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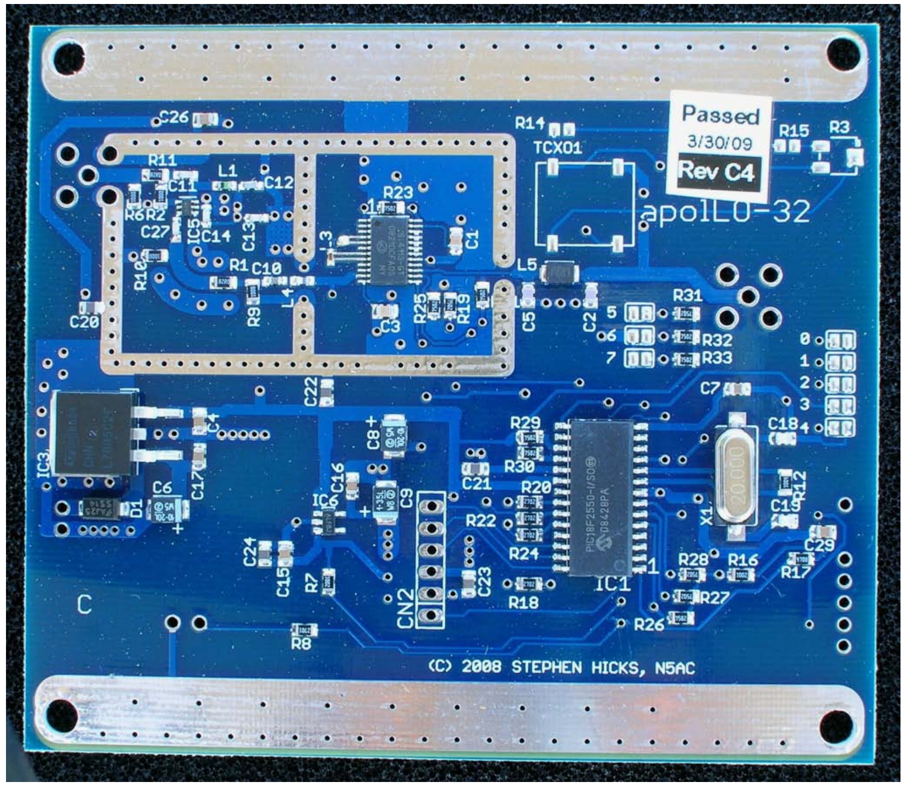
DEMI

DEM A32 Synthesizer



The DEM A32 is a pre-programmed 750 -1300 MHz. synthesizer designed exclusively for DEMI by N5AC. This synthesizer is a derivative of his original USB controllable ApolLO-1 design. The A32's design intentions are to directly replace our DEM MICRO-LO assembly used in all of our 2.3 GHz through 10 GHz transverters.

The A-32 now has 50+ pre-programmed synthesized frequencies. The frequencies include the basic RF and IF combinations required to allow any DEMI 2.3 GHz through 10 GHz transverter to operate in the standard band plans. Other frequencies include weak signal source frequencies in all bands from 902 MHz. through 24 GHz. for receiver testing and LO frequencies for standard 24 GHz transverters. Also included are LO frequencies for 23 and 33 cm transverters. The pre-set frequencies are selectable by jumpers and allow you to change the LO injection frequency on the fly for instance if you desire to operate on 2304 and 2320. Same if you desire to change your IF on 5760 to 145 MHz instead of using the standard 144 MHz. Simply, select and install the appropriate jumpers. No more "re-crystaling" the oscillator and /or adding a second outboard unit when you want to change frequencies.

Although the latest Rev A32 has provisions for an onboard 10 MHz. reference oscillator, we still recommend using an external 10 MHz reference that is stable to 1 x10-7 or better for consistent operation in the microwave bands. The more accurate and temperature stable the 10 MHz. source is, the better the performance of your Microwave transverters will be. The best being a GPS locked source. Settling for using an internal reference, we feel, would be counterproductive.

