Design Considerations for

# D-Jet AFR Calibrator

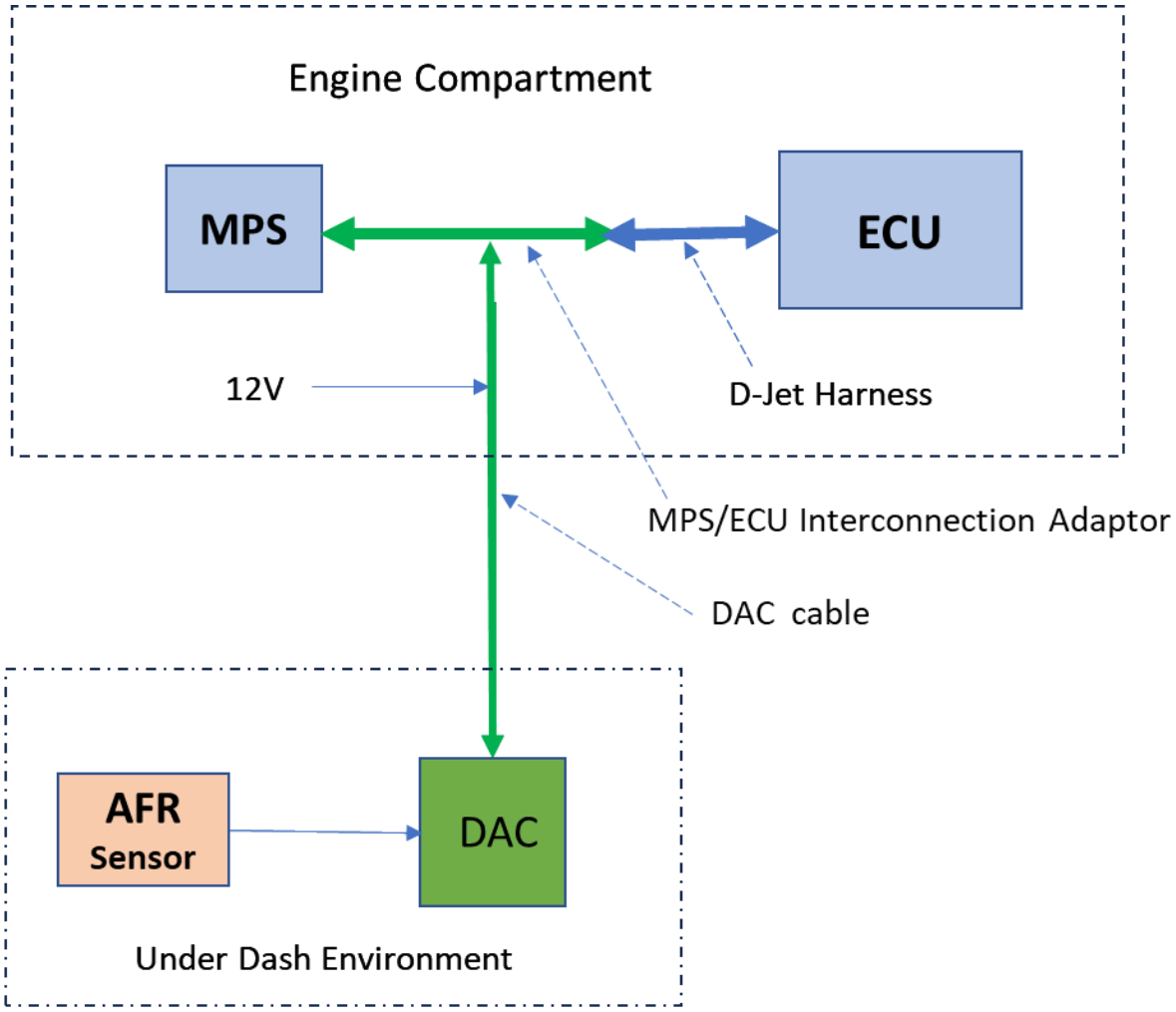
011824

The D-Jet AFR Calibrator (DAC), to be located under the car dash, allows for manual and O2-sensor feedback adjustments of the AFR levels, which otherwise is only controlled by the D-Jet MPS and ECU components. Installation and use of an O2 AFR sensor is not required but is to be considered a recommendation.

