

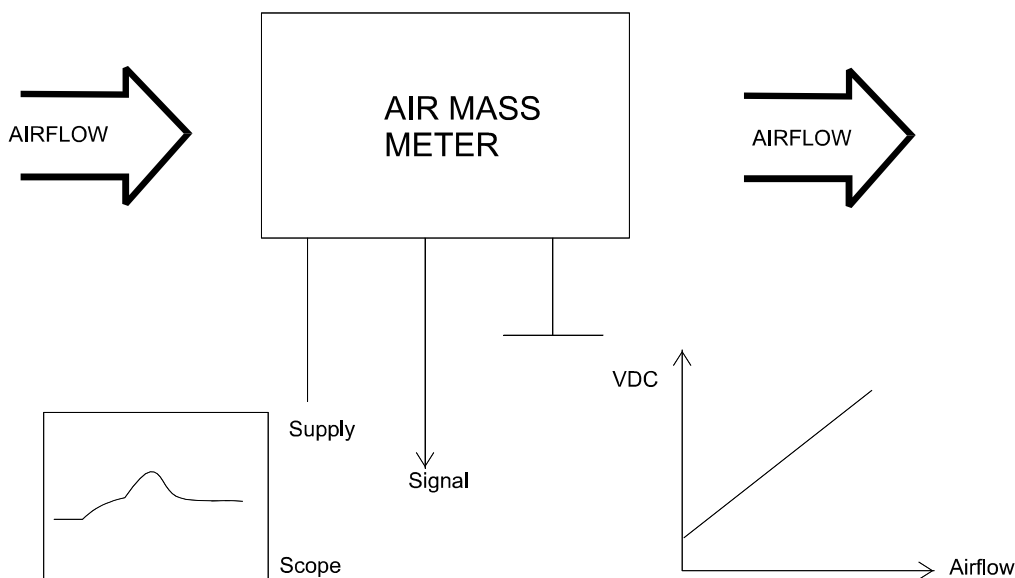
This note describes ways to adapt different airflow (air mass meters) to a stock ECU via a SMART TUNER SMT5 or SMT6.

Background

The airflow in to an engine has to be metered so that the ECU can supply the correct fuel. Very often the stock-metering device is no good, too small, or too expensive, and it must be replaced with a different unit, which leads to all kind of problems. The following different air flow meters exist:

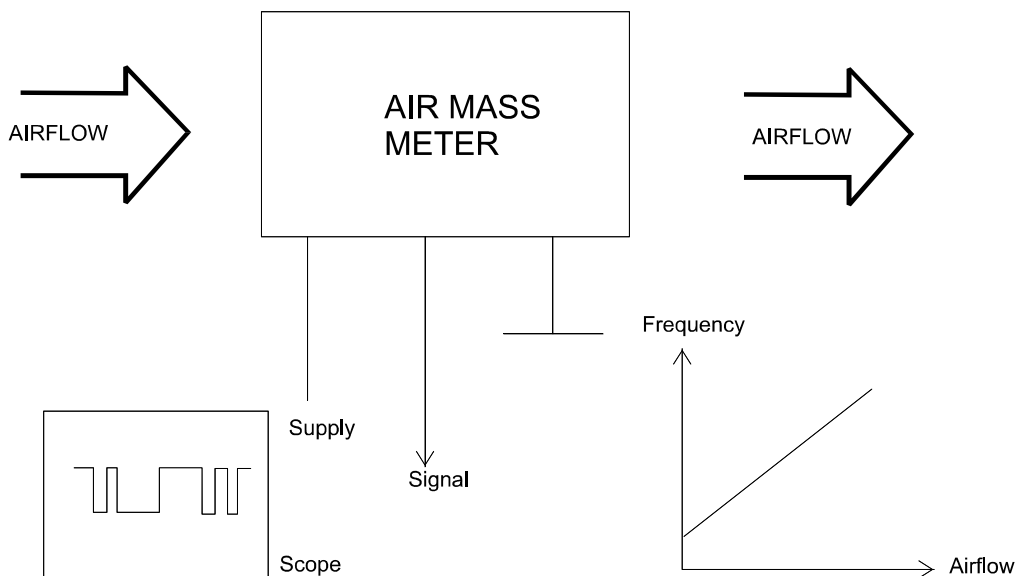
Analog Output Hot Wire System

The air flows over a heated wire and cools it. The amount of cooling is proportional to the airflow, and the output is a "DC VOLTAGE" describing the amount of air. This unit is also called an AIR MASS METER, because it recognises the air density.



