Operation

GENERAL INFORMATION

The DA1855A has been designed to be used with oscilloscopes equipped with a ProBus interface. Connecting the Differential Amplifier to the oscilloscope through the ProBus interface will automatically control all the required settings from the oscilloscope and will lock-out the DA1855A front panel controls. All front panel controls are now accessible through the oscilloscope user interface. The DA1855A user interface can be viewed by pressing the **Coupling** button when the channel connected to the DA1855A is selected. The DA1855A front panel controls will operate manually when the Differential Amplifier is connected to an oscilloscope not provided with a ProBus interface.

Note:

Removing the ProBus interface cable with the differential amplifier still powered up, requires the DA1855A to be turned OFF and ON to access the front panel controls.

DYNAMIC RANGE

The basic amplifier dynamic range in X1 Gain and ÷1 Attenuation is ± 0.500 V. Changing the gain and or attenuation will affect both the Differential Mode and Common Mode ranges.

The Differential Mode range is scaled by both gain and attenuation, while the Common Mode range is scaled by attenuation only. Refer to table 3-1.

Table 3-1. Dynamic Range

Gain	Atten*	Differential Mode*	Common Mode*
1	÷1	± 0.5 V	± 15.5 V
1	÷10	± 5.0 V	± 155 V
10	÷1	± 50 mV	± 15.5 V
10	÷10	± 0.5 V	± 155 V

* Attenuation, Common Mode and Differential Mode ranges are scaled with external probe attenuation. A ÷10 probe will increase all these values by a factor of 10.

FRONT PANEL

Input Connectors

Signals applied to the **+INPUT** and the –**INPUT** are connected either directly to the DA1855A amplifier's inputs or to the input attenuators. Maximum input voltage is ±200 Vp

A signal connected to the **+INPUT** will remain its polarity at the output connector. A signal connected to the –**INPUT** will be inverted in polarity.

Attenuators

The input attenuators are passive networks which divide each signal by ten.

In ¸**1** mode the front panel input connectors are directly connected to the DA1855A amplifier's differential inputs.

In ¸**10** mode each front panel input connector is connected to a passive 1 MΩ attenuator. The attenuator output is connected to the DA1855A amplifier's corresponding differential input. The signal at each input is attenuated by a factor of ten.

Gain

The DA1855A amplifier gain (amplification) is selectable between **X1** and **X10**. The amplified signal appears at the rear panel **AMPLIFIER OUTPUT** connector.

Gain will affect the differential mode output signal by amplifying the signal difference between the **+INPUT** and the –**INPUT**, but will not affect the common mode signal, the signal common to the **+INPUT** and them –**INPUT**.

Output Termination

Proper gain is obtained when the DA1855A drives a 50 Ω load such as an oscilloscope with input impedance set to 50 Ω. Automatic 50 Ω termination is obtained when the DA1855A is connected to a LeCroy oscilloscope through the ProBus interface.

An instrument with only a 1 MΩ input impedance available should have a 50 Ω coaxial termination placed on its input connector. The DA1855A is then connected to the oscilloscope through the coaxial termination.

Input Resistance

When the input **ATTENUATOR** is set to **¸1** and no attenuating probe is connected, the input resistance can be increased from 1 MΩ to 100 MΩ. This is advantageous when measuring high impedance circuits or when AC coupling is needed with a very low frequency cut off. When the input **ATTENUATOR** is set to **¸10** or an attenuating probe with read out capability is attached, 1 MΩ (**1M**) input resistance is automatically selected.

Unbalanced source impedances can have an adverse effect on common mode rejection. For example, a differential source with impedances of 1000 and 2000 Ω, each loaded with 1 MΩ will have a common mode rejection ratio (CMRR) of 1000 to 1. The common mode rejection ratio can be improved to 100,000 to 1 by using 100 MΩ input resistance.

