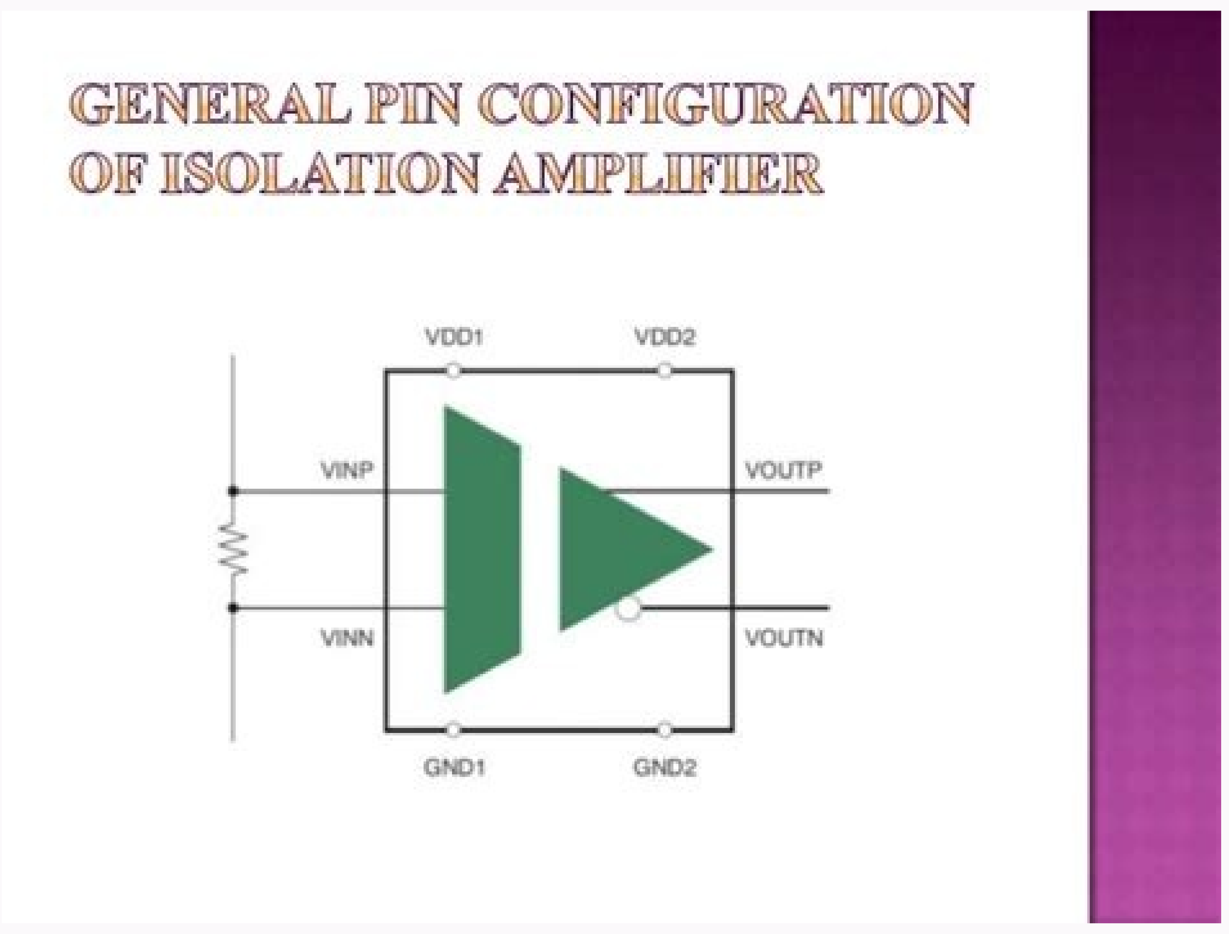
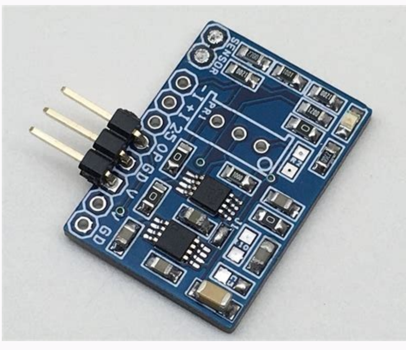
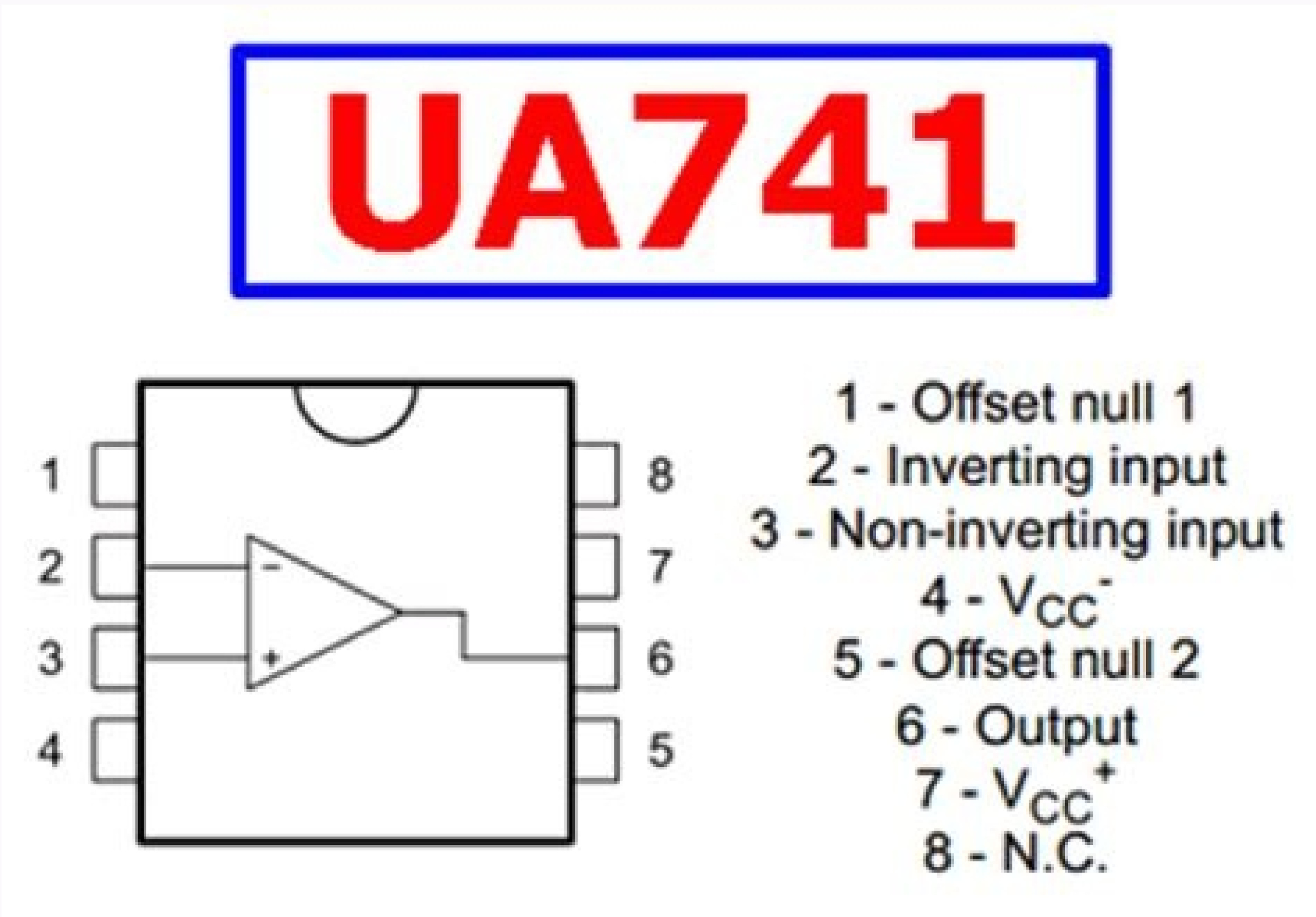
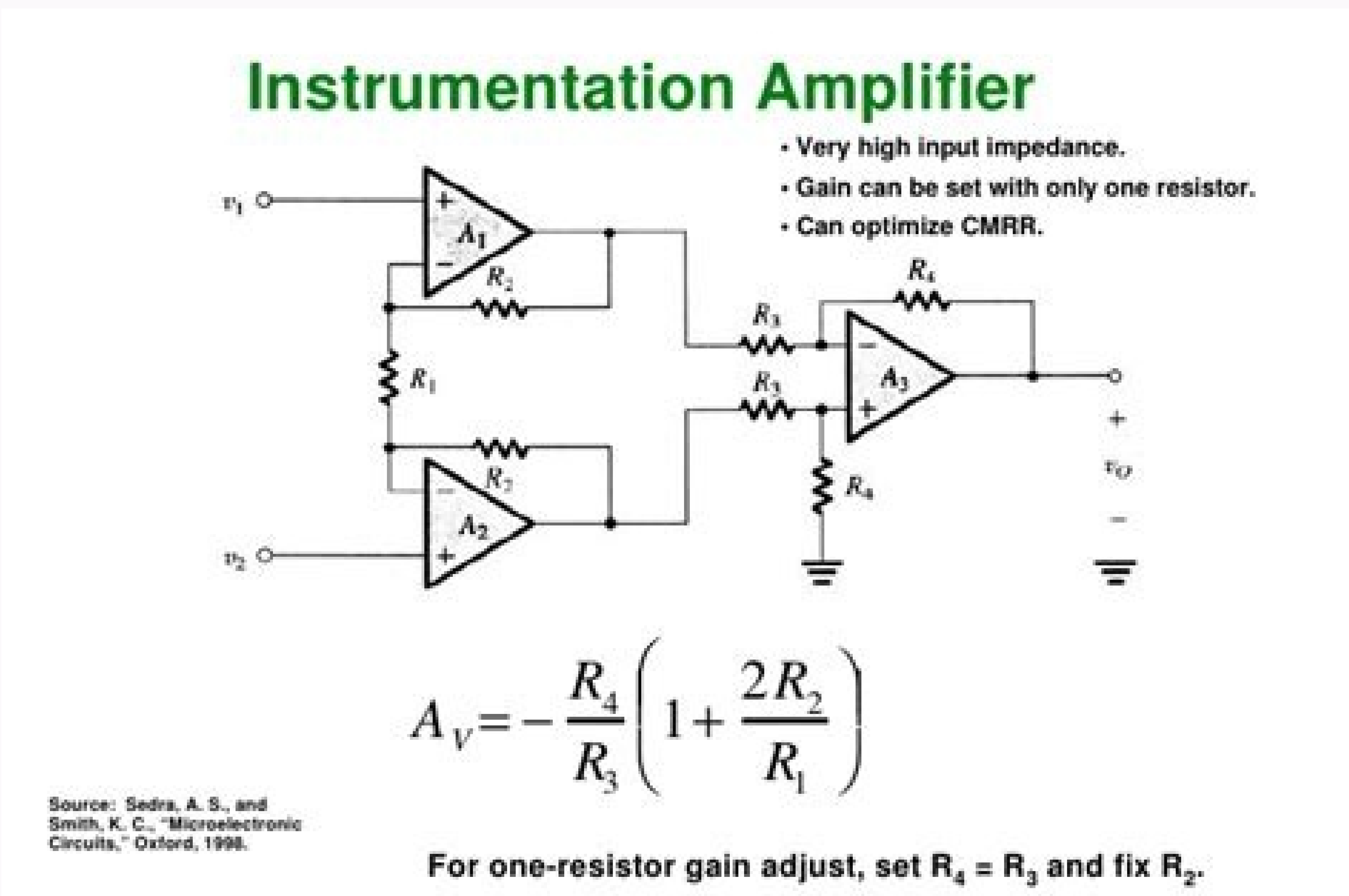
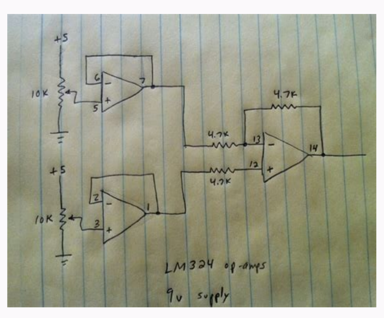
Instrumentation amplifier using op amp pdf











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BACK TO TOP Transducer Bridge Instrumentation Amplifier The resistive transducer bridge is a network of resistors whose resistance varies due to changes in some physical condition. High Slew Rate: The slew rate of the instrumentation amplifier must be as high as possible to provide maximum undistorted output voltage swing. This produces a differential input for the instrumentation amplifier and the output of the amplifier will no longer be zero. Light Intensity Meter The same circuit can be used to detect variations in the intensity of light, by replacing the thermistor by a Light Dependent Resistor (LDR). The resistive bridge is kept balanced for a particular reference temperature when Vo = 0V. For example, Thermistors change their resistance with temperature and Light Dependent Resistors change their resistance to change in light intensity. Therefore, a good instrumentation amplifier has to meet the following specifications: Finite, Accurate and Stable Gain: Since the instrumentation amplifiers are required to amplify very low-level signals from the transducer device, high and finite gain is the basic requirement. The electrical signal is fed to an instrumentation amplifier. Thus, the potential at node H is also V2. A special implementation of