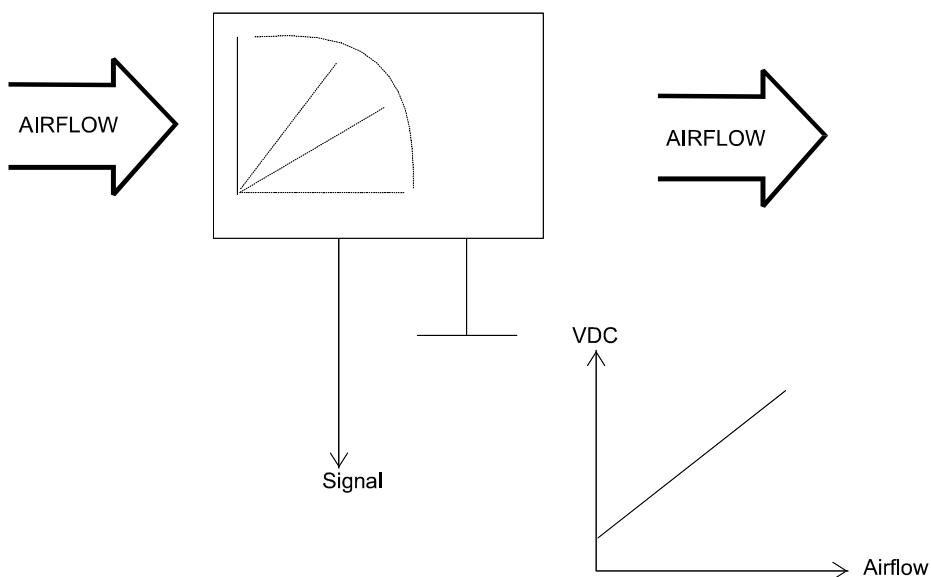
Frequency Output Hot Wire System

Same as above, but the output is a frequency, which describes the amount of airflow. This device is also called an AIR MASS METER!