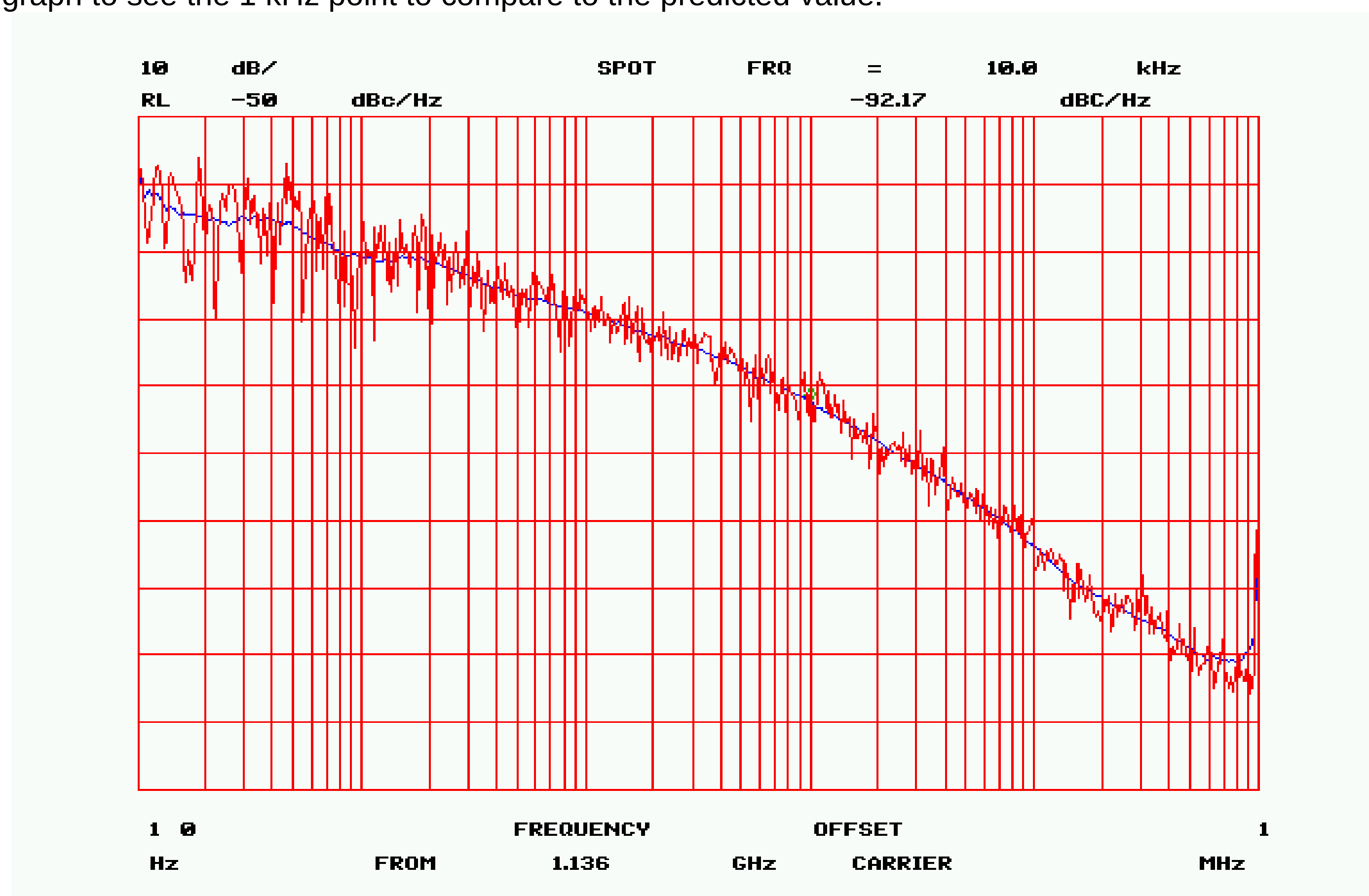
Our intentions are to upgrade the frequency stability of our transverters over the basic MICRO-LO. The MICRO-LO was a stable oscillator when it's operating temperature remained constant. The MICRO-LO's shortcoming is when the transverter's internal temperature changes throughout the Transmit and Receive cycles. Subjecting a miniature 10 MHz TCXO (**T**emperature **C**ontrolled **X**tal **O**scillator) to the same temperature changes inside of our transverters will cause the A32 to drift up and down in frequency as the 10 MHz source frequency changed attempting to compensate for the temperature change. Since the main objective of the A-32 is to achieve the best frequency stability and accuracy possible, external 10 MHz source are the best choice. A side note has been added at the end of this document concerning operation with an internal TCXO.

