The Tellun Corporation

TLN-863 Max Min Generator

User Guide, Rev. 1.1

Scott Juskiw The Tellun Corporation scott@tellun.com	TLN-863 User Guide Revision 1.1 May 26, 2008

1. Introduction

The TLN-863 Max Min Generator is an implementation of a Linear Or/And Gate from Jung's Op-Amp Cookbook. With the MODE switch set to the MAX position, the output will be the maximum of inputs 1-3 (Linear Or). With the MODE switch set to the MIN position, the output will be the minimum of inputs 1-3 (Linear And). The THRESHOLD pot sets a voltage that is normalled to the input jacks when no signal is plugged into the jacks. This turns the circuit into a "Clipper" when the MODE switch is set to MIN (output voltage will not go below the THRESHOLD), and a "Clamper" when the MODE switch is set to MAX (output voltage will not exceed the THRESHOLD).

Description of panel controls:

- THRESHOLD: sets the voltage threshold for the Clipper/Clamper feature.
- MODE: sets the operational mode to Min/And/Clipper or Max/Or/Clamper.

2. Circuit Description

The heart of this circuit is the stack of op-amps (U1a, U1b, U2a) and diodes (D1-D6) along with switch SW1. When SW1 is in the MAX position, the POS signals are connected to the inverting inputs of the op-amps through D1, D3, and D5. One of these diodes will always be conducting to provide a negative feedback path to keep one of the op-amps active. Thus the voltage at U2b (pin 5) always follows whichever input at J1-J3 is more positive. When SW1 is in the MIN position, the NEG signals are connected to the inverting inputs of the op-amps through D2, D4, and D6 and the output follows whichever input at J1-J3 is more negative. R1-R6 provide over-voltage protection for the op-amps.

U2b (and associated resistors and capacitors) form a simple buffer for the output signal.

The circuitry around U3 provides a variable bias voltage to the inputs jacks. With SW1 in the MAX position the bias voltage varies from –5V (CCW) to +5V (CW) as the THRESH pot is rotated. With SW1 in the MIN position, the bias voltage varies from +5V (CCW) to –5V (CW) as the THRESH pot is rotated. Thus the bias voltage will have no effect in either mode when turned fully counter-clockwise. The bias voltage is normalled to the 3 input jacks (J1-J3) so that a clipper or clamper level can be manually set by not inserting a patch cable into at least one of the jacks.

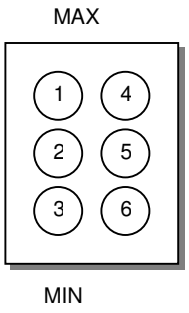
3. Construction Tips

Use 1% resistors wherever they are shown in the schematic.

If you use Bourns or Spectrol pots with the Alco PKES60 knobs, you might want to trim 1/8” off the end of the pot shafts to get the knobs to sit closer to the panel. I did not need

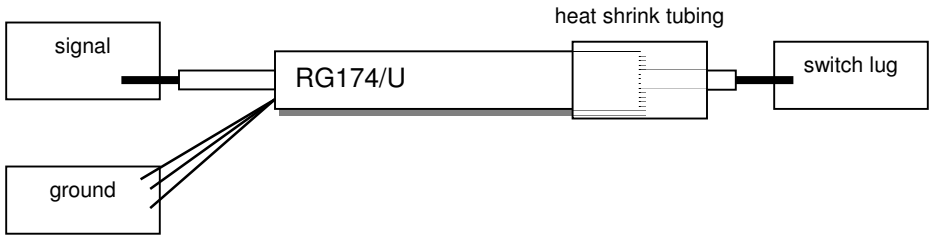
to do this for the TLN-863 seen in the website pictures (the pots I had on hand just happened to have shorter shaft lengths).

Use coax cable for the jacks and pins 4-6 of switch SW1 (the wires that connect the POS and NEG signals to the inverting inputs of op-amps U1a/U1b/U2a. The TLN-863 can be used with audio signals, so it's a good idea to use coax cable to keep noise out of the circuit. Use the following diagram when wiring up switch SW1:



Switch viewed from behind (pins facing toward you). With switch in the up position (MAX) pins 2 and 3 are connected, and pins 5 and 6 are also connected.

When hooking up coax between the PCB and switches, connect the coax shield to ground at one end only. Clip the coax shield from the other end and cover with a piece of heat shrink tubing to prevent any stray strands from coming into contact with anything. At this clipped end, connect the core (inside) conductor to the pot or switch lug.



For VR1, the pin out for most pots is (left to right): 3, 2, 1 when viewing the back of the pot with the leads facing down. These pins are labeled on the schematic.

4. Modifications

You can substitute a TL072 op-amp for U3. You can substitute OP275 op-amps for U1-U3 if you want the best audio performance, but they have poorer DC performance.

