The 2100AN IS Laboratory Turbidimeters operate on the principle that the amount of light scattered from a sample is proportional to the quantity of particulate material in that sample. Light from an 870 ±30 nm LED is collected by a glass collimating lens and imaged on the sample cell containing the fluid to be analyzed. The optics have been designed to meet the requirements described in ISO Method 7027, which describes measurements of both FNU (Formazin Nephelometric Units) and FAU (Formazin Attenuation Units).

A series of baffles in the path between the lens and the sample cell catches light scattered from the lens surface to help prevent any stray light from entering the detectors. All but the baffle closest to the sample cell are sized so that the caustic that surrounds the light from the lenses just touches the baffle edges. The final baffle is oversized so that any misalignment of the beam will not cause the edges to glow and increase the instrument stray light. Silicon photodiodes in the sample area detect changes in light scattered or transmitted by the sample.

It should be noted that the same upper and lower optics housing as well as detectors are used for both the 2100AN IS and 2100AN versions of the laboratory turbidimeters, though a different light source is used in each.

The 2100AN IS contains an 8-mW LED operating at a peak wavelength of 870 ±30 nm. Because the LED's light is invisible and the LED operates at a relatively high output power, this LED is considered a Class 3B LED device. Although the LED is considered a 3B LED device, a double-fault interlock system has been integrated into the LED driver circuitry, which enables the overall instrument to be considered a Class 1 LED device. Class 1 LED products constitute no optical hazard to the user.

DANGER
Never look at this LED while power is applied to it without adequate protective infrared eyewear*.

PERIGO
Nunca olhe directamente para o LED sem utilizar os adequados óculos infravermelhos de protecção enquanto este estiver em funcionamento.

PELIGRO
Nunca se debe mirar el LED cuando esté conectado si no se llevan las gafas protectoras infrarrojas.

DANGER
Ne jamais regarder la DEL, lorsqu'elle est alimentée, sans protection oculaire adéquate contre les infrarouges.

GEFAHR
Ohne einen speziellen Infrarot-Augenschutz darf man unter keinen Umständen in die LED schauen, während diese in Betrieb ist.

* Hach recommends the following protective eyewear:
Glendale Protective Technologies Inc. Model 2200 LSR-GARD NDGA:YAG LGS LPW10
Optical density ratings:

5,000–11,000nm	OD>7
860–1080nm	OD>7
750–860nm	OD>5
710–750nm	OD>3
190–420nm	OD>9

DANGER
The LED used in the 2100AN IS is a Class 3B LED device, which means it has enough invisible radiated energy to cause serious eye injury. The LED used as the infrared light source uses a 100 mA current, and emits invisible radiation at 870 ±30 nm at a radiated power of 8 mW. The LED is rated for a maximum input current of 200 mA, and its radiated power will increase proportionately with the current.

PERIGO
O 2100AN IS é um dispositivo que utiliza LED da categoria 3B, o que significa que emite energia invisível suficiente para provocar graves danos oculares. Como uma fonte de luz infravermelha, o LED utilizado tem uma corrente de 100 mA e emite uma radiação invisível de 870+30 nm com uma energia de radiação de 8 mW. O LED está regulado para uma corrente de entrada máxima de 200 mA e a energia radiada aumenta proporcionalmente à corrente.

PELIGRO
El LED utilizado en el modelo 2100AN IS es un dispositivo de LED de Clase 3B, que significa que irradia la suficiente energía invisible como para causar serias lesiones oculares. El LED empleado como fuente de la luz infrarroja utiliza una corriente de 100mA y emite una radiación invisible a 830 ± 30 nm con una potencia de radiación de 8 mW. El LED admite una corriente máxima de entrada de 200 mA y su energía radiada aumentará de forma proporcional a la corriente.

