The Tellun Corporation

TLN-865 Trigger Extractor & Window Comparator

User Guide, Rev. 1.0

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1. Introduction

The TLN-865 Trigger Extractor & Window Comparator is an adaptation of a window comparator from Jung's Op-Amp Cookbook. This circuit can also function as a trigger extractor. A window comparator produces an output that is high if the input signal is greater than the lower threshold and less than the upper threshold. Otherwise the output is low. In other words:

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If ( In > Lower_Threshold ) and ( In < Upper_Threshold )
  Out = High
else
  Out = Low
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The TLN-865 uses a center point and both high and low offsets from the center point to define the Lower_Threshold and Upper_Threshold. These CENTER, HIGH, and LOW voltages can all be set manually using front panel controls, or via external control voltages. Reversing attenuators are used for the input signal as well as the center, low offset, and high offset signals.

When the MODE switch is set to COMP, the circuit operates as a window comparator with the OUT 1 signal going from 0V to +13.5V whenever the input signal is within the upper and lower threshold. When the MODE switch is set to TRIG, the circuit operates as a trigger extractor that senses abrupt changes in the input signal. The threshold level can be set individually for both upwards and downwards changes using the HIGH and LOW controls. When the circuit senses an abrupt change in the input signal that exceeds these thresholds, it will output a brief pulse.

An inverted version of the OUT 1 signal (from +13.5V to 0V) is provided at the OUT 2 jack.

The panel controls are as follows:

- IN: reversing attenuator for input signal (normalled to +5V reference).
- CENTER: reversing attenuator for CENTER input (normalled to +5V reference) sets the center point for the window comparator.
- HIGH: reversing attenuator for HIGH input (normalled to +5V reference), sets the upper threshold offset from center for the window comparator, sets the trigger extractor sensitivity for rising voltages.
- LOW: reversing attenuator for LOW input (normalled to +5V reference), sets the lower threshold offset from center for the window comparator, sets the trigger extractor sensitivity for falling voltages.
- MODE: selects either trigger extractor or window comparator mode.
- LED: indicates if the output is high or low.

2. Circuit Description

U5 is the heart of this circuit. The two op-amps and diodes D1-D2 are a classic window comparator with inverted output. The output from U5b goes high whenever the input voltage (on pin 5) is greater than the HIGH reference voltage (on pin 6). The output from U5a goes high whenever the input voltage (on pin 2) is less than the LOW reference voltage (on pin 3). The two diodes perform a logical OR operation on the op-amp outputs producing a voltage that is a logical zero whenever the input voltage is between the LOW and HIGH reference voltages. Q1 is a simple inverter, thus the OUT 1 signal is +13.5V when the input voltage is between the LOW and HIGH reference voltages and zero volts otherwise. Q2 is another inverter so that OUT 2 is the inversion of OUT 1. U2b is a simple LED driver to provide a visual indication of the high or low state of the outputs.

The remainder of the circuitry consists of several reversing attenuators. An on-board +5V reference is normalled to the switching lug of jacks J1-J4 so that a constant value from –5V to +5V can be dialed in with VR1-VR4 when nothing is plugged into the corresponding jacks.

The reversing attenuator for the IN input is built around U1. U1a inverts the signal present at J1 (IN) and VR1 (IN) selects the amount of inverted or non-inverted signal sent to the rest of the circuit. The output from VR1 (the centre pin of VR1) is inverted again by U1b before being passed to the window comparator U5.

The reversing attenuator for the HIGH input is built around U3 and is similar to the IN input except that U3b also adds either the inverted or non-inverted CENTER input (from U2a and VR2) to the HIGH input. Thus the output from U3b, which forms the HIGH reference for the window comparator, is HIGH + CENTER.

The reversing attenuator for the LOW input is built around U4 and is identical to the HIGH input in that it also adds either the inverted or non-inverted CENTER input (from U2a and VR2). Thus the output from U4b, which forms the LOW reference for the window comparator, is LOW + CENTER.

Switch SW1 makes the following changes to the circuit. In Window Comparator mode, all reversing attenuators have unity gain (from –1 to +1) and capacitor C15 is inactive (i.e. not of any significance to the circuit operation) and the circuit functions as a window comparator where the OUT 1 goes high whenever IN is higher than CENTER+LOW and lower than CENTER+HIGH.

