thread/1102/triangular-c128-commodore-128-basic

TRIANGULAR YouTube channel:
https://www.youtube.com/channel/UCdnynTqbM8S6mc0EUXY58Gg/

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# G. Changelog

**Changelog for TRIANGULAR μOS 1.31/C128 for Commodore 128 [??-01-2023]:**

- Mouse pointer routines redesigned which resulted in twice faster movements
- Some additional graphic operations converted to BASIC 7.0 syntax
- Minor improvements and bugfixes


**Changelog for TRIANGULAR μOS 1.30/C128 for Commodore 128 [12-01-2023]:**

- Commodore 128 in its standard 40 column VIC-II C128 mode is supported
- Only 3.5" 1581 type disk drive is supported
- Loading and saving is up to 10x faster due to faster C128 1581 disk drive handling
- Color theme changed from C64 blue to more resembling C128
- BASIC 7.0 handles sprites and few needed instructions added
- GAMES folder contains only SIMCITY, other 3 games removed
- Minor improvements and bugfixes
- Changelog is revised and integrated back into User's Manual

**Changelog for TRIANGULAR µOS 1.25/C64 for Commodore 64 [20-10-2022]:**

- Code of TRIANGULAR µOS is reviewed, improved, cleaned and bug fixed
- Slightly updated loader module screen (LOADING/RESTARTING/SHUT DOWN)
- Multi-characters handled by special function amounted for saving 1 KB of code
- BIOS: Some minor visual changes (mostly colors)
- BIOS: Detection of C64 or C128 in C64 mode
- GUI: Mouse pointer uses sprite instead of PETSCII character
- GUI: Time separator : (in right bottom corner) is blinking as seconds progress
- GUI: Windows repositioned and stretched with minor visual changes
- GUI: Windows can activate elements outside their loops in more advanced manner
- GUI: First element of µOS API named BASICCALLY added: Window creator that draws window based on given arguments
- GUI: Windows refreshes faster and without blinking
- SETTINGS: System settings and color settings merged into one SETTINGS window, divided by 2 tabs into SYSTEM and GRAPHICS (color options)
- SETTINGS: GRAPHICS tab now supports 16 colors and 2x more background patterns
- DISK: Program window slightly enlarged and improved few minor mechanisms
- CMD: Small visual changes and improved few minor mechanisms
- WORDS: Commands panel slightly redesigned with new options added
- WORDS: Repositioned and expanded text area
- WORDS: > symbol (indicating line to write) is removed and text area is 1 character wider
- WORDS: Faster typing-in mechanism
- WORDS: Clear Screen [Shift + Home] erases currently written line
- WORDS: F6 Copy line and F7 Paste line added
- WORDS: Clipboard shared with MATH calculator (F7 will retrieve memorized number in MATH)
- MATH: Window repositioned and minimal color theme update
- MATH: Clipboard shared with WORDS word processor (memory contains number copied inside WORDS)
- MONITOR: Show memory area is reworked and enlarged
- SYNTH: Piano keyboard expanded and new voices added
- SIMCITY: Mechanism that selects land plot to activate is more random and equally covers available zoning area
- GAMES: CHUCK'S CHALLENGE & LIFE RAFT RESCUE - issues with sprites are corrected
- Changelog added as separate document

## Changelog for TRIANGULAR μOS 1.20/C64 for Commodore 64 [31-08-2022]:

- Support for Commodore 64 with its 40 column VIC-II text mode and SID chip is added
- BIOS added indicator reminding to type time (<- TYPE NEW TIME) after pressing T
- WORDS – by pressing Home key you can reach first line of document
- SYNTH – reworked with simplified keyboard and limited to 1 voice channel which now can play sounds in normal, lower and higher octave ranges
- Only SIMCITY is carried over from TRIANGULAR μOS 1.15/VIC for Commodore VIC-20
- In place of old games 3 new games from Roman Werner added (TAXI TAXI, CHUCK'S CHALLENGE and LIFE RAFT RESCUE)
- All games merged into GUI program file
- Bugfixes and improvements

## Changelog for TRIANGULAR μOS 1.15/VIC for Commodore VIC-20 [19-08-2022]:

- TRIANGULAR μOS 1.15/VIC won't start on VIC-20 with less than 29 KB of RAM (24 KB RAM Expansion is needed or higher)
- GUI merged with MONITOR, WORDS and SYNTH
- MONITOR and WORDS errors messages accompanied by beep sound
- Besides LOADING screen there is added RESTARING (with yellow TRIANGULAR logo) and SHUT DOWN (with red logo)
- Bugfixes and improvements