DANGER
La DEL utilisée dans le 2100AN IS est un équipement DEL de classe 3B, ce qui signifie qu'il émet un rayonnement invisible d'énergie suffisante pour causer des blessures graves aux yeux. La DEL utilisée comme source de lumière infrarouge utilise un courant de 100 mA et émet un rayonnement invisible à 870 ±30 nm avec une puissance rayonnée de 8 mW. La DEL est prévue pour un courant maximal de 200 mA et sa puissance émise augmente proportionnellement à l'intensité du courant.

GEFAHR
Die LED des 2100AN IS ist eine Klasse 3B LED-Vorrichtung, d. h. sie erzeugt genug unsichtbare Strahlungsenergie, um ernsthafte Schädigungen der Augen zu verursachen. Die als Infrarot-Lichtquelle benutzte LED arbeitet mit einem Strom von 100 mA und gibt bei einer Leistung von 8 mW eine unsichtbare Strahlung von 870 ±30 nm ab. Der maximale Eingangsstrom der LED beträgt 200 mA ausgelegt und die unsichtbare Strahlung wird sich proportional zum zugeführten Strom erhöhen.

The LED is mounted in a machined aluminum mount that also holds the glass lens, a spacer between the lens and LED, the LED itself, and a monitor detector. The entire aluminum assembly is inserted into a slot in the standard optics base. The LED and detector wires exit out the left and right side of the optics assembly and plug into the preamp board (which sits on top of the optics assembly).

Four detectors measure the amount of light scattered at various angles around the sample cell. Each is described below:

A detector at 90 degrees nominal to the forward direction measures light scattered from the sample normal to the incident beam. This detector is mounted out of the plane formed by the light beam and the other detectors. The angle and baffling for this out-of-plane mounting block light scattered directly from the sides of the sample cell while collecting light scattered from the light beam and refracted into the detector. This detector exclusively measures the FNU and non-ratio NTU turbidity and, in conjunction with the other detectors, measures NTU ratio turbidity.

A large "transmitted" detector measures the light that passes through the sample. A "neutral density" filter attenuates the light incident on this detector and the combination is canted at 45 degrees to the incident light. Reflections from the surface of the filter and detector do not enter the sample cell area. This detector exclusively measures the FAU turbidity and %Transmittance and Absorbance, and, in conjunction with the other detectors, measures NTU ratio turbidity.

A "forward" scatter detector measures the light scattered at 30 degrees nominal from the transmitted direction. This detector contains an integrated "fish eye" lens to focus the light onto the detector. This detector "sees" light scattered by moderately turbid samples (approx. 200–4000 NTU), and measures only NTU ratio turbidity.

A "back" scatter detector measures the light scattered at 138 degrees nominal from the transmitted direction. This detector "sees" light scattered by very turbid samples when the other detectors no longer produce a signal linear with turbidity, extending the measurement range up to 10,000 NTU. This detector measures only NTU ratio turbidity.

Figure 1 Ninety-Degree Detector Output vs. Turbidity (NTU)

