PROCITEC®

go2DECODE

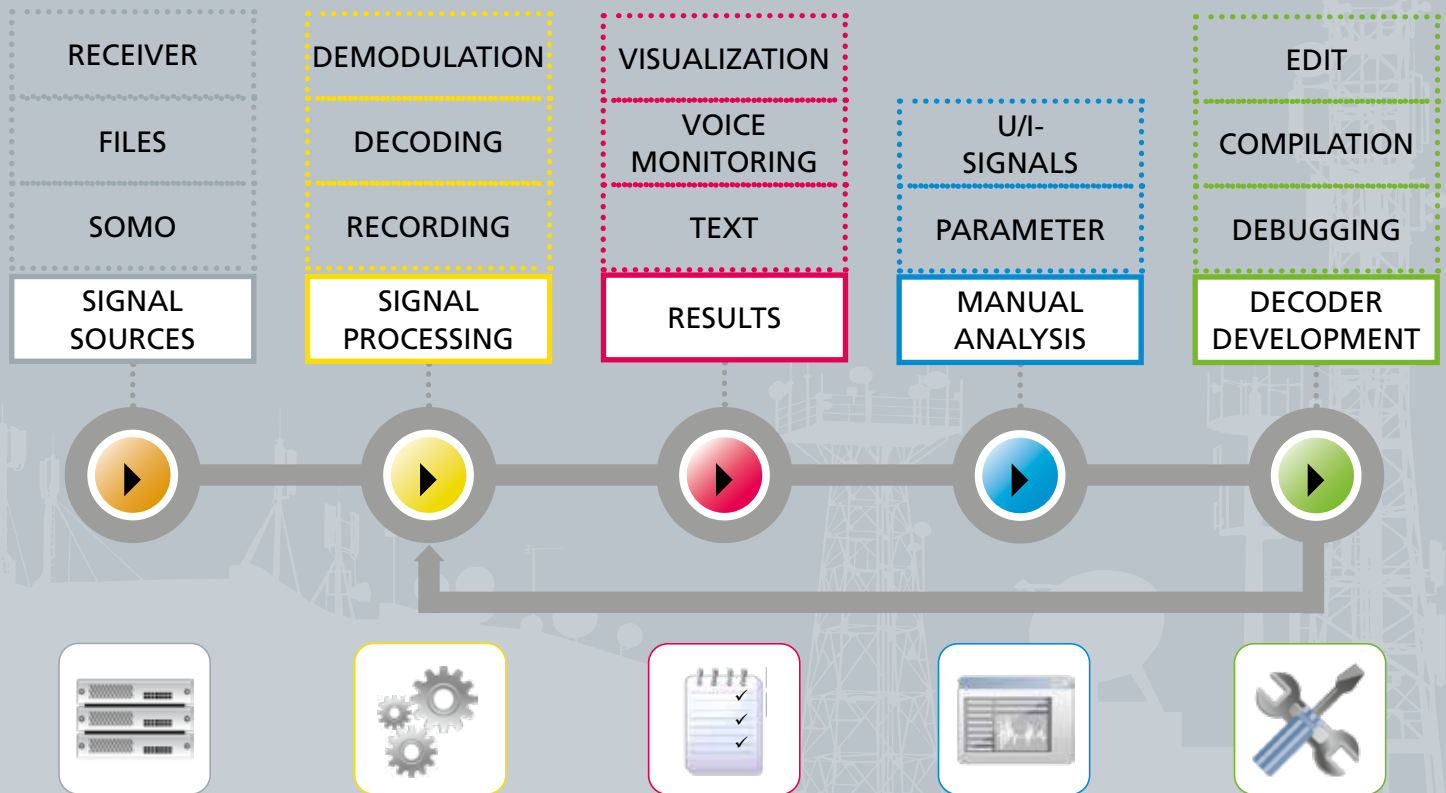# Recognition Demodulation Decoding Analysis

Key Facts

go2DECODE is the standalone software package for automatic signal recognition, demodulation, decoding, voice detection, signal recording and technical signal analysis.

- Fully automatic processing of HF/VHF/UHF/SHF communication signals

- Knowledge based recognition approach, enhancing the analyst's skillset

- Wide range of universal demodulators and standard decoders

- Automatic processing of adaptive transmission methods

- Voice detection and demodulation

- Automatic measurement and continuous tracking of signal characteristics

- IF/I&Q and AF-recordings

- Displays for monitoring and manual analysis of unidentified signals

- Definition and customization of decoders with Decoder Description Language and pyDDL

- Signal acquisition from digital or analogue receivers via LAN /USB or audio input

WORKFLOW

SIGNAL SOURCES	SIGNAL PROCESSING	RESULTS	MANUAL ANALYSIS	DECODER DEVELOPMENT
RECEIVER	DEMODULATION	VISUALIZATION		EDIT
FILES	DECODING	VOICE MONITORING	U/I-SIGNALS	COMPILATION
SOMO	RECORDING	TEXT	PARAMETER	DEBUGGING

go2DECODE

Single channel decoder for automatic recognition, demodulation and production, technical signal analysis and decoder development

- Automatic signal processing of radio data and voice signals, decoding, recording

- More than 250 demodulation and decoding modes

- Signal decoding from digital or analogue receivers via streaming, audio, files or internal signal buffer

- Manual identification and analysis of unknown signals

- Creation and modification of decoders with Decoder Description Language (DDL / pyDDL)

- Integrated receiver control

- Easy integration through TCP/IP-based data interchange via LAN

Your Vision is Our Incentive

go2DECODE is much more than a single channel automatic decoder application to analyse and monitor communication signals. The idea behind go2DECODE is to enable the user to adapt and automate their monitoring tasks, improving results and staying up-to-date with the RF environment and current requirements.

