

Sensing conducted EMI in power lines for appliance disaggregation

Highlights: Overview of NILM, Past work, Conducted EMI as a unique/deterministic aspect

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Proposed work

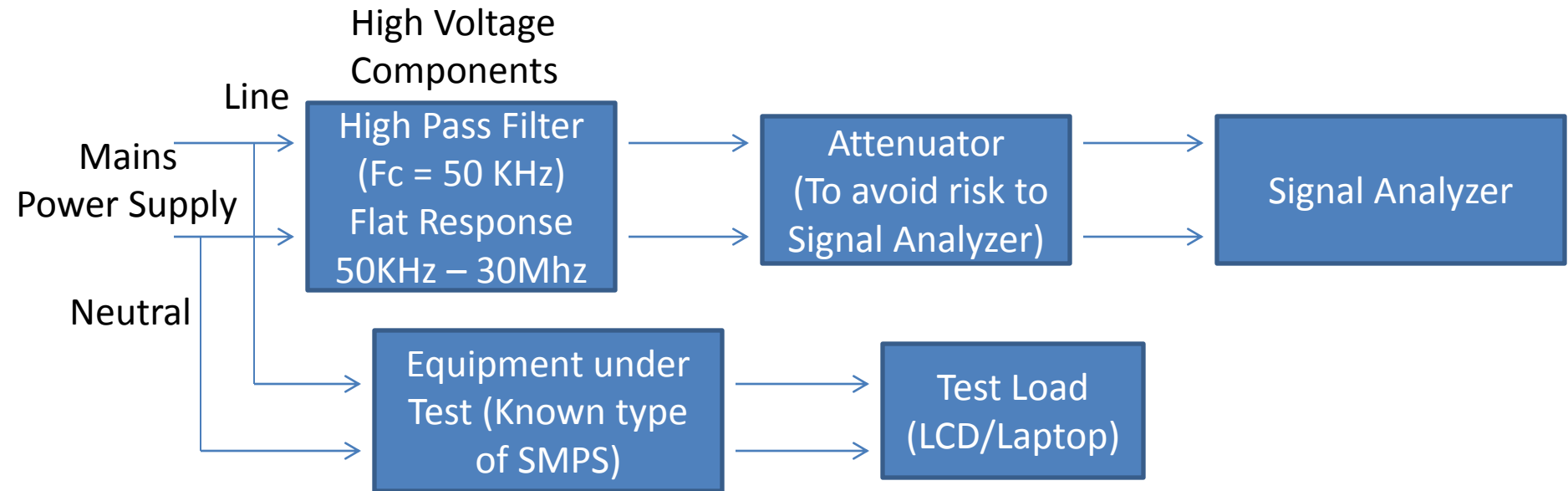
To study unique and distinct features in conducted EMI generated by multiple electrical appliances.

Specific test cases:

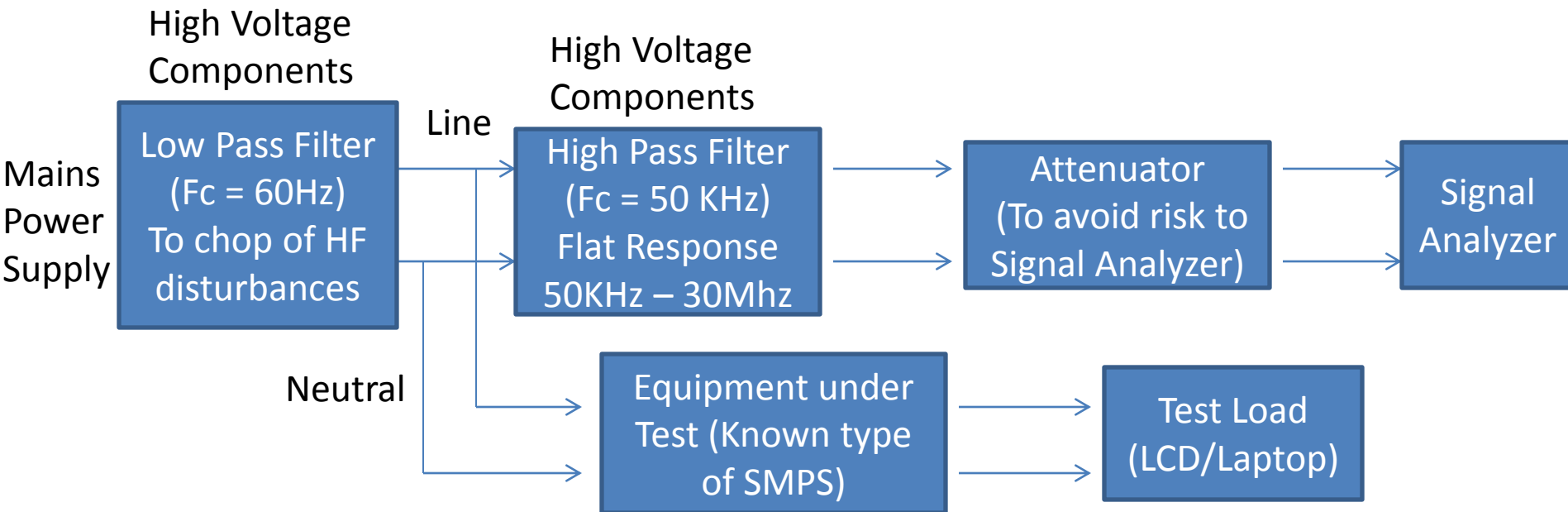
- Study impact of voltage fluctuations & building architecture on CE.
- Study dissimilar features in CE during w/ and w/o load.
- Study effect on CE of a single SMPS(EUT) for different loads.
- Analyze features and unique aspects in CM CE and DM CE for different electrical loads.
- Analyze response of EMI (constructive/destructive interference) w/o LISN.
- Analyze low freq. disturbances due to different loads.
- Try to differentiate among appliances with dual switching sections (i.e. PFC section and DC-DC convertor section).

