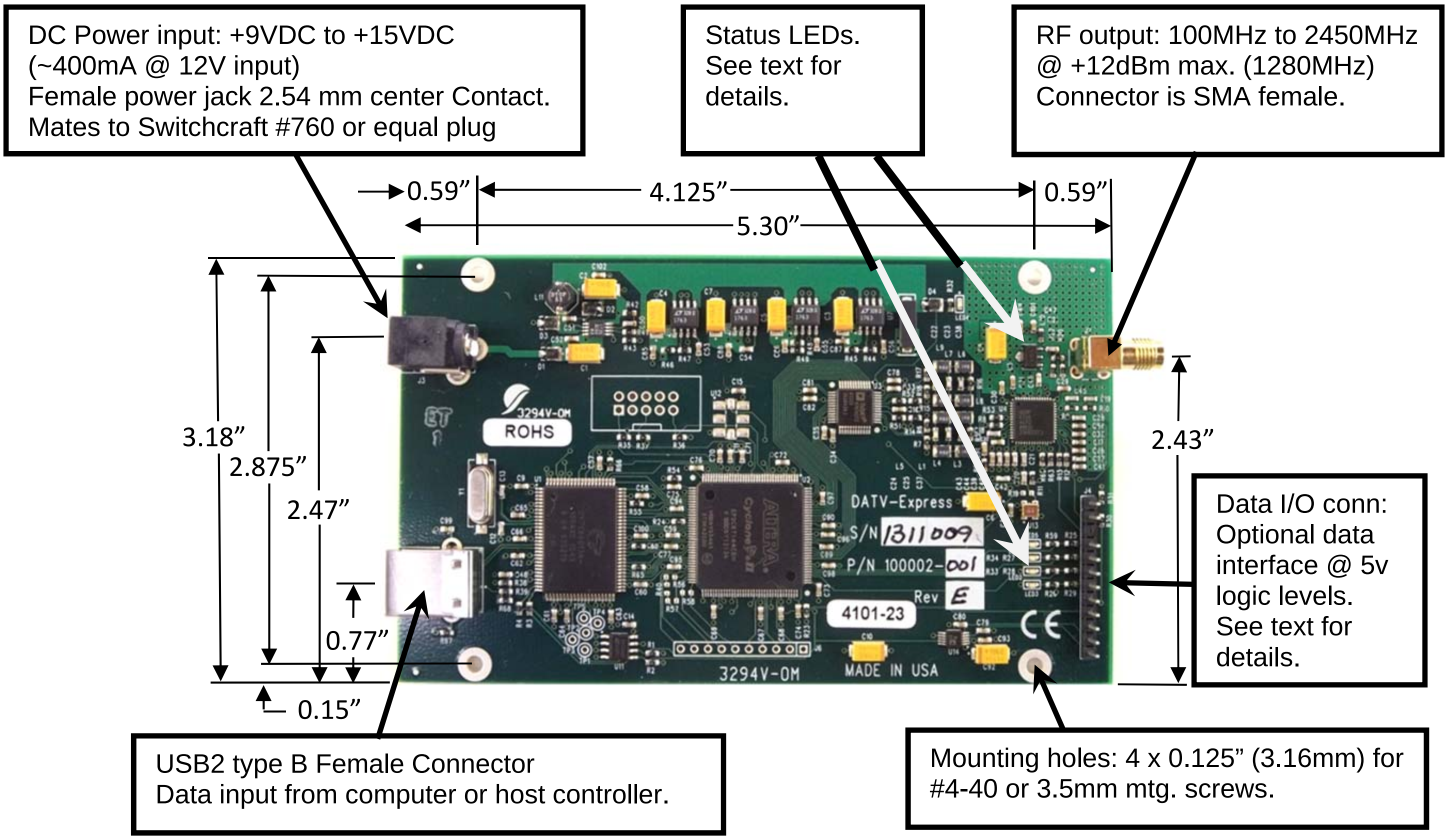
8.0 – DATV-Express Specifications

Physical details:



It is recommended that the board be placed in an enclosure of some type, preferably of metal construction. The board mounting holes mate to a (5.6" x 4.3" x 1.8") Bud Industries or DigiKey part number #CU-387 plastic enclosure and may be used from an economy standpoint. The input and output connector holes must be added by the user. If a metal enclosure is used, it is helpful for heat distribution purposes to use metal mounting standoffs if possible. The modulator IC gets very warm during normal operation so using a metal standoff here will help sink heat away from it. Ventilation holes in the enclosure around the vicinity of the output connector is desired for elevated temperature environments.

