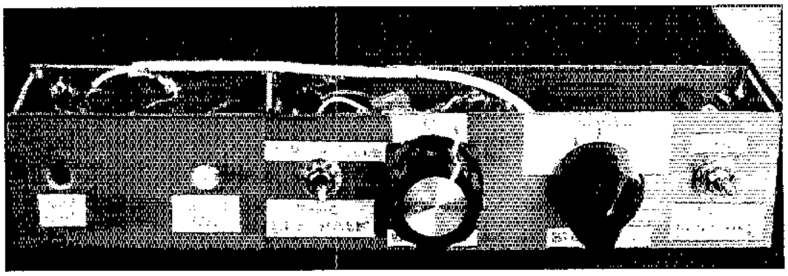
A Synchronous Detector for AM Transmissions

A "sync" detector far outshines diode detection for good amplitude-modulation reception. Here's one you can build—and all you need to align it is a digital voltmeter.



By Jukka Vermasvuori, OH2GF
Viputie 3
SF-01640 Vantaa
Finland

Do you relax or keep up on the news by listening to shortwave or long-distance mediumwave broadcasts? Are you frustrated by raucous distortion during fading minimums? This article describes how to build one solution to this problem: a simple, effective, 455-kHz *synchronous detector* for your transceiver or receiver. As a bonus, it adds basic CW/SSB reception to receivers unequipped to receive these signals.

Much like switching your receiver or transceiver to SSB and receiving AM as SSB, its carrier at zero beat, synchronous detection overcomes fading-related distortion by supplying an unfading carrier at the receiver. The difference between synchronous AM detection and such simple product detection is that synchronous detection *phase locks* its carrier to that of the incoming signal. There's no tuning error if the received signal happens to fall between your radio's tuning steps, and you don't have to correct for modest tuning drift. The result is a dramatic fidelity improvement over diode-detected AM. Enjoyable music audio is recoverable even from reduced-carrier SSB broadcasts.

The Synchronous Detector Circuit

See Fig 1. The unit uses popular NE602AN (mixer/oscillator) and NE604AN (FM subsystem) ICs to provide both synchronous and quasi-synchronous detection.[1] Operating at a supply voltage of 6, the circuit draws 10 mA. U1, an NE602AN, acts as the BFO and product detector necessary for synchronous detection. Feeding U1's balanced inputs in push-pull helps keep BFO energy from backing out of the input pins and into U3's limiting circuitry. To take advantage of the chip's internal biasing, the input transformer (T1) is isolated with dc blocking capacitors. (U1 also supplies balanced audio output, but usefully reducing this to a single-ended output would have required an operational amplifier. Doing so would reduce even-harmonic distortion in recovered audio, but would not, I decided, justify the increased circuit complexity and power consumption.)

This Synchronous Detector Circuit Affords:

- No signal-to-noise threshold. The incoming signal's IF signal-to-noise ratio is converted to audio as is—something not true of envelope and quasi-synchronous detectors.
- Suppression of overmodulation distortion during carrier fades because the strength of the locally generated BFO remains constant.
- Quality music reproduction with reduced-carrier SSB signals.
- Averaging effect against adjacent-channel splash, partially suppressing it in detection.
- Rejection of phase noise from transmitter and receiver synthesizers.
- Rejection, during reception of reduced-carrier SSB, of phase-modulated second-harmonic distortion and intermodulation-distortion products, therefore giving less distortion in detected audio than simple product detection.
- Rejection of spurious PM sidebands generated in conventional AM transmitters due to improper neutralization or antenna matching.
- Low harmonic distortion (below 1%) in audio recovery, independent of IF level.
- Low AGC-controlled IF input level, therefore needing less pre-IF amplification.—*OH2GF*

U1's oscillator amplitude is optimized to 660 mV P-P (as measured across L1) by the 220-Ω resistor at the oscillator output at pin 7. The BFO frequency is adjusted by two variable-capacitance diodes (D1 and D2) in addition to the tank coil, L1. D2 receives its control voltage via switch S3 (**BFO MODE**), which selects control voltage from either U3's phase detector (**SYNC**) or a constant voltage from a resistive divider (**CW/SSB/TUNE**).

The fixed **CW/SSB/TUNE** voltage (2.16, set by the ratio of R5 and R6) corresponds to the phase detector's optimum output voltage at lock.[2]

R2, **BFO TUNING**, drives D1 to provide manual detector tuning without upsetting D2's control-voltage optimization. S2, **BFO OFFSET**, presets R2's tuning range into the optimum regions for LSB (**−2 kHz**), DSB AM (**±0 kHz**) and USB (**+2 kHz**).[3] The **BFO TUNING** control therefore provides fine adjustment for detector lock around the receiver's tuning steps (coarse—1 kHz—in my receiver).

U3's phase detector requires a 90° phase shift between the incoming and reference phases to give the correct zero-phase output (again, approximately 2.16 V). The all-pass stage, Q1, operates as an isolation stage and adjustable phase shifter to generate the 90° phase shift.