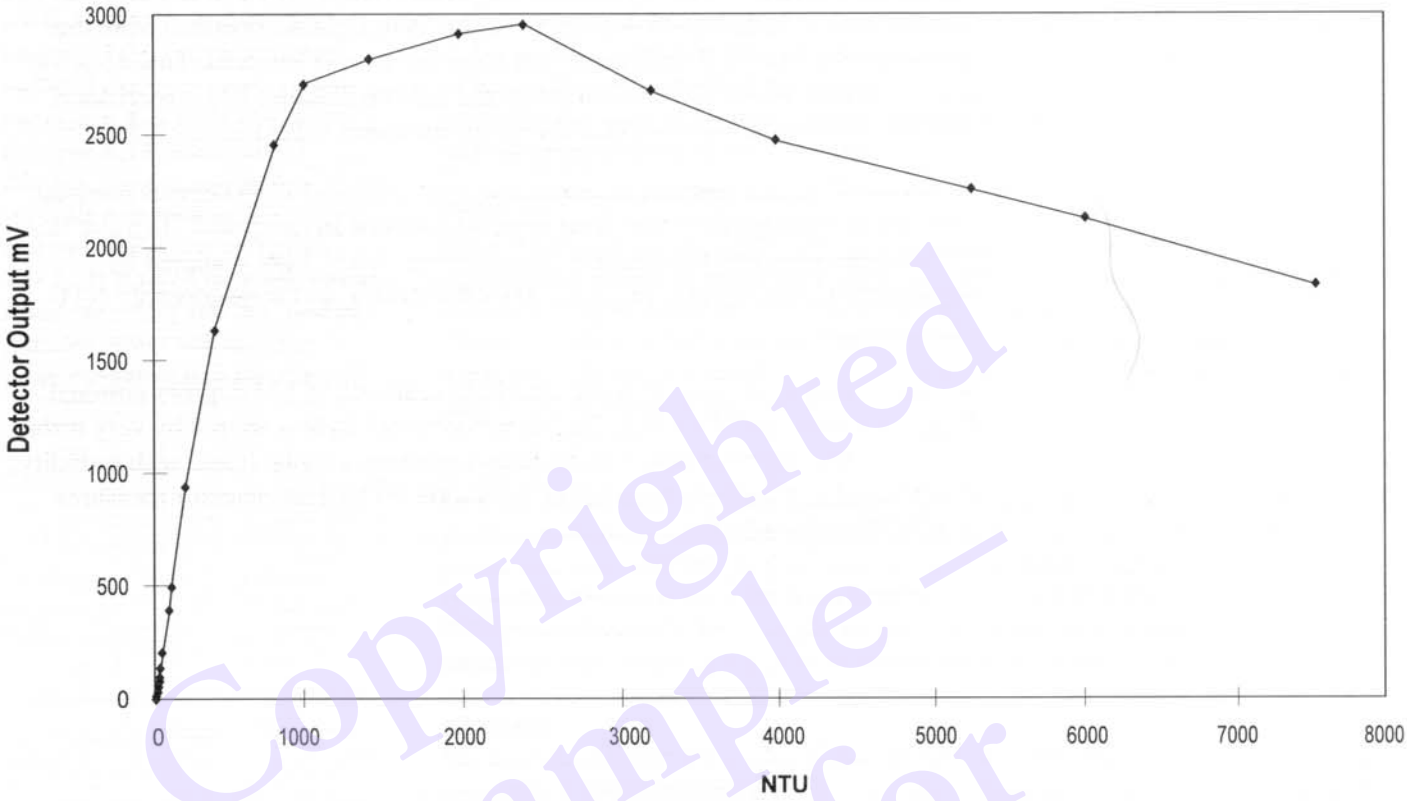


Figure 2 Forward Scatter Detector Output vs. Turbidity (NTU)