Environmental Details:

Temperature – 0 to +30°C (32-86°F)
Humidity - +10 to 95% non-condensing

Electrical Details:

Required Computer components

Host computer with at least (2) USB2 I/O ports available for DATV-Express
USB interface cable – USB type "A" connector at computer end, USB type "B" connector at DATV-Express end.
Software support requirements – for DVB-S, Pentium 4 running 2.4 GHz or better, 2GB available hard drive
– for DVB-T narrow bandwidths (2 & 3 MHz), dual-core CPU running 2.0 GHz should be adequate
– for DVB-T 2K mode to use all of the bandwidths, the CPU needs to be a quad-core i7
Operating system - 32 bit or 64 bit Ubuntu (Linux) – Version 14.04 LTS (or 12.04 LTS). Download at www.ubuntu.com/download
Hardware video capture card – Hauppauge external USB models HVR-1950, HVR-1900, PVR-USB2
– Hauppauge internal PCI-card models PVR-150, PVR-250, PVR-350, PCR-500

Input voltage requirements

+9 to + 15VDC (400 ma@12vdc). Input is polarity protected but not fuse protected. External 1 amp slo-blo fuse is required by user for safe operation.

Frequency Range

100MHz to 2450 MHz

Symbol Rate(MSymbols/sec)

Select SR from 1.00 to 9.99 in 0.01steps. (Design is optimized for 2-6 MS/sec). There are 12 preset configurable combinations.

> **Note:** Symbol rates >8.00MS/sec show increased 12MHz sidebands on each side and 35 dB down from center carrier because I/Q low pass anti-aliasing filters are optimized for 2-6 MS/sec. Below 1.5 MS/sec there could be some undesired aliases spurs (also +/- 12 MHz which is the Nyquist sampling frequency), if an interdigital bandpass filter is not used . Video displays will appear to be normal in either case.

FEC

Combinations: 1/2, 2/3, 3/4, 5/6, 7/8 for DVB-S and DVB-T protocol.

Signal quality data

EVM (Error Vector Magnitude) - 2.4%.

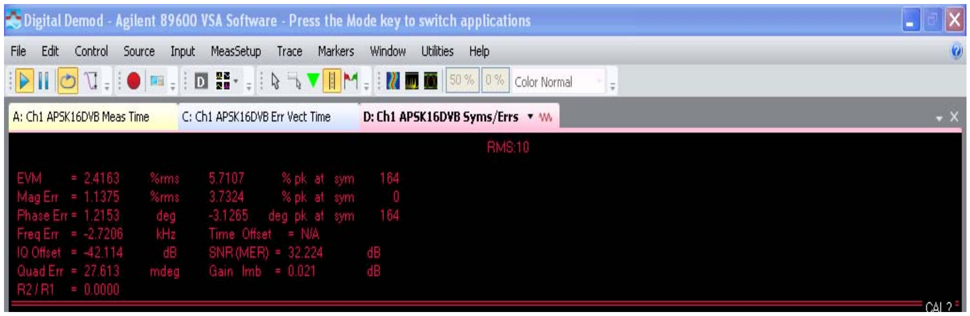
(Measured with Agilent EXA N9010A Signal analyzer – software VSA 89600B).