U3 is an NE604N FM IF subsystem IC that contains limiting-amplifier stages (total gain, 101 dB) and a quadrature detector. Band limiting can be inserted between the limiter stages, but experiments with various RC and LC filters brought no improvement, and instead led to increased delay that upset the carrier/sideband phase relationships necessary for good quasi-synchronous detection. The Fig 1 circuit uses U3's quadrature detector as a phase detector that outputs control voltage for D2.

The most difficult aspect of the phase-

[1]Notes appear on page 33.

locking chain is the selection of a time constant for the locking loop. Signal fading, and the relative absence or presence of phase-modulation components in the transmitted signal, play important roles in detector lock. Were fading not a problem, a short time constant—one allowing fast locking—would suffice for DSB AM. For SSB AM with carrier (which includes a phase-modulation component at all modulation frequencies), however, and DSB AM with fading (during which a fast PLL may unlock on the sudden phase shifts that can accompany fast, deep carrier fades), a long time constant is necessary. Particularly for SSB with carrier, the loop bandwidth must be reduced to below the lowest expected modulation frequency. C1 and R4 set the PLL time constant in the Fig 1 circuit.

The received signal strength indicator (**RSSI**) output at pin 5 of U3 follows the input level logarithmically, giving an output of 1.1 V on noise only (**RF INPUT** shorted in Fig 1) and 3.3 V at an **RF INPUT** level of 3 mV. The **RSSI** output is adaptable as an AGC-detector output, making the NE604AN attractive for simple IF-AGC designs. Because of the NE604AN's high gain, circuit layout can be critical, requiring short leads and physically small bypass capacitors. Coupling must be minimized between pin 9 of U3 and the U1 oscillator components.

U2, an NE602AN, operates as a quasi-synchronous detector. The BFO energy it requires is readily available as a square wave at pin 9 of U3. Except for the fact that its BFO input is derived from a limited input signal instead of a VCO, U2 functions the same way as U1.

Construction

Two evaluation models were constructed using ground-plane construction, mounting the ICs upside down and soldering their ground pins directly to ground with minimal lead length. The later version is constructed onto a long, narrow piece of circuit board intended to be the bottom plate of an add-on box to be fixed under a Sangean ATS-808 receiver. (Fig 2 shows the general layout of this version.) The Sangean ATS-808 (sold under this and other names in the US, including the Radio Shack DX-380), is an "all-band" double-conversion superheterodyne receiver covering 150 kHz to 30 MHz and featuring two selectable IF bandwidths. Adding this outboard detector circuit also allows it to receive CW and SSB.

To avoid crosstalk, I made the receiver-detector IF-AF connections with small-diameter coaxial cable. With these precautions and circuitry arranged as shown in Fig 2, BFO-signal leakage is unmeasurable at U3; that is, the voltage at **RSSI** does not change when the BFO is temporarily disabled under no-signal conditions.

IF signal can be obtained from the ATS-808 via a 56-pF capacitor connected to the hot end of the '808's transformer T9 (at pin 16 of the '808's U1, a TA7758P IC).

Quasi-Synchronous Detection

Synchronous detection can be mimicked by amplifying and limiting the AM signal sufficiently (at IF) so that only carrier remains, and substituting this signal for the BFO at the product detector. This *quasi-synchronous detection* acts much like envelope ("diode") detection and works best when the received signal does not fall to zero, as can often occur with SSB and, with AM, during fading. As the signal fades and the carrier-to-noise (C/N) ratio decreases, noise renders the detector's switching action inconsistent, and detection quality deteriorates rapidly. Thus, under conditions of low C/N ratio, quasi-synchronous detection exhibits a distinct detection threshold, as does a diode detector. The chief advantage of quasi-synchronous detection over simple diode rectification is its much lower input level compared to that required by a diode. The detector circuit I present in this article includes a quasi-synchronous detector for flexibility and A/B comparison with the synchronous circuit.—*OH2GF*

Connecting the detector cable detunes T9, which, though difficult to reach, must be retuned by turning its slug outwards a few turns to obtain maximum audio output. The

Non-Phasing Synchronous Detection: The Better Way?

Amateur Radio transceivers generally select USB or LSB through intermediate-frequency (IF) filtering. Most consumer multiband radios with synchronous AM detectors use *phasing* synchronous detection in which audio-frequency (AF) and IF phasing are used to select the upper or lower signal sideband.*,† Such a system requires *two* synchronous detectors, one that responds to amplitude and another that responds to phase.

The phasing approach has two serious drawbacks. First, even though phasing detection can attenuate opposite-sideband *audio*, it cannot prevent opposite-sideband RF from driving IF-derived automatic gain control (AGC) circuitry and affecting receiver gain. The second drawback is that a phasing synchronous detector detects the phase noise sidebands of transmitted carriers and its receiver's local oscillator (LO) and converts them to audio. (The system's amplitude detector demodulates AM and no phase noise; the system's phase detector demodulates phase noise and quadrature AM. Demodulated phase noise is therefore present in their summed output.)

