# Agilent AN E8859A
# Agilent GSM Design Library

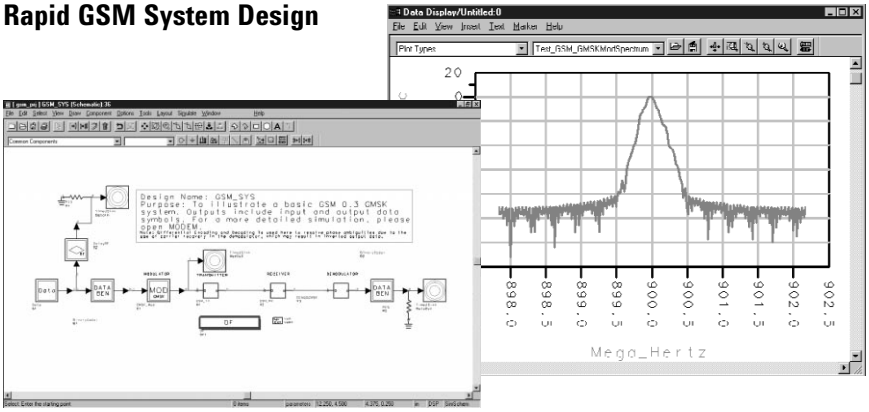
Application Note

The Agilent Technologies Global System for Mobile communications (GSM) Design Library helps you and your engineering team to successfully develop GSM communications products based on the European Telecommunication Standard Institute (ETSI) specifications. With this library, you can develop and refine specification-compliant algorithms at the system level, where design choices have the greatest impact. Using seamless links to other Advanced Design System modules, GSM signal processing algorithms, and analog and RF circuits help you move quickly from design to implementation.

Incorporating the GSM Design Library into your design flow will:

- Speed time-to-market of your GSM designs
- Increase your chances of first-time hardware success
- Optimize your existing designs for higher performance

## Rapid GSM System Design




## Comprehensive GSM Solution: from RF and Analog to Baseband Digital

The Agilent GSM Design Library is part of Advanced Design System, an integrated and diverse system from Agilent EEsof EDA. Advanced Design System gives you access to a wide array of analog, DSP, and RF behavioral models in a highly integrated design environment. It allows quick and accurate modifications to GSM system designs, serving as a foundation on which you can build your own GSM design collection.

The GSM Design Library includes the complete set of behavioral models that conform to the specifications, pre-built simulation systems, and application examples. This allows you to quickly create our GSM designs with higher performance and more efficient hardware implementation.

Agilent Advanced Design System provides a variety of design and simulation tools such as Ptolemy, Circuit Envelope, SPICE, and MATLAB®. In addition, the software allows you to link your test and measurement equipment, such as signal generators or vector signal analyzers, to your design. You refine your GSM design at the system level as you replace behavioral models with actual circuit designs or measured data.

After your design is partitioned into analog, digital, and high-frequency RF portions, you can use DSP Synthesis to create the register transfer level HDL netlist. Then, you can implement the DSP portion of the design into an ASIC or FPGA.

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## Pre-Built Behavioral Models and Systems

- Burst Error Patterns
- Fast Associated Control Channel (FACCH)
- Framing for 260-Bit Frames
- Speech Codec with Regular Pulse Excitation-Long Term Prediction and Linear Predictive Coding (LPC)
- Random Access Channel (RACH)
- Slow Associated Control Channel (SACCH)
- Synchronization Channel (SCH)
- Channel Codec with Cyclic, Fire, and/or Convolutional Coding
- Traffic Channel/Full-Rate Speech (TCH/FS)
- Traffic Channel/9600bps
- Traffic Channel/4800bps
- Traffic Channel/2400bps
- GMSK Modulation Spectrum
- Synchronization and Equalization
- Complete RF transmitter and receiver design capability, including nonlinear components, phase noise, quantization noise, and/or intermodulation distortion

## GSM Performance Measures

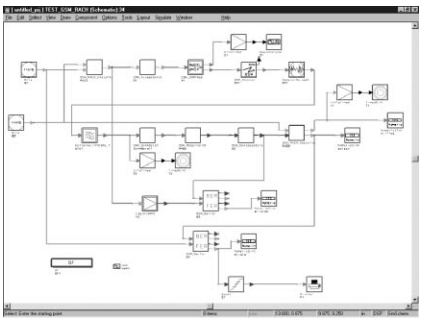
Advanced Design System and the GSM Design Library allow you to analyze and optimize major GSM performance measures, including:

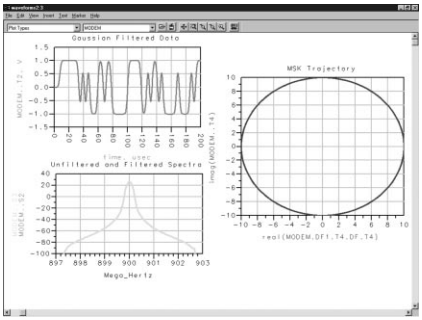
- Bit Error Rate (BER)
- Frame Error Rate (FER)
- Adjacent Channel Power Ratio (ACPR)
- Error Vector Magnitude (EVM)
- GMSK modulation/demodulation accuracy RF amplifier non-linearity
- Fading and Doppler effects in the propagation channel

## Abundant Behavioral Models for any GSM System

To reduce your costs and time to market, the GSM Design Library provides the system-level environment needed to complete high-level signal processing design and partitioning.

The library includes a variety of essential GSM behavioral models, channel codec, speech codec, framing and deframing, modulation and demodulation, frequency hopping, synchronization, channel equalization, and measurement. All models are GSM physical layer models based on ETSI GSM recommendations 03.03, 04.03, 04.06, 05.01 to 05.05, and 05.10.






**With the GSM Design Library, you can perform a large number of analyses in both time domain and frequency domain.**

## Complete Signal Path Design Approach for the Competitive GSM Market

With Advanced Design System and GSM Design Library, you can rapidly design GSM base stations and handsets for voice communication based on the ETSI GSM standards. The first step is to investigate GSM system specifications at the physical layer system level with baseband GSM models. The library as well as analog/RF models are included with Advanced Design System products such as Communications System Designer and DSP Designer.

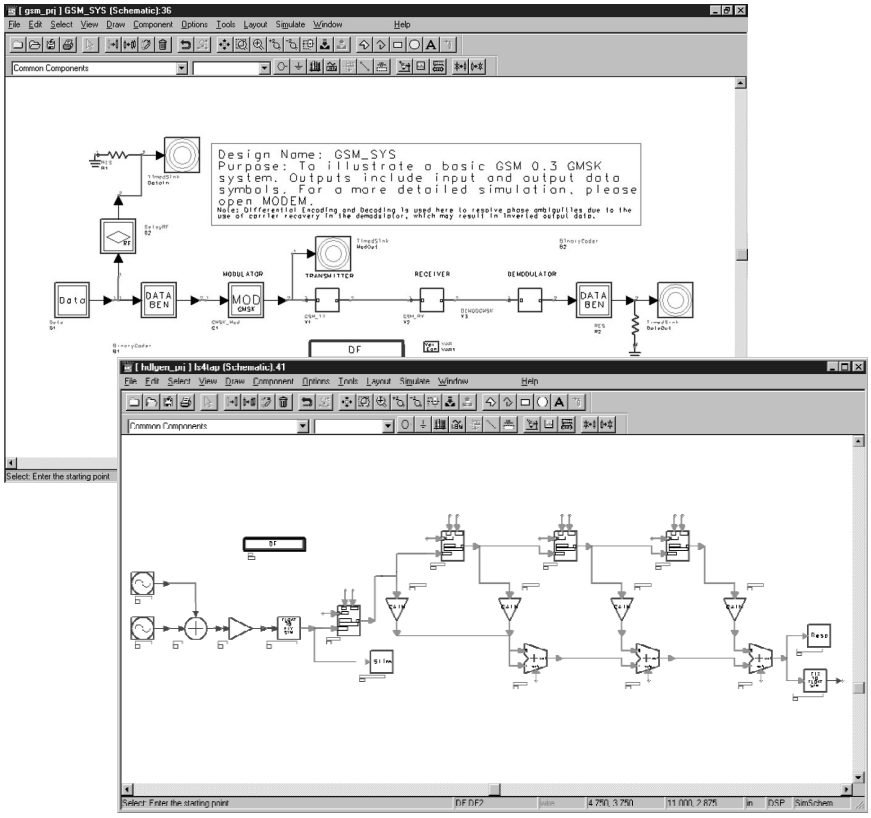
After the system specifications are determined, both analog and digital functional designs are executed within either the Communications System Designer or DSP Designer. Finally, analog/RF circuit-level design is executed within the same environment. The gate-level HDL code for the GSM digital signal processing can be generated with a popular logic synthesis tool from the register transfer-level HDL code.

## Agilent GSM Design Library Hardware Implementation

When your partitioned system level GSM design meets performance requirements, it can go to implementation. Advanced Design System includes a full range of technologies to help you design the analog, RF, and DSP circuit you need. DSP algorithms are prepared for implementation using HDL code generation models, HDL simulation, and DSP behavioral synthesis. The system's HDL generator outputs either VHDL or Verilog and their test environments. This reduces the need for hand coding and for translating test vectors.

