

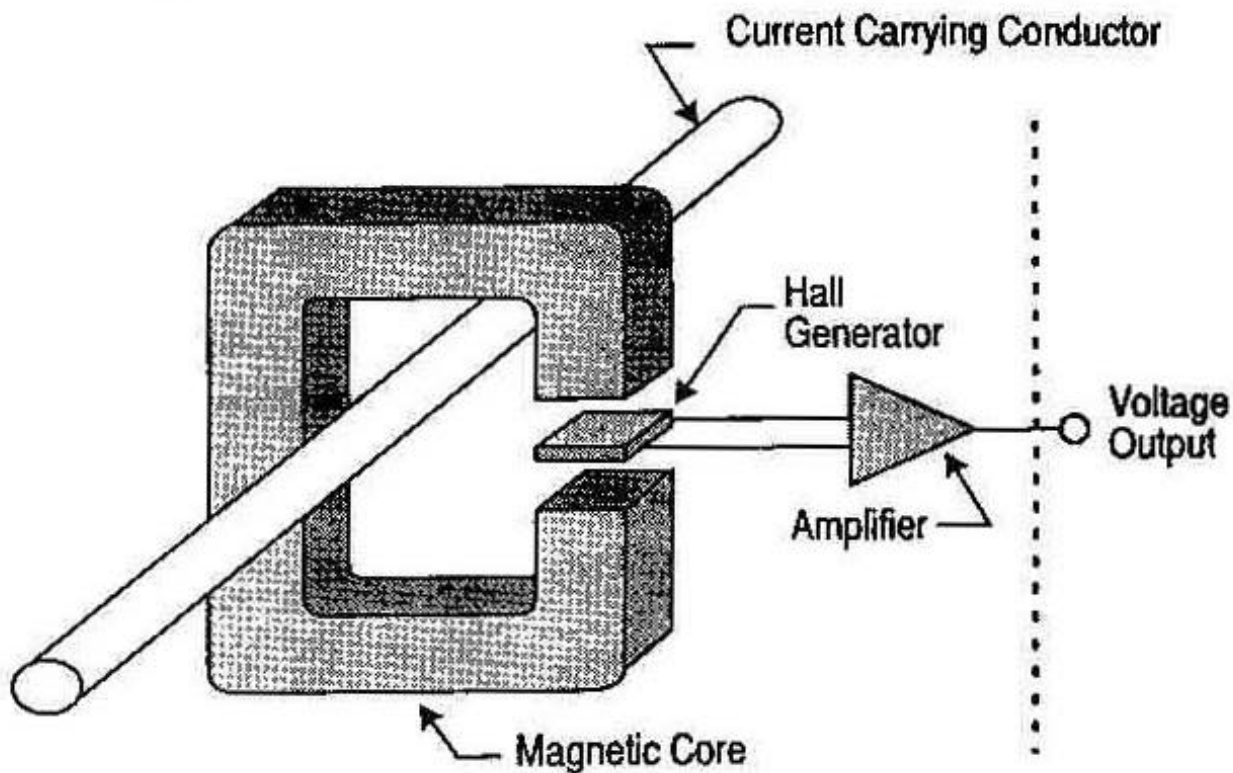
# LKP SYSTEM THEORY OF OPERATION

## Introduction

DynAmp LKP systems are based on what is commonly known as “Hall-effect” technology.

Hall Effect current sensors use Hall generators in their design. A Hall generator is a four-terminal solid-state device that outputs a voltage proportional to the magnetic field it is placed within. Both open and closed loop Hall Effect current sensors use a Hall Generator “chip” and an amplifier.

