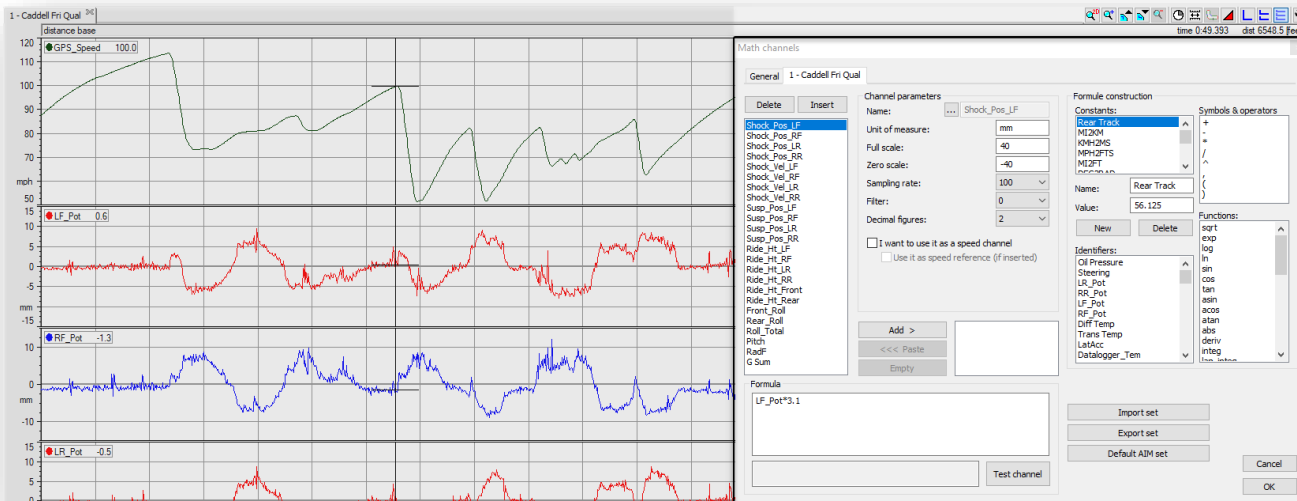




Co-Host:
Emiliano Bina

AiM-Sportline Software Developer

Webinar Series

Bringing Data Support and Training to You

More About Math Channels
In AiM Sports Race Studio

2020 Webinar #47

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1.800.718.9090

September 8th, 2020

Emiliano Bina
software@aim-sportline.com

4.02.11.308

RearDiffCk [%] 0.07

ECU_Rpm [rpm] 7062

ECU_Pedal_Pos [%] 99.500

ECU_Water_T [°F] 198

Oil_Temp [°F] 223.0

ECU_Lambda [A/F] 0.85

ECU_Spark_Adv [deg] 23.50

ECU_Intake_Air_T [°F] 99.6

External_Voltage [V] 13.0

GearRatio [ratio] 1.00

LambdaFiltered [] 0.851

Spark_AdvFiltered [deg] 23.50

OverRev [secs] 0.00

OverRevFiltered [secs] 0.00

ECU_SpeedCheckFilt [diff] 0.2

AFR [ratio] 12.51

AFR_Filt [ratio] 12.51

AvgRearWheelSpeed [mph] 121.52

RPS_Diff [%] 100.50

ECU_Speed

GPS_Speed

GPS_Lat

GPS_Lon

Inclination

Latitude

Longitude

PitchRate

RollRate

YawRate

GPS_Pos

GPS_Speed

GPS_Acc

GPS_Diff

GPS_Speed

GPS_Speed

GPS_Speed

GPS_Speed

GPS_Speed



Emiliano Bina

AiM-Sportline Software Developer

- Studies in Vehicle Mechanics and Simulation
- Software Developer for AiM Since 2000
- Passion for Motorsport and Sim Racing



AND

- When you're looking for two conditions to happen, for example coasting is when you: (A) release the TPS AND (B) you still have to apply brake.
- Compute condition A: $LT(TPS, 10.0) \dots = 1$ when A is true
- Compute condition B: $LT(BRK, 10.0) \dots = 1$ when B is true
- Compute A AND B: $A * B \dots = 1$ when A is true AND B is true

Math channels

General 1 - Kenton Koch_DP02_Road America

Delete Insert

Channel parameters

Name: EB_COAST

Unit of measure: bool

Full scale: 2

Zero scale: -1

Sampling rate: 10

Filter: 0

Decimal figures: 2

☐ I want to use it as a speed channel
☐ Use it as speed reference (if inserted)

Add >

<<< Paste

Empty

Formula

LT(EB_BRK,1)*LT(Throttle_Pos,10)

Ok, the formule has been correctly interpreted

Test channel

Formule construction

Constants:

KM2MI

MI2KM

KMH2MS

MPH2FTS

MI2FT

FT2MI

Name: KM2MI

Value: 0.621371

New Delete

Identifiers:

Logger Temperature

External Voltage

LFShock

RFShock

3rd_Spg_shock

InlineAcc

LateralAcc

VerticalAcc

RollRate

PitchRate

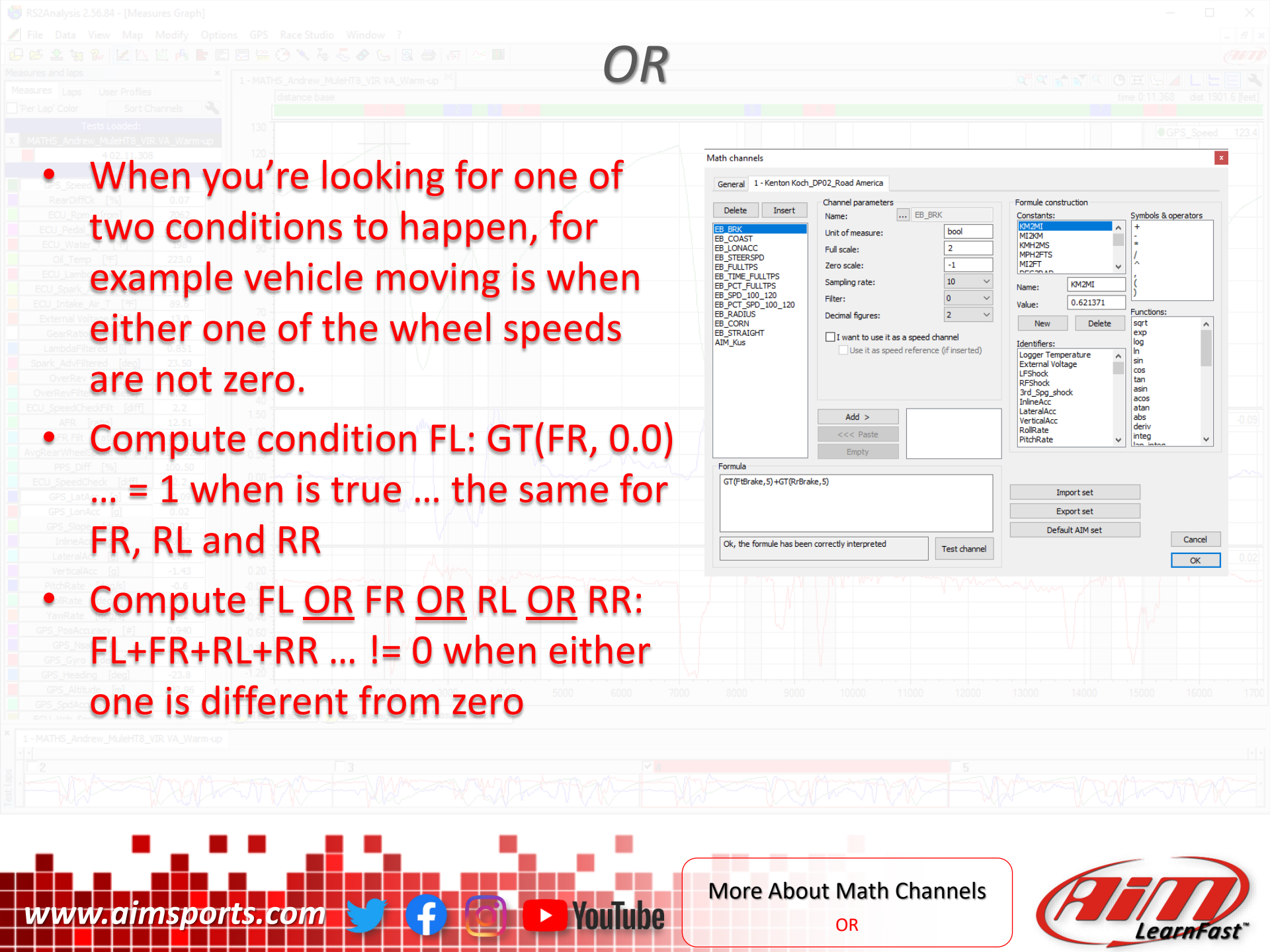
Import set

Export set

Default AIM set

Cancel

OK



OR

- When you're looking for one of two conditions to happen, for example vehicle moving is when either one of the wheel speeds are not zero.
- Compute condition FL: GT(FR, 0.0) ... = 1 when is true ... the same for FR, RL and RR
- Compute FL OR FR OR RL OR RR: FL+FR+RL+RR ... != 0 when either one is different from zero

Math channels

General 1 - Kenton Koch_DP02_Road America

Delete Insert

Channel parameters

Name: EB_BRK

Unit of measure: bool

Full scale: 2

Zero scale: -1

Sampling rate: 10

Filter: 0

Decimal figures: 2

☐ I want to use it as a speed channel
☐ Use it as speed reference (if inserted)

Add > <<< Paste Empty

Formule

GT(FtBrake,5)+GT(RtBrake,5)

Ok, the formule has been correctly interpreted Test channel

Formule construction

Constants: KM2MI, MI2KM, KMH2MS, MPH2FTS, MI2FT, FT2MI

Name: KM2MI

Value: 0.621371

New Delete

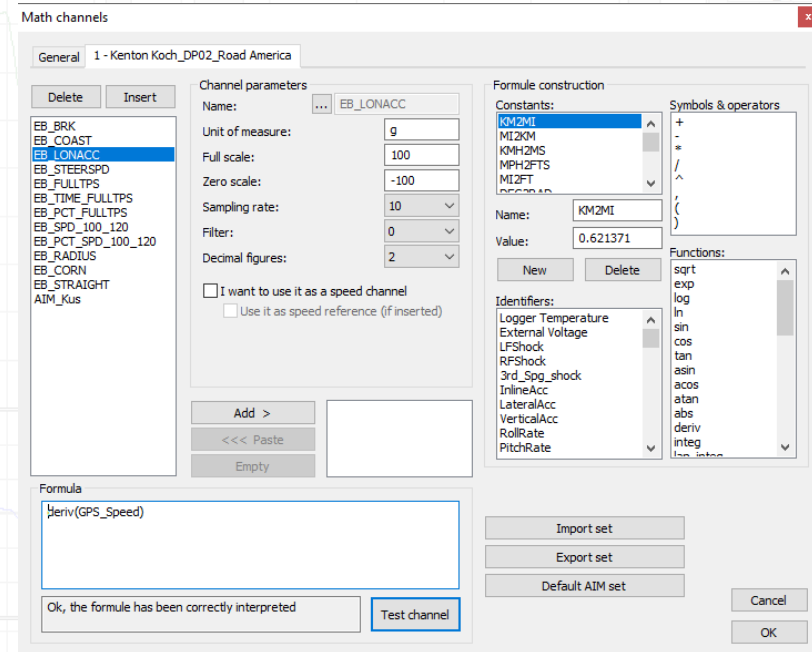
Identifiers: Logger Temperature, External Voltage, LFSHock, RFSHock, 3rd_Spg_shock, InlineAcc, LateralAcc, VerticalAcc, RollRate, PitchRate