go2DECODE enables the user to analyse signals, adapt demodulator parameters, develop new decoders, set up new protocols and automate monitoring tasks.
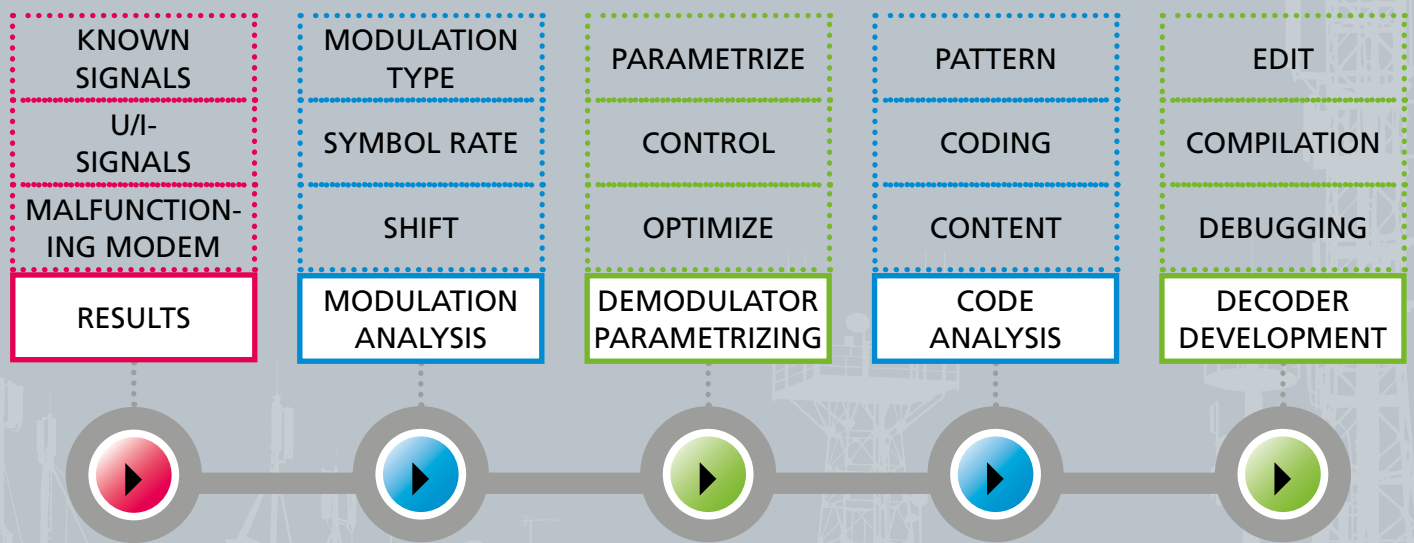
This way the user/analyst's knowledge and experience is incorporated into all monitoring solutions based on go2SIGNALS products for current and future automatic processing needs.

SINGLE WORKPLACE AND SYSTEM SOLUTIONS

Although go2DECODE is optimized for standalone applications, it is able to interact with other radio monitoring solutions based on go2MONITOR. Open interfaces allow for an easy TCP/IP based communication. The field of application ranges from a single go2DECODE connected via the audio interface with a manual adjustable receiver to a system solution, comprising receiver controls, tasking interfaces, communication with other radio monitoring systems and a central database.

USE CASE: Adaptation of Demodulation and Decoder Library

KNOWN SIGNALS	MODULATION TYPE	PARAMETRIZE	PATTERN	EDIT
U/I-SIGNALS	SYMBOL RATE	CONTROL	CODING	COMPILATION
MALFUNCTION-ING MODEM	SHIFT	OPTIMIZE	CONTENT	DEBUGGING
RESULTS	**MODULATION ANALYSIS**	**DEMODULATOR PARAMETRIZING**	**CODE ANALYSIS**	**DECODER DEVELOPMENT**

Use Cases

Manual and Automatic Signal Monitoring

go2DECODE is used to observe single Frequencies-Of-Interest. Signal detection and production is a multi-level process. The integrated Automatic Production Channel (APC) buffers the incoming signal continuously. Buffering allows lossless processing: detection, recognition and decoding without losing the first bit of an emission.

If a signal is detected, the APC checks for known modem types in its modem list. Signal parameters (e.g. centre frequency and baud rate) are determined and displayed. Decoded text will be displayed as plain text or as a formatted XML-stream.

Manual Analysis of Unidentified Signals

New and unidentified signals can be automatically or manually recorded. These recordings are used for signals analysis, measuring modulation and coding parameters. A comprehensive set of built-in analysis tools with special modulation and code analysis features supports the new or experienced operator.

Example analysis tools include:

- Spectrogram and spectrum displays for FFT analysis and baud rate measurement
- Autocorrelation display to highlight signal repetitions
- Constellation display for phase modulation analysis
- Analysis display to measure amplitude, frequency and phase behavior
- Raster ('Hell') display for coding analysis
- Extensive set of cursor functions to measure harmonics

Adaptation of Demodulator and Decoder Library

go2DECODE differs to other analysis tools, enabling the operator to parametrize its set of universal demodulators. The analysis functions can not only be used to analyse the input signals, they can also be used to monitor the internal processing of the demodulator.

The operator is able to set up a demodulator on a new signal, parametrize the demodulator and control and optimize the demodulation process. The bits can be stored and transfered for extended stream analysis too ther analysis tools (see go2ANALYSE) or used as input data for the internal decoder.

With the advanced Decoder Description Language (DDL/pyDDL), new decoders can be created and existing decoders can be modified. Therefore, we deliver go2DECODE with the DDL/pyDDL source code for many of our decoders. The DDL/pyDDL source code can then be used as a template or adapted to your needs with the integrated editor. Editor and Debugger (Spyder) are part of the go2DECODE Professional version.

Information about the demodulator settings and decoders can be stored as a signal/protocol-specific Modem Description File (MDF), extending the protocol library.

Extending the List of Modems for Manual and Automatic Monitoring

Just include your own generated protocols in the modem list used for signal monitoring. Thus, new and previously unidentified signals can be recognized and processed automatically.

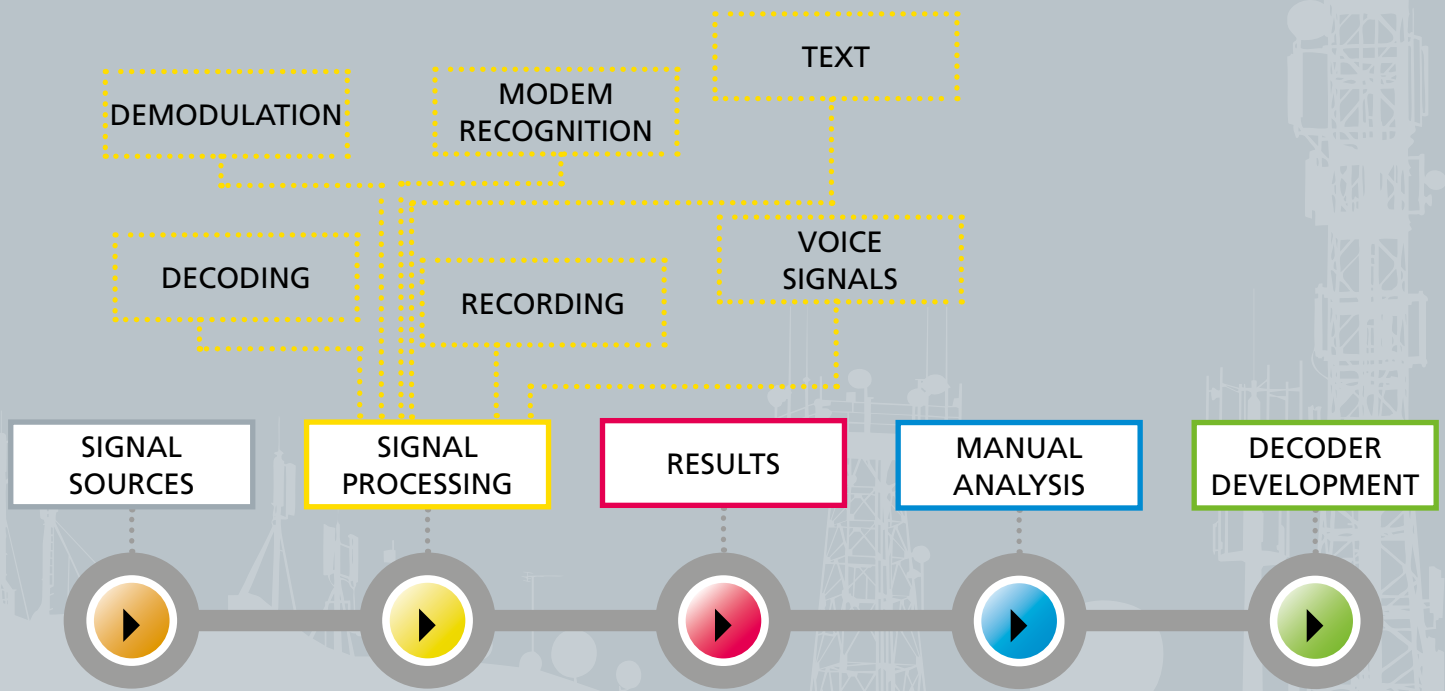Modem Description Files can be exported for use in go2MONITOR.