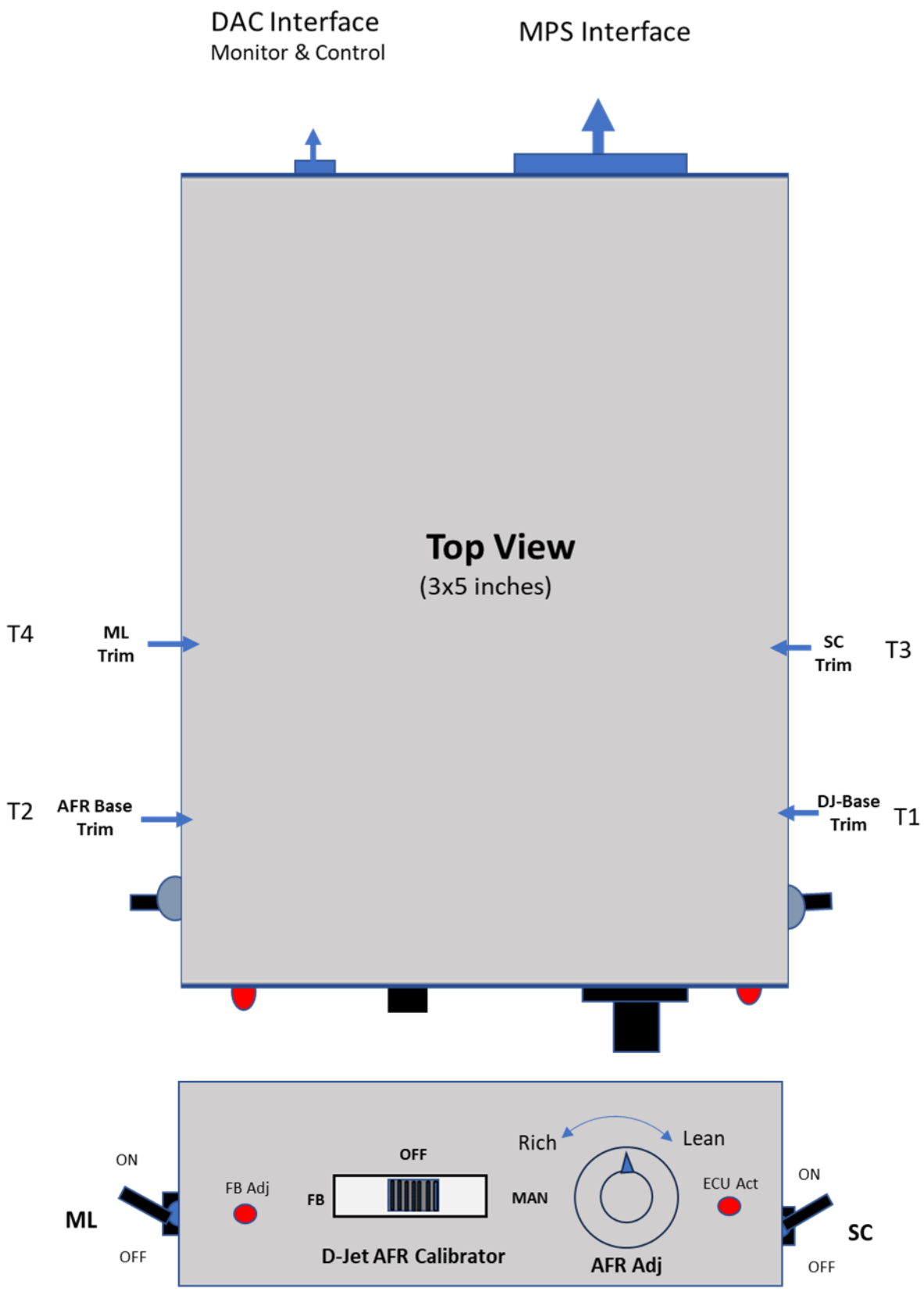
As indicated in Fig-1, the DAC is connecting to the MPS-ECU interface via a custom MPS/ECU adapter, which can easily be removed and therefore quickly restore the original D-Jet engine configuration. No ECU or MPS modifications are required. Ground and 12V signals for the DAC are supplied to the DAC via a dedicated cable routed between the engine compartment and the under-dash DAC location.