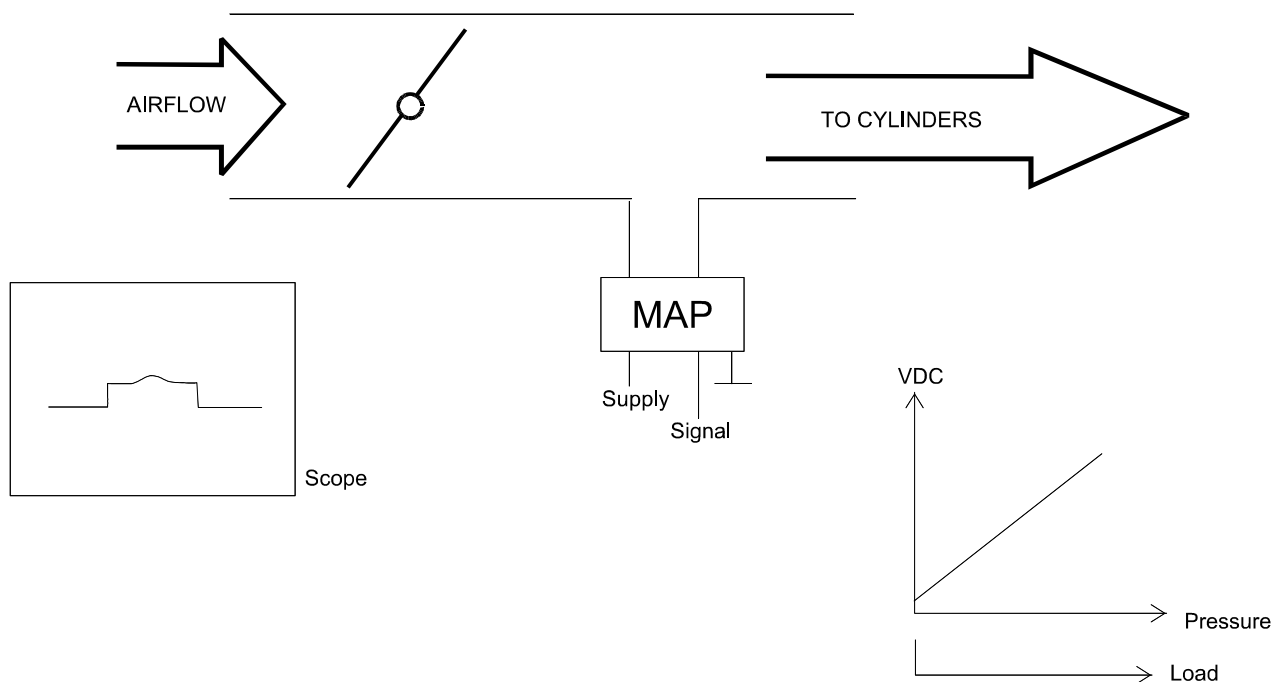
Analog Output Mechanical Door System

A trap door is placed in the air stream, and the flowing air opens the door against a spring. The degree of door movement is measured via a potentiometer and results in an analog output voltage, which is proportional to the airflow. This system relies on the spring tension and mechanical "DAMPENING", because it OVERSWINGS at acceleration.



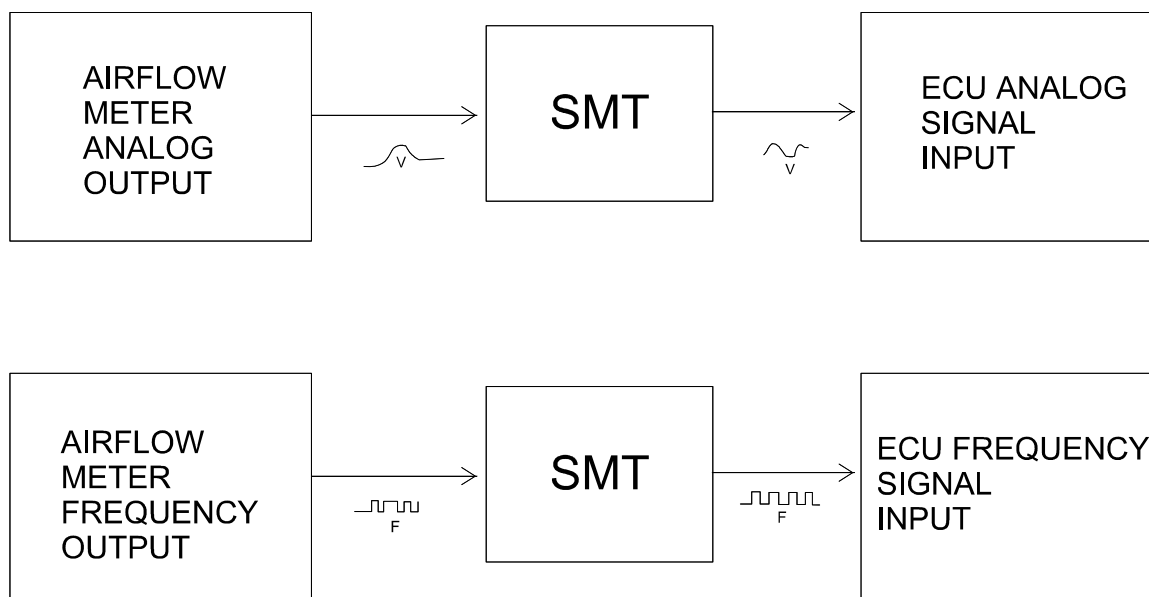
Absolute Manifold Pressure Sensor (Map, Or Amp)

This device measures the manifold pressure after the butterfly. Its output is an analog voltage. It is not directly a measurement of the airflow, but indirect the engine load can be determined from it, and the ECU can adjust the fuel accordingly.



