



GD2-Plus

Installation and Operation Handbook

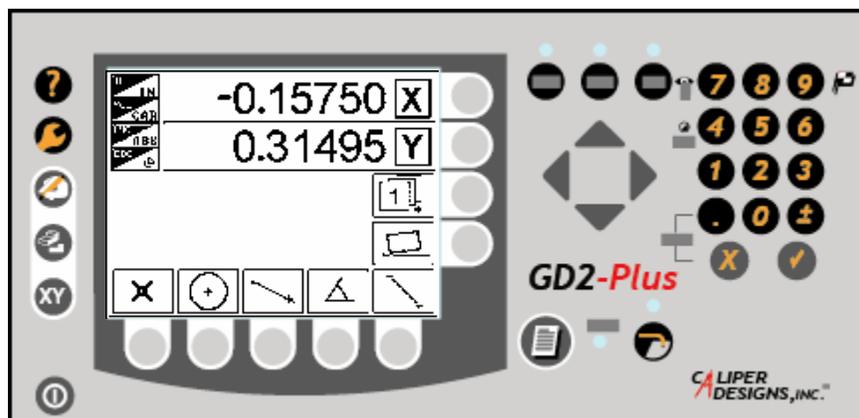


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Introduction

Snapshot

First of all, we here at Caliper Designs wish to say **THANK YOU** for purchasing our revolutionary GD2-PLUS, Geometric Digital Readout designed especially to ease inspection on comparators and microscopes. There is even a 3 axis display mode so that you can make independent measurements in the Z axis with systems that have Z axis encoders.

The main advantage of GD2-PLUS over the competition is its' part view capability. Using **PART VIEW**, you can really get the relationship of all the features to one another. Also, features can be constructed from previously measured features directly from the **PART VIEW** screen. The part view capability cannot be overstressed. This is a great simplifier of the inspection task. Novice users can quickly perform complicated inspections.

Our edge detector is of the finest and is an improvement over competitive units. Our Edge detector requires only the fiber optic cable from the screen surface. This greatly reduces installation headaches and increases overall edge detector reliability by an order of magnitude.

GD2-PLUS also has extensive **PART PROGRAMMING** with SPC exporting capability.

Feature sets can be saved, printed or both.

Manual Conventions

Items written in **BOLD** text with all capital letters refer to named keys on the front panel or named soft keys. Items written in **Bold** text with only the first letter capitalized refer to named soft keys within a menu. Lower case bold words refer to fields within a menu.

For example:

DRO is a named key on the front panel. When we refer to this category of key it will appear in **BOLD, ALL CAPS**.

Circle is a soft key on the **DRO** screen. It will appear in **Bold Capitalized Letters**.

Actual is a field in the scale setup screen. It will appear lower case **bold**.

Keys that have a second function will be noted with the main key function in **Bold** and the second function in bold capitalized in parentheses. For example **2 (Alternate Info)**

Also, when we talk about movement, we are referring to movement on the comparator screen or in the microscope eyepiece. The image moving to the left, which is the same as the crosshair moving to the right, is considered to be moving in the positive X direction. Subsequently, moving the image down, or in the case of some microscopes, toward you, is considered to be the positive Y direction.

Front Panel description

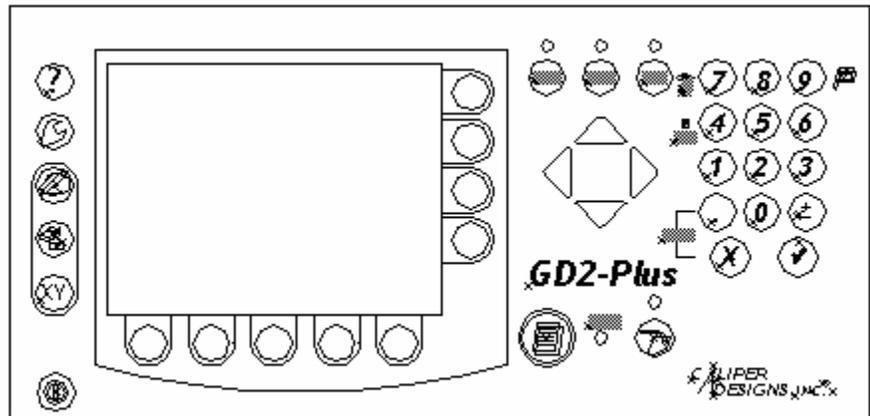


Figure 1 Front Panel

On the left hand side of the GD2-PLUS screen you can see five menu keys. These keys are used to navigate globally through the GD2-PLUS menu items. In other words these five keys determine what mode the display is in.

These global menu keys are always active and switching menus can be done at any time. For example: to check the **PART VIEW** while inspecting you simply press the **PART VIEW**. If you want to change back to the **DRO** mode, you simply press the **DRO** menu key and the GD2-PLUS will switch back to the **DRO** mode.

Underneath and on the right hand side of the screen you will notice nine so-called “soft keys,” (five on the bottom and four on the right side). These soft keys have many functions depending on which menu or sub-menu is active. The next section of this manual gives descriptions for the various indicators and toggles available for optimizing GD2-PLUS.

The Power of Part View

As mentioned earlier, one of the most useful and obvious features of GD2-PLUS is the **PART VIEW** screen. The usability of GD2-PLUS is greatly enhanced, whether you want to check your progress through an inspection sequence, or simply need an aid to make sure you are in the correct area. Whatever the reason, the **PART VIEW** capabilities of GD2-PLUS will make your inspection routines easier to understand, leading to a more productive inspection process.

Installation

Introduction

GD2-PLUS is designed to be as simple to use as possible. In line with that, it is also easy to install. Anyone with a basic understanding of system interconnects should have absolutely no problem with the installation process. The rear panel is clearly marked. Correct mating connectors for your systems scales have been provided. The only adjustment that may be necessary is for contrast. This is set at the factory but may not be optimized for your environment. Note that the contrast adjustment is a 22-turn control, located on the rear of the unit in the lower right corner, looking at the rear of the unit.

If you do have any difficulties, Caliper Designs, Inc. will be happy to provide all the support that you may need.

Physical Requirements and Guidelines

GD2-PLUS is constructed of steel inside a tough ABS plastic enclosure and weighs approximately eight pounds. The physical size of GD2-PLUS is similar to other readouts currently being used by comparator manufacturers. The bracketry to support GD2-PLUS will, in many cases, already be installed on the comparator and GD2-PLUS will be a comfortable fit. Due to the LED back lighting, GD2-PLUS can accommodate all ambient light situations via the previously mentioned **CONTRAST** adjustment on the rear panel.

Rear Panel Interconnects

The rear panel contains the scale inputs for X, Y and Q (or Z), and the AC power entry module. Various printer/com port connections are also available on the rear panel. Finally, if the unit is equipped with an optical edge detector, there is a fiber-optic connector located here.

It should be noted that the IEC power connection (power cord) also serves as the “service disconnect” for GD2-PLUS.

Setting up GD2-PLUS

Caliper Designs makes every effort to ship GD2-PLUS ready to go. Installation usually does not involve any setting up or configuring. This is a one-time process except for the possibility of changes in the linear error correction at calibration time.

Initializing GD2-PLUS

After the normal power up sequence for GD2-PLUS, you will see a normal screen like the one below.

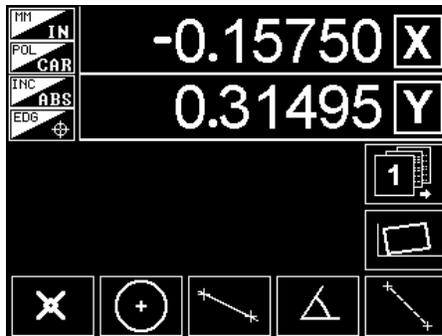


Figure 2 Normal Startup Screen

Getting to the main configuration Screen

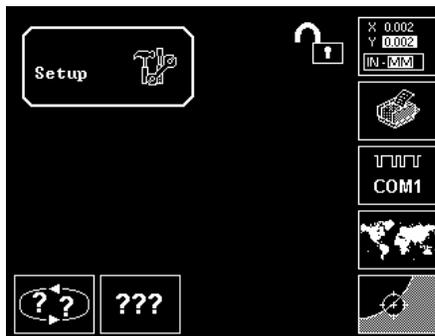


Figure 3 SETUP Screen

Pressing the **SETUP** button on the left-hand side of GD2-PLUS will get you to all the system tools. To get to the configuration screen you will need to press the soft key next to the X,Y button on the upper right. This will only work if the lock symbol is unlocked. If you see a locked condition, you will be asked for a password. You will have to get the password from your supervisor.

Warning: Changing the configuration of GD2-PLUS can seriously affect the operation and accuracy of GD2-PLUS. Use extreme caution when making changes in this area. Make sure that you understand the effect of the changes that you are making. Your dealer can help you with this. If for some reason he or she is not available, you can call Caliper Designs for clarification. (603-881-8388)

The configuration screen or scale setup is located within the **SETUP** menu selection button under the soft key for **Scale Setup**. **This is a locked screen and you will require a password to gain access.** Once in the setup screen you will use the cursor keys to move the highlight to the desired location and use the **ENTER** key to toggle through the pre-approved selections. Some fields will require you to use the numeric keypad to enter information.