This problem is not trivial. International shortwave broadcasters are working on moving from full-carrier double sideband (DSB) to reduced-carrier SSB transmission by sometime next century. Received with the simple diode detectors long established for AM reception, reduced-carrier SSB may be unacceptably distorted.†† Synchronous detection would seem to solve this, but synchronous detection requires greater receiver stability and tuning accuracy than has ever been necessary with diode detection. PLL synthesis, now used in consumer shortwave receivers even in the US$100 to $200 range, is arguably the best means of achieving these aims economically. But PLL synthesizers economical enough for this service are generally so phase-noisy that they compromise phasing synchronous detection when it is applied. Despite this, most of the radios currently available with synchronous detection use phasing detectors!

Seeking to add a synchronous detector to my Sangean ATS-808 receiver, I therefore decided that a simple basic model—one that uses the receiver's IF filtering to reject the unwanted sideband—would give better overall quality. Whether the marketplace will arrive at the same conclusion remains to be seen!—*OH2GF*

*It follows, of course, that when only one sideband is transmitted, there's no opposite sideband to reject. Even if no other stations are using the frequencies represented by the absent sideband, opposite-sideband rejection is entirely worthwhile because it keeps us from receiving the band noise and static present in that slice of spectrum. When both sidebands are present, the ability to receive either of them at will lets us choose whichever of the two is least troubled by interference.—*Ed.*

†For a nonsynchronous, high-dynamic-range system embodying these principles, see R. Campbell, "High-Performance, Single-Signal Direct-Conversion Receivers," *QST*, Jan 1993, pp 32-40.

††The severity of the distortion depends on how much the carrier is reduced relative to its full-carrier value. Broadcasters intend to use SSB_{-12}—SSB with carrier enough for synchronous detection, but considerably less than that necessary for useful envelope detection. In practice, envelope-detected SSB_{-12} sounds like suppressed-carrier SSB received with the BFO turned off.—*Ed.*