*CE Conducted EMI *CM Common mode *DM Differential mode

Experimental Setup-1

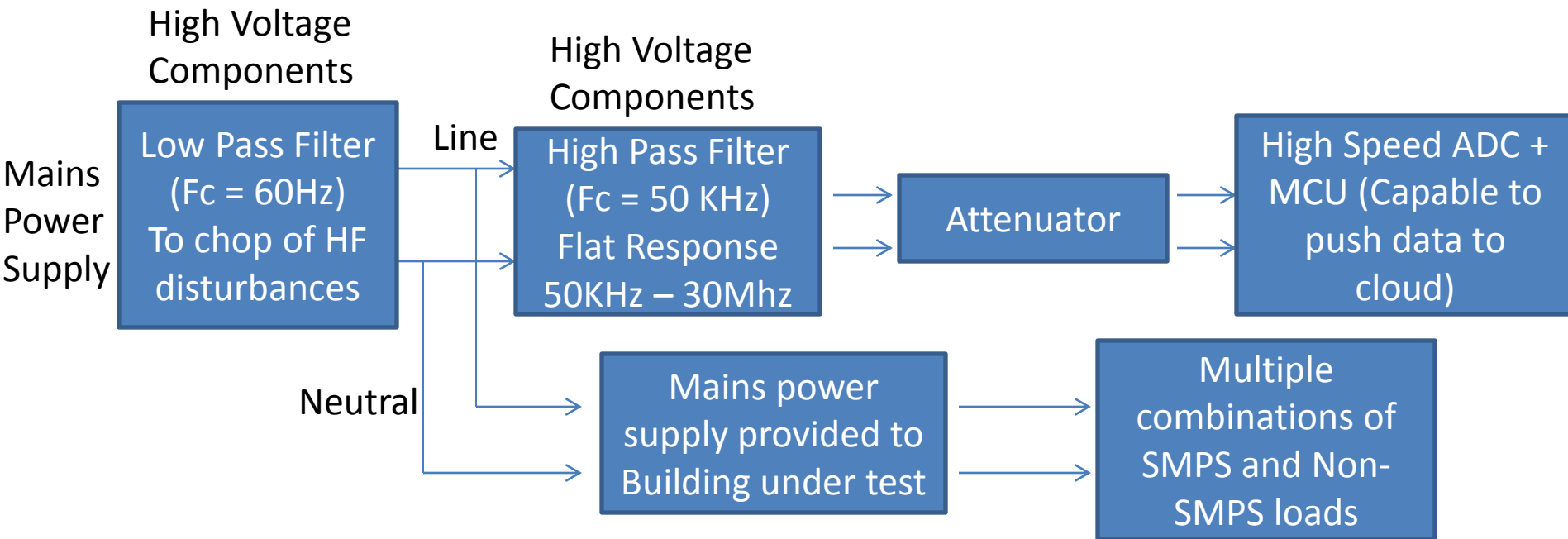


Experimental Setup-2



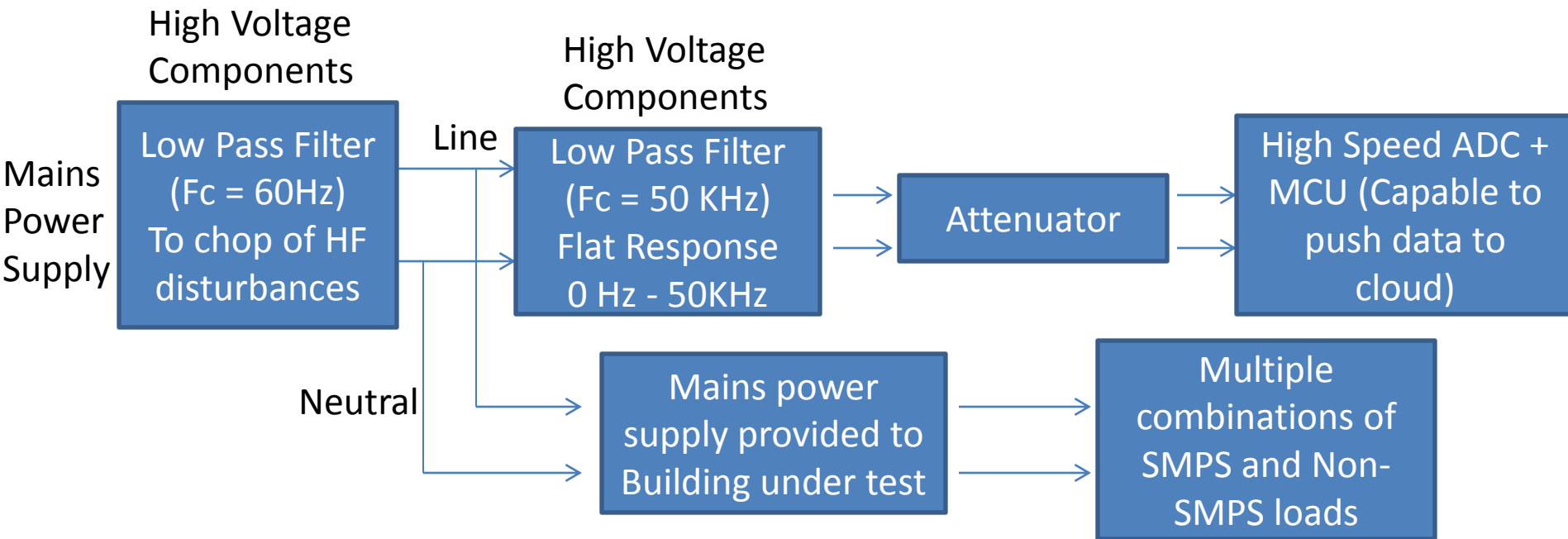
Proposed Setup-1

(To study HF disturbances)



Proposed Setup-2

(To study LF disturbances)



Power Supply Classification By SMPS Topologies

| Topology | Applications | Power | Benefits | Negative aspects |
|-----------------------|--|----------|---|--|
| Flyback | Cellphone chargers (<10W) Notebook adapters (<100W) CRT Power supplies (<150W) | <150W | Ease of implementation Well-Documented convertor. Operates on wide mains Large controller offer | High Peak currents Leakage inductance difficult to manage |
| Single switch forward | ATX power supplies (<250W) DC-DC convertors for telecom | <300W | Good cross regulation with coupled inductors. Good EMI signature. Low AC content, low conduction losses | Stress on power MOSFET. Difficult to operate on wide mains. Requires transformer reset. Duty cycle clamped to 50% |
| Two-Switch forward | ATX power supply (<500W) DC-DC convertor Telecom Servers(<500W) | 100-500W | Good cross regulation with coupled inductors. Good EMI signature. MOSFET stress clamped to V_{in} | Difficult to operate on wide mains. Requires transformer reset. Duty cycle clamped to 50% Requires high side drive. |

| Topology | Applications | Power | Benefits | Negative aspects |
|-----------------|--|----------|---|---|