Please note that the password can be disabled once you access Scale Setup. To do this, use the cursor keys to

SCALE CONFIGURATION			
	X AXIS	Y AXIS	Z AXIS
SCALE TYPE	MM	MM	<input type="checkbox"/>
SCALE RES.	0.002	0.002	0.002
OBSERVED	1.0000000	1.0000000	1.0000000
ACTUAL	1.0000000	1.0000000	1.0000000
DIRECTION	+	+	+
DISP. RES			
ENGLISH	0.00005		
METRIC	0.001		
ANGULAR	DEG.		
	0.01		
			PASSWORD: <input type="checkbox"/>

Figure 4 Scale and Display Setup

highlight **password enabled**, then use the **ENTER** key to toggle to **password disabled**.

Warning!!! GD2-PLUS has limited memory. For this reason the correctness of the data entered into various fields is not checked. Configuring GD2-PLUS requires data entry on several setup screens. Some of the fields present choices and therefore will not present a problem. Others, however, can have nonsense data entered into them and will result in the malfunctioning of GD2-PLUS. Acceptable boundaries and formats will be included in the setup and configuration instructions.

Scale Type

(Toggle via the ENTER button)

This is to specify whether or not your scales have METRIC or ENGLISH resolution. Use the **ARROW** keys to move from axis to axis and from field to field. Notice that the Z-axis has 4 choices:

1. Inch (English)
2. MM (Metric)
3. ANG (angular) the resolution will follow the angular display resolution (DMS or DD). It should be noted that angular resolution is only a possibility on the Z-axis. The X and Y displays cannot have angular resolutions.

Also, if the Z-axis is specified as ANG, then Pressing the 7 key on the numeric keypad will display Z as Q. Conversely, if Z is specified as IN or MM then pressing the 7 key will display the third axis as Z.

4. Zero Ø or off.

If you have any questions on the type of scale that you possess, consult the manufacturer of the scales or measuring equipment.

Scale Resolution

(Negative numbers not allowed. Zero not allowed. Blank not allowed)

In the previous step you specified the measurement units of the scales. This function allows you to specify the resolution or more precisely the increments of motion of each axis connected to GD2-PLUS. In other words, when GD2-PLUS gets a pulse from a scale, this is where you specify how much motion a single pulse represents.

This is typically configured at the factory and will rarely require attention. To change this simply use the **ARROW** keys to highlight the axis you want to change and using the numeric keypad key in the correct resolution. **Never leave this field blank or negative. Always use a preceding zero, and press the ENTER key after keying in the number.** For example: Type **0.001 then ENTER, not 001 ENTER.**

After keying in the number, pressing the **ENTER** key will confirm the entry.

Linear Error Correction

(Negative numbers not allowed. Zero not allowed. Blank not allowed)

Linear error correction allows your comparator or microscope to be periodically error compensated. A service technician normally performs this task. This procedure is included in the manual for informational purposes only *and should only be performed by a qualified calibration technician.*

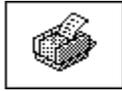
The procedure for linear error correction is:

- 1 Take an item of known size that can be measured accurately on the comparator. A glass calibration grid is preferred, but a gauge pin of known diameter can be used in an emergency.
- 2 Clamp the grid on the comparator stage, and mechanically align it with the comparator. Do ***NOT*** use the **Skew** function to get an alignment.
- 3 Move the cross hairs to a mark on the grid and Press the **X** key to zero the X-axis at this mark.
- 4 Move the X-axis to a mark 4.0000” away, for example. Any distance will do but the longer the better.
- 5 Write down the number in the X-axis. It should be very close to 4.0000”.
- 6 Go to the **Scale Setup** screen.
- 7 Using the **ARROW** keys, highlight the **actual** field of the **X-axis**.
- 8 Using the numeric keypad, type in a distance that you measured on the grid. 4.0000”. **Never leave this field blank or negative.**
- 9 Move the highlight to the **observed** field of the X-axis.
- 10 Using the numeric keypad, type in the number that you wrote down in step 5. **Never leave this field blank or negative.**
- 11 Repeat this process for the Y-axis.

Display Resolution

**(Negative numbers not allowed. Zero not allowed.
Blank not allowed)**

This function is for specifying the precision of the display. GD2-PLUS separates the scale resolution from the display resolution. Some shops do not want to see 0.0001 inches, even though the scales are capable. You can set the display resolution to any number that is coarser than the encoders.



Reports Setup (Setting up the Print Mode)

Pressing the soft key beside the **Report Setup** icon will gain you access to the printer or report setup screen. It will look like this:



Figure 5 Reports Setup

Using the cursor keys, you can highlight the **PRINTER ENABLED/TYPE**. The **ENTER** key will toggle the selection between off, 40 column or 80 column.

Note that the printer must be an Epson compatible dot-matrix or thermal printer. GD2-PLUS does not have programs to communicate with Ink Jet, Bubble Jet or Laser printers.

Moving down to the **AUTO ON** field will allow you to toggle this field between **AUTO ON** and **AUTO OFF** again using the **ENTER** key.

AUTO ON

With the printer enabled, you will get a printout after each feature measurement as it is measured.

AUTO OFF

With the printer enabled, you will get a printout of the highlighted feature each time you press the **PRINT** key.

PRINT BUTTON

This is where you tell GD2-PLUS what you want to happen when you press the **PRINT** button. There are three selections:

- Print feature prints the highlighted feature when you press the **PRINT** button.
- Print All prints all the features when you press the **PRINT** button.
- Print screen will print the current screen when the **PRINT** button is pressed.

Our recommendation would be to select Auto On so that you get a printout of each feature, plus set the **PRINT** button to Print Screen. This way you will be able to print the screen anytime you choose using the **PRINT** button, and you will automatically get a printout of all your features.

As in other screens, you can **Cancel** at any time without making any changes. **Save and Exit** will save and make the changes. In addition, there is a **Form Feed** soft key to feed one sheet of paper through the printer. This is an easy way to tell if the printer is connected properly.



RS232 Setup

When you press the soft key RS232 Setup, it will bring up the screen below:



Figure 6 RS232 Setup

This could also be called the com port setup. You will notice that the com port can have several functions:

- 1 It can also be disabled.
- 2 The com port can be used to export SPC data,

The selections available in this field and other fields are toggled via the **ENTER** key.

As in other screens, you can **Cancel** at any time without making any changes. **Save and Exit** will save and make the changes.

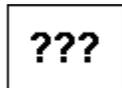
SPC

This is probably a good time to mention the Exporting capabilities of GD2-PLUS. SPC data can be exported at any time. All you have to do is highlight the feature you are interested in and then press the 5 key to get the SPC screen, as shown below:



Figure 7 Exporting SPC Data

In our example we highlighted a circle, before activating the SPC screen with the 5 key. We then pressed the Arrow key to rotate through the circle attributes, stopping on the radius. When the checkmark button is pressed the Radius of the circle will be exported out the RS232 com port using the parameters that were assigned during RS232 setup.



Setting up System Options

This area of GD2-PLUS is where you specify several parameters about how you want GD2-PLUS to work. All the fields on this screen are selected by using the **ARROW** keys and you can change the selection with the **ENTER** key.

SYSTEM OPTIONS SETUP	
DRO DISPLAY	X-Y
LINEAR UNITS X-Y MODE	IN CART
SCALE ERRORS	0
SCREEN SAVER	0
AUTO ENTER TIME	0.75 Sec
PERENDUCULARITY Value at N >	1.000 IN.
	

Figure 8 System Options Screen

The top section lets you specify what units you want the **DRO** to be in at startup (**POWER ON**). The choices are:

Inches or Millimeters

Cartesian or polar

By pressing the **UP ARROW** once you will highlight the X-Y selection. Pressing the **ENTER** key will change the selection from X-Y to X-Y-Z. When you go back to the **DRO** display, it will look like the screen below.

MM IN	X	-0.23620	X
POL CAR	Y	1.10235	Y
INC ABS	Z	1.10235	Y
EDG 			
			
			
			
			

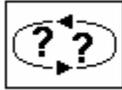
Figure 9 GD2-PLUS 3 Axis Display

The next section of the system options screen allows you to enable or disable scale errors. If you should get Scale errors they will cause the display to flash. To clear the errors, you press the **DRO** key.

This screen also gives you control over the screen saver. You can leave it off by selecting 0, or select 1,5,10, or 20 minutes.

You can also turn on **Auto-Enter** in this section and select the **Auto-Enter** time.

Finally, the bottom section is a by-product of the perpendicularity measurement. You can specify how far from the intersection of the two lines perpendicularity is to be measured. In our example, the distance is specified as 1.000 inches. This means that when you measure Perpendicularity, you will get the deviation from perpendicular at one inch from the intersection of the two lines.



Setting up Looping options

When you use the looping function GD2-PLUS needs to know how many points it takes to end the measurement so that it can loop to the next measurement.

LOOPING OPTIONS			
FEATURE TYPE	MIN POINTS	LOOPING POINTS	
POINT	1	<input type="text" value="1"/>	
CIRCLE	3	3	
LINE	2	2	
ANGLE	2	4	PER LINE
ARC	3	3	PER ARC
HEIGHT	3	3	
	2	2	
PERPEND	2	2	PER LINE
PARALLEL	2	2	PER LINE

Figure 10 Looping Data

This is the **Looping Options** screen where you can specify how many points there are in each type of feature.

The column on the left is the name of the feature. The next column is the minimum number of points for each feature. The third column is the one that you can control. This is where you specify how many points Looping will use to measure a circle for example.

