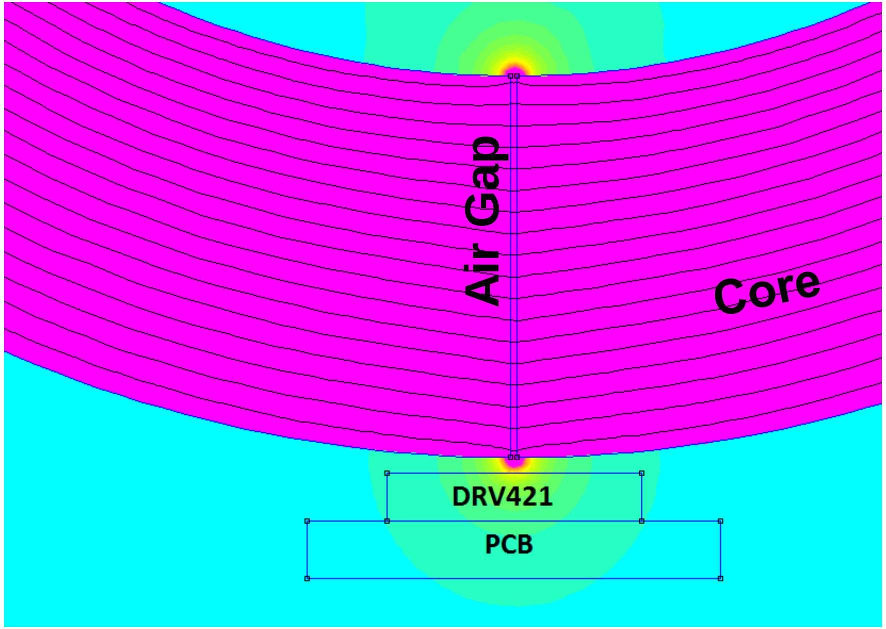
DRV421 and Core Demagnetization

Javier Contreras

DRV421 and Core Magnetization

- Magnetized Core Error Contribution
  - A magnetized core creates an additional offset error at the DRV421 fluxgate sensor.
  - This will add to the max 8µT offset of the DRV421.