## Changelog for TRIANGULAR μOS 1.14/VIC for Commodore VIC-20 [14-08-2022]:

- TRIANGULAR μOS won't start on VIC-20 with less than 21 KB of RAM (16 KB RAM Expansion is needed or higher)
- GUI merged with MATH and CMD
- MATH keys assigned for basic functions (+, -, *, /, %) and ON
- CMD beep sound added while displaying error messages

## Changelog for TRIANGULAR μOS 1.13/VIC for Commodore VIC-20 [12-08-2022]:

- TRIANGULAR μOS won't start on VIC-20 with less than 13 KB of RAM (8 KB RAM Expansion is needed or higher)
- GUI merged with COLORS & DISK
- GUI streamlined
- DISK received minor improvement of disk content handling mechanism

### Changelog for TRIANGULAR μOS 1.12/VIC for Commodore VIC-20 [09-08-2022]:

- GUI merged with APPS, GAMES and SETTINGS
- COLORS retrieve default settings with DEAULT button
- DISK & CMD directory of disk content is retrieving by once
- CMD other updates, D> (duplicate) command added and other command syntax changes
- MATH improved, various functions added and few additional keys mapped
- MONITOR command syntax overhauled into 1-line commands
- Bugfixes and other minor improvements


### Changelog for TRIANGULAR μOS 1.11/VIC for Commodore VIC-20 [31-07-2022]:

- TRIANGULAR μOS won't start on unexpanded VIC-20 5KB. VIC-20 with 8KB of RAM (3KB RAM Expansion) is needed (or higher)
- UOS and BIOS merged into single UOS program and improved error messages system
- CMD merged with its help file CMD>HLP and further improved
- CMD syntax of R> and C> operations changed to more intuitive [original file]=[new file]
- STAR WARS merged with its game engine file STAR WARS>ENG


### Changelog for TRIANGULAR μOS 1.10/VIC for Commodore VIC-20 [28-07-2022]:

- Support for Commodore VIC-20 with at least 5KB and it's 22 columns, 8 color text mode added
- New colorful loader for inter-loading operations
- BIOS Setup menu offers option to enable/disable Datasette
- BIOS Setup supports separate Work disk drive for storing system apps documents
- BIOS improvements and bugfixes
- GUI cursor is joystick operated and can move diagonally
- GUI windowed environment uses custom color background and title bar
- Up arrow button added to task bar (placed right of clock) to go back to main desktop screen
- SETTINGS is split into two apps: SETTINGS which can change time, work disk and printer options and COLORS which can change colors of GUI elements.
- DISK is now windows & cursor operated. Changed disk content display mechanism.
- CMD introduced improved mechanism for displaying success or error of performed operation. Minor review of command syntax (I> and V> instead of I and V). Bugfixes.
- APPS folder instead of OFFICE, contains WORDS, MATH, MONITOR, SYNTH
- MATH calculator revamped, simplified, windowed and cursor operated
- MONITOR have blue background. Command SHOW displays 2 hex digits instead of 4. HELP is consolidated. Minor bugfixes.
- 4 new games: SIMCITY, STAR WARS X-Wing vs TIE-Fighter (new version), BREAKOUT (new version), NEED4VIC
- Various other bugfixes and improvements
- Empty and formatted disk image called TRIANGULAR uOS 1.10-VIC Documents in .d64 and archived .zip file formats added for use as Work disk

### Changelog for TRIANGULAR µOS 1.05/PET for Commodore PET [29-06-2022]:

- Config file contains system key
- UOS/BIOS error messages system improved
- DISK text program is placed in THIS PC and it shows disk content and run programs
- SETTINGS can properly cancel changes and other bugfixes
- Improvements, bugfixes and cleaned code from redundant parts of all programs produced very stable version

### Changelog for TRIANGULAR µOS 1.04/PET for Commodore PET [21-06-2022]:

- OS name changed to TRIANGULAR µOS
- Launching program and config file names changed
- 8 KB version removed (since it is actually slower than 4 KB version)
- GUI: windows have black close buttons
- Taskbar window name moved to left side of TRIANGULAR logo orb
- Click/select key changed to 0 (zero)
- DESKTOP renamed to GUI
- THIS PC window renamed to THIS PET and contains DISK which loads program form disk
- SETTINGS now have SAVE button for saving settings
- Some icons updated
- CMD is greatly overhauled with commands syntax similar to DOS Wedge/JiffyDOS and added listing directory of disk content function
- MONITOR improved
- WORDS instead of WORD – this is completely new word processor
- SIMCITY game added in place of LUNAR LAND
- Other games have slightly different menu keys
- Games from 8 KB version removed
- Improvements and bugfixes