In addition, go2DECODE is the perfect companion for go2MONITOR if signal analysis functions are required.

The complementary go2ANALYSE software application offers additional functions for low level and forensic code inspection and bitstream analysis.
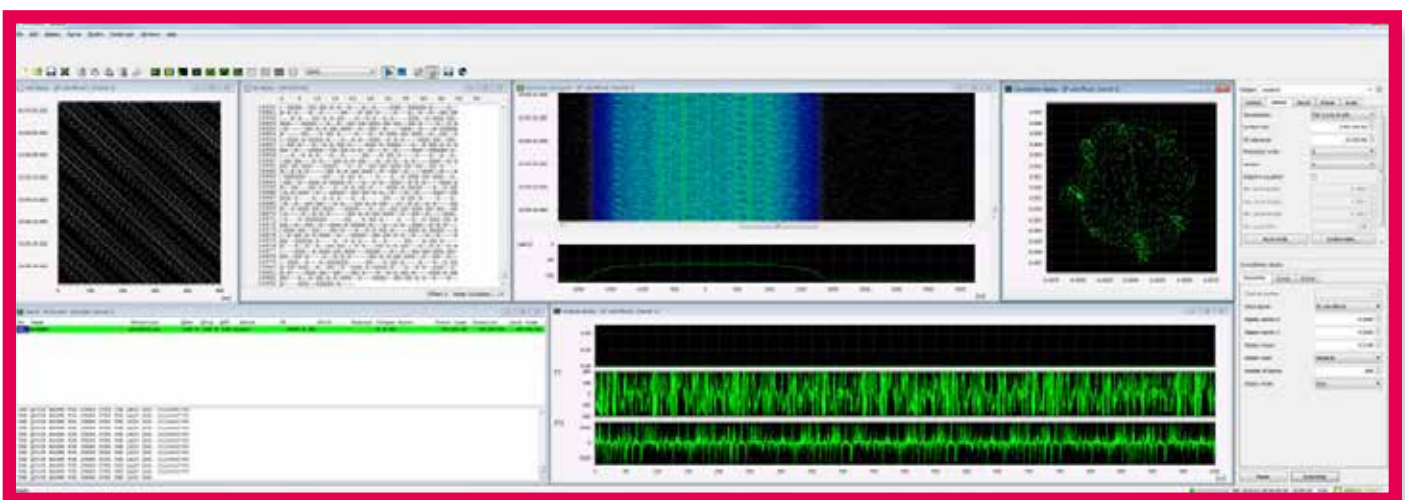
Main window of go2DECODE

FUNCTIONS

Functions: Signal Processing

Automatic Recognition and Decoding

go2DECODE's signal detection and production is a multi-level process. The incoming signal is buffered continuously. Buffering allows lossless demodulation in respect of time. The signal is checked in the modem list taking into account: detection, recognition, demodulation and decoding.

The protocol type is automatically recognized and its content produced. Signal characteristics (e. g. centre frequency and baud rate) are determined and displayed. Decoded text will be displayed as plain text or as a formatted XML-stream.

Processing of Voice Signals

A powerful voice detection module is integrated. The voice processing algorithms of go2DECODE are insensitive to wideband interference caused by noise phenomena at the air-interface (e.g. ionospheric noise).

The sensitivity level itself can be parametrized. In addition to the decision "voice yes or no" the module determines the values for nominal frequency, voice pitch and modulation type.

The voice transmission can be demodulated and stored in audio files for playback/monitoring and further processing.

Recording

In addition to the live demodulation and decoding of Signals Of Interest, the recording of signals is an important task to enable offline analysis. Recorded signals are the basis for manual technical analysis of unidentified signals and for archiving the Signals Of Interest. go2DECODE enables recording of both IF/I&Q and demodulated AF.