As in some previous setup screens, you use the **UP** and **DOWN** arrow keys to select the field you want to change. Simply type the number you want using the numeric keypad.

Keep in mind that these are also the numbers used for **Auto-Finish**.

Remember that **Save And Exit** saves your changes and **Cancel** does not.



Regional Settings

GD2-PLUS is available in several languages. Pressing the Regional Settings soft key will bring up the following screen:

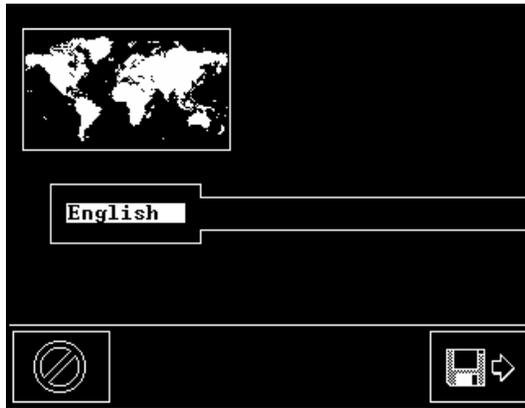


Figure 11 Selecting Languages

There is only one field on the Regional Settings screen. Pressing the **ENTER** key will toggle through the available languages.

Languages available are:

- 1 English
- 2 Italian
- 3 French
- 4 Spanish
- 5 German

Getting Started with GD2-PLUS

Introduction

GD2-PLUS is very easy to actually use for measuring. There are some things you need to know.

Scale Errors

This is a good place to mention that GD2-PLUS has error detection on all scale inputs. When there is a problem, you will notice that the display is flashing. This should be an indicator that the numbers in the display may not be correct.

To clear the scale errors, simply press the **DRO** key.

Using The Numeric Keypad Including ENTER and CLEAR

The numeric keypad, along with the **ENTER** and **CLEAR** keys is provided for the user to direct information into the GD2-PLUS. For example: When setting or changing the scale resolution in the set-up menu the correct value is entered directly via the numeric keypad, **ENTER** doubles as a **YES** response and **CLEAR** doubles as a **NO** response when required. In units that are not equipped with an optical edge detector, the **ENTER** key is used to confirm a point of interest. **CLEAR** is used to negate an erroneous point.

Explanation of Front Panel Keys and Indicators

LED's

There are five LEDs (light emitting diodes) on the front panel of GD2-PLUS. Four of these LEDs are bi-colored meaning they are constantly illuminated and alternate between red and green emissions. These colors are also used on the appropriate keys to indicate the current GD2-PLUS mode. The fifth LED is **AUTO ENTER** and is normally red. The **AUTO ENTER** option is an automatic point-entry routine. The explanation of this option and how it works shows up later in this manual.

Cursor Keys

The cursor keys are used to select items on the screen. Typically, only the up and down keys are activated. The

cursor keys do not wrap around when you reach the top of the Feature Stack , For example, you must press the down key to continue.



Inch/MM

This button is self-explanatory. In one mode the GD2-PLUS measures in Inches, in the other MMs. The information is also displayed on the upper left-hand side of the screen (See insert). The lower right corner indicates the current mode. The color of the LED corresponds to the current GD2-PLUS mode and relates to the color silk-screened on the button. Green is associated with inch, red with millimeters. Note that when you switch from inch to millimeters or vice-versa the display and features dimensions will follow.



Inc/Abs

This key, like the **INCH /MILLIMETER** key, toggles GD2-PLUS between two modes. In this case the modes are Incremental and Absolute. Again, the information is displayed in the upper left-hand corner of the display. The lower right corner indicates the current mode. The color of the LED also corresponds to the current GD2-PLUS mode, as does the color silk-screened on the key. Green is associated with incremental mode, red with absolute mode.

The incremental and absolute modes in GD2-PLUS work as two reference points within one alignment. The Absolute point is fixed. When you are in absolute mode, all the feature data and the display data are relative to the Absolute reference point. You can switch to the incremental mode and zero the display. Now, all feature data and display data is with respect to the incremental zero point. This mode is called incremental because you are free to move the zero point anywhere on the part without affecting the absolute zero point. In other words, you can

make an incremental measurement without bothering the absolute Zero point.



Polar/Cart

This button, like the **INCH /MILLIMETER** key, toggles the GD2-PLUS between two modes. In this case the modes are Polar and Cartesian notation. This information is also displayed in the upper left-hand side of the screen. The lower right corner indicates the current mode. The color of the LED indicates the current GD2-PLUS notation, as does the color silk-screened on the button. Green is associated with Cartesian, red with Polar.



Edge/+

This button, like the **INCH /MILLIMETER** button, toggles the GD2-PLUS between two modes. In this case the modes are Edge Detector and Cross hair mode. Again, the information is displayed in the upper left-hand side of the display. The lower right corner indicates the current mode. The color of the LED also corresponds to the current GD2-PLUS targeting mode, as does the color silk-screened on the button. Green is associated with Edge Detector, red with Cross hair. When in Edge mode points are collected via the optical edge detector. When in cross hair mode the **ENTER** key is used to enter the point associated with the current cross hair location.

If your GD2-PLUS has an edge detector, you will need to calibrate it to the existing light levels using “Auto-Cal” before you will be able to use it. Also, it would be a good idea to perform an “Offset-Cal” so that you will be able to mix crosshair points with edge detector points. There are other calibration modes available but these two are the only ones that you need to know about for now.

Calibrating the edge detector using “Auto-Cal

Auto-Cal is initiated by pressing the 4 key on the numeric keypad. You will see a screen like the one below.

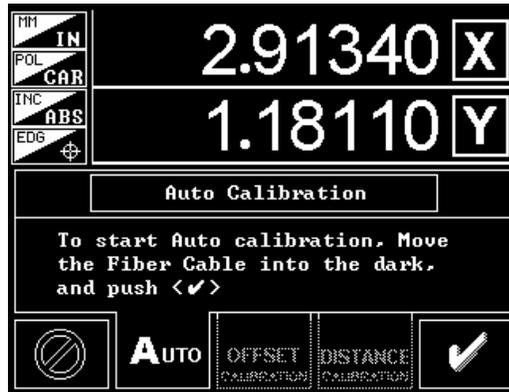


Figure 12 Step one of Auto-Cal

After you have positioned the fiber-optic cable on an area that is considered black, press the soft key under the **Check** button.

At this point the circuitry is setting the zero point. Care should be taken to ensure that the fiber optic cable is touching the ground glass screen. Ambient light has the opportunity to get into the end of the cable from leakage around the end of the cable.

After a few seconds of setup the screen will change to the following.



Figure 13 Final Step of Auto-Cal

After positioning the fiber cable in an area considered light or white, press the soft key under the **Check** symbol. You will need to wait a few seconds while the GD2-PLUS

adjusts its RCS circuitry to the existing light and power conditions.

Auto-Cal should be used any time you do anything that would change the intensity of the light:

- Changing lenses
- Changing light intensity
- Changing filters
- Changing ambient light conditions
- Changing the position of the fiber-optic cable

Calibrating the position of the fiber optic sensor using “Offset-Cal”

Offset-Cal is performed so that GD2-PLUS knows where the fiber optic sensor is located with respect to the crosshairs. Offset Cal can only be performed after the Edge Detector has been calibrated.

Pressing the **Offset Cal** soft key, you will see the following screen.



Figure 14 Offset Calibration between the Fiber-Optic Cable and the Crosshair

Pressing the **Check** soft key will cause the following screen to appear.

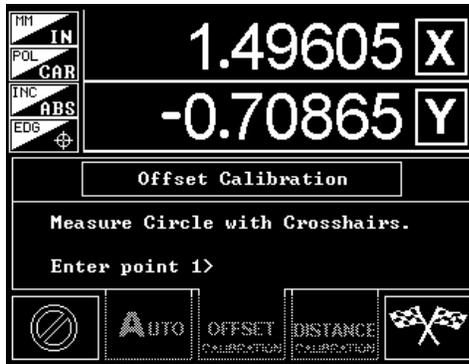


Figure 15 Offset Calibration, Step One

You are now going to measure a circle using the crosshairs. Keep in mind that you will be asked in the next step to measure the same circle using the edge detector. Target at least three points on the circle then press **Finish**. This will bring up the following screen.



Figure 16 Offset Calibration Step Two

Turn on the Edge detector and target at least three points using the edge detector and press **Finish**. You have completed Offset Cal and you will now be able to switch between crosshair mode and edge detector mode. Both targeting schemes will produce accurate results. Of course, if you never mix edge detector measurements and crosshair measurements on the same part, then you will not need to perform an Offset Calibration.

Distance Cal

Sometimes, the edge detector appears to be inaccurate due to the part shape or ambient light conditions. Bright lights always make a part look smaller, even using crosshairs.

If you have a lot of the same kind of part to inspect and you would like to use the Edge Detector because of the thru-put advantage, but the Edge Detector is not providing the

correct dimension, then the Edge Detector can be calibrated to the prevailing part/light conditions using **Distance Cal.**

Start by pressing the soft key under **Distance Cal.** This will bring up the following screen.



Figure 17 Distance Cal, Step One

You need to determine the actual dimension using the crosshairs, micrometers or calipers, and use this screen to enter the dimension. In our example here we have measured the dimension and determined that the edge detector should provide a distance measurement of 2.4988. After entering the number, press the **Check** key. This will present the following screen.



