PROCITEC®

go2DECODE

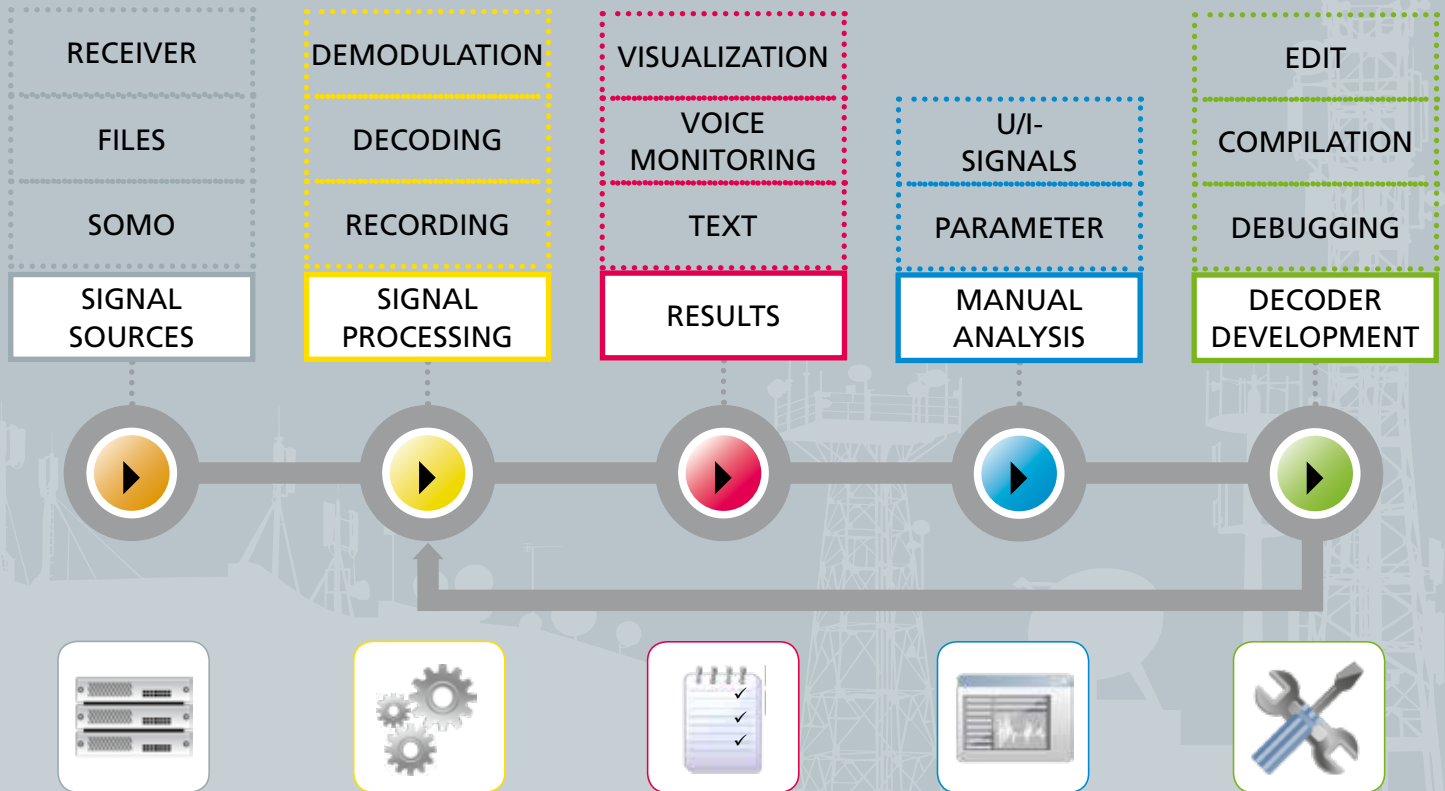# Recognition Demodulation Decoding Analysis

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

- 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	U/I-SIGNALS	EDIT
FILES	DECODING	VOICE MONITORING	PARAMETER	COMPILATION
SOMO	RECORDING	TEXT		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)