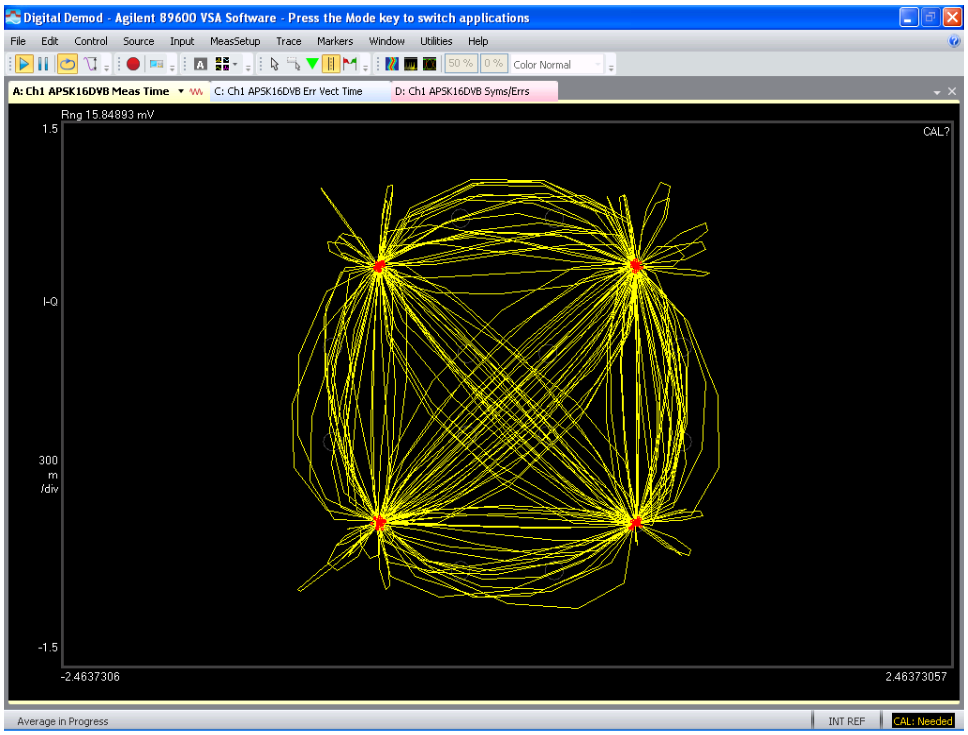
(≤3% is acceptable for commercial broadcast).

EVM is the percentage away from the ideal symbol landing spot in the signal constellation. This data is normally measured at the receiver and takes into account the combined effects of transmitter and receiver Carrier or Signal to Noise ratios (CNR or SNR).

MER (Modulation Error Ratio) - 32dB.

Minimum recommended down-stream MER = 12-13dB for QPSK and 27dB for 64QAM including 3-4dB headroom for reliability. It's calculated as: 10LOG (average symbol power / average error power).





Video – Determined by capture card specs. Hauppauge model HVR1950 will accept 1V P-P 75 ohm NTSC or PAL video.

Audio – Determined by capture card selection. Compression: MPEG1

LED identification

LED1 – I^2C activity - BLINK	Blinks quickly during I^2C communication. It's a very short blink and hard to see.
LED2 – Symbol Rate Counter	Constant FLASH. Slow for RCV. X3 for XMT. Higher symbol rates = faster flashing.
LED3 – FX2 OK - ON	ON if the USB controller is OK.
LED4 – +5V power - ON	ON when +5.5VDC is present.
LED5 – PLL locked - ON	ON for all normal operation. If OFF, there is a FPGA loading malfunction.

Connector details

USB2 type "B" connector (J1) - Standard USB2 connections to/from host computer.

RF output connector (J2) – SMA female.

DC power connector (J3) - Female DC connector, 2.54mm center pin. Mates to Switchcraft #760 or equal plug

Data I/O connector (J4)

1	+5.2vdc thru 50Ω 1/4w resistor	
2	Tx disable (Gnd to turn Xmit OFF)	(Floats to +3.3V thru 100Ω for Xmit ON condition).
3	Key (no pin)	
4	PLL locked (LED5)*	(*This data is + true to 3.3V for function indicated. The
5	I^2C activity (LED1)*	outputs are in parallel with LEDs thru a 100Ω resistor).
6	Symbol Rate (LED2)*	
7	FX2 OK (LED3)*	
8	I^2C buss SDA	Reserved for future data communication/expansion and testing analysis.
9	I^2C buss SCL	Reserved for future data communication/expansion and testing analysis.
10	Ground	
11	Analog input 1	These inputs are reserved for forward and reverse power output signals
12	Analog input 2	through a dual directional coupler. VSWR reporting and some linearization is possible with this data.