Figure 18 Distance Cal Step Two

All you have to do at this point is to keep passing the measured dimension under the fiber optic cable. Each time you make a pass, the Edge Detector will adjust itself closer and closer until it will eventually provide the correct dimension.

Now you can test your parts and be assured that you are getting the correct dimension with the thru-put advantage of the Edge Detector.

Pressing the **Check** key will exit this screen with the adjusted Edge Detector.

Print

The **PRINT** key works in conjunction with the printer setup under the **SETUP** menu. When pressed the print function is executed in accordance with functions selected in the printer setup menu.



Zero X

Using this soft key the GD2-PLUS **X-axis** can be zeroed on a particular location any time GD2-PLUS is in the **DRO** mode. To zero the **X-axis**, position the cross hairs at the zero point and press the **X** soft key. You will instantly see the X display become zero.



Zero Y

Likewise, using this soft key the GD2-PLUS **Y-axis** can be zeroed on a particular location at any time GD2-PLUS is in the **DRO** mode. To zero the Y-axis, position the cross hairs at the zero position and press the **Y** soft key. You will instantly see the Y display go to zero.

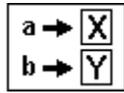
Both X and Y can be zeroed at the same time on a previously measured feature using the **ZERO ON FEATURE** key located on screen 3. In addition, performing a skew on two lines will zero both Axes.



Zero Z

Zeroing the Z axis is a little different since the Z axis is not always visible. To Zero the Z axis when it is visible simply press the soft key beside the Z axis. If the Z axis is not

visible then you must first press the **7** key to turn on the **Z** axis. Then you can press the soft key beside the **Z** axis.



Preset X, Preset Y

The **Preset** key allows the user to enter any value into the display. In order to accomplish this you select **Preset XY**, on screen 2, select the axis you want to preset, **X** or **Y**, and use the numeric keypad to enter the desired value.

Measuring Features with GD2-PLUS

Introduction

Before we get into measuring with GD2-PLUS a quick review of targeting can be helpful. The reason that we need to discuss targeting is because GD2-PLUS has the capability of several targeting methods.

Also, as easy as it is to measure with GD2-PLUS, a few simple conventions, understood now, will make using your GD2-PLUS much more straightforward.

Targeting

Targeting is the process of specifying to GD2-PLUS, or really any inspection system, that you have a point of interest for the system. In the case of cross hairs on an optical comparator, for example, you would place the cross hairs on the edge of a part then zero the display. You have just "Targeted" the edge of the part. When you zeroed the display, you made the current position of the system a point of interest. This process is used to perform all kinds of measurements. When you measure a circle, you target points around the circumference, making all the points important for the circle calculation. When you have collected all the points that you want, you tell GD2-PLUS to calculate a best-fit circle from the points that you have supplied. When we use the word targeting, we are referring to the process of generating points of interest for GD2-PLUS to work with. We could be targeting points for a circle, a line or simply a point. We could even be targeting points for an alignment.

Targeting using Cross Hairs

The first and most obvious is using the cross hair that comes with the system. Whenever you press **ENTER** on the keypad you have indicated that you are interested in that particular point. If GD2-PLUS is just sitting there, not in any kind of measurement routine, then nothing will happen. If you are in a measurement or alignment routine, however, then you will enter a point into the routine every time you press the **ENTER** key. You will notice that the point indicator at the bottom of the screen will increment each time you press **ENTER**. By the way, our auxiliary foot switch can also be used to duplicate the **ENTER** key.

To measure a circle, for example, you would place the cross hairs somewhere on the circumference of the circle, then press **ENTER**. After repeating this process for at least two more points, you press the **Finish** soft key (finish flags) to indicate that you are done collecting points. Now when you press **ENTER** the resulting "Best-Fit" circle will appear in the Feature Memory.

Targeting using Auto-Enter

Targeting using Auto-Enter is a vast productivity improvement. When you are collecting points to determine a feature, GD2-PLUS normally waits for the **ENTER** key to signal a point of interest. With Auto-Enter enabled, GD2-PLUS only waits for the encoders to become stable for a short period of time. This can be thought of as sort of an automatic foot switch.

Targeting using an Edge Detector

Edge detectors have been in widespread use for about fifteen years, and for very good reasons. They have the ability to remove the subjectivity of measurements, while at the same improving productivity by an order of magnitude. Everyone gets the same results, quickly. It doesn't matter who operates the machine.

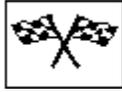
If your system has an Edge Detector installed, targeting points is unbelievably easy. After performing the setup and calibration for the Edge Detector, all you have to do is move the stage around so that the points of interest pass under the Fiber Optic cable. This cable is on the screen specifically to sense edges. Some systems have the Fiber Optic cable built in and aligned to the cross hairs. This removes the cable from the surface of the screen and keeps the cable from getting in the way of the measurement.

Once you use an Edge Detector, you will not want to go back to targeting points with the cross hairs.

Multi-point features

All of GD2-PLUS measured and constructed features are multi-point, except for distances. In other words a feature must have the minimum number of points required for construction, but can have a maximum of 250 points. The mathematics of GD2-PLUS will provide a "Least-Squares-Best-Fit" answer for the feature if more than the minimum

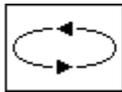
number of points have been supplied. Also you will notice that we provide the RMS distribution of the measured points around the resulting solution.



Finish Flags

Dimensionally inspecting a part is nothing more than relating a collection of the parts' features. Since all features in GD2-PLUS are multi-point, you must press **Finish** at the end of each feature measurement.

The only exceptions to this are **Looping** and **Auto-Finish**.



Looping

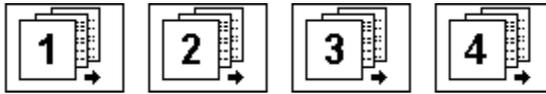
Looping is used when you want to measure a series of features of the same type. For example you may have a part that has lots of holes and you decide to measure them all as a group to save some time. A good idea would be to use looping.

In the **SETUP** menu there is a key called **Looping Options**. This screen is used to set up how many points are used for each type of feature when you are in the looping mode.

Auto-Finish

Pressing the **9** key on the numeric key pad, turns on **Auto Finish**. **Auto-Finish** uses the numbers you set up in the **Looping** options to determine if you have entered the last point of your measurement. For example if you have the number 4 in the looping options for a circle, then when you have **Auto-Enter** on and you measure a circle, GD2-PLUS will automatically finish the circle after you target the fourth point.

If the Finish Flags are waving then **Auto-Finish** is ON.



Screen Selection

The screen select soft key allows the user to toggle from screen 1 to screen 2, to screen 3, to screen 4, at any time. In addition to the screen select key, which appears on all measuring screens, the most often used items, Point, Circle, Line, Angle, Distance, and Skew are on screen 1. Less often-used features, Arc, Slot, Z Height, Perpendicularity, Parallelism, and Preset are on screen 2. Screen 3 has the create functions, Create Circle, and Create Point. The least used functions are on screen 4, which is where all the feature management functions are located. You will need to go to screen 4 if you want to do any of the following:

Managing Features and Feature sets

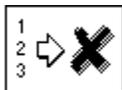
On screen 4 you will see that GD2-PLUS is capable of storing and recalling feature sets. In addition, this screen allows you to delete individual features or all the current features. Sets of features can also be deleted on this screen.

There are two icons for saving and loading feature sets.

Finally, this screen contains the Zero On Feature icon



Delete a Feature – Pressing this soft key removes the highlighted feature from the feature list.



Delete all Features – This button removes all the current features from the feature list.



Delete a set of Features – Pressing this key will bring up a dialog screen where you can select the feature set you want to delete.



Figure 19 Delete Feature Set Dialog

All you have to do is select the feature set you want to delete using the **Arrow Keys**. At this point clicking on the check box will remove the highlighted feature set.



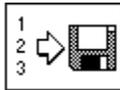
Load a set of Features – Loading a set of features brings up a similar dialog box:



Figure 20 Load Feature Set Dialog

Again, highlighting a feature set and pressing the Check soft key will load the selected feature set.

Warning!!! Loading a set of features Replaces the current feature list.



Save a set of Features – When you select Save Feature Set, you get a dialog screen:

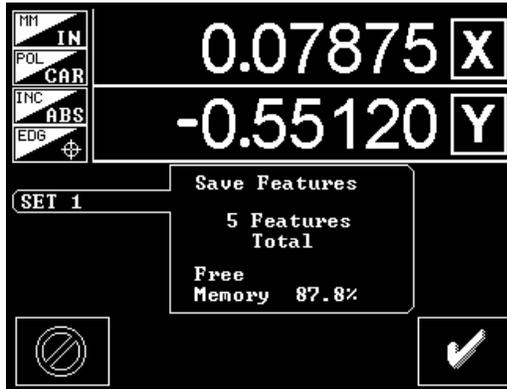
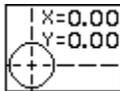


Figure 21 Save Feature Set Dialog Screen

You can choose to cancel or Save the feature set by clicking on the Check soft key.



Zero on a Point Feature – This key is used to move the current Datum or Zero Point to the highlighted feature. Zeroing on Distances or Slots is not allowed.