Auto Zero

Auto Zero is a feature invoked from the user interface in the **Coupling** menu when connected via the ProBus interface or in case the Differential Amplifier is not connected through a ProBus interface by pushing either the **X1** or **X10** button, even if a different gain is not selected. Auto Zero momentarily sets the input coupling to **OFF** and determines the offset necessary to set the output at 0 Volt. During this process the front panel input signal to the amplifier is interrupted. When the Auto Zero cycle is completed, the input coupling returns to its previous state. Auto Zero usually takes less than one second to complete. This feature allows the user to DC balance the DA1855A simply by pushing the **GAIN** button which is already illuminated. When changing gains, the Auto Zero feature is automatically invoked, adjusting the amplifier's DC balance.

+ Input Coupling (AC – OFF – DC)

In **OFF** mode, the input connector is disconnected from the amplifier input, and the amplifier input is connected to ground. The AC coupling capacitor is connected between the **+INPUT** and ground through 1 MΩ resistor, independent of the **INPUT RESISTANCE** setting. In this mode, the AC coupling capacitor is quickly charged to the average DC input voltage. **OFF** mode is also referred to as precharge mode. Precharge is particularly useful prior to selecting AC coupling when the input voltage has a DC component in excess of 19 V. The DA1855A input coupling is set to **OFF** and connected to the circuit under test. When the **+INPUT** is changed from **OFF** to **AC** mode, the coupling capacitor is already charged, and the trace properly centered on the oscilloscope screen. Additionally, the risk of tripping the input overload detector and automatically disconnecting the input is eliminated.

In the **AC** mode, the **+INPUT** is connected through an AC coupling capacitor to the amplifier input or the input attenuator. The coupling capacitor retains its charge when the input is switched to **DC**, making it possible to return to the same circuit without the precharge time. But this also makes it possible to discharge the coupling capacitor into another circuit under test if its DC voltage differs by more than approximately 19 V from the voltage on the coupling capacitor.

Note:

The discharge current from the AC coupling capacitor is limited to about 70 mA. In some situations this could damage sensitive circuits. To avoid the inrush current transient, it is therefore recommended that the ***+INPUT*** *coupling first be changed to the* ***OFF*** *(precharge) when measuring a new circuit point. This will safely recharge the AC coupling capacitor in less than 0.3 seconds.*

DC and low frequencies are attenuated by the AC coupling capacitor and the input resistance. With the **ATTENUATOR** set to **¸10**, or set to **¸1** with the **INPUT RESISTANCE** set to 1 MW, the low frequency cut off (-3dB point) is approximately 1.6 Hz. When the input attenuator is set to **¸1**, the **INPUT RESISTANCE** may be set to 100 M W, and the –3 dB point is 0.016 Hz. This extremely low frequency cut off is useful for observing low frequency noise riding on larger DC voltages.

In the **DC** mode, the **+INPUT** connector is connected to the amplifier either directly or through the input attenuator, and the AC and DC attenuation are the same.

–Input Coupling (AC–OFF – DC – V_{COMP})

The –**INPUT** has the same coupling modes as the **+INPUT** plus one additional option, $\mathbf{V_{COMP}}$ (comparison voltage).

The DA1855A contains a precision DC voltage source which is controlled by the oscilloscope **OFFSET** control. (When the amplifier is used stand alone, without ProBus interface to a LeCroy oscilloscope, the voltage is controlled by the push buttons above and below the front panel numerical display.) This voltage source is called the Precision Voltage Generator (PVG).

The DA1855A's amplifier subtracts the voltage applied to its inverting input from the voltage applied to its non-inverting input. The DA1855A output is therefore zero whenever these two voltages are equal. For this reason, the voltage applied to the inverting input is called a comparison voltage, $\mathbf{V_{COMP}}$. Stated another way, the value of the horizontal center line in the oscilloscope graticule is the voltage read in the PVG display. Each graticule line above or below the center line will add or subtract the Volts/div value from the PVG setting. Refer to figure 3-1 where the horizontal center line represents a power supply voltage of 5.030 V, the next higher line 5.050 V and the line below the center line 5.010 V. In this figure noise on a + 5.030 V signal is easily displayed using 5.030 Volt offset and a vertical scale factor of 20 mV/div.

$\mathbf{V_{COMP}}$ can be used to make precise measurements of large signals by comparing the accurately known $\mathbf{V_{COMP}}$ with the unknown signal. It can also be used to measure the actual voltage at any point of a waveform.