Import set Export set Default AIM set Cancel OK

Derivative

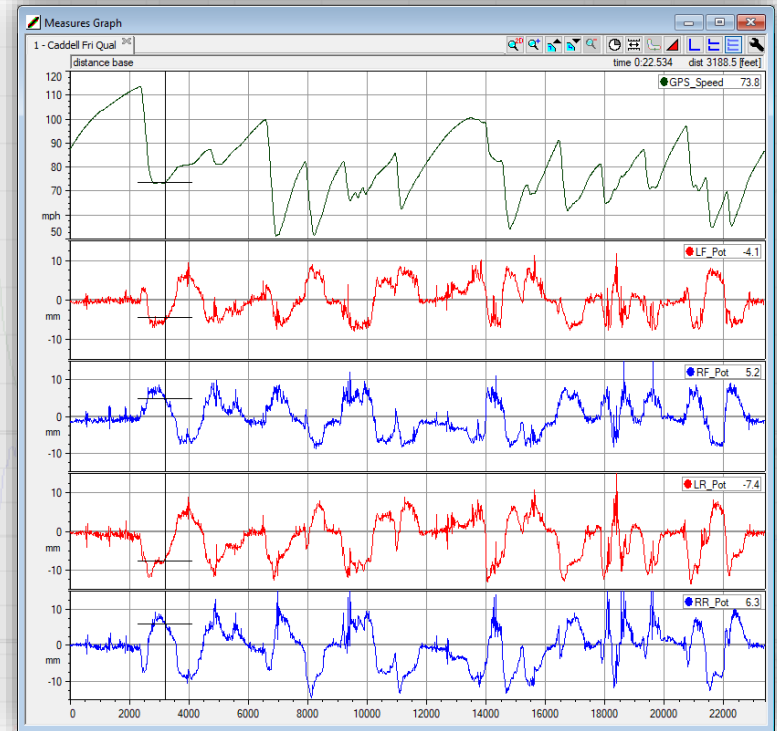
- Suppose you want to compute something based on the variation of a channel: use the derivative
- Acceleration is based on the variation of speed
- Distance = deriv(SPD)
- Some very basic traction control can be set upon the variation of rpm ... deriv(RPM)
- Steering speed... deriv(Steer)
- Basically you go computing the value of "Channel/s"

(take care for noise)
(take care for units)



Integral

- Suppose you want to compute how the effect of a channel builds up inside a session: use the integral
- Basically you go 'taking' the $\int$
- Say you want to compute the total amount of fuel used having only the instant consumption... from gallons/sec to gallons



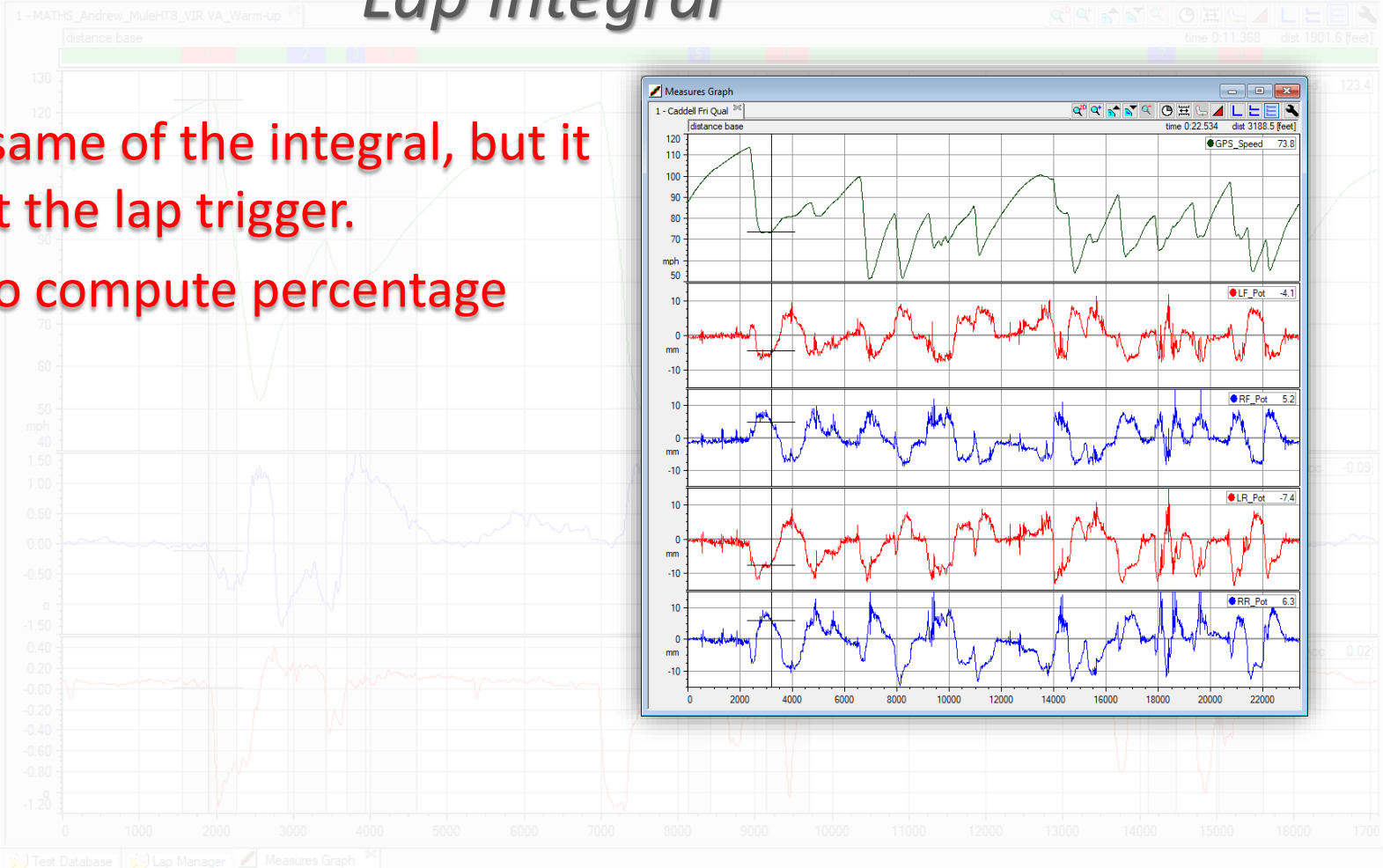
(take care for drift)

