

Cat® Electric Power

UPS Detailed Overview

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Senior Engineer



BUILT FOR IT.™



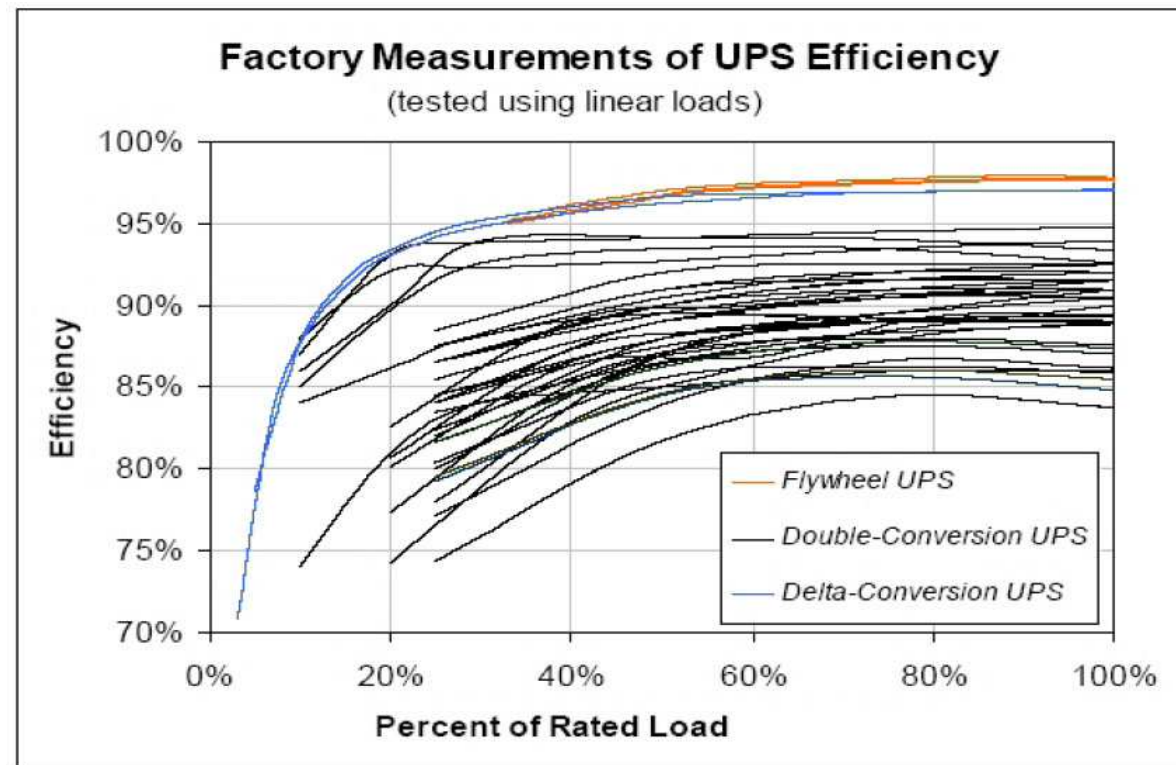
Why buy Cat[®] Flywheel UPS?

- Efficiency
- Footprint
- Maintenance
- Cooling
- Performance



Efficiency

- Cat Flywheel UPS uses an online active filtering design to provide exceptional performance with high efficiency

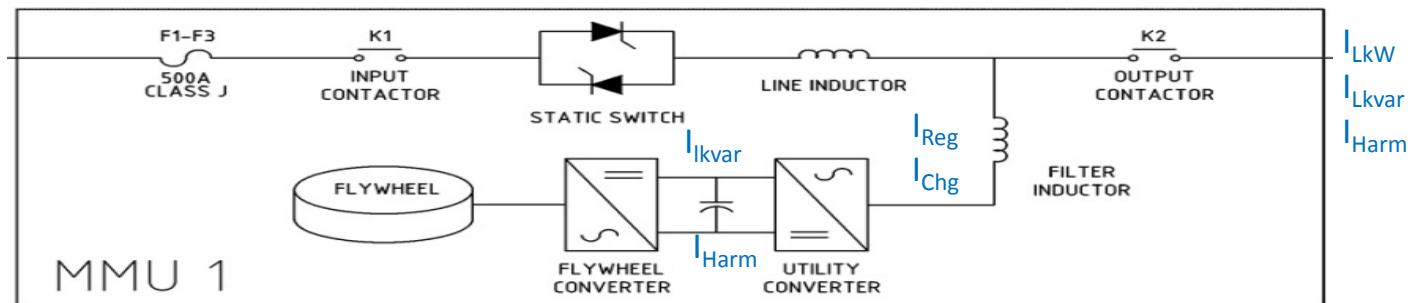


Efficiency

- The online active filtering design passes the load current directly through the UPS
- kVAR and Harmonic current are provided to the load from the Utility Convert
- A small regulator current is managed between the input and utility convert to provide the active filtering of the input sine wave
- A small charging current (about 1kW) is drawn from the input to maintain the flywheel charge

$$I_{IN} = I_{LkW} + I_{Chg} + I_{Reg}$$

I_{IN} = Input Current
 I_{LkW} = Real Load Current
 I_{Lkvar} = Reactive Load Current
 I_{Harm} = Harmonic Load Current
 I_{Reg} = Voltage Regulation Current
 I_{Chg} = Charging Current