The recordings are started and stopped either via automatic triggers or manually by the operator. The triggers supported by go2DECODE are configurable squelch, signal detection, modem recognition and voice detection.
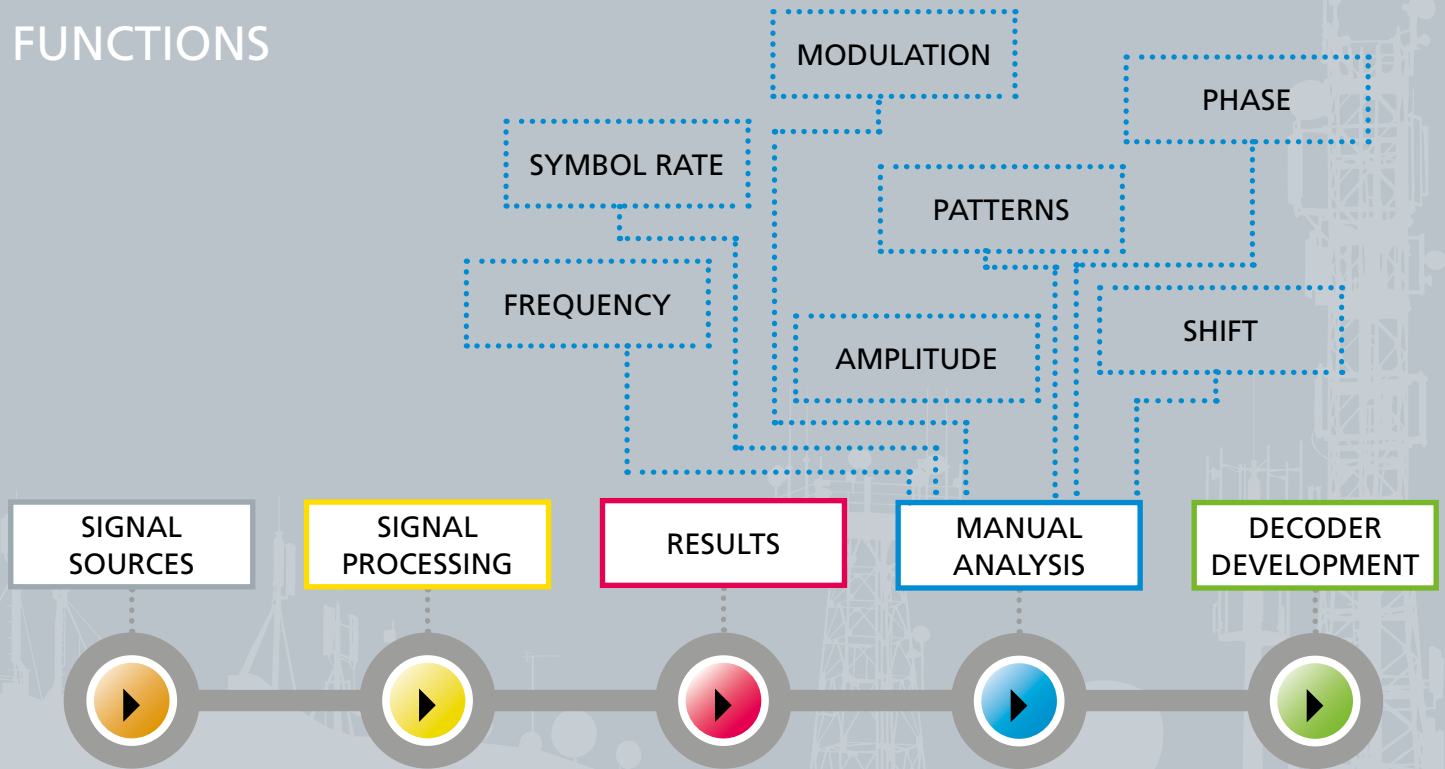
go2DECODE also allows recording of the demodulated bitstream to a txt-file or a go2DECODE format (including metadata such as the quality of each bit).
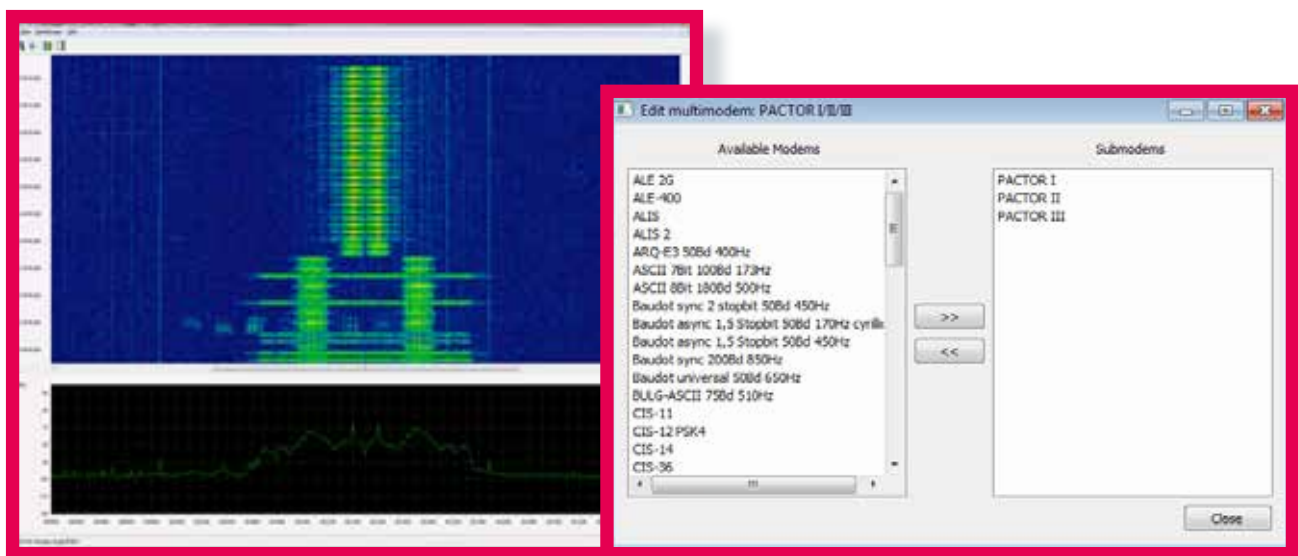
HANDLING OF ADAPTIVE PROTOCOLS

The multimodem feature describes and combines multiple modes used within the modern protocols of one multimodem (e.g. 'fallback' modes). Thereby adaptive radio signals using different modes can be produced as one signal without loss. The user can define their own multimodems or edit existing multimodems in an intuitive way.

FUNCTIONS

MODULATION

PHASE

SYMBOL RATE

PATTERNS

FREQUENCY

SHIFT

AMPLITUDE

| SIGNAL SOURCES | SIGNAL PROCESSING | RESULTS | MANUAL ANALYSIS | DECODER DEVELOPMENT |

Functions: Signals Analysis

Manual Signals Analysis

Precise measurements can be achieved with the displays provided by go2DECODE. With spectrum / spectrogram, spectrum, autocorrelation display, constellation display, time domain / eye-pattern display all the necessary tools needed to determine the signal characteristics are available.

The analysis display allows for the simultaneous interpretation of magnitude, frequency and phase of a signal to determine the utilized modulation.

The Hell display and the bit display show information about the signal's coding and binary structure. In each display, double, cross-hair and harmonic cursors are offered. These powerful functions provide in-depth analysis which is often required to setup new demodulators and decoders which may be applied for automatic decoding.

Signal Generator

go2DECODE contains a software tool to generate modulated signals.

It's the perfect capability for operator training; simulation of signal and operational scenarios, comparison of signals when analysing unidentified signals, and testing of hardware and software.

The signal generator produces a wide range of modulation types. Modulator parameters such as frequency, symbol rate, pulse shape and burst length can be changed to situation-specific values. It is possible to modify the coding scheme and to edit the text or bit-pattern used.