| Half-Bridge | ATX power supply (<500W) DC-DC convertor Telecom Servers(<500W) | 100-500W | Good cross regulation with coupled inductors. Good EMI signature. MOSFET stress clamped to V_{in} . Duty cycle <100% | Difficult to operate on wide mains. Requires high side drive. Cannot easily work with current mode. |
| Half-Bridge LLC | Medical power supplies LCD or plasma TV | <500W | Excellent EMI signature Can work in no load. Smooth waveforms, zero voltage switching (ZVS) possible. | High side drive Large RMS current Narrow mains operation. Dangerous short circuit. |
| Full bridge | Server and mainframe power supplies. High power DC-DC convertors for telecom. | >500W | Good cross regulation with coupled inductors. Resonant operation via phase shift. Good EMI signature. MOSFET stress clamped to V_{in} . Duty cycle <100% | Difficult to operate on wide mains. Requires two high side drive circuits. Four MOSFETs to drive. |
| Push-Pull | DC-DC convertors | <200W | MOSFETs control is ground referenced Duty cycle <100% | Voltage stress of $2V_{in}$ Center-tapped primary. |

Current Status

- Prepared PCB for HPF ver1.1 going to test it on 08-2-2014 with Low amplitude High freq. signals to observe freq. response on Signal analyzer.
- Second test will be with 230VAC in controlled environment, initially with DSO then with Signal analyzer.
- Preparing NILM survey to figure out what all approaches are currently being used to disaggregate appliance level information/ appliance states.
- Improving upon appliance classification list to motivate my current research problem.
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Survey of NILM Papers (Not yet completed)

- Will update by Sunday (9-2-2014)