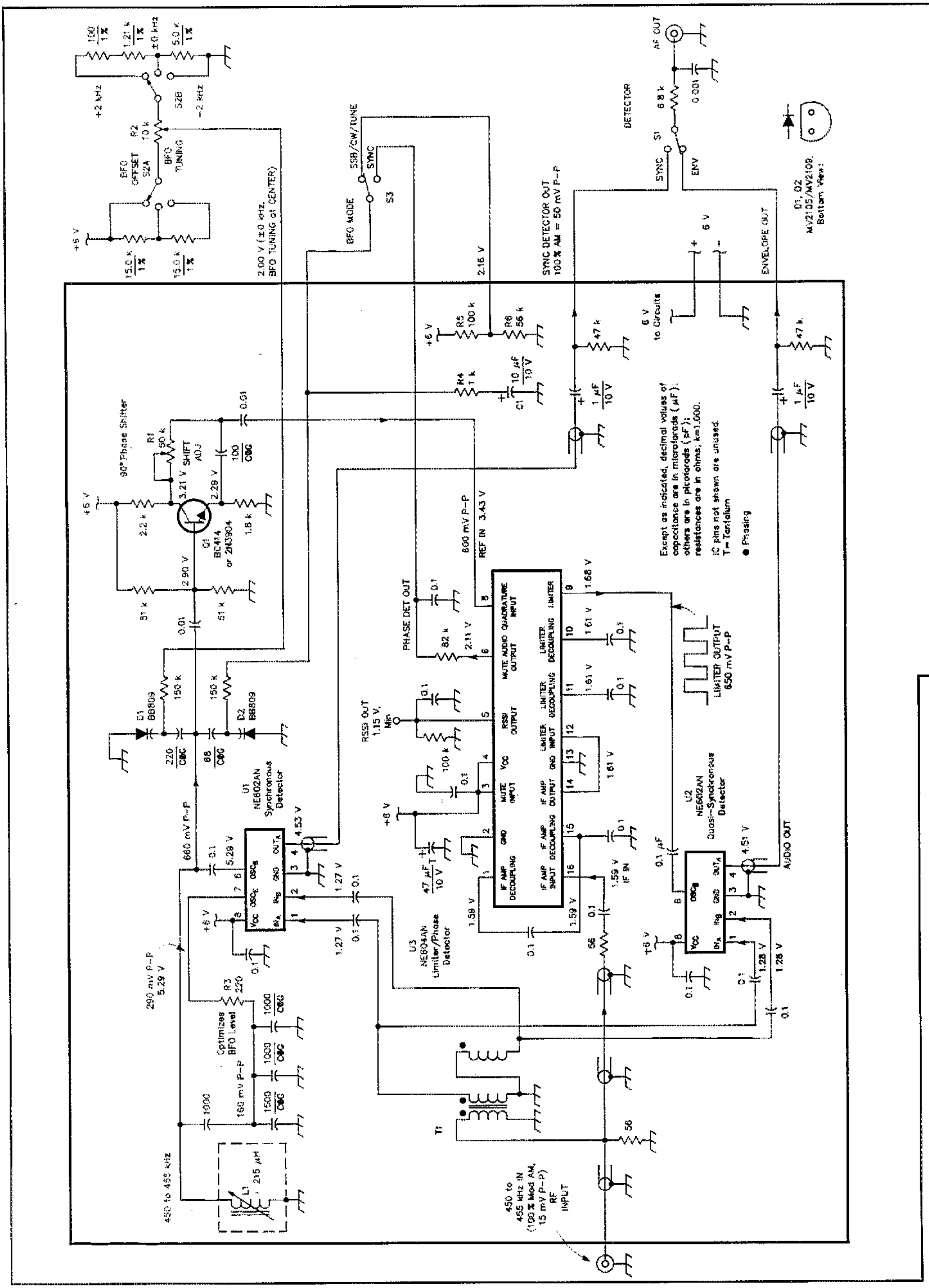

U1 NE602AN Synchronous Detector
U2 NE602AN Quasi-Synchronous Detector
U3 NE604AN Limiter/Phase Detector
90° Phase Shifter
R1 50 k SHIFT ADJ
Q1 BC414 or 2N3904
D1 BB809
D2 BB809
BFO OFFSET S2A
R2 10 k BFO TUNING
S2B
+2 kHz
−2 kHz
±0 kHz
BFO MODE
SSB/CW/TUNE
SYNC
S3
DETECTOR
S1
SYNC
ENV
AF OUT
2.00 V (±0 kHz, BFO TUNING at CENTER)
SYNC DETECTOR OUT 100% AM = 50 mV P-P
ENVELOPE OUT
6 V to Circuits
D1, D2 MV2105/MV2109, Bottom View
Except as indicated, decimal values of capacitance are in microfarads (µF); others are in picofarads (pF); resistances are in ohms; k=1,000.
IC pins not shown are unused.
T= Tantalum
● Phasing
PHASE DET OUT
REF IN 3.43 V
600 mV P-P
RSSI OUT 1.15 V, Min
LIMITER OUTPUT 650 mV P-P
AUDIO OUT
Optimizes BFO Level
R3 220
L1 215 µH
450 to 455 kHz
450 to 455 kHz IN (100% Mod AM, 15 mV P-P) RF INPUT
T1

Fig 1—The OH2GF synchronous detector operates in the 450- to 455-kHz region. Except as otherwise specified, its fixed-value resistors are ¼-W, 5%-tolerance units, and its capacitors' working voltages can be 10 or higher. See the 1993 *ARRL Handbook's* Chapter 35, Component Data, for the full addresses of the part suppliers mentioned below. Be sure to check *QST* ads for additional part sources for this project.

D1, D2—BB809 or BB409 tuning diode. Each of these, a "28-V" diode, exhibits approximately 33 pF at 2 V and an unusually high voltage-versus-capacitance slope of 10. WJ1Z has used two paralleled 30-V Motorola tuning diodes (one MV2109 [≈45 pF at 2 V] and one MV2105 [≈18 pF at 2 V], both with a slope of 3) to replace each BB809 or BB409 in this application. MV2105 and MV2109 diodes are available from Oak Hills Research, tel 616-796-6633 or 800-842-3748; fax 616-796-6633.
L1—Approximately 215 µH. Toko RWRS-T1019Z (nominally 220 µH, Q of 100 at 796 kHz, available as Digi-Key Corporation's #TK1223), suitable.
R1—50-kΩ trimmer.
R2—10-kΩ linear control.
T1—13 trifilar turns of #28 enameled wire, twisted, on an FT-37-77 toroidal ferrite core.
U1, U2—Signetics NE602N, NE602AN, SA602N, SA602AN mixer/oscillator IC. Available from Digi-Key, Oak Hills Research, Ocean State Electronics and others.
U3—Signetics NE604N, NE604AN, SA604N or SA604AN FM receiver subsystem IC. Available from Ocean State Electronics.