- 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.
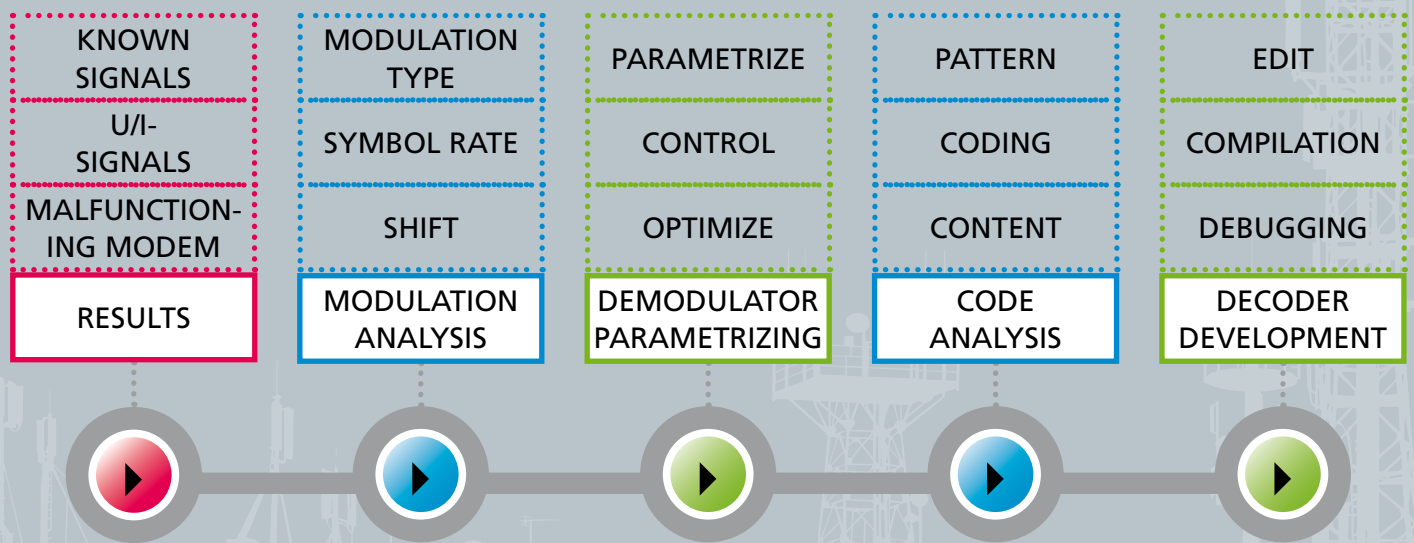
This way the user/analyst's knowledge and experience is incorporated into all monitoring solutions based on go2SIGNALS products for current and future automatic processing needs.

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

4

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), new decoders can be created and existing decoders can be modified. Therefore, we deliver go2DECODE with the DDL source code for many of our decoders. The DDL source code can then be used as a template or adapted to your needs with the integrated DDL editor. An additional decoder debugger tool is 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.
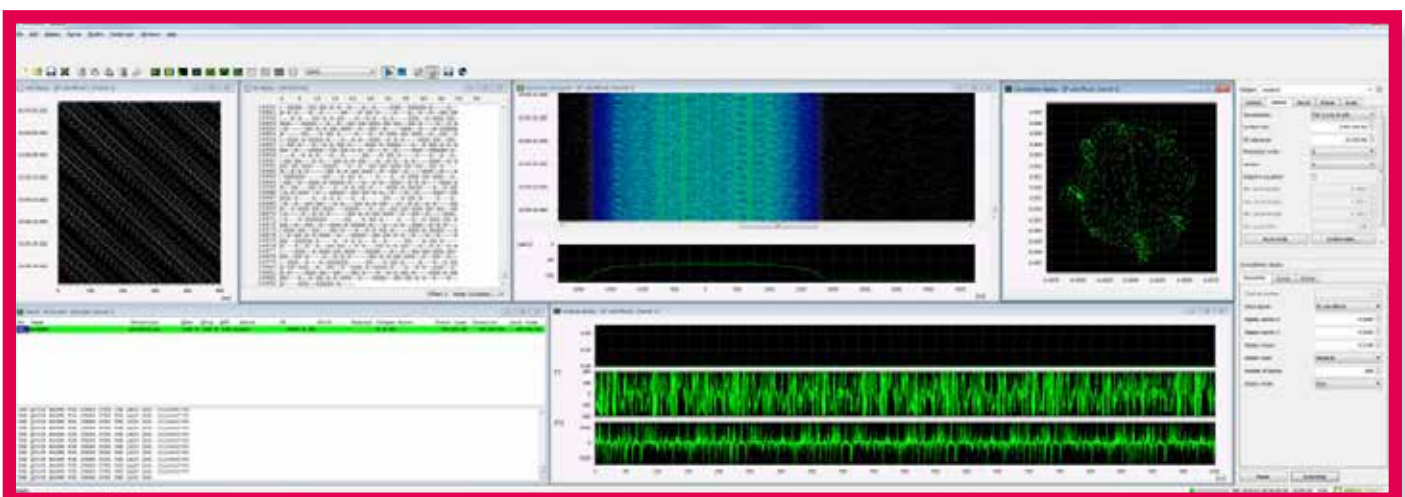
Extending the list of modems for manual and automatic monitoring