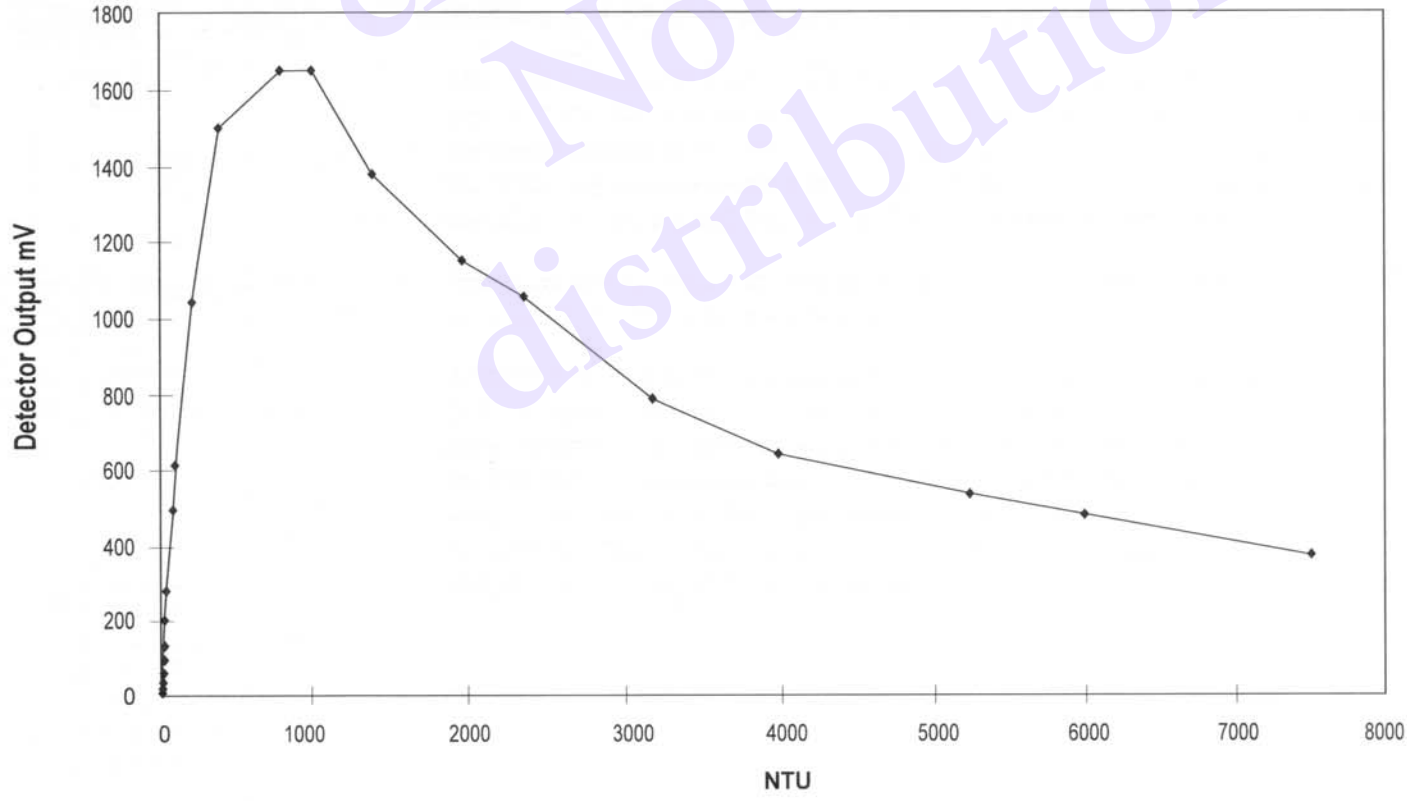


Figure 3 Transmitted Detector Output vs. Turbidity (NTU)

