Application

Vehicle docking with DUSBL system

In this example, a vehicle equipped with a DUSBL at 24 kHz for homing and a Micromodem-2 at 10 kHz for communication and navigation, is configured for docking. The dock is a Hybrid Gateway Buoy equipped with Iridium, RF comms and a Micromodem-2.

Docking scenario with a Hybrid Gateway Buoy as the dock:

1. Vehicle pings the 'dock' at 10 kHz using $CCPGT with an upsweep.
2. Simultaneously, it pulls a GPIO line (J1.P7) low for the DUSBL to provide timing on the outgoing ping. The 'dock' modem is configured to listen for USBL start signal as well as comms signals at 10 kHz. The USBL ping reply is sent out at 24 kHz to match the DUSBL system capability.
3. DSUBL hears the dock reply at 24 kHz and provides USBL navigation to the vehicle.

Set up:

Vehicle modem configuration parameters:

$CCCFG,BND,0
$CCCFG,BW0,4000
$CCCFG,FC0,10000
$CCCFG,nav.dt.txtrig_gpio4,1
$CCCFG,nav.nst,1

Dock (transponder) modem configuration parameters:

$CCCFG,BND,0
$CCCFG,BW0,4000
$CCCFG,FC0,10000
$CCCFG,nav.dt.mode,3
$CCCFG,nav.dt.type,1
$CCCFG,nav.nst,1

Command from vehicle to all four transponders (DT4 A-D), with reply from DT4A, host to mode commands are in bold, modem to host commands are regular. See Micromodem-2 Users-Guide for

details on modem messages. Since the modem does not listen for replies in this case, ‘rx_seq_code’ fields can be left as zeroes.

$CAREV,211404,AUV,2.0.32731*19
$CCPGT,1,10000,40,0,1000,24000,28,0,0,0,0,4000,4000,0
$SNPGT,1,10000,40,0,1000,24000,28,0,0,0,0,4000,4000,0*67
$CATXP,400*46
$CATXF,400*50
$CAXST,6,20190411,211410.530441,3,0,40,4000,10000,-2,0,0,0,0,0,-1,0*7A
$SNTTA,,,,,211410.53*5F
$SNNST,0,10000,10,20190411211410.530441,5,246,50,0,,,,,01,24000,,,,,02,24000,,,,,03,24000,,,,,04,24000,,,,*40

On the dock side, the log will show a transmission (CATXF) in response to the reception, with a CANXT message following it:

$CAREV,193350,AUV,2.0.32731*16
$CAREV,193350,COPROC,0.30.0.56*4E
$CATXF,280*5E
$CANXT,20190507193350.271274,1147,30,0097,00,10000,1,1,24000*4B
$CAREV,193350,AUV,2.0.32731*16

Navigation Sentences

CCPGT – Ping Generic transponder, host to modem

Ping Generic Transponder from host to modem.

$CCPGT,Mode,Ftx,nbits_tx/nsyms,tx_seq_code/dir,transponder_timeout_ms,Frx,nbits_rx,rx_seq_code1, rx_seq_code2,rx_seq_code3,rx_seq_code4, Bandwidth_Hz_tx,Bandwidth_Hz_rx,reserved*CS

Mode	0 – transmit a sequence 1 – transmit a FM sweep
Ftx	Transmit frequency for outgoing ping or FM sweep, Hz
nbits_tx/nsyms	Mode 0: number of bits to use from the signal sequence for outgoing pings Mode 1: Number of symbols for outgoing sweep
• **tx_seq_code** • **dir**	Mode 0: outgoing sequence bits, packed into a 64 bit int Mode 1: outgoing probe direction, 0/1 for up/down.
transponder_timeout_ms	Maximum time to listen for in milliseconds
Frx	Receive frequency for incoming ping, Hz
nbits_rx	number of bits to use from the signal sequence for incoming pings
rx_seq_code1,2,3,4	which signals to receive, 0 being no signal
Bandwidth_Hz, tx	chiprate/bandwidth, of outgoing signals
Bandwidth_Hz, rx	chiprate/bandwidth, of receive signals
Reserved	Reserved field, set to zero
***CS**	Hex coded checksum (8 bit XOR of sentence) optional.

In Mode=1 (send FM sweep), the sweep parameters are set by the following configuration parameters:

- Sweep bandwidth, set by PSK detector bandwidth, **detector2.fm_bw_Hz**
- Sweep carrier, set by PSK detector carrier, **detector2.carrier_Hz**
- Sweep length, in symbols, set by FSK detector length, **detector1.length_sym**

Example 1: Sending $CCPGT with txsig,rxsig [41, 21, 22, 23, 24]

$CCPGT,0,26000,28,4A1C0370,1000,24000,4A1C0370,6C8F7D30,2107E320,37BCD1E0,4000,0,0*68

$SNPGT,26000,28,4A1C0370,1000,24000,4A1C0370,6C8F7D30,2107E320,37BCD1E0,0,0,0*75
$CATXP,280*48

$CATXF,280*5E
$SNMFD,01,1726,1205,0143*51
$SNTTA,0.003104,,,,*68

Example 2: Sending $CCPGT with txsig set to 10 ms upsweep, centered at 10000 Hz, 4 kHz bandwidth, listening for replies of sequences of length 28, centered at 24 kHz, 4 kHz bandwidth

$CCPGT,1,10000,40,0,1000,24000,28,4A1C0370,6C8F7D30,2107E320,37BCD1E0,4000,4000,0*68

$SNPGT,26000,28,4A1C0370,1000,24000,4A1C0370,6C8F7D30,2107E320,37BCD1E0,0,0*75
$CATXP,280*48
$CATXF,280*5E
$SNMFD,01,1726,1205,0143*51
$SNTTA,0.003104,,,,*68

SNNST

Navigation statistics message, printed at the end of an LBL navigation cycle. Controlled by the nav.nst configuration parameter.