**GSM Design Library Specifications**

| | |
|---|---|
| Access Method | TDMA/FDMA |
| Channel Bandwidth | 200 kHz |
| Burst Length | 577 µs |
| TDMA Frame | 4.615 ms |
| Data Rate | 2400/4800/9600 bps |
| Modulation/Demodulation | Gaussian Minimum Shift Keying (GMSK) with BT = 0.3 and rate 270 5/6 kBd |
| Error Correction | Cyclic, Fire, and/or convolutional/Viterbi coding |
| Frequency Hopping | Slow frequency hopping once every 577-µsec time slot |




**When the system-level design is complete, the synthesizable models allow you to generate HDL code efficiently.**

In addition, you can download modulated signals for hardware testing using a built-in link to Agilent ESG-D digital signal generators. This powerful feature helps reduce mistakes commonly found during the integration and test phase of design.

Within the Advanced Design System, RFIC Designer and RF Board Designer modules include the technologies needed to design and implement analog and RF circuits. Simulation technologies include SPICE, Harmonic Balance, and Circuit Envelope, to allow the widest range of design capabilities.

Advanced Design System also includes physical design capabilities and links to back-end tools to move your LSI or board designs into your company-wide design framework.

## Product Configuration

The GSM Design Library (E8859A/AN) requires Design Environment (E8900A/AN), Data Display (E8901A/AN), Ptolemy Simulator (E8823A/AN), and Ptolemy Fixed Point Analysis (E8822A/AN).*

* DSP Designer Pro (E8821A/AN) has all software modules required to run GSM Design Library. Customers purchasing Communication Systems Designer Pro (E8851A/AN) or Premier (E8852A/AN) should also buy Ptolemy Fixed Point Analysis (E8822A/AN). For other possible product configurations, please consult your local representative.

A Ptolemy Fixed Point Analysis (E8822A/AN) License is required for designs using the GSM Speech Coding models in the GSM Design Library.

## Comprehensive Components and Sub-Networks

### GSM Design, Channel Coding

- Cyclic Encoder/Decoder
- Reorder
- InverseReord
- Interleaving_8/Deinterleaving_8
- Interleaving_4/Deinterleaving_4
- Interleaving_f96/Deinterleaving_f96
- RmvStlFlgs
- Splitter/Combiner
- BlockCodeRACH
- FireDecoder
- TailBits
- Convolutional encoder with tail-bits
- Viterbi decoder
- Puncture/Depuncture

### GSM Design, Framing

- AccessBurst
- DeAccessBurst
- DeBcchCcchDn
- DeMultiframe26
- DeNormalBurst
- DeSBurst
- DummyBurst
- FBurst
- Multiframe26
- NormalBurst
- SBurst
- TrainBitGen
- TimeBaseCounter
- 51-Multiframe Constructors and Deconstructors (Up/Down)

### GSM Design, Modems

- DifferEncoding/Decoding
- Carrier
- AQuarterBitAdd/AQuarterBitOff
- MpyClock
- HoppingFrequency
- FHDH

### GSM Design, Synchronization

- PhaseRecovery
- DataSelection
- Sampler

### GSM Design, Equalization

- ChannelEstimator
- Derotator
- Equalizer
- EquCombiner
- EquSpliter
- EquComposeAB/ EquDecomposeAB

### GSM Design, Speech Coding

- ScaleInput
- OffsetCompensation
- Preemphasis
- Autocorrelation
- Schur
- LogAreaRatios
- CodeLARs
- DecodeLARs
- Interpolation
- LARsToRefCoe
- Long/ShortTermAnalysis
- LTP_Parameters
- ShortTermPrediction
- Long/Short Term Synthesis
- WeightingFilter
- RPE_GridSelection
- APCM_Quantization
- InverseAPCM
- RPE_Grid Position
- Framing/Deframing
- Deemphasis
- Postprocessing

### Additional Models

- BER/FER Measurement
- Error Pattern Drawer

### GSM Design, Sub-Networks

- FreqHopDehop
- GMSK Mod/Demod
- TCHFS_Encoding/Decoding
- SACCH_Encoding/Decoding
- FACCH_Encoding/Decoding
- RACH_Encoding/Decoding
- ReceiverAB
- Speech Encoder/Decoder

For more information about Agilent EEsof EDA visit:
**www.agilent.com/eesof-eda**

For more assistance with your test and measurement needs visit:
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