Generating a DVB-T2 Signal with Composite T2-Base and T2-Lite Content

Application Note

Products:

R&S®BTC	R&S®SFU	R&S®SFE100
	R&S®SFE	R&S®SFC

Version 1.3.1 of the DVB-T2 standard ETSI 302 755 introduced the T2-Lite profile to ease the implementation of mobile TV services. This was achieved by minimizing the complexity of the required receiver and allowing side-by-side integration into existing conventional (T2-Base) DVB-T2 channels.

For the purposes of testing the compatibility and performance of receiver modules, this application note describes how this type of composite RF signal can be simulated using one R&S®BTC or alternatively two instruments from the family of broadcast signal generators comprised of the R&S®SFU, R&S®SFE, R&S®SFE100 and R&S®SFC.

Only one corresponding multiple profile T2-MI stream is required, either in the form of a file or via an external gateway.

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1 Introduction

The new DVB-T2 terrestrial television standard is becoming increasingly important. New systems are being tested in many countries around the world. Others have already completed the introductory phase.
Such an advanced level of implementation means that more complex innovations of the standard will find increasing usage in real systems.
This includes T2-Base/T2-Lite composite signal transmission.

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1.1 Organization

Section 1.2 describes the technical background of the composite T2-Base/T2-Light technology used in the DVB-T2 standard. Implementation details follow in Chapter 2, starting with the basic setup with a multiple profile T2-MI file. In the second part of this application note, the solution is complemented by including an external multiple profile gateway for long-term testing.

1.2 Technical Background

The T2-Lite profile uses only a subset of the parameterization options that are used in the regular T2-Base profile of the DVB-T2 standard:

- Fewer modes and combinations of FFT modes, pilot patterns and guard intervals
- Fewer modes and combinations of modulation and code rates
- Reduced length of time interleaver
- Data rate limited to max. 4 Mbit/s per Physical Layer Pipe (PLP)
- Limited receiver buffer model
- New code rates and longer future extension frames (FEF)

This customization of parameters to mobile reception requirements reduces the receiver memory requirements and complexity by approx. 50%, significantly reducing development costs for future mobile end devices.

The future extension frames (FEF) feature of the DVB-T2 standard makes it possible to generate regular T2-Base and T2-Lite signals within the same channel, each with a different transmission mode. This achieves the required dependability for each receiver.

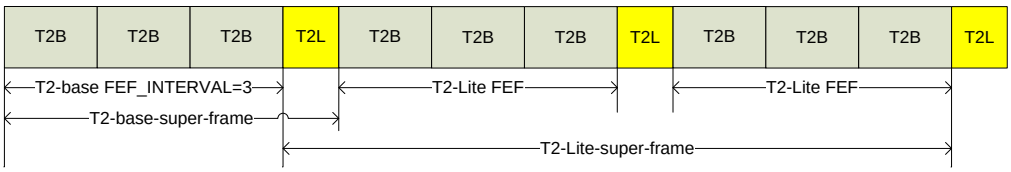

Fig. 1: Both T2-Base and T2-Light profile can be combined within one DVB-T2 signal using FEF [1]

When introducing new mobile TV services, this makes use of the existing DVB-T2 network capacity, without needing additional transmitters and frequencies. This makes it easy to evaluate market acceptance before making a decision to invest in new infrastructure. Finally, the way FEF structures transmissions over time also enables mobile receivers to save power by switching their frontend to idle mode during T2-Base periods.

2 Implementation

The R&S®BTC broadcast test center with two RF paths generates a composite T2-Base/T2-Lite RF signal in a single box. This setup is described in subchapter 2.1.

Alternatively, one R&S®SFU broadcast test system coupled with one additional R&S®SFU, R&S®SFE broadcast tester, R&S®SFE100 test transmitter or R&S®SFC compact modulator can also be used. This setup is described in subchapter 2.2.

Subchapter 2.3 then explains how to fine-tune the synchronization between the generated RF signals with using a dual channel oscilloscope.

Finally, subchapter 2.4 describes how to extend the test setups for long term testing.

2.1 R&S®BTC Setup

2.1.1 Requirements

- 1 x R&S®BTC (firmware version ≥ 1.50)
  each of the two RF paths equipped with DVB-T2 coder (R&S®BTC-K516)
- 1 x multiple profile T2-Base/T2-Lite T2-MI stream as a file, including relative time stamps for synchronization (e.g. from R&S®LIB-K57, version ≥ 1.30)
- 2-path RF power combiner matching the desired frequency and power range (Resistive tee technology is not recommended, since its suboptimal isolation performance negatively affects signal quality. Thus alternative concepts based on coupled transmission lines or transformers are preferred.)