Restrictions

If your ECU requires an ANALOG airflow signal, then you need an ANALOG airflow meter. NOT the same make, but analog!



If your ECU requires a DIGITAL (FREQUENCY) airflow signal, then you can replace the existing metering device with a frequency meter ONLY.

Solutions

The SMT (5 or 6) can handle analog signals (every mode) and frequency signals in mode 10 only.
Mode 10: Single ignition retard/advance + FREQUENCY

The SMART TUNER cannot convert an analog signal to a digital (frequency) one, or a digital signal to an analog one. (These features may be added later). The analog-to-analog adaption or frequency-to-frequency adaption is a standard feature of the SMART TUNER range.

The signal adaption is done via the analog map. Following is the DOS screen of the SMT6 software.

7	16	28	41	53	65	77	90			
0	0	0	0	0	0	0	0	7017	1.00	120
0	0	0	0	0	0	0	0	6584	1.00	112
0	0	0	0	0	0	0	0	6168	1.00	104
0	0	0	0	0	0	0	0	5744	1.00	96
0	0	0	0	0	0	0	0	5303	1.00	88
0	0	0	0	0	0	0	0	4883	1.00	80
0	0	0	0	0	0	0	0	4456	1.00	72
0	0	0	0	0	0	0	0	4027	1.00	64
0	0	0	0	0	0	0	0	3595	1.00	56
0	0	0	0	0	0	0	0	3167	1.00	48
0	0	0	0	0	0	0	0	2738	1.00	40
0	0	0	0	0	0	0	0	2311	1.00	32
0	0	0	0	0	0	0	0	1884	1.00	24
0	0	0	0	0	0	0	0	1456	1.00	16
0	0	0	0	0	0	0	0	1028	1.00	8
0	0	0	0	0	0	0	0	600	1.00	0
								RPM		
Main Map									A_ENGT Map	

Each map point (128) can be programmed with a value from -99 to 126.

A ZERO map value:	The output equals the input
A POSITIVE map value:	The output is HIGHER than the input
A NEGATIVE map value:	The output is LOWER than the input

The map points are SELECTED by a cursor, which is moved via two SMT6 inputs:

ANALOG DEFLECTION:	Moves cursor left to right (horizontal) Normally the throttle signal.
RPM DEFLECTION:	Moves the cursor up and down (vertical) Comes from the RPM IGN1IN signal.

For a straight adaptation, the analog deflection can be grounded and the following map will suffice:

SMART TUNER SMT6: Digital Technology Pty Ltd

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Dscr:

Map: GROUNDED DEFLECTION, SIGNAL ADAPTATION

		Analog deflection (%)								ANALOG		
AnaDefl:	%	7	16	28	41	53	65	77	90			
Rpm:		10	0	0	0	0	0	0	0	7017	1.00	120
An Input:	V	8	0	0	0	0	0	0	0	6584	1.00	112
Eng Temp:		6	0	0	0	0	0	0	0	6168	1.00	104
AMP:		4	0	0	0	0	0	0	0	5744	1.00	96
AFR:	V	2	0	0	0	0	0	0	0	5303	1.00	88
AnOutput:	V	0	0	0	0	0	0	0	0	4883	1.00	80
An mod:		-2	0	0	0	0	0	0	0	4456	1.00	72
Inject:		-4	0	0	0	0	0	0	0	4027	1.00	64
Ignmod:		-6	0	0	0	0	0	0	0	3595	1.00	56
		-8	0	0	0	0	0	0	0	3167	1.00	48
No Tune:		-10	0	0	0	0	0	0	0	2738	1.00	40
Mode bad:		-12	0	0	0	0	0	0	0	2311	1.00	32
RPM bad:		-14	0	0	0	0	0	0	0	1884	1.00	24
Ign bad:		-16	0	0	0	0	0	0	0	1456	1.00	16
StoreSel:		-18	0	0	0	0	0	0	0	1028	1.00	8
Version:	0	-20	0	0	0	0	0	0	0	600	1.00	0
										RPM	A_ENGT	
Error:	SmtLib=											

