DIGITAL MODES

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Well, we really are on a roll! In the last column I introduced CMSK[1], a new digital mode for LF/MF. I am now also able to announce a new Hellschreiber program, from the same source! The new program, ZL2AFP MSK-Hell[2], offers new Hell-style modes, based on MSK modulation, and also some ASK (on-off keyed) traditional Hell modes.

Hellschreiber is a deceptively simple facsimile technique, where characters are represented as a series of dots (like a dot-matrix printer). These dots are transmitted one at a time, scanning up and then across each character. Developed by Rudolf Hell, and patented in 1927, Hellschreiber was widely used for press services for more than thirty years. The system had the advantage that it was mechanically simple, and worked in any language. Mechanical teleprinters were a more recent invention: much more expensive, complex and less reliable. Hell was used by the German forces during WW II, and was also used in New Zealand for diplomatic traffic. After the war Hell was largely supplanted by RTTY, using newly developed FSK techniques, but Hell always was, and remains, inexpensive, simple and effective. From the 1930s until the 1960s, German press services were broadcast on LF using Hellschreiber, and Hell was used by the North Koreans as late as the 1980s, because of course any character set, including ideographic characters such as Korean, can be sent using the Hell technique.

Con ZL2AFP and I thought it would be a good idea to resurrect Hell for LF and MF, since that is the part of the spectrum where it started, but to now utilise MSK modulation, which is used by the military on LF, and more recently in CMSK. The original invention of PSK-Hell (back in 1998) was mine, and while IZ8BLY and I were experimenting with it, Nick UT2UZ (co-author of MIXW) suggested that MSK would be superior, and so it proved. That is where the idea of MSK-Hell began. (It is called FM-Hell in the FLDIGI, IZ8BLY and MIXW software, but is all the same technique).

The new program is again aimed at LF and MF, since there is already good Hell software for HF. The slowest mode, MSK-Hell 31, goes at about 7 wpm, and has a bandwidth of only 50 Hz. It is reasonably easy to tune in, and even the weakest signals can be seen on the tuning display. Most important of all, the sensitivity is excellent, about -15dB S/N for noise-free copy. There are two faster speeds, 62.5 and 105 baud. The latter is compatible with IZ8BLY FM-Hell 105, as I will explain in a moment. This mode is still fairly sensitive, and goes at 25 wpm, fast enough for any keyboard QSO! I have been copied easily in VK on 508.1 kHz, running this mode (see Fig. 2). The same three speeds are offered by the program in ASK Feld-Hell, and again the 105 baud mode is fully compatible with traditional 122.5 baud Feld-Hell.

So, you ask, how is it that 105 baud and 122.5 baud modes can be compatible? Well, back when IZ8BLY Hellschreiber was introduced, we were looking for a way to reduce the bandwidth in a differential PSK mode, where there were coding and modulation restrictions which didn't apply in quite the same way as they did to ASK modes. As a result, we had to redesign the font and restrict the font resolution. This is because for PSK we needed an even number of pixel pairs in all characters (because of the differential coding), to avoid inadvertent dots between characters. You may recall this reduced font from operating IZ8BLY's FM105 mode. The same reasoning applies to the new ZL2AFP software, except that for coding convenience we have applied the same font to Feld-Hell as well.

The original Hell font, from 1927, was very cunning. It retained 14-pixel column resolution while achieving half the bandwidth, a bandwidth equivalent to 7 pixels per column, by never transmitting individual pixels or pixel gaps. It achieved 14-pixel equivalent resolution by subtly shifting the transmitted pixels groups around in the font design. Seven pixel pairs per column at 122.5 baud means a column rate of 17.5 col/sec.

The new ZL2AFP system, and IZ8BLY/MIXW/FLDIGI FM105, have 12 dots per column, instead of 14, and since the dots are always sent in pairs, rather than shifted around subtly as in the original design, the font does not look quite as good as the original Hell font. However, the rate at which the columns are scanned does remain the same, 17.5 columns per second. Because of this, the characters print correctly when received with the IZ8BLY or any other standard software. With only six pixel pairs per column, that works out at 17.5 x 6 = 105 baud.