Since the amplifier's gain and input attenuator are individually selectable, the comparison range can be changed from ± 15.500 V to ± 155.000 V by changing the **ATTENUATION** from **÷1** to **÷10**, while the overall gain can still be set either to 1 or 0.1 by selecting either **X10** or **X1 GAIN**.

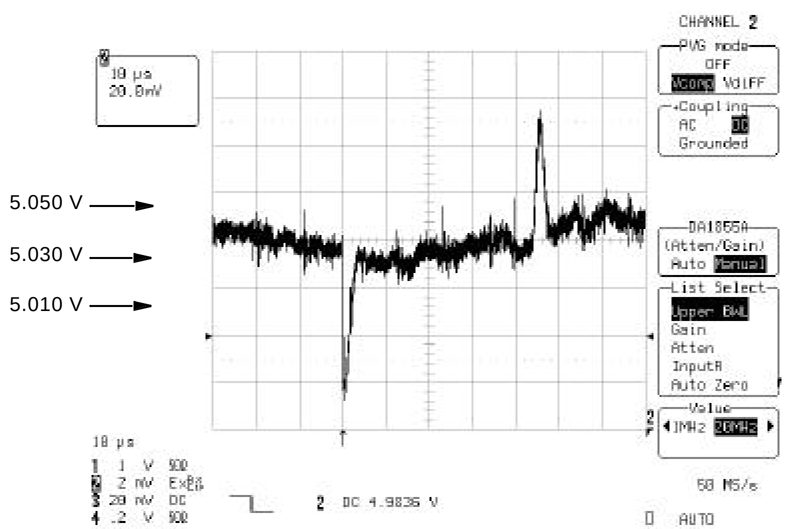

Figure 3-1. Voltage Measurement

Note that while in **V_{COMP}** mode, the amplifier is configured for single ended measurements. The –**INPUT** connector is not usable when **V_{COMP}** is selected. The input signal applied to the **+ INPUT** is referenced to ground offset by the value set by the Precision Voltage Generator. Large calibrated offsets can be obtained while making differential measurements by using **V_{DIFF}** mode.

Precision Voltage Generator

The PVG generates the voltage which is used in the **V_{COMP}** and **V_{DIFF}** modes and appears at the rear panel **OFFSET VOLTAGE** (PVG) output connector for use as a reference voltage.

The Precision Voltage Generator (PVG) output range is ± 15.500 Volt. The PVG is never attenuated by the input attenuator. Attenuation of the **+INPUT** signal by the **¸10** input attenuator will cause the PVG to null out an input voltage up to ± 155.00 Volt which is ten times larger than the actual PVG voltage.

The increase in common mode voltage range also applies when using attenuating probes.

When the DA1855A is used with attenuating probes that feature readout, the PVG display is changed to indicate the voltage at the **+INPUT** probe tip which will bring the amplifier output to zero.

When connected to a LeCroy oscilloscope via the ProBus interface, the oscilloscope **OFFSET** control increments or decrements the PVG’s output voltage and the offset value will be shown on the six PVG front panel indicators. The new offset value will also be displayed on the oscilloscope’s screen for a few seconds after a change has been made.

When connected to an oscilloscope not provided with a ProBus interface, the PVG can be accessed by means of push buttons. Above each digit is a push button which increments the corresponding digit by one when pushed. When held, the digit continues to increment, eventually incrementing the next higher digit.

Similarly, below each digit is a push button which decrements the corresponding digit.

The ± button above the left-most digit changes the PVG output polarity. The **ZERO** button below the left-most digit sets the output to zero and invokes the PVG's Auto Zero function.

PVG absolute mode: DA1855 PVG increment and decrement buttons always function to increment or decrement the *voltage display* respectively. When decrementing from a positive voltage, the display always stops at zero. To obtain negative voltages, the ± button must be pushed, and the increment button is used to increase the magnitude of the negative voltage. This operation is natural if simply setting a voltage, but unnatural if moving a displayed oscilloscope waveform. This is known as the PVG absolute mode, and the only mode available in the original DA1855, (non “A” model). The DA1855A retains the option of operating in this same manner as well as supporting PVG roll through zero mode.