You can add additional input channels by duplicating the following components for each additional channel: J1, R1, R2, U1a, D1, D2.

5. Building the Max Min Generator with MUUBs

You'll need one MUUB-4 and one MUUB-2 to build one instance of the TLN-863. I built two TLN-863s as independent circuits mounted to Stooge modular brackets and a Stooge compatible 1U wide panel (a prototype panel made from plexiglass). Described below are details for building a single TLN-863. You'll need to duplicate this effort to build a dual version like mine. There is an additional bit of jiggery-pokery needed to get two instances to mount on the Stooge bracket: you have to mount one MUUB-2 on top of another MUUB-2 using spacers. Not too difficult, but keep that in mind as you connect wires between the MUUB boards because at some point the whole contraption will wind up looking like one of those 3D chessboards from Star Trek. Make sure your wires will reach between Queen's level 3 and King's level 1.

Prepare your panel and Stooge brackets before you do any soldering. Get all the mechanical issues dealt with first. You'll need two of the Stooge "2 jack modular bracket" and one of the Stooge "flat plate modular bracket". If you use the same panel layout as my dual TLN-863, note that the pots are 1/8" closer to the middle of the panel than the jacks. When you attach the jack brackets to the panel (at the THRESH B pot and the OUT B jack), they will not be in the same plane. This is easy to remedy by simply inserting an extra nut between the flat plate bracket and the jack bracket that attaches to the OUT B jack.

Once you get the three bracket parts bolted together (use ¼" #6 screws) and attached to the panel, you should have enough space to mount two MUUB-4s and one MUUB-2 to the bracket using ¼" spacers and ½" #6 screws. Make sure you leave enough space for the Switchcraft 112A jacks so that they don't interfere with the lower MUUB-4 board. If you are building a dual version, you'll also need additional spacers to mount a second MUUB-2 board on top of the first MUUB-2 board. I used 3/8" spacers and 1" #6 screws but you may be able to get by with a ¼" spacer. If you used an extra nut between the flat plate and the lower jack bracket, you'll need a 3/8" spacer to mount the right side of the lower MUUB-4 board to the bracket (because the extra nut is 1/8" thick) and a ¾" #6 screw. I recommend getting some ¼" and 3/8" spacers, a wide selection of #6 screws in different lengths (from ¼" to 1"), and some extra #6 nuts.

Before beginning the soldering, note the following labeling conventions used in this document for diodes, pots, and transistors.

1. Diodes: banded end is cathode, other end is anode.
2. Pots: when viewing the back of the pot (the shaft facing away from you) with the leads facing down, the pins are (left to right): 3, 2, 1.

5.1. Building Board #1 (MUUB-4)

This circuit board contains the power supply connector (MTA-156), two ferrite beads (L1-L2), and two 10 uF caps (C7 and C8). Power and ground will be supplied to board #2 by running wires from board #1 to board #2.

Use the following table to place components from the TLN-863 schematic onto board #1. For short jumpers, use a scrap resistor lead. For longer jumpers, use a piece of #22 wire. Note that R2, R4, and R6 must be installed standing upright in order to fit into the closely spaced holes. Also note the peculiar placement of R7 and R8. Check the website pictures.

Schematic	*MUUB-4 Location (board #1)*
R1-470K	RC6
R2-10K	CC2, middle and bottom holes
R3-470K	RD6
R4-10K	CD2, middle and top holes
R5-470K	RA6
R6-10K	CA2, middle and bottom holes
R7-100K	RA1, RA10 (right hole) and TA1 (bottom hole)
R8-100K	RA9, CB1 (bottom hole) and TB1 (bottom hole)
R9-470	RB14
R10-47K	RB10
D1-1N4148	RC14, cathode (band) to left
D2-1N4148	RB2, cathode (band) to left
D3-1N4148	RD14, cathode (band) to left
D4-1N4148	RB3, cathode (band) to left
D5-1N4148	RB1, cathode (band) to left
D6-1N4148	RA14, cathode (band) to left
C1-100N	C5 (bypass cap for U1)
C2-100N	C6 (bypass cap for U1)
C3-100N	C3 (bypass cap for U2)
C4-100N	C4 (bypass cap for U2)
C7-10M	C1 (power supply bypass cap)
C8-10M	C2 (power supply bypass cap)
C9-1N	CB3
C10-1N	CB4
L1	L1 (ferrite bead)
L2	L2 (ferrite bead)
JP1	MTA-156 power connector
jumper	JC6
jumper	RC5
jumper	CC1, middle and bottom holes
jumper	JD6
jumper	RD5
jumper	CD1, middle and top holes
jumper	JA6
jumper	RA5
jumper	CA1, middle and bottom holes
jumper	RA2
jumper	RB4
jumper	CC4 (top hole) to CA4 (bottom hole)
jumper	RC10 (right hole) to CD4 (top hole)

jumper	RA3 (right hole) to RC3 (right hole)
jumper	RD3 (right hole) to CB2 (top hole)
jumper	RC1 (right hole) to RD1 (right hole)
jumper	JB1 (right hole) to CA3 (bottom hole)
jumper	JB2 (right hole) to CC3 (bottom hole)
jumper	JB3 (right hole) to CD3 (top hole)

5.2. Building Board #2 (MUUB-2)

Use the following table to place components from the TLN-863 schematic onto board #2. For short jumpers, use a scrap resistor lead. For longer jumpers, use a piece of #22 wire. Check the website pictures.

