

Contents

Foreword	pag.	7
Introduction.....	pag.	9
The Authors.....	pag.	10
Acknowledgements and Key factors of success	pag.	11
Index to Figures.....	pag.	13
1. Description of text, definitions and acronyms.....	pag.	19
2. The ERTMS in Italy: integration of the High-Speed project and European Interoperability.....	pag.	35
3. ERTMS and Interoperability	pag.	43
• What is ERTMS?	pag.	45
• Objectives of ETCS	pag.	48
• ERTMS/ETCS levels.....	pag.	53
• Development of ERTMS specifications.....	pag.	54
• Management of Unisig Specifications and the new “BaseLines”	pag.	57
4. Architecture and Operation of the HS Signalling Subsystem (HSSS)	pag.	59
• General	pag.	59
- Safety connection	pag.	62
• General architecture	pag.	65
- Functional Architecture	pag.	68
- <i>Functional architecture and delimitation of the signalling system</i>	pag.	68
- Physical Architecture	pag.	70
- The ETCS Level 2 Ground Subsystem (SST)	pag.	75
Fixed Peripheral Points (PPF).....	pag.	76
RBC	pag.	77
Operating modes	pag.	77
- Types of ground Train Separation Subsystems.....	pag.	77
Train Separation Subsystem - Ground part - Alstom type	pag.	77
Train Separation Subsystem - Ground part - Ansaldo type.....	pag.	84
- Radio Block Sections.....	pag.	87

- RBC data and virtual signals	pag.	87
- Point mechanisms.....	pag.	90
Point mechanisms for radii less than or equal to 0.074.....	pag.	90
- Track Circuits (cdb)	pag.	90
- Lowering pantographs (POC) and neutral stretches (PCF)	pag.	91
- Kilometre markers.....	pag.	91
- Information Points (PI) - Spatial reference	pag.	91
- Telecommunications System	pag.	92
GSM-R	pag.	92
Long Distance TLC Subsystem	pag.	94
- The ETCS Level 2 Trainborne Subsystem (SSB)	pag.	97
Description of trainborne subsystem equipment	pag.	97
Description of main displays	pag.	99
CAB Radio	pag.	102
5. Description of System Operation	pag.	103
• Operation without degrades	pag.	103
- SSB connection and data entry (start of mission).....	pag.	106
- Entrance into the ERMTS area.....	pag.	109
- Itinerary Management.....	pag.	114
- POC Management	pag.	119
- Phase Change	pag.	120
- FS Mode Management	pag.	122
- RBC Handover.....	pag.	126
- Exit from the ERMTS area and end of mission.....	pag.	130
• Degraded operation	pag.	134
- SoM (Start of Mission) from PdS (PPF)	pag.	134
- SoM (Start of Mission) in line	pag.	134
- End Of Mission	pag.	139
- Emergency Management.....	pag.	141
- Unconditional emergency stop management	pag.	141
- Urgent close of Station management	pag.	142
- Conditional emergency stop management	pag.	142
- On Sight travel management	pag.	147
- Staff Responsible travel management.....	pag.	147
- Override Procedure	pag.	150
- RTB alarm management (Track-Train).....	pag.	152
- Train management with “very hot” alarm	pag.	153
- Train management with “hot” alarm	pag.	154
- Deceleration management.....	pag.	156

- Setting a TSR.....	pag.	157
- Activating a TSR	pag.	157
- Cancelling a TSR.....	pag.	158
- Protection of stopping points at the entrance to or inside a Station.....	pag.	158
- Stopping at the entrance to a PdS	pag.	160
- Arriving at the station and stopping at the end of an MA.....	pag.	160
- Single component exclusion protection	pag.	161
- Excluded Station Zone (PdS) protection	pag.	161
- Radio block inversion management.....	pag.	162
- In-line stopping point protection.....	pag.	164
- Line out of service protection	pag.	164
- Reversing.....	pag.	166
- Braking commanded by the ETCS SSB.....	pag.	166
6. ERTMS/ETCS Level 2 Life Cycle.....	pag.	169
• Project organisation	pag.	171
• Validation and assessment process.....	pag.	171
• Trainborne Subsystem	pag.	175
7. CENELEC life cycle for ERTMS/ETCS Level 2 in Italy	pag.	177
• Phase 1 Target concept of the railway project.....	pag.	177
- Mission profile	pag.	177
- <i>Train Separation Safety Objectives</i>	pag.	177
• Phase 2 System Definition and Application Conditions.....	pag.	180
• Phase 3 Risk Analysis.....	pag.	181
- System FMEA and FTA analysis	pag.	181
• Phase 4 System Requirements	pag.	186
- Verification Reports of Requirement Specifications.....	pag.	186
• Phase 5 Apportionment of System Requirements	pag.	187
• Phase 6 Design and Implementation.....	pag.	187
• Phase 7 Manufacturing and Phase 8 Installation	pag.	190
• Phase 9 System validation including safety acceptance and putting into service	pag.	190
- Safety Cases and Technical Safety Reports.....	pag.	196
- Assessment	pag.	204
- RFI Technical Department Technical Committee.....	pag.	205
- Functional Assessment activities for the Generic Application and initial Specific Application of the ETCS Level 2 SDT	pag.	206
- Safety assessment.....	pag.	211
- Organisation of tests in worksite, pre-operation and operation scenarios	pag.	211
- Incremental regulatory process for ETCS level 2 train testing and sequencing.....	pag.	213
- Train Separation System Technical Verification Commission.....	pag.	213

- Qualification and training	pag.	217
• Pre-operation period	pag.	217
• Phase 10 System Acceptance.....	pag.	218
• Phase 11 Operation and Maintenance	pag.	218
• Phase 12 Performance Monitoring	pag.	218
• Phase 13 Modification and Retrofit.....	pag.	219
• Phase 14 Decommissioning	pag.	219
• Future Developments and New Solutions	pag.	220
- ETCS Level 1	pag.	222
8. Analytical Sections	pag.	225
• Radio Messages - Message 3 Movement Authority	pag.	225
• Alstom RBC Path Concept	pag.	227
• ACC (IXL) and RBC interfacing	pag.	228
• Alstom RBC keyboard.....	pag.	232
• Speed step before stopping the train.....	pag.	233
• Odometry and ETCS train braking curves.....	pag.	234
• Management of Cryptographic Keys between ETCS Level 2 SST and SSB	pag.	236
• RBC Condition Tables	pag.	238
• RBC Logic.....	pag.	241
• Detecting the illegal occupation of the track circuit subsequent to the one occupied by the train (first axle occupation or “shadow track circuit”)	pag.	251
• Time parameters for radio disconnection management	pag.	253
• System Response Times	pag.	256
• ETCS Error Management	pag.	258
• National Values and suitability and ERTMS/ETCS Level 2 parameters	pag.	260
• Delayed opening of the Virtual Signal	pag.	262
• Management of Line Management subsystem components.....	pag.	263
• Configuration documentation for ETCS L2 SDT SST and SSB	pag.	265
• Safety requirements	pag.	270
• Design and development process	pag.	273
• ERTMS/ETCS Level 2 Workshops and Trial Sites.....	pag.	288
• Assessment Backup Tools for Specific Applications of ETCS level 2 SST	pag.	290
• SSB Homologation Process	pag.	292
• Functional assessment of test specifications using formal methods.....	pag.	294
• Train sequencing tests - Integration ETCS L2: SST ASF and SSB Alstom.....	pag.	295
• GSM-R integration on the Rome-Naples HS/HC line	pag.	300
Reference documents	pag.	301