Note:

When the DA1855A is controlled remotely through a LeCroy oscilloscope, neither PVG absolute or PVG roll through zero modes apply. When operated remotely, the PVG value is controlled with the use of the OFFSET knob on the oscilloscope, when in effect, operates in the roll through mode.

PVG roll through zero mode: The DA1855A increment buttons are oscilloscope waveform related by factory default. The increment buttons move a displayed oscilloscope waveform upward and the decrement buttons move the waveform downward independent of the PVG polarity. Decrements from a positive voltage will roll smoothly through zero. This is known as roll through zero mode.

Toggle PVG modes: To change from roll through zero to absolute mode of operation hold the PVG ZERO button and press the ± button. Change back to the roll through zero mode by repeating the same operation.

Differential Offset

$\mathbf{V_{DIFF}}$ (differential offset voltage) is an instrument mode rather than a type of input coupling. The $\mathbf{V_{DIFF}}$ mode allows the PVG to inject a calibrated offset signal into the DA1855A while still using both inputs for full differential operation. This mode can be used as a position control to move the trace on the oscilloscope screen in preference to using the oscilloscope's position or offset control. The oscilloscope's position and offset controls should always be set to zero so that the DA1855A's dynamic range is properly centered. (This is done automatically when using a LeCroy oscilloscope with ProBus interface.) When the oscilloscope is set to greater sensitivities (lower Volts/Div settings), the Differential offset provides much greater range than the conventional position control. For example, at 50 mV/div, the $\mathbf{V_{DIFF}}$ mode provides up to ± 200 divisions of range.

Operation of the DA1855A using the $\mathbf{V_{DIFF}}$ function is the same as $\mathbf{V_{COMP}}$ except for the following:

- The –**INPUT** remains active, allowing full use of the DA1855A as a differential amplifier.
- The maximum range of the PVG is ±10.000 Volt in **X1 GAIN** and ±1.0000 Volt in **X10 GAIN**. The effects of the **¸10** input **ATTENUATOR** and probe attenuation are the same as when using $\mathbf{V_{COMP}}$, i.e., any input attenuation multiplies the effective offset.

The DA1855A's PVG display is changed to indicate the voltage that, if applied between the **+INPUT** and –**INPUT**, would bring the amplifier output to zero. When the DA1855A is used with attenuating probes which feature readout, the PVG display is scaled to include the effect of probe attenuation.

Effective Gain

Six indicators (LEDs) across the top of the DA1855A front panel show the total gain from the instrument input to output. Logic within the amplifier includes the gain, internal attenuation, and probe attenuation factors (when readout encoded probes are used) to determine the effective gain. When the **X1** light is ON, the overall amplifier voltage gain (amplification) is unity. Similarly, **X10** indicates an overall amplification of ten times. **¸10** Indicates the voltage amplification is 0.1, and so forth.

The DA1855A communicates the effective gain information to the LeCroy oscilloscope when the ProBus interface is used. This corrects the scale factor of the displayed waveforms, cursors and measurements.

When LeCroy DXC series or other readout encoded probes are used, the effective gain includes the probe’s attenuator factor.

BW Limit

FULL — The DA1855A amplifier's full bandwidth, over 100MHz, is passed to the oscilloscope, spectrum analyzer or digitizer. Frequency response and transient response are essentially independent of the oscilloscope’s input impedance.

20 MHz — A 20MHz three pole (18dB/octave) filter allows the DA1855A to reduce extraneous noise. This filter is a passive LC design and is intended to drive a 50 Ω load. Without the load, the filter's frequency response and transient response are altered.

1 MHz — The 1MHz filter is of the same design as the 20 MHz filter, and the same remarks apply.

100 kHz — The 100kHz filter is an active filter with a 50 Ω output impedance. Transient and frequency response are independent of the load impedance.

Overload

When a signal, which could damage the DA1855A, has been applied to either input connector, the DA1855A protects itself by disconnecting the signal. The input coupling mode changes to **OFF**, and the **OVERLOAD** light is turned on.

To reset the amplifier to normal operation, remove the offending input, press any of the input coupling modes (**AC**, **OFF**, or **DC**). The Overload light will turn off indicating the amplifier is reset.