The numbers in the first column are the values, which change the input voltage to produce a different output voltage at the indicated RPM. The numbers itself are arbitrary, they just demonstrate that at 600 RPM the output is LOWER than the input. The important thing is that the signal is tuned by the RPM, which is not necessary the right thing.

If the analog deflection input is connected to the throttle, then the following map may be useful:

SMART TUNER SMT6: Digital Technology Pty Ltd

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Dscr:

Map: DEFLECTION VIA THROTTLE

		Analog deflection (%)								ANALOG		
AnaDefl:	%	7	16	28	41	53	65	77	90			
Rpm:		8	9	10	11	12	13	14	15	7017	1.00 120	
An Input:	V	7	8	9	10	11	12	13	14	6584	1.00 112	
Eng Temp:		6	7	8	9	10	11	12	13	6168	1.00 104	
AMP:		5	6	7	8	9	10	11	12	5744	1.00 96	
AFR:	V	4	5	6	7	8	9	10	11	5303	1.00 88	
AnOutput:	V	3	4	5	6	7	8	9	10	4883	1.00 80	
An mod:		2	3	4	5	6	7	8	9	4456	1.00 72	
Inject:		1	2	3	4	5	6	7	8	4027	1.00 64	
Ignmod:		0	1	2	3	4	5	6	7	3595	1.00 56	
		-1	0	1	2	3	4	5	6	3167	1.00 48	
No Tune:		-2	-1	0	1	2	3	4	5	2738	1.00 40	
Mode bad:		-3	-2	-1	0	1	2	3	4	2311	1.00 32	
RPM bad:		-4	-3	-6	-1	0	1	2	3	1884	1.00 24	
Ign bad:		-5	-4	-3	-2	-1	0	1	2	1456	1.00 16	
StoreSel:		-6	-5	-4	-3	-2	-1	0	1	1028	1.00 8	
Version:	0	-7	-6	-5	-4	-3	-2	-1	0	600	1.00 0	
										RPM	A_ENGT	
Error:										SmtLib=		

This map lowers the output at 600 RPM closed throttle, but increases the output as the throttle is opened. The signal is RPM and THROTTLE tuned. Again the numbers are arbitrary, just demonstrating the principle.

The next variation is only possible with an ANALOG input signal from the air-metering device. If the analog deflection input is connected to the input signal then the map may look like:

SMART TUNER SMT6: Digital Technology Pty Ltd

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Dscr:

Map: DEFLECTION IS AIRFLOW SIGNAL

		Analog deflection (%)								ANALOG	
AnaDefl:	%	7	16	28	41	53	65	77	90		
Rpm:		-4	-2	0	2	4	6	8	10	7017	1.00 120
An Input:	V	-4	-2	0	2	4	6	8	10	6584	1.00 112
Eng Temp:		-4	-2	0	2	4	6	8	10	6168	1.00 104
AMP:		-4	-2	0	2	4	6	8	10	5744	1.00 96
AFR:	V	-4	-2	0	2	4	6	8	10	5303	1.00 88
AnOutput:	V	-4	-2	0	2	4	6	8	10	4883	1.00 80
An mod:		-4	-2	0	2	4	6	8	10	4456	1.00 72
Inject:		-4	-2	0	2	4	6	8	10	4027	1.00 64
Ignmod:		-4	-2	0	2	4	6	8	10	3595	1.00 56
		-4	-2	0	2	4	6	8	10	3167	1.00 48
No Tune:		-4	-2	0	2	4	6	8	10	2738	1.00 40
Mode bad:		-4	-2	0	2	4	6	8	10	2311	1.00 32
RPM bad:		-4	-2	0	2	4	6	8	10	1884	1.00 24
Ign bad:		-4	-2	0	2	4	6	8	10	1456	1.00 16
StoreSel:		-4	-2	0	2	4	6	8	10	1028	1.00 8
Version:	0	-4	-2	0	2	4	6	8	10	600	1.00 0
										RPM	A_ENGT

