

# 2013 Clarkson University Winter Knights



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# Design Intent



- Improve upon the Best Available Technology (BAT) standard of the power sports industry to enhance fuel efficiency while reducing emissions and noise
- Fully automatic tuning for flex-fuel blends from E0 to E85
- Maintain a stock appearance and familiar rider ergonomics
- Make the machine more appealing to consumers





## **Turbo - 600 ACE**

### ***(Intended Design)***

- Garrett GT12 Turbocharger
- Custom Intercooler by Bell
- Custom Aluminum Intake Plenum
- Rotax 1200 4-TEC Injectors
- Modified Power Commander V with MAP input
- E-Drive II Clutching System
- Custom *Wiseco* low compression pistons [ $\sim 10:1$ ]
- SMART Emissions Reducer
- Integrated 3-way Catalyst

## **ECO - 600 ACE N/A**

### ***(Design Used)***

- Rotax 1200 4-TEC Injectors
- GM/Delphi Flex-Fuel Sensor
- Zeitronix Ethanol Content Analyzer
- Custom Power Commander V Pti with AutoTune and Wideband 2 Controllers
- SMART Emissions Reducer
- Integrated 3-way Catalyst



## **Issue:**

Stock ECU correlates between primary charge (MAP) and secondary charge detection (throttle position). Both models must fit using stock MAP sensor.



# Engine Control



## - Prototype Power Commander V Fuel/Ignition Control Unit with Wideband2 Lambda Sensor and PTI

- Closed Loop with Single O2 Sensor
- Target Lambda Table
- Analog Input for Ethanol Sensor
- USB Connection, Existing Software



## - Delphi Flex Fuel Sensor & Zeitronix Ethanol Content Analyzer

- 0 – 5 V input to PCV (*linear relationship*)
- Digital Readout (Exx) to Rider



## - Custom Low Compression Pistons (Turbo only), developed by Wiseco and Clarkson Winter Knights

# Fuel Mapping



	Throttle Position %									
	0	2	5	10	15	20	40	60	80	100
500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
750	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1000	1.02	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1250	1.02	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1500	1.02	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1750	1.02	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2000	1.02	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2250	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2750	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3000	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.00	1.00
3250	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.04	1.04
3500	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.04	1.04
3750	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.04	1.04
4000	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.04	1.04
4250	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.04	1.04
4500	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.04	1.04
4750	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.04	1.04
5000	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.02	1.02
5250	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.02	1.02
5500	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.05	1.02	1.02
5750	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.05	1.02	1.01
6000	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.05	1.02	1.01
6250	1.02	1.02	1.02	1.02	1.02	1.02	1.05	1.02	1.01	1.01
6500	1.02	1.02	1.02	1.02	1.02	1.01	1.05	1.02	0.98	0.98
6750	1.02	1.02	1.02	1.02	1.02	1.01	1.02	0.99	0.98	0.98
7000	1.02	1.02	1.02	1.02	1.02	1.01	1.01	0.99	0.98	0.98
7250	1.02	1.02	1.02	1.02	1.02	1.01	1.01	0.99	0.98	0.98
7500	1.02	1.02	1.02	1.02	1.02	1.01	1.01	0.99	0.98	0.98
7750	1.02	1.02	1.02	1.02	1.02	1.01	1.01	0.99	0.98	0.98
8000	1.02	1.02	1.02	1.02	1.02	1.01	1.01	0.99	0.98	0.98
8250	1.02	1.02	1.02	1.02	1.02	1.01	1.01	0.99	0.98	0.98
8500	1.02	1.02	1.02	1.02	1.02	1.01	1.01	0.99	0.98	0.98
8750	1.02	1.02	1.02	1.02	1.02	1.01	1.01	0.99	0.98	0.98
9000	1.02	1.02	1.02	1.02	1.02	1.01	1.01	0.99	0.98	0.98

**Tuning Target Lambda**

1.0 = Stoich

> 1.0 Lean Mixture

*(cruise fuel eco)*

< 1.0 Rich Mixture



- Land & Sea DYNomite Engine Dynamometer
- DYNO-MAX 2000 Analysis and Charting Software
- Closed Loop Automatic Tuning to Target Lambda
- Automatic Compensation for Ethanol Percentage
- Snap-On Handheld 5 Gas Analyzer (HC, CO<sub>2</sub>, CO, Nox, O<sub>2</sub>)



# Handling and Ride



## - Split Rail Ski Testing

- Real World Testing in a Variety of Trail Conditions
- Improved Handling, Reduced Effort, Reduced Darting
- Lower Engine Temperatures, Longer Hyfax Life