In Trigger Extractor mode, capacitor C15 is active and forms a differentiator along with R26. The voltage across a capacitor cannot change instantaneously, thus any abrupt change at the output of U1b results in a sudden change in voltage to the comparator input (U5 pins 2 and 5) that discharges via R26. Therefore the comparator input only sees a short “blip” whenever the input changes. The height of the blip depends on how quickly the input changes and on how much the voltage changes. The HIGH and LOW reference voltages (U5 pins 6 and 3) determine how large the blip needs to be in order for the

comparator to change state. The HIGH and LOW inputs determine the sensitivity to rising and falling voltages respectively. Putting all of this together, the output is a short pulse (or trigger) that occurs whenever there is a sudden voltage change at the IN input. Also, in Trigger Extractor mode, resistors R13 and R24 are switched into the feedback loops of U3b and U4b to lower their gain substantially. This is necessary so that the HIGH and LOW attenuators will be useful over their full range; the pulses from the differentiator are very low amplitude and with U3b and U4b at unity gain, the controls would only be useful over 5% of their rotation.

Note that no hysteresis is used in this circuit. Hysteresis works fine for the window comparator, but it kills the trigger extractor.

The +5V reference is constructed from a 78L05 regulator (U6). To avoid the possibility of momentarily shorting the regulator output to ground when a jack is inserted into J1-J4, a protection resistor (R40) is inserted between the regulator output and the switching lugs.

C11 and C12 are power supply bypass caps. Normally these would each be 22 uF caps if the circuit is being built on one monolithic PCB. When building this circuit onto MUUBs, I recommend breaking each of these caps into dual 10 uF caps and placing them onto separate circuit boards. See the section on MUUB construction for more details. If you are using a different circuit board, then there's no need to split C11 and C12.

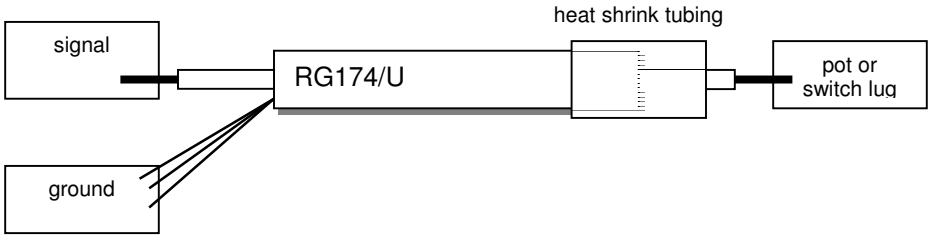
3. Construction Tips

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

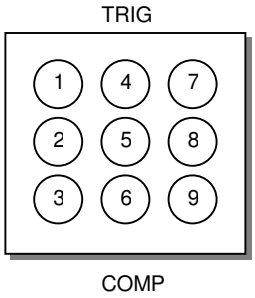
If you use Bourns or Spectrol pots with the Alco PKES60 knobs, you might want to trim 1/8" off the end of the pot shafts to get the knobs to sit closer to the panel. I did not do this for the TLN-865 seen in the website pictures.

The Lumex bicolour LED was difficult to buy in small quantities at one time. I bought some from Synthesis Technologies and they came with red and black wires already attached. The schematic shows which wire connects to R33 and which connects to ground so that the red LED is lit when OUT 1 is low and the green LED is lit OUT 1 is high. Reverse these two wires if you want the opposite colour scheme.

Use coax cable for the jack, switch, and pot connections. The TLN-865 can be used with audio signals, so it's a good idea to use coax cable to keep noise out of the circuit (especially since no hysteresis is used). When hooking up coax between the PCB and pots or 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.



SW1 is a 3PDT switch (with nine pins in total) that should be connected to the PCB with coax cable. The nine pins of SW1 are labeled on the schematic. Use the drawing below to match the switch pins to the correct locations on the PCB. Note that pins 1 and 4 are connected to ground. Connect the shield from the coax cables (that are connected to pins 2 and 5) to pins 1 and 4. Make sure the shield is also connected to ground at the PCB. In other words, DON'T clip the shield from both ends of the coax for the two wires that connect to pins 2 and 5 of SW1.



Switch viewed from behind (pins facing toward you). With switch in the up position (Trigger Mode) pins 2 and 3 are connected, pins 5 and 6 are connected, and pins 8 and 9 are connected.

For VR1-VR4, 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.

For the 78L05 regulator, the pin out is (left to right): 3, 2, 1 when viewing the front of the regulator (flat side facing you) with the leads facing down. These pins are labeled on the schematic.