Quality 10 MHz sources are available on the surplus markets, or new in catalogs. You may choose to "Roll Your Own" or build one from numerous designs available to amateurs throughout the world. They can be simple temperature controlled devices or complex GPS phase locked units. At 1x 10-7, you will be almost within 1 kHz of your expected frequency on the 10 GHz band. Of course 1 x 10-8 is better but not required to make reliable contacts with minimal tuning.

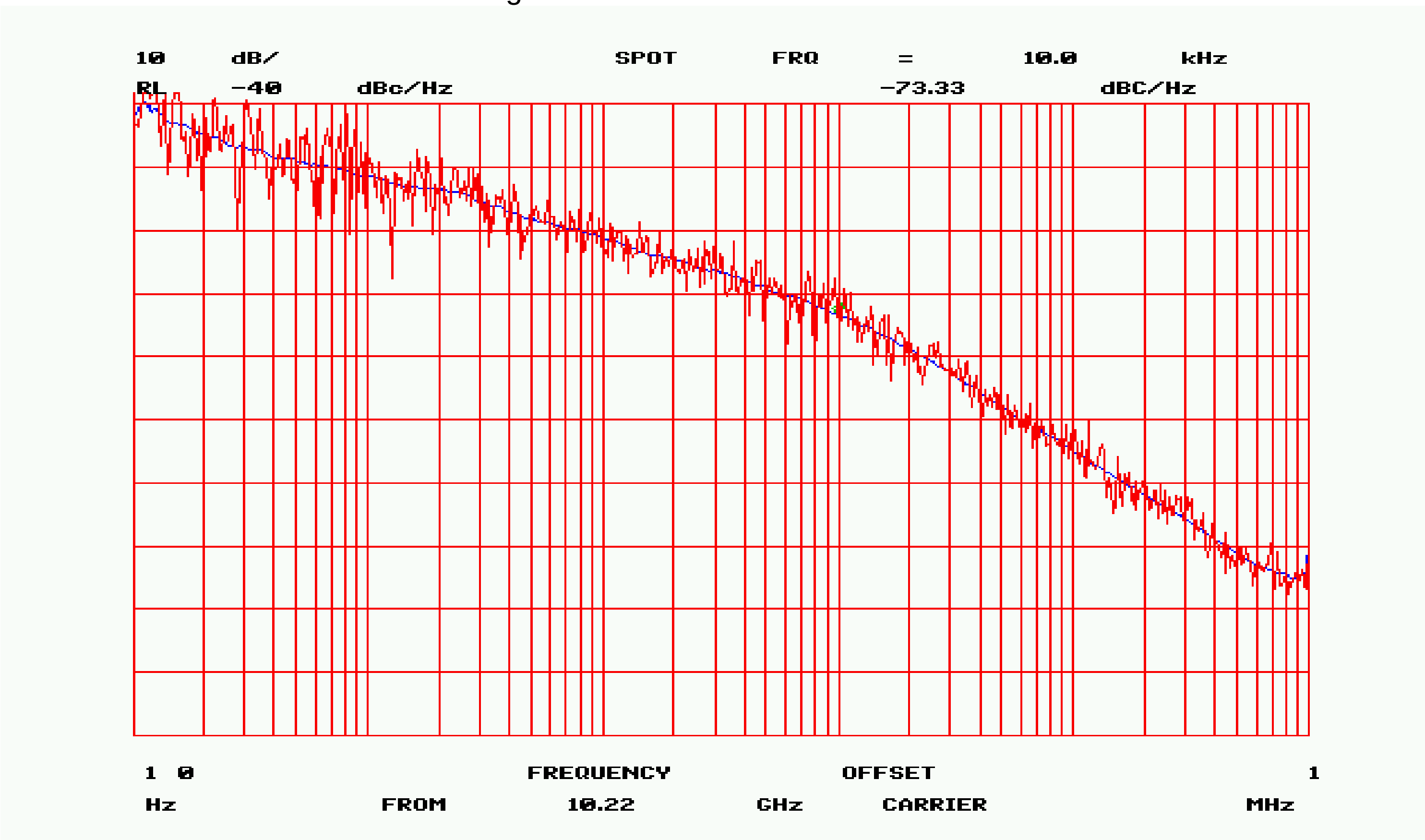
So, Phase noise? Of course there is! This is a synthesizer. The output frequency phase noise of the A32 will vary, depending on the frequency selected, from -74 to better than -81 dBc/Hz. @ 1 kHz. (Actual Measurements) This variance is caused by characteristics of the actual synthesizer chip and how it performs with certain programmed R and N values, coupled with the different phase detector frequencies required to generate the desired frequencies. Bottom line is the simpler the frequency, (1136 MHz, 1104 Mhz.) the better the final phase noise of the A32.