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.

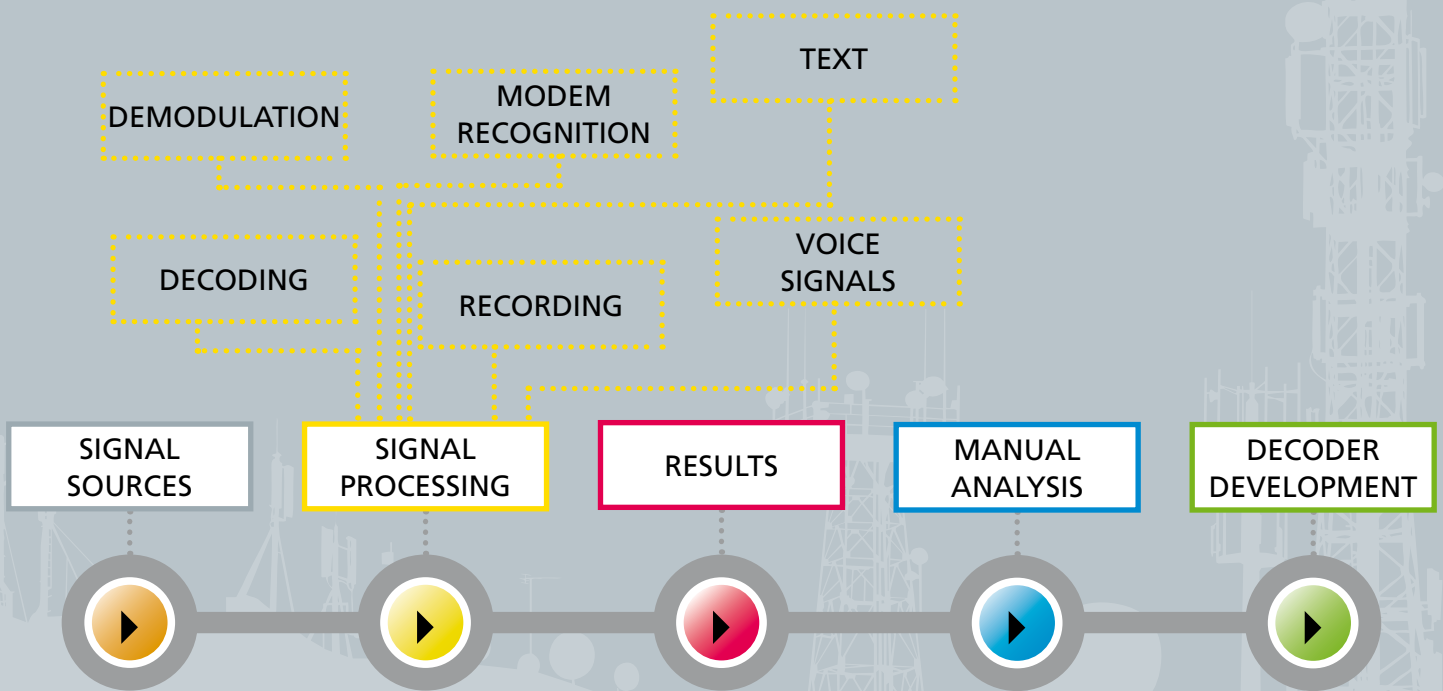Modem Description Files can be exported for use in go2MONITOR.