4. Modifications

C15, R13, and R24 determine the circuit sensitivity in Trigger Extractor mode. C15 can be increased to provide wider trigger pulses, or lowered to provide narrower trigger pulses. But increasing C15 lowers the number of triggers/second that the circuit can respond to. R13 and R24 can be lowered to give more control for setting the sensitivity to small changes at the input. The values chosen for these components should suffice for most situations.

Hysteresis can be added to Window Comparator mode. This will require a DPDT switch to add a 1M resistor between pins 5 and 7 of U5 and another 1M resistor between pins 1 and 3 of U5. You will need to turn hysteresis off when operating in Trigger Extractor mode.

Resistor R31 produces a small voltage drop (around 10 mV) on the +5V reference. You can lower this resistor value a bit to reduce the voltage drop if it bothers you. Just be careful that you don't short out the switching lug for too long if you use a lower resistor value.

You don't have to use a bicolour LED. You can use two LEDs in parallel, or just one LED.

5. Building the Switching Comparator with MUUBs

Be sure to check out the construction pictures on the website. Most of what I try to describe below can best be understood just by looking at the pictures.

You'll need two MUUB-4s and one MUUB-2 to build the TLN-864. If you look at the pictures on the website, you'll see the three boards mounted on the stooge brackets (from top to bottom):

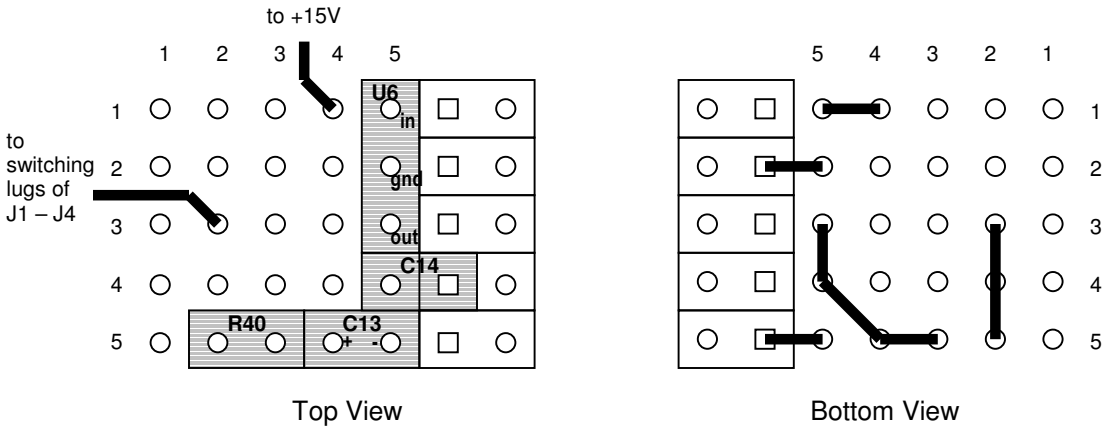
MUUB-4, board #1: U1, U2, +5V reference, power connector
MUUB-2, board #3: U5, transistor inverters
MUUB-4, board #2: U3, U4

I built the TLN-865 with Stooge modular brackets and a Stooge compatible 1U wide panel (a prototype panel made from plexiglass). 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 shown on the website, 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 HIGH pot and the LOW/OUT 2 jacks), 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 LOW/OUT 2 jacks.

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 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.

5.1. Building Board #1 (MUUB-4)

This board has an additional bit of circuitry to construct in the lower left corner for the +5V reference. Study the schematic, the pictures on the website, and the drawing below to see how I fit C13, C14, R40, and U6 into that small square of 25 holes. Use the square holes of JD4-JD8 for ground connections. Bend the leads of the components on the underside of the PCB to connect everything up. The centre pin of U6 connects to ground using the square hole of JD5. You will need one small wire to jumper U6 pin 1 to the +15V supply (the holes labeled V+ on the PCB). This is the small red wire in the website pictures. Place this wire in the hole to the left of U6 pin 1 (regulator in), then bend it underneath the PCB so that it touches U6 pin 1. Another wire will eventually connect to the switching lugs of jacks J1-J4 from R40 (+5V REF).



