SIGNALS

Rockwell Collins

Monthly Newsletter of the

Amateur Radio Club

Volume 37 Issue 05 | **Web Site** http://www.w5rok.us | **February 2016**

RCARC
Membership Meeting

Tuesday 23 February 2016
1700 Social 1730 Meeting
1800 Program

Methodist Richardson Medical Center
At Bush/Renner/Shiloh Intersection
Second Floor Conference Room 200

Subject:
Army MARS, Not Like You May Have Known In The Past
By Bill Swan K5MWC

Local Club News

Meeting Notice

At the February program Bill Swan, K5MWC, will be speaking on MARS. The Military Auxiliary Radio System is a Department of Defense sponsored emergency communications program consisting of licensed amateur radio operators. You can read ahead at https://www.txarmymars.org/.

RCARC Community Service Activities

Crime Watch Patrol Jim Skinner WB0UNI participated in Richardson Duck Creek Crime Watch Patrol (CWP). CWP members, after successful completion of Richardson Police Department Training, patrol their neighborhoods and report all suspicious activities to the Police Department.

Siren Testing Dennis Cobb WA8ZBT, Chris Havenridge KF5GUN, Frank Krizan K5HS, John McFadden K5TIP and Jim Skinner WB0UNI participated in the Richardson emergency siren testing on 3 February 2016. All sirens failed to function. The siren testing is performed at 12:00 on the first Wednesday of each month. The sirens are monitored by amateur radio operators and reports made using the Richardson Wireless Klub (RWK) repeater at 147.120 MHz.

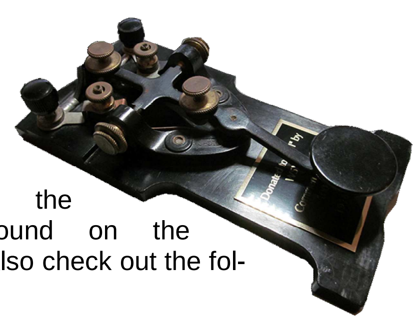
University of Arkansas Radio Club, W5YM, Donates Vintage J-37 Key to B-29 Restoration

The Amateur Radio Club of the University of Arkansas (W5YM), which celebrates its centennial this year, has donated a J-37 telegraph key to be used in a radio position under restoration onboard "Fifi," a World War II vintage B29 Superfortress. RCARC members have been recreating a radio operator's position on the aircraft.

"It's a grand addition to Fifi's restored radio operating position," the restoration team noted on its website. "Many thanks to the 100-year-young University of Arkansas Amateur Radio Club W5YM and Dan Puckett, K5FXB, for facilitating this most thoughtful, generous and historic commemorative donation."

The J-37 was nicknamed the "Mae West" key after the 1930s-1940s comic actress for its unusual base with its curvy indentations, designed for wrapping the key's lead for storage. The J-37 will be a component of the Smith-Erwin Memorial Radio Operator Position onboard the still-flying B-29 aircraft. The plaque on the donated key reads:

Donated to "FIFI" by
W5YM
Commemorating
100 Years
1916-2016



More information on the donation can be found on the b29radio.com website. Also check out the following websites:

The University of Arkansas Amateur Radio Club: https://rso.uark.edu/w5ym/w5ym-donates-telegraph-key-to-fifi/

A video history of the Morse code key can be found at: http://www.telegraph-office.com/

(Contributed mostly by Bob Kirby, K3NT)

RCARC OFFICERS

PRESIDENT
Chris Havenridge KF5GUN
972.509.8580
chris.dfw.tx@gmail.com

VICE-PRESIDENT
Gene Duprey K1GD
319.270.8159
geneduprey2015@gmail.com

SECRETARY
Jim Brown AF5MA
972.495.2209
jhksbrown@verizon.net

TREASURER
Mike Montgomery WD5TX
972.705.1498
dmmontgo@rockwellcollins.com

ACTIVITIES
Bob Kirby K3NT
319.360.0500
k3nt@arrl.net

WEBSITE MANAGER
Mike Hollingsworth W5QH
972.571.6060
w5qh@arrl.net

STATION TRUSTEE
Steve Phillips K6JT
972.517.3332
k6jt@arrl.net

NEWSLETTER EDITOR
Jim Skinner WB0UNI
214.535.5264
wb0uni@arrl.net

MEMBERSHIP
Joe Wolf N5UIC
214.202.2757
n5uic@arrl.net

W5ROK CLUB STATION
972.705.1349
461-290

VE SESSIONS

Dallas tests are held on the fourth Saturday of each month at 1000 hrs. 13350 Floyd Rd. (Old Credit Union) Contact Bob West, WA8YCD 972.917.6362

Irving tests are held on the third Saturday of each month at 0900. Fifth and Main St. Contact Bill Revis, KF5BL 252-8015

McKinney VE test sessions are held at the Heard Museum the first Sunday of the month. The address is 1 Nature Place, McKinney TX. The time of the testing is 1430, ending no later than 1645. ***Note: no tests given on holiday weekends.***

Garland testing is held on the fourth Thursday of each month, excluding November, and begins at 1930 sharp. Location is Freeman Heights Baptist. Church, 1120 N Garland Ave, Garland (between W Walnut and Buckingham Rd). Enter via the north driveway. A HUGE parking lot is located behind the church. Both the parking lot and the Fellowship Hall are located on the east side of the church building, with big signs by the entrance door. Contact Janet Crenshaw, WB9ZPH at 972.302.9992.

