EXTERNAL ALC BOARD ASSEMBLY INSTALLATION & USE INSTRUCTIONS

By Clyde Washburn, K2UE

K2UE@ IEEE.org

Rev. 0.3, March 25, 2015

DISCLAIMER:

This an Experimental device. It is intended for use only by licensed Radio Amateurs who assume all liability for their equipment and its operation, and no assertion is made that damage cannot occur while this device is in use. We do not approve or support the use of component values or adjustment procedures other than those given here.

SOFTWARE NOTE:

This hardware device ***requires*** the use of OpenHPSDR mRX PS v3.2.25 or later. ***Do not*** check the box for "Limit Drive on Ext. Amp. Overload" if the hardware External ALC assembly is not installed and powered, as Tx power output may be greatly reduced without the board present and active.

STEP 1: SELECT YOUR AMPLIFIER TYPE BELOW:

Q: Why are there different setups for different amps?

A: All ALC sources start with a rectifier producing similar voltages, but some shift it against a reference voltage, others divide it down, and some do both. This External ALC Board is actually a servo control loop, rather than simple brute force gain reduction, and will give the best results in terms of rapid smooth power reduction without over or undershoot if correctly matched to the ALC source.

Acom Amplifiers:	A2000: Input Drive Detector with divider pot. **TYPE 1**
Ameritron Amplifiers:	AL-572: Input Drive Detector with front panel Offset Control & divider pot. **TYPE 3**
	AL-80B: Input Drive Detector with front panel Offset Control & divider pot. **TYPE 3**
	AL-82: Input Drive Detector with divider pot. **TYPE2**
	AL-800 & AL-800H: Input Drive Detector with front panel Offset Control & divider pot. **TYPE 3**
	AL-811 & AL-811H: Input Drive Detector with divider pot. **TYPE 2**
	AL-1200: Input Drive Detector with divider pot. **TYPE 2**
	AL-1500: Input Drive Detector with divider pot. **TYPE 2**
	ALS-600 & ALS-600S: Fwd/Rev Power Detector with front panel Offset Control only. **TYPE 4**
	ALS-1300: Fwd/Rev Power Detector with front panel Offset Control only. **TYPE 4**
	ALS-1306: Fwd/Rev Power Detector with front panel Offset Control & divider pot. **TYPE 5**
Expert Amps:	1K-FA/1.3K-FA/2K-FA: Input Drive detector. **TYPE 8**
Icom Amplifiers:	IC-PW1: Fwd/Rev Power Detector with divider pot. **TYPE 6**
Tokyo High Power:	All models with ALC Output: **TYPE 7**
Yaesu Amplifiers:	VL-1000 Quadra: Fwd/Rev Power Detector with front panel Offset Control only. **TYPE 7**

STEP 2: CONNECT THE EXTERNAL ALC BOARD:

1. Remove any connector presently on the rear panel Accessory connector of the Anan-100/100D/200D.
2. Plug the male end of the External ALC Board into the Accessory connector, and secure with the two captive screws in the connector.
3. Place any plug previously removed from the Accessory connector into the rear female connector of the External ALC Board, and secure using the female threads on the board connector. Previous connections now pass-thru, with exception only of AI#1 (pin 8) and DI#1 (pin7), which are used by the ALC Board.
4. Preset any rear panel ALC control (left side panel in the ALS-1306) on your amplifier to maximum.
5. Connect the ALC output of the amplifier to the RCA Phono ALC Input of the ALC Board using a suitable shielded cable. Ferrites may be used on the cable to discourage RF currents on the shield, and multiple turns are often helpful for operation at low frequencies.
6. Connect +13.8V nominal power to the ALC Board using the cable provided. **CHECK THAT THE CENTER PIN IS POSITIVE BEFORE** plugging the cable on the board! ***ON THE CABLES WE SUPPLY WITH THE PROTOTYPE BOARD THE CENTER PIN IS THE WIRE WITH THE WHITE TRACER ON IT***. Confirm that the LED on the ALC Board illuminates when power is applied.
7. Install OpenHPSDR software that supports Ext. Amplifier ALC, and insure that the checkbox for “Limit Drive on Ext. Amp. Overload” (on the Setup/Transmit tab) is **UNCHECKED** at this time.
8. Setup according to Type Number, below.

STEP 3: SET UP ACCORDING TO TYPE NUMBER:

Type 1: (such as Acom A2000)

These amplifiers provide a grid-derived ALC signal primarily intended to prevent grid damage, and only protect the amplifier from other types of faults to the extent that the manufacturer sums in other fault signals, or that grid current is affected by other faults.