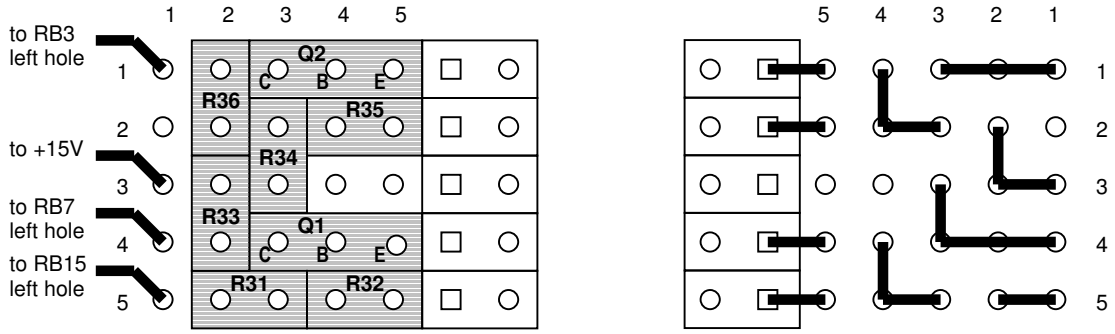
This circuit board also contains the power supply connector (MTA-156), two ferrite beads (L1-L2), and two 10 uF caps (C11a and C12a). Power and ground will be supplied to the other two MUUBs by running wires from this board to the other boards. C11b and C12b will be installed on board #2 (MUUB-4).

Use the following table to place components from the TLN-865 schematic onto board #1. For short jumpers, use a scrap resistor lead. For longer jumpers, use a piece of #22 wire. Check the website pictures.

Schematic	*MUUB-4 Location (board #1)*
R1-100K	RA1
R2-100K	RA9
R3-49K9	RA13
R4-100K	RB1
R5-100K	RB9
R6-49K9	RB13
R15-100K	RC1
R16-100K	RC9
R17-49K9	RC13
R26-100K	RB15
R37-1K2	RD14
R38-100K	RD11
R39-100K	RD1
C1-100N	C3 (bypass cap for U1)
C2-100N	C4 (bypass cap for U1)
C3-100N	C5 (bypass cap for U2)
C4-100N	C6 (bypass cap for U2)
C11a-10M	C1 (power supply bypass cap)
C12a-10M	C2 (power supply bypass cap)
C15-100N	RB14
L1	L1 (ferrite bead)
L2	L2 (ferrite bead)
JP1	MTA-156 power connector
jumper	RA14
jumper	CA1, middle and bottom holes
jumper	TA2, middle to ground hole (at immediate left)
jumper	CB1, middle and top holes
jumper	TB2, middle to ground hole (at immediate left)
jumper	RC14
jumper	CC1, middle and bottom holes
jumper	TC2, middle to ground hole (at immediate left)
jumper	JD1
jumper	TD1, middle and bottom (+) holes
jumper	CD1, middle and top holes

5.2. Building Board #3 (MUUB-2)

This board has an additional bit of circuitry to construct in the lower left corner for the transistor inverters. Study the schematic, the pictures on the website, and the drawings below to see how I fit these into that small square of 25 holes. Use the square holes of JB4-JB8 for ground connections. Bend the leads of the components on the underside of the PCB to connect everything up. You will need one small wire to jumper to the +15V supply (the holes labeled V+ on the PCB). This is the small red wire in the website pictures. You will also need to run a jumper from the comparator output (RB15 left hole) to the first inverter's input, and two more for the inverter outputs (to RB7 left hole for OUT 1, and RB3 left hole for OUT 2).



Top View Bottom View

Use the following table to place components from the TLN-865 schematic onto board #3. For short jumpers, use a scrap resistor lead. For longer jumpers, use a piece of #22 wire. Watch the orientation of the diodes; the circuit won't work if you put them in backwards. Check the website pictures.

Schematic	*MUUB-2 Location (board #3)*
R27-10K	RB1
R28-10K	RB5
R29-10K	RA1
R30-10K	RA5
C9-100N	C3 (bypass cap for U5)
C10-100N	C4 (bypass cap for U5)
D1-1N4148	RB14, cathode (band) to the left
D2-1N4148	RA14, cathode (band) to the left
jumper	CA1, middle and bottom holes
jumper	CA2, middle and bottom holes
jumper	CB1, top and middle holes
jumper	CB2, top and middle holes
jumper	CA4 bottom hole to CB4 top hole
jumper	JA2 right hole to JB5 right hole, leave a long enough piece of wire exposed at the JA2 end so you can bend it on the underside of the PCB such that JA2 (right hole) is connected to JA1 (right hole), a coax wire will eventually go into JA1 so don't plug the hole with solder just yet

5.3. Building Board #2 (MUUB-4)

This circuit board contains the remaining two 10 uF caps (C11b and C12b) for power supply bypassing.