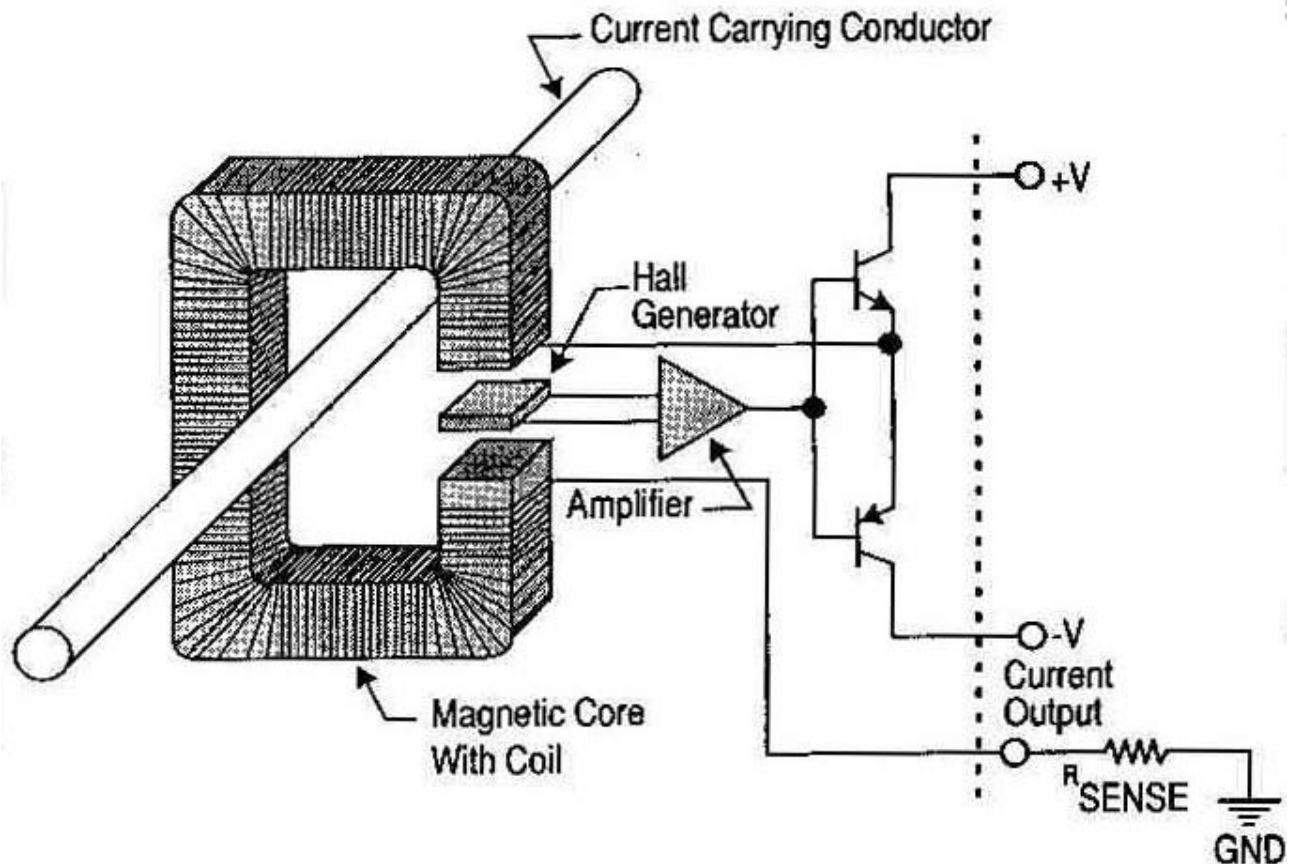
## Basic Open Loop Hall Effect Current Sensor



An open-loop Hall Effect current measurement system is the easiest to understand. The Hall generator is mounted in the air gap of a magnetic core placed around the current carrying conductor or bus. This Hall Generator “chip” is driven by a constant current source. The conductor produces a magnetic field proportional to the current it is carrying. The magnetic core concentrates the magnetic field which is then sensed by the Hall Generator “chip” together with its electronic driving electronics. Because the output of the Hall Generator “chip” is quite low, it is amplified to a useful level. In open loop designs, this amplified signal is the measurement output.

The performance of an open loop technology sensor is dependent upon the linearity of the Hall Generator “chip” and the linearity of the magnetic core. At higher currents, the linearity of the magnetic core declines quite rapidly dramatically degrading performance.