1. Preset the **Gain** pot (pot closest to the radio) to exactly midrange (slot vertical).
2. Preset the **Threshold** pot (pot to the rear) fully clockwise.
3. Using Tune mode (or Two Tone Test if continuous carrier operation of your amp is discouraged), adjust your amplifier for normal full rated power operation on the band that requires the highest drive power.
4. Unkey and set the Tune power (or Two Tone power, if used) to zero; then enable ALC with the checkbox for “Limit Drive on Ext. Amp. Overload” on the Setup/Transmit tab.
5. Key in Tune (or Two Tone) and increase the Drive setting slowly until the ALC limits the amplifier output and the red ALC “Ext. Amplifier Overload” warning message appears on the OpenHPSDR screen (same place as the ADC Overload warning).
6. Reduce the ALC pot setting on the rear of the amp until ALC limiting does not occur until you reach rated power, or slightly above – **there should be NO ALC limiting during normal operation with PureSignal enabled – it cannot correct linearity while ALC is active.**
7. You should now be able to increase the drive setting to 100 and confirm that ALC prevents further amplifier output or grid current increases.
8. Adjust the drive on each band until you are just **below** the ALC point to assure proper operation of PureSignal Predistortion. If adjust Drive power frequently, you may want to install DDUtil v3 by K5FR which will return the drive power to a saved value each time you return to a given band.

Type 2: (such as Ameritron tube amps without a front panel ALC control)

These amplifiers provide a cathode-derived ALC signal primarily intended to limit input power, and only protect the amplifier from other types of faults to the extent that the manufacturer sums in other fault signals. Follow the steps for Type 1, above.

Type 3: (such as Ameritron tube amps with a front panel ALC control)

These amplifiers provide a cathode-derived ALC signal primarily intended to limit input power, and only protect the amplifier from other types of faults to the extent that the manufacturer sums in other fault signals.

1. Preset the **Gain** pot (pot closest to the radio) to exactly midrange (slot vertical).
2. Preset the **Threshold** pot (pot to the rear) fully clockwise.
3. Using Tune mode (or Two Tone Test if continuous carrier operation of your amp is discouraged), adjust your amplifier for normal full rated power operation on the band that requires the highest drive power. While keyed Adjust the ALC control on the front panel of the amplifier for -4V ALC output from the amp. On many Ameritron amps you can read this voltage with the amp's front panel meter.
4. Unkey and set the Tune power (or Two Tone power, if used) to zero; then enable ALC with the checkbox for "Limit Drive on Ext. Amp. Overload" on the Setup/Transmit tab.
5. Key in Tune (or Two Tone) and increase the Drive setting slowly until the ALC limits the amplifier output and the red ALC "Ext. Amplifier Overload" warning message appears on the OpenHPSDR screen (same place as the ADC Overload warning).
6. Reduce the ALC pot setting on the rear of the amp until ALC limiting does not occur until you reach rated power, or slightly above – **there should be NO ALC limiting during normal operation with PureSignal enabled – it cannot correct linearity while ALC is active.**
7. You should now be able to increase the drive setting to 100 and confirm that ALC prevents further amplifier output or grid current increases.
8. Adjust the drive on each band until you are just **below** the ALC point to assure proper operation of PureSignal Predistortion. If adjust Drive power frequently, you may want to install DDUtil v3 by K5FR which will return the drive power to a saved value each time you return to a given band.

Type 4: (such as the Ameritron ALS-600 & 1300)

These amplifiers provide a forward and reverse Power-derived ALC signal which protects the amplifier from excess drive and adverse loads, typically those over 2:1 SWR.

1. Preset the **Gain** pot (pot closest to the radio) to exactly midrange (slot vertical).
2. Preset the **Threshold** pot (pot to the rear) fully clockwise).
3. Using Tune mode (or Two Tone Test if continuous carrier operation of your amp is discouraged), adjust your amplifier for normal full rated power operation on the band that requires the highest drive power. While keyed Adjust the ALC control on the front panel of the amplifier for -4V ALC output from the amp. On many Ameritron amps you can read this voltage with the amp's front panel meter.
4. Unkey and set the Tune power (or Two Tone power, if used) to zero; then enable ALC with the checkbox for "Limit Drive on Ext. Amp. Overload" on the Setup/Transmit tab.
5. Key in Tune (or Two Tone) and increase the Drive setting slowly until the ALC limits the amplifier output and the red ALC "Ext. Amplifier Overload" warning message appears on the OpenHPSDR screen (same place as the ADC Overload warning).
6. Rotate the **Threshold** (rearmost) pot on the ALC Board counter-clockwise (anti-clockwise) until ALC limiting does not occur until you reach rated power, or slightly above – **there should be NO ALC limiting during normal operation with PureSignal enabled – it cannot correct linearity while ALC is active.**
7. You should now be able to increase the drive setting to 100 and confirm that ALC prevents further amplifier output or grid current increases.
8. Adjust the drive on each band until you are just **below** the ALC point to assure proper operation of PureSignal Predistortion. If adjust Drive power frequently, you may want to install DDUtil v3 by K5FR which will return the drive power to a saved value each time you return to a given band.