The DAC is connecting to very basic MPS-to-ECU signals (10, 8), which is very similar for all MPS/ECU modules installed in various car models. It is therefore likely the DAC can be used unchanged in many D-Jet equipped car models. (years 69 to 74). However, further testing is required to confirm this assumption!

The DAC controls, indicators and interfaces are shown in Fig-2 and Fig-3 and described further below.

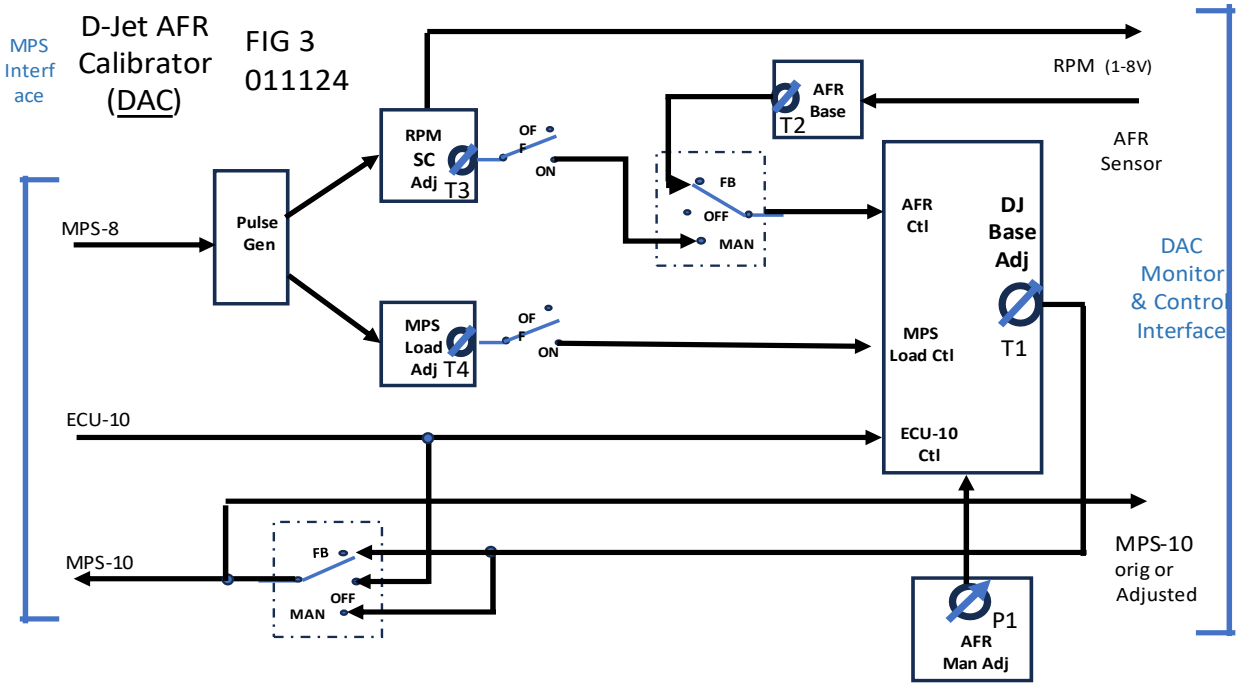



D-Jet AFR Calibrator (DAC) Interfaces
Fig 1 010824




# D-Jet AFR Calibrator

**Fig2 010824**


MPS Interface
D-Jet AFR Calibrator (DAC)
FIG 3
011124
RPM (1-8V)
AFR Base
T2
AFR Sensor
RPM SC Adj T3
OFF
ON
FB
OFF
MAN
MPS-8
Pulse Gen
AFR Ctl
DJ Base Adj
T1
DAC Monitor & Control Interface
MPS Load Adj T4
OFF
ON
MPS Load Ctl
ECU-10
ECU-10 Ctl
MPS-10
FB
OFF
MAN
MPS-10 orig or Adjusted
P1
AFR Man Adj

## Front Panel.

- **AFR Adjust Potentiometer:**
  - The AFR Adjust pot-meter (P1) at the front of the DAC can at any time be used to make instantaneous modification to the AFR level when operating in the manual (MAN) or the feedback (FB) mode.
    There is a dedicated Base level that must be set for each mode of DAC operation (T1 - DJ-Base and T2 – AFR-Base) as described further below. It is therefore recommended to turn the P1 knob into the mid (upwards) position before the DJ-Base and the AFR-Base levels are to be set.
  - If the DAC is installed and operating without an AFR sensor, the use of the AFR Adjust pot-meter could become a little problematic. In such a case, there will be no active AFR display to help determine what the actual AFR level will be when turning the AFR Adjust pot-meter away from the "neutral" upwards position - except moving into a richer or a leaner condition. It may, therefore, be necessary to consider adding an on/off toggle switch to the DAC to disable/enable the P1 pot-meter.
  - Resetting of the DJ-Base level without the use of an AFR sensor could then be done by disabling the AFR Adjust pot-meter. This allows the car driver always to restore the initial DJ-Base AFR level, which was initially set as described further below.

- **D-Jet AFR Calibrator slide switch:**
  - **OFF:**
    In the OFF mode, the ECU-10 and MPS-10 signal is closed by the DAC, which brings the D-Jet system into the original factory mode of operation. The DAC still receives the ECU-10 and MPS-8 signals, allowing for monitoring of RPM and original MPS/ECU-10 signal level via the DAC Monitor and Control interface.