When the **ATTENUATOR** is set to ¸**1**, an input signal of approximately ±19 Volt will activate the overload protection circuit. Fast transients will draw up to about 70 mA of input current for a brief period before the input coupling relay acts to disconnect the input.

Caution:

Inputs in excess of 250 Volt may cause permanent damage to the DA1855A.

The input is not disconnected when the **ATTENUATOR** is set to ¸**10**. The input attenuator can withstand up to 200 Volt continuous input.

REAR PANEL

Power

Normal instrument operation is obtained with the power switch in the **1** (ON) position. The instrument can be used immediately, however it requires a 30 minute warm up period to reach specified performance. Prior to reaching operating temperature, the amplifier offset will drift and the output from the Precision Voltage Generator may not be within specification. In high-humidity environments the time to stabilize may be much longer. In high humidity environments or when warm-up time inhibits usage, the instrument may be left plugged in at all times and the power switch left in the **1** (ON) position.

Power up indication

Upon turn-on, the model number and firmware version are briefly displayed in the PVG readout. For example, 1855.12 indicates that the instrument is a model DA1855A and the firmware version is 1.2.

Precision Voltage Generator Offset Voltage

The rear panel **OFFSET VOLTAGE** BNC (PVG) output connector, is a monitor of the Precision Voltage Generator (PVG). The voltage present on this connector is the same voltage as that applied to the –**INPUT** when the –**INPUT** coupling is set to $\mathbf{V_{COMP}}$ or internally to the DA1855A when $\mathbf{V_{DIFF}}$ is selected. The **OFFSET VOLTAGE** output can be used to monitor the PVG with a digital Voltmeter (DVM). A low pass filter between the PVG output and the –**INPUT** removes radio frequency interference (RFI) from the signal. This filter does not attenuate the PVG signal.

The PVG output is not attenuated by the input attenuator or probes, whereas the input signal is. Therefore the effective range of $\mathbf{V_{COMP}}$ is increased by a factor of 10 when the **÷10 ATTENUATOR** is selected or a ÷10 attenuating probe is used to attenuate the input signal. The PVG numerical display reflects the attenuator setting and probe attenuation when the probe is readout encoded. As an example, if there are no probes attached, the **÷10 ATTENUATOR** is selected and the display is set to read –155.000, the PVG output will actually be –15.5 Volt.

The decimal in the display will be in the correct location to indicate the voltage at the PVG output when no probes are attached and **÷1 ATTENUATOR** and **X1 GAIN** are selected.

The **OFFSET VOLTAGE** BNC (PVG) output also presents the same voltage used internally for differential offset when $\mathbf{V_{DIFF}}$ is selected. Because the PVG is applied to the amplifier to create a true differential offset, the relationship between $\mathbf{V_{DIFF}}$ and the voltage at the **OFFSET VOLTAGE** BNC (PVG) output (changes with the amplifier gain selection according to the following table:

The maximum $\mathbf{V_{DIFF}}$ is multiplied by any probe attenuation factor.The DA1855A front panel displays the correct offset referred to the instrument input.

Table 3-2 V_{DIFF} Range for Different Gain and Attenuator Settings

Gain	Attenuation	Max. V_{DIFF}
X1	¸1	± 10 V
X1	¸10	± 100 V
X10	¸1	± 1 V
X10	¸10	± 10 V

When using readout encoded probes which the DA1855A senses, the PVG readout calculates the effective differential offset at the probe tip. Of course, both probes must have the same attenuation factor.

In the **V_{COMP}** mode, the maximum **OFFSET VOLTAGE** input is limited by the DA1855A common mode dynamic range. In the **V_{DIFF}** mode it is limited by the dynamic range of the internal **V_{DIFF}** amplifier.

Tables 3-3 and 3-4 will help the operator stay within the maximum input voltage limits and understand the relationship between the actual voltage applied and the effective voltage. Effective voltage is always referred to the input of the DA1855A or the probe tip if a probe is used. When using probes, the maximum effective voltage range may be limited by the maximum voltage rating of the probe.