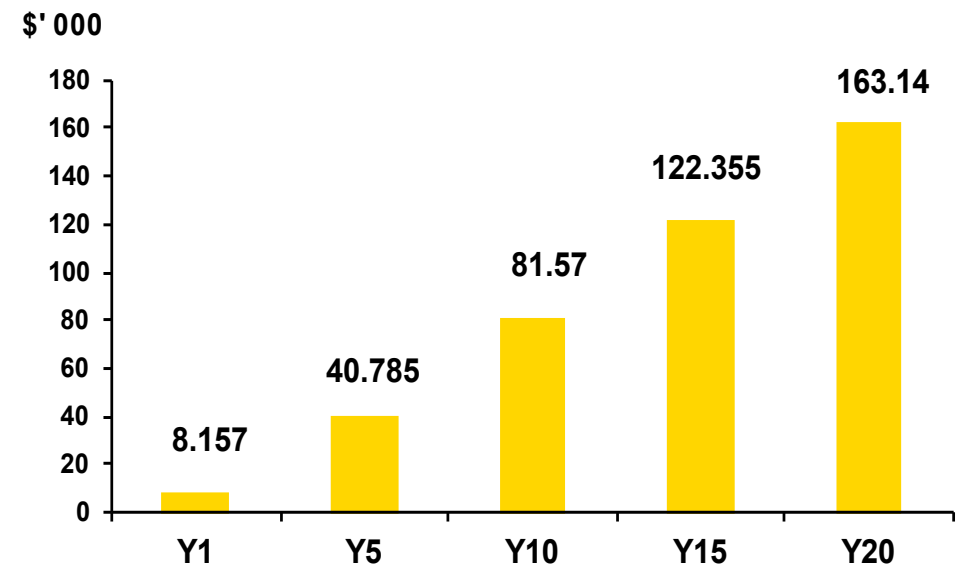


Efficiency

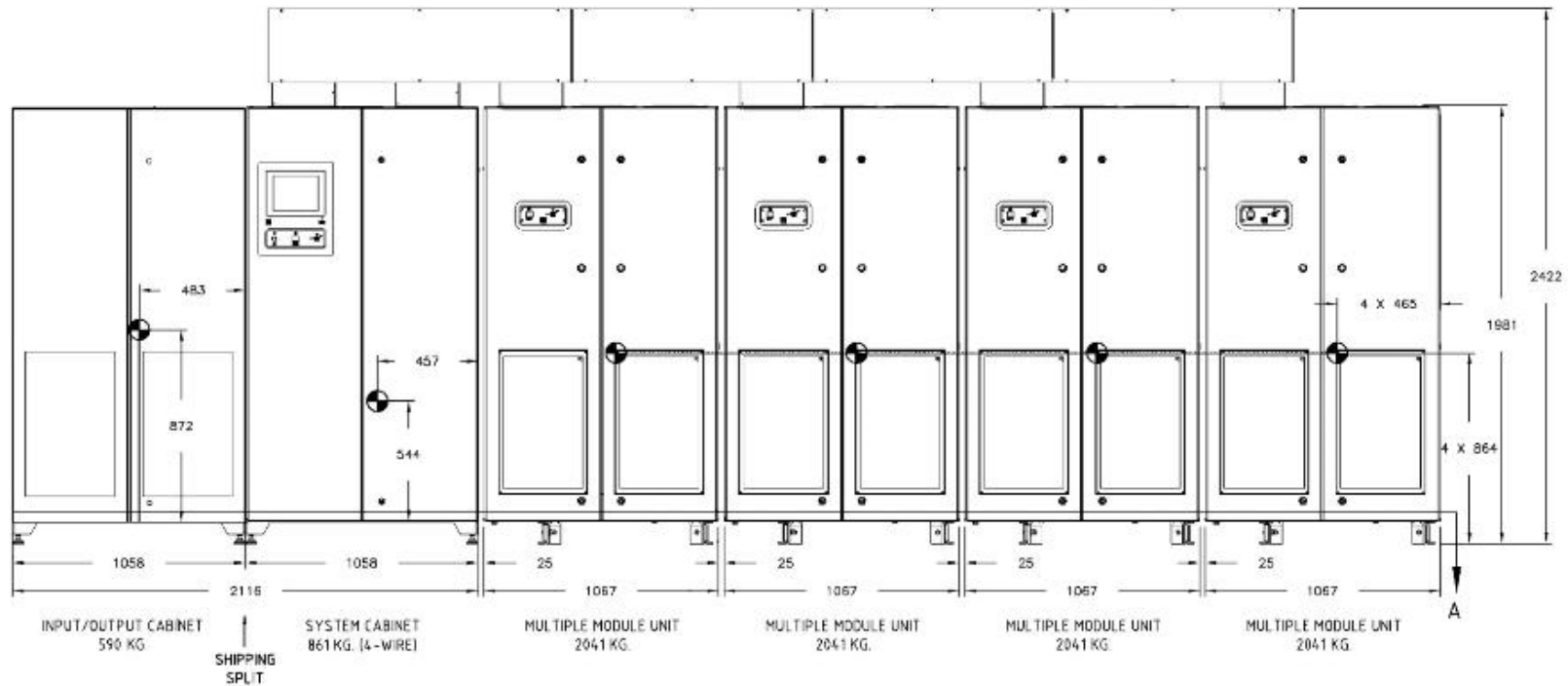
- For a 300kW UPS at \$0.07 kWh the savings due to efficiency is **\$8,157** a year