  - **MAN with an AFR sensor connected:**
    The DAC controls the DJ-Base signal (MPS-10) - with input from the AFR sensor. The DJ-Base Adj trim (T1) is used to set the desired manual AFR level

for a garage idle or driving (2000-3000 RPM) condition. While operating in MAN mode, the AFR Adj potentiometer (P1) can be used anytime, especially while driving, to make further adjustments. The MPS and ECU are also active in the MAN mode, generating factory AFR adjustments determined by current MPS vacuum and the ECU engine Speed-Compensation levels.

- **MAN – without using an AFR sensor:**
  The DJ-Base Trim (T1) can be used to set a desired "garage idle" AFR level without using an AFR sensor as follows:
  - Connect a voltmeter to the MPS-10 signal and another voltmeter to the RPM signal – both accessible via the DAC Monitor & Control interface.
  - Start the already warmed-up engine and insert a 19-20 MIL gauge feeler at the throttle-stop screw to maintain a steady 2000-2300 RPM "garage idle" running condition.
  - Observe how the MPS-10 value (range 1.5V to 2.5V) is decreasing and RPM level increasing when the T1 is turned richer (i.e. counter-clockwise) – and vice versa when T1 is turned clockwise.
  - Continue adjusting the T1 to obtain the max-power rich position where the maximum RPM level can be observed. Continuing to an even richer position will cause the RPM to drop. Make a note of what the MPS-10 voltage is (V-max-AFR) at this max-power (highest engine torch) position. Existing articles documenting (gasoline driven) internal combustion engines conclude that the AFR level will be 11.8:1 when max torch (in this case highest garage-idle RPM) is obtained.
  - Hereafter, as the T1 trim is steadily turned clockwise to obtain a desirable "DJ-base" AFR level for using the DAC daily, the MPS-10 signal level is increasing almost linearly as the AFR level is also increasing. The ECU SC signal contribution during this small (typically only 300 to -400 RPM decrease) is neglectable.
  - Previous testing of the DAC (with the help of an active AFR sensor display) indicates the MPS-10 signal will increase by 7.5% for each AFR "unit" the desired "garage-idle AFR" should end at - above the previously obtained 11.8 max torch AFR level.