Hellschreiber is an asynchronous technique, there is no synchronization, the data is just displayed as it arrives, with the transmitter and receiver running independently at about the same speed. In the examples (Fig. 1 and Fig. 2) you can see the text is on a slope. This has nothing to do with the wrong baud rate as such, but illustrates what happens when asynchronous equipment runs at very slightly different speeds (sound card sample rate differences). Although the text is slanted, it remains readable because it is printed twice, one image above the other. The characters are always only transmitted once.

As described when CMSK was introduced recently, MSK represents the narrowest possible mode that can be reliably demodulated. In fact the bandwidth and spectrum is the same as PSK, the difference being the phase relationship between the data and the carrier. In MSK the phase shift is introduced by making a continuous phase frequency shift of one half the baud rate, so the phase changes by 180° smoothly over the duration of one symbol, rather than as a discontinuity between symbols.

One major difference between MSK and PSK, and the reason why MSK is popular commercially on LF and MF, is that with no sudden phase discontinuities in signalling with MSK, no raised cosine AM envelope is required to suppress keying sidebands. This in turn means that you need not use a linear transmitter or amplifier, a major point where it is desirable to use very efficient high power Class D or Class E transmitters.

With MSK, the receiver demodulator must recover the data symbol sync from the data, rather than from the AM envelope (as is done with PSK31, for example). While this adds to the complexity, it also improves the robustness as the noise rejection is improved. A digital demodulator called a Costas Loop is generally used to demodulate MSK (and will also demodulate PSK).

When MSK is applied to Hellschreiber, the modulation technique is very simple–a white pixel is one frequency, and a black pixel another (generally lower). The total shift is one half the baud rate. If received 'upside down' (on LSB instead of USB), the text will simply appear as white on a black

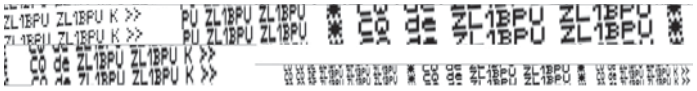

Figure 1. Examples of Hellschreiber text.

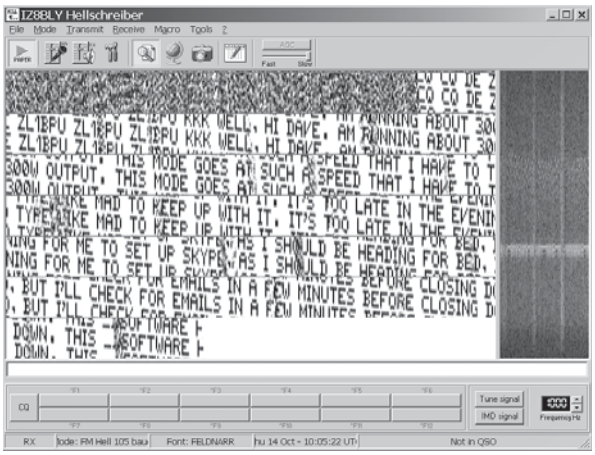

Figure 2. VK2DDI receiving ZL1BPU on 508.1 kHz using IZ8BLY Hellschreiber.

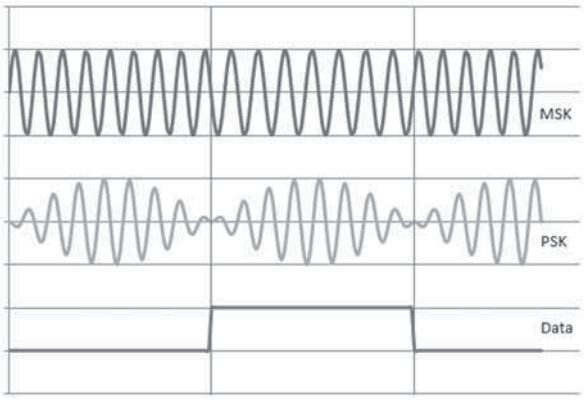

Figure 3. Illustration of PSK and MSK modulation.

