Qosmotec

Software Solutions GmbH

Electronic HF Switch Matrix

Technical Description

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0 Document Control

0.1 Imprint

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0.2 Document History

Date	Author	Version	Status	Changes/Comments
10. July 2006	DKR	R0.1	draft	Document started
16. July 2006	DKR	R1.0	released	Document released
14. January 2009	DKR	R1.1	released	Adaptations to non-blocking switches
25. October 2013	DKR	R1.1	released	Adaptations to the 40:1 switches

0.3 References

[1] Product Description for Qosmotec Propagation Effects Replicator; Qosmotec Document Number PS-2004-004-R2.1

1 Overview

This document describes the Qosmotec Electronic HF Switch Matrix (ESM), that is used in telecom test plans as an electronic and software controlled replacement of manual patch panels. It shows the setup of the system and advantages and the application cases of a non-blocking switching of HF sources to test rooms or test mobiles. Additionally, it shows the combination with a Qosmotec Propagation Effects Replicator ([1]), an attenuator hardware with a software to model handover conditions under realistic HF propagation condition models.

Appendix A lists the technical data of the ESM hardware.

2 ESM Functional Description

The Qosmotec Electronic HF Switch Matrix (ESM) is a device that, by means of electronic switches, allows the computer-controlled, non-blocking selection of a number *m* of HF lines (“HF out” in Figure 1) from a larger set of *n* (“HF in” in Figure 1). “Non-Blocking” means, that each of the *n* input sources may be switched to any of the *m* ouput lines – also multiple times, whereas each of the *m* outputs can have only one of the *n* inputs assigned. The communication is bidirectional on all switched links, i.e. the radio devices on the HF out ports receive commands from the switched input radio device, whereas the radio devices on the inputs receive commands from all devices where they are switched to. ESM is available in various sizes, from 8 to 40 ports on the HF in side and 1 to 16 ports on the HF out side. Unused input lines are terminated with 50 Ohms. Thus, the ESM acts as an electronic HF patch panel that can be inserted between UEs and NodeBs in a telecom test plant and can be used with HF signals from 400 MHz to 6 GHz.

Figure 1 shows the connection scheme of a non-blocking 40:16 ESM as an example . Internally, it consists of 40 power dividers and 16 electronic pin-diode switches, that select one of 40 inputs. Such a switch component is depicted in Figure 2.