Schematic	*MUUB-2 Location (board #2)*
R11-300K	RA1
R12-100K	RA9
R13-75K	RA13
R14-100K	RB1
R15-100K	RB9
R16-49K9	RB13
R17-100	RA14
R18-100	RB14
C5-100N	C3 (bypass cap for U3)
C6-100N	C4 (bypass cap for U3)
jumper	CA1, middle and bottom holes
jumper	TA2, middle to ground hole (at immediate left)
jumper	CB1, middle and top holes
jumper	TA2, middle to ground hole (at immediate left)
jumper	CA3 (bottom hole) to JB1 (right hole)

5.3. Power Connections

Run three power lines (+/-15V and ground) from board #1 to board #2. Make sure you tap the +/-15V lines on board #1 after the ferrite beads (where they connect to the two 10uF caps). I recommend using the V+ and V- pads, the holes are too small for #18 wire, but you should be able to fit #22 wire in them. On board #2, connect these +/-15V lines to the V+ and V- pads. There are lots of unused ground connections on the MUUB boards (e.g. the square holes for JA1-8, JB1-8, JC1-8, JD1-8). Pick ones that are close to the power supply connection points and run a ground wire from board #1 to board #2.

Future versions of the MUUB boards will have larger holes specifically for chaining power supply connections between boards.

If you're building a dual TLN-863, you'll need to supply power to both circuits. A simple way to do this is to use a pass-thru MTA-156 connector. This connector can be installed on an existing MOTM power cable to provide two outlets from one cable.

5.4. Panel Wiring

Use coaxial cable to hook up the jacks and 3 of the switch wires (see table below). You don't need coax cable for the pots or the other 3 switch wires. One of the switch connections is daisy chained to the switching lug of the input jacks (J1-J3). The coax connection for jacks is connected to ground at both the jack and on the PCB. The coax connection for the switch is connected to ground only at the PCB. The square holes on the PCB for the input and output connections (JA1-9, JB1-9, JC1-9, JD1-9) are ground. The lengths given below are the ones I used to build the dual TLN-863. The first number is for the B channel (mounted first), the second number is for the A channel.

Panel Item	*PCB connection*	*Length (inches)*
VR1 pins 1,2,3 (THRESH pot)	board #2, pin 1 (right pin) to V+ power connections (+15V), pin 2 (middle pin) to JA1 (right hole), pin 3 (left pin) to V– power connections (–15V)	6 (B) and 6 (A) (3 wires twisted, not coax)
SW1, pin 1 (top left pin)	board #2, JB9 (right hole)	4.5 (B) and 4.5 (A) (single wire)
SW1, pin 2 (middle left pin)	connect to switching lug of J1 (IN 1)	1.5 (B) and 1.5 (A) (single wire)
SW1, pin 3 (bottom left pin)	board #2, JA9 (right hole)	4.5 (B) and 4.5 (A) (single wire)
SW1, pin 4 (top right pin)	board #1, JB4	3.5 (B) and 5.5 (A) (coax)
SW1, pin 5 (middle right pin)	board #1, JA2	3.5 (B) and 4.5 (A) (coax)
SW1, pin 6 (bottom right pin)	board #1, JA9	3.5 (B) and 5.5 (A) (coax)
J2 switching lug	connect to J1 switching lug	1.5 (B) and 1.5 (A) (single wire)
J3 switching lug	connect to J2 switching lug	1.5 (B) and 1.5 (A) (single wire)
J1 (IN 1)	board #1, JC5	6 (B) and 5 (A) (coax)
J2 (IN 2)	board #1, JD5	6 (B) and 5 (A) (coax)
J3 (IN 3)	board #1, JA5	7 (B) and 3 (A) (coax)
J4 (OUT)	board #1, JB9	7 (B) and 3 (A) (coax)

6. Testing

You'll need an oscillator and an oscilloscope to fully test the circuit. If you don't have an oscilloscope you can still test by listening to the output signal.

Patch a 10Vpp triangle wave oscillator to the IN 1 jack, set the MODE to MAX and turn the THRESH control fully counter clockwise (CCW). Connect your oscilloscope channel 1 to the oscillator and trigger from that. Connect channel 2 of your oscilloscope to the OUT jack.