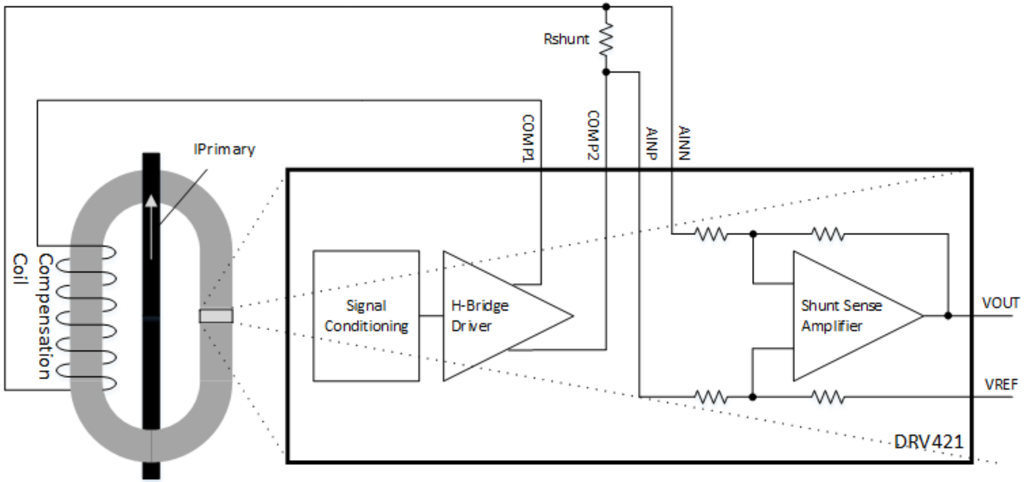
DRV421 and Core Magnetization

- How does a core get magnetized?
  - Saturating a core with unchecked strong magnetic fields will magnetize the core. This can happen a few ways:
    - Running large currents through the primary current conductor in the core that creates a field greater than compensation coil and driver can negate.
    - Running current on primary without compensation, either unpowered or disconnected.
    - Connecting the compensation coil backwards to pins IComp1 and IComp2.
    - Creating large transient fields (often by large jumps in current through the primary current conductor) where the compensation coil and driver are not fast enough to negate the field.
- What is the potential magnitude of the added error?
  - This will vary on each individual core design. A small selection of core sampled have measured approximately 50µT after magnetization techniques are applied.
  - How much does 50µT affect a current measurement?
    - Example: Choose a core with gain = 500uT/A
    - 50µT/(500µT/A) = 100mA (error from ideal measurement of primary current conductor)

Existing DRV421 Degauss Function

- The existing demagnetization (Degauss) function of the DRV421 does not remove the offset for all nature of cores in all conditions.
  - Core variation and potential saturation levels make it difficult for a single implementation of the Degauss feature to work for every application.
  - Large Rshunt values will limits current and will prevent degauss.

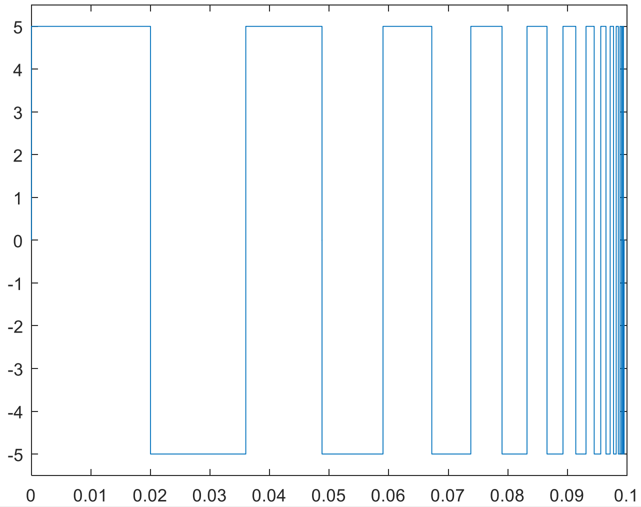
- Alternative methods to address offset error contributed by core magnetization:
  - Calibrate the output measurement
    - Measure Vout with Iprimary = 0A. Remove this offset from future measurements.
  - Create an external circuit to demagnetize the core.



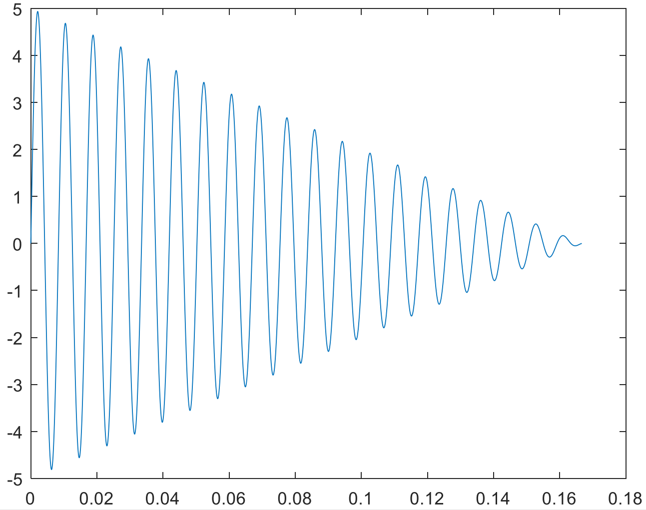
How to Degauss a Core (1 of 2)

1. Saturate the core in alternating directions by applying an alternating current through the compensation coil and decaying the signal until it no longer saturates the core.
2. Decay with amplitude variation or time variation seen below.
   - In the figures below, the voltage across the compensation coil is shown as if it were driven with an H-Bridge with a 5V supply.