$$\frac{.07(.07) \times 300 \times 8760}{.93} = \$ 13,846$$

$$\frac{.07(.03) \times 300 \times 8760}{.97} = \$ 5,689$$



Footprint



4 flywheel (6.5m or 255")

3 Flywheel (5.4m or 212")

2 Flywheel (4.3m or 169")

1 Flywheel (3.2m or 126")

Flywheel =
250kVA @ 50HZ
300kVA @ 60HZ

Cat® Electric Power



CAT®

Footprint

- Single Flywheel
- 480V @ 60HZ, 750KVA/675KW
- 400V @ 50/60HZ, 625KVA/625KW
- Parallel up to 8
 - 3.4m x 1m x 2m
 - 132" x 39.3" x 80"
 - 5,375 kg
 - 11,850 lbs

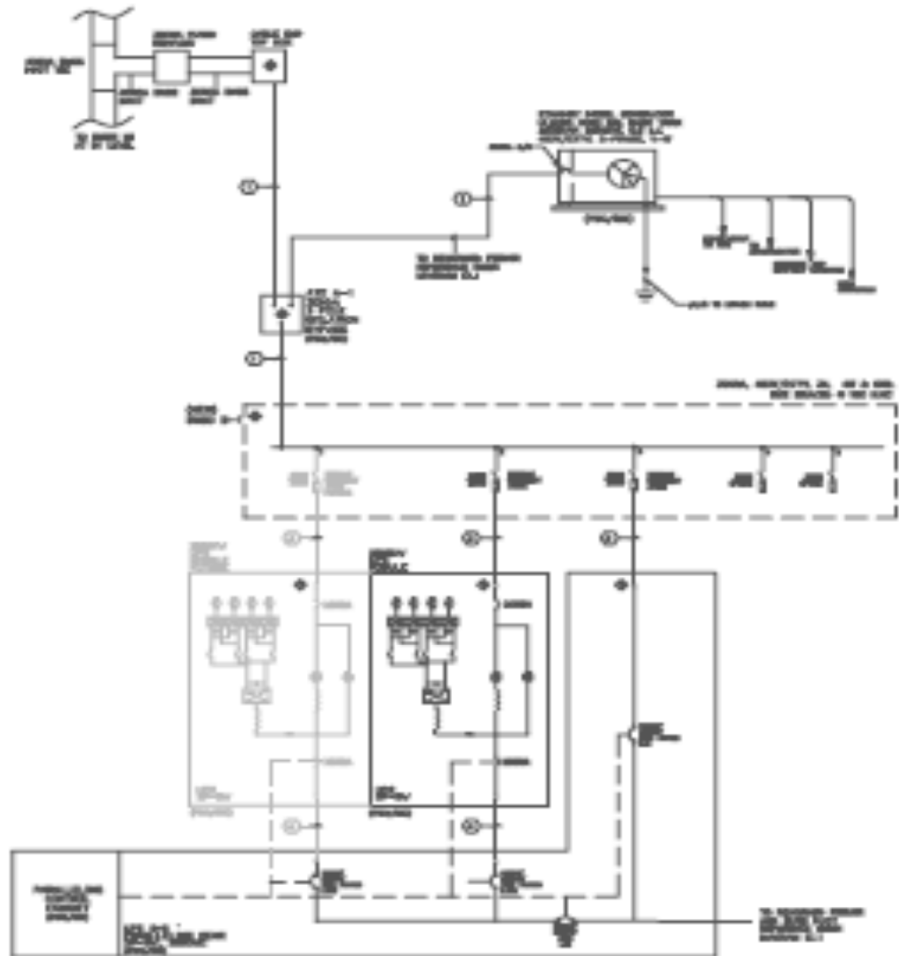
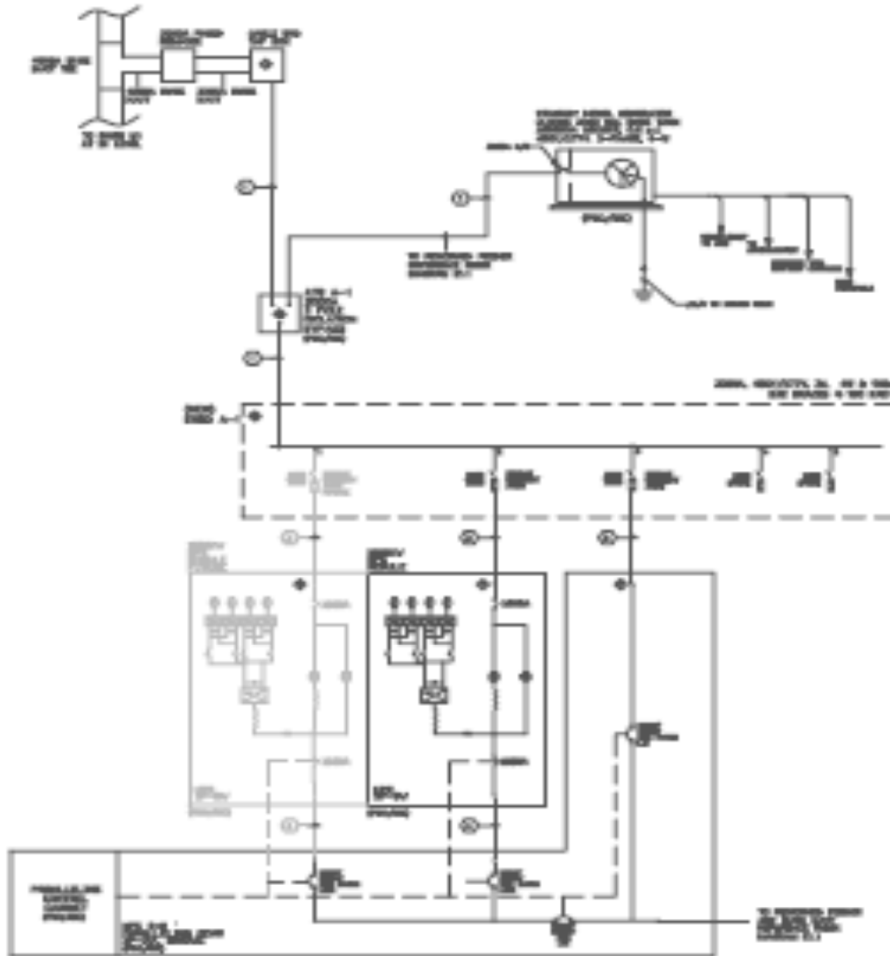