Type 5: (such as the Ameritron ALS-1306)

These amplifiers provide a forward and reverse Power-derived ALC signal which protects the amplifier from excess drive and adverse loads, typically those over 2:1 SWR. Make sure the amp's rear panel (left side panel on the ALS-1306) ALC divider control is set to maximum output (largest negative voltage at rated power), then follow the steps for Type 4, above.

Type 6: (such as the Icom IC-PW1)

These amplifiers provide a forward and reverse Power-derived ALC signal which protects the amplifier from excess drive and adverse loads, typically those over 2:1 SWR. They are factory-adjusted to provide -4V ALC output at rated power with the rear panel ALC control at maximum.

1. Preset the **Gain** pot (pot closest to the radio) to exactly midrange (slot vertical).
2. Preset the **Threshold** pot (pot to the rear) fully clockwise.
3. Unkey and set the Tune power (or Two Tone power, if used) to zero; then enable ALC with the checkbox for "Limit Drive on Ext. Amp. Overload" on the Setup/Transmit tab.
4. Key in Tune (or Two Tone) and increase the Drive setting slowly until the ALC limits the amplifier output and the red ALC "Ext. Amplifier Overload" warning message appears on the OpenHPSDR screen (same place as the ADC Overload warning).
5. Rotate the **Threshold** (rearmost) pot on the ALC Board counter-clockwise (anti-clockwise) until ALC limiting does not occur until you reach rated power, or slightly above – **there should be NO ALC limiting during normal operation with PureSignal enabled – it cannot correct linearity while ALC is active.**
6. You should now be able to increase the drive setting to 100 and confirm that ALC prevents further amplifier output.
7. Adjust the drive on each band until you are just **below** the ALC point to assure proper operation of PureSignal Predistortion. If adjust Drive power frequently, you may want to install DDUtil v3 by K5FR which will return the drive power to a saved value each time you return to a given band.

Type 7: (such as the Yaesu VL-1000 Quadra & Tokyo High Power*)

Yaesu amplifiers provide a forward and reverse Power-derived ALC signal which protects the amplifier from excess drive and adverse loads, typically those over 2:1 SWR. They are factory-adjusted to provide a nominal -4V ALC output at rated power. *THP ALC is derived only from Forward Power, and is adjusted via a rear panel ALC Offset control.

1. Preset the **Gain** pot (pot closest to the radio) to exactly midrange (slot vertical).
2. Preset the **Threshold** pot (pot to the rear) fully **counter-clockwise (anti-clockwise)**.
3. Using Tune mode (or Two Tone Test if continuous carrier operation of your amp is discouraged), adjust your amplifier for normal full rated power operation on the band that requires the highest drive power. While keyed adjust the ALC of the amplifier per its instructions for **-6V** ALC output from the amp.
4. Unkey and set the Tune power (or Two Tone power, if used) to zero; then enable ALC with the checkbox for "Limit Drive on Ext. Amp. Overload" on the Setup/Transmit tab.
5. Key in Tune (or Two Tone) and increase the Drive setting slowly until the ALC limits the amplifier output and the red ALC "Ext. Amplifier Overload" warning message appears on the OpenHPSDR screen (same place as the ADC Overload warning). Adjust the ALC per the amplifier instructions until ALC limiting does not occur until you reach rated power, or slightly above – **there should be NO ALC limiting during normal operation with PureSignal enabled – it cannot correct linearity while ALC is active.** If rated power is reached without ALC action, readjust the amp ALC upward per instructions until ALC occurs at, or just above rated power.
6. You should now be able to increase the drive setting to 100 and confirm that ALC prevents further amplifier output.
7. Adjust the drive on each band until you are just **below** the ALC point to assure proper operation of PureSignal Predistortion. If adjust Drive power frequently, you may want to install DDUtil v3 by K5FR which will return the drive power to a saved value each time you return to a given band.

Type 8: (such as the Expert Amps)

These amplifiers provide a non-adjustable Drive Power-derived ALC signal which protects the amplifier from excess drive. They provide no adjustment for the ALC output, and ***the ALC threshold will be that set by the amplifier***.

1. Preset the **Gain** pot (pot closest to the radio) to exactly midrange (slot vertical).
2. Preset the **Threshold** pot (pot to the rear) fully **counter-clockwise (anti-clockwise)**.