Time Variation

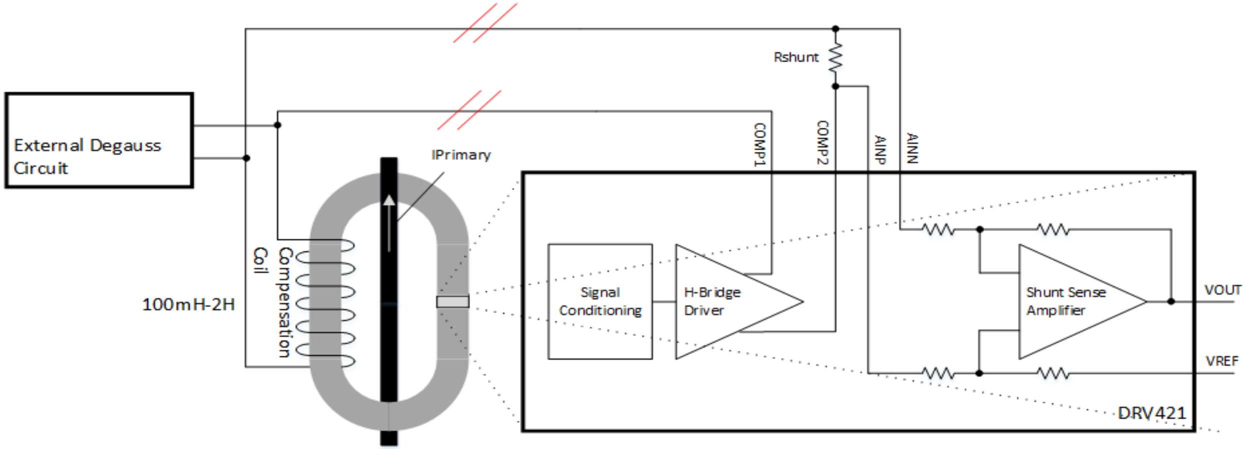


Amplitude Variation

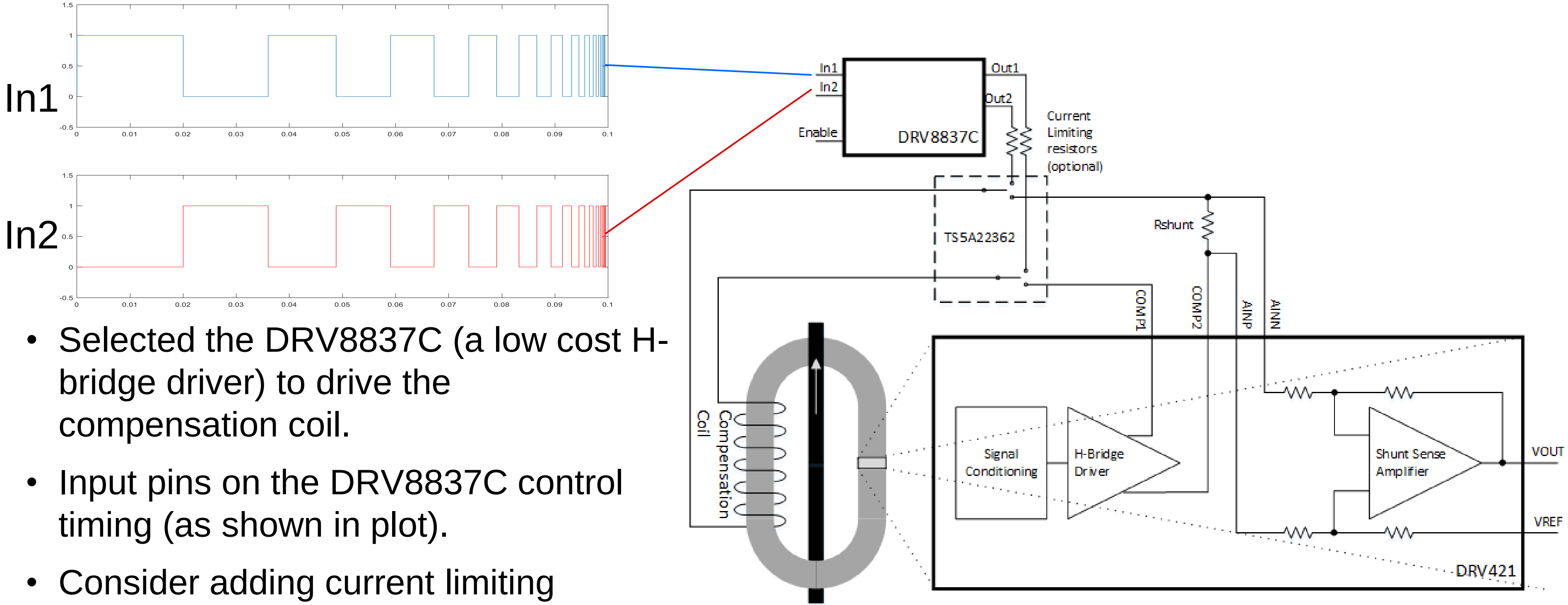


How to Degauss a Core (2 of 2)

- When using an external circuit to Degauss a core, the DRV421 ICOMP pins need to be disconnected from the coil or the whole device to be simply powered off. This is required as in normal operating mode, the DRV421 drives ICOMP1 and ICOMP2 to the VREF voltage.