- The desired "garage-idle-MPS-10" level for a given desired "garage-idle-AFR" level can therefore be calculated as follows:

  desired **garage-idle-MPS-10 = V-max-AFR * (1 + MPS-10-increase-rate)**

  **MPS-10-increase-rate** = (garage-idle-AFR – 11.9) * 0.075

  **for example**: a desired "garage-idle-AFR" of 14.7:1 will be obtained when the MPS-10 increase-rate is:

  **MPS-10-increase-rate** = ((14.7 – 11.9) * 0.075) = 0.21

  and the desired **garage-idle-MPS-10 = V-max-AFR * 1.21**

  **In Short:** when turning the T1 clockwise to obtain an MPS-10 value of **V-max-AFR * 1.21** the **garage-idle AFR should be close to 14.7:1.**

  Smaller variations in the 7.5% MPS-10-increase-rate may be applicable for ECU models other than the .017 and .034 ECU used for Volvo cars. Further testing is yet to be performed!

- **FB - with an AFR sensor connected:**

  After setting the DJ-Base level, the AFR-Base Trim (T2) and AFR sensor display will now be used to set a desirable AFR-Base level to be maintained by the DAC operating in FB mode.

  The AFR-Base level may be set at a different level than the DJ-Base level. This allows for switching between two different AFR settings while driving. For example, selecting the DAC FB mode may be used for economical (AFR 14.7:1 to 15.0:1) cruising conditions, while a richer DJ-Base AFR setting will be obtained when switching to the MAN DAC mode. The reverse FB/MAN setting may also be chosen if a more aggressive rich AFR driving is desirable. In the FB mode of operation. The DAC is continuously using the AFR sensor O2 input to increase the fuel mixture when it is dropping below the selected AFR-Base level.

  It is recommended to switch the DAC to the MAN FB mode (or OFF mode) before cold starting the engine. Although some AFR sensor units are disabling the O2 sensor and presenting a "default neutral feedback signal" during the first minute or so after a cold start – there is no way the DAC operating in FB mode can override the highly rich cold-start condition controlled by the ECU and associated temp sensors.

After a few minutes of warmup, it is, however, possible to use the DAC to lean out the still highly enriched Temp-sensor / ECU controlled warmup condition - which typically lasts for several minutes. Turning the P1 front control to a leaner position (while in MAN operation mode) will gradually overwrite the ECU enrichment control and hereby obtain a more neutral AFR condition sooner than otherwise. Switching the DAC to the FB mode during warmup will fairly quickly get the AFR level close to the previously set AFR-Base level, allowing to start driving the car without excessive fuel consumption.

While the DAC is operating in FB mode the continuous O2 sensor input allows for the DAC fuel mixture controls to be extended into the engine idle (900-1200 RPM) range. This allows for the ECU Idle Control to be disabled - simply by adjusting the TPS position slightly so the TPS Stop Switch will not be closing.

- **FB – without using an AFR sensor:**
  When no AFR O2 input is available (or the O2 signal is not connected to the DAC), an AFR-Base level may still be set and used – much like the DJ-Base setting. This allows for switching between two different AFR settings while driving – simply by switching between the MAN and FB DAC modes.