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

DEMODULATION

MODEM RECOGNITION

TEXT

DECODING

RECORDING

VOICE SIGNALS

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

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).
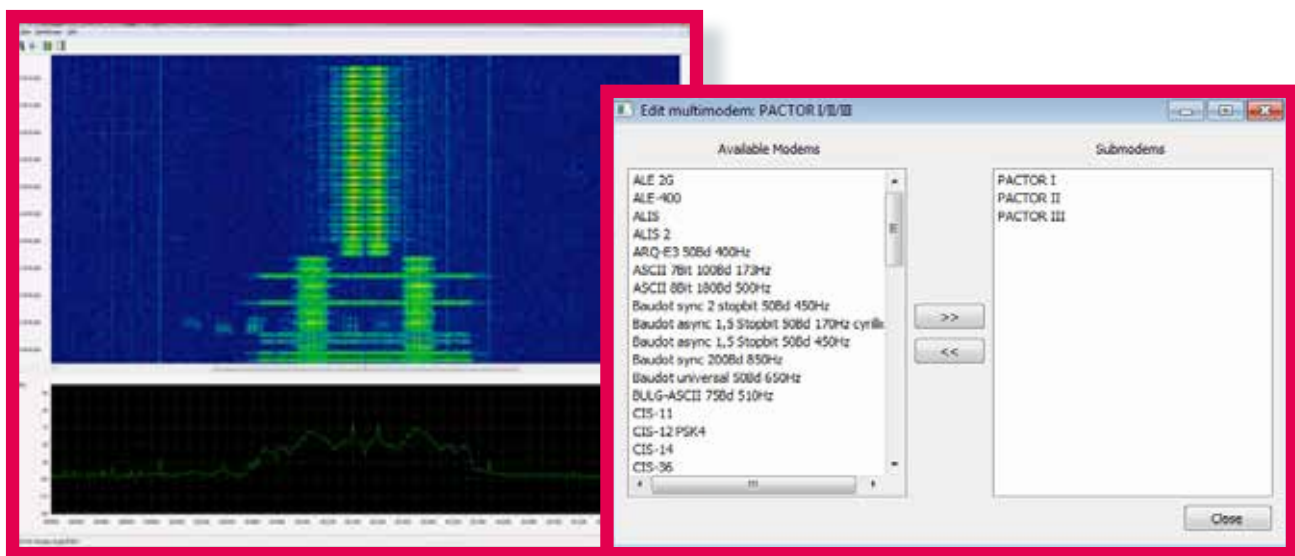
HANDLING OF ADAPTIVE PROTOCOLS

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 a intuitive way.