(take care for units)

Lap Integral

- It's the same of the integral, but it resets at the lap trigger.
- Useful to compute percentage

Measures	Laps	User Profiles
☐ Per Lap Color		Sort Channels
Tests Loaded:		
MATHS_Andrew_MuleHT8_VIR_VA_Warm-up		
GPS_Speed	4.02 11.308	
RearDiffOk [%]	0.97	
ECU_Rpm		
ECU_Pedal		
ECU_Water [%]	198	
Oil_Temp [°F]	223.0	
ECU_Lambda	0.95	
ECU_Spark		
ECU_Intake		
External_Voltage [V]	13.0	
GearRatio [ratio]	1.00	
LambdaFiltered []	0.851	
Spark_AdvFiltered [deg]	23.50	
OverRev [secs]	0.00	
OverRevFiltered [secs]	0.00	
ECU_SpeedCheckFilt [diff]	2.2	
AFR [ratio]	12.51	
AFR_Filt [ratio]	12.51	
AvgRearWheelSpeed [mph]	121.52	
RPS_Diff [%]	100.50	
ECU_SpeedCheck [diff]	2.2	
GPS_LatAcc [g]	-0.09	
GPS_LonAcc [g]	0.02	
GPS_Slope [deg]	0.22	
InlineAcc [g]	-0.02	
LateralAcc [g]	-0.17	
VerticalAcc [g]	-1.43	
PitchRate [deg/s]	-0.6	
RollRate [deg/s]	0.8	
YawRate [deg/s]	-0.2	
GPS_PosAccuracy [°]	0.940	
GPS_Neat [°]	15	
GPS_Gyro [deg/s]	-0.9	
GPS_Heading [deg]	-23.8	
GPS_Altitude [m]	142.96	
GPS_SpdAccuracy [°]	0.157	
GPS_Veh_PosAcc [m]	1.71	



Percent of Laptime @ Full TPS

- GT(TPS, 90.0) tells me when I'm at Full TPS... let's call it "A"
- Lap_integ(A)
- $100 * \text{Lap_integ}(A) / \text{time}()$

Math channels

General 1 - Kenton Koch_DP02_Road America

Delete Insert

Channel parameters

Name: EB_PCT_FULLTPS

Unit of measure: %

Full scale: 100

Zero scale: 0

Sampling rate: 10

Filter: 0

Decimal figures: 2

☐ I want to use it as a speed channel
☐ Use it as speed reference (if inserted)

Add >

<<< Paste

Empty

Test channel

Formula construction

Constants: KM2MI, MI2KM, KMH2MS, MPH2FTS, MI2FT, RPM2RPS

Value: 0.621371

Identifiers: Logger Temperature, External Voltage, LFShock, RFShock, 3rd_Spg_shock, InlineAcc, LateralAcc, VerticalAcc, RollRate, PitchRate

Functions: sqrt, exp, log, ln, sin, cos, tan, atan, asin, acos, abs, deriv, integ, lap_integ

Formula: $100 * \text{lap_integ}(\text{EB_FULLTPS}) / \text{time}()$

Import set

Export set

Default AIM set

Cancel

OK

Math channels

General 1 - Kenton Koch_DP02_Road America

Delete Insert

Channel parameters

Name: EB_TIME_FULLTPS

Unit of measure: s

Full scale: 100

Zero scale: 0

Sampling rate: 10

Filter: 0

Decimal figures: 2

☐ I want to use it as a speed channel
☐ Use it as speed reference (if inserted)

Add >

<<< Paste

Empty

Test channel

Formula construction

Constants: KM2MI, MI2KM, KMH2MS, MPH2FTS, MI2FT, RPM2RPS

Value: 0.621371

Identifiers: Logger Temperature, External Voltage, LFShock, RFShock, 3rd_Spg_shock, InlineAcc, LateralAcc, VerticalAcc, RollRate, PitchRate

Functions: sqrt, exp, log, ln, sin, cos, tan, atan, asin, acos, abs, deriv, integ, lap_integ

