

ILT1000 and ILT5000 4-20mA Application Note

Overview and basic configurations

Both the ILT1000 and ILT5000 provide a programmable 4-20mA connection for interfacing to a programmable logic controller (PLC). This document describes the usage of that interface.

Figure 1 shows a typical ILT1000/5000 connection to a PLC. The actual loop power, commonly called the “Transmitter Supply” is either supplied by the PLC or an external supply. In the case of Figure 1 below, the loop power is supplied by a 24V DC power supply. The device controlling the current on the loop, the ILT1000 or ILT5000 in this case, is commonly called the “Current Transmitter”.

It is important to note that the ILT1000/5000 *logic* is powered by the USB port and not by the loop/transmitter supply. This is referred to as a “self-powered” device, as opposed to a “loop-powered” device. This allows programming and control of the 4-20mA loop while the loop is connected. Typically, however, a computer is used to program the ILT1000/5000 to establish a relationship between the light level and 4-20mA current level, after which time the computer is removed and the PLC monitors the 4-20mA output. Figure 2 shows a configuration where the loop/transmitter supply can also be isolated and stepped-down to power the ILT1000/5000 via the USB port, effectively creating a more traditional and simplified “loop-powered” configuration.

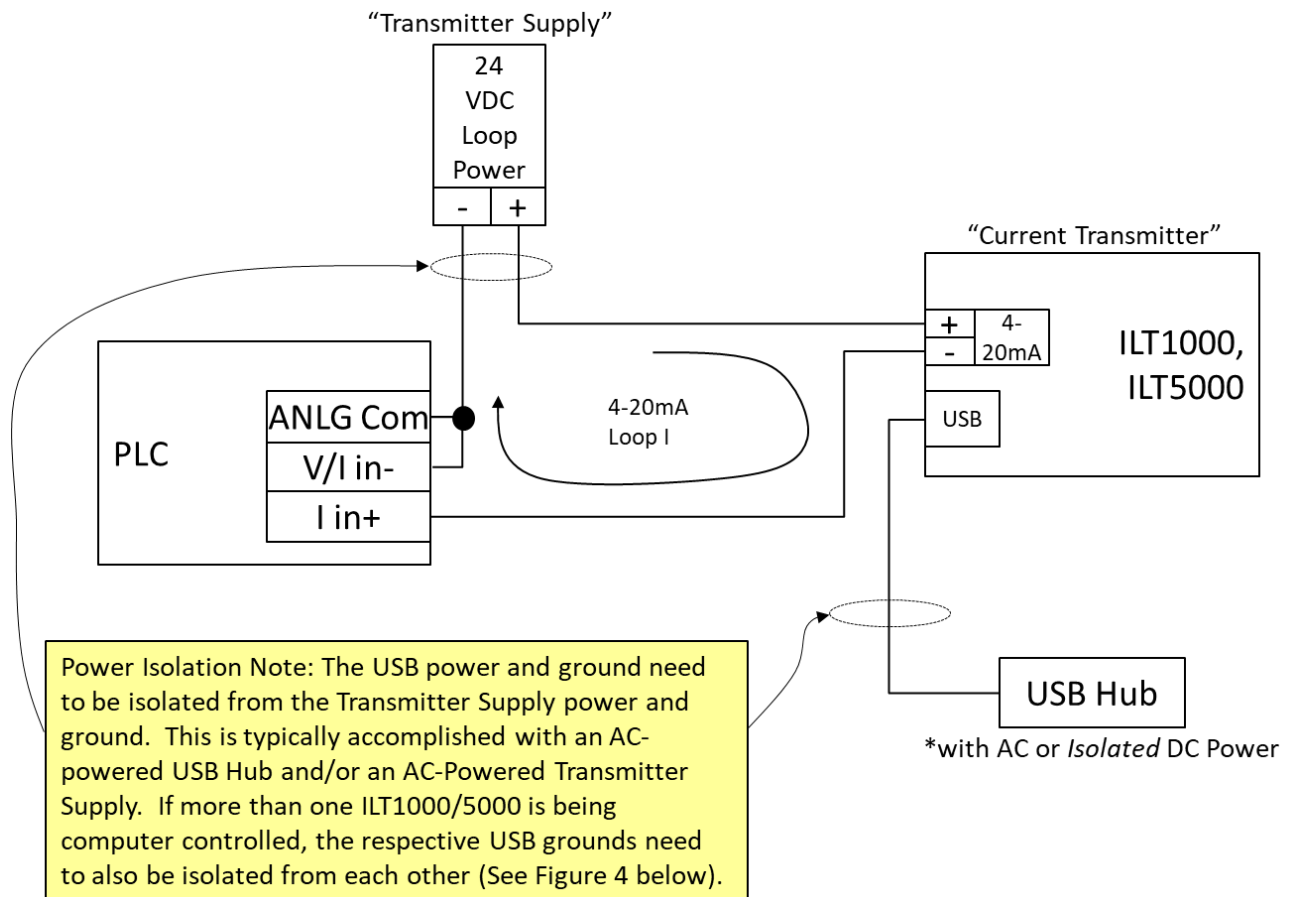


Figure 1. Typical ILT1000/5000 to PLC connection.