3. Unkey and set the Tune power (or Two Tone power, if used) to zero; then enable ALC with the checkbox for "Limit Drive on Ext. Amp. Overload" on the Setup/Transmit tab.
4. Key in Tune (or Two Tone) and increase the Drive setting slowly until the ALC limits the amplifier output and the red ALC "Ext. Amplifier Overload" warning message appears on the OpenHPSDR screen (same place as the ADC Overload warning). **There should be NO ALC limiting during normal operation with PureSignal enabled – it cannot correct linearity while ALC is active.** You should now be able to increase the drive setting to 100 and confirm that ALC prevents further amplifier output.
5. Adjust the drive on each band until you are just **below** the ALC point to assure proper operation of PureSignal Predistortion. If adjust Drive power frequently, you may want to install DDUtil v3 by K5FR which will return the drive power to a saved value each time you return to a given band.

INSTALLATION IS NOW COMPLETE!

STEP 4: OPTIONAL: Check Transient Response ONLY if you have appropriate equipment:

The suggested settings will typically produce near-optimum transient response. However, if you are using an amplifier not listed above, and/or have the ability to perform the test, you may want to do this to obtain optimum results:

1. Connect an oscilloscope so that you can observe the envelope of a full power Two Tone signal, clearly seeing the bow-tie envelope cycles, with a resolution of approx. 20 msec per division
2. Set the scope for one-shot triggering and adjust the triggering so that the ***leading edge*** of the envelope is displayed each time you key
3. After setting the **Threshold** using the applicable procedure above, go to the OpenHPSDR Setup/Tests Tab and in the right column under Transmit select:
    - Mode: Pulse,
    - Level: 0 dB,
    - Freq: 1000,
    - Pulse Freq: 10.00,
    - Pulse Duty Cycle: 0.10,
    - Trans: 0.0001
4. In the Setup/Transmit Tab set the Tune Power to 100 and uncheck Use Drive Power.
5. Key the radio in Tune and capture **FIRST** pulse – subsequent pulses are not helpful for analysis purposes.
6. Observe that the envelope initially grows until limited in the PA, then quickly declines to the level enforced by ALC (see scope photo on a following page). This initial overshoot is the result of the system being non-linear during the initial overload due to PA envelope compression, thus producing a smaller error signal than it would if linear, and the processing delay in the ALC chain. What we are looking for is that the level decreases to the ALC-controlled level without significant under or overshoot as it reaches the final level.
7. If significant overshoot is observed, adjust the **Gain** pot (closest to the radio) slightly CW (clockwise) until overshoot is minimized. ***See the scope photo on the last page for what correct response without over or undershoot will look like.***
8. If significant undershoot is observed, adjust the **Gain** pot (closest to the radio) slightly CCW (anti-clockwise) until undershootshoot is minimized. ***See the scope photo on the last page for what correct response without over or undershoot will look like.***

Note that there is normally no overshoot at all when the overload condition is present at the time the unit is keyed – the raised-cosine envelope shaping in the Anan allows the ALC to act to prevent exceeding the set point as the output rises. This test applies the overload later, when initial system is settled in normal operation, as a worst case.

Also note that no other exciter of which we are aware allows any control of its transient response or damping, but we are striving to be as good as the electronics allow.

The Transient Response test makes it clear why you never want to use ALC as a form of pseudo-compression: besides defeating PureSignal, the initial syllables sounds will overshoot, and cause splatter, and will happen repeatedly as the ALC decays and new envelope peaks occur.

Schematic, Parts List and Component Layout appear on the following pages.

The last page shows the typical response to the First Pulse in Blue, with the corresponding ALC input from the amplifier in Yellow.

ABOUT THE ALC BOARD CONTROLS:

ALC sources and circuits can best be discussed in terms of Volts per dB, V/dB, the number of volts change resulting from 1 dB of power output change, or causing 1 dB of exciter gain change.

The **THRESHOLD** control is a voltage divider which changes both the threshold voltage at which ALC will being and the sensitivity – as the threshold becomes more negative the sensitivity in V/dB decreases. This is used to "match up" the source characteristics with the needed exciter gain – choosing as high threshold will reduce the loop gain. The control operations with the positive convention, i.e. full counter-clockwise (anti-clockwise) is the most negative threshold (~-6V), full clockwise is the least (~-1.5V).