$SNNST,version,TX_Hz,TX_ms,yyyymmddhhmmss.ssssss,timing_mode,AGN,TAT,NAV_mode,det0_peak,det0_pow,det0_ratio,xpond0_owtt,xpond1,xpond1_freq,det1_peak,det1_pow,det1_ratio,xpond1_owtt,… xpond4,xpond4_freq,det4_peak, det4_pow,det4_ratio,xpond4_owtt*CS

version	Version number of message, currently 0	
TX_Hz	Outgoing ping frequency, Hz	
TX_ms	Outgoing ping and replies width, ms	
yyyymmddhhmmss.ssssss	Timestamp of outgoing ping. In passive mode, timestamp of start of the receiver	
timing_mode	4-bit bitmask: bits 0-1 RTC source	
	00	RTC none
	01	RTC onboard
	10	RTC user command synced
	11	RTC GPS synced
	Bits 2-3 PPS source	
	00	PPS none
	01	PPS from RTC
	10	PPS from external pin
	11	PPS from RTC, sync'd to the last external PPS pulse.
AGN	Analog gain setting at receiver	
TAT	Turnaround time, ms, for transponders	
NAV mode	0, active nav, transmit ping 1, passive nav, do not transmit ping, listen for outgoing ping and replies.	
det0_peak	MFD detection peak, outgoing ping, blank if active nav cycle	
det0_pow	MFD detection power, dB, outgoing ping, blank if active nav cycle	
det0_ratio	MFD detection ratio, outgoing ping, blank if active nav cycle	
xpond0_owtt	One way travel time, ms, transponder 0, blank if no detect	
xpond1 number	The sequence number of the transponder, range 1-4.	

xpond1_freq	Reply frequency, Hz, of transponder 1
det1_peak	MFD detection peak, transponder 1, blank if no detect
det1_pow	MFD detection power, dB, transponder 1, blank if no detect
det1_ratio	MFD detection ratio, transponder 1, blank if no detect
xpond1_owtt	One way travel time, ms, transponder 1, blank if no detect
xpond2_number	…
xpond4_owtt	One way travel time, ms, transponder 4, blank if no detect
***CS**	The NMEA sentence checksum, hex coded (8-bit XOR or CRC-32). See Message Checksums.

CANXT – Transponder reply report, modem to host

Diagnostic sentence, printed after a transponder responds to a ping with a reply. Printed only if nav.nst (nav stat message) is set to 1.

$CANXT,transmit_time,rx_det_pk,rx_det_pow,rx_det_ratio,rx_MFD_shift,Frx,DT_group,DT_type, Ftx*CS

transmit_time	YYYYMMddHHmmss.ssssss: the time when the reply was sent.
rx_det_pk	Peak Amplitude of Matched Filter Detector (MFD)
rx_det_pow	Peak Power (dB) of Matched Filter Detector
rx_det_ratio	Ratio of peak filter output to noise, multiplied by 100
rx_MFD_shift	Shift value of buffer containing MFD peak
Frx	Receive frequency for incoming ping, Hz
Transponder_group	A,B,C or D, mapping to 1,2,3 or 4.
Transponder_type	Currently 1, for DT
Ftx	Transmit frequency, in Hz, of outgoing signal
***CS**	Hex coded checksum (8 bit XOR of sentence)

Digital Transponder mode

In this mode, the modem can act as a navigation transponder beacon. This is a special REMUS transponder (DT4) mode, which when activated, will listen for REMUS vehicles, as well as a Ranger ping. There are four transponder families, A, B, C, and D. All of them listen for ranger and DR1, 2, 3 and 4 signals. Each family has a unique response to each vehicle channel. Thus one vehicle or Ranger ping can elicit 4 unique replies from a transponder family.

Listing of transponder navigation parameters

`$CCCFQ,nav.dt`

Parameter Name	Values	Description
`nav.dt.mode`	0 (default)	Transponder mode off
	1	REMUS DT4[A-D] configuration
	2	REMUS DR[1-4] configuration
	3	FM probe (upsweep) mode
`nav.dt.type (mode=1,3)`	1 (default)	DT4A
	2	DT4B
	3	DT4C
	4	DT4D
`nav.dt.type (mode=2)`	1	DR1
	2	DR2
	3	DR3
	4	DR4
`nav.dt.txtrig_gpio4`	0 (default)/1	If 1, use gpio4 hi to lo as transmit trigger