Moreover, it serves to generate complex signal scenarios with many different signals in parallel and channel simulation which can be stored and reloaded.
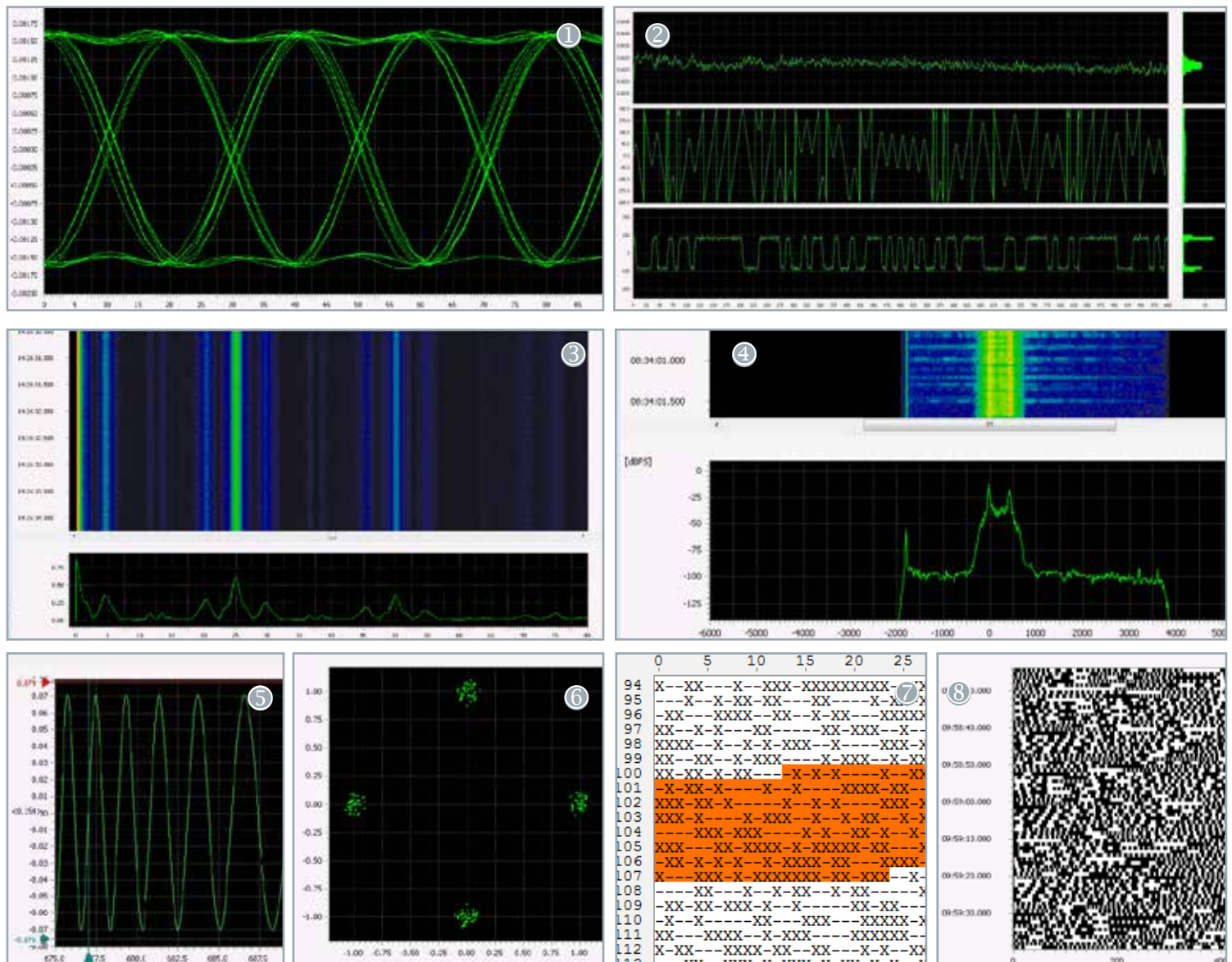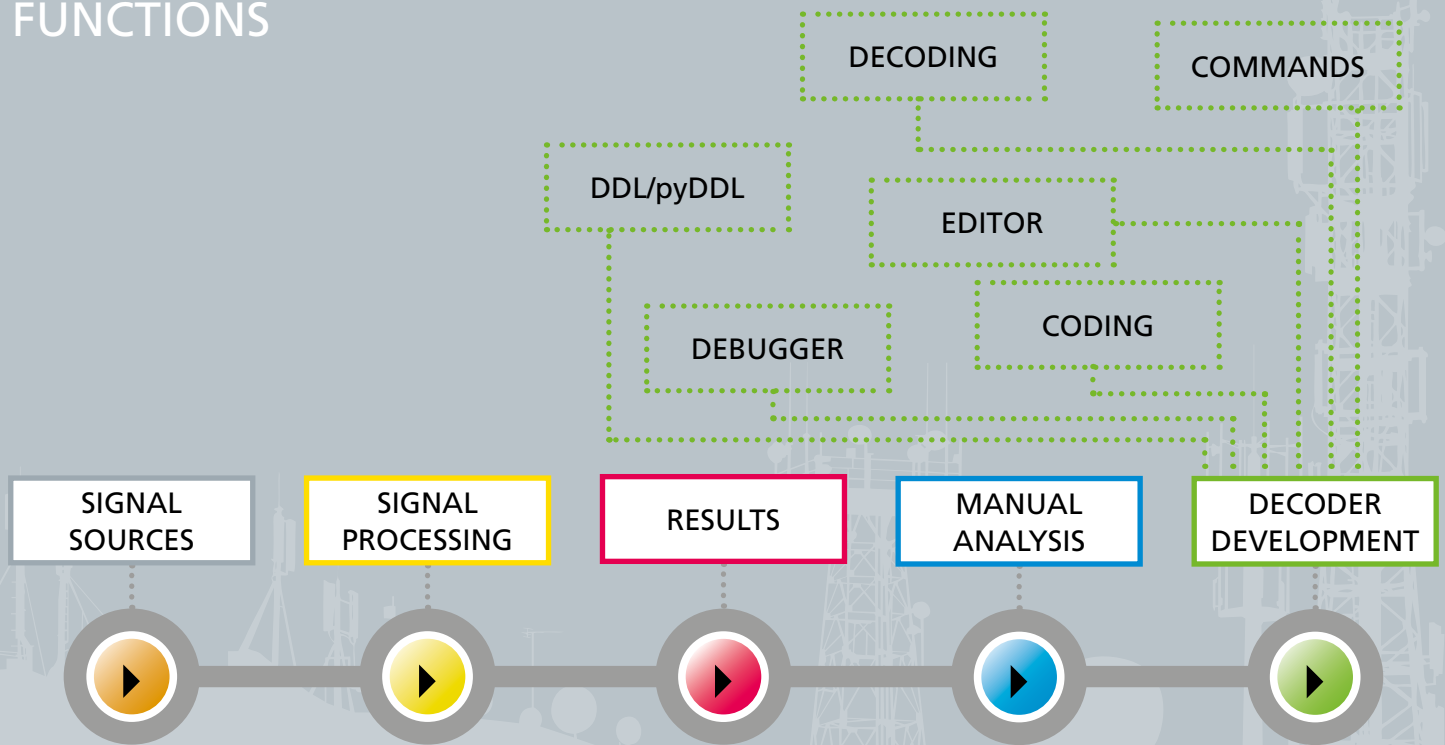
FUNCTIONS FOR EASY OPERATION

- In each display double, cross-hair or harmonic cursors are available.

