

Constant Current Circuit Operation

Assume that terminals I_{hi} and I_{lo} of Figure E-3 are shorted, and 0.5 volt is applied to E_{in} so that I_{hi} is positive. To equalize the 0.5 volt applied to E_{in} , the inputs of IC202, IC201 must be driven to zero. This condition occurs only when the voltage drops across R212 and R222 are equal to the drops across R213 and R221. For these voltage drops to be equal, the output of IC202 must be at +0.5 volt. Since the output of IC201-8 must be zero, the drop across R213 is 0.25 volts, making the inverting input 0.25 volts. The drops across R212, R221 and R222 will also be 0.25 volts. Since the inputs to IC201 are essentially equal, its output is zero (offset by the few microvolts required to drive IC202 to +0.5 volt). Under these conditions the sum of the voltages across R212, R213, R221 and R222 equals the sum of E_{in} plus the output of IC202.

Consider now that the short is removed from the I_{hi} and I_{lo} terminals and a 100-ohm resistor (R_L) is connected in its place. The current through R_L increases the voltage at the input to IC201. A balanced condition will be reached when the output of IC201 is equal to the non-inverting input of IC202. Again, this condition occurs when the voltage drops across R212 and R222 are equal to the voltage drops across R213 and R221. At this time the output of IC202 is 0.5 V. The voltage drop across the range resistor is 0.5 V, just as it was when the output terminals were shorted. The current through R_L is 5 mA, just as it was through the jumper when the output terminals were shorted.

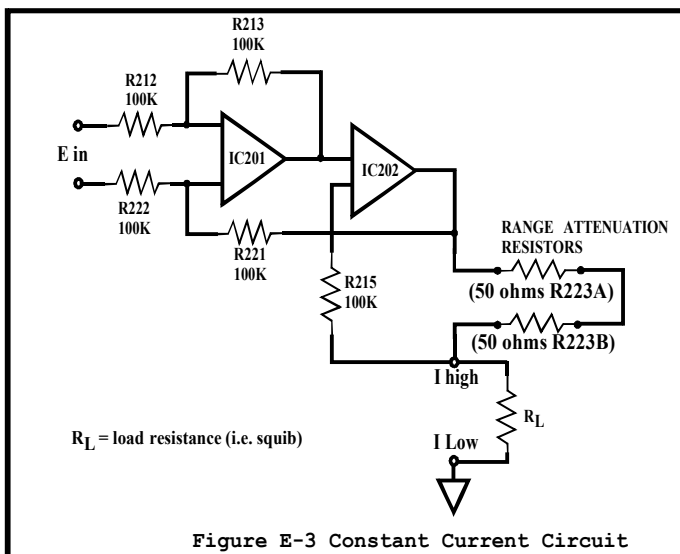


Figure E-3 Constant Current Circuit

Failsafe Design

The AMPTEC 630ES Igniter Tester measurement circuitry is failsafe current limited, even under worst case component failure.

For the 630ES the normal or typical operating current level is less than 5 mA, and <8mA on 2 Ohm and the 20 ohm range(s) as a Failsafe Level. The AMPTEC 630ES Igniter Tester schematic will show that the output of IC202-6 is actually applied to the base of transistor Q202, *which acts as a current limiter*. A *component failure that could occur in this circuit would be a Q202 short*, which would effectively connect the -5 volt supply through R218 to the cathode of D202. The anode side of D202 would be limited by D203. The voltage limiting diode, D203, provides a 1.6 volts maximum across R227 ~ 112W (comprised of 2 each 56W carbon composition resistors in series) and the 2 and 20 ohm range attenuation resistor R223 (100 W wirewound resistor), which are a total of 212 Ohms across the Igniter Testers output terminals. **All other range attenuation resistors are much higher values (900W and 999 KW), which makes for significantly lower (safer) current levels.**

(I_{max}) Current Max. Calculation (2 or 20 Ohm range)

$$1.6V/212 \text{ ohms} \leq 0.008 \text{ Amperes (8mA) max}$$

Even if every component in the amplifier circuit shorted, the current through the igniter could not exceed safe limits, because the -5 volt and +5V supplies are current limited themselves. The ± 5 volt supplies can only deliver 20 to 25 milliamperes before the DC/DC converter disengages, dropping the -5 volt output to zero due to the design of both supply isolation micro-transformers T101 and T102. See Section D-7 of the operator manual for complete circuit diagram.

**note - Additional safety margin is provided by the historic failure mode for all wirewound resistors (ie R223A is a 50 Ohm wirewound) and carbon composition resistors is to fail "open circuit" (infinite resistance) not as a dead short (zero ohms). R223B is a different mfg. and type of precision resistor (metal foil) that is also 50 ohms in series with R223A (together they make a 100 ohm attenuation string). Should either R223A or R223B fail as a "short" there is still the other 50 ohms in series to act as a failsafe current limiter. If either R223A or R223B fails as an "Open" then the current goes to zero "0".*