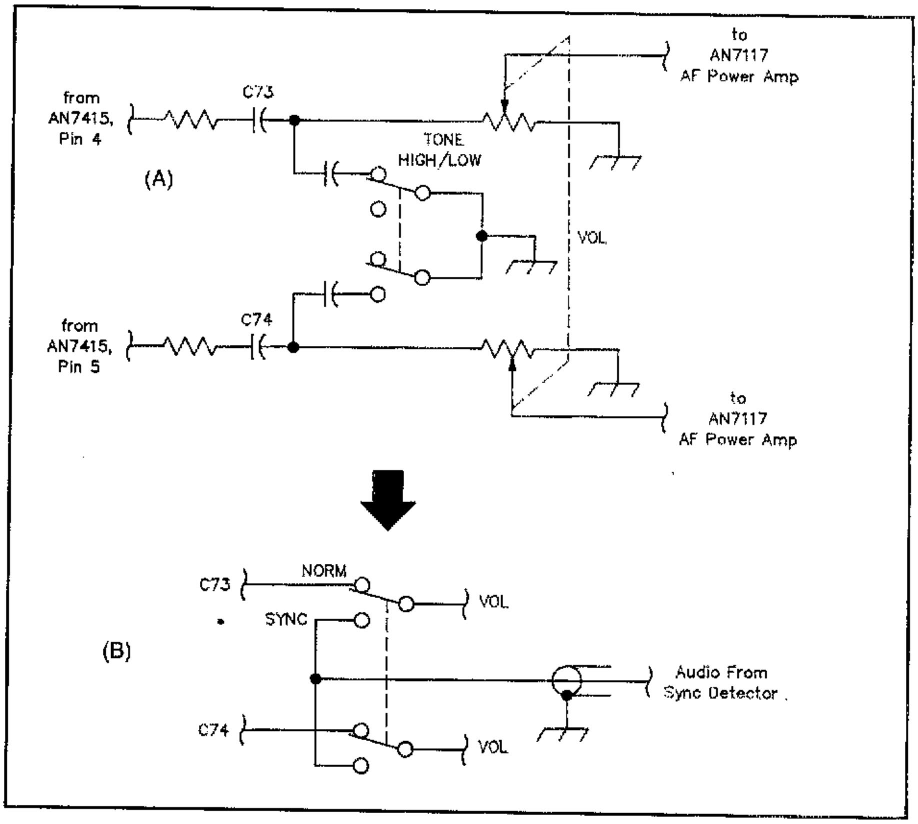


Fig 3—Rewiring the Sangean ATS-808's **TONE** switch (A) to select audio from the synchronous detector (B). The detector receives its power via a 22-Ω resistor connected to the '808's 6-V bus.

detector's audio output (**AF OUT**) returns to the ATS-808 by means of the '808's **TONE** switch, which I rewired to select audio from the outboard detector as shown in Fig 3.

Operation

After checking the circuit, connect it to a 6-V power supply. The total current consumption should be approximately 10 mA. Switch the **DETECTOR** switch to **ENVELOPE**; you should hear band noise. Tune in a strong AM signal, switch S3, **BFO MODE**, to **SSB/CW/TUNE**, and set the **DETECTOR** switch to **SYNC**. The detector may sound very quiet at this point. Adjust L1's core until you hear the signal you were listening to in **ENVELOPE** mode swoop into audibility. Now you know that the BFO is oscillating. If possible, measure the BFO level across L1 with an oscilloscope and 10:1 probe; it should be about 660 mV. (If you can't measure the BFO level, go to the next paragraph.) If it's not, experiment with R3's value to make it so.

Accurately tune the receiver to a strong, pure carrier, such as a beacon. Adjust R2, **BFO TUNING**, for a wiper voltage of 2.00 with S2, **BFO OFFSET**, set to ±0 **kHz**. Mark as **CENTER** this point in its knob's travel. With the **BFO MODE** switch in the **SSB/CW/TUNING** position, use a nonmetallic tool to adjust L1, the VCO coil, for zero beat with the incoming carrier. Returning S3 to the **SYNC** position should allow carrier lock if R1, **SHIFT ADJ**, is reasonably near adjustment. Adjust **SHIFT ADJ** for carrier lock if necessary. This completes coarse adjustment of **SHIFT ADJ**. Return the **BFO MODE** switch to the **SSB/CW/TUNING** position; the BFO