2.1.2 Test Setup

2.1.2.1 Rear side

Connect TS SERIAL OUT of baseband generator module 1 (left side) to TS SERIAL IN of baseband generator module 2 (right side).

Fig. 2: R&S®BTC rear side setup.

2.1.2.2 Front side

Connect the 2-path power combiner to RF path output 1 and 2 to get the composite T2-Base/T2-Lite RF sum signal.

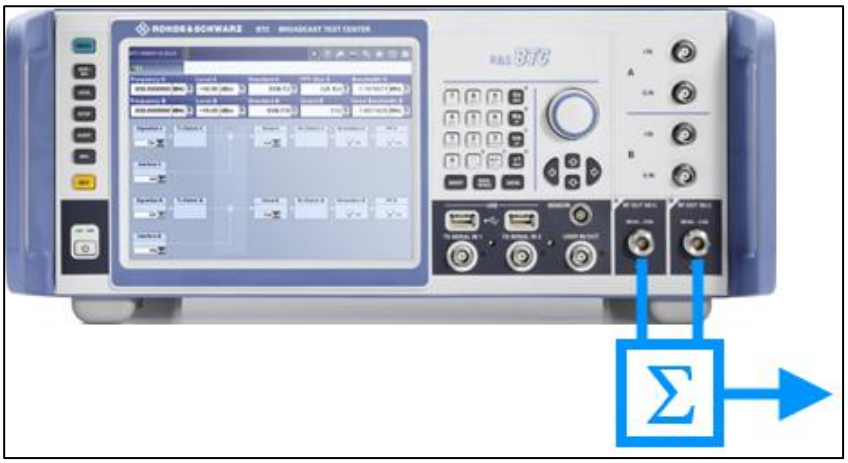

Fig. 3: R&S®BTC front side setup.

2.1.3 Configuration

2.1.3.1 Settings for RF paths

a) Activate the DVB-T2 coder with the same frequency, channel bandwidth and output power.

b) In “TX:SignalGen:Input Signal”, set “T2-MI Interface” to “On”.

c) In “TX:SignalGen:Input Signal”, set “T2-MI PID” and “T2-MI SID” depending on the desired profile of your multiple profile T2-MI stream.
When using a T2-MI stream file from the R&S®LIB-K57 library, then assign
- PID 0x1001 / SID 0x1 for the T2-lite content
- PID 0x1000 / SID 0x0 for the T2-base content.

d) In “TX:SignalGen:T2 System”, set “Network Mode” to “SFN” and “Profile Mode” to “Multi”.

2.1.3.2 Specific settings for RF path A

a) In “TX:SignalGen A:Input Signal”, set “Source” to “MM Generator”.

b) In “MMGen:Player 1”, select the appropriate multiple profile T2-MI T2-Base/T2-Lite transport stream.
(e.g. t2mi_vv851_801-826_rs_gmit_180sec.T2MI_C from the R&S®LIB-K57 library)

c) Make sure the “MMGen:Player 1” output data rate matches the selected T2-MI file. (This value is automatically set correctly when selecting a file from the R&S®LIB-K57 library.)

2.1.3.3 Specific settings for RF path B

a) In “TX:SignalGen B:Input Signal”, set “Source” to “External”.

b) In “TX:SignalGen B:Input Signal”, set “Input” to “TS IN 3”.

c) In “TX:SignalGen B:SFN”, set “1PPS Routing” to “Internal Input”.

2.1.4 Synchronization

Fine-tune the synchronization between the generated RF signals with a dual channel oscilloscope like described in subchapter 2.3.

2.2 R&S®SFU based setup

2.2.1 Requirements

2.2.1.1 Master transmitter

- 1 x R&S®SFU
  with DVB-T2 coder (R&S®SFU-B15 and R&S®SFU-K16)
  and TRP player (R&S®SFU-K22)
- 1 x multiple profile T2-Base/T2-Lite T2-MI stream as a file, including relative time stamps for synchronization (e.g. from R&S®SFU-K227, version ≥ 1.30)
- 1 x adapter cable DA-15 (male) to BNC (male):

Fig. 4: The required adapter cable connects the DA-15 pin (blue) with the BNC inner contact and the other pin (gray) with the outer contact

2.2.1.2 Slave transmitter

- R&S®SFC or R&S®SFE100 or R&S®SFE or R&S®SFU
  each with a DVB-T2 coder (R&S®SFx-B15 and R&S®SFx-K16)

2.2.1.3 Cabling

- BNC cables for the following signals:
  - 1 x TS-ASI (75 Ω, 800 mV)
  - 1 x 10 MHz reference frequency (50 Ω, 5 dBm)
  - 1 x 1 pps (50 Ω, 2 V)
  - 2 x RF (50 Ω)
- RF coupler for desired frequency and power range
  (Resistive tee technology is not recommended, since its suboptimal isolation performance negatively affects signal quality. Thus alternative concepts based on coupled transmission lines or transformers are preferred.)