Plano testing is on the third Saturday of each month, 1300 hrs at Williams High School, 1717 17th St. East Plano. Check Repeater 147.180+ for announcements.

Greenville testing is on the Saturday after the third Thursday, 1000 hrs at site TBA, contact N5KA, 903.364.5306. Sponsor is Sabine Valley ARA. Repeater 146.780(-) with 118.8 tone.

Richardson The Richardson Wireless Klub (RWK) VE team hold license testing on the third Thursday of each month at St. Barnabas Presbyterian Church, 1220 West Beltline Rd. Testing begins at 1900 hrs in room 12. Enter through the Northern most door on the east side of the church building. For further information contact Dave Russell W2DMR, at 972.690.9894 or E-mail warhog4 @tx,rr.com.

President and VP Messages

I hope everyone has had a great year so far. With the weather being so nice and warm these past few weeks, we have had some time for thinking about antennas, and other HAM related activities. I personally, have just completed re-installing my Dual Band radio into my VW Touareg, after getting it back from the body shop. They did a pretty good job, but there remain some niggly *(Editor's note: this actually is a word!)* problems. But I can now operate from both of my cars. Next is the home station. I have a G5RV antenna, which I am thinking of putting up, if I can get it up high enough. I suspect there are those of you who will also be doing some maintenance to your station, or planning a new antenna or two. This looks like a great time to get it done.

Also this weekend is the Garland Skywarn Class. This is a very excellent program to attend, so if you have the time, get out and get some training. Rowlett is also having a Basic Skywarn Class if you cannot attend the Garland event. Rowlett is having theirs on March 3rd. at the Rowlett High School from 6 to 9PM.

As many of you may have heard, Chris our President has resigned, although we hope he still makes some of the meetings. I am sorry to see him give up the position, but he has other matters that are of greater importance at this time. I wish him well.

See all of you at the meeting.

73's
Gene, K1GD

Secretary's Report

26 January 2016

The meeting was called to order by Vice President Gene Duprey K1GD at 1741.

The following were present at the meeting:

Brian Belcher	WA5M
Jim Brown	AF5MA
Ron Carlson	WW2CBI
Dennis Cobb	WA8ZBT
Kathy Cobb	Guest
Chris Duprey	KD5IBA
Gene Duprey	K1GD
Bob Kirby	K3NT
John McFadden	K5TIP
Mike Schmit	WA9WCC
Jim Skinner	WB0UNI
Bill Swan	K5MWC
Joe Wolf	N5UIC

Officers and Committee Reports:
There were no formal reports other than the Secretary's Report, which is contained in this newsletter.

Old Business:
There was no old business.

New Business:
Joe Wolf N5UIC proposed that club dues be reduced or eliminated. The motion was tabled by a unanimous vote of those present.

Joe Wolf briefly discussed Wiggio, a new Internet mail and collaboration resource he has made available to the club. He will do a presentation and demo on Wiggio for the club at the April 2016 meeting.

Bill Swan K5MWC discussed Department of Defense and Department of Homeland Security interest in amateur radio, with emphasis on military-affiliate stations (the Army's MARS and others). He mentioned an exercise planned for 12 February 2016 intended to evaluate communications among these groups using offline encryption. The discussion addressed the Government's need to for communications with sparsely-populated areas of the country in event of natural or man-made disasters. The amateur radio community of over 700,000 operators using HF-band communications is seen as essential in filling this need. Bob Kirby K3NT requested that Bill consider a full presentation on this subject at a later meeting.

Dennis Cobb WA8ZBT mentioned the landing of a Chinook helicopter (CH-47) at the Rockwell Collins Richardson campus a day earlier.

John McFadden K5TIP introduced new member Brian Belcher WA5M.

Adjournment:
The meeting was adjourned at 1814.

Amateur Radio Parity Act

As all of you may know, the "Amateur Radio Parity Act" is now before Congress.

H.R. 1301 would direct the FCC to extend its rules relating to reasonable accommodation of Amateur Service communications to private land-use restrictions, such as deed covenants, conditions, and restrictions. The bill has attracted 120 cosponsors from both sides of the aisle. An identical US Senate measure, S. 1685, has attracted three cosponsors. It cleared the Senate Committee on Commerce, Science, and Transportation last November.

On a voice vote, the US House Subcommittee on Communications and Technology has sent the Amateur Radio Parity Act, H.R. 1301, to the full House Energy and Commerce Committee with a favorable report for further consideration. The measure was among three bills the Subcommittee considered during a February 11 "markup" session.

Please take a few moments to visit the web site in the URL below and send a letter of support to your Congressional representatives:

https://arrl.rallycongress.net/ctas/urge-congress-to-support-amateur-radio-parity-act.

Presentations for Monthly RCARC Meetings

RCARC has an urgent need for presenters to present a short topic on Ham Radio at our monthly club meetings. 45-60 minute Presentations may include, but are not limited to:

- Set-up, Building or Modifying Station Equipment (Antennas, Audio, Dummy Loads, Desks, Lights, ...)
- Operating a Radio Station (Listening & Transmission tips, Ham Logo decrypted, Popular Frequencies, ...)
- My Radio Broke (Possible Alternatives before using the Sledge Hammer, ...)
- Different types of Digital Operation (APRS, Packet, PSK 31-64, RTTY, ...)
- Software Defined Radios (Commercial, Kits, Remote, Internet, ...)
- Software used for Ham Radios (WSPR, PSK-31, ...)
- Emergency Radio Equipment (Go Kits, Batteries, Solar power, Easy-Up Antennas, ...)
- Ham Radio Activities (MARS, RACES, MARC, Contests, Satellites, Mobile, Portable, Remote, Field Day, SWL, ...)
- Radio Reference (On-line manuals, theory, how to books & Videos, ...
- Social Mingle (With light snacks? Ham & Cheese crackers? ...)