## - Ski-Doo TNT Package Shocks

- Adjustable Preload without Tools



## - Camoplast Ice Attak XT Pre-Studded Track, 1.22" Lug

- Improved Grip in Icy Conditions and Off-Trail



# Exhaust/Emissions

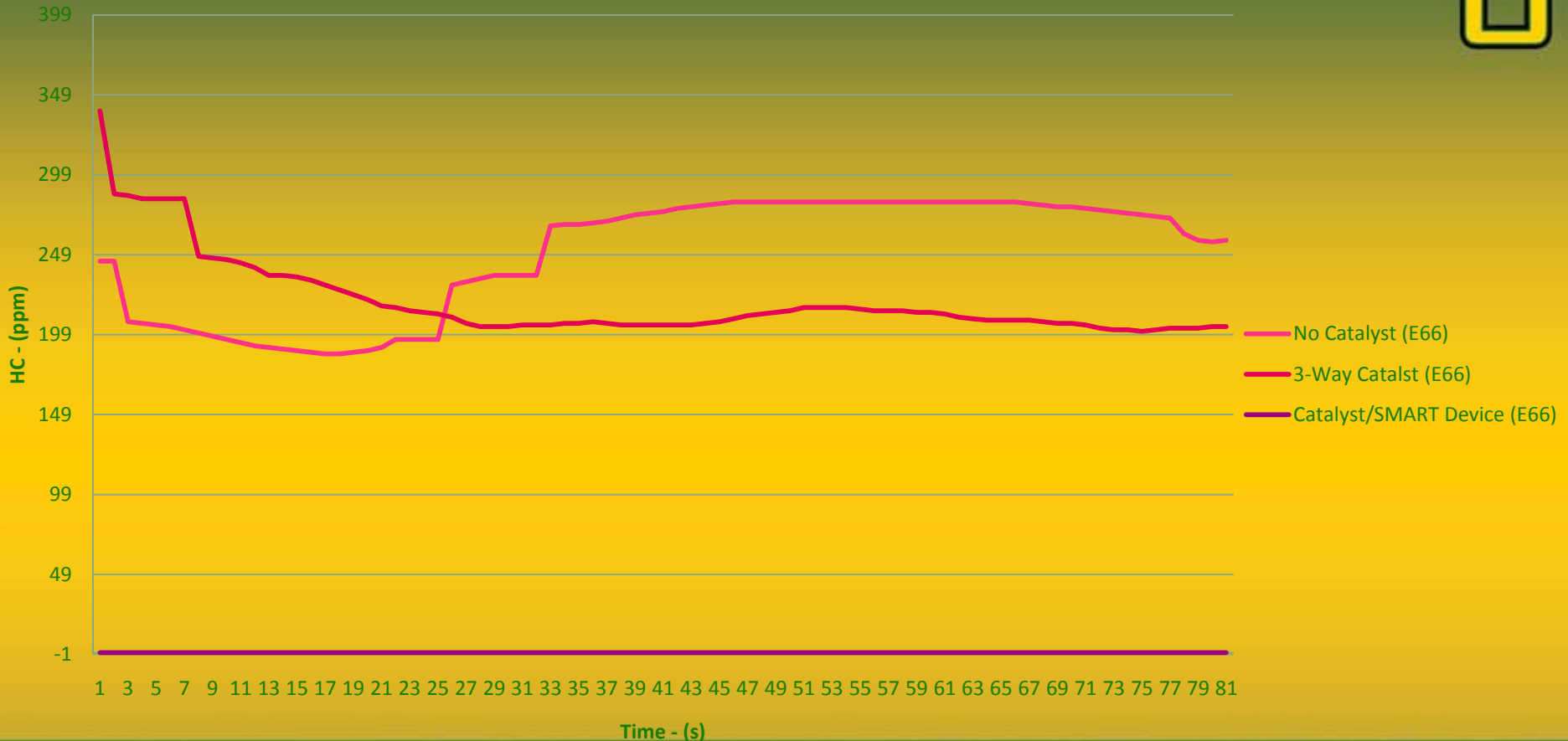


- Custom 2-1 Header
- Fiberglass Wrap for Fast Catalyst Warm-Up
- Integrated Lambda and Dual Exhaust Temperature Sensors
- 3-Way Catalyst by EMITEC & Aristo in Modified Stock Silencer
- SMART Emissions Reducer  
Cold Catalyst in Crankcase Breather





# Emissions Data Example



## Test Information

- Cases: Testing Stock, With Exhaust Catalyst, and Exhaust Catalyst/SMART Device
- Testing done with E66 at simulated Cruising speeds of 4500RPM
- Example shows measured HC at simulated cruise

# Emissions Improvements

Table Represents Average % Change in vehicle emissions at Simulated Cruise Speeds using E66 Fuel ~4500RPM

Gas Tested	Stock to Catalyst	Stock to Catalyst & S.D.	Catalyst to Catalyst & S.D.
HC [ppm]	249 → 219 /-12%	249 → 0 /-100%	219 → 0 /-100%
CO [%]	0.987 → 0.5 /-49%	0.987 → 0.37 /-62%	0.5 → 0.37 /-26%
CO <sub>2</sub> [%]	10.6 → 6.7 /-37%	10.6 → 8.4 /-21%	6.7 → 8.4 /+25%
NOx [ppm]	65.7 → 15.6 /-75%	65.7 → 9.45 /-86%	15.6 → 9.45 /-39%

## SMART Emissions Reducer (S.D.)

- Enhances the combustion burning process, lowering emissions. The molecular structure of the gases are broken down, becoming electronically charged. The electro-chemically charged gases burn more completely causing fewer emissions, improving performance, and fuel efficiency. [http://extremeenergysolutions.net/SMART\\_Emissions\\_Reducer.html](http://extremeenergysolutions.net/SMART_Emissions_Reducer.html)



# Marketability



- Established Ski-Doo Brand
- Popular REV-XP Chassis
- Familiar Stock Controls
- Electric Start/ Reverse
- MSRP \$13,715 (*Proposed Turbo*)
- MSRP \$10,720 (*Naturally Aspirated*)
- Low Maintenance, No Smoke/Odor, Long Lasting 4 Stroke Engine
- Average MPG > 20
- Advanced Gauge Package with Instant Fuel Economy (MPG)
- Lightweight < 480 lbs (dry weight)
- Fully Automated Flex-Fuel Capability (E0-E85)
- Fun to Drive, Sharp Handling, ~80mph Top Speed



# Thank You!



## Questions?