MODULATION

PHASE

SYMBOL RATE

PATTERNS

FREQUENCY

SHIFT

AMPLITUDE

SIGNAL SOURCES	SIGNAL PROCESSING	RESULTS	MANUAL ANALYSIS	DECODER DEVELOPMENT
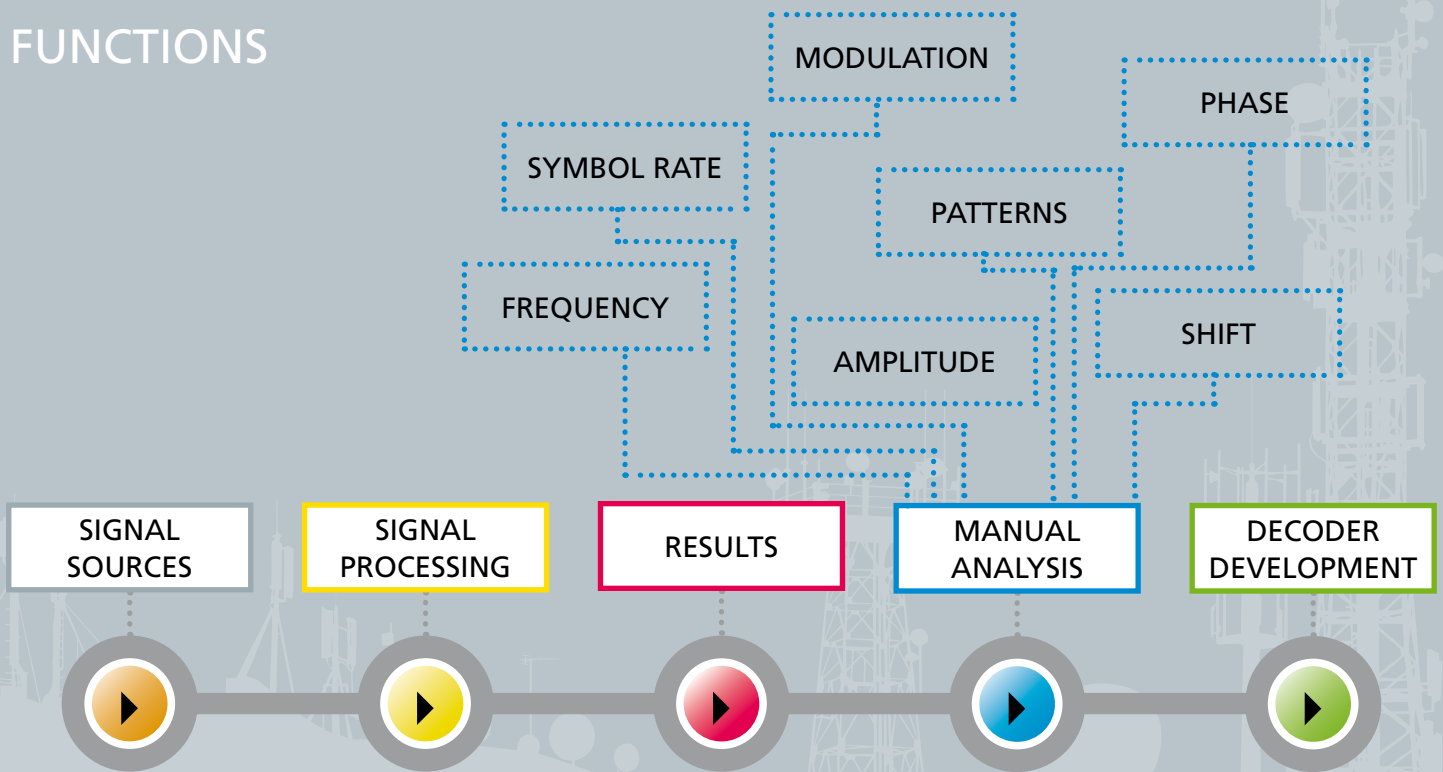
Functions: Signals Analysis