Use the following table to place components from the TLN-865 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-4 Location (board #2)*
R7-100K	RA1
R8-100K	RA9
R9-49K9	RA13
R10-100K	RB1
R11-100K	RB9
R12-3K9	RB13
R13-4K7	RB10
R14-100K	RB2
R18-100K	RC1
R19-100K	RC9
R20-49K9	RC13
R21-100K	RD1
R22-100K	RD9
R23-3K9	RD13
R24-4K7	RD10
R25-100K	RD2
C5-100N	C5 (bypass cap for U3)
C6-100N	C6 (bypass cap for U3)
C7-100N	C7 (bypass cap for U4)
C8-100N	C8 (bypass cap for U4)
C11b-10M	C1 (power supply bypass cap)
C12b-10M	C2 (power supply bypass cap)
jumper	CA1, middle and bottom holes
jumper	RA14
jumper	TA2, middle to ground hole (at immediate left)
jumper	CB1, middle and top holes
jumper	TB2, middle to ground hole (at immediate left)
jumper	CC1, middle and bottom holes
jumper	RC14
jumper	TC2, middle to ground hole (at immediate left)
jumper	CD1, middle and top holes
jumper	TD2, middle to ground hole (at immediate left)
jumper	JB3 right hole to JD2 right hole, leave a long enough piece of wire exposed at the JB3 end so you can bend it on the underside of the PCB such that JB2 (right hole) is connected to JB3 (right hole), a coax wire will eventually go into JB2 so don't plug the hole with solder just yet

5.4. Power Connections

Run three power lines (+/-15V and ground) from board #1 to board #2 and from board #1 to board #3. 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 boards #2 and #3, 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 and from board #1 to board #3. Avoid the urge to daisy chain the power supply lines from board to board. Maintain a star connection by connecting boards #2 and #3 directly to board #1.

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

5.5. Board to Board Wiring

There are several wires that need to be hooked up between the MUUB boards. Use the table below to hook up these wires. I recommend using coax for these connections unless noted otherwise. Connect the coax shield at one end only (as noted below).

Board # and Location	*Board # and Location*	*Length (inches)*
board #1, JB9 (right hole, do not connect shield at this end)	board #3, JA1, connect shield at this end	3.5 (coax)
board #1, RD13 (left hole)	board #3, RA15 (left hole)	1 (single wire)
board #2, RB14 (right hole, do not connect shield at this end)	board #3, JB1, connect shield at this end	5.5 (coax)
board #2, RD14 (right hole, do not connect shield at this end)	board #3, JA5, connect shield at this end	5 (coax)

5.6. Panel Wiring

Use coaxial cable to hook up the jacks, pots, and switch. You don't need coax cable for the LED or the +5V reference. The coax connection for jacks is connected to ground at both the jack and on the PCB. The coax connection for pots and switches 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. To minimize wiring between panel components, most panel connections are brought back to the PCB. There are plenty of unused holes on the PCB that are used as anchor points to tie two coax connections together. When applicable, bend the centre wire of the coax connection underneath the PCB to connect to the adjacent hole as indicated in the table below.

Panel Item	*PCB connection*	*Length (inches)*
LED	board #1, black wire in JD9 left hole, red wire in JD9 right hole	5 (twisted pair)
J1-J4 switching lug	board #1, +5V reference (R40), daisy chain the switching lugs of J1-J4 together then run one wire from J3's switching lug back to the PCB	7 (single wire)
VR1, pin 1 IN	board #1, JA2, bend wire in right hole underneath PCB to connect to right hole of JA1	4 (coax)
VR1, pin 2 IN	board #1, JB1	4 (coax)
VR1, pin 3 IN	board #1, JA9	3.5 (coax)
VR2, pin 1 CENTER	board #1, JC2, bend wire in right hole underneath PCB to connect to right hole of JC1	5.5 (coax)
VR2, pin 2 CENTER	board #2, JB2	6 (coax)
VR2, pin 3 CENTER	board #1, JC9	5.5 (coax)

