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iCon Advanced Security FlexNet Integrated Display Transceiver

Modulation Specification

5.1 SUPPORTED MODULATION MODES

The second generation FlexNet Integrated Display Transceiver supports five different on-air message modulation formats. Normal Mode, mPass Mode and C&I mode were supported in the previous generation transceiver.

For the iCon Advanced meter, a new modulation format, 13-FSK, was developed to increase the throughput of power outage messages. Since 13-FSK is approximately twice the effective baud rate of the previously developed 7-FSK, it can effectively cut the on-air message duration for the same amount of data.

In a deployed FlexNet system for an electric utility, the TGB will contain three independent receive channels that cover 50 kHz of contiguous bandwidth. One channel will receive the 25 kHz Normal and Double Density transmissions. The second channel will receive the 12.5 kHz transmissions. Finally, a third channel will receive the 12.5 kHz priority channel transmissions.

5.2.1 "NORMAL" MODE (FULL BAUD 7-FSK)

Normal mode is the standard modulation scheme used by the FlexNet transceiver when transmitting directly to a TGB. Normal mode uses a proprietary narrow band modulation scheme (7-FSK) to transmit data at an 8.044 kbs rate in a 25 kHz radio channel. Normal mode modulation is extremely tolerant to fast fades and Doppler shift created by moving objects near the transmitter or a non-Line of Sight signal path to the tower. Normal mode modulation provides the greatest link margin in the system as the receiver in the TGB achieves a greater than -120 dBm level of sensitivity.

5.2.1.1 MODULATION TYPE: 7 Level Frequency Shift Keying (7FSK), a 16 QAM Signal, Beta=1.89 (Patent Pending)

5.2.1.2 BAUD RATE: 8.04455 kBits/sec

5.2.1.3 NECESSARY BANDWIDTH: (Baud/4)+2(3808) = 9.627321 kHz

5.2.1.4 EMISSION DESIGNATOR: 9K60F2D

5.2.1.5 EMISSIONS COMPLIANCE:

- FCC Part 90.210 Mask J Standard
- FCC Part 101.111 (6) 25 KHz BW
- FCC Part 24.131 Mask 20 kHz Authorized BW

5.2.1.6 ERROR CORRECTION: Interleaved and ½ bit rate Viterbi convolutionally encoded with constraint length K=3.

5.2.2 "mPASS" MODE (GMSK)

mPass or "Buddy Mode" is the standard modulation scheme used by the FlexNet transceiver to pass messages through nearby FlexNet transceivers and pole-mounted FlexNet Remote Portals. mPass modulation is also used by the TGB for all commands to FlexNet devices.

mPass modulation uses Gaussian Minimum Shift Keying FM modulation. GMSK is simply a spectrally efficient version of 2-level MSK. (Minimum Shift Keying)

mPass modulation is the only modulation format that the receiver IC on the FlexNet transceiver can receive. The receiver at the endpoint does not listen to meters configured to Normal mode. Likewise, the tower does not listen to mPass mode transmissions.

The baud rate for the mPass channel is 5.00 kbs and the GMSK transmissions can fit in a 12.5 kHz radio channel.

5.2.2.1 **MODULATION TYPE:** Minimum Shift Keying (MSK), 2 Level FSK with Beta = 0.5

5.2.2.2 **BAUD RATE:** 5 kBits/sec

5.2.2.3 **NECESSARY BANDWIDTH:** Baud * 1.18 = 5.9 kHz

5.2.2.4 **EMISSION DESIGNATOR:** 5K90F1D

5.2.2.5 EMISSIONS COMPLIANCE:

- FCC Part 90.210 Mask J Standard
- FCC Part 101.111 (6) 25 KHz BW
- FCC Part 24.131 Mask 10 KHz and 20 KHz Authorized Bandwidth

5.2.2.6 **ERROR CORRECTION:** Interleaved and ½ bit rate Viterbi convolutionally encoded with constraint length K=3.

5.2.3 "C&I" MODE (HALF-BAUD 7-FSK)

C&I mode is simply Normal mode with the baud rate cut in half. Since the FM beta remains the same, the peak deviation is also cut in half. This reduction is baud rate basically allows 7-FSK data to be transmitted at 4.022 kbs in a 12.5 kHz radio channel.

C&I mode as the name implies is used mainly by C&I meters as a poll and respond channel for the system. (There are no supervisory read messages sent by any meter on the C&I channel) The C&I channel is used mainly for demand resets, TOU tier queries, and load profile downloads.

