

# Using the HP48G+ to Calculate Stereo Base, Hyperfocal Distance, Focus Distance, F-stop, Diffraction-Limited F-stop and Shutter Speed

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## Instructions For Use in the Field

(See instruction/example for programming the HP48G+ at the bottom of this document.)

Note: Calculate Hyperfocal Distance before Focus or F-stop. The latter two make use of H. Calculate DiffStop last – it makes use of CoC set when F-stop is calculated.

### Initialize:

CANCEL Same as the “ON” key  
Clear Use “DEL” key

### Calculate Base (mm) when Far:Near ratio > or = 2:1

SOLVE Use cyan function key (rt. arrow), then the “7” key. Select “Solve equation”  
OK Use “F” key  
CHOOS Use “B” key  
B: ‘Base =... Use up or down arrows to find Base equation  
OK Use “F” key to select

Overtyping your choice of values other than Base, using OK to set value. Near and Far should be entered in feet, VFL and FL (Viewer Focal Length and Camera FL) in mm, %MAOFD as an integer less than or equal to 100.

**Highlight Base before solving.**

SOLVE Use “F” key  
CANCEL Same as the “ON” key

Base is displayed in the stack.

### Calculate Base (mm) when Far:Near ratio < 2:1

SOLVE Use cyan function key (rt. arrow), then the “7” key. Select “Solve equation”  
OK Use “F” key  
CHOOS Use “B” key  
B: ‘Base =... Use up or down arrows to find Base equation  
OK Use “F” key to select

Overtyping your choice of values other than Base, using OK to set value. Near and Far should be entered in feet, **but FAR should be set to a value that’s exactly twice the Near**, VFL and FL (Viewer Focal Length and Camera FL) in mm, %MAOFD as an integer less than or equal to 100.

**Highlight Base before solving.**

**SOLVE**      Use “F” key  
**CANCEL**     Same as the “ON” key

Base is displayed in the stack.

## **Calculate Hyperfocal Distance (ft):**

(This is equal to Focus Distance only when Far is Infinity)

**SOLVE**      Use cyan function key (rt. arrow), then the “7” key. Select “Solve equation”  
**OK**            Use “F” key  
**CHOOS**      Use “B” key  
**H: ‘Hyper =...** Use up or down arrows to find Hyper equation  
**OK**            Use “F” key to select

*Do not overwrite the variables Near, Far and FL! Leave them as set when Base was calculated.*  
**Highlight Hyper before solving.**

**SOLVE**      Use “F” key  
**CANCEL**     Same as the “ON” key

Hyper is displayed in the stack.

## **Calculate Focus Distance (ft):**

(This is equal to Hyperfocal Distance only when Far is Infinity)

**SOLVE**      Use cyan function key (rt. arrow), then the “7” key. Select “Solve equation”  
**OK**            Use “F” key  
**CHOOS**      Use “B” key  
**F: ‘Focus =**    Use up or down arrows to find Focus equation  
**OK**            Use “F” key to select

*Do not overwrite the variables Hyper, FL and Near! Leave them as set when Base was calculated.*  
**Highlight Focus before solving.**

**SOLVE**      Use “F” key  
**CANCEL**     Same as the “ON” key

Focus Distance is displayed in the stack.

## **Calculate F-stop:**

**SOLVE**      Use cyan function key (rt. arrow), then the “7” key. Select “Solve equation”  
**OK**            Use “F” key  
**CHOOS**      Use “B” key  
**S: ‘Stop =**    Use up or down arrows to find Stop equation  
**OK**            Use “F” key to select

**Overtyping CoC variable if necessary**, using a value you’ve calculated in advance. I recommend you build a personalized table of Max. CoC’s you intend to use for any combination of post-crop format diagonal, enlargement factor and desired print resolution you anticipate. Tape it to the back of your calculator.

To calculate the Circle of Confusion diameter that's right for various situations, you can use the spreadsheet available at:

<http://www.primenet.com/~zilch0/tools/CoCCal23.xls>

But, here are tables I did for nominally cropped 35mm and 6x7cm formats (cropped as close as possible to full frame to suit the aspect ratio of the Print Size shown.) Except where indicated, these prints will tolerate scrutiny at a viewing distance of 10-inches. Scale the values downward proportionate to any further cropping of the full frame diagonal. Diffraction's Airy disks will equal the Max CoC diameter at the indicated apertures. Don't stop down any further than this!

(Note: 0.0222mm is the reciprocal of the assumed minimum system resolution of 45 lp/mm on-film and thus, this is the smallest CoC diameter that can be resolved by the lens/film system. CoC values larger than 0.0222 mm were not system resolution limited – they are instead set to the pre-enlargement reciprocal of the assumed resolving power of the human eye at a viewing distance of 10 inches: 5 lp/mm on-print.)