(Continued on page 9)

Smart AM Receivers for the 21st Century

Stephen F. Smith and Thomas F. King
Kintronic Labs, Inc.
Bristol, TN

Abstract - *Currently available AM receivers in automobiles and for home and portable use incorporate narrow RF and audio bandwidths to counter the increasing noise environment caused by man-made RF interference sources, such as power lines with ill-maintained insulators and transformers; overhead cable TV and DSL services; fluorescent lamp ballasts; computer modems; and LED traffic lights and household lights, to name a few. By utilizing currently available software-defined radio design techniques, coupled with CQUAM AM stereo technology, this paper will address the design and features of a new smart AM receiver that will serve to restore listenership to the AM band. Audio examples will be included in the presentation.*

OVERVIEW

AM radio constitutes the most bandwidth-efficient broadcast medium and provides an essential service to many Americans, particularly in rural and remote areas, and those traveling in the vast expanses of this nation. AM radio, due to its generally lower capital requirements, can also provide a realistic setting for family-based, community-focused station programming and ownership, especially in smaller localities. AM radio is truly a national resource, a source of unique voices, and particularly in light of its unique propagation characteristics has tremendous reach, especially in times of local, regional, and even national emergencies [1]*.*

Fundamentally, the two greatest issues currently threatening AM radio are: **(1)** the worsening electromagnetic environment; and **(2)** the concurrent failure of the consumer-products industry to provide the listening public with high-quality AM receiver systems (comparable to their FM counterparts). It has been all too easy for the receiver manufacturers to simply reduce overall receiver bandwidths down to even 2-3 kHz to address the pervasive issues of electromagnetic interference (EMI) noise from power lines, fluorescent-lamp ballasts, personal computers, consumer devices, and the like, not to mention broadband static impulses from lightning and increased adjacent-channel and alternate-channel interference from more recently allocated AM stations. Another factor in the lack of receiver bandwidth is the inability of radio manufacturers to obtain decently matched low-cost varactor tuning diodes to provide the required tracking accuracy for the simultaneous electronic tuning of the AM RF front-end, mixer, and local-oscillator stages in their receivers (both home *and* auto). Added on top of all this is the progressive trend in the automobile industry to replace metal body parts with plastic (which worsens EMI shielding), adopt windshield-type antennas (which provide markedly poorer reception performance for both AM and even FM), and add a multitude of noise-generating microcomputers for engine control, antiskid braking systems, and the like. The net result has been AM radios with low (and ever declining) audio and reception quality.

It is thus imperative to the sustainability of AM radio that the FCC strongly encourage (or even mandate) significant improvement in consumer AM systems. Without this the American listening public will continue to regard AM as a noisy, low-fidelity medium and will consequently tune out. Without advanced consumer-receiver features to address the severe noise, interference, and bandwidth challenges to good, clean AM-band reception, the appeal of AM to the public will inevitably be lost.

The technical goals of vastly-improved consumer AM receivers are actually near at hand. The great majority of the required receiver functions are already offered by international chip manufacturers such as Silicon Labs (Austin, TX), NXP Semiconductor (Netherlands), ST Microelectronics (Switzerland), and Frontier Silicon (U.K.) in their advanced software-defined radio (SDR) AM/FM chip products. For example, it is now possible to offer agile, programmable channel bandwidths and audio high-cut filters [to address the increased levels of nighttime and critical-hours sky-wave adjacent-channel interference (ACI)], noise limiters, and adaptive RF/IF AGC functions. A few U.S.-specific enhancements such as adaptive notch filters at 10 kHz could be easily added.

BACKGROUND

We acknowledge the FCC's past leadership role in the overall thrust to improve AM radio, beginning in the 1989-1991 period. It is our view that the FCC in large measure did its job well with the establishment of wider-bandwidth, consistent AM transmitter performance, reduction of mutual broadcast interference, and the encouragement of the production of better receiver hardware by the consumer-electronics industry. Initially the consumer manufacturers made a concerted attempt to specify performance of AM receivers through the 1993 AMAX standard, a joint effort of the EIA and the NAB, with FCC backing. In that standard, the desirability for higher receiver bandwidths and noise performance was broadly acknowledged, with the purpose to restore the reception of high-quality AM signals to the public. An AMAX-certified receiver had at least 7.5-kHz bandwidth for home and auto versions, and 6.5-kHz for portables, plus some form of bandwidth control, either automatic or at least two manual settings (e.g., “narrow” and “wide”). It also had to meet NRSC receiver standards for distortion, de-emphasis, effective noise blanking, and include provisions for an external antenna and coverage of the Expanded AM band. The FCC rapidly followed up on this with codification of the CQUAM AM stereo standard, also in 1993. At this point, the stage appeared to be set for rejuvenation of the AM band. Nevertheless, with the legacy of confusion and disappointment in the rollout of the multiple incompatible AM stereo systems, and failure of the manufacturers (including the auto makers) to effectively promote AMAX radios, coupled with the ever-increasing background of noise in the band, the general public soon lost interest and moved on to other media.