5.2.3.1 **MODULATION TYPE:** 7 Level Frequency Shift Keying (7FSK), a 16 QAM Signal, Beta=1.89 (Patent Pending)

5.2.3.2 **BAUD RATE:** 4.022277 kBits/sec

5.2.3.3 **NECESSARY BANDWIDTH:** (Baud/4)+2(1875) = 4.813569 kHz

5.2.3.4 **EMISSION DESIGNATOR:** 4K80F2D

5.2.3.5 EMISSIONS COMPLIANCE:

- FCC Part 90.210 Mask J Standard
- FCC Part 101.111 (6) 25 KHz BW
- FCC Part 24.131 Mask 10 KHz and 20 KHz Authorized Bandwidth

5.2.3.6 **ERROR CORRECTION:** Interleaved and ½ bit rate Viterbi convolutionally encoded with constraint length K=3.

5.2.4 "PRIORITY" MODE (HALF BAUD 13-FSK)

Priority mode uses the new 13-FSK narrowband FM modulation scheme and will be used primarily to send messages that require a clear channel and a high level of priority such as power fail, power restore and hot socket messages.

Since the on-air bit rate is effectively doubled with 13-FSK as compared to 7-FSK, 13-FSK in full baud mode can transmit 16.088 kbs in a 25 kHz radio channel. For the priority channel, the baud rate of 13-FSK is cut in half allowing for 8.044 kbs transmissions in the 12.5 kHz priority channel.

In order to further reduce on-air message duration the data payload of a priority mode transmission has been reduced to 12-bytes instead of 28-byte for a normal mode transmission.

5.2.4.1. **MODULATION TYPE:** 13 Level Frequency Shift Keying (13FSK), a 256 MCM Signal, Beta=2.62 (Patent Pending)

5.2.4.2. **BAUD RATE:** 8.04455 kBits/sec

5.2.4.3. **NECESSARY BANDWIDTH:** (Baud/8)+2(1875) = 4.813569 kHz

5.2.4.4. **EMISSION DESIGNATOR:** 4K80F2D

5.2.4.5. EMISSIONS COMPLIANCE:

- FCC Part 90.210 Mask J Standard
- FCC Part 101.111 (6) 25 KHz BW
- FCC Part 24.131 Mask 10 KHz and 20 KHz Authorized Bandwidth

5.2.4.6. **ERROR CORRECTION:** Interleaved and ½ bit rate Viterbi convolutionally encoded with constraint length K=3.

5.2.5 "DOUBLE DENSITY" MODE (FULL BAUD 13-FSK)

As mentioned in the preceding section, Double Density mode gets its name since the baud rate of 13-FSK is effectively doubled compared to 7-FSK normal mode.

Double density mode will be used for two purposes in the iCon Advanced meter. The first purpose is to extend the effective history length for high resolution meter reads. This allows the meter to more than double the amount of history transmitted in each meter read message for a slight reduction in on-air message duration as compared to Normal mode.

The second purpose for Double Density mode is the preserve an identical history length as a standard Normal mode transmission but cut the on-air message duration nearly in half. This reduction in message duration allows more endpoints to be in range of a single TGB for dense instillations in urban environments.

Since there are two uses of double density mode, there will be two different message lengths supported. One message length will be "Extended History" and the other will be "Reduced Duration".

There is a setup option in the FlexNet configuration that configures all meter read supervisory messages to be transmitted in Normal Mode, Extended History Double Density or Reduced Duration Double Density Mode depending on the system design for a particular installation.

Double Density however does not come without a price – since the same number of bits is transmitted in half of the time the energy per bit is effectively halved resulting in a 3 dB reduction in receiver sensitivity.

5.2.5.1. **MODULATION TYPE:** 13 Level Frequency Shift Keying (13FSK), a 256 MCM Signal, Beta=2.62 (Patent Pending)

5.2.5.2. **BAUD RATE:** 16.0891 kBits/sec

5.2.5.3. **NECESSARY BANDWIDTH:** (Baud/8)+2(3808) = 9.627321 kHz

5.2.5.4. **EMISSION DESIGNATOR:** 9K60F2D

5.2.5.5. EMISSIONS COMPLIANCE:

- FCC Part 90.210 Mask J Standard
- FCC Part 101.111 (6) 25 KHz BW
- FCC Part 24.131 Mask 20 kHz Authorized BW

5.2.5.6. **ERROR CORRECTION:** Interleaved and ½ bit rate Viterbi convolutionally encoded with constraint length K=3.

5.2.6 FUTURE UNDEFINED MODULATION MODE SUPPORT

The Flexnet modulation is digitally generated in firmware and sent out via SPI writes to a sigma-delta fractional-N synthesizer. This allows for future upgradability of modulation modes remotely via FW upgrade. The PLL in the XCVR has three selectable loop filters to allow future higher data rate, of wider bandwidth modulations to be transmitted.