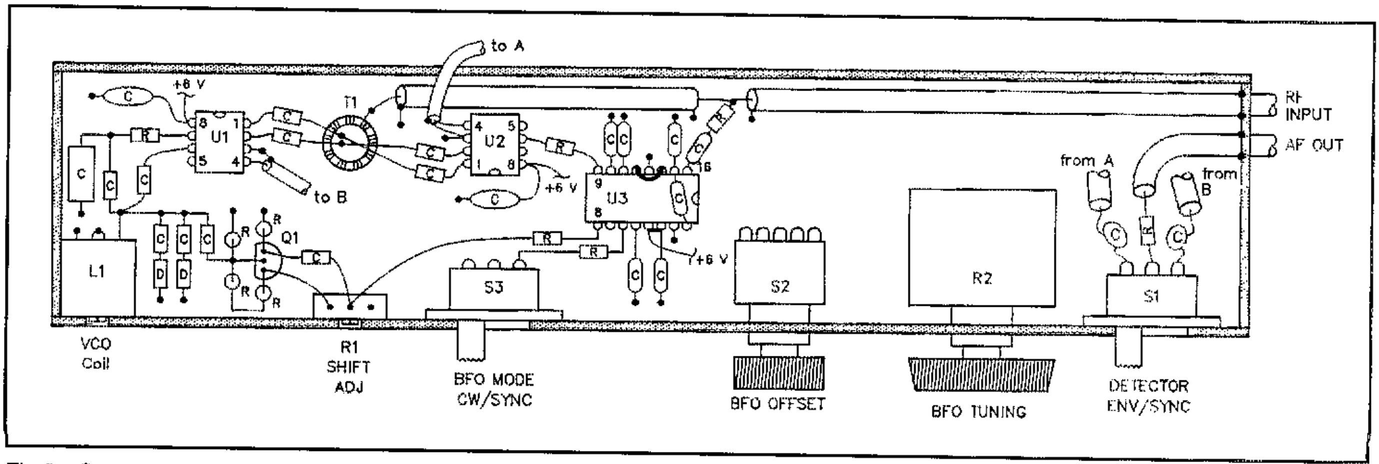


Fig 2—One recommended layout for the synchronous detector—that used by the author to match the footprint of his ATS-808 multiband receiver. U3's high gain requires care in construction—see text.

Notes on Applying OH2GF's Synchronous Detector

OH2GF built this synchronous detector for use with a Sangean ATS-808 portable receiver, but it can also work well with tabletop, communication-quality receivers. I tested my version of the detector (see title photo) with a Drake SW-4A receiver and an ICOM IC-729 transceiver. Fig A shows how I connected the detector to them.

The key to success with this circuit is getting interference-free IF drive. U3's RSSI output can be of critical importance in scoping out possible BFO leakage and/or unwanted signal input. With the detector's RF input shorted, a voltmeter connected to RSSI should indicate about 1.1. If it doesn't, U1's BFO signal may be getting into U3. The RSSI indication shouldn't be much higher than this with the detector connected to your receiver and your receiver's RF gain control turned all the way down for minimal noise input to the detector. (Whatever receiver you use must be in "AM" mode—BFO *off*.) If you read an RSSI voltage above the 1-V range at this point, a receiver oscillator or some other signal, however inaudible to you, may be driving U3's limiter.* *The detector will be unable to achieve and hold lock if anything other than the receiver IF signal grabs its limiter.* Just such a condition kept my detector from locking when I drove it with energy from the final 455-kHz IF stage in a Japan Radio Company JST-135HP transceiver. With the '135HP's **RF GAIN** control all the way down and no antenna connected, the detector's RSSI voltage was 3.3—full limiting! Time did not allow the spectrum analysis necessary to characterize the culprit signal, but turning off the receiver returned the RSSI reading to its no-signal value—so the interfering signal is in there *somewhere.*

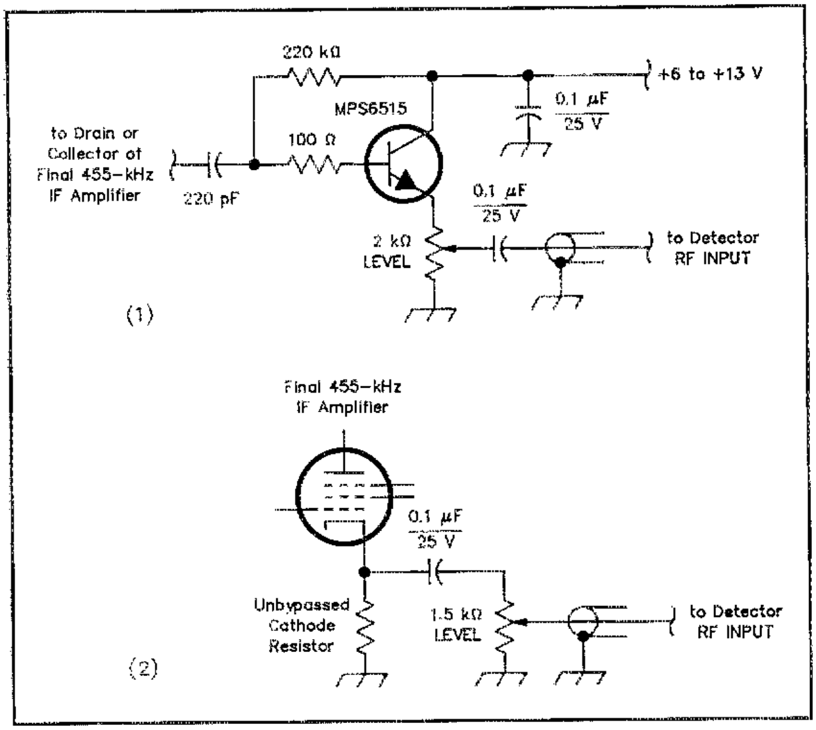


Fig A—A simple bipolar junction transistor emitter follower (1) can connect the synchronous detector to a solid-state transceiver. As shown at 2, the synchronous detector can be driven from the unbypassed cathode resistor of a vacuum-tube receiver's final IF stage. (The WJ1Z Drake SW-4A receiver required other changes, including AGC redesign for low distortion at high signal levels.) If you lack the equipment necessary to adjust these circuits for OH2GF's suggested drive level of 15 mV P-P, just keep the detector drive comfortably below that at which distortion begins. Likewise, if you can't measure the VCO level across L1, just stick with the 220-Ω value Fig 1 shows for R3—it's in the ballpark.