2.2.2 Required Firmware Versions

R&S®SFU	R&S®SFE	R&S®SFE100	R&S®SFC
≥ 2.70	≥ 2.70	≥ 2.70	≥ 2.70

2.2.3 Test Setup

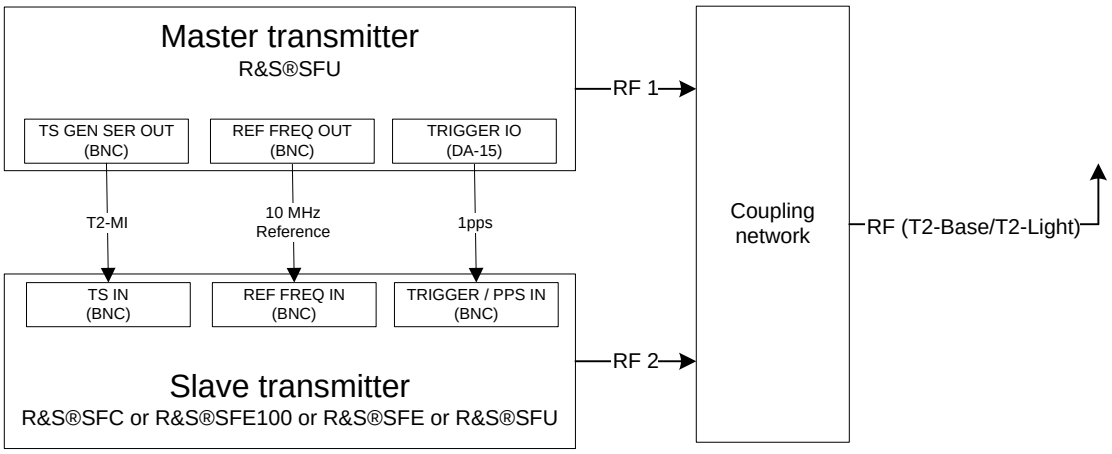

Fig. 5: Test setup

The R&S®SFU master transmitter is the central element of the architecture. In addition to providing the 10 MHz reference, the multiple profile T2-MI input file can be used directly to generate T2-MI & 1 pps signals, not only for itself but also for the slave transmitter. This eliminates the need for an external multiple profile T2-MI gateway or external GPS receiver.

2.2.4 Configuration

2.2.4.1 Settings for both transmitters

a) Activate the DVB-T2 coder with the same frequency, channel bandwidth and output power.

b) In TX:DIGITAL TV:INPUT SIGNAL, set T2-MI INTERFACE to ON.

c) In TX:DIGITAL TV:INPUT SIGNAL, set the T2-MI PID and T2-MI SID depending on the desired profile of your multiple profile T2-MI stream.
When using a T2-MI stream file from the R&S®SFU-K227 library, then assign
- PID 0x1001 / SID 0x1 for the T2-lite content
- PID 0x1000 / SID 0x0 for the T2-base content.

d) In TX:DIGITAL TV:T2 SYSTEM, set NETWORK MODE to SFN and PROFILE MODE to MULTI.

2.2.4.2 Specific settings for the master transmitter

a) Configure SETUP:HARDWARE SETTINGS:TRIGGER as follows:

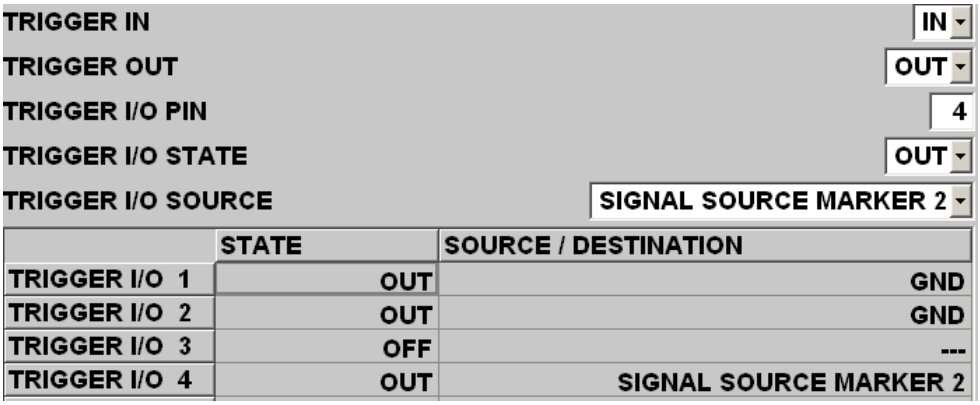

Fig. 6: Configuration of the 1 pps signal at the Trigger Out interface.