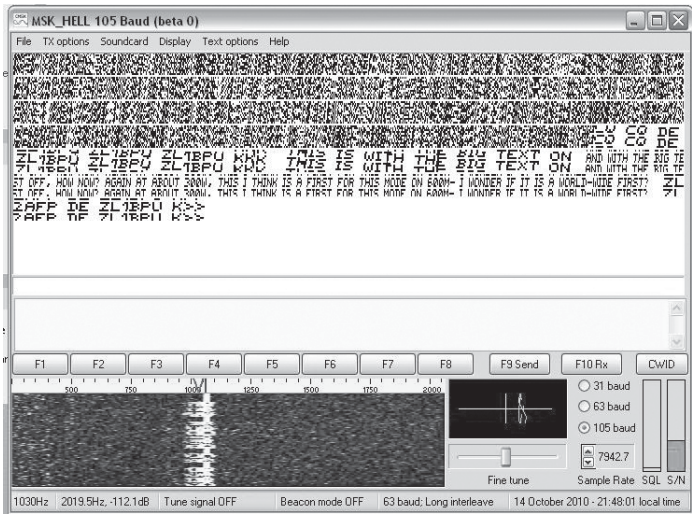

Figure 4. Screenshot of the ZL2AFP MSK-Hell program in QSO.

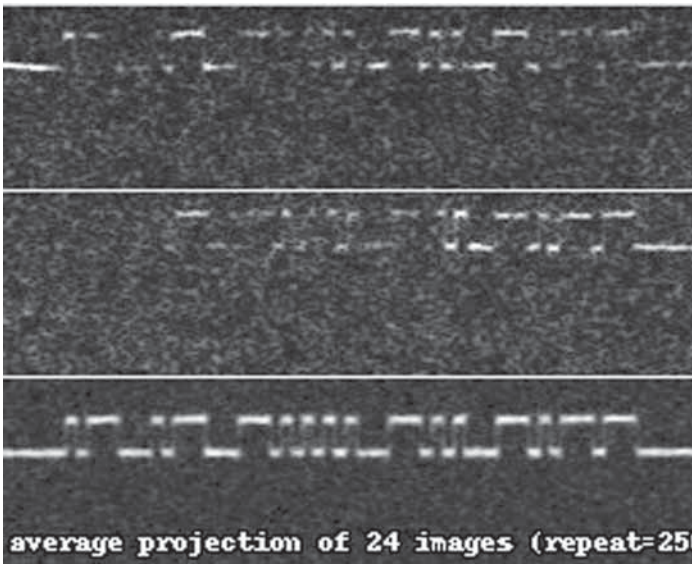

Figure 5. Stacking example by WA8KNE.

background. Although with narrow transmissions tuning needs to be done with care, it is simple enough. You just adjust for sharp black text on a white background. It's best to fine tune by watching the background and setting it just as it starts turning grey. Because the demodulator is completely insensitive to noise, even when the signal is weak, the result is high contrast sharp text against a noise-free white background.

While the software will work fine on HF (it has been extensively tested on 80m), the really narrow 31 and 63 baud modes will only reach their full potential where reasonable phase stability of received signals is assured (i.e. LF and MF). Otherwise the slow-speed text tends to be broken up by Doppler-induced phase noise. Multi-path timing effects are much reduced on the slower speeds.

Hellschreiber has been described as a 'Fuzzy' mode, like Morse, where the human eye or ear and brain are used to achieve superior character recognition in noise. In order to do this, the characters must be presented to the reader without computer or hardware decisions, such as what is received, or when it is received. For Hell this means that dots that aren't strong come out grey, or can even be missing, and if they arrive early or late, or surrounded by noise, you see that too. No decisions are made by the computer. One of the features of computer-received Hell is that to achieve these requirements, the incoming data is asynchronously sampled several times faster than the dot rate, and the tiny portions of dots displayed on the screen are reconstructed by the reader's eye. Because no assumptions are made of timing, the received information is displayed twice to ensure that it is readable (see Fig. 1).