The Power Isolation Note in Figure 1 is important to understand. In many 4-20mA sensors, the sensor is completely powered from the loop power (typically a 24VDC input to the sensor). In these cases, there is no need for isolation as only one power source exists. The ILT1000/5000 devices, however, allow for concurrent programming over USB and sensing over the 4-20mA current transmitter output. As a result, and because the ILT1000/5000 does not contain its own voltage isolation, external isolation between the USB power and the Transmitter Supply is required.

IMPORTANT note on loop power and cabling:

Voltages of > 50V at the ILT1000/5000 4-20mA terminals will cause permanent damage to the unit. This is true for misconfigured power configurations as well as momentary EMI/ESD-related voltage spikes. It is recommended that all power is double-checked before application to the device and that grounded, shielded cabling is used to attenuate any EMI/ESD impacts.

Figure 2 uses an isolated USB power cable to power the ILT1000/5000 logic from the loop power. This configuration mimics a more traditional 4-20mA sensor configuration. In this setup, the ILT1000/5000 is either used in the default mode (log output) or the ILT1000/5000 is programmed for a custom output using one of the `setcurrentloop` API's prior to being placed into service.

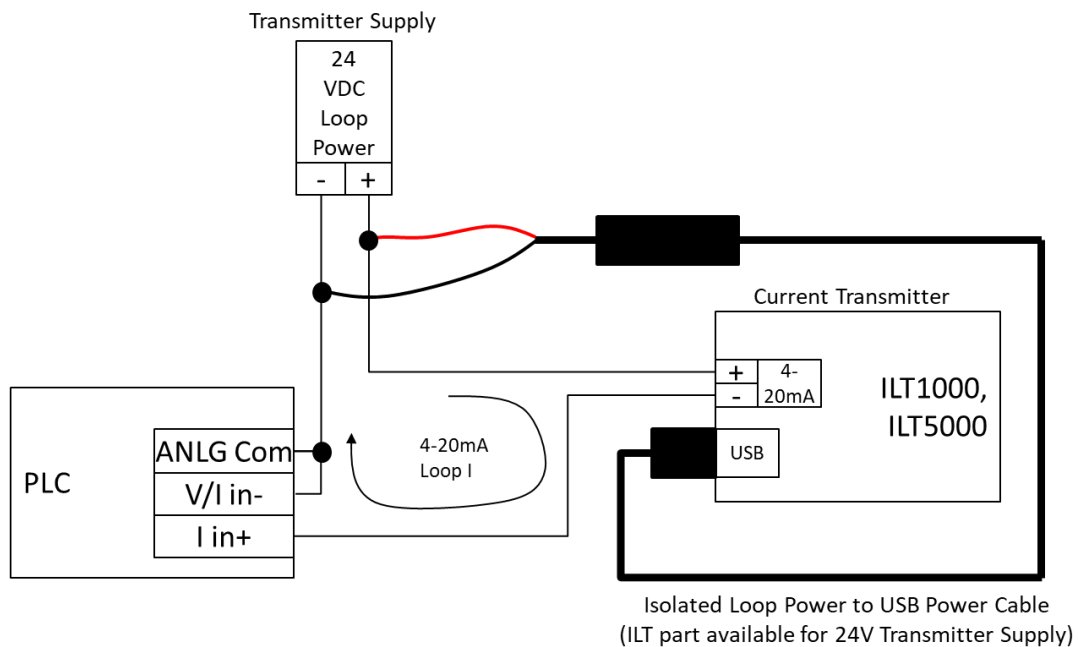


Figure 2. Powering the ILT1000/5000 USB port with isolated Loop Power.