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.
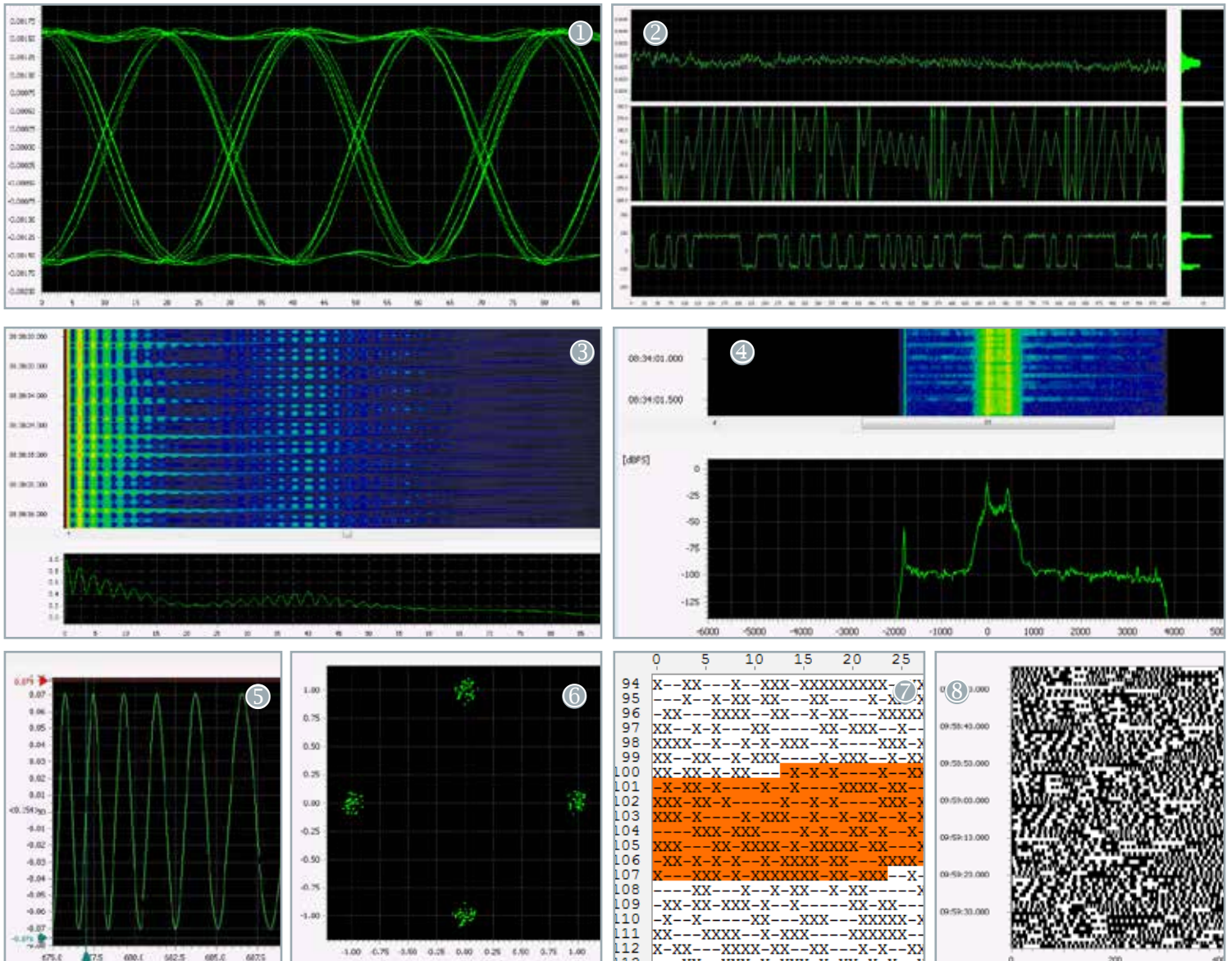
FUNCTIONS FOR EASY OPERATION