With the THRESH control fully CCW, the output signal should be identical to the input signal. Gradually turn the THRESH control clockwise and observe that the bottom of the triangle wave is being removed (clamped). As the THRESH control is turned fully CW there should be little or no triangle wave left, just a +5V DC signal (and silence if you are listening to the output).

Return the THRESH control to the fully CCW position and set the MODE to MIN. The output signal should be identical to the input signal. Gradually turn the THRESH control clockwise and observe that the top of the triangle wave is being removed (clipped). As the THRESH control is turned fully CW there should be little or no triangle wave left, just a –5V DC signal (and silence if you are listening to the output).

Repeat the above two tests for the other two inputs.

TLN-863 Parts List

This bill of materials (BOM) is for building one instance of the TLN-863. If you are building a dual version, you must double all of these parts (except for the panel and brackets).

Resistors (18)

Quantity	*Description*	*Part No.*	*Notes*
2	100	R17, R18	5% or better, Mouser #291-100-RC
1	470	R9	5% or better, Mouser #291-470-RC
3	10 K	R2, R4, R6	5% or better, Mouser #291-10K-RC
1	47K	R10	5% or better, Mouser #291-47K-RC
2	100 K	R7, R8	5% or better, Mouser #291-100K-RC
3	470 K	R1, R3, R5	5% or better, Mouser #291-470K-RC
1	49.9 K	R16	1%, Mouser #271-49.9K-RC
3	100 K	R12, R14, R15	1%, Mouser #271-100K-RC
1	75 K	R13	1%, Mouser #271-75K-RC
1	300 K	R11	1%, Mouser #271-300K-RC

Capacitors (10)

Quantity	*Description*	*Part No.*	*Notes*
2	1N poly	C9, C10	Mouser #581-BF014D0102J
6	100N ceramic	C1 – C6	Mouser #147-72-104-RC Mouser #581-SA105E104MAR
2	10 uF 35V elec.	C7, C8	Mouser #140-XRL35V10-RC (35V)

Semiconductors (9)

Quantity	*Description*	*Part No.*	*Notes*
2	TL072 dual op amp	U1 – U2	Allied #735-2727 Mouser #595-TL072CP Digikey #296-1775-5-ND
1	MXL1013 (or LT1013) dual op amp (can substitute TL072)	U3	Digkey #ADG419BN-ND Allied #630-5019 Mouser #595-LT1013CP
6	1N4148 diode (can substitute 1N914)	D1 – D6	Allied #263-1538 Mouser #512-1N4148 Digkey #1N4148FS-ND

Potentiometers & Trimmers (1)

Quantity	*Description*	*Part No.*	*Notes*
1	100 K linear pot	VR1	Spectrol 149 series, Allied #970-1791, or Bournes 91 series, Allied #754-9420

Miscellaneous

Quantity	*Description*	*Part No.*	*Notes*
4	phone jack Switchcraft 112A	J1 – J4	Allied #932-9391 Mouser #502-112AX
3	8 pin DIP socket		for U1 – U3
2	axial ferrite bead	L1, L2	Active #MURJP2141

			Mouser #623-2743002112LF
1	DPDT switch, NKK M2022ES1W01	SW1	Allied #870-8652 Mouser # 633-M202202-RO
1	MTA-156 4 pin header	JP1	Mouser #571-6404454 Digikey #A1973-ND

Hardware

Quantity	*Description*	*Notes*
1	knob ALCO PKES60B1/4	Mouser #506-PKES60B1/4 (not the same size as MOTM knobs, this is the smaller knob found on Encore's UEG and Frequency Shifter, Radio Shack has a knob that looks almost identical to this)
1	TLN-863 panel	front panel
1	MUUB-4	printed circuit board
1	MUUB-2	printed circuit board
2	2 jack modular bracket	Stooge bracket
1	flat plate modular bracket	Stooge bracket
	#6-32 screws (1/4", ½", ¾", 1") spacers (1/4", 3/8") #6-32 nuts #6-32 lock washers	Mouser part numbers: 534-405, 534-407 (spacers) 5721-632-1/4, 5721-632-1/2, 5721-632-3/4 (screws) 5721-632 (nuts), 5721-LWI-6 (lockwashers) (for mounting main circuit boards to Stooge bracket)
	pot nut	Mouser #534-1456 (for mounting Stooge bracket to front panel)
1	MTA-156 power cable	Mouser #571-6404264 (connector) Mouser #571-6405514 (dust cover)
1	MTA-156 4 pin pass-thru	Mouser #571-6405994 (connector) Mouser #571-6406434 (dust cover) (optional, for supplying power to two TLN-863s using one power cable)
4	#8-32 black screw	(for mounting module to cabinet)
	cable ties	
	coax cable (RG174/U)	Mouser #566-8216-100 (100 foot spool)
	hookup wire	
	solder	both organic and no clean