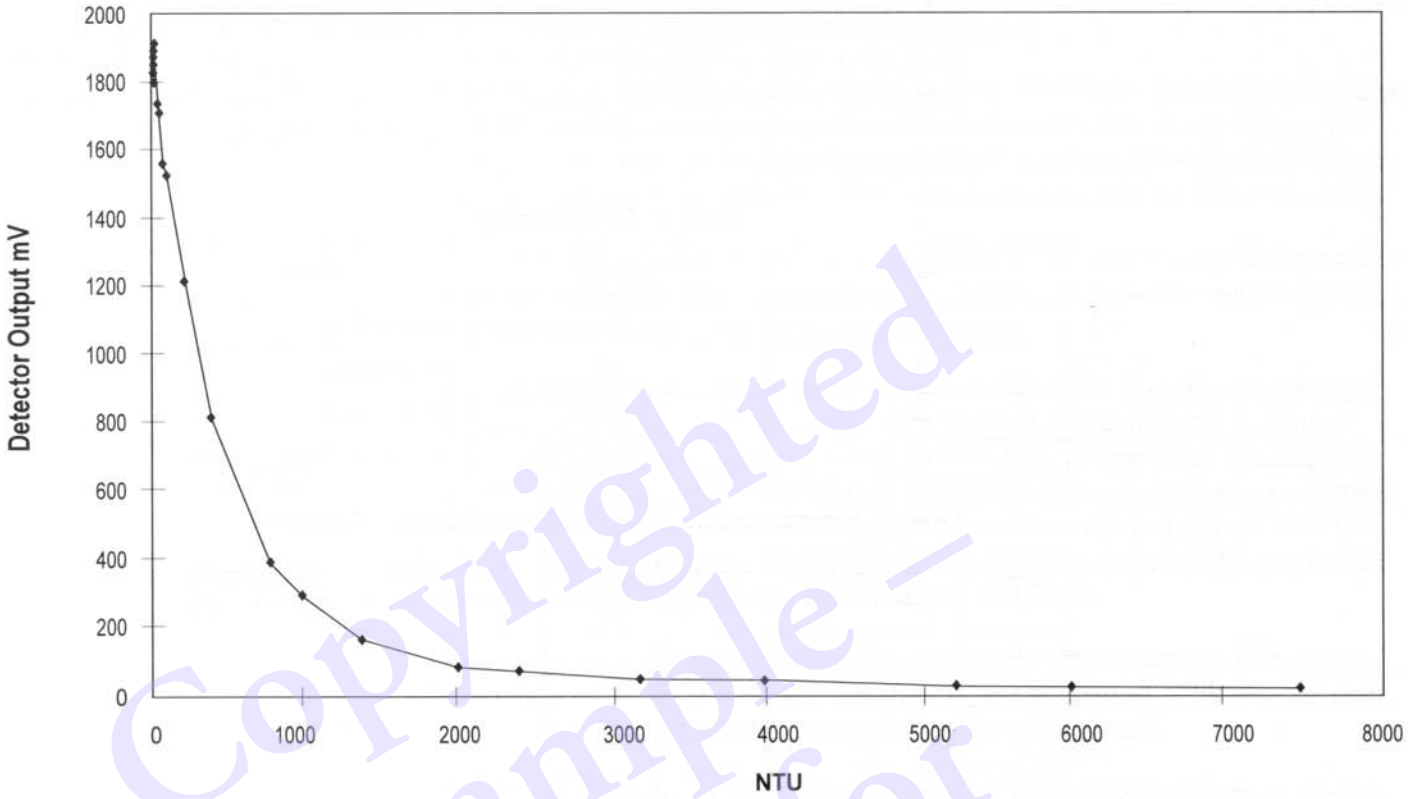
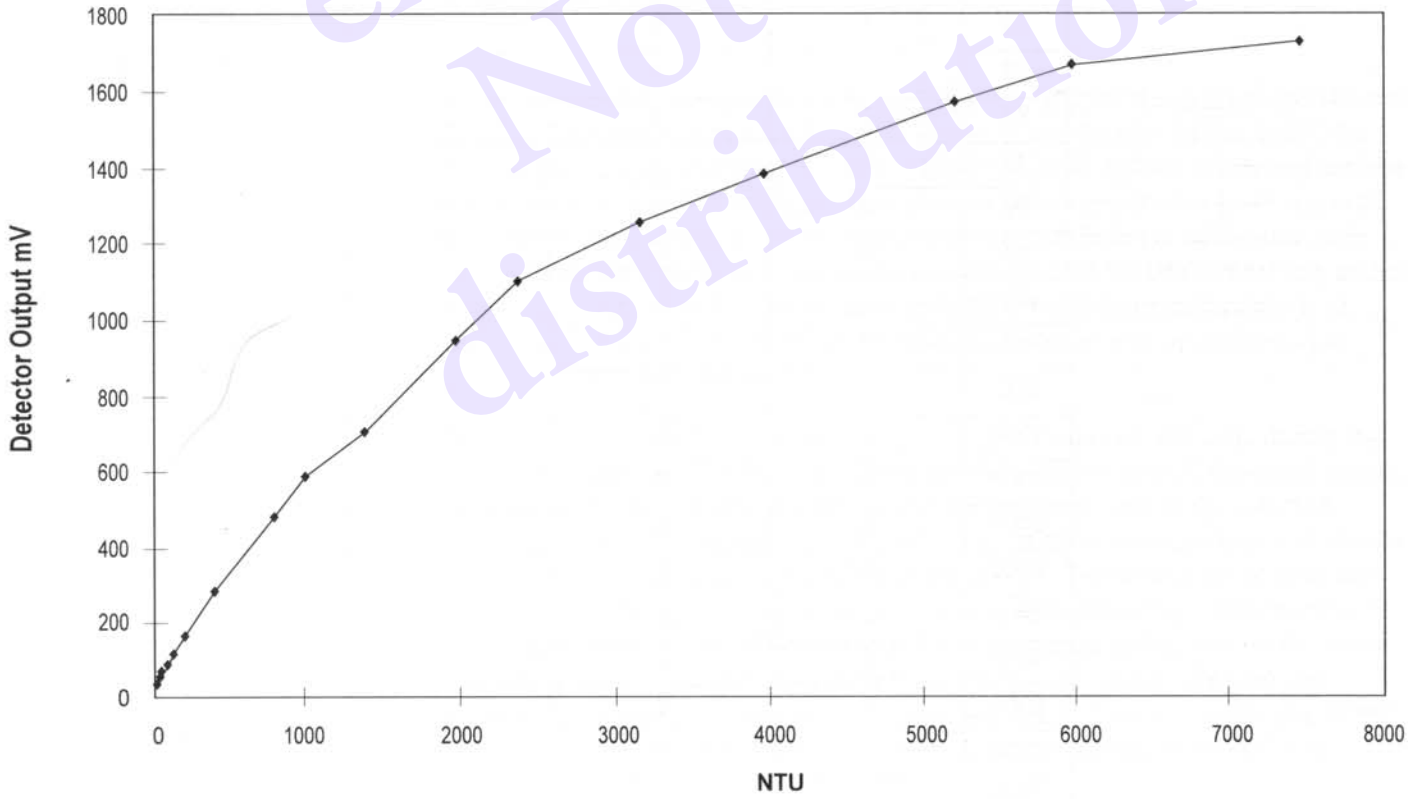