- Search frequency and bandwidth are shown as well as the nominal frequency in addition to the live signal currently being monitored in the spectrum / spectrogram display

- The absolute signal time is shown and switching between line and dot drawing mode is easily possible.

- Easy adjustment of the zoom factor with „Ctrl + mouse wheel" in the results and the bit display

① Eye pattern display
② Analysis display
③ Autocorrelation display
④ Spectrum / spectrogram display
⑤ Time ('oscilloscope') display
⑥ Phase-constellation display
⑦ Bit display
⑧ Hell display

DECODING

COMMANDS

DDL/pyDDL

EDITOR

DEBUGGER

CODING

| SIGNAL SOURCES | SIGNAL PROCESSING | RESULTS | MANUAL ANALYSIS | DECODER DEVELOPMENT |

Functions: Decoder Development

Decoder Description Language (DDL/pyDDL)

For many reasons the users might wish to define and create their own decoders or modify the integrated standard decoders. The continually evolving Decoder Description Language (DDL/pyDDL) - provides the perfect toolkit for this task.

DDL offers many new features by using Python language as base (pyDDL) for future development. Decoder development takes place with the huge set of commands and libraries inherited from Python and the additional specialized set of more than 100 specialized commands e.g. for pre-processing, searching, reading, transformation and output formatting. The set of commands is designed not only for basic detecting and synchronising tasks, but also for complex channel decoding techniques.

All factory-supplied decoders have been created using DDL and pyDDL in future. Operators can use the supplied sources as a template for their own decoder development.

The starting point is a demodulated bitstream produced with the free parametrized demodulators inside. DDL/pyDDL enables analysis and processing of these bitstreams to ensure that the decoded message content and his metadata are successfully extracted. This way, even modern, complex channel decoding techniques are applied in only a few steps.
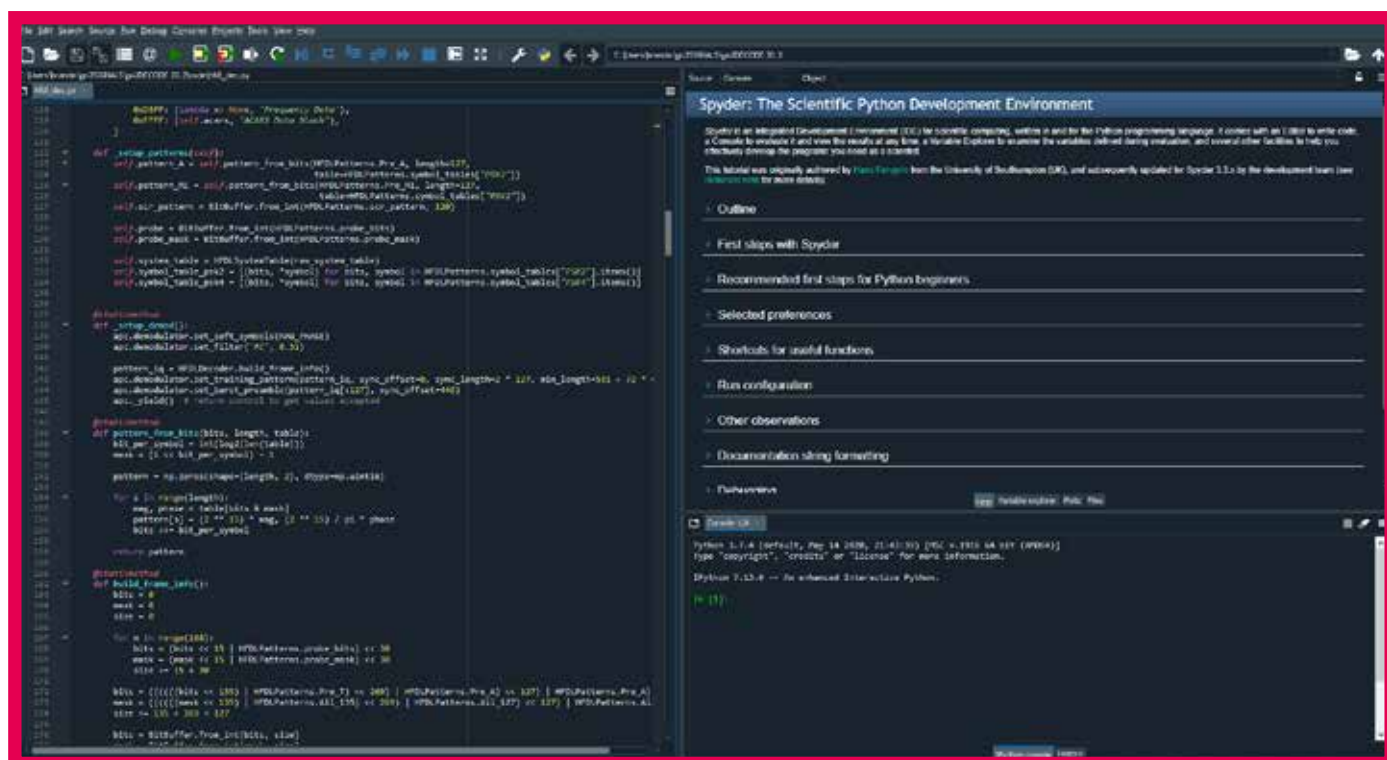
The decoders can be exported to other go2SIGNALS applications e.g. go2MONITOR. DDL/pyDDL ensures high decoding quality, i.e. fast synchronization, selectivity, precise error correction etc. The flexibility to react fast on new signals or changing operational areas or requirements makes it an indispensable feature.

Decoder Development Tools

Decoders are preferably created and tested using specialised tools. This way, decoder developers obtain the best possible insight into the entire modem function flow. go2DECODE's pyDDL-based decoder development tools consist of Spyder as integrated editor and debugger.

Spyder is used to create and modify the pyDDL scripting source code. The editor offers automatic command completion and context sensitive help. Correct commands, functions and keywords are highlighted in color for visual checks. In the case of coding errors, Python scripting interpreter logs detailed error messages to help debugging code.