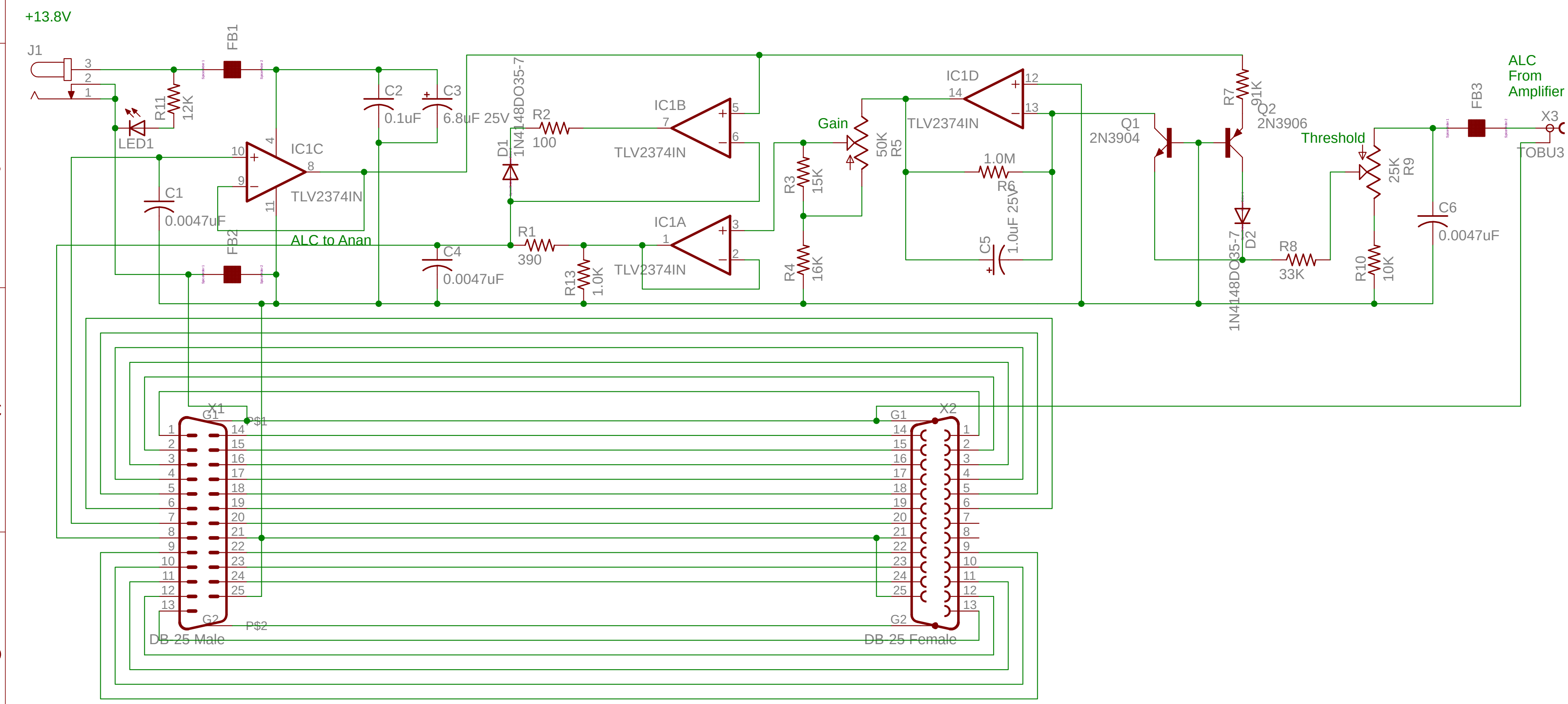
ALC sources are fundamentally very similar: a rectifier of the input or output power with a voltage with the range of +/-12V-powered opamps. When the raw output is provided using a voltage divider at either the source or the **Threshold** control will match the gain and threshold pretty well.

But some sources artificially offset the output from the native detector output, then gain it up a bit, probably for flatter ALC slope with conventional exciters. In these cases the **Threshold** control wants to be set for a high threshold, so the signal is heavily divided down, and the desired loop gain restored.

The **GAIN** control is primarily a hedge against the future, and allows a +/- 2:1 (6dB) gain change without affecting the set threshold. This allows changes in the behavior of OpenHPSDR or new SDR hardware to be accommodated so some extent without the need to change component values.

PROTOTYPE ERRATA:

1. Pin 9 in not connected through on the prototype PCB's. Since pin 9 is not in current use this has not been corrected.
2. There was an erroneous connection from Q2-C to +13.8V on the prototype PCB. The trace has been cut on the prototype boards.

