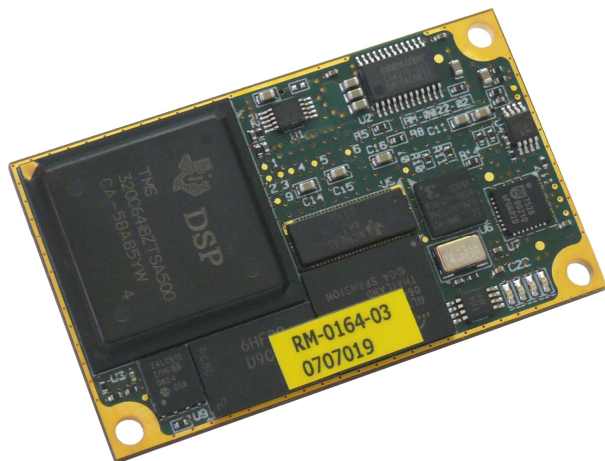


# TC4: V/UHF Modem Module [Prelim.]

## High Data Rate Modem

The **TC4** is a very compact high-performance V/UHF high data rate (HDR) modem module. The module is intended for integration into V/UHF radios and systems with an audio bandwidth exceeding 21 kHz (-30 db). Data is transferred at rates of up to 96,000 bps over a standard 25 kHz (-50 dB) V/UHF radio channel.



## Key Features & Benefits

- High Data Rate Modem
- 96000 bps (coded) in a 25 kHz VHF or UHF channel
- Embedded ARQ
- Interface for external ARQ (e.g. S 5066)
- Collision Avoidance Capability
- Analog or digital audio interface
- Low power consumption (< 1.3 W)
- Compact size: 33 x 55 x 8 mm
- RAP1/RIPC Control Protocol
- Easy system integration

Low data rates (up to 32 kbps) use Offset QPSK and 8-PSK waveforms. The low data rates are suitable for radios with a non-linear power amplifier (PA). The very high rates use QAM and require a linear PA or can work with wideband FM or AM radios.

Adaptive equalization mitigates the effects of channel multi-path. Convolutional encoding and soft-decision Viterbi decoding provides forward error correction.

## Control Protocol

The **TC4** uses a sub-set of the RAP1/RIPC Control Protocol. Alternatively a simple ASCII protocol is supported. The **TC4** Control Protocol also enables the user to log key communication parameters:

- Signal to noise ratio
- Frequency offset, Doppler Frequency etc.

## Waveforms

The **TC4** offers a choice of two waveforms:

- RM-VH1: Optimized for naval channels
- RM-VH2: Optimized for land mobile channels

**TC4-HDR** supports following modem data rates:

DATA RATE	MODULATION	CODE RATE	SNR FOR BER < 10 <sup>-5</sup>
96000	128-QAM*	0.86	27
76800	64-QAM	0.80	23
64000	32-QAM	0.80	18
48000	16-QAM	0.75	14
32000	3π/8 8-PSK	0.67	10
16000	π/4 QPSK	0.50	4

\* This data rate requires an end-user certificate.

The interleaver settings are shown in the table below.

#	DATA RATE	USER DATA PAYLOAD [BYTES]		
		US	S	L
		20 MS	160 MS	2560 MS
1	96000	240	1920	30720
2	76800	192	1536	24576
3	64000	160	1280	20480
4	48000	120	960	15360
5	32000	80	640	10240
6	16000	40	320	5120

## Embedded ARQ

The **TC4** offers the optional use of an internal ARQ protocol which ensures error-free delivery of data. This has advantages including following:

- Wide SNR range and V/UHF channel conditions
- No error-amplification due to crypto

ARQ MODE	MOD.	PACKET [BYTES]	THROUGH-PUT* [BPS]	EFFICIENCY
V-25-Q64-H4	64-QAM	377	63,495	82.68%
V-25-Q8-H2	8-PSK	313	26,358	82.37%

\* Max data rate excluding link setup (LSU).