- 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
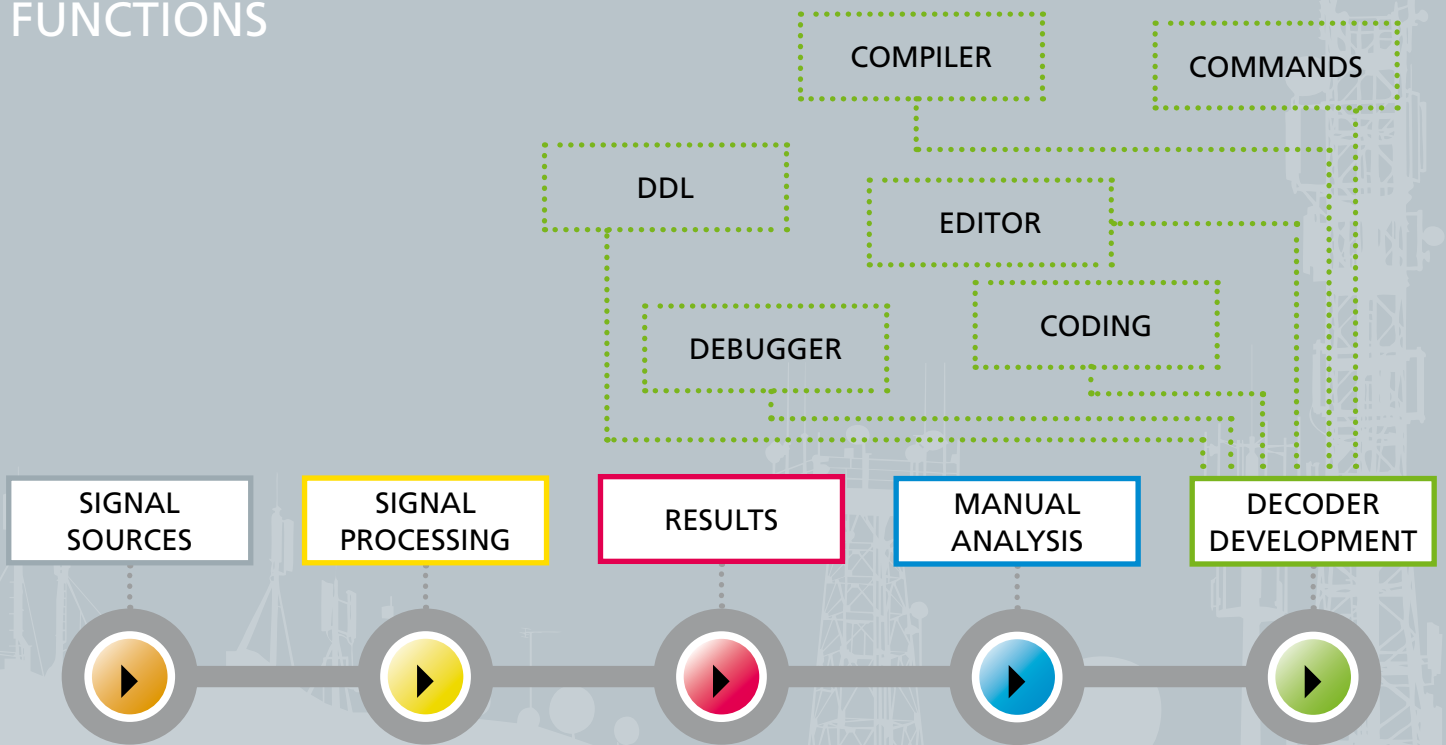
Functions: Decoder Development

Decoder Description Language (DDL)

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

More than 100 commands e.g. for pre-processing, searching, reading, transformation and output formatting can be easily learned and used in the same way as a standard programming language. 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. Operators can use the supplied resources as a template for their own decoder development.

The starting point is a demodulated bitstream produced with a correctly parametrized demodulator. DDL enables analysis and processing of these bitstreams to ensure that the decoded message content is successfully obtained. This way, even modern, complex channel decoding techniques can be applied in only a few steps.

The decoders can be exported to other go2SIGNALS applications e.g. go2MONITOR. The DDL ensures a high decoding quality, i.e. fast synchronization, selectivity, precise error correction etc.

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 DDL-based decoder development tools consist of an editor, a compiler and a debugger.

The editor is used to create and modify the DDL source code. The editor offers automatic command completion and context sensitive help. Correct commands, functions and keywords are highlighted in colour for visual checks. In the event of syntax errors, the integrated compiler provides detailed errors, the integrated compiler provides detailed error messages and generates an executable decoder programme, when compilation is error free.

In addition the debugger is used to verify the executable decoders. The application enables analysis of the decoding procedure in detail. In advanced mode, the debugger can be operated with further analysing possibilities together with all signal processing components of the system. For example, to analyse the behaviour of decoder-controlled demodulators when processing adaptive transmission methods or the interaction of several modems in automatic demodulation and decoding.

①
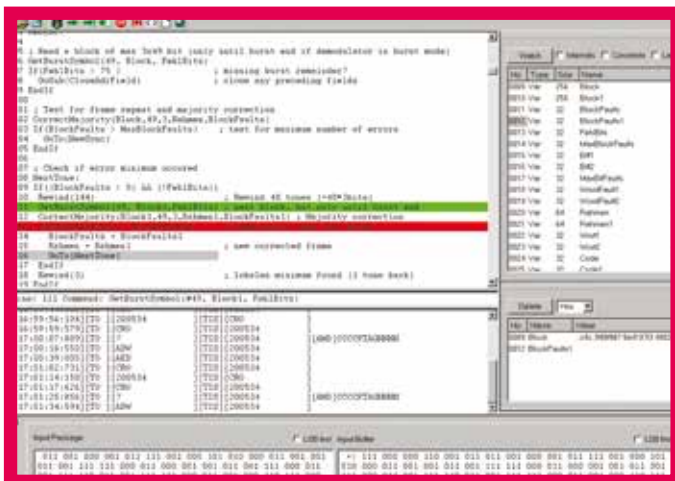
②

① Debugging of decoders with breakpoints
② The Decoder Debugger's advanced mode allows for analysis of the interaction of decoders