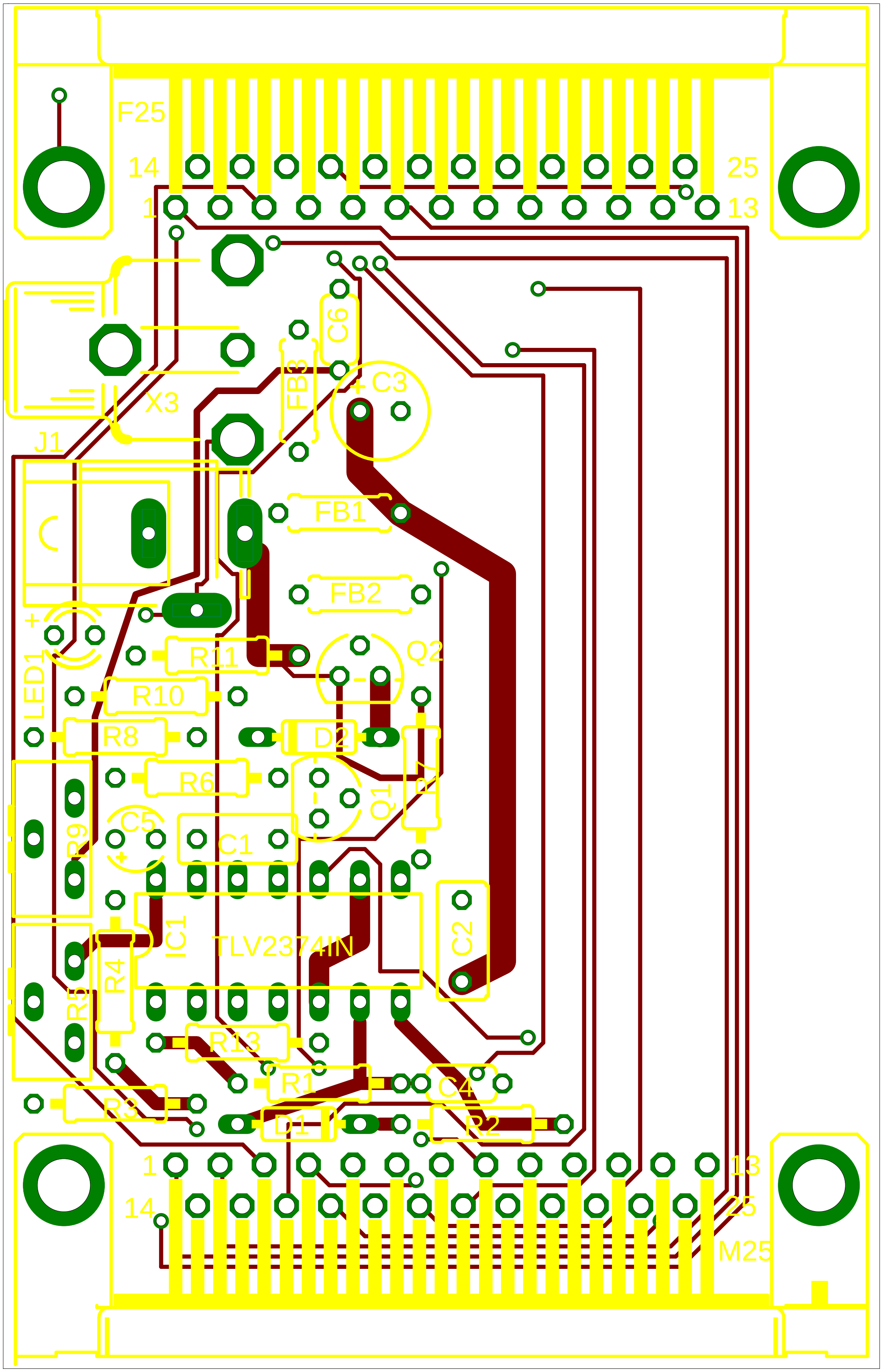


External ALC for Apache Labs Transceivers

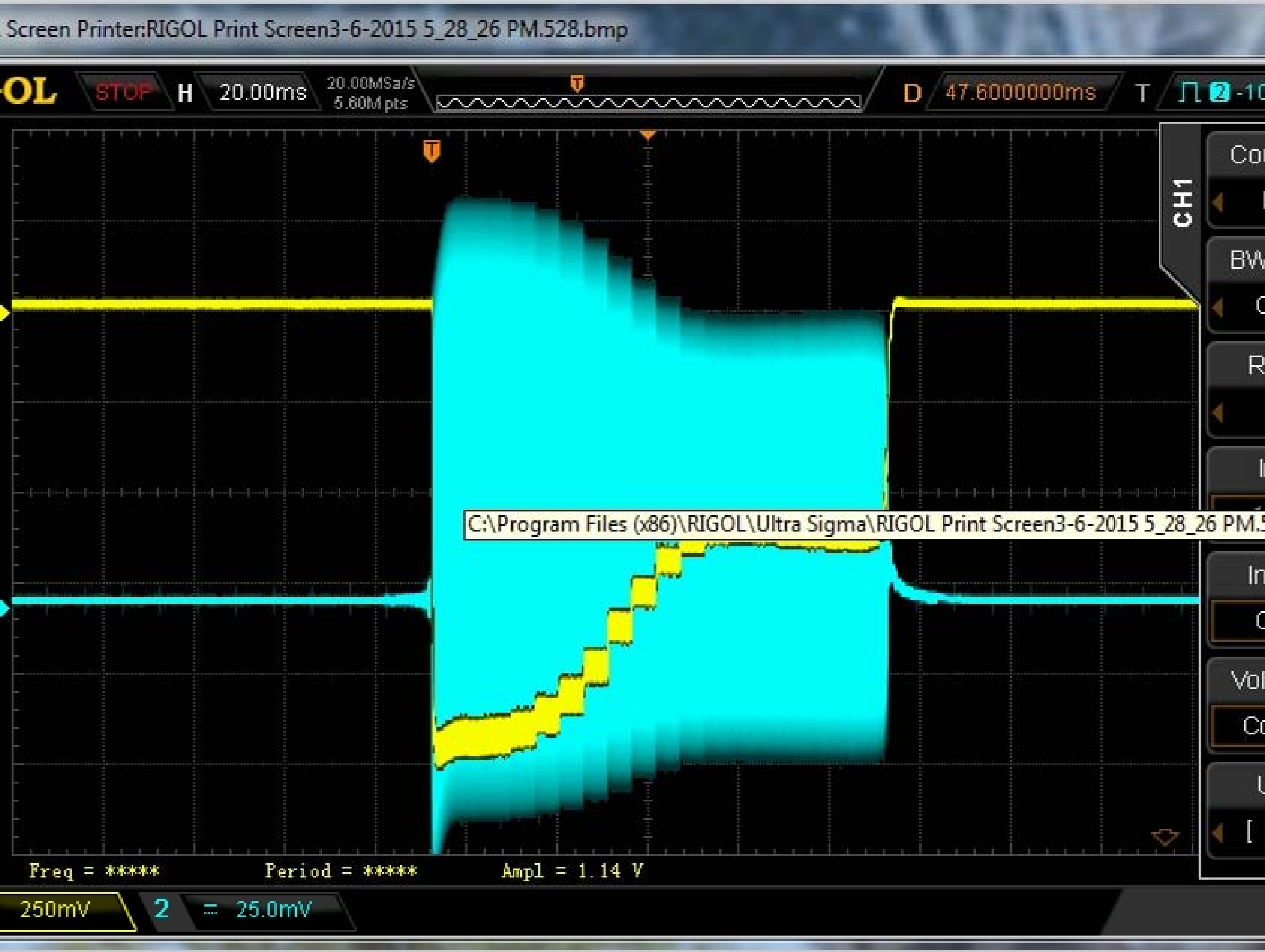
Clyde Washburn, K2UE 3-14-15

TITLE: ExtALC	
Document Number:	REV: A
Date: not saved!	Sheet: 1/1

Part	Qty	Value	Device	Package	Description	MF	MPN	Digikey	Cost	Extended
C1, C3, C6	3	0.0047uF	C-US050-030X075	C050-030X075	CAPACITOR, Ceramic	Murata	RDER72E472K1M1H03B	490-8921-ND	$0.24	$0.73
C2	1	0.1uF	C-US050-030X075	C050-030X075	CAPACITOR, Ceramic	Murata	RDER71H104K0K1H03B	490-8814-ND	$0.26	$0.26
C3	1	6.8uF 25V	CPOL-USTT2D6	TT2D6	POLARIZED CAPACITOR, Tantalum	AVX	TAP685K025SCS	478-1921-ND	$0.79	$0.79
C5	1	1.0uF 25V	CPOL-USTT2D4	TT2D4	POLARIZED CAPACITOR, Tantalum, 10%	AVX	TAP105K025SCS	478-1834-ND	$0.63	$0.63
D1, D2	2	1N4148	1N4148	DO35-7	DIODE	Fairchild	1N4148TA	1N4148TACT-ND	$0.06	$0.12
FB1, FB2, FB3	3		FERRITEBEAD2	0207/7	Multiturn Ferrite Bead	Laird	28C0236-0EW-10	240-2492-ND	$0.41	$1.24
IC1	1	TLV2374IN	TLV2374IN	DIL14	Quad Op Amp CMOS	TI	TLV2374IN	296-12221-5-ND1	$2.25	$2.25
J1	1		JACK-PLUG0	SPC4077	DC POWER JACK 2.1mm	CUI	PJ-202A	CP-202A-ND	$0.93	$0.93
LED1	1		LED3MM	LED3MM	LED, Green	Dialight	555-2301F	350-1716-ND	$1.69	$1.69
Q1	1	2N3904	2N3904	TO92D	NPN TRANSISTOR	Fairchild	2N3904BU	2N3904FS-ND	$0.19	$0.19