Figure 3 below shows a simple test setup that can be used for validation before connecting to a more complex PLC circuit. This can be used to test basic functionality as well as the light level to current loop scaling. This can also be used with the manual current loop API to set the current loop to an integer value, i.e. `setcurrentloop 10`, `setcurrentloop 15`, etc.

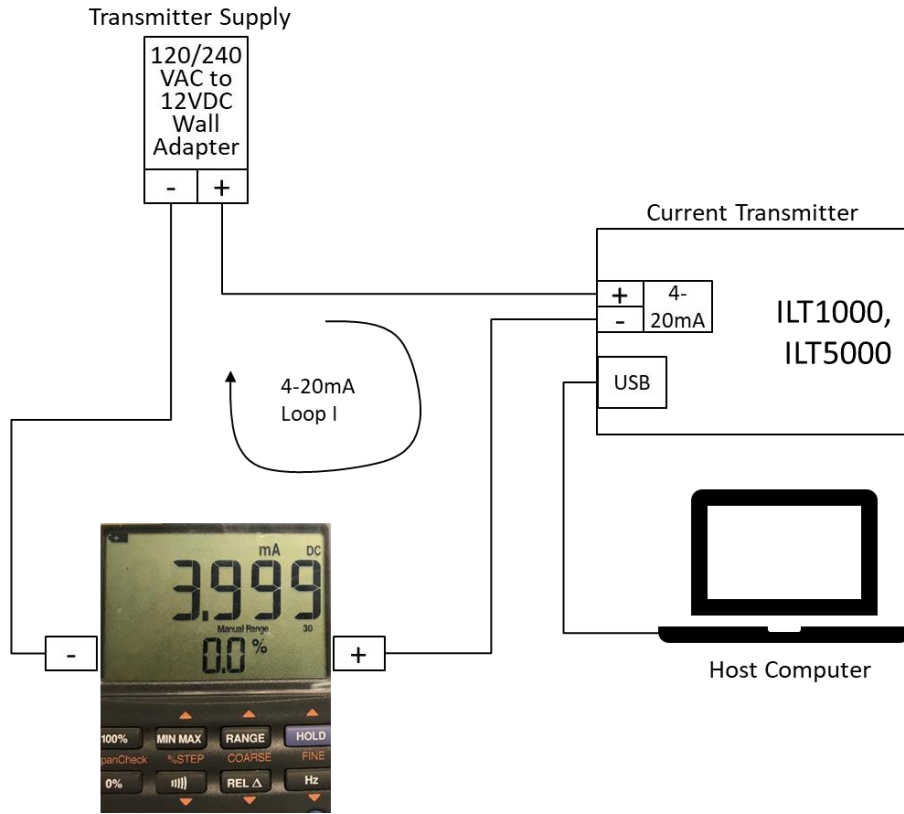


Figure 3. Simple ILT1000/5000 4-20mA Test Setup

The *4-20mA Programming* section further below describes details for controlling and configuring the device. Short of this programming detail, the device can be tested quickly as shown in Table 1.

Test Scenario	Expected 4-20mA Current Loop Output
ILT1000, expose the sensor to light	No light = 4mA For applied light, every 2.15x the light level results in another 1mA of loop current. For example, if a certain light level is producing 10mA on the loop, 2.15x that light level will produce 11mA, 4.62x (2.15 x 2.15) that light level will produce 12ma, etc.
ILT5000, connect detector and expose the sensor to light	No light = 4mA For applied light, every 10x the light level results in another 1mA of loop current. For example, if a certain light level is producing 10mA on the loop, 10x that light level will produce 11mA, 100x that light level will produce 12ma, etc.
ILT1000/5000, manually set the current on the loop using the DataLight CLI software and the <code>setcurrentloop [0-24]</code> command as follows: <pre>setcurrentloop 10 setcurrentloop 20</pre>	These will manually set the loop current to 10mA and 20mA respectively. Use: <pre>setcurrentloop log</pre> to return the unit to the default light sensing mode.

Table 1. Basic testing scenarios.

Additional configurations

Figure 4 depicts a more elaborate setup where (a) each ILT1000/5000 meter can be independently and actively controlled and monitored from the USB input and (b) full USB power isolation is maintained between both the PLC and the USB as well as among all the USB inputs. ILT has tested with the B&B Smartworx BB-UH401-2KV, but similar devices should work as well.