Formula: $\text{lap_integ}(\text{EB_FULLTPS})$

Import set

Export set

Default AIM set

Cancel

OK

(take care for channel frequency)

Percent of Laptime @ 100-120 mph

- GE(SPD, 50.0) tells me when I'm above 50 mph... let's call it "A"
- LT(SPD, 70.0) tells me when I'm above 70 mph... let's call it "B"
- $100 * \text{Lap_integ}(\text{A} * \text{B}) / \text{time}()$

Math channels

General 1 - Kenton Koch_DP02_Road America

Delete Insert

Channel parameters

Name: EB_PCT_SPD_100_120

Unit of measure: %

Full scale: 100

Zero scale: 0

Sampling rate: 10

Filter: 0

Decimal figures: 2

☐ I want to use it as a speed channel

☐ Use it as speed reference (if inserted)

Add > <<< Paste Empty

Formula

$100 * \text{lap_integ}(\text{EB_SPD_100_120}) / \text{time}()$

Test channel

Formule construction

Constants:

KM2MI

MI2KM

KMH2MS

MPH2FTS

MI2FT

Name: KM2MI

Value: 0.621371

New Delete

Identifiers:

Logger Temperature

External Voltage

LFSHock

RFSHock

3rd_Spg_shock

InlineAcc

LateralAcc

VerticalAcc

RollRate

PitchRate

Symbols & operators

+ - * / ^ ()

Functions:

sqrt exp log ln sin cos tan asin acos atan abs deriv integ

Import set Export set Default AIM set Cancel OK

(take care for channel frequency)

Am I On Straight

- Compute Corner Radius
 $\text{RADIUS} = \text{SPD}^2 / \text{LATAACC}$
- $\text{GT}(\text{RADIUS}, 5000.0)$ [m]
- $\text{GT}(\text{RADIUS}, 15000.0)$ [ft]
- ... = 1 if I'm on a straight

Math channels

General 1 - Kenton Koch_DP02_Road America

Delete Insert

Channel parameters

Name: EB_STRAIGHT

Unit of measure: bool

Full scale: 2

Zero scale: -1

Sampling rate: 10

Filter: 0

Decimal figures: 2

☐ I want to use it as a speed channel
☐ Use it as speed reference (if inserted)

Add > <<< Paste Empty

Formula

LT(EB_CORN,0.1)*GT(EB_CORN,-0.1)

Test channel

Formule construction

Constants:

KM2MI
MI2KM
KM2MS
MPH2FTS
MI2FT
FT2MI

Name: KM2MI

Value: 0.621371

New Delete

Identifiers:

Logger Temperature
External Voltage
LFShock
RFShock
3rd_Spg_shock
InlineAcc
LateralAcc
VerticalAcc
RollRate
PitchRate

Symbols & operators

Functions:

sqrt
exp
log
ln
sin
cos
tan
asin
acos
atan
abs
deriv
integ
lin_integ

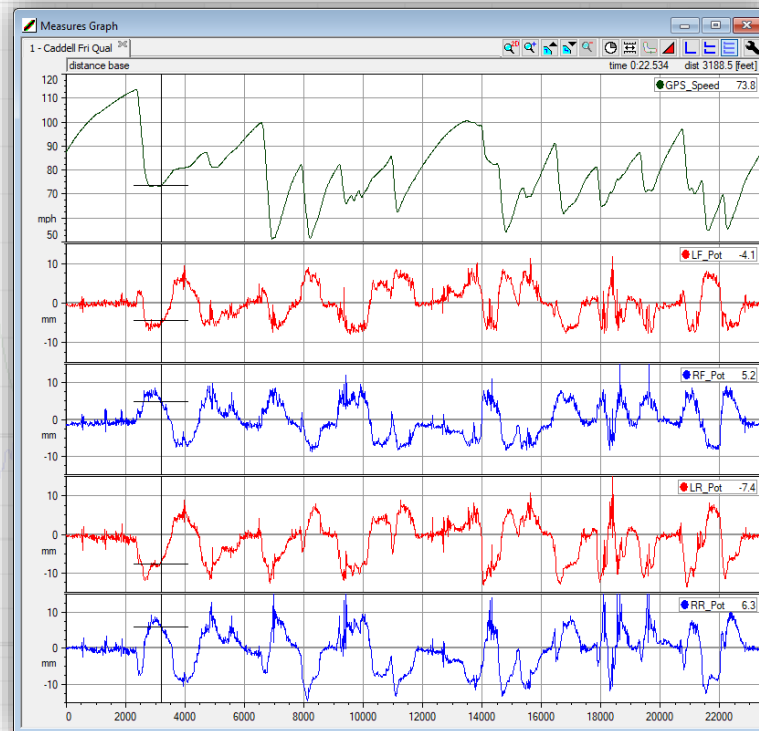
Import set
Export set
Default AIM set

Cancel OK

(take care for units)

Distance Traveled While Shifting

- It depends upon what you mean with "shifting"
- Clutch is being operated
- TPS is released
- ... create a condition A upon this and use it with a speed channel
- $SPD_A = IF(A, SPD, 0.0)$
- Compute the distance upon SPD_A lap_integ(SPD_A)



(Use "delta" 😊)

RS2Analysis 2.56.84 - [Measures Graph]

File Data View Map Modify Options GPS RaceStudio Window ?

