Specification
Transimpedance Amplifier Product

Document No. 1

Prepared by: Carl Angotti

Date: February 25, 2025

Revision: 0.1 (New)

Signatures:

____
Project Manager

____
Engineering Manager

____
Project Engineer

Section 1.0
Revision History

Date	Change Prepared by	Description of change
2/25/2026	Carl Angotti	Initial Document, for revised Device

Section 2.0 Table of Contents

Not Applicable

Section 3.0 List of Reference Documents

Not Applicable

Section 4.0 Product Definition

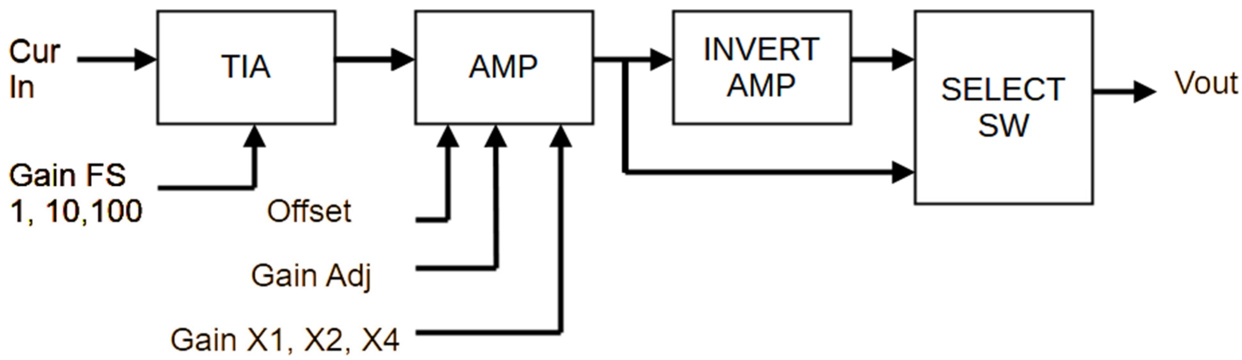
This document defines a hardware product to be developed for the low-input-current-to-voltage (Transimpedance) amplifier (TIA) market. The product is a board-level, multi-range TIA module intended for interfacing photodiodes and other low-current sensors with digital voltmeters, oscilloscopes, and microcontrollers with analog inputs.
The module provides multiple selectable transimpedance gain ranges, enabling users to match sensitivity and dynamic range to sensor currents spanning from very low (picoamp-class) to higher (microamp-class) levels. This multi-range capability supports both feasibility testing of photo-optical systems and integration into embedded sensing applications.

TIA devices of this type are commonly used in proximity detection, robotics, and general low-current sensor interfaces. The product is intended as a general-purpose, high-stability front-end suitable for both benchtop laboratory use and embedded system development.

Section 5.0

General Description of the Function of the System

The functional System for the simplest version of the Transimpedance Design is shown below. The TIA input is transformed into a voltage that passes through a multiple-gain amplifier, onto a Gain of 1 Inverting Amplifier, and through an output selection switch. The selection switch allows the signal to be inverted to accommodate different photodiode and low-level current configurations.



Block Diagram 1 – Simplest Version of the TIA circuit.

Gain Range: The TIA has a gain selection of 1, 10, or 100 times the 40 nA full-scale base conversion. This is followed by a selectable X1, X2, and X4 gain via jumpers. This creates a full-scale range of 10, 20, or 40 nA. This configuration will be the equivalent of adding 2 bits of dynamic range from the input to the output. This will add 2 bits of dynamic range to the standard 12-bit A/D available on most microcontrollers

Output Voltage Range: The output has a selectable (via jumpers) full-scale dynamic range of 3.3 or 5.0 volts. Hence, it will be compatible with two standard microcontroller ADC (Analog-to-Digital Converter) devices, such as the Arduino or Raspberry Pi.

Power Input Voltage Range: The device requires two power voltage inputs. One is a positive and one a negative, ranging from +9 Volts to +24 Volts and -9 Volts to -24 Volts, respectively.

Section 6.0

Definition of Critical System Parameters

This can include noise, bandwidth, accuracy, drift, etc, for hardware. It can include response time, code size limitations, special algorithms, languages used, etc., for software. These often appear in tables or lists.

AC or DC coupling Parameters – This feature is switch-selected via a jumper

Input Signal Range (with Selection) – 1 nA to 10 uA (TBD)

Output Signal at Full Scale – 3.3 or 5 V Selectable

Absolute Accuracy (with Adjustment) – 0.1% of full scale

Zero Adjustment Range - +/- 5% of full scale

Large Gain Range – Fixed and Selectable – 0 to 10 na, 100 nA, 1 uA

Small Step Gain Range – Fixed and Adjustable - X1, X2, X4
Note: This expands the gain range by 2 bits from input to output to accommodate the maximum MCU resolution required for a signal input. Most MCUs have a 12-bit resolution on the front end. For example, if the output signal is not greater than ½ Scale (1.75 or 2.5 volts), one bit of resolution is lost.

Gain Adjustment - +/- 20% of Full Scale to accommodate an MCU ADC range full scale of 3.3 to 5 Volts

Temperature Stability at Full Scale and gain – < 10 uV per degree Centigrade

Step Transient Response - 10% to 90% - < 100 uSec

Target Bandwidth:

- **Upper Bandwidth** - Minimum of 10 Khz @ -3db point
- **Lower Bandwidth –** 0 Hz or 1 Hz, depending on whether AC or DC Coupling are selected.

Output Noise Level Peak to Peak – 3 mV at Full Gain, resolves to approximately1 bit at a 12-bit resolution and 5 Volts output

Section 7.0

Definition of User Controls and/or User Interface
This design has all manually selectable controls and two alignment potentiometers.

These selections are accomplished by jumpers installed within the circuit.

1. Input Gain Selection – 0 to 10 na, 100 nA, or 1 uA
2. Range Gain Selection - X1, X2, X4
3. Max. Output Voltage Selection – +3.5 or +5 volts

These selections are set via potentiometers during calibration.

1. Zero Adjust
2. Gain Adjust

Section 8.0

Mechanical Characteristics

This includes Size, Weight, Special Materials, etc., for hardware projects.

Section 9.0

Operating and Other Design Environments

This section is common for hardware projects but could be useful for software projects that have physical deliverables to the customer.

a) Operating Temperature 25 deg C, plus or minus 5 Degrees
b) Storage Temperature - TBD
c) Shock and Vibration d) - TBD

Section 10.0

Tests Used to Define System Operation

This area defines how the unit will be tested to verify that it meets the specifications. This describes when the "deliverables" are declared completed.

Section 11. 0

Other Tests to Assure the Quality of the Design

This section can be critical for intermediate and final hardware portions of the project. Groups outside of the design group will normally perform these tests.

a) Functional Testing – See Functional Test Spec
b) Temperature Testing – 25 Deg C, plus or minus 10 degrees
c) Compliance Testing - UL, VDE, FCC, etc - TBD
d) Reliability Analysis and/or Testing - TBD