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, 64 bit, Linux (CentOS 7) 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	AM /A3E Analogue Selcal ASK 2, 4 ASK2PSK8 ASK4PSK8 Chirp Clover II Clover 2000 Clover 2500 Coquelet DPSK 2, 4, 8, 16 A/B F1A FM / F3E F6/F7B FSK 2 matched FSK 2, 3, 4 disc. FSK 2,3 auto shift MSK / GMSK J3E (USB, LSB) LINK 11 MDPSK 2, 4, 8, 16 A/B MFSK 2 Morse	MPSK 2, 4, 8, 16 A/B MT63 MultiModem MultiTone (FSKn) OFDM OQPSK Pactor II, III, IV PSK 2, 4, 8, 16 A/B PSK data aided (mode controlled by decoder) QAM 16, 32, 64, 128, 256 TFM3 THROB / THROBX Automatic frequency, amplitude and symbol rate control Fast equalizer using known training sequences (via DDL) Primary demodulation USB/LSB/AM/FM Automatic burst synchronization

The performance of our software products depends on the hardware used.
Technical parameters can differ under real operational conditions. Specifications subject to change.

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 compiler (DDL)		
Input Audio (DANA)	Up to 10 MHz sampling rate (note: functionality may be limited for sampling rates higher than 2 MHz) 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 AF (WAV 8, 16, 32 Bit) Playback of Perseus and WiNRADiO WAV recordings with correct frequency display		
Input TCP/IP Streaming	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		
Compatible receivers		Windows supported	LINUX supported
	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 EM100 / PR100	x	x
	RFSPACE NetSDR	x	x
	RFSPACE SDR-14	x	
	RTLSDR/Noxon USB-sticks	x	

Compatible receivers		Windows supported	LINUX supported
	SDRplay RSP	x	
	ThinkRF R5500-408	x	x
	ThinkRF R5500-427	x	x
	ThinkRF WSA5000-408	x	x
	ThinkRF WSA5000-427	x	x
	WiNRADiO G31DDC / G33DDC/ G35DDC / G39DDC	x	
	Generic VITA 49 receiver support	x	x
	Other generic "Winrad ExtIO" supported receivers	x	

Features

Software Feature	Remarks
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
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	Automatic command completion Content related help Syntax highlighting
Compiler	Generation of binary decoder files Detailed code check and error messages
Debugger	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	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	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 Training

This training course familiarises the participant with all go2DECODE components and functions and their practical use. It focuses on delivery of basic knowledge and signal analysis. Configuration and parameter setting of demodulators and decoders for automatic detection of new modems will be explored in more depth. Skills will be gained in practical authentic situations using live signal recordings.

This training offers the possibility to handle individual tasks and queries as well as discussing the signal samples provided by the participants.

Training content:

- Field of application for go2DECODE
- Introduction to the user interface
- Fundamentals of digital signal modulation
- Use of signal analysis function
- Creation of new transmission modes for automatic detection and production

DDL Training

In this training course, participants are introduced to the fundamentals of the Decoder Description Language (DDL). The essential functions will be explained in detail and the commands of this easy to learn programming language will be explained.

Building on the participant's prior knowledge of the principles of channel coding and the fundamentals of bit error correction procedures, existing decoders will be modified and adapted to individual requirements. Following this training course, participants will be able to modify and create new decoders. This training course is addressed to technical employees who are familiar with programming, modification and adaptation of signal decoding software.

Training content:

- Creation and modification of decoders
- Program structure, function and commands and interfaces of the DDL
- Use of the decoder debugging function
- Practical exercises: writing a simple decoder
- Methods for bit error recognition and correction

19.2 I 07/2019 (Subject to modification)