VR3, pin 1 HIGH	board #2, JA2, bend wire in right hole underneath PCB to connect to right hole of JA1	6 (coax)
VR3, pin 2 HIGH	board #2, JB1	6.5 (coax)
VR3, pin 3 HIGH	board #2, JA9	5.5 (coax)
VR4, pin 1 LOW	board #2, JC2, bend wire in right hole underneath PCB to connect to right hole of JC1	5.5 (coax)
VR4, pin 2 LOW	board #2, JD1	6 (coax)
VR4, pin 3 LOW	board #2, JC9	5 (coax)
J1, signal lug IN	board #1, JA1	5 (coax)
J2, signal lug CENTER	board #1, JC1	7 (coax)
J3, signal lug HIGH	board #2, JA1	4 (coax)
J4, signal lug LOW	board #2, JC1	5 (coax)
J5, signal lug OUT 1	board #3, JB7	6 (coax)
J6, signal lug OUT 2	board #3, JB3	6 (coax)
SW1, pin 1	connect to ground via shield on coax cable connected to SW1 pin 2	
SW1, pin 2	board #2, JB9, left hole is ground connection, the shield from SW1 pin 2 and SW1 pin 3 both need to connect to the left hole of JB9	4 (coax) with shield connected at PCB and to SW1 pin 1
SW1, pin 3	board #2, signal (center wire) connects to CB3 (top hole), shield connects to JB9 (left hole), the shield from SW1 pin 2 and SW1 pin 3 both need to connect to the left hole of JB9	4 (coax)
SW1, pin 4	connect to ground via shield on coax cable connected to SW1 pin 5	
SW1, pin 5	board #2, JD9, left hole is ground connection, the shield from SW1 pin 4 and SW1 pin 5 both need to connect to the left hole of JD9	5.5 (coax) with shield connected at PCB and to SW1 pin 4
SW1, pin 6	board #2, signal (center wire) connects to CD3 (top hole), shield connects to JD9 (left hole), the shield from SW1 pin 4 and SW1 pin 5 both need to connect to the left hole of JD9	5.5 (coax)
SW1, pin 7	board #1, signal (center wire) connects to CB3 (top hole), shield connects to JB9 (left hole)	4 (coax)
SW1, pin 8	board #1, signal (center wire) connects to CB4 (top hole), shield connects to CB4 (middle hole)	4 (coax)

Run one wire from the +5V reference (which is after R40) to the switching lug of J3 (HIGH), then daisy chain three 2" jumpers to the switching lugs of J1, J2, and J4 (IN, CENTER, and LOW). This is the only wiring that goes between panel components. All other wires go from panel components to the PCBs.

6. Testing

Below are some simple test procedures you can use to get acquainted with the TLN-865. Note the following notation conventions for the four panel pots:

- fully clockwise (5 o'clock) is +5
- straight up (12 o'clock) is 0
- fully counter clockwise (7 o'clock) is -5

6.1. Basic Window Comparator

Create a simple patch on your synthesizer with an LFO (MOTM 320) patched into the FM input of an oscillator (MOTM 300 or 310). Use a rising (or falling) sawtooth wave on the LFO with a rate of several seconds per period and set the FM sensitivity so that you can hear at least an octave of pitch bend. The sawtooth wave must cover the range –5V to +5V over one cycle. Patch the LFO to the IN jack of the TLN-865. Patch OUT 1 of the TLN-865 to the GATE input of an envelope generator (EG). Patch the oscillator output to a filter's audio input and patch the EG output to the filter's FM input. Set the filter and EG so that you can hear the oscillator at all times but when the EG fires the filter will open up to let a lot more of the signal pass through. Set the EG to full sustain, zero attack, zero decay, zero release.

Set the TLN-865 panel controls as follows: MODE = COMP, IN = +5, CENTER = 0, HIGH = +1, LOW = –1. This creates a window with a 2V width centered at 0V with the upper threshold at +1V and the lower threshold at –1V. As the LFO waves passes through this window, the LED should change from red to green and the EG should fire. Turn the CENTER control clockwise and note how the EG now fires when the LFO voltage is nearer the top of its range. At the most clockwise setting, the upper threshold for the window is +6V and the lower threshold is +4V. Since the sawtooth wave only goes as high as +5V, the EG will only fire for half the time that it did when the CENTER control was at zero. Turn the CENTER control counter-clockwise past the mid point and note how the EG now fires when the LFO voltage is nearer the bottom of its range. At the most counter-clockwise setting, the upper threshold for the window is –4V and the lower threshold is –6V. Again, since the sawtooth wave only goes as low as –5V, the EG will only fire for half the time that it did when the CENTER control was at zero.

Return the CENTER control to the mid point (zero). Slowly turn the LOW control clockwise. Note how the window width becomes narrower until it disappears altogether once LOW is greater than HIGH.

Return the LOW control to –1. Slowly turn the IN control counter-clockwise to the +2 position. Note how the window width appears to increase due to the reduced range of the input signal (rather than being –5V to +5V, it's now only –2V to +2V). Turn the IN control to zero and the EG should be on all the time. Continue turning the IN control counter-clockwise to the –5 position. The input is now at full strength but inverted. Turn the CENTER control clockwise then counter-clockwise and note that the window center

moves in the opposite direction compared to before (i.e. the window moves to the lower part of the sawtooth wave when CENTER is turned clockwise).