In the new program, a slight departure is made from the 'Fuzzy' rules. An alternative synchronous demodulator is offered, where the symbol clock recovered from the incoming signal is used to time dot placement on the screen. While not quite as sensitive as the 'Fuzzy' asynchronous option, and slightly more prone to multi-path errors, this option has the ability to straighten out the text (as the clock follows incoming timing variations), making it easier to read. It won't however correct for sampling rate error. The asynchronous MSK detector normally used has the endearing characteristic that, while remaining sharp and clear, the text tends to wander up and down. Under the same propagation conditions, ASK (Feld-Hell) becomes quite blurred.

The new program includes such 'user friendly' features as macro keys, a beacon mode, CWID and two nice tuning displays. The popular waterfall display is used to select the received signal (coarse tuning). There is also an eye diagram display (as in the CMSK software) which is used for fine tuning, in association with a slider control under the display. Although Feld-Hell is the easiest of modes to use, and needs no fine tuning, the eye diagram display (without the eye, of course) also operates in Feld-Hell modes. To operate this software on LF or MF, you will need an SSB exciter, but you do not need a linear transmitter (for MSK-Hell), or very much transmitter power.

Stacking

In the last column I briefly mentioned 'stacking', the process of signal enhancement by combining (superimposing) several grabber images. A really good example is shown in Figure 5. The upper images are two of the 24 individual frames used to make the composite (lowest) picture, which is clearly identifiable as a QRSS3 transmission by AA6DY. Now you'd never be able to decipher the call reliably from any of the individual frames, because the signal suffers from fades and has 'holes' in it, probably due to AGC wind-back caused by lightning. However the composite frame is quite clear. All you need to make these analyses is a spectrogram program (could be a grabber on the web), transmissions with the same time frame as the grabber (typically ten minutes), and some suitable software, such as QRSS Stacker by Scott Harden AJ4VD[3]. There are now plenty of stacking examples on the web, and I have a couple below.

In this next example (Figure 6), Bill W4HBK has stacked six images. There are three signals that are synchronous with the ten minute period of his grabber, and right in the middle you can clearly see 'ZL1EE' in MT-Hell and CASTLE. In between these features, five diagonal stripes are transmitted, at 6 dB per step reducing power levels from 100 mW. I can just see the third one; representing 6.3 mW, all the way to Florida on 10 MHz! My little QRSS3 MEPT on 10.139 MHz uses a 6m vertical whip antenna, has an output of 100mW PEP, and operates with a ten minute period.

W4HBK has also made stacked enhancements from other grabbers than his own, for example that of Peter ZL2IK. In this example (Figure 7), there are three ten minute synchronous signals enhanced: mine, VK6JY, and W4HBK's own. You will rarely see

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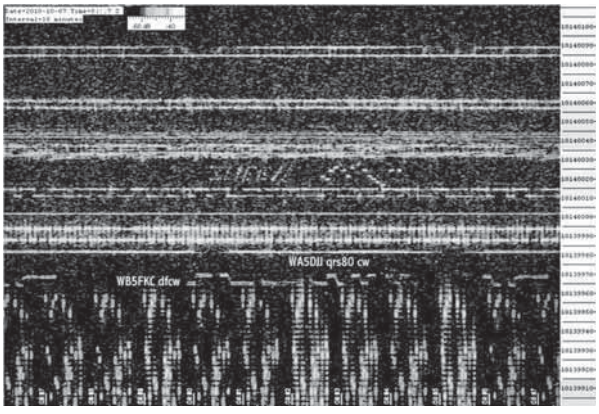

Figure 6. Stacking example by W4HBK.

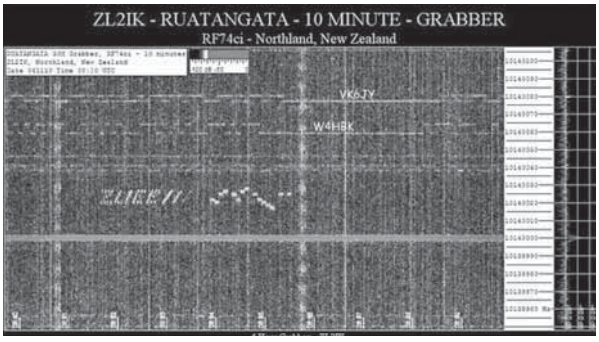

Figure 7. Stacking example from ZL2IK grabber.