It appears at this point (2015), the FCC has a fundamental choice for AM radio: either take a firmer hand in pushing new, improved receiver technology implementations, or permit AM to spiral downward into a slow, painful death. The legal precedent for the former is quite strong. In the early 1960s, the UHF television band was close to economic extinction, as very few TV receivers were equipped with UHF tuners. This was a problem at the time since the major TV networks were well established on VHF, while many local-only stations on UHF were struggling for survival. As a result, the **All-Channel Receiver Act** was passed by the United States Congress in 1961, to allow the FCC to require that all television set manufacturers include UHF tuners. Specifically, the Act provided that the FCC would "have authority to require that apparatus designed to receive television pictures broadcast simultaneously with sound be capable of adequately receiving all frequencies allocated by the FCC for television broadcasting." Under authority provided by the All-Channel Receiver Act, the FCC also adopted a number of technical standards to increase parity between the UHF and VHF television services, including a 14-dB maximum UHF noise figure for television receivers [2].

The original UHF tuner improvements mandated by the All-Channel Receiver Act represented a relatively small cost increment for the TV sets of the day; similarly, with modern high-volume chip technology, the needed signal-processing features for the AM-side of modern receivers can be added for a few dollars at most.

Clearly, automobiles are the prime venue; home hi-fi systems and portables will undoubtedly follow. Further, it would seem logical that all HD Radios also be upgraded on analog AM; with the greater processing complexity of these premium units, the additional cost on a per-unit basis to augment them would be negligible. If Congressional action is actually deemed necessary to enable all the requisite steps in AM revitalization to occur, it is encouraging to remember that the CALM Act was very recently passed to address a far less significant public issue (loud TV commercials!).

It would seem that due to the huge receiver disparity, AM radio is now in a similar situation, which must be remedied very soon. The fundamental solutions for AM are strikingly similar to those of UHF-TV; ***receiver parity with the dominant FM band must be established to enable the public to make listening choices on a more level playing field.*** This critical *receiver* audio bandwidth issue is depicted in Figure 1 below.

The ***transmitted*** bandwidth for FM is about 15 kHz, while the corresponding AM systems handle up to 10 kHz a very respectable figure. As can be seen from the figure, not only are virtually all AM ***receivers*** limited to about a 2.5-kHz response on the high end, but are also rolled-off in the bass to reduce the effects of the all-too-frequent interference from power lines and other AM-band EMI sources. Thus, compared with FM, with its full audio bandwidth and stereo imaging, AM sounds dull, thin, flat, and noisy. The result is a staggering disadvantage to AM stations, especially on music programming, which must be corrected as soon as possible.

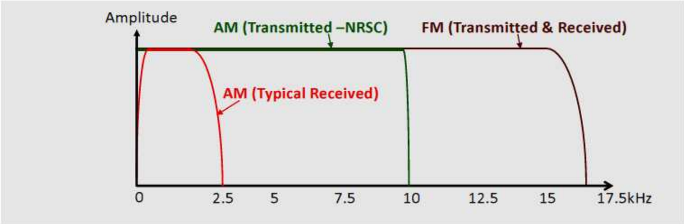


Figure 1 – FM Vs. AM Audio Frequency Response

THE AM NOISE ISSUE

The gradual growth of EMI from electric power lines (at all voltage levels), telephone and cable lines, and a variety of consumer devices has been a tremendous detriment to AM broadcast reception. Part 15 of the FCC Rules sets quite reasonable limits for both conducted and radiated emissions, both within the AM band and elsewhere. Although AM-band emissions are especially problematic to broadcasters, out-ofband radiation can also affect amateur radio operations, and other communications users; such illegal emissions are rightfully deemed "harmful interference" and have been universally understood as such in the communications field. The proliferation of bad high-voltage line insulators, transformer bushings, transient protectors, and line/ground connections, has led to broad degradation in AM radio reception, particularly since in most cases power lines follow roads.

Although electric utilities are the most common offenders in this regard, telephone and cable firms also have caused problems, usually due to DSL and other forms of signal leakage. Most current AM radios are quite susceptible to the resulting impulse-type noise. Once this raucous "buzz" even temporarily overwhelms the radio, the listener is strongly prompted to switch to FM or another programming source. We submit that the FCC must protect the public interest, along with its licensed broadcasters, by aggressively enforcing its own Regulations. Closer to home, many existing radios, TVs, consumer devices (e.g., CD players), computers, MP3 players, and such, emit very high levels of local RFI produced by internal clock circuits, RF synthesizers, microprocessors, and the like. Poor unit design (including lack of effective shielding) thus impairs or even precludes nearby AM radio reception. Common problems with FCC Laboratory Type-Accepted, Verified, or Certified devices for consumers could be resolved, with some extra effort, through existing regulatory channels. Numerous internationally marketed products (from radios to fluorescent ballasts and LED drivers) with RF power-line filters for EU countries, when sold in the U.S. have filter components missing, in clear violation of Part 15 Rules. This major problem should be soluble through concerted

FCC action, particularly on resellers. As a direct result, the AM broadcast medium will be afforded some critical relief to reception noise and coverage issues. ***Major FCC Part-15 enforcement action here is absolutely vital.***

Obviously, before we can correct the bandwidth deficiencies of AM radios, we must vigorously address the handling of environmental noise, both natural ***and*** manmade. Most of the required techniques have existed for many decades in military and amateur receivers [3], and were optimized in CQUAM AM stereo receiver chips designed and sold by Motorola, Sprague, and others in the mid-1990s, but have been largely neglected until recently.