Things to keep in mind about the window comparator:

- OUT 2 is the inversion of OUT 1, so patching OUT 2 to an EG's gate input will cause the EG to fire whenever the IN signal is outside of the window, rather than inside the window.
- The CENTER, HIGH, and LOW set points are all voltage controllable. Instead of setting a fixed window, use an LFO, EG, or S&H to modulate the set points.
- The window width is the difference between the CENTER+LOW signal and the CENTER+HIGH signal. Therefore, the LOW signal has to be more negative than the HIGH signal otherwise the window width will be zero. If the window width is zero, OUT 1 will always be low, and OUT 2 will always be high.

6.2. Basic Trigger Extractor

Create a simple patch using an oscillator into a filter and an envelope generator (EG) controlling the filter frequency. Set the EG to zero sustain, zero attack, ½ second decay, ½ second release. Set up a simple sequence that alternates between a base note and notes that are between one tone and one octave above the base note (e.g. C-D-C-E-C-F-C-G). If you don't have a sequencer, use an UEG (from Encore Electronics), or some other module that can create a repeatable sequence of stepped voltages. At worst, you can use a CV keyboard, or a MIDI keyboard with a MIDI-to-CV module, and play the sequence manually. Patch the sequencer output into the oscillator's V/OCT input and to the IN jack of the TLN-865. Patch the OUT 2 jack from the TLN-865 to the EG's gate input. Make sure to use OUT 2, not OUT 1.

Set the TLN-865 panel controls as follows: MODE = TRIG, IN = 0, CENTER = 0, HIGH = +5, LOW = –5. As the sequence plays the EG should not fire on any note intervals. Slowly rotate the IN control clockwise. Around the +1 setting the EG should start firing on note intervals that are greater than a fifth. Continue to rotate the IN control clockwise, the note interval necessary to cause the EG to fire should become smaller and smaller. At the +5 setting, even semi-tones should result in a trigger.

Set the IN control to a very low value, between 0 and +1 such that no triggers are being generated while the sequence is played. Slowly turn the LOW control clockwise from –5 to –1. Triggers should start to be generated on downward intervals only. At first the intervals will have to be quite large, but as the LOW control gets closer to –1 even semi-tone downward intervals should result in a trigger.

Return the LOW control to the –5 position and slowly turn the HIGH control counter-clockwise from +5 to +1. Triggers should start to be generated on upward intervals only. At first the intervals will have to be quite large, but as the HIGH control gets closer to +1 even semi-tone upward intervals should result in a trigger.

Return the HIGH control to the +5 position and slowly turn the CENTER control count-clockwise from 0 to –5. Triggers should once again start to be generated on upward intervals. When the CENTER control is at –5, even semi-tone upward intervals should result in a trigger.

Return the CENTER control to 0 then slowly rotate it clockwise to the +5 position and notice how triggers are once again being generated on downward intervals. When the CENTER control is at +5, even semi-tone downward intervals should result in a trigger.

Repeat the above tests but this time set the IN control to negative values. You'll notice that everything will be the opposite: the HIGH control will set the sensitivity for downward intervals, and the LOW control will set the sensitivity for upward intervals.

Things to keep in mind about the trigger extractor:

- Expect to use OUT 2 rather than OUT 1. It is possible to set the controls so that triggers are generated from OUT 1, but in general you will find OUT 2 to be much more predictable.
- Sensitivity to upward and downward intervals is determined by the difference between the IN signal and the HIGH and LOW signals respectively. Since the CENTER signal is added to both HIGH and LOW, you should always begin with the CENTER control in the middle (zero) position. Set the IN and LOW controls to get the response you want for downward note intervals, then set the HIGH control to get the response you want for upward note intervals. The CENTER control can then be used to skew the sensitivity so that it becomes less sensitive to downward transitions and more sensitive to upward transitions, or vice versa.
- The CENTER, HIGH, and LOW set points are all voltage controllable. Instead of using a fixed sensitivity, use an LFO, EG, or S&H to modulate the sensitivity.
- Similar to the window comparator, the LOW signal has to be more negative than the HIGH signal otherwise no triggers will be generated.