Table 3-3. Effective Offset Range with ¸1 Probe

Front panel Settings		Effective Offset Range	
Gain	Attenuation	V_{COMP}	V_{DIFF}
X1	¸1	± 15.5 V	± 10 V
X1	¸10	± 155 V	± 100 V
X10	¸1	± 15.5 V	± 1 V
x10	¸10	± 155 V	± 10 V

Note

The effective voltage is always increased by the attenuator. It therefore follows that any probe will increase the effective voltage of both V_{COMP} *and* V_{DIFF} *by its attenuation factor. For example, a probe with a 100X attenuation factor will increase the effective full scale range by 100.*

Table 3-4. Effective Offset Range with ¸100 Probe

Front Panel Settings		Effective Offset Range with ¸100 Probe	
Gain	**Attenuation**	V_{COMP}	V_{DIFF}
X1	¸1	± 1.55 kV	± 1 kV
X1	¸10	± 15.5 kV	± 10 kV
X10	¸1	± 1.55 kV	± 100 V
x10	¸10	± 15.5 kV	± 1 kV

Although the full scale range may be 10 kV or 15.5 kV, most probes have a much lower maximum input voltage rating which must not be exceeded.

Amplifier Output

The **AMPLIFIER OUTPUT** BNC is intended to be used with an oscilloscope, spectrum analyzer or instrument having a 50 Ω input resistance. The amplifier's output impedance is 50 Ω. Without the 50 Ω load, the amplifier gain will be uncalibrated and will be approximately twice the amount indicated on the front panel. Proper operation of the 1 MHz or 20 MHz bandwidth limit filters requires an output load impedance of 50 Ω.

Remote Operation

A **REMOTE** connector on the rear panel of the DA1855A allows total control of the instrument through a LeCroy oscilloscope when connected to ProBus using the supplied cable. All of the instrument functions can be controlled through the oscilloscope user interface.

Remote control is also possible using commands sent through the IEEE-488 bus or through RS-232 connected to the oscilloscope. The DA1855A cannot be remotely controlled without a LeCroy oscilloscope. Refer to Section 7 for a description of the Remote Commands.

When the ProBus cable is installed, the buttons on the front panel of the differential amplifier are disabled.

Note:

Remote operation requires software version V8.1.0 or higher.

Probe Coding Input

This jack is to be used with LeCroy DXC series probes to detect the probe attenuation factor. Other manufacturer's probes with standard probe coding capability will be properly decoded through the DA1855A's front panel **+INPUT** BNC connector.

INSTRUMENT SETTINGS

The DA1855A output is intended to connect directly to the input of an oscilloscope, or other instrument, but it is important to observe some rules so that the DA1855A delivers its specified performance.

CAUTION

A properly terminated differential amplifier can deliver an output voltage of ±0.5 Volt. The output is DC coupled and will follow any DC component applied to the input. Some instruments such as spectrum analyzers could be damaged from overload or DC components.

Retained Settings

All front panel settings, including Precision Voltage Generator (PVG) settings are retained when the instrument is turned off. The DA1855A return to the same state they were in when power was removed.

When used without ProBus interface, the instrument can be set to factory default settings by pressing the $\mathbf{V_{COMP}}$ and $\mathbf{V_{DIFF}}$ buttons simultaneously. Table 3-4 lists the factory default settings.

Table 3-5. DA1855A Factory Default Settings

Gain	X1
Attenuation	÷10
+ Input Coupling	Off
– Input Coupling	Off
Bandwidth Limit	Full
PVG Voltage	+00.000 V
V_{COMP}	Off
V_{DIFF}	Off
Input Resistance	1 MΩ
PVG Mode	Roll through zero

Sensitivity, Position and Offset

Oscilloscopes are designed to maintain their accuracy for that portion of a signal that is displayed on-screen. When the signal is large enough to drive the display off-screen, the oscilloscope's amplifier must limit the signal in a non-linear mode. Oscilloscopes are designed so that no matter how the sensitivity, position and offset controls are set, the operator cannot view this distorted portion of the signal.

When used with a LeCroy oscilloscope, the setup is automatic to prevent the user from entering a mode which could result in displaying a distorted signal resulting from overload.