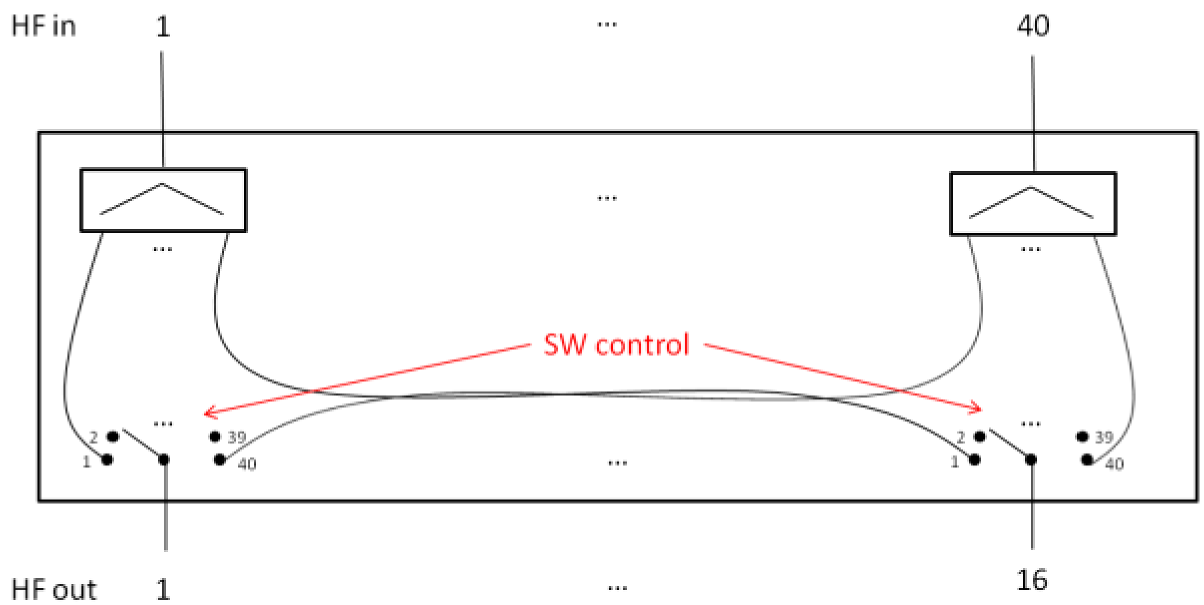


Figure 1: Schematic of the Electronic HF non-blocking Switch Matrix

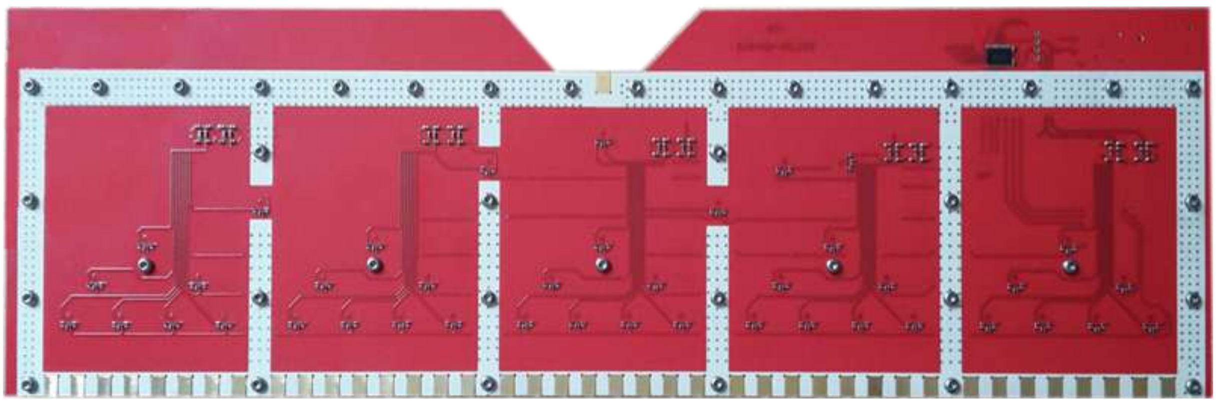


Figure 2: The electronic switch component for selecting one of 40 inputs

An ESM is constructed in a 19'' mountable rack housing. Figure 3 shows an example of an ESM with two 8:1 switches. This fits into a 3U housing. The 40:12 setup in Figure 1 requires only 12 U of a rack. The connectors are N(f) by default, but can be adapted to other connector types on demand. They can also be placed anywhere else on the system than on the front plate. A typical setup is for example to place the inputs on top, so that they can easily be cabled to the Base Station lines coming from the ceiling and place the outputs either on the front or on the bottom. The last setup is handy in case the ESM is combined with an attenuator matrix (see chapter 3.2), that also has its input ports on the top.

Figure 3: Switch System consisting of two 8:1 switches

Compared to a mechanical patch panel, an ESM has a number of advantages:

- Fast switching, extremely short link interruption (sub-millisecond).
- Fully automatic, that means usable for unattended operation under control of a test automation system.
- Graphical user interface for manual usage as well as command line interface for integration into other automatic test systems
- Multi-user capability and protection with access rights

3 Who Needs ESM?

3.1 Administrators of Test Labs

In test labs, HF connections are often routed to different test rooms, groups of test mobiles, HF measurement / simulation equipment by means of a *patch panel,* where manually routed cables connect selected inputs and outputs. The problem of patch panels is that their cabling tends to become very confusing, so there is the danger that somebody disconnects a cable currently in use for an active test. Also, if it is possible for anybody to re-plug cables, it is hard to control and trace back, who was responsible for what modification, and if a modification was done at all. A particular cabling scheme can be rather complex, so changing from one scheme to another takes time and careful consideration. It would be quite helpful, if such a configuration could be saved and restored with a few keypresses.