Operational Amplifiers is the Instrumentation Amplifier, a type of Differential Amplifier with Input Buffer Amplifier. The op-amp 3 is a difference amplifier that forms the output stage of the instrumentation amplifier. In this circuit, a non-inverting amplifier is connected to each input of the differential amplifier. The circuit diagram of an instrumentation amplifier is as shown in the figure below. The instrumentation amplifier is intended for precise, low-level signal amplification where high input resistance, low noise and accurate closed-loop gain is required. The potential at node D is the input voltage V2. When the bridge is balanced, i.e. at some reference condition of the physical quantity being measured, we get, Va = Vb RA(Vdc)/(RA+RT) = RB(Vdc)/(RB+RC) Under this condition, the differential input to the instrumentation amplifier is VDiff = Vb – Va = 0 Thus, the output of the amplifier is zero. Note: The overall voltage gain of an instrumentation amplifier can be controlled by adjusting the value of resistor Rgain. A transducer is a device which converts one form of energy into another. The potential at node A is the input voltage V1. The display can be calibrated in terms of the units of the physical quantity being measured. The input impedance of the instrumentation amplifier is dependent on the non-inverting amplifier circuits in the input stage. The gain also needs to be accurate and the closed-loop gain must be stable. Consider the input stage of the instrumentation amplifier as shown in the figure below. Hence the potential at node C is also