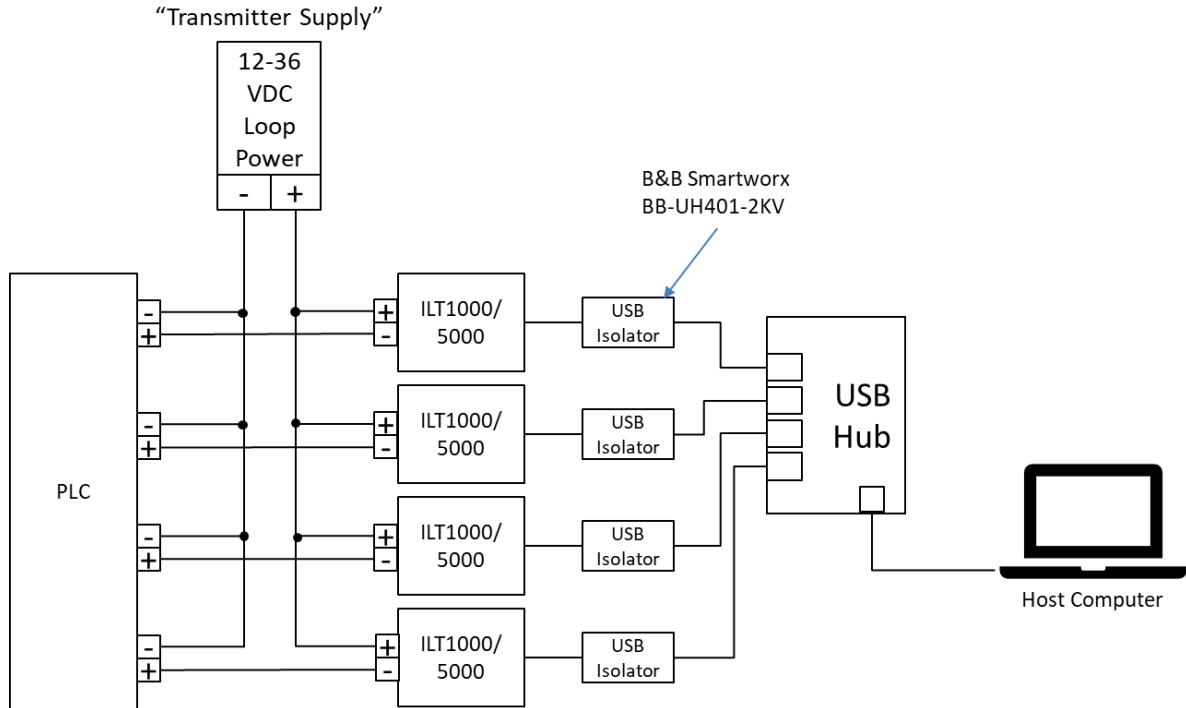


Figure 4. Unit-to-Unit USB Isolation.

Figure 5 below illustrates the use of a current loop isolation device. This is to address situations where the PLC and Transmitter Supply require isolation from each other. Acromag is an example of a supplier of 4-20mA loop isolators (<http://www.acromag.com>).