### Changelog for TRIANGULAR OS 1.03 for Commodore PET [27-02-2022]:

- System now have 4KB and 8KB modes – launcher will choose which one to boot into
- 8KB mode has consolidated code of GUI, STAR WARS into 1 program, as well as BIOS and TRIANGULAR OS launcher, CMD and its HELP, Monitor and its HELP
- Fixed bug in disk detection system
- Few minor bugfixes
- 2 new games (RATRUN & MAD BOMBER) only in 8KB mode (instead of SNAKES and LUNAR LAND)

### Changelog for TRIANGULAR OS 1.02 for Commodore PET [6-02-2022]:

- Minor visual changes across the board (mostly highlighted key letters)
- Launch program renamed to TRIANGULAR OS
- TRIANGULARS OS/BIOS – has improved disk drive detection system. Drive database expanded (include SD2PET (experimental)). Loads OS>CFG file with wallpaper settings.
- BIOS Setup Menu – option is added to exit to BASIC
- GUI OS – SETTINGS saves wallpaper settings in file OS>CFG
- CMD – fixed drive # change mechanism. Minor bugfixes.
- OFFICE apps visual revision and many bugfixes
- GAMES minor visual changes and bugfixes

### Changelog for TRIANGULAR OS 1.01 for Commodore PET [16-01-2022]:

- First version to have manual
- Various minor improvements done in launching TRIANGULAR program
- BIOS – fixed launching logo position
- GUI – memorize cursor position in-between loading modules plus minor bugfixes
- CMD – many bugfixes
- MONITOR – fixed serious bug preventing user from running machine language programs
- OFFICE – apps can now properly load and save data on disk
- STAR WARS – added music in intro and outro. Game engine now don't reset system clock
- SNAKES – AI opponent fixed and minor esthetic changes
- LUNAR LAND – received minor esthetic changes

### Changelog for TRIANGULAR OS 1.00 for Commodore PET [24-12-2021]:

- Starting procedure changed: TRIANGULAR disk detecting program -> BIOS (Launching screen combined with Setup Menu) -> DESKTOP (GUI)
- BIOS detects if there are disk drives #8 - #11, detecting mechanism is improved and functioning drive type detection added
- BIOS Setup Menu displays drives and can change BOOT drive and restart system
- DESKTOP is streamlined and icons redesigned
- START Menu is placed on center of task bar and is displayed just as TRIANGULAR logo and have SETTINGS, RESTART and SHUT DOWN options
- SETTINGS (renamed CONTROL PANEL) can change desktop wallpaper from 5 patterns
- MY COMPUTER is renamed THIS PC and disk icon now open CMD program
- CMD (renamed DOS) can change operating disk (#8 - #11) plus some improvements
- OFFICE – apps have minor improvements
- MONITOR – heavily reworked and improved, operates on HEX values.
- GAMES icon in place of STAR WARS icon opens folder with 4 games: STAR WARS, SNAKES, LUNAR LAND and BREAKOUT

**Changelog for TRIANGULAR OS 1.00 BETA for Commodore PET [2016 to 24-10-2021]:**

- System supports 1 cassette recorder as device #1 and only 1 disk drive as device #8
- BIOS have implemented simple PET type detection and it detects if there is disk drive #8
- BIOS Setup Menu is accessed with DEL key where you can change or reset system time
- Starting procedure: BIOS -> TRIANGULAR DOS -> Launch screen -> DESKTOP (GUI)
- DESKTOP (GUI) contains wallpaper, task bar on which is clock (right bottom), START Menu with TRIANGULAR logo (left bottom) and 4 icons: MY COMPUTER, OFFICE, STAR WARS and MONITOR
- START Menu has CONTROL PANEL, RESTART, EXIT TO DOS and QUIT TO BASIC options
- CONTROL PANEL can change and reset system clock
- MY COMPUTER contains cassette and disk icon which can load first encountered program (LOAD for cassette icon and LOAD "*",8 for disk icon)
- OFFICE contains 4 office suite programs: WORD a word processor, CALC spreadsheet, CONTACTS contact manager and MATH calculator
- STAR WARS brings fabulous STAR WARS X-Wing vs TIE-Fighter game
- MONITOR a very simple memory monitor program, operates on decimal numbers