This brings about another point worth discussing. Let's use 5760 MHz as an example. With a 144 MHz IF, you would require the A32 to synthesize an 1123.200 MHz signal. (1123.200 x 5 = 5616 with a 144MHz IF = 5760) It is available by selecting the correct jumpers. But if you select 1123.000 MHz, (x 5 with a 145 MHz IF = 5760) the actual phase noise will be 3dB better. Now, yes its better but is the 3dB difference detectable by the user? Most likely not unless you have a keen ear! A list of the actual programmed frequencies and their uses are found at the end of this product description. Also listed are the predicted Phase Noise levels in dBc/Hz @ 1 kHz

Below is a actual Phase noise plot of a A32 at 1136 MHz, the LO frequency for our 10 GHz transverter. Please note that data point recorded is at 10 kHz not 1 kHz. Just slide back on the graph to see the 1 kHz point to compare to the predicted value.



Anyone that is familiar with Phase Noise can see that this is definitely not a plot of a crystal oscillator but very respectable for a synthesizer and more than useful as a base frequency oscillator being utilized for week signal work. Understand that the phase noise will degrade in the multiplier chains of the four transverters with the 10 GHz unit being the worst case. The next plot shows the 10 GHz transverter's LO signal at 10224 MHz.



This plot is the A32 at 1136 MHz multiplied 9X in the 10 GHz transverter's multiplier chain to 10224 MHz. The phase noise increase is near calculated by theory of 20 log N or 19dB. "N" being the 9X multiplication factor in this case. With this phase noise level, a crystal controlled signal "Pure" at 10368.045 MHz. was monitored. The signal strength was varied to simulate both weak and strong signals. A second signal at a strong level was introduced from a signal generator that had more phase noise than the A32 at 10368.075. The "Pure" signal was varied to week levels noting the interference from the noisy generator. It was then determined by us that the amount of phase noise in the A32 will only be noticed with very strong signals or crowded band conditions. Very similar to the first 2 M synthesized transceivers we used back in the '70's. As for Transmit, it's not a pure "Crystal Quality "signal but its stable, on frequency and better than all other synthesizers of this nature on the microwave bands today. Bottom line, we have a synthesizer that we feel is worth the effort of using and experimenting with.

We will continue to strive for better performance but for now, we need to start somewhere. The A32 is installed in all newly purchased transverters and will be supplied as an assembled and tested unit in all kit transverters. It will also be available as a standalone unit for you to upgrade your older transverters complete with all materials required to get you on the air. For those of you that do not want to upgrade your own, a service will be provided to do so that will evaluate your transverter and replace the MICRO-LO with the A32 for a nominal fee. Get your 10 MHz sources ready! We are getting synthesized!

A32 with Internal 10 MHz. Clock

The performance of the A32 synthesizer depends on the accuracy of the 10 MHz clock or standard it is connected to. For the best possible performance, we recommend using a GPS derived source. This not only guarantees the best possible performance but will ensure that you are on the same frequency as others using a GPS derived system. The next best option is an external 10 MHz. source that is temperature stable separate from the transverter it is being used with. The transverter temperature will vary depending on the ambient temperature and the amount of power dissipated as heat in the transverter. Hence, the low power transverters will be more temperature stable than the high power versions. The last option is to utilize an “on board” 10 MHz clock installed on the A32 synthesizer. This side note will address the use and performance of what DEMI will install if a internal 10 MHz clock is desired.

The latest production A32 units have been designed to accommodate a surface mount TCXO produced by FOX, model 801BE. It was chosen for its performance over other designs. This model does have temperature compensation but it will not out perform and external source. The 801BE does have an internal trimmer control but we found it difficult to adjust so we have installed an “on board” frequency trimmer. This trimmer is adjusted at room temperature (25-28 °C) for the correct frequency depending on the model of transverter and operating frequency chosen. This trimmer can be re-adjusted at anytime to compensate for your type of operation or oscillator aging.