V2, from the virtual short. The effective resistance of the transducer device is RT ±ΔR. The general single ended amplifiers are not suitable for such operations. This causes the amplifier to produce a finite output, which in turn drives the meter. Low Output Impedance: The output impedance of a good instrumentation amplifier must be very low (ideally zero), to avoid loading effect on the immediate next stage. Consequently, the display device connected at the output displays the reference value of the physical quantity being measured. The resistive bridge is kept balanced for some reference temperature. High Input Impedance: To avoid the loading of input sources, the input impedance of the instrumentation amplifier must be very high (ideally infinite). The resistive bridge is supplied with a DC voltage, Vdc. The gain of the amplifier can be appropriately set to indicate the desired range of temperature. BACK TO TOP Applications of Instrumentation Amplifier The instrumentation amplifier, along with a transducer bridge can be used in a wide variety of applications. The amplified signal is then fed to a display device, which is calibrated to detect the change in the quantity being measured. High CMRR: The output from the transducer usually contains common mode signals, when transmitted over long wires. Also, low power consumption, high slew rate and high common-mode rejection ratio are desirable for good performance. BACK TO TOP Requirements of a Good Instrumentation Amplifier An instrumentation amplifier is usually employed to amplify low-level signals, rejecting noise and interference signals. BACK TO TOP Working of Instrumentation Amplifier The output stage of the instrumentation amplifier is a difference amplifier, whose output Vout is the amplified difference of the input signals applied to its input terminals. The overall gain of the amplifier is given by the term (R3/R2){(2R1+Rgain)/Rgain}. For the rejection of noise, amplifiers must have high common-mode rejection ratio. Thus, the CMRR of the instrumentation amplifier must be ideally infinite. Such an electrical signal can be amplified and used to monitor and control the physical process. BACK TO TOP Three Op-Amp Instrumentation Amplifier The most commonly used Instrumentation amplifiers consist of three op-amps. The resistances RB and RC are constant and hence the voltage VB remains same as before, i.e. Vb = RB(Vdc)/(RB+RC) But the voltage Va changes due to the change in resistance of the transducer device and is now given as, Va = RA(Vdc)/(RA+RT+ ΔR) The differential voltage VDiff is, VDiff = Vb – Va VDiff = {RB(Vdc)/(RB+RC)} – {RA(Vdc)/(RA+RT+ ΔR)} If all the resistances in the circuit are chosen to be of same value, i.e. RA = RB = RC = RT = R VDiff = {R(Vdc)/(2R)} – {R(Vdc)/(2R+ ΔR)} VDiff = {RVdc[2R+ΔR] – R.Vdc.2R}/ 2R(2R+ΔR) VDiff = R.Vdc[2R+ΔR-2R]/{2R(2R+ΔR)} VDiff = ΔR(Vdc)/{2(2R+ΔR)} If the value of VDiff is positive, it indicates that Vb is greater than Va. The output of the instrumentation amplifier is given as, VO = (R3/R2)Vd Vo = (R3/R2) [ΔR(Vdc)/{2(2R+ΔR)}] As the change in resistance ΔR

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