Figure 4 Back Scatter Detector Output vs. Turbidity (NTU)



To extend the range of the instrument, the preamp board implements multiple gain settings for each photodetector amplifier. *Table 2* describes each gain setting, and *Table 3* shows the typical switch point for each detector amplifier (in NTUs). These gain settings can be manually selected from the setup mode by entering the appropriate setup number. For example, to obtain the 90 degree gain setting x100, enter setup number 27 (according to *Table 5*, Section *12* of the *2100AN IS Instruction Manual*).

Table 2 Gain Settings

Gain	Setting	Notes
0	x1	All detectors
1	x10	All detectors
2	x100	All detectors
3	x1000	90 Degree Detector Only

Table 3 Typical Switch Point for Each Detector Amplifier

NTU	90 Degree Detector Gain	Forward Scatter Detector Gain	Transmitted Detector Gain	Back Scatter Detector Gain
0	3	2	0	2
1	2	2	0	2
2	2	2	0	1
4	2	1	0	1
5	2	1	0	1
10	1	1	0	1
15	1	1	0	1
20	1	1	0	1
30	1	1	0	1
40	1	1	0	1
80	0	0	0	1
100	0	0	0	1
200	0	0	0	1
400	0	0	0	1
800	0	0	0	0
1000	0	0	0	0
1400	0	0	0	0
2000	0	0	1	0
2400	0	0	1	0
3200	0	0	1	0
4000	0	0	1	0
5250	0	0	1	0
6000	0	0	1	0
7500	0	0	2	0