Fundamentally, the effective rejection of AM-band RFI requires a distributed, multi-stage noise-limiting approach, including: **(1)** antenna/front-end fast clamping; **(2)** a triggered blanker at the output of the (first) mixer; **(3)** a delayed blanker at the I-F output/detector input; **(4)** a delayed sample-and-hold at the audio output; and **(5)** a variable 10-kHz notch filter to reject adjacent carrier signals; and **(6)** a noise-sensing circuit to achieve the desired system control actions. The Motorola circuits proved very effective in extended field testing at rejecting even very severe RFI noise, while rendering the output audio substantially noise-free. Figure 2 provides a functional diagram of the 3rd-generation CQUAM MC13027/MC13122 receiver chip combo, with key noise-limiting circuits noted in red [4].

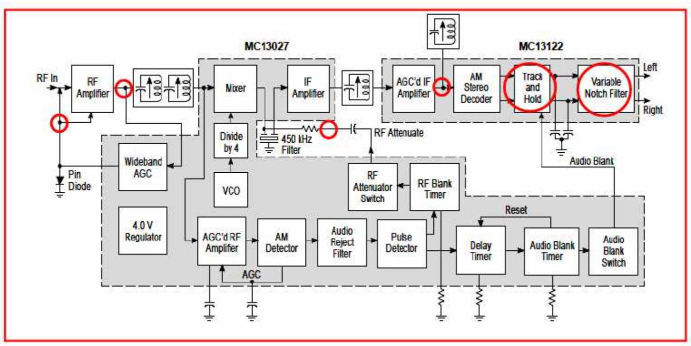


Figure 2 – Motorola AM Receiver With Advanced Noise Limiting

RECEIVER SPECIFICATIONS

It is essential for the future of AM radio that very close to full parity be established for new AM receivers versus their FM counterparts. This includes: **(1)** low internal noise floor, well below the average AM-band atmospheric noise level; **(2)** high overall RF sensitivity, selectivity, and dynamic range, to provide adequate amplification of weak signals, even in the presence of significant adjacent- and/or alternate-channel signals, especially in strong-signal environments; **(3)** highly effective noise (EMI) rejection, including staged RF and IF noise blanking, accompanied by appropriate audio blanking when required**; (4)** full 10-kHz audio bandwidth capability with low detector distortion, plus dynamic bandwidth control (including adaptive 10 kHz notch filtering) as dictated by noise and adjacent-channel interference; and **(5)** stereo capability (if the receiver has FM stereo capability, it must have CQUAM decoding for AM). Without the first three requirements, basic AM reception will suffer compared with FM; without the last two, the output sound quality cannot be closely competitive with FM. The key suggested receiver specs are summarized below:

Audio Bandwidth: 50 Hz to 9-10 kHz typical, adaptive with a minimum nominal bandwidth of 7.5 kHz; reduced adaptive bandwidth (~ 3-kHz *minimum*) permitted in high noise or adjacent-channel interference situations (i.e., nighttime). Variable-Q notch filter @ 10 kHz standard.

Signal-to-Noise Ratio (Ultimate): minimum 55 dB, preferably □ 60 dB.

Sensitivity: -120 dBm (~1 □V) for a signal-to-noise ratio (SNR) of 10 dB.

Selectivity: 25-50 dB (adaptive, using co-, adjacent-and alternate-channel detection).

Dynamic Range: □ 100 dB.

Noise Figure: 1 - 3 dB.

Image Rejection: 50 dB or better.

Intermodulation: $_{\text{IP2,}}$ IP3 intercepts +10 to +40 dBm.

IF: low, with image-rejecting down-conversion or alternatively, double (up-down) conversion.

Stereo Separation: minimum 25 dB, 50 Hz - 10 kHz

Noise limiting: multi-stage, with adaptive timing and performance as per the AMAX standard or better.

The unique nature of the AM broadcast band, in terms of the aliased channel allocation structure, high levels of atmospheric and man-made noise, and propagation characteristics, provides challenges to receiver designers to provide high levels of RF performance in difficult environments at low unit cost. With the advent of advanced, highly integrated radio receiver chips as cited above, many of the needed complex functions can now be implemented at modest cost in the receiver hardware (vehicle or home).

A detailed comparison between high-quality consumer FM receivers and their typical AM counterparts clearly reveals the vast gulf in overall performance between the two bands (see Table I below). The sensitivity, signal-to-noise ratio, dynamic range, noise figure, impulse noise rejection, and almost universal lack of stereo capability are major deficiencies of modern AM receivers; even their inexpensive FM counterparts are far better in almost every respect. Further, the effective adjacent- and alternate-channel rejection figures are much worse for AM units due to the unavoidable sideband-spectrum overlap between close-spaced stations; FM has fewer problems in this regard. FM receivers are also inherently much more resistant to impulse noise, owing both to the amplitude-insensitive nature of the limiter/detector system and the higher carrier frequencies.

From the fourth column in Table I, it is acutely clear that effective receiver parity between the two bands does not exist in currently produced models. The suggested specs for a next-generation AM unit in the fifth column would provide for reception and sound quality closely competitive with those of FM. Key to this is the ability of AM audio to be on a par with FM for music as well as news/talk programming. Smart adaptive gain, bandwidth, noise rejection, and selectivity characteristics would permit the listener to have similar experiences with both bands, assuring the longevity of the AM radio industry.