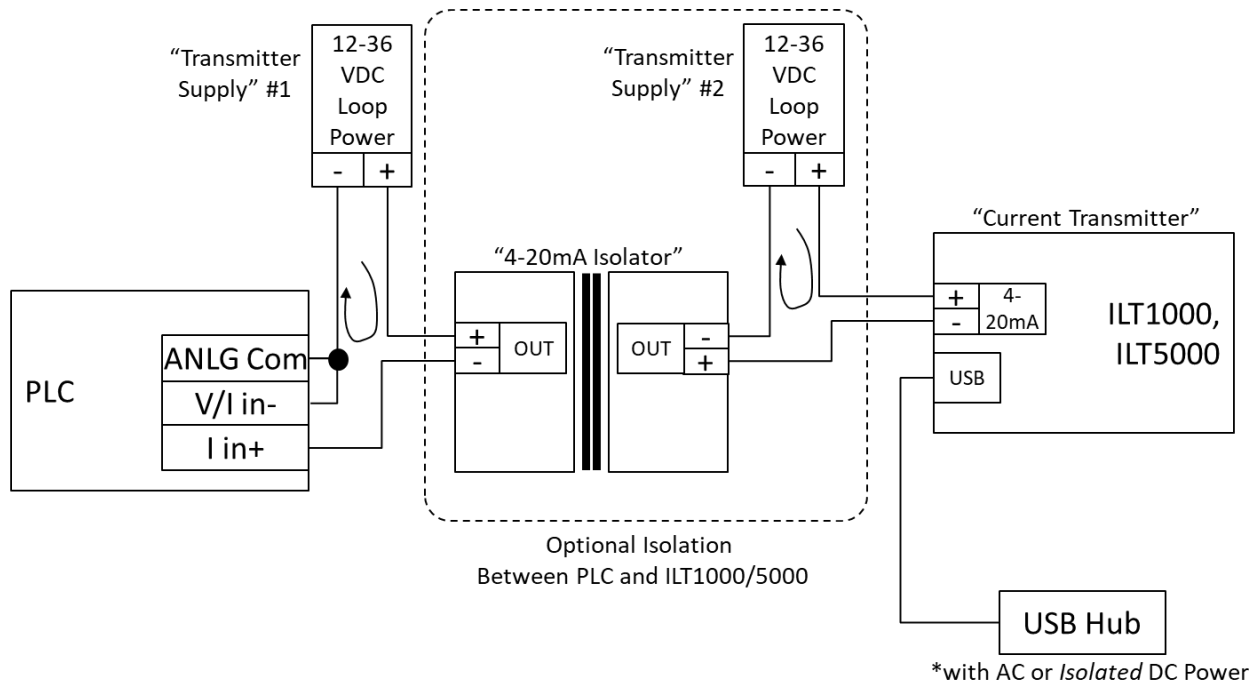


Figure 5. Isolated Transmitter Supply.

Figure 6 shows a configuration whereby a 4-20mA loop current is converted to 2-10V input. This can be used to interface with any 0-10V analog input. The value of the 500 Ohm resistor can be changed to accommodate smaller voltage input ranges. In this configuration it is important that the voltage of the transmitter supply be high enough to accommodate the voltage drop of the load resistor. In the diagram below, at with a 20mA current loop, the voltage drop across the 500 Ohm resistor would be 10V. The 24 VDC transmitter supply depicted would support this additional voltage drop.