The data provided below will demonstrate what to expect as the internal air temperature of the transverter changes. The data is a compilation of worst-case frequency change of different units tested in the lab at the specified temperature ranges. We believe this is a good representation of what someone could expect when using an A32 with an internal FOX 801 10 MHz clock. Because of the nature of the 10 MHz clock (being crystal derived), the frequency change over temperature depends on the characteristics of the crystal used in the circuit. This is why we specify it as “Change in frequency or Delta” and not actual frequency change in a positive or negative direction. The delta can be in either positive or negative direction from “0” offset or “0” could be the center of the range. Just understand that at any temperature range, the data is the maximum frequency change that was observed.

Next item to understand is that data is a measurement of the A32 frequency change. (The base LO Multiplier frequency) This means that if you have a 10 GHz transverter, the base A32 frequency of 1136 MHz, is multiplied 9 times. So, the delta specified needs to be multiplied by 9. For 5760 by 5, 3456 by 3 and 2304 by 2.

Last item is to not underestimate the operating temperature of the transverter. A high power 5 or 10 GHz. transverter if left unattended in the sun in the transmit mode can exceed an internal temperature of 60 °C! In a laboratory environment, 50-55 °C can be achieved with a ½ hour of continuous transmit time. Now, the data.

Operating Temperature	Delta Frequency Change in Hz.
-10 to +50 °C	375
+20 to +40 °C	200
+30 to +55 °C	110

Below is the frequency selection chart. "X" indicates a jumper in that position.

Band	IF	Frequency	REV	Predicted PN, dBc/Hz @ 1 kHz
2304	144	1080		-81
"	145	1079.5		-79
"	147	1078.5		-79
2320	144	1088		-81
2424	144	1140		-81
3456	144	1104		-81
"	145	1103.6667		-78
"	147	1103		-81
3400	144	1085.3333		-80
"	145	1085		-81
5760	144	1123.2		-78
"	145	1123		-81
"	147	1122.6		-76
"	432	1065.6		-78
"	435	1065		-81
10368	144	1136		-81
"	145	1135.8889		-74
"	147	1135.6667		-78
"	432	1104		-81
"	435	1103.6667		-78
"	1296	1008		-81
24192	144	1002		-81
"	147	1001.875		-80
"	432	990		-81
"	435	989.875		-75
24048	144	996		-81
"	147	995.875		-75
"	432	984		-81
"	435	983.875		-75
903.1	WSS	903.1		-74
915	WSS	915		-81
1296.1	WSS	1296.1		-74
1152.02	WSS	1152.022		-74
2401	WSS	1200.5		-79
902.1	WSS	902.1	C2	-74
1275	WSS	1275	C2	-81
1420	WSS	1420	C2	-81
1296	144	1152	C2	-81
2400	144	1128	C2	-81
5760	1296	1116	C2	-81
1296	28	1268	C2	-81
1296	145	1151	C3	-81
2300	145	1077.5	C3	-79
2300	144	1078	C3	-81
2400	145	1127.5	C3	-81
10368	145	1022.3	C3	-74
10368	144	1022.4	C3	-78
1296	147	1149	C3	-81
1296	29	1267	C3	-81
1420	144	1276	C3	-81

Band	IF	Frequency	REV	Predicted PN, dBc/Hz @ 1 kHz
10368	144G3WDG	1278	C4	-81
10450	144G3WDG	1288.28	C5	-77
10450	144	1145.11	C5	-76
10450	145	1145	C5	-81
10450	432	1113.11	C5	-76
10450	433	1113	C5	-81
10450	1296	1144.25	C5	-77
10450	WSS	1116.111	C5	-76
3400	WSS	1133.333	C5	-78
2320	145	1087.5	C5	-79
2424	145	1139.5	C5	-79
10368	432	1242	C6	-81
10450	432	1252.5	C6	-77
1296	50	1246	D7	-81
2304	50	1127	D7	-81
3456	51	1135	D7	-81
5760	50	1142	D7	-81
10368	51	1146.333	D7	-78
2403	145	1129	D8	-81
10368	145	1277.875	D9	-75