Table I - Comparison of FM vs. AM Receiver Specs

Specification	FM (Current)	AM (Current)	Parity?	AM (New)	Parity?
Audio Bandwidth	15 kHz	2.5 kHz	No!	10 kHz	Close
Signal/Noise	65 dB	35 dB	No!	55 dB	Close
Sensitivity (20 db SNR)	2 µV	500 µV	No!	20 µV	Close
Selectivity (Adj./Alt.)	45/60 dB	40/50 dB	Close	40/50 dB (Adaptive)	Yes
Dynamic Range & Intercepts	100 dB	70 dB/ 0-10 dBm	No!	100 dB/ +10-40 dBm	Yes
NF/Noise Rejection	3/50 dB	14/20 dB	No!	2-3/50 dB	Yes
Image Rejection	60 dB	30-40 dB	Close	50 dB/50 dB	Yes
Stereo Separation	35 dB	------	No!	25-30 dB	Yes
Antenna	E-field (Fair)	E-field (Poor)	No!	H-field/ Diversity	Yes

Illustrating this advanced adaptive behavior, the receiver response is shown in Figures 3-7 at 4 different signal levels: **(1)** Close-in [10 mV/m]; **(2)** Suburban [2 mV/m]; **(3)** Fringe [0.5 mV/m]; and **(4)** Nighttime [2 mV/m]. The receiver's response is dependent on relative carrier and modulation levels, including on-frequency, adjacent, and alternate channel signals. Dynamic bandwidth control, interference cancellation, and audio control are performed digitally for higher performance plus lower unit cost/complexity (comparable to HD Radio units).

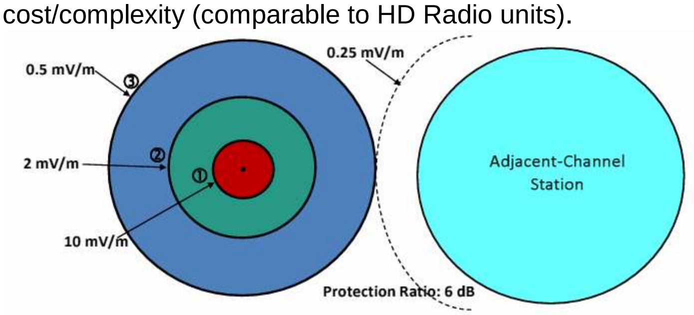


Figure 3 - AM Reception Cases

As can be seen from the plots in Figures 4-6, the adaptive receiver exhibits near-full bandwidth for close-in strong-signal conditions (i.e., 10 mV/m), reduces it slightly under suburban signal levels (~2 mV/m), and draws it in progressively further as the desired signal drops to fringe levels (<1 mV/m). Likewise, noise-limiter thresholds also *decrease adaptively* to deal with the increased noise. In Figure 7, for nighttime reception in suburban areas, the fully adaptive receiver can utilize single-or vestigial-sideband techniques to more effectively reject the overlapping lower-adjacent interfering signal. These adaptations are dynamic, so the receiver can rapidly adjust to changing signal conditions as needed. Further, the use of optimized synchronous detectors can vastly improve AM sky-wave reception at night by providing a stable local carrier reference during deep selective-fading intervals and thereby eliminating the severe envelope distortion so often encountered. A co-benefit of the proposed wide-scale and/or local synchronization of AM transmitters [5],[6],[7] is that more elaborate signal-processing techniques to optimize overall AM reception can be implemented without having to deal with the constant high-amplitude low-frequency carrier beats. This will yield much smoother, more listenable AM audio in weaker signal areas for the consumer, especially in terms of stereo imaging for music programming.