➢ **Front Panel indicators:**

- **ECU Act.**

  Illuminated when the engine is running, the ECU has activated the Fuel Pump relay, and the ECU is triggering the injector drivers.

- **FB Adj.**
  The FB Adjust indicator is illuminated when the DAC has detected the AFR sensor signal is moving in a leaner direction, while it is off when the O2 signal remains at a richer level.
  When the DAC is operating in the FB mode, the FB Adj indicator can be observed to be more frequent and lasting for shorter intervals than when operating in the MAN or OFF modes.

## Side Controls.

- **Right Side controls**
  - **The DJ-Base trim-pot** (T1) is used to set the desired DJ-Base level -- i.e. the default base AFR level to be applied during the MAN DAC operation mode. The T1 trim adjustment is providing for the same level of AFR adjustment (without use of a DAC) which will be obtained when adjusting the **MPS inner tuning screw**.

  - **The SC trim-pot** (T3) provides for further adjustment of the engine Speed Compensation (SC) signal level, which is otherwise only controlled by the ECU and the current engine RPM.

    This extra SC adjustment may come in handy if there have been changes made to the engine (more aggressive camshaft, intake polishing, etc.) which could change the air volume and intake vacuum levels – thus effecting the overall engine Volumetric Efficiency curve.
    The SC adjustment trim is only effective when DAC is operating in the MAN mode. When operating in the FB mode (with the AFR sensor connected) the O2 feedback signal will cause the DAC to adjust also for changes of the engine Volumetric Efficiency.

    The SC toggle switch enables/disables the SC-trim setting.

  - Both trimmers set a richer level when turning it anti-clockwise and a leaner level when turning it clockwise.

- **Left side controls**
  - The AFR-Base trim-pot (T2) is used to set the desired AFR-Base level to be applied during the FB DAC operation mode - with or without the use of an AFR sensor.

- The MPS-Load (ML) trim-pot (T4) provides for further adjustment to the MPS engine load compensation, which is otherwise only determined by the ECU, the MPS and actual vacuum level.

  The T4 trim can be used to compensate for incorrect AFR levels under increasing engine load, if the MPS model in use is not well “tuned” to match the current engine compression. The Volvo B20-F engine, which has a lower compression ratio than the earlier B20-E engines, is therefore requiring use of another MPS model (035) different from the 010 and 015 models used for the B20-E engines.
  Using an old MPS where the alloy metal of the Aneroid Cells is no longer flexible enough to respond correctly to the changing vacuum levels while driving may also be compensated for using the T4 trim.

  While the T4 trim adjustment may be most usable in the MAN operation mode, the T4 trim may also be used in the FB mode of operation. Especially when driving uphill in a mountain environment for longer time periods, it may then be desirable to enrich the AFR level (thus helping to cool the engine) as the AFR O2 sensor input otherwise will tend to maintain the AFR-base level selected for continuous level driving.
  The AFR Adj pot-meter at the front of the DAC can, of course, be used at any time to adjust the AFR level.

  The ML toggle switch enables/disables the ML-trim setting.

- Both trimmers set a richer level when turning it anti-clockwise and a leaner level when turning it clockwise.

## Back Side Connections.

- Socket for 8-pin mini DIN cable - connecting the DAC to the MPS/ECU Adaptor located in the engine compartment. See MPS Interface signals shown in Figure 3 for further details.

- Socket for 4-pin AMP MINI CT header is used for AFR O2 sensor input and output of the DAC RPM and MPS-10 test and monitor signals. See Figure 3 for details.

## Top View outline.

The proposed 3x5 inch DAC dimension is based upon initial use of a through-hole PCB configuration, which will be used only when building a handful of DAC prototype modules needed for pilot testing. Future potential production-manufacturing efforts should be using surface mount components and would therefore result in a smaller DAC outline. Especially the module depth could be reduced considerably.

Could of course also consider building a DAC which does not include the SC-Trim and ML-Trim options. This could make such less capable DAC considerable smaller.