Reviewing your work using PART VIEW

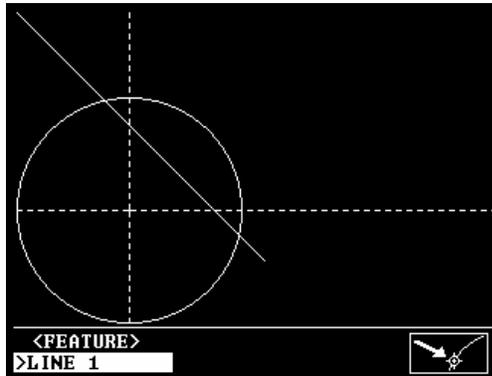


Figure 22 PART VIEW Screen

One of the unique features of GD2-PLUS is the **PART VIEW** screen. The above illustration is what you would see if you had measured a line and a circle, then zeroed on the center of the circle, and you decided to view them using **PART VIEW**. As you progress through measuring your part, you can periodically check your work by pressing the **PART VIEW** key. When you are in the **PART VIEW** mode, you will notice that one of the features is flashing. This is the feature that is on the top of the feature stack in the **DRO** mode. The following illustration shows what the **DRO** screen would look like if you pressed the **DRO** key while the line was flashing.

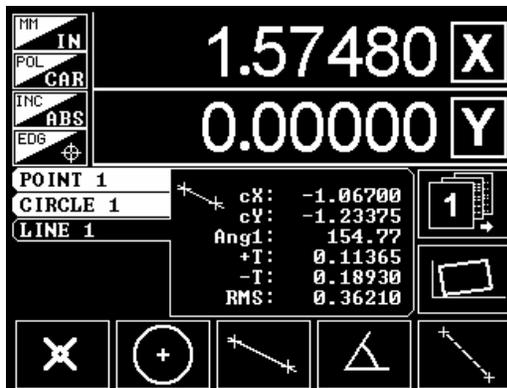


Figure 23 Circle, Line, Point DRO Screen

Imagine if you had a part with lots of holes. You are asked measure all the holes and to construct a circle from the centers of some of them. After inspecting all the holes, it is easy to get confused as to which ones are to be used in the construction. On the **DRO** screen you would start the

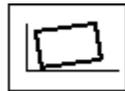
measure circle routine, then switch over to **PART VIEW** to see all the holes. You can pick out any of the holes by using the **UP** and **DOWN** arrow keys until the hole you are interested in is flashing. Then you can press **Use Feature** button on the **PART VIEW** Screen.



Figure 24 PART VIEW Use Feature

This would use the highlighted feature in the construction

Another use would be if you were confused about which feature was which on the **DRO** screen. Switching to the **PART VIEW** screen allows you to select the feature. Then when you return to the **DRO** screen the feature will be highlighted.

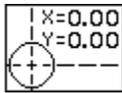


Aligning a Part Using Skew

Skew could also be called “Align on Corner”. The Routine, as you will see, will remind you of the angle routine. In order to accomplish an alignment, you first select **Skew**, then target at least two points on the base, then press **Finish**. Target two or more points on the side and again press **Finish**. The part is now skewed or aligned on the chosen corner and the corner is 0,0. X will be zero anywhere on the base line, and Y will be zero anywhere on the side.

Sometimes you will need to align a part but you do not want to use a corner. Aligning on two circle centers is a good example of this. After you select **Skew**, select the first circle using the **UP** or **DOWN** arrows and press **Use Feature**. Select the second circle and press **Use Feature** again. When you press **Finish** you will still be prompted to target points on the second line. Pressing **Finish** a second time will complete the **SKEW** function without targeting a second line.

At this point, if you want one of the circles to be 0,0 go to screen 4, select the circle and press **Zero On Feature**.



After you have performed a Skew operation, the digits in the display will be italicized to indicate that a Skew has taken place. See below.

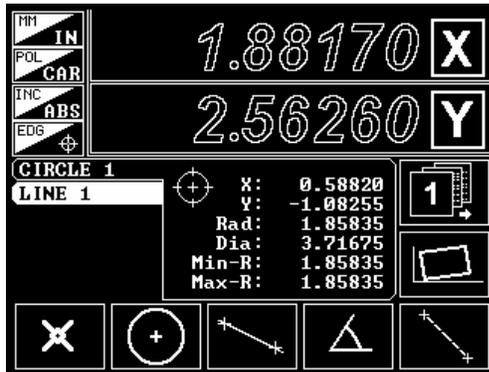


Figure 25 DRO screen after a Skew operation



Measuring a Point

For our discussions, a point is defined as a place on the surface of the X-Y plane.

To measure a point using GD2-PLUS, you simply select point on screen 1 of the **DRO** screen by pressing the **Point** soft key. Next, target the spot you want to be a point. Keep in mind that the point routine also calculates a multi-point feature. If you supply more than one point (250 max), you will get the average of all the points. This is very useful when you are trying to determine the midpoint of a feature, or part. The center of a square or rectangle can be determined by targeting opposite corners. When you are done entering points, press **Finish** you will see the X,Y location of the average of all the points that you entered.

You will get:

The X,Y location of the average of all the targeted points.

The illustration below shows a typical screen with a Point feature highlighted.

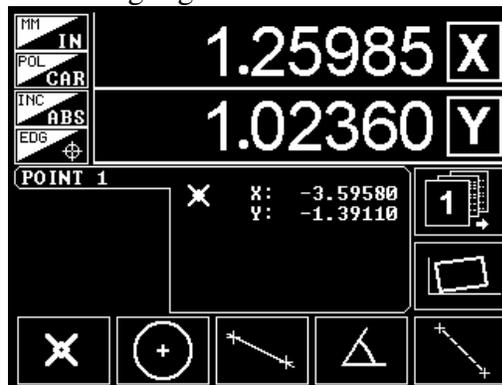
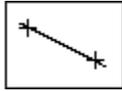


Figure 26 DRO screen with one Point feature



Measuring a Line

A basic line is defined as an infinitely long line passing through 2 or more points on the X-Y plane. The lines in GD2-PLUS are bounded by the targeted end points. Multi-point lines are “Best Fit” lines and may or may not pass through any of the targeted points.

To measure a line with GD2-PLUS you must first select **Line** from screen 1 of the **DRO** screen. Using the cross hairs, or if equipped with the optical edge detector, target with points you wish to use for the line. Remember, a line can have as few as 2 points or as many as you like, up to a maximum of 250. When you are done targeting points for the line, press **Finish**.

You will get:

X,Y location of the center of gravity or average of the end points of the line.

The angle of the line with respect to the +X-axis.
Angles of up to 180 degrees are allowed.

The form tolerance of the line expressed as +T and -T. These are the maximum targeted points on both sides of the best-fit line.

The RMS or 1 Sigma distribution of the targeted points around the best-fit line.

The illustration below is a typical display with a Line feature highlighted.

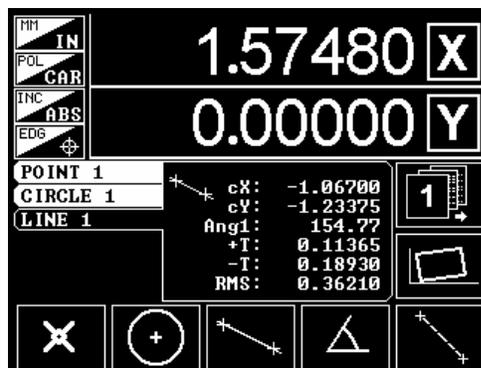


Figure 27 Line feature highlighted



Measuring a Circle

A circle has at least three or more points and spaced more than 180 degrees of radial travel up to a maximum of 250 points. Multi-point circles are “Best Fit” circles and may or may not pass through any of the targeted points. The points for a circle do not have to be widely spaced out around the circle, but a circle made up of bunched up points will be less accurate. In other words, the further you can space the points, the more accurate your result will be.

To measure a circle with GD2-PLUS you must first select **Circle** from screen 1 of the **DRO** screen. Using the cross hairs, or if equipped with the optical edge detector, target the points that you wish to use. When you are done targeting points for the circle, press **Finish**.

Note: GD2-PLUS defaults to **1** (*Alternate info*). If you have previously selected **2** (*Alternate Info*) then you will get the information as shown in figure 29. If you want to display the information in Figure 28, then you will need to press **1** (*Alternate Info*).

You will get:

X,Y location of the center of the best-fit circle.

The Radius of the best-fit circle.

The diameter of the best-fit circle.

The minimum radius.

The maximum radius.

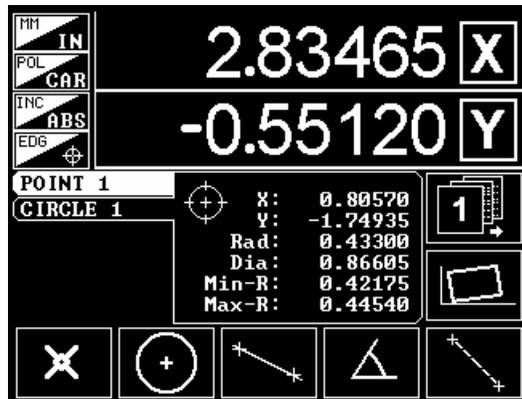


Figure 28 Circle data screen

By pressing the **2** (*Alternate Info*) key on the numeric key pad, you will change the circle screen to show:

The form tolerance of the circle expressed as +T and -T. These are the maximum targeted points on both sides of the best-fit circle.

The RMS or 1 Sigma distribution of the targeted points around the best-fit circle.