Datacenter Application

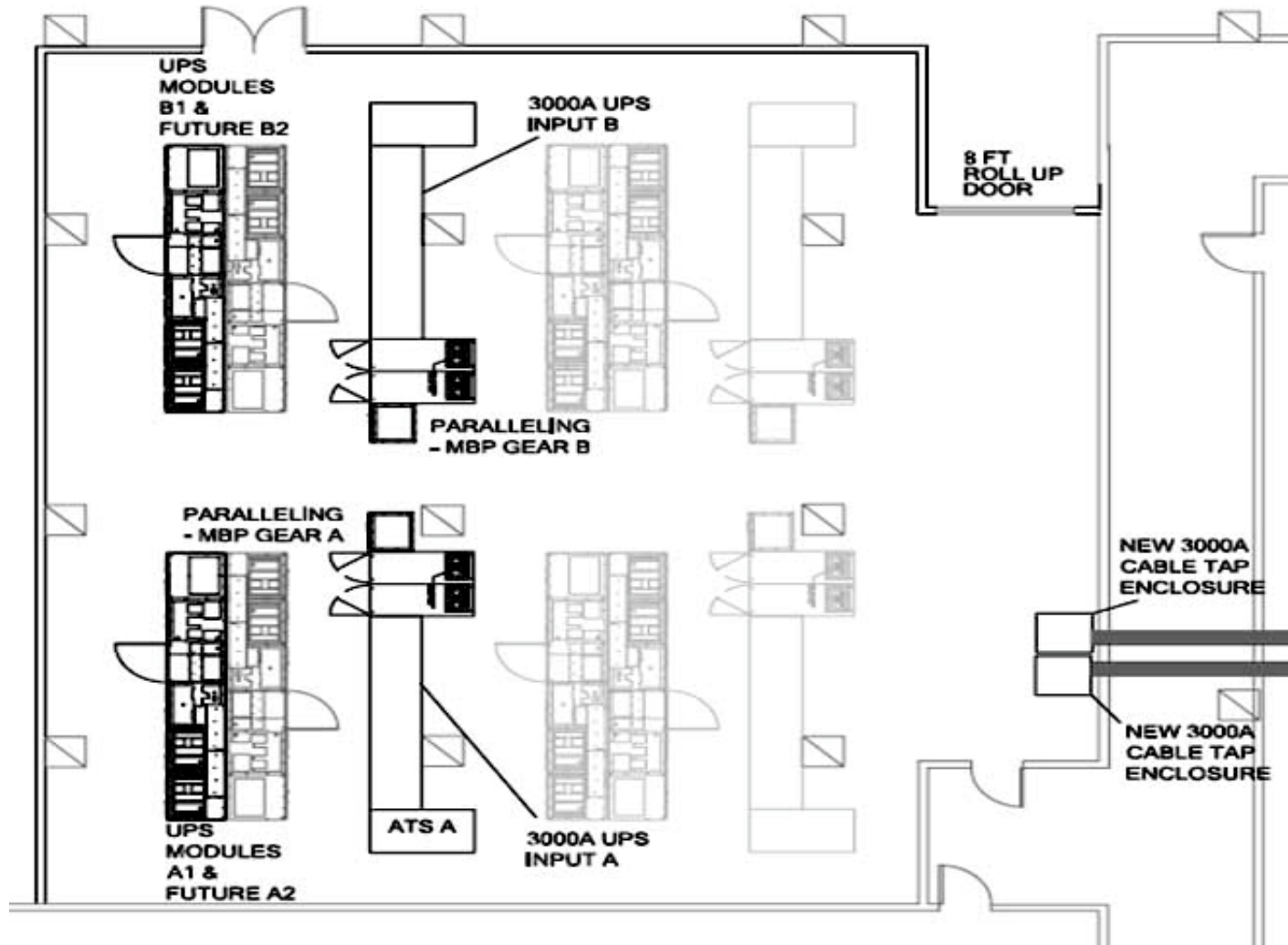
- Co-location Data Center
- Electrical architecture
 - A/B bus configuration with 1x engine on each side
- Cat 2 MW Generator sets
- Cat Switchgear
- Cat Flywheel UPS - 4800 kVA
 - 2x1200 CAT UPS in parallel per 2 MW engine
 - 4 total UPS systems



System Overview



System Layout



CAT Flywheel UPS Benefits

- 9.6MVA of Cat Flywheel UPS in less space than 3.5 MVA of Double Conversion UPS
- Additional capacity accounted for a potential of ~\$500k of additional billable revenue a year
- For every 1 MW of load, \$48,666/yr in utility costs is saved

Double Conversion UPS:

$$\frac{.08 \times .10}{.90} \times 1000 \times 8760 = \$77,866$$

Flywheel based UPS:

$$\frac{.08 \times .04}{.96} \times 1000 \times 8760 = \$29,200$$

Annual Electrical savings based on 1MW load = \$48,666

- Customer received Utility Rebate of \$50K

Total
\$750,000
per year



Maintenance Comparison

CAT Flywheel UPS

- When Required
 - Clean the Flywheel housing
 - Clean the oil level site gauge
 - Check the oil level
