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*Electronics*

**Energy Division**

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## **DC Shunts**

Direct current instrument shunts are used to extend the range of ammeters whenever the current to be measured is too large to be passed through the instrument--usually currents over 50 amperes. The shunt, therefore, is a diverter which is used to "shunt" the majority of the current around the indicating instrument. Essentially, the shunt is a specially-designed resistor which delivers a millivolt output (to a millivolt meter or instrument) in proportion to the current flowing through the resistor.

Shunts are standardized to deliver either 50 millivolts or 100 millivolts at their full rated current, although there are times when other millivolt ratings are desired or other physical sizes or configurations are more suitable for an application. Since the shunt is a resistor which operates in a varying ambient temperature environment and generates heat whenever current flows through it, we must design the shunt resistance portion with a special metal alloy which has, essentially, a constant resistance value through its operating range. In addition to using a precision resistance alloy with a negligible temperature coefficient of resistance, the alloy must have a low resistivity in order to keep the self-heating to a minimum, and it must also have a low thermal E.M.F. against copper. All our shunts are designed using a special alloy called manganin, which meets these criteria.

The final design consideration is size, which relates to self-heating as well as its cooling characteristics to dissipate the heat generated by the resistance alloy. Our shunts have been optimally designed for size based on these various factors. Generally, the higher-current shunts (bus-type) are designed with large end blocks (current terminals) for switchboard use so they can be installed in the bus or connection bar structure of the circuit whose current is to be measured. The lower current shunts (portable type) are designed with an insulating base and are intended to be laid on, or fastened to, any flat surface. These shunts, also may be used for switchboard applications where the current is relatively low and connection bars are not used. Shunts are used not only to extend the range of instruments, but also where low current must be applied to the metering panel. Shunts may be useful where the metering panel is quite a distance from the circuit carrying the current to be measured as well as when it would not be practical to run large cables or bus bars to the metering panel or switchboard.

## **SPECIFIC SHUNT DESIGN**

All commercial shunts are designed in accordance with IEEE STD 316-1971. The military lightweight shunts are manufactured in accordance with MIL-S-61B. The commercial lightweight series of shunts is designed similar to the military lightweight shunts, except commercial materials are utilized. We also manufacture shunts in accordance with MIL-I-1361B when specified.

## **SHUNT SELECTION**

Selection of current ratings should be based on a normal operating current of  $2/3$  the rated value of the shunt.

## **SHUNT INSTALLATION**

The proper installation of a shunt is extremely important in maintaining its accuracy during normal use. The major factor to be considered is the heat generated by the shunt itself, along with the ambient temperature influence based on air movement and heat radiated to the shunt by other heat-radiating devices located nearby. The shunt is cooled by radiating heat to its surroundings and convection air passing through the shunt while conducting the majority of the heat through its connecting cables or bus bars. Therefore, the following points must be considered:

The **BUS-TYPE SHUNTS** are intended to be installed in the bus bar structure.

The **PORTABLE-TYPE SHUNTS** have an insulating base which can be fastened to any flat surface.

In each of the above cases, the blades are to be vertical with the longitudinal axis horizontal.

The cables or bus bars of proper cross-section (one square inch of copper per 1000 amps) used to connect the shunts into the circuit must be tightly bolted to the shunt current terminals with the bus bars inserted to within  $1/4$  inch of the bottom of the bus bar slots. Any unused slots are to be filled with  $1/4$  inch copper pieces in order to fully fill all the slots.

These shunts should operate at a temperature rise not to exceed  $80^{\circ}\text{C}$  when carrying their rated current.

Any other types of mounting or environment than that described above may require derating of the shunt.

Shunts should be installed so that they will not be damaged by thermal expansion forces in the connecting bus bars or by short circuit forces. Shunts are inherently weaker than their current connections, and special flexibility may be needed at times.

Where possible, all shunts should be connected in the ground side of the line. Portable type shunts with insulating bases, when used on circuits above 750 volts, must be mounted in the grounded side of the circuit.

When more than one bus bar is to be connected to each end of single terminal shunts, these bars should be distributed as equally as possible on each side of the shunt terminals.

## **SHUNT LEADS**

Standard shunt leads have a total resistance of 0.065 ohms and they range in length from 5 to 7 feet. The shunt leads are considered as a part of the metering circuit, and therefore their voltage drop must be considered when calibrating the millivolt meter when a high degree of accuracy is to be achieved

## **FREQUENCY RESPONSE (AC APPLICATIONS)**

The current shunts may be used in alternating current applications with the following understanding: dc current shunts have a very small inductance and exhibit a negligible effect (AC impedance) up to 1 kilohertz, and can be used up to 5 kilohertz where a slightly noticeable effect (AC impedance) takes place. Therefore, we recommend that you investigate the use of a conventional direct current shunt in your AC application to establish whether or not it is suitable for your application.

On low current AC shunts, we can design a non-inductive shunt which will operate on much higher frequencies, but here again, you must evaluate the design to see if it is suitable for your application.

## **ADJUSTMENT ACCURACY**

Shunts are adjusted to within  $\pm 0.25$  percent nominal value with an applied current that will not raise the temperature of the terminal blocks more than  $10^{\circ}\text{C}$  with an ambient room temperature of  $25^{\circ}\text{C} \pm 2^{\circ}$ .

## **RATED ACCURACY**

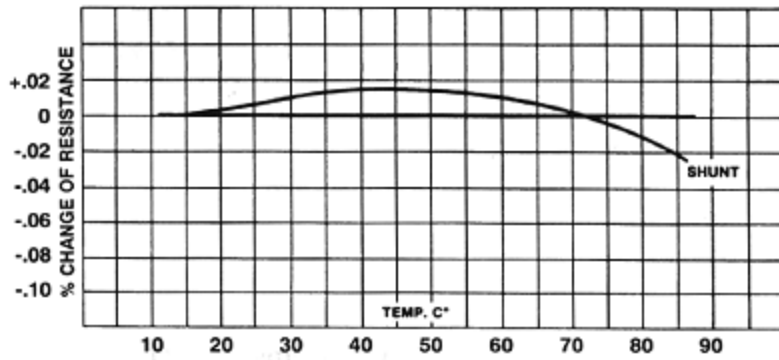
Commercial shunts up to 1000 amps have an accuracy of  $\pm 0.33$  percent.  
Commercial shunts 1000 amps and above have an accuracy of  $\pm 0.5$  percent.  
Commercial lightweight shunts have an accuracy of  $\pm 0.6$  percent.  
Military lightweight shunts have an accuracy of  $\pm 0.6$  percent.

This allows for self-heating variation at the higher current values and variance in connections.

## **CALIBRATION AND CERTIFICATION**

Shunt calibration and certification are traceable to NIST.

### CHARACTERISTICS OF MANGANIN SHUNT STRIP



TEMPERATURE COEFFICIENT OF RESISTANCE  $\pm 0.000015$  BETWEEN 40 - 60°C.