Measures and laps

Measures

Laps

User Profiles

Per Lap Color

Sort Channels

Tests Loaded:

MATHS_Andrew_MuleHT8_VIR_VA_Warm-up

4 02.11.308

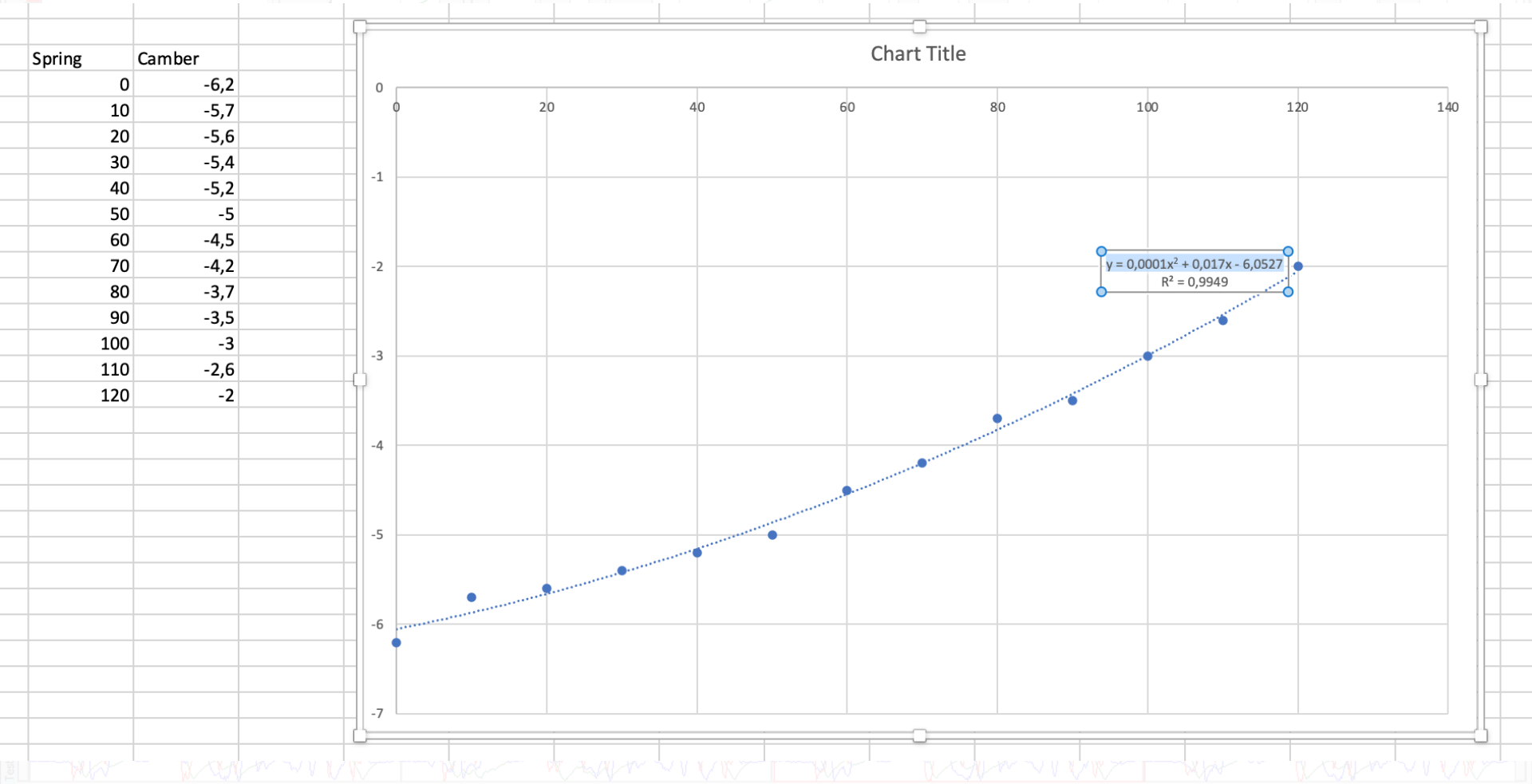
1 - MATHS_Andrew_MuleHT8_VIR_VA_Warm-up

distance base

time 0:11.368 dist 1901.6 [feet]

GPS_Speed 123.4

Using Excel



Using Excel

- Insert the measured values
- Plot them
- Add the trendline (polynomial)
- Take note of the numbers:
$$y = 0,0001x^2 + 0,017x - 6,0527$$
- Y is camber
- X is spring displacement, we suppose we measure it with a pot
- Add a math channel
- $$\text{CAMBER} = 0.0001 * \text{pot} * \text{pot} + 0.017 * \text{pot} - 6.0527$$

(Take care o polyn.
order: not too high)

Math channels

General 1 - Caddell Fri Qual

Delete Insert

Channel parameters

Name: ... EB_CAMBER

Unit of measure: deg

Full scale: -5.5

Zero scale: -6.5

Sampling rate: 10

Filter: 0

Decimal figures: 2

☐ I want to use it as a speed channel

☐ Use it as speed reference (if inserted)

Add >

<<< Paste

Empty

Formula

0.0001*(LF_Pot*LF_Pot)+0.017*LF_Pot-6.0527

Test channel

Formule construction

Constants:

KM2MI

MI2KM

KM2MS

MPH2FTS

MI2FT

MPH2M

Name: KM2MI

Value: 0.621371

New Delete

Identifiers:

Oil Pressure

Steering

LR_Pot

RR_Pot

LF_Pot

RF_Pot

Diff Temp

Trans Temp

LatAcc

Datalogger_Tem

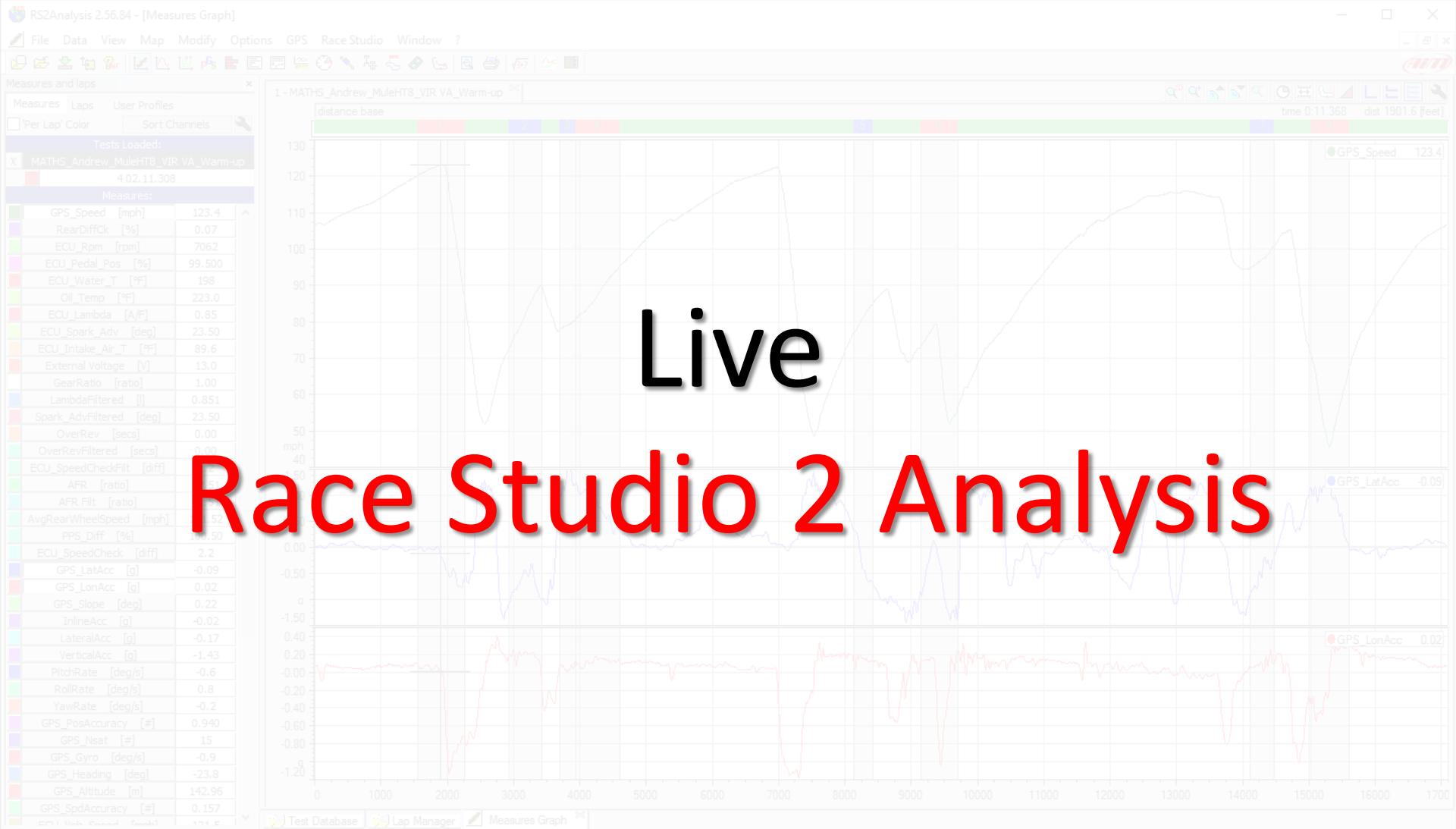
Import set

Export set

Default AIM set

Cancel

OK

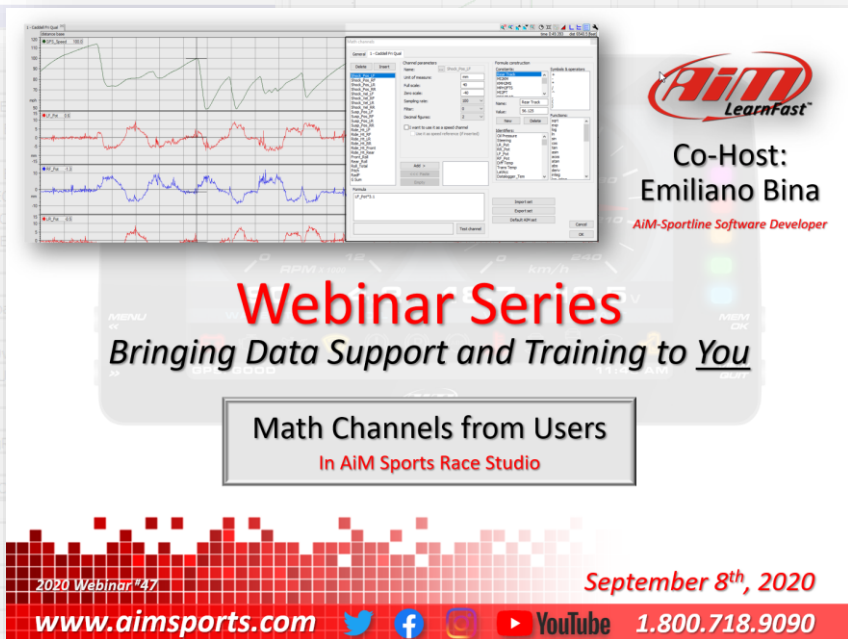


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- **I Have Downloaded my Data, Now What - Part 1*
- **I Have Downloaded my Data, Now What - Part 2*
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- Sort Channels
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FileDataViewMapModifyOptionsGPSSoftwareStudioWindow?