Q2	1	2N3906	2N3906	TO92D	PNP TRANSISTOR	Fairchild	2N3906BU	2N3906FS-ND	$0.20	$0.20
R1	1	390	R-US_0207/10	0207/10	RESISTOR, 1/4W 5%	Stackpole	CF14JT390R	CF14JT390RCT-ND	$0.10	$0.10
R2	1	100	R-US_0207/10	0207/10	RESISTOR, 1/4W 5%	Stackpole	CF14JT100R	CF14JT101RCT-ND	$0.10	$0.10
R3	1	15K	R-US_0207/10	0207/10	RESISTOR, 1/4W 5%	Stackpole	CF14JT15K0	CF14JT15K0CT-ND	$0.10	$0.10
R4	1	16K	R-US_0207/10	0207/10	RESISTOR, 1/4W 5%	Stackpole	CF14JT16K0	CF14JT16K0CT-ND	$0.10	$0.10
R5	1	50K	TRIM_US-S63X	S63X	POTENTIOMETER, Cermet 10%	Bourns	3386H-1-503LF	3386H-503LF-ND	$1.60	$1.60
R6	1	1.0M	R-US_0207/10	0207/10	RESISTOR, 1/4W 5%	Stackpole	CF14JT1M00	CF14JT1M00CT-ND	$0.10	$0.10
R7	1	91K	R-US_0207/10	0207/10	RESISTOR, 1/4W 5%	Stackpole	CF14JT91K0	CF14JT91K0CT-ND	$0.10	$0.10
R8	1	33K	R-US_0207/10	0207/10	RESISTOR, 1/4W 5%	Stackpole	CF14JT33K0	CF14JT33K0CT-ND	$0.10	$0.10
R9	1	25K	TRIM_US-S63X	S63X	POTENTIOMETER, Cermet 10%	Bourns	3386H-1-253LF	3386H-253LF-ND	$1.60	$1.60
R10	1	10K	R-US_0207/10	0207/10	RESISTOR, 1/4W 5%	Stackpole	CF14JT10K0	CF14JT10K0CT-ND	$0.10	$0.10
R11	1	12K	R-US_0207/10	0207/10	RESISTOR, 1/4W 5%	Stackpole	CF14JT12K0	CF14JT12K0CT-ND	$0.10	$0.10
R13	1	1.0K	R-US_0207/10	0207/10	RESISTOR, 1/4W 5%	Stackpole	CF14JT1K00	CF14JT1K00CT-ND	$0.10	$0.10