Ironically, hi-fi may have its price: Listening to the detector with an outboard audio amplifier may reveal distortion and IF hiss inaudible through the driving receiver's audio channel. Many modern radios launder their audio with high-end rolloff between their detectors and AF power amplifiers. A graphic equalizer can do this work for you.

Once I had the detector properly adjusted, I only rarely heard it lose lock on a full-carrier signal, even in one of my toughest subjective tests: Radio Australia's strong but muscularly fady 9580-kHz signal audible in North American mornings. (Judged subjectively, the circuit performed the same with BB409s and MV2105-MV2109 pairs installed at D1 and D2.) It was routinely possible to achieve lock on full-carrier signals right down to the band noise—not that such signals can provide the kind of entertainment-quality listening synchronous detection can provide! I also achieved lock-loss-free listening with HCJB's SSB_{12} transmission at 21455 kHz, and several independent-sideband, reduced-carrier feeders. So OH2GF's synchronous detector means business.—*WJ1Z*

*A local mediumwave broadcaster may even be the culprit, especially if your antenna system is extensive and your detector is relatively unshielded. During tests, I listened to our 1410-kHz local with a turned-off receiver and a powered-up detector switched to **ENVELOPE** and connected to an audio amplifier. Remember: The NE604's limiter stages, specified to work up to at least 21 MHz, are capable of 101 dB of overall gain and specified to be several decibels into limiting with *as little as 3 µV* (−92 dBm) applied across a 50-Ω load at the '604's input!

should still be at or very close to zero beat with the incoming signal.

Return the **BFO MODE** switch to the **SYNC** position. After the detector locks, fine-tune **SHIFT ADJ** to minimize detected low-frequency hiss. (If a sufficiently strong unmodulated local signal is not available off-air, transmit into a dummy antenna with a PLL-synthesized transceiver and make this adjustment by listening to its signal. You should find a **SHIFT ADJ** setting at which detected hiss distinctly nulls. As a less-desirable alternative, tune in an unfading AM signal modulated with a 1-kHz tone and adjust **SHIFT ADJ** for maximum tone recovery.) Once this is done, the detector's carrier phase is within exactly 0° or 180° of the BFO signal applied to the amplitude detector (U1), and you have minimized the detector's response to phase noise. Significantly, this alignment procedure also sets the detector to lock in a range centered on the control voltage that corresponds to optimum locking sensitivity *and* minimum phase noise demodulation. That's it—you're ready to listen.

To zero-beat and lock a given station: Set the **BFO TUNING** control to its center (2.00 V) position, **BFO MODE** switch to **CW/SSB/TUNE** and **BFO OFFSET** to match the sideband(s)—LSB, USB or both—you want to receive. Tune your receiver as close to zero beat as its tuning steps allow. Adjust **BFO TUNING** for zero beat. Switch the **BFO MODE** switch to **SYNC** to lock the detector.

Toggling S1, **DETECTOR**, between **ENVELOPE** and **SYNC** allows you to easily compare the effects of detection mode under adverse propagation conditions. You'll find the synchronous mode to be considerably superior much of the time. The quasi-synchronous (**ENVELOPE**) mode may give crisper audio under average or poor signal conditions; this effect may be due to increasing distortion as the signal approaches the noise floor, however.

The sound picture compared to the original ATS-808 detector, in addition to level difference, is slightly different, probably as a result of the "loudness" band limiting in the original circuit prior to the selection switch. The audio may be processed to individual taste.

Properly adjusted, the synchronous detector operates at less than 1% total harmonic distortion. (The quasi-synchronous detector provides comparable performance—but only on a nonfading test signal.) Measurements confirm the importance of setting R1, **SHIFT ADJ**, properly: Improper adjustment can increase low-order harmonic-distortion products detected from possible phase-modulation sideband components and allow the detection of phase noise.

Conclusion

The synchronous detector I've presented opens new possibilities for simple receiver design by requiring as little as 3 mV of IF output for proper operation. This means that 30 dB less pre-detector gain is required compared to traditional designs. Outfitted with this detector, my Sangean ATS-808 receiver can now receive CW and SSB signals, although the '808's AGC decay time is too short for enjoyable SSB listening.[4] A simple synchronous detector therefore may be the best solution for a compatible, multimode detector.

The modified ATS-808 especially demonstrated its detection power during a trip I made to Springfield, Massachusetts, where it was possible to follow Radio Finland's daily, one-hour SSB transmission beamed to West Europe (225°) on 15330 kHz at 1310 UTC with adequate signal quality.