When used with instruments lacking ProBus interface, the instrument's gain and position controls should be properly set to avoid displaying the non-linear portion of the DA1855A's output signal when it is in overdrive. This can be accomplished by observing the two following rules:

1. **Turn the oscilloscope input coupling to "OFF" or "GND", set the oscilloscope position control to center screen, and do not change it!** If the oscilloscope has an **OFFSET** control, it too should be set to zero. Return the oscilloscope's input coupling to "**DC**". Subsequently adjust the trace position on the oscilloscope screen using the DA1855A PVG and $\mathbf{V_{DIFF}}$ mode or $\mathbf{V_{COMP}}$ input. This assures that the oscilloscope is set to the center of the DA1855A's dynamic range.

2. **Set the oscilloscope deflection factor to no greater than 100mV/div.** The most useful range for the oscilloscope deflection factors will be between 1mV/div and 100mV/div. Using a scale factor of 200 mV/Div will allow the nonlinear portion of the DA1855A's output to be viewed on screen.

More sensitive settings (e.g. 100µV/div) available on some oscilloscopes can be used, but their usefulness may be limited by noise, particularly with the DA1855A **FULL** bandwidth limit selection and without averaging. With the oscilloscope set to 100µV/div and the DA1855A in the **X10 GAIN** mode, the overall scale factor will be 10µV/div.

In the **X10 GAIN** mode, the DA1855A has lower noise than many oscilloscopes, so it is preferable to use the /DA1855A **X10 GAIN** mode and a lower oscilloscope scale factor. For example, to obtain the best noise performance at 1mV/div, set the DA1855A to **X10** mode and the oscilloscope to 10mV/div rather than the use **X1** mode and 1mV/div. This also maximizes the bandwidth, as some oscilloscopes give up some bandwidth at their most sensitive settings. Some oscilloscopes give up bits of resolution to obtain 1mV or 2 mV/div sensitivity. The loss of resolution can be avoided by using this technique. Any oscilloscope bandwidth limit setting may be used so long as the unlimited signal does not exceed full screen before invoking bandwidth limit.

Gain Control Modes

When the DA1855A is connected to a LeCroy oscilloscope equipped with ProBus interface, the displayed scale factor and measurement values will be adjusted to account for the effective gain of the differential amplifier.

With software version 8.1.0 and higher, there are two modes of gain control, **Auto** and **Manual**. The oscilloscope defaults to Auto mode when the amplifier is first attached. In Auto mode, the **VOLTS/DIV** knob controls the oscilloscope scale factors Gain and Attenuation to give the full available dynamic range 200µV/div to 1 V/div without external probe attenuation, or 20 mV/div to 100 V/div with ÷100 probe installed.

Some of the transitions in scale factor will result in a change of the attenuation of the external probe. Changing the amplifier's gain or attenuation will alter the common mode range and noise performance of the differential amplifier. For Volt/Div settings which can be produced with more than one combination of amplifier gain and attenuation settings, Auto mode selects the combination which results in greater common mode range.

In some situations, the user may wish to select amplifier settings optimized for the lowest noise performance with lower common mode range. Or, the user may require the amplifier not to change noise or common mode range when the **VOLTS/DIV** setting is changed. These requirements can be met by selecting the Manual mode in the menu box of user interface window.

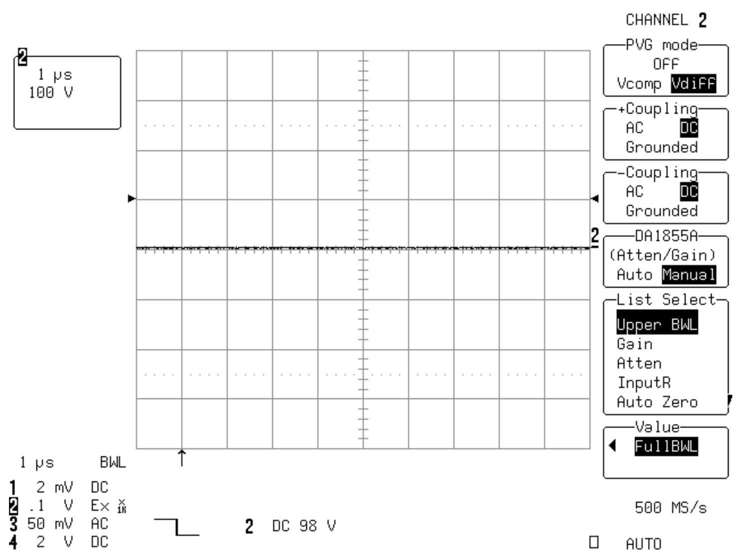

Figure 3-2. DA1855A Control Menu in Manual Mode.