### 35mm Format CoC's:

On-Film Max CoC	Print Size	On-Print Resolution	Diffraction @
0.0378 mm	5x7	5 lp/mm	f/27.9
0.0236 mm	8x10	5 lp/mm	f/17.5
0.0222 mm	8.5x10.63*	5 lp/mm	f/16.4
0.0222 mm	11x14	3.87 lp/mm**	f/16.4
0.0222 mm	16x20	2.66 lp/mm***	f/16.4

\* Maximum 4:5 aspect ratio Print Size at which system resolution can deliver 5 lp/mm on-print

\*\* Viewing distance must be at least 13 inches

\*\*\* Viewing distance must be at least 19 inches

### 6x7cm Format CoC's:

On-Film Max CoC	Print Size	On-Print Resolution	Diffraction @
0.0788 mm	5x7	5 lp/mm	f/58.2
0.0551 mm	8x10	5 lp/mm	f/40.7
0.0394 mm	11x14	5 lp/mm	f/29.1
0.0276 mm	16x20	5 lp/mm	f/20.4
0.0222 mm	19.84x24.80*	5 lp/mm	f/16.4
0.0222 mm	20x24	4.96 lp/mm	f/16.4
0.0222 mm	24x30	4.13 lp/mm**	f/16.4

\* Maximum 4:5 aspect ratio Print Size at which system resolution can deliver 5 lp/mm on-print

\*\* Viewing distance must be at least 12 inches

*DO NOT overtype the variables Hyper and FL! Leave them as set when Base was calculated.*

**Highlight Stop before solving.**

**SOLVE**      Use "F" key  
**CANCEL**     Same as the "ON" key

F-Stop is displayed in the stack.

## Calculate Diffraction-Limited F-stop:

**SOLVE**      Use cyan function key (rt. arrow), then the "7" key. Select "Solve equation"  
**OK**            Use "F" key  
**CHOOS**      Use "B" key  
**D: 'DiffStop =** Use up or down arrows to find DiffStop equation

**OK** Use “F” key to select

*DO NOT Overtyp*e the CoC variable! You want it to remain as it was for calculating Stop!  
**Highlight DiffStop before solving.**

**SOLVE** Use “F” key  
**CANCEL** Same as the “ON” key

DiffStop is displayed in the stack.

## Calculate Minimum Shutter Speed (denominator in 1/n sec.):

**SOLVE** Use cyan function key (rt. arrow), then the “7” key. Select “Solve equation”  
**OK** Use “F” key  
**CHOOS** Use “B” key  
**SS: ‘ShutS =** Use up or down arrows to find ShutS equation  
**OK** Use “F” key to select

Overtyp

e your choice of values other than ShutS, using OK to set values.  
See description of variables below.  
**Highlight ShutS before solving.**

**SOLVE** Use “F” key  
**CANCEL** Same as the “ON” key

ShutS is displayed in the stack.

## Instructions For Programming the HP48G+

### Formulas:

B: ‘Base=(FL/30\*(VFL/FL)\*(%MAOFD/100)\*(304.8\*Near\*Far/(Far-Near))\*  
(1/FL-1/(2\*(304.8\*Near\*Far/(Near+Far))))’

H: ‘Hyper=(FL/304.8\*Near)+FL/(304.8\*Far)-2/(1/(304.8\*Far)-1/(304.8\*Near))/304.8’

F: ‘Focus=(Hyper\*304.8-FL)/(Hyper/Near-1)/304.8’

S: ‘Stop=FL^2/(Hyper\*304.8\*CoC)’

D: ‘DiffStop=CoC/0.00135383’

SS: ‘ShutS=1/(DistSS\*DirSS/(875\*(FPS\*3600/5280)\*NFL/FL))’

### Variables:

Base: Stereo Base Separation (mm) when Far:Near ratio is greater than or equal to 2:1.

Hyper:	Hyperfocal Distance (feet)
Focus:	Distance at which to Focus (feet)
Stop:	F-stop that provides nominal Depth of Field
DiffStop:	Diffraction-Limiting F-Stop
ShutS:	Minimum Shutter Speed (denominator in 1/n sec)
FL:	Lens Focal Length (mm)
VFL:	Viewer Focal Length (mm)
%MAOFD:	% of Maximum Acceptable On-Film Deviation (MAOFD = FL/30), i.e. 70 for 70%
Near:	Distance to Nearest Subject (feet)
Far:	Distance to Farthest Subject (feet)
CoC:	Maximum Permissible CoC Diameter on-film (mm)
DistSS:	Shutter Speed Distance – to moving object (feet)
DirSS:	Shutter Speed Direction of Movement: 1 = left/right or up/down 2 = diagonal 4 = towards or away
FPS:	Feet Per Second Velocity of Subject
NFL:	Normal Focal Length for this format/cropping diagonal (mm)

## To Create a new Equation and Store it in Memory:

**MEMORY** Use cyan function key (rt. arrow), then the “VAR” key.  
**NEW** Use “D” key  
 ‘ The tick-mark key that’s above the “SIN” key

Define the Object ‘DiffStop=CoC/0.00135383’ as follows:

**D**  $\alpha$  D  
**i**  $\alpha$  I  
**f**  $\alpha$  F  
**f**  $\alpha$  F  
**S**  $\alpha$  S  
**t**  $\alpha$  T  
**o**  $\alpha$  O  
**p**  $\alpha$  P  
**=** 0  
**C**  $\alpha$  C  
**o**  $\alpha$  O  
**C**  $\alpha$  C  
 /  
**0.00135383’**

**OK** Use “F” key to select  
 Enter the Variable ‘D’ as follows:  
**D**  $\alpha$  D  
**OK** Use “F” key to select  
 Store the Variable (the equation) as follows:  
**OK** Use “F” key to select

The latest version of this doc can be found at: <http://www.primenet.com/~zilch0/tools.htm>  
 Or try David Kesner’s site at: <http://www.dddphotography.com/mikedavis>