I hope that you'll put this circuit to work with *your* receiver, perhaps modifying it for use at another intermediate frequency. I look forward to hearing of your results.

Notes

[1]This article refers to U1 and U2 as NE602ANs, but NE602Ns, SA602Ns and SA602ANs will work equally well in this application. Likewise, an NE604N, NE604AN, SA604N or SA604AN will work well at U3 in this application.

[2]The resistances given for R5 and R6 set this value only with a supply voltage of 6. If a different supply is used (the NE602s and NE604 can be operated at up to 8 V), change R5's value to return the **SSB/CW/TUNE** voltage to 2.16. This 2.16-V value should itself be considered only as an average for the NE604; the optimum value can be found by using a DVM to measure the voltage across C1 when the receiver is tuned to an empty channel. This optimization is important because manually tuning with **BFO MODE** set to **SSB/CW/TUNE** zero beats the incoming signal at this control voltage. When **BFO MODE** is then switched to **SYNC**, the detector's VCO idling frequency is therefore still almost correct, and easiest locking is guaranteed.

[3]Whether this correspondence between LSB and USB and S2's **–2 kHz** and **+2 kHz** positions holds with receivers other than the author's Sangean ATS-808 depends on whether the radio in question inverts SSB signals in moving them to 455 kHz. At the ATS-808's 455-kHz IF, SSB signals are reversed relative to their on-air sense (USB becomes LSB, and vice versa). For radios in which SSB signals are not inverted at 455 kHz, S2's – position will correspond to USB, + to LSB. During selectable-sideband synchronous reception with communication-quality radios using tighter SSB filtering than that afforded by ATS-808's narrow filter, BFO offsets on the order of ±1.5 kHz will likely be required for optimum carrier lock and tonal balance in recovered audio.—*Ed.*

[4]Proper adjustment of the **SHIFT ADJ** trimmer minimizes the detector's sensitivity to phase noise, but only when the detector is phase-locked. Thus, this phase-noise rejection doesn't apply when the detector is operated in its fix-tuned, unlocked (**CW/SSB/TUNE**) mode.

With the ATS-808, *receiving strong CW signals* therefore includes the addition of keyed noise—the '808's synthesizer phase noise transferred to the CW note. This illustrates how non-synchronous product detection reveals the true quality of a communication system's various oscillators and sets stringent quality requirements for their design and performance.

Jukka Vermasvuori has been an active ham ever since receiving his license in 1956 at age 15. His hobby within the hobby is designing HF receivers and transmitters: He received "First 1970 Award" at RSGB Radio Engineering and Communications Exhibit for a receiver that used dual-gate FETs and a double-balanced mixer.

Jukka has spent 30 years with the Finnish Broadcasting Company, purchasing new AM, FM and TV transmitter equipment. Highlights of his career have included the purchase and commissioning of three 1-megawatt-PEP SSB transmitters for shortwave broadcasting, and recently dealing with IOT (inductive output tube) common amplification UHF-TV transmitters.

He has been actively participating in the preparation of "CCIR Report to World Administrative Radio Conference (HFBC-93) Dealing With Matters Connected With The HF Broadcasting Service" (part: SSB System for HF Broadcasting). He is also the author of several technical articles published in Finland and elsewhere.

New Products

HAM HEADPHONES

◊ Designed for the needs of DXers, contesters and DXpeditioners, the Heil PRO-SET boomset headphones are comfortable and efficient. Vinyl earpads snap into the headpiece for easy removal, washing or replacement. The headband is fully padded with detent stops on each side, and features a clever microphone boom that can be placed in almost any position or folded up for storage and traveling. The PRO-SET is available with one of three microphones: the full-range HC-5, the HC-4 "DX Dream Machine" or the HC-6 full-range broadcast-quality element. Suggested retail price is $134.95. Heil Sound Ltd, Heil Dr, Marissa, IL 62257; tel 618-295-3000, fax 618-295-3030.

LiTZ BOX

◊ VHF/UHF FM and repeater operators who want to take advantage of long-tone zero (LiTZ) and other signaling techniques (see the FM/RPT column in October 1992 *QST*) can use wired and tested decoders or "LiTZ Kitz" to set up specialized monitoring capabilities. Based on a project described in December 1992 *73 Amateur Radio Today* ("Build a LiTZ Decoder," page 30), by Marshall Macy, N7IOB, and Paul Holmes, KA5RZI, this compact device connects to your receiver's audio output and can be set to respond to a long "0" or other DTMF tone to trigger an alarm or activate a speaker. An etched and drilled PC board is $9.95; the board with Silicon Systems IC SSI-202 is $16.95; a complete kit (excluding enclosure) is $36.95; and the complete wired and tested LiTZ decoder with case is $56.95. Discounts are available for purchases in quantities of two or more. Marshall Macy, N7IOB, 303 East S Mountain Ave #163, Phoenix, AZ 85040; tel 800-484-9691 (code 7373) or 602-268-3838.