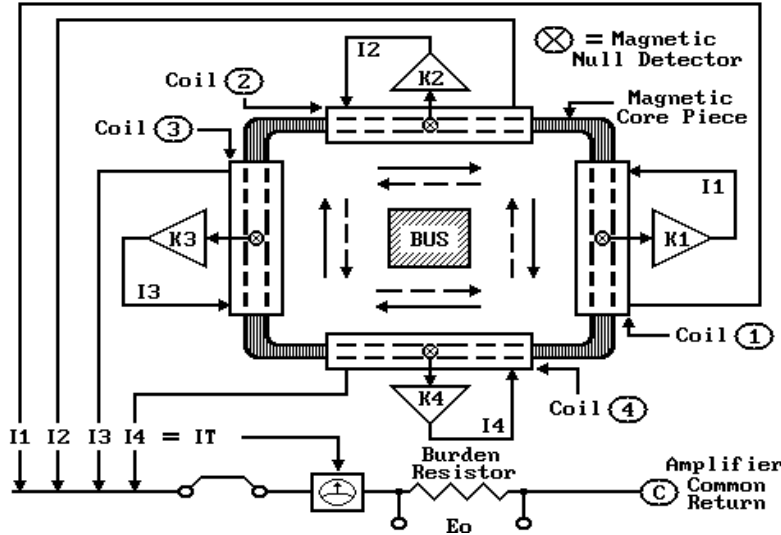
## Basic Closed Loop Hall Effect Current Sensor



A Closed loop Hall Effect current measurement system starts with the same five basic building blocks : The magnetic core, Hall Generator “chip”, its constant current source and its amplification. However, in a closed loop design, this amplified Hall Generator “chip” signal is used quite differently. In a closed loop design, this signal is passed through coils wound around the core at a precise number of turns to offset or “null” the concentrated magnetic field in the core from the current carrying conductor or bus. The measurement output is simply the current it takes to ‘null’ the flux in the core accounting for the turns ratio of the coil around the core to accomplish this.

The Closed loop technique allows great improvements in sensor performance. By driving the core to nearly zero magnetic flux, the effects of magnetic core linearity as well as the effects of Hall Generator “chip” linearity are practically eliminated. This also eliminates the performance effects of temperature on the performance of the Hall Generator “chip”. The result is superior linearity, low temperature drift and fast measurement response.

# Multi-Channel LKP Closed Loop Systems



The high currents present in Aluminum Smelting, both on individual rectifiers and the ‘mainline’ bus present unique measurement challenges. Once currents exceed a few thousand amps, the magnetic fields become so large that factors including bus shape, bus configuration, nearby structures and dynamic operating conditions can result in magnetic field distortions that would cause multi-percent errors in a basic closed-loop system. To handle these unique factors, DynAmp developed a specialized multi-channel closed loop approach for its high accuracy, High Current Measurement systems.

The DynAmp measuring head is actually many discrete measurement systems in one containing many Hall Generator ‘Magnetic Null Detectors’ and feedback amplifiers paired with individual feedback coils. Together, these elements are called a channel. For the highest performance, each channel and then respond independently to null the bus field in its own specific section of magnetic core. Depending on the configuration of the measurement head, LKP systems have from 4 to 20 independent channels. The measurements of all channels are summed to produce the output measurement.

This multi-channel approach allows the measurement head to accurately sense the magnetic field produced by the current carrying conductor / bus while successfully rejecting the influence of external magnetic structures and fields.

# Accuracy Diagnostics for LKP Systems

“Accuracy Diagnostics” (AD) is an option that can further assure users of the accuracy of all LKP systems.

AD consists of a number of special circuits which monitors the conditions of critical components, circuits, and connections within the LKP system.

The AD indicates the feedback circuits are functioning properly and the system’s power supplies are within specifications. More specifically, this indicates the following conditions exist:

1. Each individual channel is successfully nulling the magnetic field in its section of the core:
  - a.) All components in the circuits appear to be operating normally.
  - b.) Input fields are of the expected polarity.
  - c.) Input magnetic flux appears balanced by feedback flux.
2. Power supplies are operating within acceptable ranges.
  - a.) Mains input power is on.
  - b.) Hall plate sensor power supply output is correct.

The AD outputs indicate the current operating condition. Although the AD does not monitor every possible error condition, it is an effective means, giving the user continual assurance of overall system accuracy and signal reliability.