- Every 3 Months
 - Clean/check Air Filter
- Every Year
 - Change the Vacuum Pump Oil
- Every 3-4 Years
 - Flywheel Bearing Replacement
- Every 5 Years
 - Replace Controller Battery
- Every 10 Years
 - DC Capacitor Replacement

Double Conversion/Battery UPS

- Monthly
 - Battery inspection/clean*
 - Torque battery terminals*
 - Clean internals
- Every 3 Months
 - Clean/check Air Filter
 - Battery Test – Ohmic*
- Every Year
 - Battery Test – Resistance*
- Every 5 Years
 - DC Capacitor Replacement
 - Battery Replacement
- Every 10 Years
 - AC Capacitor Replacement

Cooling

CAT Flywheel UPS

- Heat Rejection of 1200kVA UPS
 - 83,967 BTU/HR
 - 24.6 kW
- UPS Temp Limits
 - 0-40° C (32° F - 104° F)
- Energy Storage Temp Limits
 - 0-40° C (32° F - 104° F)

Double Conversion/Battery UPS

- Heat Rejection of 1100kVA UPS
 - 250,000 - 339,000 BTU/HR**
 - 74 - 99.35 kW**
- UPS Temp Limits
 - 0-40° C (32° F - 104° F)
- Energy Storage Temp Limits
 - 25° C (77° F)*
 - Life decreases 50% for every 8° C to 10° C increase*
 - Batteries have less capacity at colder temperatures*