Below is an illustration of a typical display of circle form tolerances

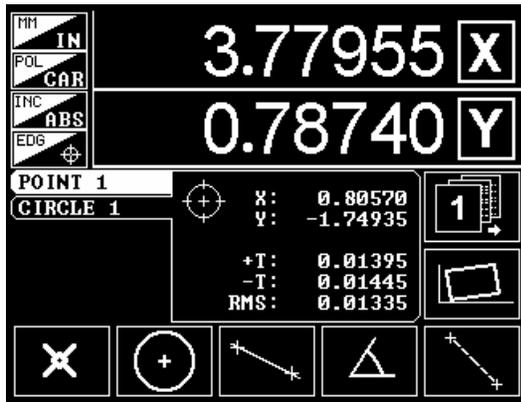
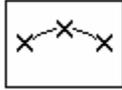


Figure 29 Form tolerance of a circle



Measuring an Arc

An arc has at least three or more points and spaced less than 180 degrees of radial travel up to a maximum of 250 points. Multi-point arcs are “Best Fit” arcs and may or may not pass through any of the targeted points. The points for an arc do not have to be widely spaced out around the arc. But just like a circle, an arc made up of bunched up points will be less accurate. In other words, the further apart you can space the points, the more accurate your result will be.

To measure an arc with GD2-PLUS you must first select **Arc** from screen 2 of the **DRO** screen. Using the cross hairs, or if equipped with the optical edge detector, target the points that you wish to use. When you are done targeting points for the arc, press **Finish**.

You will get:

X,Y location of the center of the best-fit arc.

The form tolerance of the arc expressed as +T and -T. These are the maximum targeted points on both sides of the best-fit arc.

The RMS or 1 Sigma distribution of the targeted points around the best-fit arc.

Below is a representation of a **DRO** screen with an Arc highlighted.

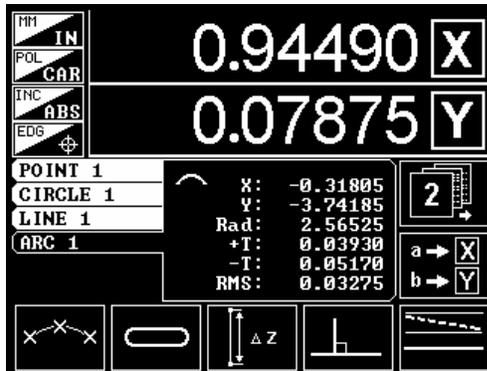


Figure 30 DRO screen for ARC



Measuring an Angle

Measuring an angle consists of targeting two lines, then having GD2-PLUS calculate the included angle between the two lines and the apex of the angle.

To measure an angle you first select **Angle** from the screen 1 menu. GD2-PLUS will prompt you through measuring two lines. Everything that we said about measuring lines applies to each of these lines. Multi-point lines are “Best-Fit” lines and may or may not pass through any of the targeted points. Using the cross hairs, or if equipped with the optical edge detector, target the points that you wish to use for the first line. Remember, a line can have as few as 2 points or as many as you like, up to a maximum of 250. Use the **ENTER** key to enter points when not using an optical edge detector. When you are done targeting points for the first line press **Finish**.

Repeat the process to target the second line of the angle. When you have successfully targeted two lines, press **Finish**.

You will get:

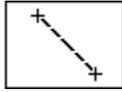
X,Y location of the apex of the angle

The included angle between the two lines. Angles of up to 180 degrees are allowed.

A **DRO** display with an Angle highlighted would look like this.



Figure 31 DRO screen showing an Angle



Measuring a Distance

A distance is similar to a line except that a distance is not a multi-point feature. A distance is only measured between two distinct points. The distance automatically ends after 2 points have been specified. There is no need to press the **Finish** button.

To measure a distance select **Distance** from the screen 1 selection. Using the cross hairs, or if equipped with the optical edge detector, target the 2 points that you wish to use for the distance. Use the **ENTER** key to enter points when not using an optical edge detector. When you have specified 2 points, the distance will automatically show in the feature list.

You will get:

The distance in the X-axis between Point 1 and Point 2.

The distance in the Y-axis between Point 1 and Point 2.

The straight line distance between Point 1 and Point 2.

A Distance looks like this.

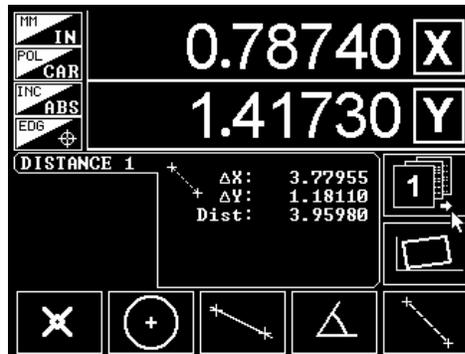


Figure 32 DRO screen showing a Distance



Perpendicularity

Perpendicularity could also be called “Right Angle” and is a little bit special. Some shops make their perpendicularity measurements always at the same distance. GD2-PLUS allows you to set this common distance in the **System Options** menu in **SETUP**. You will see N for Perpendicularity. This is the distance from the intersection of the two lines that the measurement will be made. The routine will remind you of the angle routine.

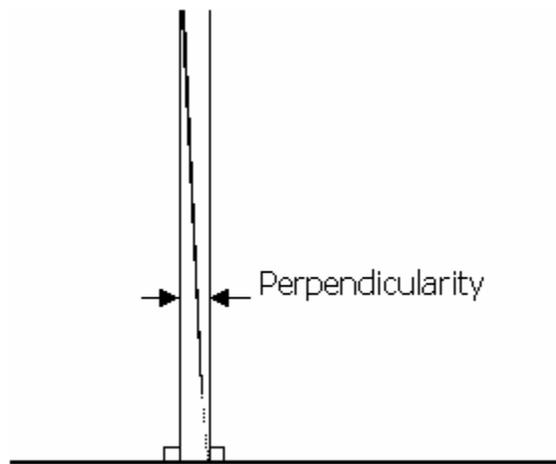


Figure 33 Perpendicularity Defined

The actual definition of perpendicularity is:

The distance between two lines that are perpendicular to the reference line that contain the intersection of the second line with the first line and all the targeted points of the second line.

In order to inspect this feature you first select **Perpendicularity** from the screen 2 menu. First, target the reference line with two or more points. Use the **ENTER** key to enter points when not using an optical edge detector. Now target the line in question with two or more points. When you have completed targeting the second line, press **Finish**.

You will get:

The location of the intersection of the 2 lines. This is similar to an angle location.

The perpendicularity (deviation from perpendicular) of the second line with respect to the first expressed in measurements units at the targeted point farthest from the intersection.

The perpendicularity (deviation from perpendicular) of the second line with respect to the first expressed in measurements units at N distance.

The angle between the two lines

The **DRO** screen with a Perpendicularity highlighted would look like the screen below.

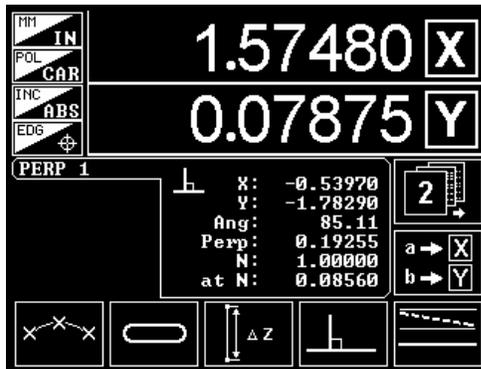


Figure 34 DRO screen showing a Perpendicularity



Parallelism

The routine will remind you of the angle routine in that you again have to target two lines. In order to inspect this feature you first select **Parallelism** from the **Screen 2** menu. First, target the reference line with two or more points. Use the **ENTER** key to enter points when not using an optical edge detector. Now target the line in question with two or more points. When you have completed targeting the second line, press **Finish**.

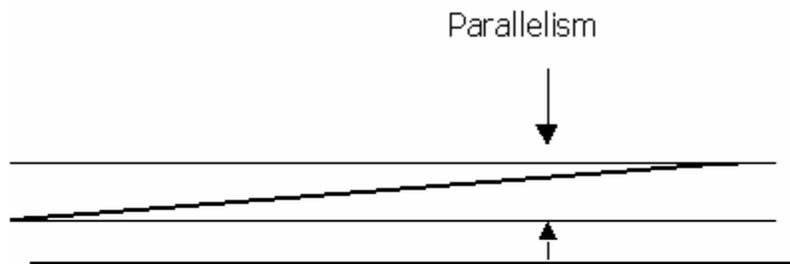


Figure 35 Parallelism defined

The actual definition of Parallelism is:

The distance between two lines that are parallel to the reference line that contain all the targeted points of the second line.

You will get:

The parallelism (deviation from parallel) of the second line with respect to the first expressed in measurement units. The lines are bounded by targeted end points, therefore the measurement only considers the line as it exists between the end points.

The distance between the two lines at their centers of gravity.

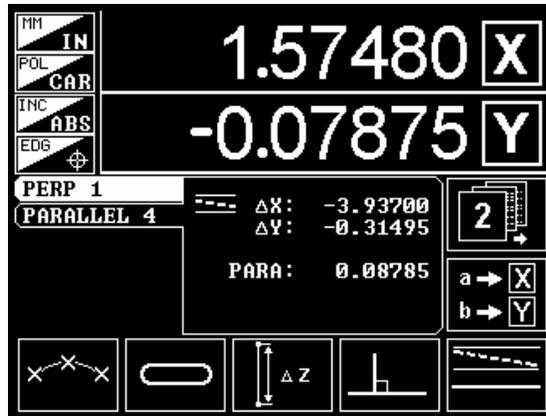
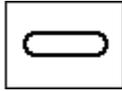


Figure 36 DRO screen showing a Parallelism measurement



Slot

The slot measurement will prompt you to measure two arcs, one at each end of the slot. First, select **Slot** from the selection on Screen 2. Target at least 3 points on each arc. Use the **ENTER** key to enter points when not using an optical edge detector. Remember to press the **Finish** key at the end of the first arc.