TLN-865 Parts List

Resistors (40)

Quantity	*Description*	*Part No.*	*Notes*
2	1 K	R33, R36	5% or better, Mouser #291-1K-RC
1	1.2 K	R37	5% or better, Mouser #291-1.2K-RC
8	10 K	R27, R28, R29, R30, R31, R32, R34, R35	5% or better, Mouser #291-10K-RC
2	100 K	R38, R39	5% or better, Mouser #291-100K-RC
3	100	R40	1%, Mouser #271-100-RC
2	3.9 K	R12, R23	1%, Mouser #271-3.9K-RC
2	4.7 K	R13, R24	1%, Mouser #271-4.7K-RC
5	49.9 K	R3, R6, R9, R17, R20	1%, Mouser #271-49.9K-RC
17	100 K	R1, R2, R4, R5, R7, R8, R10, R11, R14, R15, R16, R18, R19, R21, R22, R25, R26	1%, Mouser #271-100K-RC

Capacitors (17)

Quantity	*Description*	*Part No.*	*Notes*
1	100N poly	C15	Mouser #581-BQ014D0104J
11	100N ceramic	C1 – C10, C14	Mouser #147-72-104-RC Mouser #581-SA105E104MAR
5	10 uF 35V elec.	C11a, C11b, C12a, C12b, C13	Mouser #140-XRL35V10-RC (35V)

Semiconductors (11)

Quantity	*Description*	*Part No.*	*Notes*
5	TL072 dual op amp	U1 – U5	Allied #735-2727 Mouser #595-TL072CP Digikey #296-1775-5-ND
2	1N4148 diode	D1, D2	Allied #263-1538 Mouser #512-1N4148 Digikey #1N4148FS-ND
1	LM78L05	U6	Mouser #511-L78L05ACZ
1	bicolour LED	LED1	Mouser #696-SSI-LXH387HGW
2	BC549B transistor (NPN)	Q1, Q2	Mouser #512-BC549B (can substitute BC550)

Potentiometers & Trimmers (4)

Quantity	*Description*	*Part No.*	*Notes*
4	100 K linear pot	VR1 – VR4	Spectrol 149 series, Allied #970-1791, or Bournes 91 series, Allied #754-9420

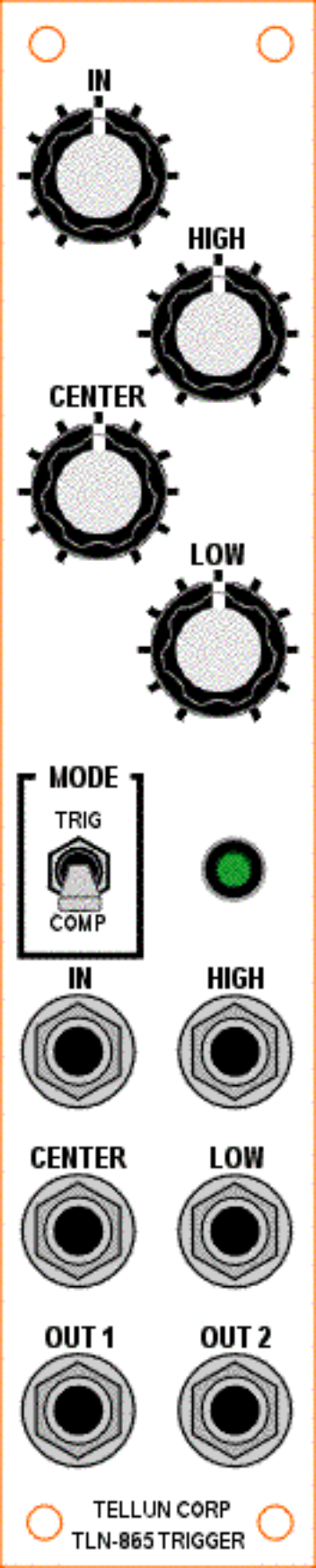
Miscellaneous

Quantity	*Description*	*Part No.*	*Notes*
6	phone jack Switchcraft 112A	J1 – J6	Allied #932-9391 Mouser #502-112AX
5	8 pin DIP socket		for U1 – U5
2	axial ferrite bead	L1, L2	Active #MURJP2141

			Mouser # 81-BL01RN1A1F1J Mouser #623-2743002112LF
1	3PDT switch, NKK M2032ES1W01	SW1	Digikey #360-1860-ND Mouser #633-M2032ES1W01-RO
1	MTA-156 4 pin header	JP1	Mouser #571-6404454 Digikey #A1973-ND

Hardware

Quantity	*Description*	*Notes*
4	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-865 panel	front panel
2	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)
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


IN
HIGH
CENTER
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IN
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CENTER
LOW
OUT 1
OUT 2
TELLUN CORP
TLN-865 TRIGGER