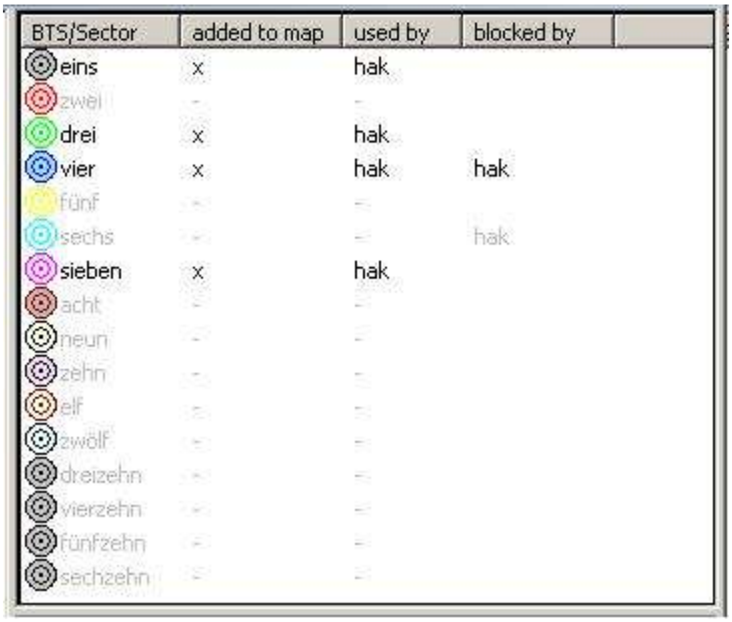
Finally, test labs are sometimes used by tester teams in other offices, countries, or even continents. Manual patch panels always require somebody local to do a requested modification, and this person might be hard to reach when needed, especially with time differences between continents.

The ESM as a standalone tool solves all these problems. The cabling scheme can be viewed on the screen in a graphical user interface for administrators. It is clearly visible, which RF signal is going into which port. The access to the ESM can be restricted with login account and password, so that not everybody can change the configuration, however, it can be changed remotely from other offices, if suitable persons have been authorised with the necessary access rights over there.

If the test plant has an RF isolation chamber, inside which radio signals are broadcasted into the air through antennas, the ESM can be used to select which of the base stations of the test plant shall deliver their radio signals into the isolation chamber.

The Graphical User interface features a *BTS Selection Window* (Figure 4), from which users can drag base stations into a virtual landscape. Correspondingly, there is a *Mobile Selection Window*, from which the users may select mobiles to be used within the scenery. Depending on the selection of base stations (ESM inputs) and mobiles (ESM outputs) the links in the switch matrix are set. The number of concurrently usable base stations is limited to the number of ESM outputs, thus the remaining base stations become greyed out and cannot be selected any more, when the maximum number or selections is reached. Figure 4 depicts this for a 16:4 switch, where already 4 base stations have been selected and therefore no other of the remaining 12 ESM inputs is available any more.

Since the ESM is non-blocking, it is multi-user capable. Multiple users working in different rooms or on different test equipment can select the input RF signals independently. The 40:1 switches (see Figure 2) also have an extraordinarily high isolation of more than 70 dB on two neighbouring ports, so that it is guaranteed, that multiple users will not disturb each other by crossing HF signal paths.