When set to Manual mode, the dynamic range of the **VOLTS/DIV** knob is limited to the scale factors which can be obtained without changing the DA1855A gain or attenuation. Thus in Manual gain control mode, only the scale factor of the oscilloscope will be changed. In this mode, dedicated menu boxes are displayed for amplifier Attenuation and Gain. (Refer to figure 3-2).

The available attenuation values which appear in the Value box will be **/10** or **/1** independent of the attenuation of any external probe.

With software version 8.1.0 or higher, the channel **OFFSET** knob will control the amplifier's offset rather than the amplifier's PVG buttons.

Probes and Differential Amplifiers

When using a differential amplifier it is very important to understand the role probes play in the overall measurement system performance. Probes not only make attachment to the circuit under test more convenient, ÷10 and ÷100 attenuating probes also extend the common mode range of the differential amplifier. For example, the DA1855A amplifiers have a common mode range of ±15.5 volts when their internal attenuators are set to ÷1 and 155 volts when set to ÷10. The addition of a probe with an attenuation factor of ten will extend the common mode range to 1550 volts or the rating of the probe, whichever is less.

There is a trade-off, however. The Common Mode Rejection Ratio (CMRR) capability of even highly matched differential probe pairs is seldom as good that of the amplifier. In order to preserve as much of the amplifier's performance as possible at the probe tips, it is important to use probes that are designed for differential performance. Attempting to use normal ÷10 or ÷100 attenuating oscilloscope probes, even high quality probes, will result in very poor CMRR performance. Nominally matching ÷1 probes however, will provide excellent common mode rejection and are recommended.

For applications which do not require additional attenuation, ÷1 probes present relative high capacitive loading to the circuit under test, limiting their usefulness to low frequency measurements.

When making differential measurements, accurate probe compensation is much more important than in single-ended measurements. Most probes depend on the accuracy of the oscilloscope's 1 MΩ input resistor to determine the accuracy of the probe's attenuation factor. Two probes with a 1% accuracy specification can yield a CMRR as low as 50 to 1 at DC while the amplifier CMRR may be higher than 100,000 to 1. At high frequencies, the CMRR will be worse.

A differential probe pair must allow for matching at DC as well as over their useful frequency range. Changing the compensation of a differentially matched probe set without following the proper compensation procedure can result in a significant decrease in the CMRR capability of any differential probe pair.

It is a good practice to compensate a probe pair for a given amplifier and then leave the probe pair and amplifier together as a system. Similarly, it is important that, once compensated for a given amplifier, each probe always be used on the same input (one probe always on the +INPUT and the other always on the –INPUT).

The DXC100A Differential Probe Pair

The DXC100A is a high performance matched passive differential probe pair designed for use with LeCroy DA1855A series differential amplifiers. The probe pair consists of two well-matched individual probes that share a common compensation box to allow the attenuation factor on both probes to be simultaneously switched between ÷10 and ÷100. When used with the DA1855A Differential Amplifier, the probe's attenuation factor is automatically incorporated into the effective gain display and the decimal properly located in the Precision Voltage Generator (PVG) display.

Probe Grounding

The DXC100A Probe Pair is supplied with accessories that allow for three methods of connecting probe grounds.

In most cases, when the common mode portion of the signal consists mainly of low frequencies (1 MHz and below), the probe ground leads should not be connected to the ground of the circuit under test. They should be connected to each other. This minimizes the effects of ground loop currents. The signal corruption caused by not having the probes connected to the ground of the circuit under test will be common to both inputs and will be rejected by the differential amplifier.

However, when working in an environment with high RF ambient noise, it is best to connect the probe ground leads to a good RF ground near the point where the signal is being measured.

The best way to determine which probe grounding technique should be used is to try both methods and use the one that gives the least corruption of the differential signal.

When adjusting the compensation and probe CMRR, the use of probe tip to BNC adapters is required. They provide the best performance of the three grounding method.

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