Expansion connector (J6)

1	Ground
2	Key (no pin)
3	FPGA I/O pin97
4	FPGA I/O pin 96
5	FPGA I/O pin 95
6	FPGA differential -output pin 72
7	FPGA differential +output pin 71
8	FPGA differential - input pin 70
9	FPGA differential + input pin 69
10	FPGA I/O pin 67

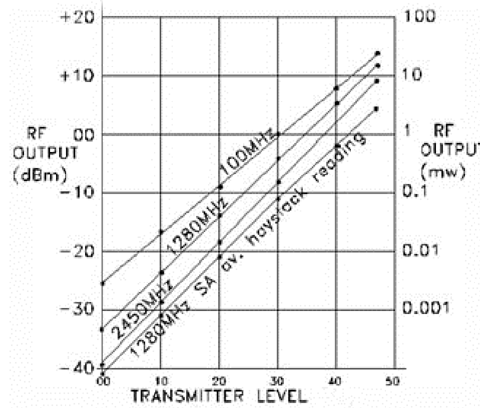
Transport Stream

A "transport stream" feature is incorporated in the software to enable signal analysis. When the" **TS log to file**" button is checked, the computer will collect the active signal in a continuous datvexpress.ts data stream in the default Home directory. The data will continue to collect as long as the "**TS log to file**" button is checked at the rate of about 20-30 MB/minute. The file can then be played back with Windows Media Player or equal software to view the video. The transport stream captured is the same one sent to the DATV-Express board in normal operation. (It is NOT the actual transmitted RF signal).

Example: Your friend has a computer program with video analysis capability. You can Email the datvexpress.ts file to him so he can analyze your signal details as the video plays.

RF output
Frequency range: 100MHz to 2450MHz.
Resolution: 100 Hz Accuracy: ±2KHz
Frequency stability: ± 100 PPM
Output Impedance: 50 ohms

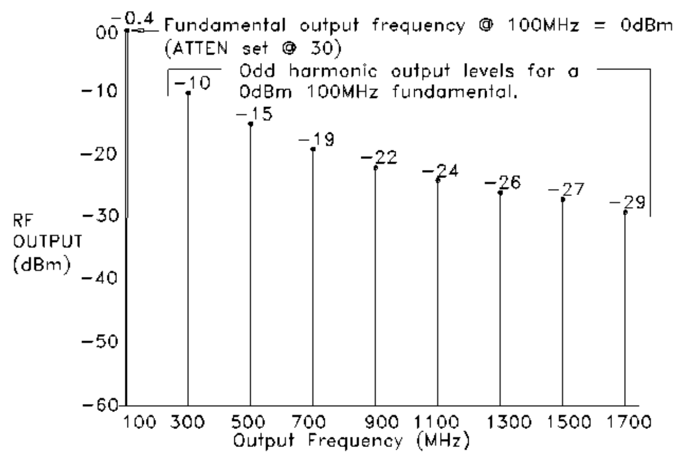
Level: -34dBm to +13dBm in 1dB steps (100MHz)
-35dBm to +12dBm in 1dB steps (1280MHz)
-39dBm to +8dBm in 1dB steps (2450MHz)
Spectral regrowth: -60dBc (RF output settings 00 to 35)
-50dBc (RF output settings 36 to 47)
Software controlled RF output: 00 to 47 in 1 dB steps
(00 is lowest level)



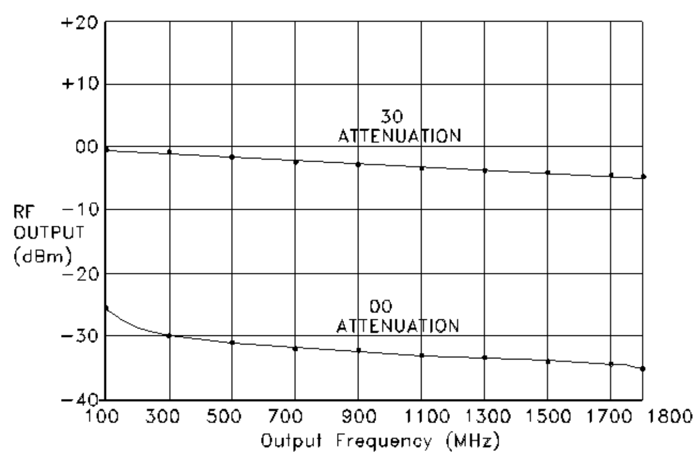
The table above illustrates the RF signal level at 100, 1280 and 2450MHz frequencies verses the internal software controlled RF output settings. An RF output setting of "00" produces the minimum level of RF output from the board and a setting of "35" is the maximum RF level out with no detectable signal distortion (spectral regrowth). Above a setting of 35, some sideband regrowth becomes noticeable on a spectrum analyzer as the power level increases due to slight compression in the RF MMIC amplifier. The 100MHz carrier is given to establish a reference point. It is below what a QPSK signal is allowed on the Amateur radio frequencies. **!CAUTION! DO NOT ATTEMPT TO TRANSMIT A SIGNAL OUTSIDE THE ALLOWED HAM FREQUENCIES?**