- Compensation coil's large inductance needs to be taken into account when driving current as not all amplifiers can drive a large inductance.



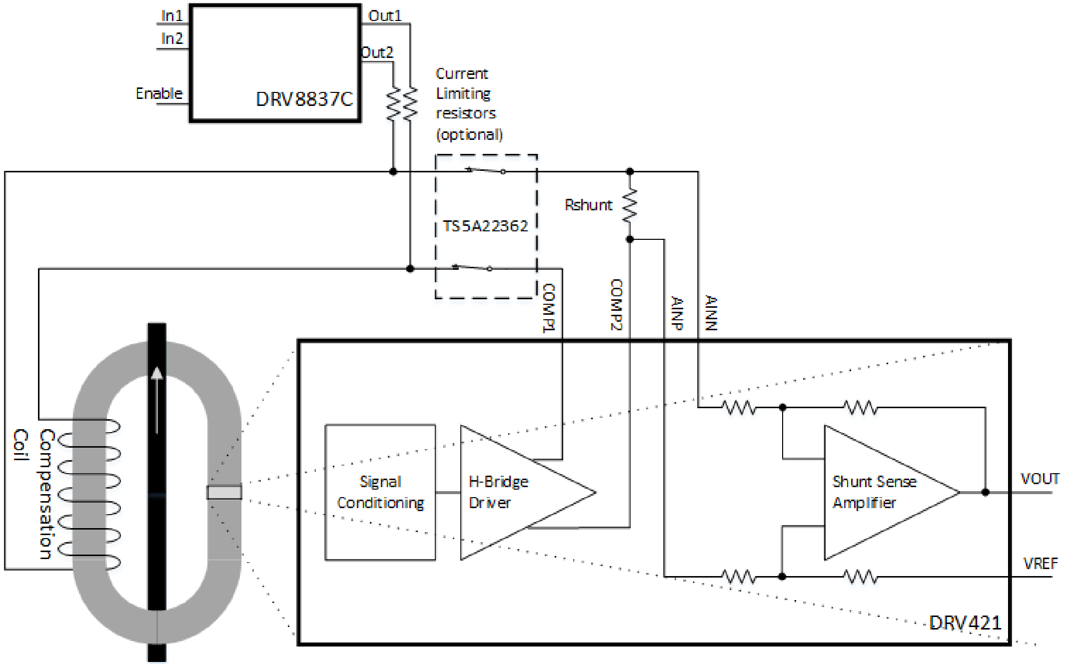
Example External Circuit Degauss (1 of 2)



- Selected the DRV8837C (a low cost H-bridge driver) to drive the compensation coil.
- Input pins on the DRV8837C control timing (as shown in plot).
- Consider adding current limiting resistors in series to lower the maximum current through the coil.