Performance

Input

- Voltage Range +10% / -15% (programmable)
- Frequency 60 Hz +/- 10% max (programmable) +/- 3% (default)
- Power Factor 0.99 at rated load and nominal voltage
- Harmonic Current Distortion <2% at 100% linear load

Output

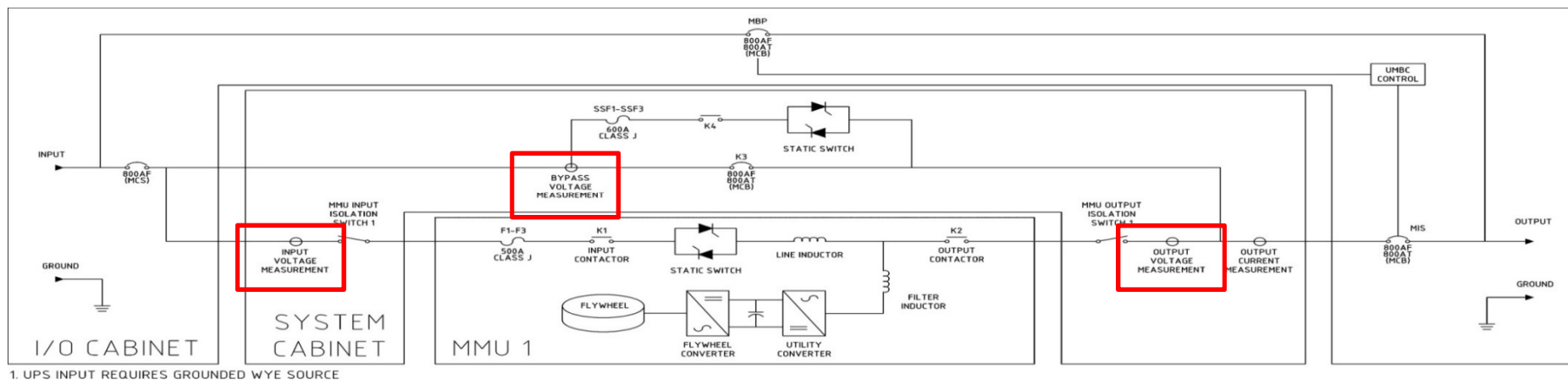
- Steady state Voltage regulation +/-1%
- Voltage distortion <1% linear loads
- Frequency 60Hz (mains synchronized)
 - (normal operation +/- 0.2% free running)



Power Correction – Sample rate

Voltage is monitored at three locations within the UPS

- Input, Bypass and Output



Bypass voltage is used to confirm voltage before transfer

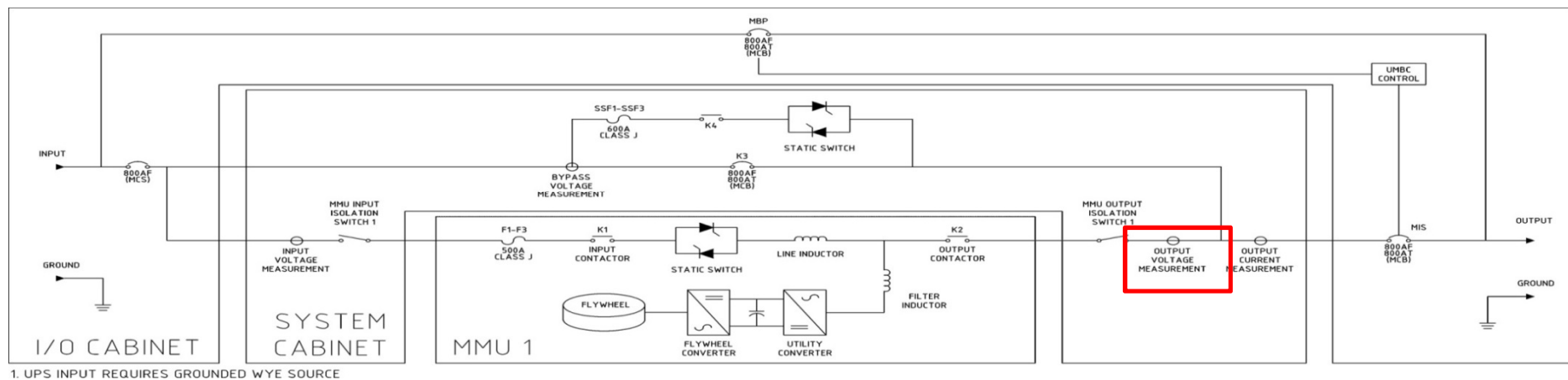
Input voltage is used to determine disconnect

Output voltage is used for correction



Power Correction – Sample rate

- Sample rate of 20kHz for 300 series
 - 333 samples per cycle at 60HZ
 - 400 samples per cycle at 50HZ