FMTAG

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SRD interference TO 70cm repeaters

FMTAG has received enquiries from Branches suffering Short Range Device (SRD) interference to the input of their 70 cm repeaters.

The three, most common, solutions are:

- Add a Continuous Tone Coded Squelch (CTCS) encoder to the user's transmitter and add a Continuous Tone Coded Squelch decoder to the repeater's receiver. These additions do not require MED licensing action.
- Change the receive and transmit frequencies of the repeater. This change requires MED licensing action. Unfortunately, this change may only give short-term relief, since SRDs can pop up on any repeater input frequency.
- Invert the receive/transmit frequency sense of the repeater (and of the user's transceiver). This repeater change also requires MED licensing action. Branches can start the licensing process by completing NZART Form 10, available on the NZART website, and sending it to: <fmtag@nzart.org.nz>

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the ZL1EE signal directly on the ZL2IK grabber, as the distance puts me in skip, but the ghostly signal rises out very clearly in this nine-frame stack.

Need a cheap oscilloscope?

Here's an interesting idea I came across; it is both an oscilloscope and a digital voltmeter. It contains just one chip (an ATTiny45 micro), and is powered by a computer USB port. There are two analog inputs, and it is arranged so you can connect it directly into a plug-in prototyping board. The A-D is only 10-bit, but the software and schematic are available free[4]. There are under 20 components involved, and I would imagine a cost of $30 or less.

Signal Level Measurement

If you are interested in making accurate off-air signal level measurements, there's no substitute for a real Selective Level Meter, such as the old Wandel & Goltermann SPM-6 (which I have), Siemens D2057 or Anritsu ML422C. Several ZLs are now using such instruments for signal strength reporting on LF and MF. I've come across an interesting technique developed by Owen Duffy VK1OD[5] which allows measurements to be made using a relatively conventional SSB receiver or transceiver. The technique relies on the fact that the audio output power of the receiver is relatively linear with signal strength up to the point where AGC action occurs. He has demonstrated reasonable linearity between –135dBm and –115dBm. Clearly for stronger signals you would need an external calibrated attenuator. Worth experimenting with your receiver!

References

[1] <www.qsl.net/zl1bpu/CMSK/cmsk.htm>
[2] <www.qsl.net/zl1bpu/HELL/MSK/LF_mskhell.htm>
[3] <www.swharden.com/blog/vd-labs-software-by-aj4vd/>
[4] <yveslebrac.blogspot.com/2008/10/cheapest-dual-trace-scope-in-galaxy.html>
[5] <vk1od.net/software/fsm/>

Proposals published on the NZART web site and in HQ-Infoline

Branch 66 Auckland VHF Group has applied for a Spectrum Licence on TV Channel 39 for its Nihotupu ATV repeater, to replace its previous Radio Licence, cancelled by the MED as part of the Digital Switch-Over process. The location is Nihotupu, Topo50 map reference BA31 401.84 114.69. All of the engineering parameters are unchanged from those of the cancelled licence.

Branch 74 Wellington VHF Group has applied for a Spectrum Licence on TV Channel 39 for its Belmont ATV repeater, to replace its previous Radio Licence, cancelled by the MED as part of the Digital Switch-Over process. The location is Belmont, Topo50 map reference BQ32 568.79 398.86. All of the engineering parameters are unchanged from those of the cancelled licence.

Final recommendations to NZART Council

Branch 11 Gisborne has applied for a 2 metre APRS Digipeater at Whakapunake, Topo50 map reference BH42 992.89 915.63. An engineering evaluation confirms that there will be no interference to other stations and that the transmit and receive frequency will be 144.575 MHz.