Example External Circuit Degauss (2 of 2)

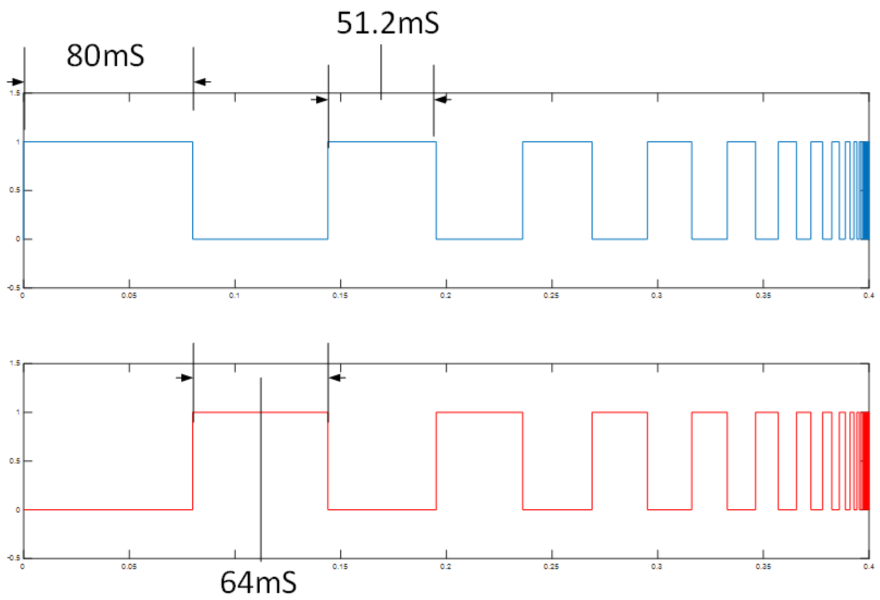
- Switch selection
  - 2 Channel SPDT (previous slide)
    - Example TS5A22362 *verified
  - 2 Channel SPST (current slide)
    - Example TS5A23167



- Switch parameters of interest
  - R_{ON} Max
  - Continuous/Peak Current

External Degauss Verification

- MSP432E401Y to drive digital inputs of DRV8837C and Switches
- DRV8837CEVM
- TS5A22362 (SPDT Switch)
- Pulses started at 80ms and decayed by 20% until it got approximately ~5uS
- DRV421EVM – Degauss pin set low.
- Core with 1667 windings.



TEXAS INSTRUMENTS

External Degauss Verification Data

- Rshunt =10 Ω
- Windings 1667
- Full Scale Current 100A
- $I_{Primary} = \frac{Vout}{Rshunt * DiffGain(4)} \times \#\text{Windings}$

- Notes:
  - External degauss works with small current on primary
  - DRV421 needs zero current during internal degauss function

Current at Primary during Degauss	Post Degauss Vout offset	Current Error	Field Error *
0	167 µV	6.98 mA	3.5 µT
.1A	253 µV	10.54 mA	5.27 µT
1A	951 µV	39.6 mA	19.82 µT
5A	3.84 mV	160 mA	80.0 µT
10A	6.9 mV	287.6mA	143.8 µT

* Field Error calculated assuming 500µT/A magnetic core gain.

External Degauss Design

- Adjustments that may need to be required for other cores
  - Switches
  - Decay rate
  - Output voltage/current of DRV8837C
  - Starting Pulse (Example 80 mS)
  - Ending Pulse (Example 5 µS)
  - Current limiting resistors