Error:

SmtLib=

Again, at very little airflow the output is lower than the input, and at high airflow the output is higher than the input. This map is deflection tuned, because the change in RPM does not change the output. Of course the numbers in the RPM rows can be tuned.

In all above considerations, we left the ENGINE TEMPERATURE MAP disabled by entering a constant value. The map values in the RPM/THROTTLE map are multiplied with the values in the A_ENGT map. The engine temperature input can be connected to:

ANY ANALOG VOLTAGE IN THE RANGE FROM 0 to 5 volts.

Of course it can be calibrated! Connect the ENGINE TEMPERATURE INPUT to:

- ENGINE TEMPERATURE
- AIR TEMPERATURE
- MAP (or AMP) OUTPUT!!!!
- AIRMASS METER OUTPUT!!!!!!

All the examples above had a somewhat LINEAR result: at a particular operating point (map point) the output followed the input by the specified map value. With the introduction of the A_ENGT map, the main map values are MULTIPLIED with the A_ENGT values, which results in a "THREE DIMENSIONAL" approach, or UNLINEAR output.

The following tuning map demonstrates a THROTTLE/RPM and ENGINE TEMP map:

SMART TUNER SMT6: Digital Technology Pty Ltd

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Dscr:

Map: THROTTLE DEFLECTION/RPM and ENGINE TEMPERATURE

		Analog deflection (%)								ANALOG	
AnaDefl:	%	7	16	28	41	53	65	77	90		
Rpm:		8	9	10	11	12	13	14	15	7017	0.50 120
An Input:	V	7	8	9	10	11	12	13	14	6584	0.50 112
Eng Temp:		6	7	8	9	10	11	12	13	6168	0.50 104
AMP:		5	6	7	8	9	10	11	12	5744	0.55 96
AFR:	V	4	5	6	7	8	9	10	11	5303	0.60 88
AnOutput:	V	3	4	5	6	7	8	9	10	4883	0.65 80
An mod:		2	3	4	5	6	7	8	9	4456	0.70 72
Inject:		1	2	3	4	5	6	7	8	4027	0.75 64
Ignmod:		0	1	2	3	4	5	6	7	3595	0.80 56
		-1	0	1	2	3	4	5	6	3167	0.85 48
No Tune:		-2	-1	0	1	2	3	4	5	2738	0.90 40
Mode bad:		-3	-2	-1	0	1	2	3	4	2311	0.95 32
RPM bad:		-4	-3	-2	-1	0	1	2	3	1884	1.00 24
Ign bad:		-5	-4	-3	-2	-1	0	1	2	1456	1.00 16
StoreSel:		-6	-5	-4	-3	-2	-1	0	1	1028	1.00 8
Version:	0	-7	-6	-5	-4	-3	-2	-1	0	600	1.00 0
Error:		SmtLib=								RPM	A_ENGT

At 600 RPM, the output signal is always LESS than the input. However, as the engine temperature increases, the output signal increases at idle. At high engine temperatures, the main map modifications are only HALF (0.5!) as effective as at lower temperatures.

The above example may not be that practical. The real practical application depends on what YOUR engine needs. The signal adaptation is relative easy. If your engine requires temperature adjustment, then the A_ENGT map is good. If you engine requires ABSOLUTE PRESSURE (not manifold!) adjustment, then connect a pressure sensor to the engine temperature input and calibrate it accordingly.

The calibration, setting of modes, and all other operations of the SMART TUNER are explained in the relevant manuals and other application notes.