The 100MHz and 1280MHz graph lines represent the true average power output for either the single carrier or QPSK signal. The 1280 SA graph line is included to show how the signal amplitude at "top of haystack" on a standard scalar **S**pectrum **A**nalyzer compares to the true average power. The true power is actually close to 10dB greater than the SA reading! Note: A thermal milliwatt meter such as the Hewlett Packard model 432A, which has a bolometer probe does, in fact, indicate true average power for both "carrier only" and complex QPSK signals. Use that data to predict post amplifier maximum input requirements.

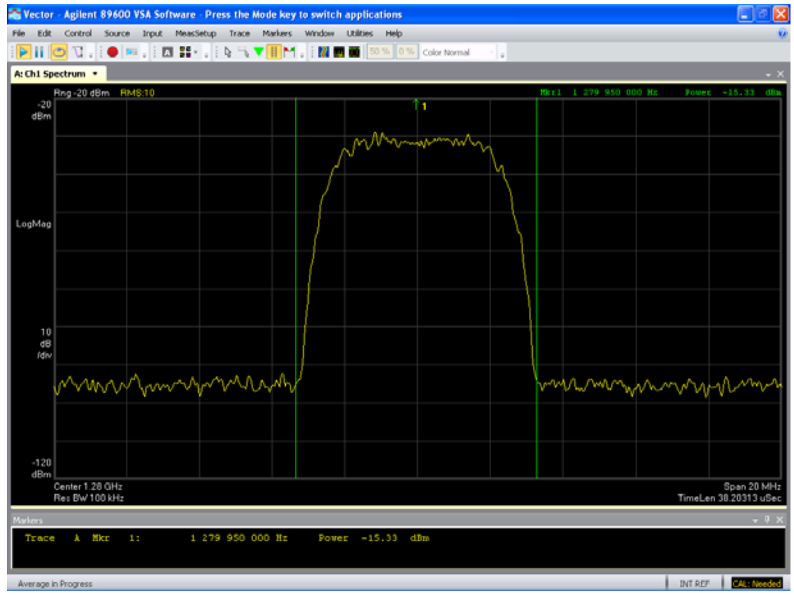
The graph at the right illustrates the harmonic content expected in the RF output signal. **It MUST pass through a filter of some type in order to suppress unwanted harmonics**. Since all unwanted frequencies are **above** the fundamental, a simple low pass filter may be all that is needed. The graph was created with a 100MHz signal to illustrate that the harmonic content extends many times beyond the fundamental. Only odd harmonics are produced. Even harmonics are below the SA measurable limit. If operation is planned for the 70cm band (420-450MHz), a third harmonic at ~1290MHz will be present about 26dB below the fundamental. **DO NOT use an interdigital filter here as that type of filter passes the third harmonic with almost no added loss!** Low pass filters are easy to construct and should be placed **between** the DATV-Express board and power amplifier, not after the PA. For low pass filter design examples go to www.CalculatorEdge.com/ .