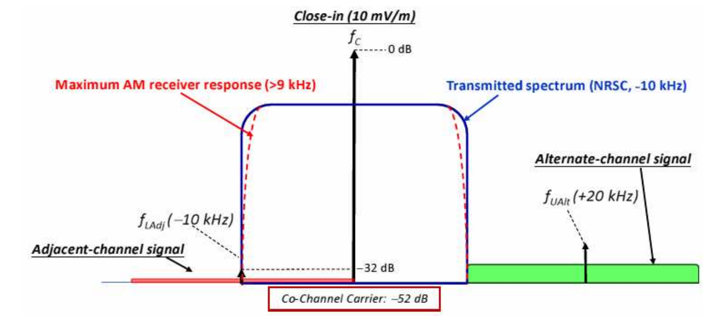


Figure 4 - Receiver Close-In Frequency Response

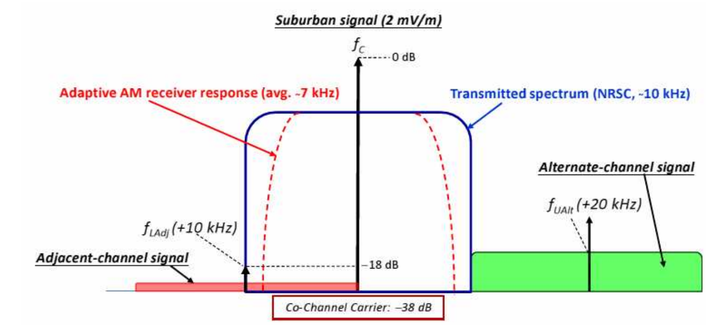


Figure 5 - Receiver Suburban Frequency Response

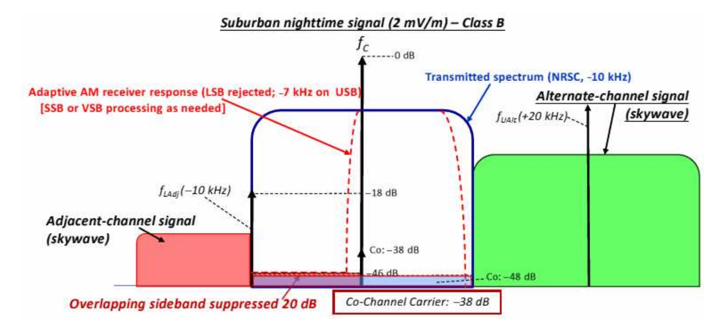


Figure 6 - Receiver Fringe Frequency Response

As stated earlier, several chip manufacturers have in the past few years begun offering numerous very high-performance, highly integrated radio-receiver chips to provide advanced AM/FM processing features with low parts count and moderate cost to the worldwide consumer market. These devices, generally fabricated in modern fast, small-geometry CMOS processes, contain all the basic circuitry to implement a fully optimized, adaptive AM/FM receiver, including: **(1)** front-end preamps; **(2)** advanced AM/FM noise blankers; **(3)** dynamic AM/FM channel bandwidth control; **(4)** AM low-cut filter; **(5)** selectable soft mute; **(6)** advanced stereo blend; **(7)** a programmable suite of signal metrics, including dynamic on-channel, adjacent-, and alternate-channel signal-strength measurements [e.g., RSSI, SNR]; **(8)** onboard frequency synthesizer with fully integrated PLL-VCO local oscillator; **(9)** integrated clock; **(10)** digital low-IF or double-conversion architecture; **(11)** an on-chip AM/FM RF/I-F AGC system with integrated resistor and capacitor banks; and **(12)** a complete digital interface to an associated microcomputer for adaptive, programmable system control [8],[9],[10].

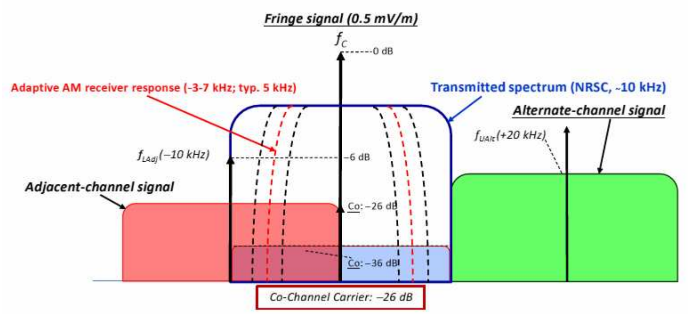


Figure 7 - Receiver Nighttime Frequency Response

The RF signal-processing architecture basically provides a series of sensors to detect the on-channel and neighboring signals, which are then used to program the receiver's bandwidth and noise-limiting actions and thus automatically optimize the reception of the selected station in an ongoing fashion. These currently available chips already meet the majority of the essential specs for the next-generation AM receiver; with a few additional functions such as CQUAM AM stereo decoding and agile AM signal processing, the required feature suite for full-fidelity AM reception would be complete.

The adoption of these specs for new AM radios will assure excellent performance in both strong-signal and fringe areas, both during daytime and at night, even with significant sky-wave interference. The advanced adaptive receiver features mentioned above, plus others, can be economically implemented using modern DSP-based radio and (optionally) external DSP chips; a typical AM/FM unit block diagram is given in Figure 8.

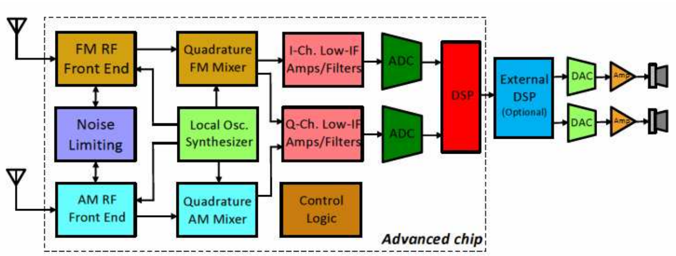


Figure 8 – Typical Advanced Receiver Architecture

No discussion of radio receivers should omit the fundamental source of the received signal — the antenna (or, in the case of diversity reception, antennas). As cited previously, the tendency for modern vehicles is for appearance's sake to eliminate the tried-and-true vertical "stalk" antenna, which was quite efficient for FM (at least with vertical transmission polarization) and was generally adequate for decent AM reception. However, with the need for better RF pickup for the AM band and multipath reduction in FM, other antenna configurations should be carefully considered. A shielded loop, for example, permits good magnetic (**H**) field AM signal reception, while screening out much of the local E-field noise from auto electronics and nearby power lines. Loop-antenna units (including ferrite loopsticks) can be fabricated at low cost and mounted in windshields, windows, trim, and under plastic body panels. Further, multiple air-core units, mounted vertically, can be effectively utilized when coupled with standard diversity-combining techniques. These AM loops can be configured for good FM reception as well. Figure 9 below provides an illustration of how such H-field antennas could be incorporated into vehicles at low cost.

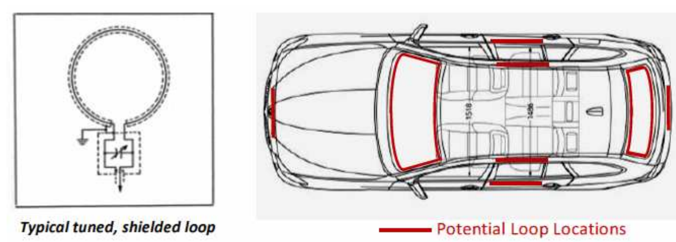


Figure 9 – Vehicle H-Field Implementations

As can be seen at left, the fundamental element in these antennas is the tuned loop. Obviously, the smart receiver hardware should incorporate appropriate tuning elements such as varactor diodes and associated control circuitry to permit the tracking of the antenna(s) with the selected station's frequency. This would significantly improve sensitivity and simultaneously afford additional selectivity to address close-in stations as well as local RFI sources. With multiple antennas as shown at right, effective diversity schemes for both FM and AM reception could be affordably implemented and provide a significant boost in reception quality in all types of terrain.