b) In TX:DIGITAL TV:INPUT SIGNAL, set T2-MI SOURCE to INTERNAL.

c) In TSGEN, select the appropriate multiple profile T2-MI T2-Base/T2-Lite transport stream.
(e.g. t2mi_vv851_801-826_rs_gmit_180sec.T2MI_C from the R&S®SFU-K227 library)

d) Make sure the TSGEN output data rate matches the selected T2MI file. (This value is automatically set correctly when selecting a file from the R&S®SFU-K227 library)

2.2.4.3 Specific settings for the slave transmitter

a) In SETUP:HARDWARE SETTINGS:REFERENCE, set SOURCE to EXT.

b) In TX:DIGITAL TV:INPUT SIGNAL, set T2-MI SOURCE to EXTERNAL.

c) In TX:DIGITAL TV:INPUT SIGNAL, set T2-MI INPUT to match the cabling.

2.3 Synchronization

Ensure that the “Static Delay” value in the SFN settings is set to zero for both DVB-T2 coders.

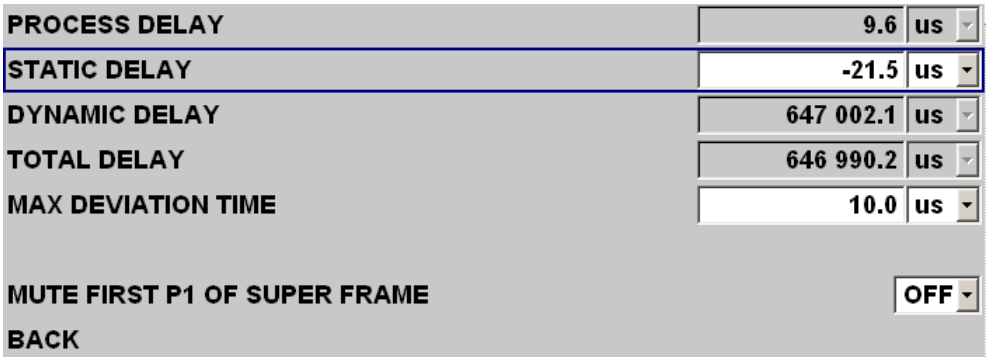

Fig. 7: The STATIC DELAY parameter must be set to zero.

The timing can then be verified by viewing both RF signal outputs on a dual channel oscilloscope simultaneously:

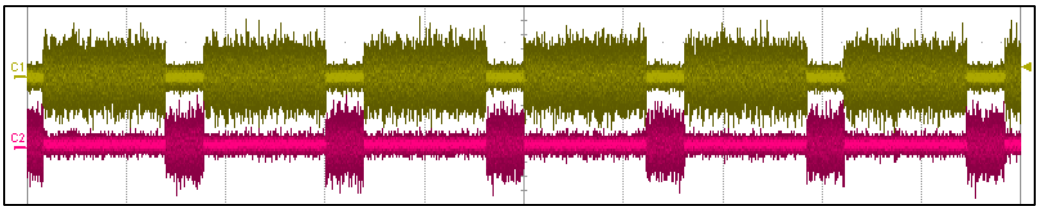

Fig. 8: Synchronization check between T2-Base-signal (yellow) and T2-Light signal (red)

If latency introduced by the external input cabling causes the second RF signal to run with a slight delay, then reduce its “Static Delay” SFN setting (see Fig. 7) to less than zero until adequately compensating for the effect.

If the T2-MI data stream is changed in the transport stream generator, or if one of the coder settings is changed, the individual coders will, on rare occasions, lock in on the common T2-MI signal to such a different degree that the delay becomes significantly greater than the length of the guard interval.

In this case, the PROCESS DELAY values (see Fig. 7) for the coders will differ by significantly more than several 10 µs. This problem can be fixed by stopping and then restarting the T2-MI data stream in the transport stream generator.

2.4 Modifications for Long-Term Testing

The T2-MI streams in the recommended R&S®LIB-K57 / R&S®SFU-K227 library offer a runtime of 1 and 3 minutes. Even when the stream is cycled infinitely, the system causes the output signal to be interrupted when the stream loops back to the beginning of the file because both DVB-T2 coders involved must be resynchronized to the T2-MI stream. However, the time delay setting between the RF signals remains in place.