Measures and laps

MeasuresLapsUser Profiles

Per Lap Color

Sort Channels

Tests Loaded:

MATHS_Andrew_MuleHT8_VIR_VA_Warm-up

4 02:11.3

Measures:

GPS_Speed [km/h]

RearDiffCk [rpm]

ECU_Rpm [rpm]

ECU_Pedal_Pos [%]

ECU_Water_T [°F]

Oil_Temp [°F]

ECU_Lambda [A/F]

ECU_Spark_Adv [deg]

ECU_Intake_Air_T [°F]

External_Voltage [V]

GearRatio [ratio]

LambdaFiltered []

Spark_AdvFiltered [deg]

1 - MATHS_Andrew_MuleHT8_VIR_VA_Warm-up

[distance base]

time 0:11.368 dist 1301.6 feet

123.4

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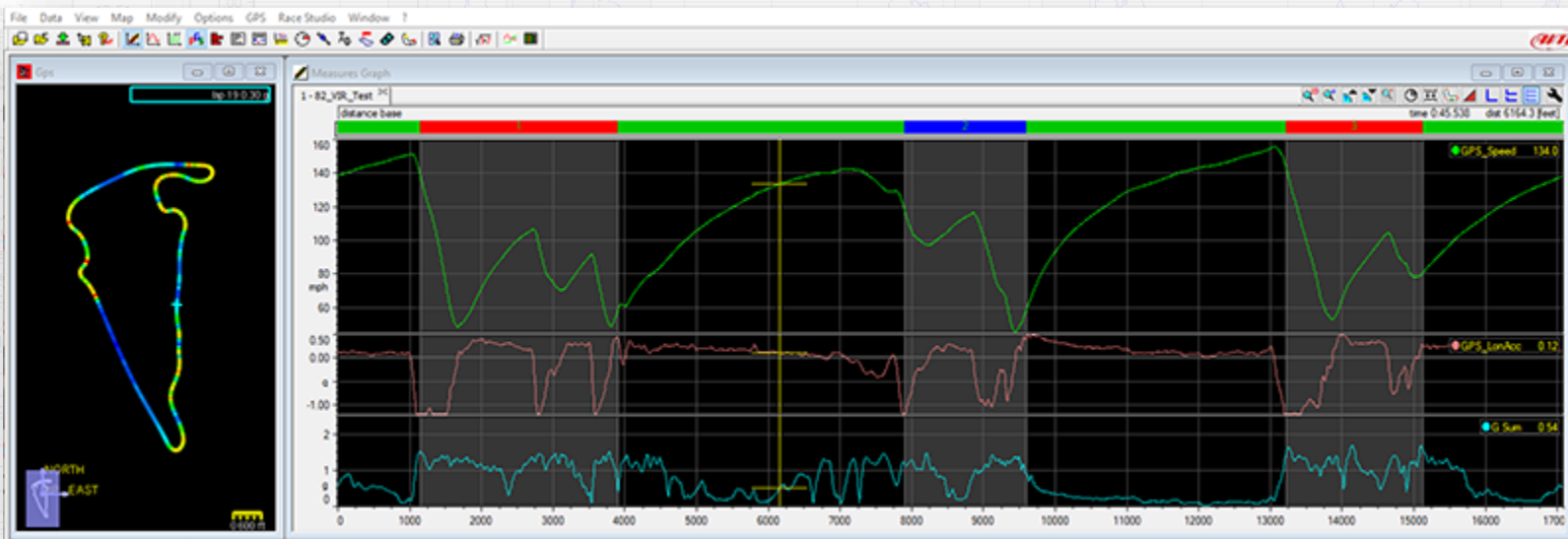


Co-Host
David Free

DFree Trackside Service



Matching Data Analysis to the Driver in AiM Sports Race Studio Software



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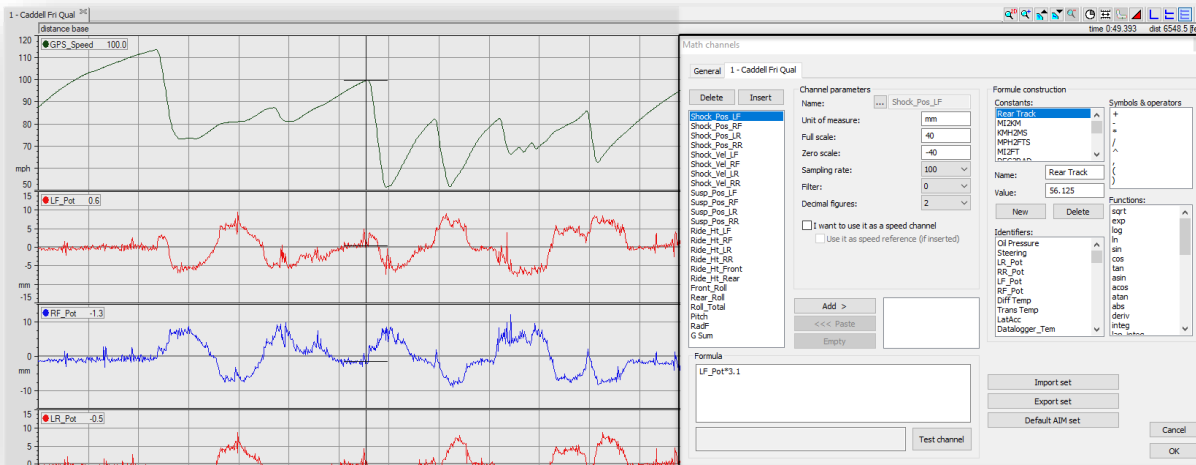


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Next Webinar Topic

Matching Data Analysis to the Driver





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