CONCLUSIONS

AM radio is a longstanding American institution, a source of unique voices, and one that we can ill afford to abandon. During the recent national disasters, Hurricane Katrina and Superstorm Sandy, AM radio stations proved to be the news source that the public utilized more than any other when telecom and other services were unavailable.

In this paper we have presented the technical specifications and circuit topology for smart AM receivers for the 21st century, which will be characterized by high- fidelity AM stereo reception in today's difficult noise environment, which in turn will serve to draw listeners back to the AM band and will enable music programming to be restored to this vital local radio service. The state-of-the-art AM receiver features that are addressed in this paper can be largely implemented with off-the-shelf radio receiver chip sets, augmented by advanced software-defined techniques.

Further, these advanced AM receivers will utilize the Motorola-developed (and FCC-sanctioned) C-QUAM compatible stereo technology, which is now non-proprietary due to the expiration of the associated patents. It is the opinion of the authors that the AM receiver technical specifications presented in this paper should be established by the FCC as the minimum acceptable technical standards for any new AM receivers introduced in U.S. retail stores, online outlets or in new automobiles and trucks. These changes, by establishing effective parity with FM, will greatly incentivize the listening public to return to the AM band, via the rapid establishment of noticeably better audio and reception conditions throughout the U.S.

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[5] Stephen F. Smith and James A. Moore, ***"A Precision, Low-Cost GPS-Based Synchronization Scheme for Improved AM Reception"***, IEEE 2006 Broadcast Technical Symposium, Washington, DC, September 29, 2006.

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[8] Product Datasheet for Si4764/65/66/67-A20, High-Performance Automotive AM/FM Radio Receiver and HD Radio Tuner, Silicon Labs, Inc., 2011.

[9] Product Datasheet for Si4770/77-A20, High-Performance Consumer Electronics Broadcast Radio Receiver and HD Radio Tuner, Silicon Labs, Inc., 2012.

[10] Product short data sheet for TEF665X, DSP-based radio tuner, one-chip, NXP Semiconductors, 2013.

Presentations for Meetings *(Cont. from page 3)* If you would like more information on a particular topic, and would like someone to do a presentation on it, you may suggest it as a topic. Please email Bob Kirby K3NT, Jim Skinner WB0UNI, Chris Havenridge KF5GUN, or Gene Duprey K1GD to present a topic or to suggest a topic for presentation.

(Contributed by Bob Kirby, K3NT)

Useful Websites for Amateur Radio Operators

The following websites were recommended by Paul Venstra, AA5PV. The first has several menu items that provide technical help and the second one provides an easy way to determine HF band conditions.

http://www.k7mem.com/

http://bandconditions.com/

Upcoming Events

FEBRUARY

20-21 — **International DX—CW** The objective is to encourage W/VE stations to expand knowledge of DX propagation on the HF and MF bands, improve operating skills, and improve station capability by creating a competition in which DX stations may only contact W/VE stations. W/VE amateurs work as many DX stations in as many DXCC entities as possible on the 160, 80, 40, 20, 15, and 10 meter bands. DX stations work as many W/VE stations in as many of the 48 contiguous states and provinces as possible. The event starts 0000 UTC Saturday; ends 2359 UTC Sunday. More info at http://www.arrl.org/arrl-dx.

MARCH

5-6 — **International DX—Phone** The objective is to encourage W/VE stations to expand knowledge of DX propagation on the HF and MF bands, improve operating skills, and improve station capability by creating a competition in which DX stations may only contact W/VE stations. W/VE amateurs work as many DX stations in as many DXCC entities as possible on the 160, 80, 40, 20, 15, and 10 meter bands. DX stations work as many W/VE stations in as many of the 48 contiguous states and provinces as possible. The event starts 0000 UTC Saturday; ends 2359 UTC Sunday. More info at http://www.arrl.org/arrl-dx.

REGULAR ACTIVITIES

Daily	DFW Early Traffic Net (NTS) at 6:30pm 146.88 – PL 110.9Hz
Daily	DFW Late Traffic Net (NTS) at 10:30pm 146.72 – PL 110.9Hz
Daily	Texas CW Traffic Net (NTS) at 7:00pm on 3541 KHz and at 10pm on 3541 KHz www.k6jt.com
1st Wednesday	Richardson Emergency Siren Test. At noon using the Richardson Wireless Klub (RWK) repeater at 147.120 MHz.
2nd Wednesday	ARES North Texas HF Net Every month—3860 KHz at 8:30 pm—9:30pm

Rockwell-Collins

Amateur Radio Club

Mail Station 461-290

P.O. Box 833807

Richardson, TX 75083-3807

TO:

CLUB STATIONS
(972) 705-1349

W5ROK REPEATER
441.875 MHz +5 MHz Input
131.8 Hz PL - RX and TX

W5ROK-1 PACKET BBS ROK Node
145.05 MHz

W5ROK-N1, W5ROK-N2 & W5ROK-N3 HSMM-MESHNET Nodes 2.4 GHz

Tuesday 23 Febuary 2016

1700 Social 1730 Meeting

Methodist Richardson Medical Ctr
At Bush/Renner/Shiloh Intersection

Second Floor Conference Room 200

NEXT SIGNALS INPUTS DEADLINE:
➔➔➔ 11 March 2016 ➔➔➔