In addition the integrated debugger is used to verify the executable decoders. The application enables analysis of the decoding procedure in detail. The large set of functionalities like stepping line-by-line, setting breakpoints, checking values of variables a.m. meet customers' expectations on a modern development platform.

Spyder editor and debugger

Technical Specifications

Specifications Overview

Data acquisition	Digital IF stream (complex baseband I/Q); Soundcard (real or complex); Digital AF (WAV 8, 16, 32 Bit); Others on request
Localization	English or German; Others on request
Documentation	PDF User manual / PDF Online-Help
Recommended PC hardware	Notebook or Desktop; CPU: Intel i5, min. 2 GHz; Memory: ≥ 2 GByte RAM, HDD: ≥ 10 GB, Screen Resolution min. 1280 x 1024 Pixel, Soundcard for analogue IF input, 1 GBit/s Ethernet for digital IF input
OS	Windows 7 SP1 (with Microsoft Windows patch KB2999226) / 10 de/en, 64 bit, Linux (CentOS 7.5) 64 bit
ISO 9001:2015	Company is certified (not only hardware)
License	USB-Dongle (Codemeter) License sharing with license server The AMBE+2™ voice coding Technology embodied in this product is protected by intellectual property rights including patent rights, copyrights and trade secrets of Digital Voice Systems, Inc. This voice coding Technology is licensed solely for use within this Licensed Product. The user of this Technology is explicitly prohibited from attempting to extract, remove, decompile, reverse engineer, or disassemble the object code, or in any other way convert the Object Code into a human-readable form. US Patent Nos. #8,595,002, #8,359,197, #8,315,860, #8,200,497, #7,970,606, #6,912,495 B2, #6,199,037

Features

Software Feature	Remarks
Alphabets	Can be added to the decoder source code, free configurable (requires go2DECODE Standard or Professional)
Decoders	Our list of standard, military and PMR decoders is subject to continuous development. See the current list of available decoders on our website: www.procitec.de. 1. MIL and PMR decoders may need an End-User-Certificate (depending on the country of the user) 2. Automatic sideband detection can be achieved via two modems set to inverse sidebands. 3. A gap between message bursts and acknowledge burst must be detectable. 4. Separation of slow selcall types cannot be guaranteed. 5. Slow multitone modems are recommended to operate with fixed nominal frequency
Voice detection, demodulation, recording	Modulation types: AM, FM, USB, LSB Detection: voice yes/no Nominal frequency Voice Pitch Automatic audio demodulation and recording
Demodulators	Voice Morse F6/F7B ASK 2 (OOK) FSK 2, 3, 4 discr. FSK 2 matched FSK 2,3 auto shift Multitone (FSKn, single or simultaneous tones) MFSK 2 (G)MSK TFM3 DPSK 2, 4, 8,16 A/B PSK 2, 4, 8,16 A/B PSK data aided MDPSK2, 4, 8, 16 A/B MPSK2, 4, 8, 16 A/B OQPSK ASK2PSK2 (ASK 4) ASK2PSK8 ASK4PSK8 QAM 16 QAMn OFDM CHIRP	MultiModem Analogue Selcal Clover II Clover 2000 Clover 2500 Coquelet MT63 Pactor II Pactor III Pactor IV THROB / THROBX Automatic frequency, amplitude and symbol rate control Fast equalizer using known training sequences (via DDL/pyDDL) Primary demodulation USB/LSB/AM/FM Automatic burst synchronization

Features

Software Feature	Remarks	
GUI	Easy and intuitive to operate Input spectrogram with live audio Manual and automatic demodulator and decoder control Different analysis displays for manual signal analysis Specialized signals analysis cursor measurement functions Modem editor with demodulator and decoder settings Decoder editor and debugger (DDL/pyDDL, Option Professional)	
Input Audio (DANA)	Playlist (files) Loop mode Complex IQ / real files Remove DC Filtering Mirror FM demodulation Time source (File/System clock) Sample rate converter Centre frequency tuning Streaming TCP/IP	
Input Files (DANA)	Digital IF (complex baseband I/Q 32 Bit), Sampling rate <= 10 MHz (note: functionality may be limited for sampling rates higher than 2 MHz) Playback of standard wav files. Digital IF/AF (WAV 8, 16, 32 Bit) Playback of Perseus and WiNRADiO WAV recordings with correct frequency display	
Input TCP/IP Streaming	Up to 10 MHz sampling rate (note: functionality may be limited for sampling rates higher than 2 MHz) Generic PROCITEC/PLATH format VITA 49 PXGF	
Signal recordings	Types: IF / AF Start / Stop - Manual by operator - Automatic by trigger Trigger types - Configurable squelch level - Signal detected - Transmission method recognized - Transmission method unknown - Voice/Morse detected File formats: WAV	

Features

Software Feature	Remarks		Windows supported	LINUX supported
Compatible receivers				
	AirSpy		x	
	CommsAudit CA7851		x	x
	Grintek GRX Lan		x	
	IZT R3xxx series		x	x
	IZT R4000 (SignalSuite)		x	x
	Microtelecom PERSEUS		x	
	narda® NRA-3000 RX		x	x
	narda® NRA-6000 RX		x	x
	narda® IDA 2		x	x
	narda® SignalShark® 3310		x	x
	PLATH SIR 5110/5115		x	x
	R&S EB 500		x	x
	R&S EB 510		x	x
	R&S EM100 / PR100		x	x
	RFSPACE NetSDR		x	x
	RFSPACE SDR-14		x	
	RTLSDR/Noxon USB-sticks		x	
	SDRplay RSP1 & RSP2		x	
	SignalHound BB60C		x	x
	ThinkRF R5500-408		x	x
	ThinkRF R5500-427		x	x
	ThinkRF WSA5000-408		x	x
	ThinkRF WSA5000-427		x	x
	USRP X310		x	x
	WiNRADiO G31DDC / G33DDC/ G35DDC / G39DDC		x	
Output	Decoding results TXT-File with decoded text XML-File with decoded text and metadata Signal recordings Voice recordings Bitstream *.rec files (bits and quality of each bit) Bitstream *.txt files (bits)			
Sonagram Viewer (SoVi)	Standalone application for spectrum/spectrogram display			
ResultViewer (PMO)	Display of: Decoder output, demodulated audio files (CW, TETRA etc.), text output (ALE, HFDL, etc.), binary files			
Signal Generator (SOMO)	For standard test signals. Requires go2DECODE-Professional; detailed description see page 17			
Decoder Development	Modification of standard decoders Definition of new decoders Integration of existing decoders, requires go2DECODE-standard or professional;detailed description see page 16			
Soundcard Interface (DANA)	Analogue input WiNRADiO VSC Virtual-Audio-Cable (VAC) etc.			
Third party decoder	Interface to the DDC channel output Interface to the bitstream output Streaming and control interface with DDL/pyDDL			
Training	Very short training period Same technology as in large decoding systems			

