

Technical Note



Real-Time Baseband Option 008 Ancillary Information



This document contains the data bit to symbol mapping for the generic modulation formats of Opt 8 Real-Time Baseband.

Generic modulation formats

Option 8 Real-Time Base Band generates baseband I and Q signals that modulate the RF in real-time to produce generic FSK, PSK and QAM signals at rates up to 2 M symbols/sec. The symbol data may be generated internally as a PRBS or fixed data pattern, or externally as real-time symbol data. Such data may be applied in serial or parallel format, or as digitized IQ data, via the LVDS interface.

This document summarizes each of the generic modulation formats and follows this with the data bit to symbol mapping information. The QAM formats are supported with constellation diagrams.

PSK	BPSK, QPSK, 8PSK, 16PSK 8PSK, EDGE (8PSK with $3\pi/8$ rotation) $\pi/2$ DBPSK, $\pi/4$ DQPSK, $\pi/8$ D8PSK DBPSK, DQPSK, D8PSK OQPSK (time offset)
MSK	GMSK
FSK/ GFSK	2 and 4 level symmetric
QAM	16, 32, 64, 128, 256 level

Symbol Rate

Range:	5 kHz to 2 MHz
Resolution:	1 Hz

Baseband Channel Filters

Filter Types

Nyquist	$\alpha = 0.2$ to 0.8 , resolution 0.01
Root Nyquist	$\alpha = 0.2$ to 0.8 , resolution 0.01
Gaussian	Bt 0.1 to 1.0 , resolution 0.1
EDGE	"Linearised Gaussian" as defined in GSM 05.04

Data mapping for each modulation scheme is as follows:

Modulation Mapping

In most cases, Gray coding is applied to the modulation mapping.

BPSK

0	0
1	$+\pi$

QPSK, OQPSK

0 0	$+\pi/4$
0 1	$+3\pi/4$
1 0	$-\pi/4$
1 1	$-3\pi/4$

$\pi/4$ DQPSK

0 0	$+\pi/4$
0 1	$+3\pi/4$
1 0	$-\pi/4$
1 1	$-3\pi/4$

8PSK, D8PSK

0 0 0	$+0\pi/4$
0 0 1	$+1\pi/4$
0 1 1	$+2\pi/4$
0 1 0	$+3\pi/4$
1 1 0	$+4\pi/4$
1 1 1	$+5\pi/4$
1 0 1	$+6\pi/4$
1 0 0	$+7\pi/4$

$3\pi/8$ 8PSK (EDGE)

0 0 0	$+3\pi/4$
0 0 1	$+4\pi/4$
0 1 0	$+2\pi/4$
0 1 1	$+1\pi/4$
1 0 0	$+6\pi/4$
1 0 1	$+5\pi/4$
1 1 0	$+7\pi/4$
1 1 1	$+0\pi/4$

NOTE: This is Gray coded but not in the conventional manner.

2FSK

0	Carrier - deviation
1	Carrier + deviation

4FSK

0 0	Carrier - deviation
0 1	Carrier - (deviation / 3)
1 0	Carrier + deviation
1 1	Carrier + (deviation / 3)

NOTE: For P-25, the data encoding must be set to inverted.