BTS/Sector	added to map	used by	blocked by
eins	x	hak	
zwei	-	-	
drei	x	hak	
vier	x	hak	hak
fünf	-	-	
sechs	-	-	hak
sieben	x	hak	
acht	-	-	
neun	-	-	
zehn	-	-	
elf	-	-	
zwölf	-	-	
dreizehn	-	-	
vierzehn	-	-	
fünfzehn	-	-	
sechzehn	-	-	

Figure 4: The BTS Selection List in the ESM graphical user interface

3.2 Users of Attenuation Hardware

The Electronic HF Switch Matrix is an extension of the Qosmotec Propagation Effects Replicator QPER to make more cells available in an QPER attenuator-array system (see [1] for more detailed information on the field strength emulator). QPER systems with many BS inputs can become rather bulky and expensive. A reasonable compromise between universal connectivity of all mobiles and base stations on one hand and the desire to reduce the costs of the QPER hardware on the other hand is to put an ESM in front of a QPER attenuator array and to actively select the set of desired base stations. That way, all base stations connected to the ESM can be potentially used. The limitation, however, is that only as many base stations can be used *in parallel* by QPER users as there are outputs of the ESM.

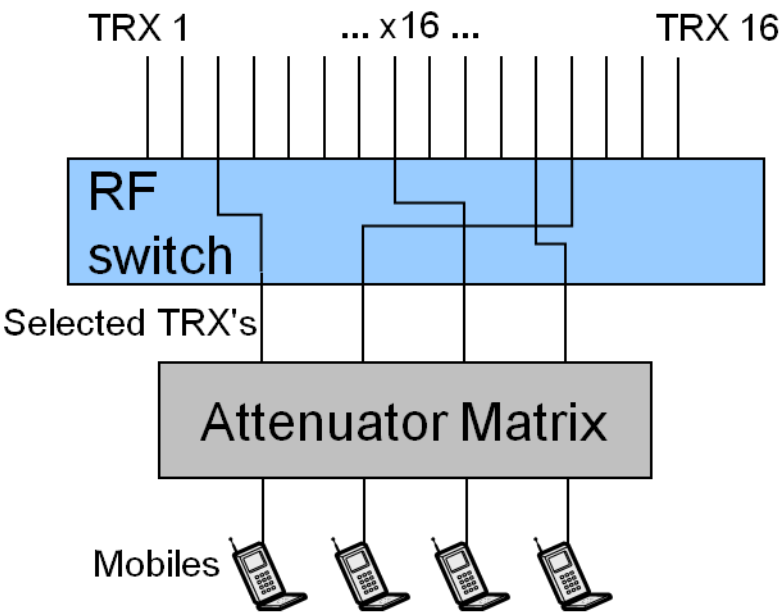


Figure 5: Schematic of the ESM combined with an attenuator matrix

For instance, in Figure 5, a 16:4 ESM is connected in cascade with a 4x4 QPER that controls the ESM with its internal CPU. The QPER is an attenuator array that connects 4 Mobiles with 4 Base Stations via 16 variable attenuators, so each mobile can receive each base station. The Switch Matrix allows the QPER users to select 4 arbitrary cells from the 16 that feed the Switch Matrix. Thus, potentially 16 cells can be reached by the mobiles connected to the AIS, but only 4 at the same time. If another cell shall be connected, one of the through-connected cells must be disconnected first.

The ESM integrates transparently with QPER. The users do not need to operate the switches directly, but QPER handles them implicitly by switching the desired cell and setting the associated attenuators in one single step. Figure 6 displays a typical QPER scenario with a virtual landscape of base stations with antenna radiation patterns, mobiles on a virtual drive test along trajectories and the respective attenuation settings calculated and set dynamically.