Analysis

Analysis	Items
Displays	Spectrum Spectrogram/Sonagram Autocorrelation I/Q Constellation Eye pattern Time domain (oscilloscope) with additional histogram Analysis (magnitude, frequency and phase) with additional histogram Hell Bit
Signal squaring	Squaring: 0, 1, 2, 3
Windowing	Rectangle Hanning Hamming Kaiser Flat Top Blackman
Cursors	Harmonic Crosshair 2 cursor modes
Centre frequency	Adjustable
Operation modes	Online / offline

Technical Specifications

Decoder Development (optional)	
Decoder Development	**Items**
Basic functions	Modification of standard decoders Definition of new decoders Integration of existing decoders
Function library	Preprocessing Symbol conversions Descrambling procedures Channel selections Pattern search Burst detection Forward/backward time jumps Deinterleaving Check and correction procedures: CRC, Hamming, Viterbi, BCH, Reed-Solomon Elementary arithmetic and bit manipulations Table handling Various output formats, alphabets, channels Control of demodulation and decoding Setting of demodulator parameters Selected voice codecs Branches and sub-routines (special functions on request) Soft decision
Decoder Editor Spyder	Automatic command completion Content related help Syntax highlighting
Debugger Spyder	Debugging - Breakpoints on lines of code - Single-step mode for lines of code - Display of variable contents in various formats and displays - Editing of variable contents - Display of all input data packages - Display of internal data buffer and current read position Advanced analysis of recognition, demodulation and decoding - Breakpoints in several decoders for one modem list - Comparison of the decoder behaviour in search phase and decoding phase - Monitoring the current demodulator state

SOMO Signal Generator (optional)

SOMO Signal generator	Items
Modulation generation	Single and multichannel, continuous and short-duration / burst signals Waveform and digital modulation (using ITU emission designators): - ASKn - PSKn (single and multi channel) - QAMn (single and multi channel) - ASKnPSKm (single and multi channel) - NCPFSKn (Non-Coherent-Phase FSK) - FSKn (single and multi channel) - MSK (single and multi channel) - GMSK (single and multi channel) - F7B (FM with 2 or more digital channels) - TFM 3/5 (Tamed Frequency Modulation) - Morse - Sine - Rectangle - Sawtooth - Triangular Analogue modulation: - AM, SSB (LSB / USB), FM Variable modulation parameters: - Attenuation - Center frequency - Baud rate - Pulse shapes: RC pulse, RC/RRC spectrum, Gauss pulse - Short-duration / burst parameters
Coding generation	Binary, Baudot, ASCII, HC ARQ, ITA2 Differential/absolute coding Convolutional encoding / Viterbi CCITT standards V.17 … V.33 Variable bitstream, bit order, parity Various scrambling algorithms and recursive sequences
Channel simulation	AWGN Multipath propagation: Watterson (ITU) and enhanced ITS model
Output	Soundcard / Wav Files / network stream

Order Guide

x = included o = as option available	Automatic processing	Signal analysis	Edit of demodulator / decoder	Spyder Decoder Debugger	Signal generator (SOMO)	Recording / replay	Standard set of decoders	Set of military decoders [1]	Set of PMR decoders [2]
Software go2DECODE Light	x					x	x	o	o
Software go2DECODE Standard	x	x				x	x	o	o
Software go2DECODE Professional	x	x	x	x	x	x	x	o	o

The products are configurable. The software delivered will be configured as stated in the order confirmation.

Export conditions:

[1] In case of an export from the Federal Republic of Germany an export permission must be granted by the German authorities. Enduser certificate is required.

[2] In case of an export from the European Union an export permission must be granted by the German authorities. Enduser certificate is required.

go2DECODE
Standard Operator Training

Automatic and Manual Recognition, Analysis and Decoding of Communications Signals

The go2DECODE Standard Operator Training course familiarizes the Students with all go2DECODE components and functions, and their practical use. The course focuses development of the Students' knowledge of signals analysis techniques and procedures using go2DECODE. Configuration and parameter settings of demodulators and decoders for automatic detection of new modems are explored in-detail. During training delivery, the Students' skillsets are developed using practical 'real world' exercises employing live signal recordings sourced by PROCITEC and, optionally, the Students' User-Units. Upon completion of training, Students will understand the functionalities and capabilities of go2DECODE, and will have acquired skills in the analysis of modulated signals and creating effective modems for manual or automatic signal recognition, decoding and reporting.

Course content:
- General System Introduction
- Fundamentals of digital signal modulation
- Signal inputs, interfacing and adjustments (DANA)
- Signal Simulation Tool (SOMO)
- Rapid Pre-Classification of Modulation Types
- Analysing FSK, MFSK and PSK Signals
- Setting Up Demodulators and analysis of Demodulation Results
- Setting Up Modems and Modem Lists
- Automatic Production and Signal Recording
- Introduction to Decoder Description Language (DDL/pyDDL) and decoder adaptation

Target Audience:
Signals Analysts and technical staff involved in writing, modifying and editing signal-decoders.

go2SIGNALS DDL/pyDDL Training

Decoder Description Language (DDL/pyDDL) Fundamentals for Developing and Adapting Signals Decoders

In this training course, Students are introduced to the fundamentals and general use of the go2SIGNALS Decoder Description Language (DDL/pyDDL). All essential functions and commands are described in detail. The course focusses towards adaptation of existing decoders, design of new decoders, and use of the decoder development toolset. The course also captures the basics of channel coding and the fundamentals of forward error correction techniques. Upon completion of the course, Students will be able to use DDL/pyDDL to modify and create new decoders for use in the go2SIGNALS range of software products.

Course content:
- Lectures and practical exercises
- Introduction and Overview
- Basic Steps to Create and Modify Decoders
- Basic Language Structure, Functions and Interfaces
- Basic Language Elements
- Discussion of Simple Decoder Programs
- Use of Decoder Editor and Debugger
- Detailed Discussion of Vital Commands
- Special Aspects of Automatic Production
- Exercises in Writing Simple Decoders
- Methods of Error Detection and Correction

Target Audience:
Technical staff involved in writing, modifying and adjusting decoders.

Entry Criteria:
Completion of go2DECODE Basic Training and some experience in alternative software programming languages; it is strongly recommended that all Students per-course have a similar start-state

For further information please contact our sales team sales@procitec.com.

go2**SIGNALS**

PROCITEC® SOFTWARE

go2MONITOR

go2DECODE

go2ANALYSE

Software
Bundesverband
IT-Mittelstand
Made in Germany

100%
Service
Quality
Future

TÜV
SÜD
ISO 9001

Management System
ISO 9001:2015