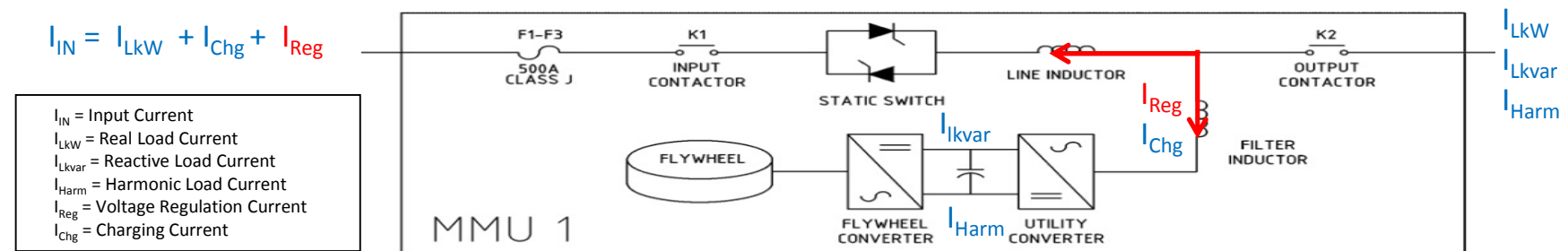
- Sample rate of 217kHz for 750 series
 - 3616 samples per cycle at 60HZ
 - 4340 samples per cycle at 50HZ

Power Correction – Voltage

As Real Power is drawn across the Line Inductor a phase shift will occur

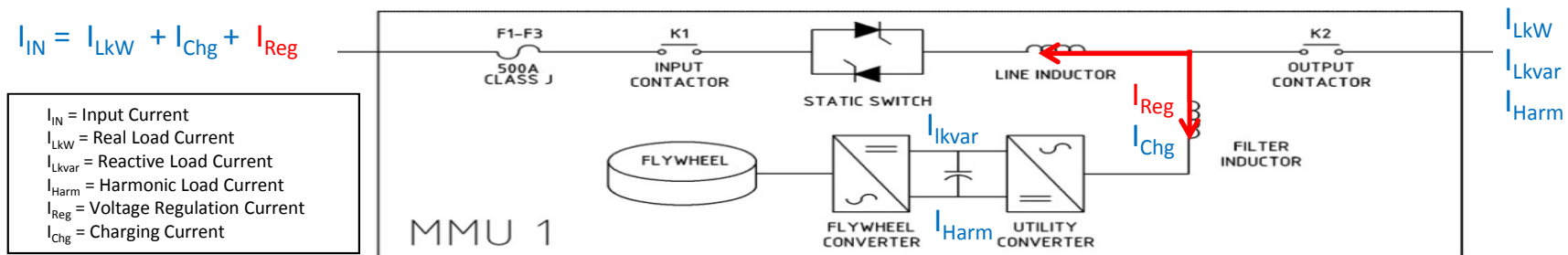
- The phase shift is kept to less than 10 degrees at full load

The phase shift creates a Reactive Current that is managed by the Utility Converter to control the Output Voltage