You will get:

The overall length of the Slot, which is the distance between the centers of the two arcs, plus the radius of each arc.

The width of the slot, which is the average of the two arc diameters.

The angle of the Slot with respect to the positive X-axis.

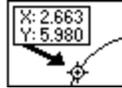


Figure 37 DRO screen showing a Slot measurement

Constructing Features with GD2-PLUS

Introduction

One of the more powerful features of GD2-PLUS is the ability to construct features from previously measured features. This allows the user to construct features that would normally very difficult to accomplish.



Using the Use Feature Key

The **Use Feature** key shows up in two places. First, each time you start a measurement, you will see the **Use Feature** key in the lower-right corner of the screen. Second, when you start to measure a feature and you switch to the **PART VIEW** screen, you still see the **Use Feature** on the **PART VIEW** screen.



When GD2-PLUS is measuring a feature and asks for a point, you have the option of using a point derived from a previously measured feature. By using the **Use Feature** key instead of the **ENTER** key, the point associated with the selected feature will be used instead of the cross hair position. To select the feature, use the cursor keys to scroll through the previously measured features. At the point the desired feature is highlighted in the feature stack or, on the **PART VIEW** screen. . Press **Use Feature** and the point from that feature is automatically inserted into math equations.

Allowed Constructions

One of the most powerful features of GD2-PLUS is the allowance of constructions from previously measured features. This feature virtually eliminates having to re-target features that you need to construct a new feature. A measured **POINT**, **LINE**, **ARC**, **CIRCLE** or **ANGLE** has an X and Y location that can be used as a **POINT** in additional constructions. A **LINE** can be used in 4 constructions **ANGLE**, **SKEW**, **PERPENDICULARITY** and **PARALLELISM**. In fact all four of these features can be constructed completely thereby not requiring any

repeated feature measurements. For example, you could target 4 **POINTS**, construct 2 **LINES** from them, then use the constructed **LINES** to **SKEW** the part.

Points can be constructed from the intersection of:

2 Lines

2 Circles (results in 2 points)

1 Line and 1 Circle (results in 2 points)

Construction Examples

What follows are examples of some of the constructions that are allowed by GD2-PLUS. The development team spent a lot of time figuring out which constructions would be most useful for the inspector. Just because a construction is not spelled out in this manual does not mean that it cannot be performed. GD2-PLUS math kernels are quite open-ended and will allow many different combinations. If you run into one that you cannot figure out, give us a call at Caliper Designs and we will work with you on a solution.

Alignment on Circle centers

This is a modification of the **SKEW** feature. If you do not give GD2-PLUS the second leg of the **SKEW** function, it becomes by default a rotation routine, that is, it will align to the line and zero the axis that the line is closest to, without establishing a zero point for the alternate axis. In the case of this alignment you would select **SKEW**, select Circle X, press **FINISH**, select Circle Y press **FINISH**, then press **FINISH** one more time and you are done. At this point you would normally use the **ZERO ON FEATURE** key on screen 3 to establish one of the circles as X,Y zero, but you are not required to.

Alignment on other Point Features

Alignment on circle centers is useful but so are many other combinations. **POINTS, ARCS, CIRCLES and ANGLES** can all be used in any combination in this alignment routine

Bolt Hole Circle

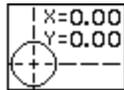
Establishing a bolt hole circle is a simple process with GD2-PLUS. The basic procedure is as follows:

Measure at least three bolt holes as circles.

Measure an additional circle but instead of targeting an actual circle, use the centers of the previously measured circles. This will provide you with the diameter of the bolt hole pattern, or the bolt hole circle. Use the arrow keys to select the previously measured bolt holes and insert them into this bolt hole circle with the **Use Feature** key.

After you have used all the bolt holes you want, press **FINISH**.

You will get a new circle made from the previously measured bolt holes.



Zeroing on a Point Feature

Zeroing on a feature is easily accomplished by first selecting the feature using the cursor keys. Once the correct feature is highlighted go to SCREEN 3 and press **Zero On Feature**. The X,Y location of this feature will now be 0,0.

Distance between 2 circles

When you measure the distance between 2 circles, you can get the minimum distance (closest) and the maximum (furthest) distance, by simply pressing the **2 (Alternate Info)** key.

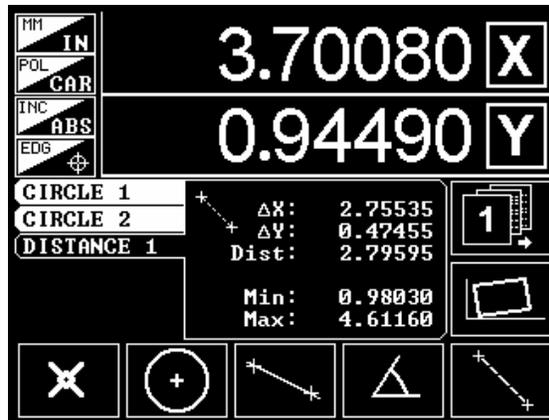


Figure 38 Min and Max distance between 2 Circles

The maximum distance is the distance between the centers plus the radius of the first circle plus the radius of the second circle.

The minimum distance is the distance between the centers minus the radius of the first circle, minus the radius of the second circle. If the circles intersect, then the minimum distance defaults to zero.

Intersecting Features

GD2-PLUS is capable of intersecting features to get points. For example: You can intersect two Circles and you will get two Points. The same is true if you intersect a Line and a Circle.

To intersect two features you will need to:

Press the Point soft key

Select the first feature

Press the Use Feature soft key

Select the second feature

Press the Use Key soft key

This will bring up the following screen:



Figure 39 Intersect Dialog

Pressing the Check soft key will intersect the two features and add the points to the feature list.

Getting Familiar with the Feature Memory

Introduction

GD2-PLUS can store up to approximately 410 features either as features or saved sets of features. This allows the user to group the features for a given part under one name. Below is an illustration of screen 4, which is the feature memory screen.

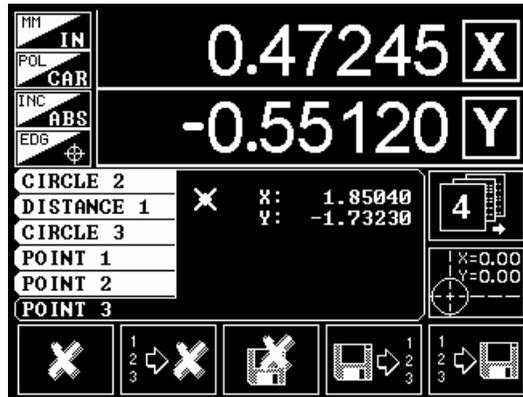


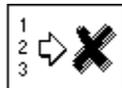
Figure 40 Feature Memory and Zero on Feature

What you can do with the Feature Memory



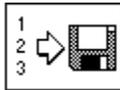
Delete Feature

The first thing that can be accomplished with the feature memory is to delete a feature. All you have to do is select the feature with the **UP** arrow or **DOWN** arrow keys then press **Delete Feature**.



Delete All Features

This function clears the feature memory of all features that have not been saved in sets.



Save Set

When you press the **Save Set** key, the screen changes and will look like this.

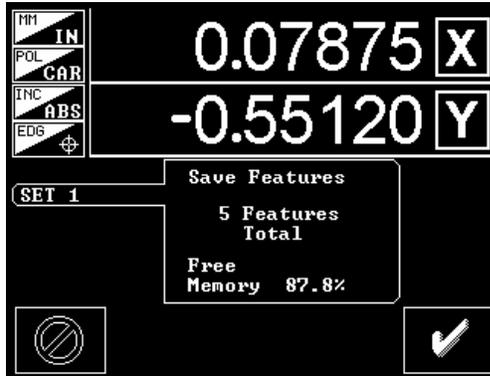


Figure 41 Save Feature Set Screen

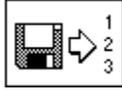
You have the opportunity to cancel the save operation by pressing the **Cancel** key, or continue by pressing the **OK** key.

Notice that there is a notation of available memory, in this case 87.8%. ***This is important.***

The feature memory is organized in such a way that both the previously saved sets of features and the unsaved features that are currently in the feature list, occupy the feature memory area. This means that if the set that you are saving is larger than the available memory, it won't fit and you will get an error message resulting in the set not being saved.

An example of this would be if this were the first set that you were trying to save and it was large enough that the available memory was less than 50%, the set would not fit. This would be a very large set of features. (more than 205 features)

Pressing the **OK** key will save the set as SET 1



Load Set

Load Set is the opposite of save set. The screen changes again to the one below.