Branch 26 Nelson has applied to relocate its 890 repeater to Fringed Hill North, Topo50 map reference BQ26 265.95 270.15. An engineering evaluation confirms that there will be no interference to other stations and that the repeater transmit frequency can remain on 438.900 MHz and the repeater receive frequency can remain on 433.900 MHz.

Branch 30 Otago has applied for a 70 cm repeater at Rudd Road, Topo50 map reference CE17 032.61 204.29. We have selected a repeater transmit frequency of 439.150 MHz. The associated repeater receive frequency will be 434.150 MHz. An engineering evaluation confirms that there will be no interference to other stations.

Branch 33 Rotorua has applied for a 2 metre APRS Digipeater at Makatiti Dome, Topo50 map reference BE38 038.75 730.97. An engineering evaluation confirms that there will be no interference to other stations and that the transmit and receive frequency will be 144.575 MHz.

Branch 71 Rodney has applied to relocate its 730 repeater to Moirs Hill Road, Topo50 map reference AZ31 475.39 625.68. An engineering evaluation confirms that there will be no interference to other stations and that the repeater transmit frequency can remain on 147.300 MHz and the repeater receive frequency can remain on 147.900 MHz.

Branch 81 Waikato VHF has applied to relocate a simplex linking transceiver from Te Aroha to Te Uku, Topo50 map reference BD32 733.36 067.57. An engineering evaluation confirms that there will be no interference to other stations and that the transmit and receive frequency can remain on 430.2125 MHz.

Branch 81 Waikato VHF has applied for a simplex linking transceiver at Te Uku, Topo50 map reference BD32 733.36 067.57. FMTAG has chosen a transmit and receive frequency of 439.350 MHz. An engineering evaluation confirms that there will be no interference to other stations.

Branch 81 Waikato VHF has applied for a simplex linking transceiver at Te Weraiti, Topo50 map reference BD36 558.18 103.12. FMTAG has chosen a transmit and receive frequency of 439.350 MHz. An engineering evaluation confirms that there will be no interference to other stations.

Branch 81 Waikato VHF has applied to relocate its 2 metre repeater from Te Aroha to Te Weraiti, Topo50 map reference BD36 558.18 103.12. An engineering evaluation confirms that there will be no interference to other stations and that the repeater transmit frequency can remain on 146.950 MHz. The associated repeater receive frequency will be 146.350 MHz.

Branch 88 Tauranga Emergency Communications has applied for a 2 metre repeater at TECT All Terrain Park, Topo50 map reference BE36 749.37 969.25. FMTAG has chosen a repeater transmit frequency of 147.025 MHz and associated repeater receive frequency of 147.625 MHz. An engineering evaluation confirms that there will be no interference to other stations.

ZL2BDI has applied for a 70 centimetre ATV Beacon at Lower Hutt, Topo50 map reference BQ32 575.50 361.93. An engineering evaluation confirms that there will be no interference to other stations and that the Vision Carrier frequency will be 431.250 MHz, in accordance with the NZART bandplan.

Comments and applications

Please send your comments and suggestions on the above matters, and on any other FMTAG matters, by e-mail to: <fmtag@nzart.org.nz>.

Applications for repeaters, beacons, digipeaters, point-to-point links, and so on, should be made on the latest version of FMTAG Form 10. The latest versions of FMTAG Form 10, and the explanatory Form 10A, are available on the NZART web site: <http://www.nzart.org.nz/fmtag/index.html>.

Completed forms should be sent by e-mail to <fmtag@nzart.org.nz>.

NEW MEMBERS

Name	*City/Town*	*Branch*	*Call-sign*
P J T Power	Christchurch	5	ZL3UPP
Rowena Johnstone	Hataitai Wellington	13	ZL2ROW
Anne Stell	Havelock North	13	ZL2CDX
Michael Tololi	Napier	13	ZL2CEP
J A French	Napier	13	ZL2ADX
W A Lamb	Napier	13	ZL2AWL
B E Cutfield	Whakatane	51	ZL1AFN
R C Claydon	Christchurch	5	ZL3THD
R Blaha	Napier	25	ZL2KBR
J D MacKenzie	Christchurch	5	ZL3JDM