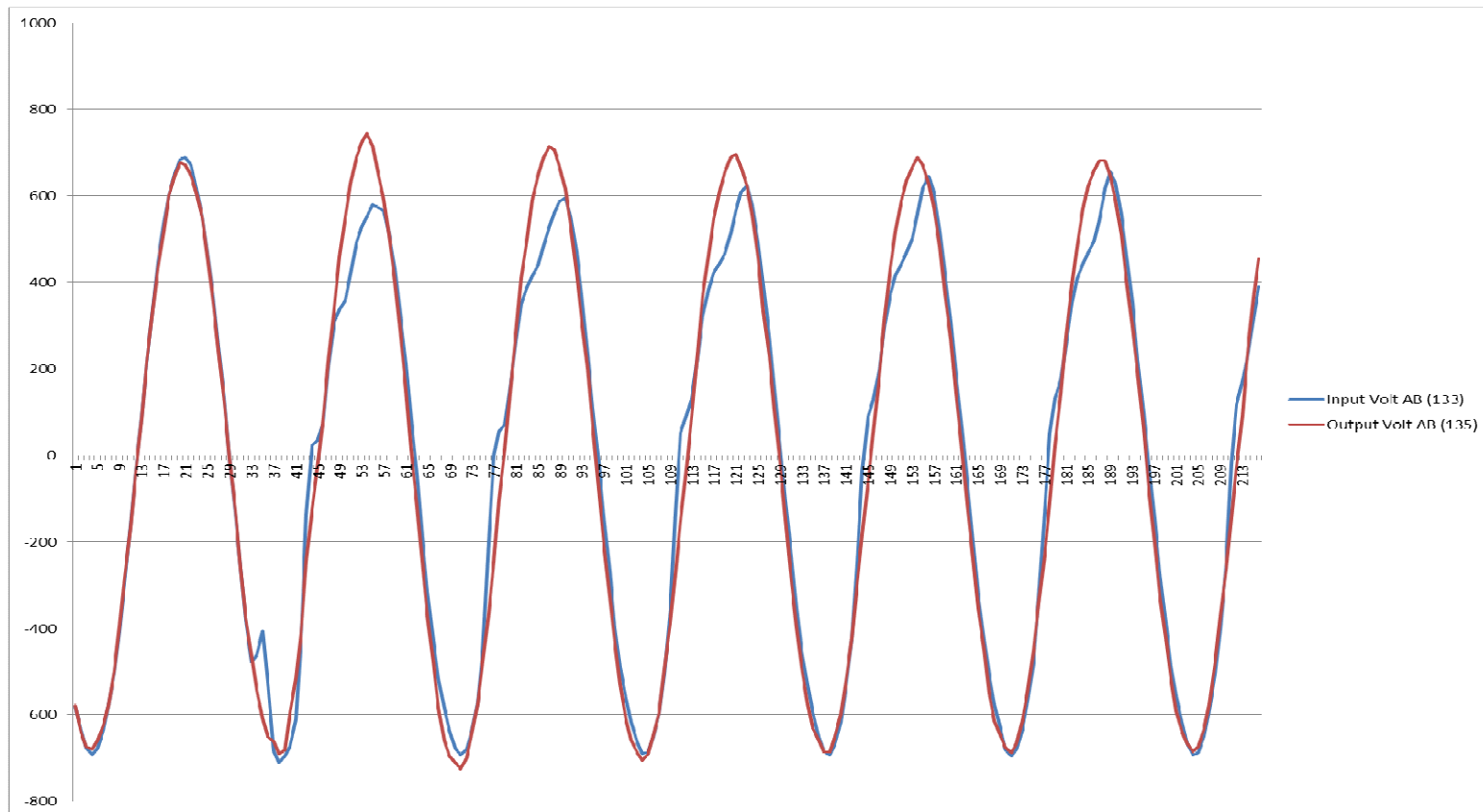
Power Correction – Voltage

- Leading reactive current causes a voltage boost
- Lagging reactive current causes a reduce voltage.



Power Correction

- Actual data demonstrating voltage correction



Why buy Cat[®] Flywheel UPS?

- Efficiency
 - \$48,666/yr for 1 MW of load in electrical savings
- Footprint
 - More billable space to increase revenue
- Maintenance
 - Lower cost and Less down time
- Cooling
 - Lower heat rejection and cooling requirement
- Performance
 - Exceptional power quality



Total Cost of Ownership (TCO) Tool

WELCOME

SUMMARY

FULL REPORT

FINISH

TCO CALCULATOR

CATERPILLAR

SYSTEM CONFIGURATION

GENERAL

OF YEARS IN MODEL 20 years

UPS RATING 1000 kW

AVERAGE LOAD FACTOR 40 %

BATTERY RUNTIME 5 minutes

EFFICIENCY

CAT FLYWHEEL UPS 98.0%

COMPETITOR 92.0%

ENERGY STORAGE

☒ VRLA

☐ FLOODED CELL

☐ ROTARY

CURRENCY

USD

SYSTEM COST

UPS SYSTEM CAPITAL

			TOTAL COST
CAT FLYWHEEL UPS	<input type="text" value="406.80"/>	\$/kW	\$406,800
COMPETITOR	<input type="text" value="198.76"/>	\$/kW	\$198,760

ELECTRICITY

COST \$/kWh

VRLA BATTERY

TOTAL COST	\$51,150
SYSTEM COST	<input type="text" value="10.23"/> \$/kWmin.
BATTERY INSTALLATION	<input type="text" value="2.15"/> \$/kWmin.
REDUNDANT BATTERIES	<input type="checkbox"/>

COST FACTORS

SERVICE & MAINTENANCE

OTHER

INFLATION	<input type="text" value="2.92"/> %	ENERGY COST GROWTH	<input type="text" value="4.35"/> %
COMMODITY INDEX	<input type="text" value="10.05"/> %	EMPLOYMENT COST INDEX	<input type="text" value="3.63"/> %
CO ₂	<input type="text" value="0.72"/> MT/MWh	WACC	<input type="text" value="7.8"/> %



A large, white industrial generator, likely a Caterpillar model, is the central focus of the image. It is situated in a spacious industrial facility, possibly a power plant or manufacturing plant, with various pipes and structural elements visible in the background. The generator is mounted on a yellow-painted concrete base. The text "BUILT FOR IT." is superimposed in large, bold, white capital letters across the middle of the image. The "IT." part of the text is slightly offset to the right, suggesting it might refer to a specific application or environment. The overall scene conveys a sense of industrial strength and reliability.

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