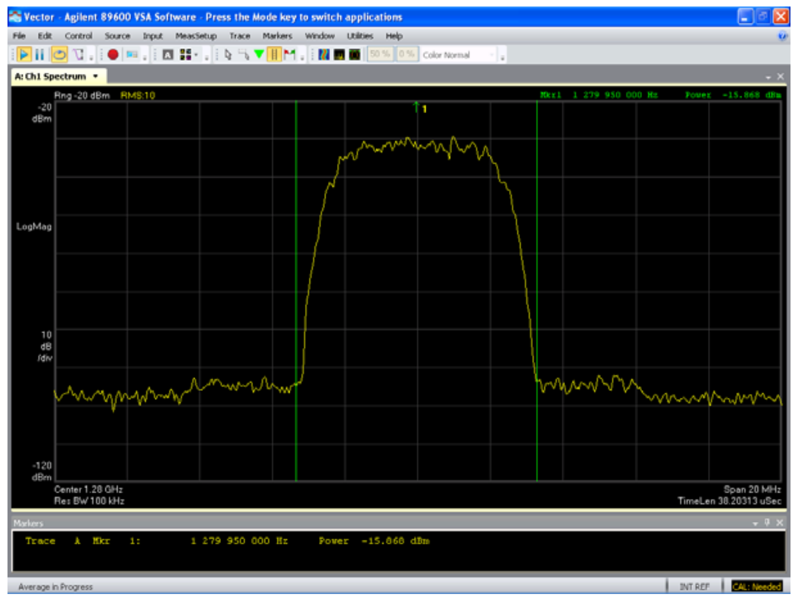
The graph at the right illustrates how the RF output decreases as the output frequency increases. At software-controlled RF output setting = 30, a 100MHz 0dBm signal reduces to about -5dBm at 1800MHz, everything else remaining the same.



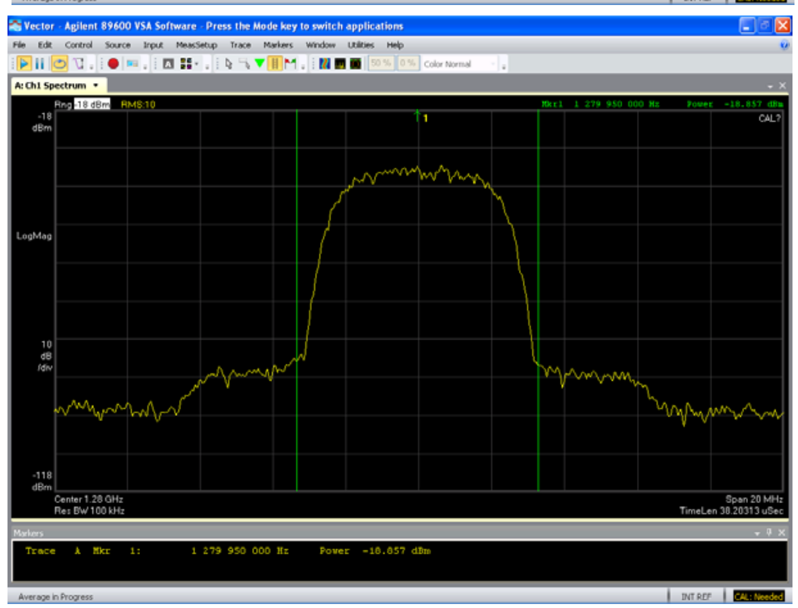
QPSK Analysis:
Since the spectral regrowth becomes noticeable when the attenuator output is greater than about 35, the graphs below show the RF output change as it passes thorough those points. From software-controlled RF output setting 00 to about 35, the regrowth is practically non-existent.



The graph at the right was taken with attenuator = 30 on an Agilent EXA analyzer and external 10dB attenuator in place between the DATV-Express board and analyzer. It shows a “top of the haystack” signal of about -30dBm which equates to true power = -15.3dBm between the 6MHz green markers. (Signal level is lower here than in earlier references due to added cable length and external attenuator). The noise floor is about -95dBm. This represents the noise being about a 65dB below the main signal.



The middle graph, taken with the software controlled output = 40 and external 20dB attenuator, shows slightly visible regrowth on each side of the main signal. It raises the noise floor up about 5dB resulting in distortion being down 60dB. This is still very good.



The bottom graph, taken with RF output setting = 47 (highest RF output) and external attenuator, shows higher regrowth sidebands. Regrowth is now about 10dB above the -95dB noise floor but still well within acceptable transmission limits. Here the spectral regrowth is down ~ 50dB.

The distortion and spurs on a QPSK DATV transmitter signal should be down at least 30 dB or more from the main signal. Remember, any post signal amplification and (or) filters will tend to add distortion and decrease the overall signal quality.