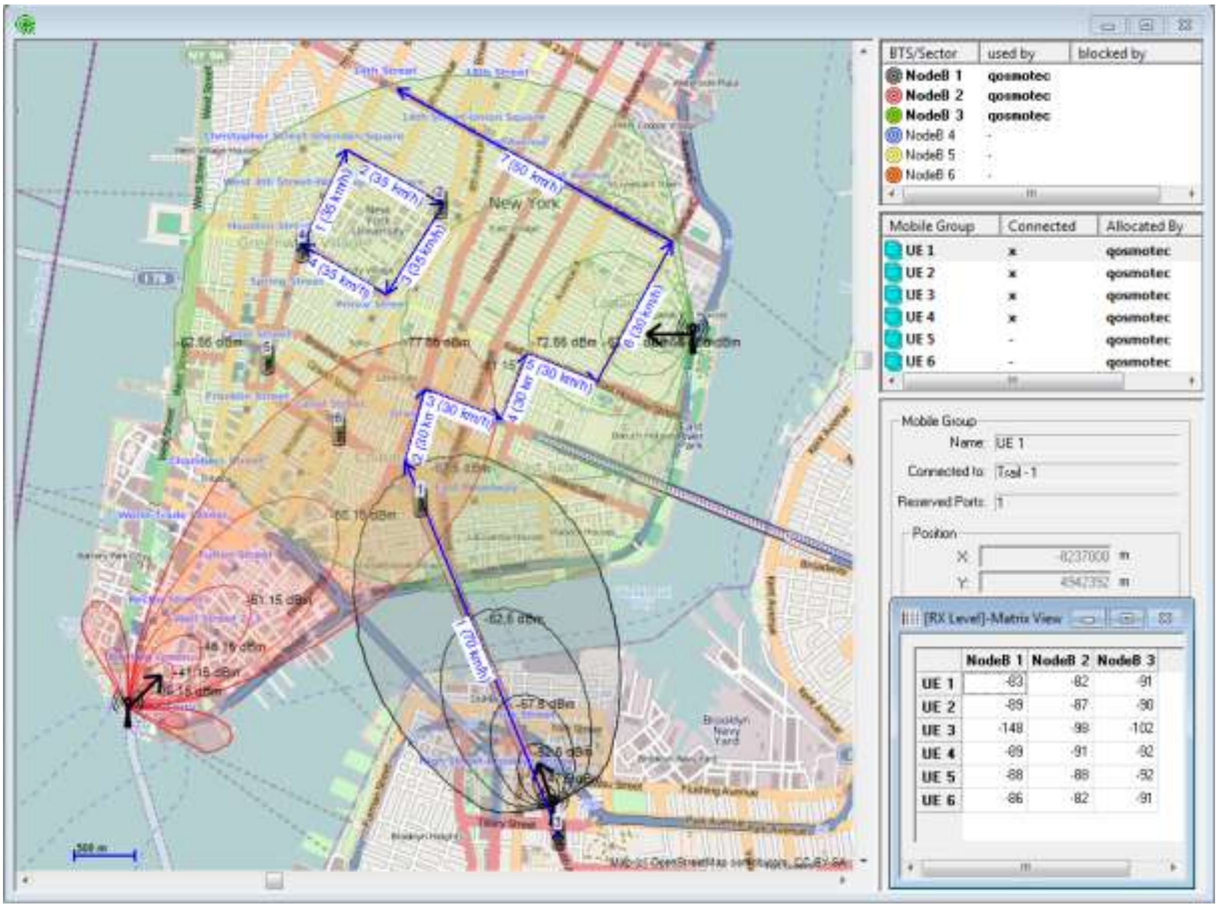


Figure 6: A virtual landscape in a QPER scenario

3.3 Users of Automatic Test Systems

An integration like described above with the QPER field strength emulator can be done in similar way by users of third-party automatic test systems. Qosmotec provides a command line interface (CLI) to the ESM, so it can be integrated in other test environments as well.

Appendix A Technical Data

The following technical data refers to a 40 : 1 PIN-Diode switching unit:

Frequency Range:	0.4 – 6.0 GHz
Insertion Loss:	1 dB @ 1 GHz … 2 dB @ 2 GHz
Switching Time:	< 0.1 ms
Max. VSWR on all ports:	1.8:1
Min. Isolation	
(on two neighbouring inputs):	> 70 dB
Max. Input Power:	+27 dBm
Control Interfaces:	Ethernet, RS232