QAM

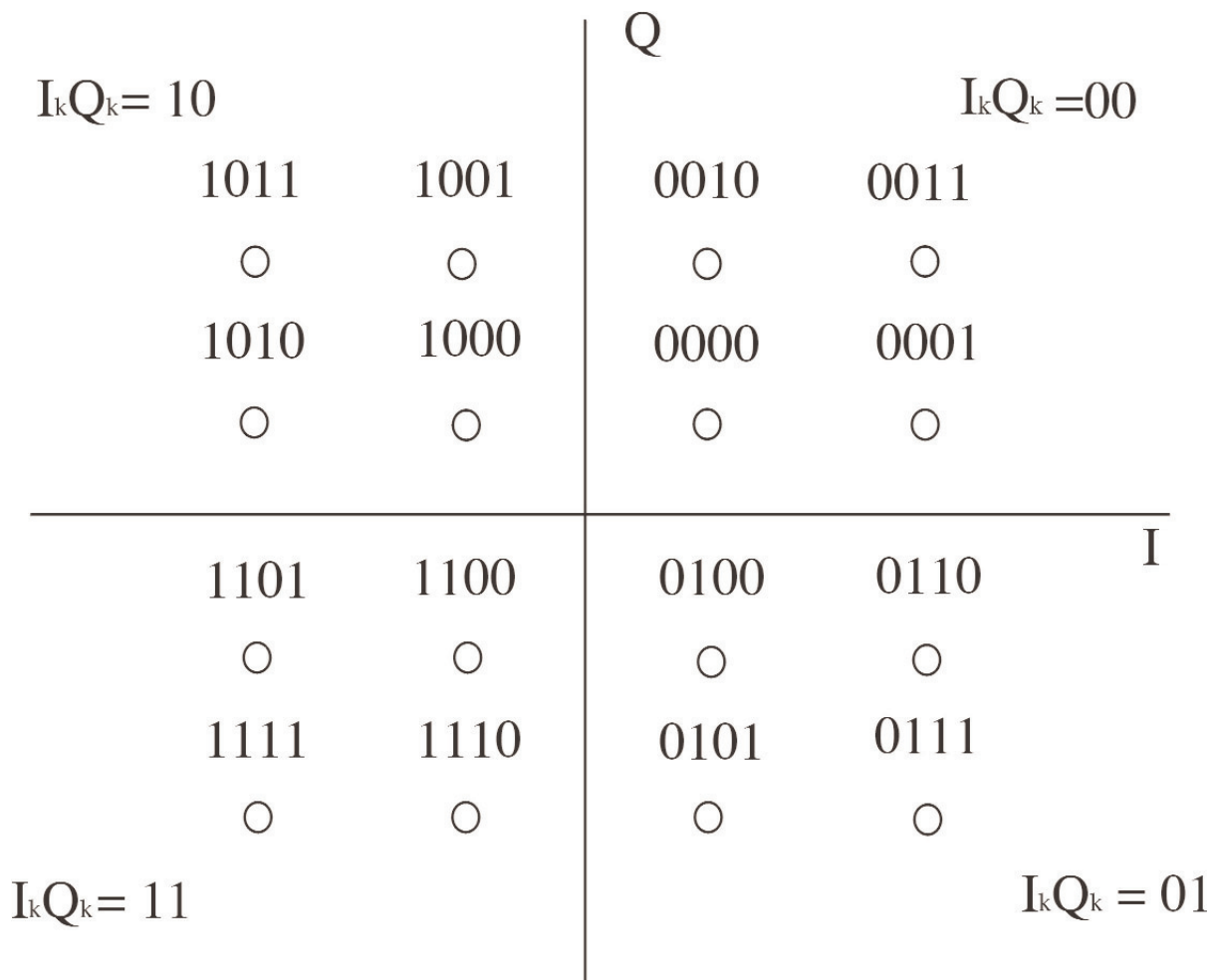
These are to be implemented in accordance with ETSI standard EN300-429 for Digital Video Broadcast (DVB). The constellation points in Quadrant 1 are converted to Quadrants 2, 3 and 4 by changing the two MSB (I_k and Q_k) and by rotating the LSB's according to the following rule -

Quadrant	MSBs	LSBs rotation
1	00	
2	10	$+\pi/2$
3	11	$+\pi$
4	01	$+3\pi/2$

The constellation points (symbols) in each quadrant are Gray-coded.

In the following diagrams, I_k and Q_k are the two most significant bits in the quadrant.

16-QAM



32-QAM

$I_k Q_k = 10$			Q	$I_k Q_k = 00$		
	10111	10011		00110	00010	
	○	○		○	○	
10010	10101	10001		00100	00101	00111
○	○	○		○	○	○
10110	10100	10000		00000	00001	00011
○	○	○		○	○	○ I
11011	11001	11000		01000	01100	01110
○	○	○		○	○	○
11111	11101	11100		01001	01101	01010
○	○	○		○	○	○
	11010	11110		01011	01111	
	○	○		○	○	
$I_k Q_k = 11$						$I_k Q_k = 01$

64-QAM

$I_k Q_k = 10$				Q	$I_k Q_k = 00$			
101100	101110	100110	100100		001000	001001	001101	001100
○	○	○	○		○	○	○	○
101101	101111	100111	100101		001010	001011	001111	001110
○	○	○	○		○	○	○	○
101001	101011	100011	100001		000010	000011	000111	000110
○	○	○	○		○	○	○	○
101000	101010	100010	100000		000000	000001	000101	000100
○	○	○	○		○	○	○	○
110100	110101	110001	110000		010000	010010	011010	011000
○	○	○	○		○	○	○	○
110110	110111	110011	110010		010001	010011	011011	011001
○	○	○	○		○	○	○	○
111110	111111	111011	111010		010101	010111	011111	011101
○	○	○	○		○	○	○	○
111100	111101	111001	111000		010100	010110	011110	011100
○	○	○	○		○	○	○	○
$I_k Q_k = 11$								$I_k Q_k = 01$

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