For long-term testing, a multiple profile T2-MI gateway can be used to prevent these periodic signal interruptions.

2.4.1 BTC setup

Instead of feeding both DVB-T2 coders by the internal “MMGen:Player 1”, the T2-MI stream is provided externally from a multiple profile T2-MI gateway using R&S®BTC front side “TS INPUT 1” or “TS INPUT 2”, which will distribute the signal to both coders.

This also requires using further signals from the multiple profile T2-MI gateway:

- Connect its 10 MHz reference signal to the R&S®BTC “REF IN” input, and activate this interface by setting “Setup:Hardware Settings:External Reference Frequency:Source” to “External”.

- Connect its 1 pps signal to the R&S®BTC “EXT 1” input, and activate this interface by setting TX:SignalGen:SFN:1PPS Routing” to “External Input” for both RF paths.

2.4.2 SFU based setup

The multiple profile T2-MI stream, 10 MHz reference signal and 1 pps signal can be connected to any two slave transmitters. A dedicated R&S®SFU master transmitter is no longer required. Apart from relative timestamps in the multiple profile T2-MI stream, absolute timestamps can also be used for transmitter synchronization. Refer to the operating manual of the instrument when coupling with an absolute time server.

3 Abbreviations

FEF	Future Extension Frame
GPS	Global Positioning System
PID	Packet Identifier
PLP	Physical Layer Pipe
T2-Base signal	DVB-T2 signal using the T2-Base profile
T2-Lite signal	DVB-T2 signal using the T2-Lite profile
T2-MI	DVB-T2 Modulator Interface

4 Literature

[1] "Digital Video Broadcasting (DVB);
Frame structure channel coding and modulation for a second generation digital terrestrial television broadcasting system (DVB-T2)",
ETSI EN 302 755, V1.3.1, 2011-02

5 Additional Information

Our Application Notes are regularly revised and updated. Check for any changes at http://www.rohde-schwarz.com.

Please send any comments and suggestions about this Application Note to Broadcasting-TM-Applications@rohde-schwarz.com.

6 Ordering Information

Designation	Type	Order No.
One box solution: R&S®BTC		
Broadcast Test Center	R&S®BTC	2114.3000.02
RF Path A - 100 kHz to 3 GHz or - 100 kHz to 6 GHz	R&S®BTC-B3103 R&S®BTC-B3106	2114.3100.02 2114.3200.02
RF Path B - 100 kHz to 3 GHz or - 100 kHz to 6 GHz	R&S®BTC-B3203 R&S®BTC-B3206	2114.3300.02 2114.3400.02
Baseband Main Module, two I/Q paths to RF	R&S®BTC-B12	2114.6600.02
Baseband Generator, 1st channel	R&S®BTC-B1	2114.3500.02
DVB-T2 Coder	R&S®BTC-K516	2114.7035
Baseband Generator, 2nd channel	R&S®BTC-B2	2114.3600.02
DVB-T2 Coder	R&S®BTC-K516	2114.7035
Recommended		
DVB-T2 MI Streams	R&S®LIB-K57	2116.9429.02
Alternative Master Transmitter: R&S®SFU		
Broadcast Test System	R&S®SFU	2110.2500.02
DVB-T2 Coder	R&S®SFU-K16	2110.7847.02
Coder Extension 15 (for digital TV)	R&S®SFU-B15	2110.7918.02
TRP Player	R&S®SFU-K22	2110.7499.02
Recommended		
TS/ETI Recorder[1]	R&S®SFU-K21	2110.7482.02
Alternative Slave Transmitter: R&S®SFU / R&S®SFE / R&S®SFE100		
Broadcast Test System	R&S®SFU	2110.2500.02
DVB-T2 Coder	R&S®SFU-K16	2110.7847.02
Coder Extension 15 (for digital TV)	R&S®SFU-B15	2110.7918.02
Broadcast Tester	R&S®SFE	2112.4300.02
DVB-T2 Coder	R&S®SFE-K16	2113.4290.02
Coder Extension Board	R&S®SFE-B15	2112.4200.02
Test Transmitter	R&S®SFE100	2112.4100.02
DVB-T2 Coder	R&S®SFE100-K16	2113.4284.02
Coder Extension Board	R&S®SFE100-B15	2112.4222.02

[1] For optional recording of T2-MI streams.

Designation	Type	Order No.
Alternative Slave Transmitter: R&S®SFC		
Compact Modulator	R&S®SFC	2115.3510.02
DVB-T2 Coder	R&S®SFC-K16	2115.5494.02
Coder Extension Board	R&S®SFC-B15	2115.5836.02

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