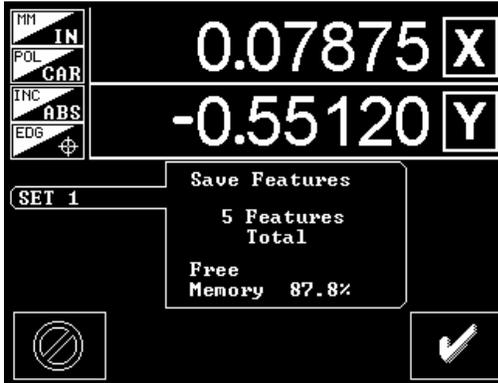


Figure 42 Load Feature Set Screen

This looks the same as the screen for **Save Set**, except notice that the available memory is now 88% as a result of saving the previous set of features.



Delete Set

This key is used to delete feature sets that are no longer needed, thus freeing up feature memory for more pertinent feature sets. The screen will look like the one below.

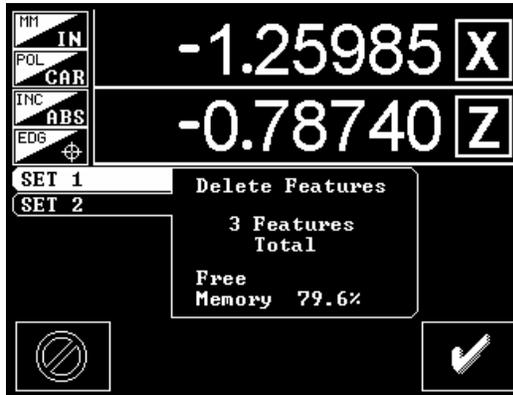


Figure 43 Delete Feature Set Screen

Again, the screen looks the same. Pressing the **OK** key however will delete SET 1 and return the available memory to 93%.

Part Programming

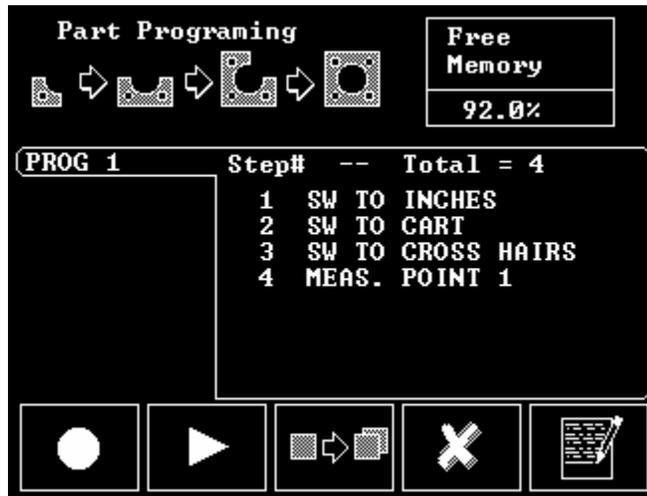
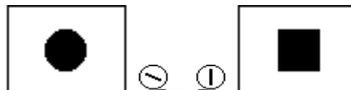


Figure 44 PART PROGRAMMING Screen

Introduction

Without the **PART PROGRAMMING** features included in GD2-PLUS it would be a good geometric readout, but with them it becomes an inspection powerhouse. Never before has so much power been crammed into such an easy to use geometric readout.



How to Record a Part Program

To record a Part Program you first press the **PART PROGRAM** menu button located on the far left of the GD2-PLUS, third button down. You then select **Record** from the **PART PROGRAM** menu and begin to measure your part. GD2-PLUS is now in learn or record mode and will remain in this mode until **Stop** is pressed (note that GD2-PLUS will automatically switch back to the **DRO** menu during recording). You will also notice an icon of a tape reminding you that you are in the record mode. Continue to inspect your part. When you are done, return to the Program screen by pressing **PART PROGRAM**, and then press the soft key under the **Stop** icon.

PART PROGRAMMING Example

To illustrate how easy it is to create a Part Program, the steps for a simple program are listed below:

Press the **Record** button. This will bring up the **DRO** screen with the tape reel symbol running.

Press **Circle**. This will prompt you for the first point of the circle.

Position the cross hairs on the circumference of the Circle and press **ENTER**.

Repeat this step for at least two more points.

Press the **Finish** key after you have collected at least three points for the Circle.

Press **Point**. This will prompt you for the first point of the point. (Remember that the point routine is multi-point also)

Press **Distance**. This will prompt you for the first point in the distance measurement.

Press **Use Feature**. This will insert the point as the first point of the Distance.

Press the **UP** arrow key. This will highlight the Circle.

Press **Use Feature** again. This will insert the center of the Circle as the second point in the Distance. You will now see the distance between the point and the circle as the third feature.

Press the **PART PROGRAM** key. This will return to the Part Programming screen.

The **Record** key has been replaced by the **Stop** key. Pressing the **Stop** key will end the recording process and you now have a part program that will measure the distance between a circle and a point.



How to Play a Part Program

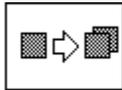
To play a part program you select the program using the up and down cursor keys. Press **Play** and GD2-PLUS will begin to prompt you through the inspection sequence. Should you make a mistake (I know - you never make mistakes) while running the Part Program and you get a point that you don't want, you can press the **CLEAR** key to remove the point. Pressing the **CLEAR** key again will remove the next point back. Etc.

It should be noted that entering the last point of a feature while in a part program would finish the routine.

Warning!!! You will not be able to CLEAR the last point.

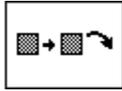
How to Save a Part Program

All part programs are saved when recorded. GD2-PLUS will assign a number to the program so that you can find it later.



How to Copy a Part Program

This key is included as a convenience. It is used to copy a part program that is similar to a new one that is being considered. The **Make Copy** button can be used to duplicate an existing part program so that it can be edited, thus providing a new program based on an existing one.



How to Edit a Part Program using “Insert After” button

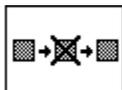
The **Insert After** key is used to add to the existing program. Keep in mind that **Insert After** is the only insertion mode available. There is no Insert Before. To insert steps into the program:

Position the insertion point, using the **UP** and **DOWN** arrow keys, on the step before (above) the insertion point.

Press the **Insert After** key. This will bring you to the **DRO** screen with the tape reel symbol running. This happens because you are actually starting the Record mode again.

Go ahead and add the steps to the program by adding the inspection steps you need.

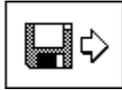
When you have completed the additions, press the **PART PROGRAM** key to return to the Editing screen.



Delete Step

Delete Step does just what it says. Pressing the **Delete Step** soft key will remove the highlighted step from the program.

Use the **UP** or **DOWN** arrow keys to select the step you want removed, then press the **Delete Step** key. The step is removed.



Save and Exit

Save and Exit must be used prior to exiting the editing screen if you want to save the editing changes that have been made during this session. Of course, you can exit using **Cancel** before using **Save and Exit** if you do *not* want to save the changes.

Creating Features

GD2-PLUS has the capability of feature creation. There are instances where creating features is very convenient. For example, in an offset alignment, you may need to create a point as part of the alignment.

Feature creation is all done on screen 3 as shown below.

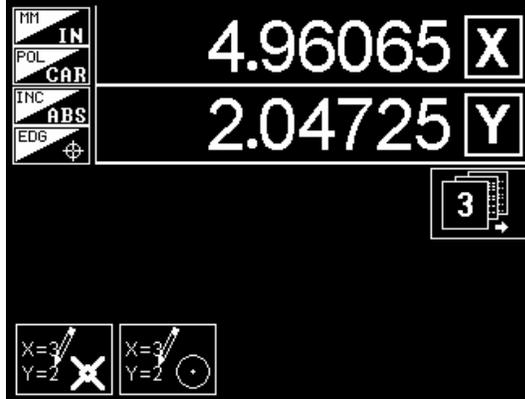
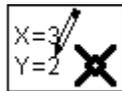


Figure 45 Create Features Screen



Creating Points

Pressing this button will open a screen where you can specify the location of the point in X and Y.

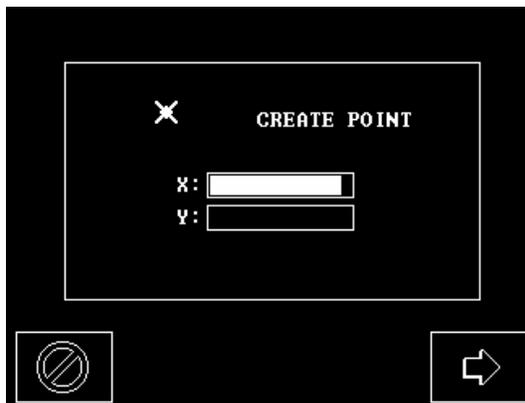
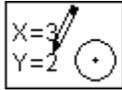


Figure 46 Create Point Screen

Using the Arrow key will move the highlight to the next field.



Creating Circles

Creating Circles is very similar to creating points except that you get to specify a location AND a radius.

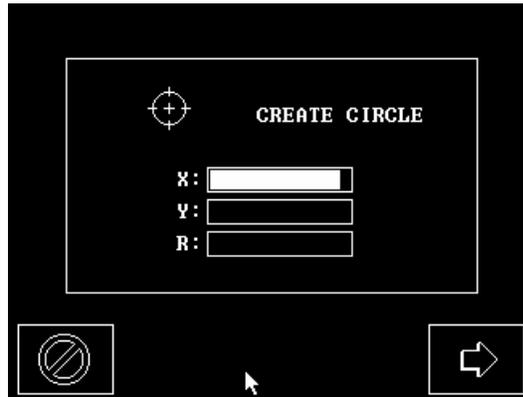


Figure 47 Create Circle Screen

Again the right arrow moves the highlight.

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