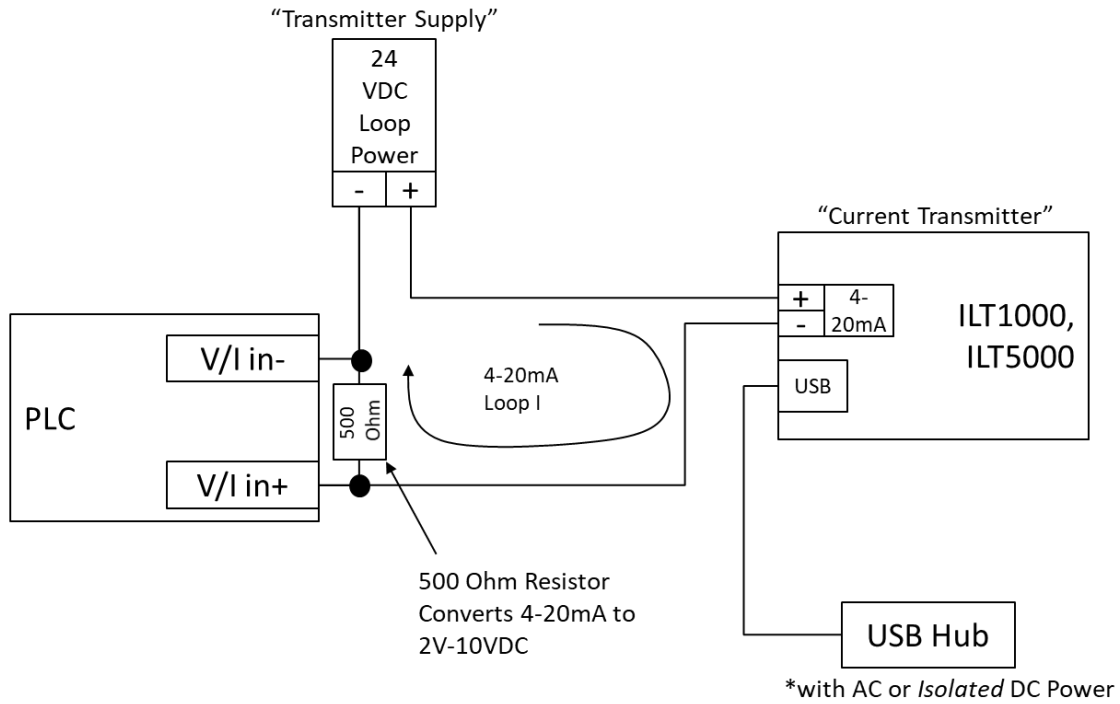


Figure 6. 4-20mA conversion to 2-10V

4-20mA Programming

Table 2 provides detail programming instructions to configure the 4-20mA output. These configuration settings are stored in non-volatile memory and persist across power cycles. As a result, the system can be configured by using a host computer, and then put into production without a computer.

International Light provides a “4-20mA Current Loop Programming” Excel spreadsheet that translates light sensing requirements to API settings. Use of this document is highly recommended to simplify and validate the programming.


```
setcurrentloop
(ILT1000, 5000)

Support Starting in
Firmware Version: 2.0.0.5

setcurrentloopirr
setcurrentloopirr
log
setcurrentloopdose
all
setcurrentloopdose
alllog
setcurrentloopdose
sample
setcurrentloopdose
samplelog

Support Starting in
Firmware Version: 3.2.1.6

Support Ending in Firmware
Version: N/A
```

Syntax:

```
setcurrentloop log
setcurrentloop midpoint
setcurrentloop [min picoamps] [max picoamps]
setcurrentloop [0-24]
setcurrentloopirr [min irradiance] [max irradiance]
setcurrentloopirrlog [min irradiance] [max irradiance]
setcurrentloopdoseall [min dose] [max dose]
setcurrentloopdosealllog [min dose] [max dose]
setcurrentloopdosesample [min dose] [max dose]
setcurrentloopdosesamplelog [min dose] [max dose]
```

What it does:

This command controls the 4-20mA current loop output of devices that support such a current loop.

`setcurrentloop log` sets the device to output a logarithmic scale current that is in relation to the current sensed by the detector. The transfer function is:

ILT1000:
4-20mA current = (LOG10(detector current)+8)*3+5
Detector Current = 10^(((4-20mA Current]-5)/3-8)

ILT5000:
4-20mA current = (LOG10(detector current)+11)*1+5
Detector Current = 10^(((4-20mA Current]-5)/1-11)

If a calibration factor is set, the 4-20mA output will have a similar relationship to irradiance, but multiplied by the calibration factor.

If the detector current is below 10 nA (ILT1000) or 1pA (ILT5000), the 4-20mA current is set to 4mA. In this mode, the ILT1000 is nuanced in that measurements fluctuating around 10nA will result in the 4-20mA output bouncing between 4mA and 5mA (where the default log range starts in the ILT1000).

`setcurrentloop midpoint` sets the device to output a linear scale where:

4mA = 0 detector current
12mA = the detector current when this command was set
20mA = double the detector current when this command was set

`setcurrentloop [min picoamps] [max picoamps]` sets the device to output a linear scale where:

4mA = min picoamps
20mA = max picoamps

Note: [min picoamps] must be 25 or greater to avoid defaulting to manual mode (below).

`setcurrentloop [0-24]` sets the device to manually output the current indicated, in milliamps. This is used for testing the current loop.

setcurrentloop
(cont)

setcurrentloopirr [min irradiance] [max irradiance] sets the device to output a linear scale where:

4mA = min irradiance
20mA = max irradiance

setcurrentloopirrlog [min irradiance] [max irradiance] sets the device to output a log scale where:

$4-20\text{mA} = (\text{LOG}_{10}(\text{irradiance}) - \text{LOG}_{10}([\text{max irradiance}]) * 16$
 $* \text{LOG}_{10}([\text{max irradiance}]/[\text{min irradiance}]) + 20$

Irradiance =
 $10^{((\text{LOG}_{10}([\text{max irradiance}]/[\text{min irradiance}]) * ([4-20\text{mA Current}]-20) / 16$
 $+ \text{LOG}_{10}([\text{max irradiance}]))}$

setcurrentloopdoseall [min dose] [max dose] sets the device to output a linear scale where:

4mA = min dose
20mA = max dose

Where dose starts integrating at the earliest of: power on of the device (if setcurrentloopdoseall is set at power on), issuing the startintegrate command, or issuing the setcurrentloopdoseall command

setcurrentloopdosealllog [min dose] [max dose] sets the device to output a log scale where:

$4-20\text{mA} = (\text{LOG}_{10}(\text{dose}) - \text{LOG}_{10}([\text{max dose}]) * 16$
 $* \text{LOG}_{10}([\text{max dose}]/[\text{min dose}]) + 20$

Dose =
 $10^{((\text{LOG}_{10}([\text{max dose}]/[\text{min dose}]) * ([4-20\text{mA Current}]-20) / 16$
 $+ \text{LOG}_{10}([\text{max dose}]))}$

Where dose starts integrating at the earliest of: power on of the device (if setcurrentloopdoseall is set at power on), issuing the startintegrate command, or issuing the setcurrentloopdoseall command

<pre>setcurrentloop (cont)</pre>	<pre>setcurrentloopdosesample [min dose] [max dose] sets the device to output a linear scale where: 4mA = min dose 20mA = max dose Where dose is calculated over the time period set by setsampletime or setsampletimeemp setcurrentloopdosesamplelog [min dose] [max dose] sets the device to output a log scale where: 4-20mA = (LOG10(dose)-LOG10([max dose]) * 16 * LOG10([max dose]/[min dose]) + 20 Dose = 10^ (LOG10([max dose]/[min dose]) * ([4-20mA Current]-20) / 16 + LOG10([max dose])) Where dose is calculated over the time period set by setsampletime or setsampletimeemp Special Current Loop Values: 3.25mA Loop issue 1.00mA Calibration factor not selected for setcurrentloopirr/dose 2.00mA Detector is saturated Normal return value(s): 0 on success Error return value(s): -500 if command not supported, i.e. on Gen1 devices -501 if missing fields -502 if there is a bad current loop value (applies to setcurrentloop [0-24]) Persist through power-cycle: Yes for all but setcurrentloop [0-24], which is intended as more of a test function.</pre>
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Table 2. Programming API for the ILT1000/5000 4-20mA Output

Other Considerations

Minimum Firmware Versions

- Ensure your meter has firmware version 3.1.4.7 or later installed.
- Firmware version 3.2.1.6 is required for irradiance- and dose-based current loop output.

Dose Modes

- When the current loop is used to represent dose (integrated energy), the meter switches to high-speed sampling mode such that it can accurately capture fast/flashing signals. As a result, standard meter operation is compromised as the signals being read are not averaged for noise reduction. As a result, dose modes are recommended for installations where the primary use of the meter is to provide 4-20mA output to a PLC. To temporarily disable the dose mode, issue `setcurrentloop log` or `setcurrentloop 10`, followed by re-issuing the `setcurrentloopdose...` command to resume 4-20mA output.
- If one of the dose modes is being used to sample high speed light signals, it is highly recommended to use a fixed gain range, i.e. `usefeedbackres 1`.

Error Currents Presented on the Loop

- The ILT1000/5000 will present 3.25mA on the loop (a fault current) in any case where a loop is properly formed, but for a variety of reasons the ILT1000/5000 cannot reliably control the current. This 3.25mA fault current can also sometimes be seen at initial loop connection, for an instant, before the ILT1000/5000 takes over control of the loop current.
- On firmware versions 3.2.1.5 and later, the ILT1000/5000 will output 2.00mA on the loop to indicate that the detector is saturated.
- On firmware versions 3.2.1.5 and later, the ILT1000/5000 will output 1.00mA on the loop to indicate that the device is setup to scale the 4-20mA output based in irradiance, but a calibration factor has not been defined.
- The ILT1000 detector current log scale (`setcurrentloop log`) is fixed at 4mA when the detector current is below 10nA, but immediately moves to 5mA at any current above 5mA. This results in a jump from 4mA to 5mA upon detection of anything above 10nA.

Transmitter/Loop Supply Voltage

- The Transmitter Supply voltage must be at least 10V greater than the voltage drop throughout the entire loop, including any resistor load that might be in place for current-to-voltage conversion. The 10V value is roughly 6V of internal voltage drop across protection diodes and 4V internal voltage drop across resistors at the maximum current of 24mA.

Loop Output Frequency

- The 4-20mA output is updated based on the sample time of the meter. For example, if the sample time is set to 0.250 seconds, the 4-20mA output is updated every 0.250 seconds. This can also be adjusted with the `setsampletime [ms]` command.