X1	1	DB-25 Male	M25HP	M25HP	SUB-D	TE	5747238-4	A32074ND	$6.02	$6.02
X2	1	DB-25 Female	F25HP	F25HP	SUB-D	TE	5747846-6	A32128-ND	$5.25	$5.25
X3	1	TOBU3	TOBU3	TOBU3	Female Cinch CONNECTOR (RCA Phono Jack)	CUI	RCJ-011	CP-1400-ND	$0.96	$0.96
										$0.00
P1	1				DC POWER PLUD & CORD 2.1mm	Tensility	CA-2185	CP-2185-ND	$2.05	$2.05
X1-Screw	1				MALE SCREW & RETAINER (discard retainer)	TE	5746881-1	5746881-1-ND	$2.24	$2.24
X1 & X2 Top	4				4-40 x 3/8" 100 degree Flathead Screw	McMaster-Carr	90471A160	(McMaster-Carr)	$0.05	$0.20
X1 & X2 Bottom	4				#4 Split Lockwasher	McMaster-Carr	91102A720	(McMaster-Carr)	$0.01	$0.04
X1 & X2 Bottom	4				#4 Small Pattern Nut	McMaster-Carr	90760A005	(McMaster-Carr)	$0.02	$0.08
PCB	1				PCB Fab'ed by OSH Park in Qty 3, each	OSH Park	Order #gCfFLFrz	(OSH Park)	$12.00	$12.00
Anan External ALC Board Assy, less Shield Covers								**TOTAL COST OF MATERIALS:**		$42.06



3/14/2015 4:04:01 PM f=2.64 C:\Users\washburn\Documents\eagle\ALC\ExtALC.brd


Screen Printer:RIGOL Print Screen3-6-2015 5_28_26 PM.528.bmp
STOP
H
20.00ms
20.00MSa/s
5.60M pts
D
47.6000000ms
T
CH1
C:\Program Files (x86)\RIGOL\Ultra Sigma\RIGOL Print Screen3-6-2015 5_28_26 PM.5
Freq = *****
Period = *****
Ampl = 1.14 V
250mV
2
25.0mV