## Collision avoidance, ACS

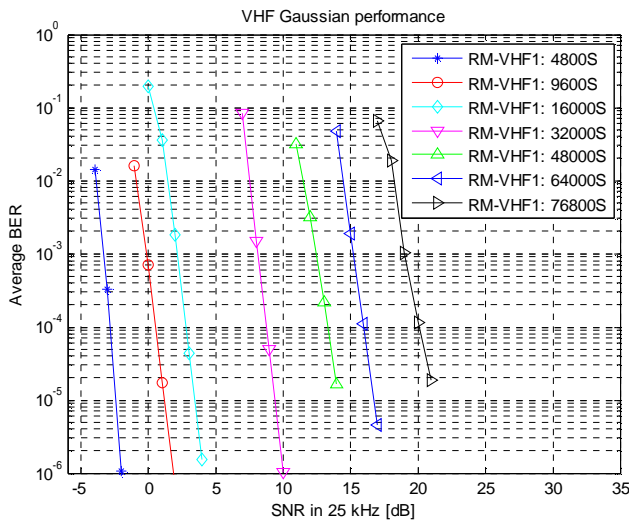
The collision avoidance mechanism uses an **ALLCALL** (no address information transmitted). The transmitter first listens on the channel. If the channel is occupied, the operation depends on the mode, namely:

- Fixed Frequency No ACS: Keep listening on the channel until NO ACTIVITY, then start 2-way ALLCALL after a Random Back-off period
- ACS & Radio Control: Change channel and keep listening until a channel is found with NO ACTIVITY, then start ALLCALL

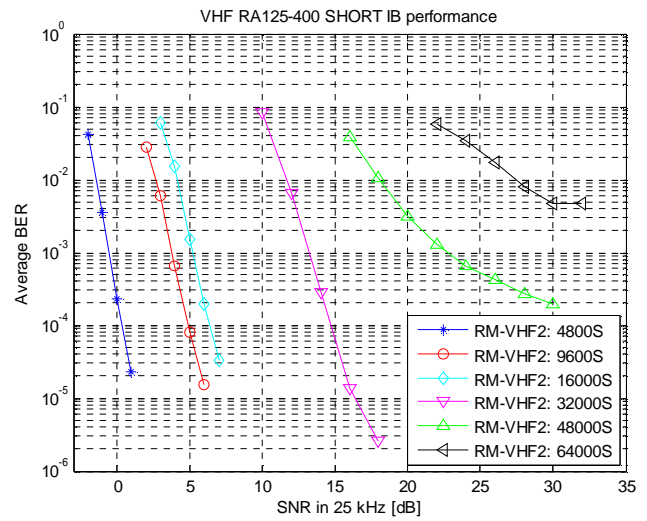
Transmission of data is only possible once the system is in the **LINKED** state. Linking Protection (LP) is used to isolate the network from denial of service attacks. This requires an accurate time base, (±7 minutes).

# Performance

The performance of the RM-VHF1 and RM-VHF2 waveforms are shown in the figures below.



RM-VHF1: Bit Error Rate Results for Gauss Channel



RM-VHF2: Bit Error Rate Results for RA125-400 Channel: Rural Area, 125 km/h, 400MHz

INTERFACES*	
SERIAL DATA PORT	Raw data modem port. Data Rate: 38400 to 115200 bps, async Flow ctrl: CTS/RTS, XON/XOFF. Electrical 3.3V LVTTTL
SERIAL CONTROL PORT	1) Control Port of <b>TC4</b> (for configuration of modem parameters). Uses RAP1/RIPC or a simple ASCII protocol, OR 2) Radio Control port (ACS): Required for Automatic Channel Select function Data Rate: 4800 to 115200 bps, async.
AUX. CONTROL PORT	Control Port of <b>TC4</b> (for configuration of modem parameters). Alternative to Serial Control Port. Supports encapsulated (user) data over RAP1/RIPC (available from <i>RapidM</i> ) Synchronous serial I/F McBSP port.
DIG. BASEBAND AUDIO PORT	Synchronous serial I/F McBSP port. (please refer to <b>TC4</b> V/UHF modem User Manual for details)
AUDIO PORTS	Signal carrier = 12500 Hz, bandwidth = 5000 – 20000 Hz, -3dB. Analog Audio Input : Rx line: 10 kΩ unbalanced 1.5 V p-p. PTT sense line: 3.3V LVTTTL. Analog Audio Output : Tx line: 40 Ω unbalanced 2.0 V p-p. Keyline: 3.3V LVTTTL.
DISCRETE LINES	PPS Pulse-Per-Second (for ALE LP) Speed select Man-pack mode or other Reset/P Down Power down and/or H/W reset Supply 3.3VDC

\* All **TC4-HDR** interfaces via a single 100-way fine pitch connector (Samtec YFT-20-xx-H-05-SB).

INSTALLATION	
SIZE	33 x 55 x 8mm (w x d x h)
POWER	3.3V DC, 0.83 Watt low-speed (man-pack) 1.27 Watt high-speed (vehicle & base)

ENVIRONMENTAL	
TEMPERATURE	-40°C to +85°C (operating); -40°C to +90°C (storage)

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