



TECHNOLOGY MANAGEMENT ANNEXURE B TO SPECIFICATION

SPECIFICATION BBB1776 VERSION 3

INTERFACE REQUIREMENTS:

TELEMETER/EoT

and

TRAIN COMMUNICATION SYSTEM (TCS)

(or EoT "Remote Head")

1 Scope

This document specifies the interfacing requirements between the Telemeter / End of Train (EoT) system Cab Units (CU) and the Train Communication System (TCS) when installed in TFR's locomotives.

This interface requirement arises from space limitations in the locomotive cab, thus necessitating the EoT CU to be installed in a suitable nearby location in the locomotive, and all its outputs / indications and controls being available on the display panel of the TCS, with the same "look & feel" as the actual CU.

OR

Alternatively (per clause 3.3.1.4c of specification BBB 1776), the EoT CU must be provided as a "split unit" with a separate compact "remote head" (external display & controls), which is connected to the CU via an Ethernet connection, as detailed in this specification.

(Certain sections of this document refer more specifically to the interface/display aspects of the TCS, and are indicated by "\$".)

2 Applicable documents

BBB 1776 Telemeter / EoT specification
BBC 8282 Train Communication System (TCS) specification
BBC 4204 Triton Data Communication Protocol

3 Requirements

3.1 General Operational Requirements

3.1.1 Telemeter CU

- ∅ As soon as power is applied to the CU, it shall be in a “standby mode” so that its Ethernet port is active, and able to accept messages from the TCS / client.
- ∅ The CU shall have *at least* the following menu options available:
 - § “Comms Test / Status Update”
 - § “Acknowledge Current Alarm”
 - § “Restart EoT CU”
 - § “System / Diagnostics”
 - § “Exit”
- ∅ The above commands shall be selectable from the TCS / client.
- ∅ The Menu shall be activated by pressing either the “UP” or the “DOWN” keys whilst the CU is in its normal state.

3.1.2 TCS / Client

- ∅ The TCS shall provide 3 buttons adjacent to each other, close to the default Telemeter / EoT display, to facilitate the ‘UP’, ‘DOWN’ and ‘Select / Enter’ functions.
- ∅ A button for selecting and de-selecting the “Pop Up” (Full) Telemeter display.
- ∅ An “Emergency” button for selecting the “Emergency Brake Application” option
- ∅ An audible alarm output, to facilitate audible alarms as described elsewhere.
- ∅ A Red visual indicator, to facilitate visual alarms as described elsewhere.

3.2 Indications (\$)

3.2.1 DEFAULT DISPLAY

Under normal conditions, the minimum display on the TCS screen shall comprise

- § Pressure (or Vacuum) value in kPa [3 digits]
- § “Pressure” (or “Vacuum”) and “kPa” indicators [plus “-” for vacuum]
- § “Train Status” indication
(“TRAIN OK” / “CAUTION” / “TRAIN ERROR” / “INACTIVE”)

3.2.1.1 ALARM CONDITION

When an alarm is received (see also 3.3.3.2, DGI Frame, Field 4) the entire Default display background area must flash RED on and off, and the “Train Status” indication must be replaced with “ALARM”

3.2.1.2 The above is required in case the “Pop-Up” display below, does not occur for some reason or other.

3.2.2 “POP-UP” DISPLAY (FULL EoT CU DISPLAY)

The display shown below is required on the TCS

- Ø Immediately after any alarm message is received or updated
- Ø When an EoT event occurs which requires response from the train driver
- Ø When requested by the train driver

It may be timed out after 20 seconds (i.e. revert to the Default Display). However, if an alarm condition still exists, an indication on the default display is required. (e.g. by flashing the “Pressure/Vacuum” or “Train Status” indications, or flashing the background, on the default display.)

The following parameters which are normally displayed on the EoT CU display, must be displayed in a similar manner, on the TCS display when required:

3.2.2.1 Primary Display

- ✓ Pressure (or Vacuum) value in kPa [3 digits]
- ✓ “Pressure” (or “Vacuum”) and “kPa” unit indicator [plus “-” for vacuum]
- ✓ Remaining Battery Life (hrs) for both CU and RU [2 digits each]
- ✓ Symbols for a Battery and “External Power”
- ✓ High Visibility Marker (HVM) on RU indicated by (e.g.) an “F” when ON
- ✓ RU stationary/stopped or moving indicated by “S” or “M”
- ✓ Emergency Valve on RU Closed or Open indicated by “X” or “O”

3.2.2.2 “Train Status” Display

- ✓ Symbol for a Train as well as “Train OK” / “Caution” / “Train Error”
- ✓ Symbol for a Speedometer plus CU & RU speeds in km/h (max 3 digits)
- ✓ Distance (between RU & CU at start-up) [m] plus deviation [+/- m]
- ✓ ID (of RU) plus actual value [5 digits]
- ✓ Time (GPS) [hh:mm]
- ✓ Other parameters (Lat, Long, etc - Menu selectable – in the “Status” area)

The above parameters shall be displayed in the following manner:

<h1 style="margin: 0;">587</h1> <p style="margin: 0;">Pressure kPa</p>	F	(TrainSymbol) TRAIN OK	
	S	CU	RU
	X	0 km/h	0 km/h
(Batt)	Distance		ID: 12345
CU (ExtPwr) (Symbol) RU 40 h	2215 m (+ 15)		16:55

Illuminated Indicator Lights / LED's

- ✓ At least 1 (one) Red LED (or Icon) to visually indicate an Alarm Condition
 - Ø Steady and Flashing display is required when applicable.

3.3 Controls (\$)

Push Buttons / Switches

- ✓ 3 (three) push buttons:
 - § Scroll UP
 - § Enter / Select
 - § Scroll DOWN
- ✓ The push buttons must be located to the *right* of the display as above, in the order mentioned.
- ✓ A button for selecting the “Pop Up” (Full) display.
- ✓ An “Emergency” button for selecting the “Emergency Brake Application” option (equivalent to the simultaneous pressing of the “UP” & “DOWN” buttons on the CU or “Remote Head”).
Emergency (Rear Brake) Application will be initiated by pressing this button. (Thereafter the message “Emergency Brake?” is displayed, so that if the ENTER button is pressed within 5 seconds, the brake function is activated.)

3.4 Data Communication Interface

3.4.1 Electrical interface:

With TCS or Remote Head:	Ethernet 10/100 Mbit/s TCP/IP	
Connectors:	RJ-45.	
IP address & Port:	192.168.0.20 : 9760.	(EoT CU)
	192.168.0.12	(TCS)
Encoding Format:	ASCII or Binary	

3.4.2 Proposed Configuration

The EoT CU shall be set up as a TCP/IP server listening on port 9760. As soon as the client (TCS) is connected to the server (EoT CU), it shall send status updates to the client as events occur on the server. It shall be possible for the client to interrogate the server for update information as required, or to evaluate or test the state of the connection. The CU server shall then automatically update the client on any status changes and/or alarm events.

It is important to note that the primary objective of this specification is to ensure provision of the complete control & displays of the actual EoT Cab Unit (CU) front panel remotely from the TCS screen & controls (or “Remote Head”), without duplicating the CU functionality itself.

3.4.3 Messages (Frames)

Messages between server and client shall be as follows:

Three (3) frames from the Telemeter Cab Unit (server) to the TCS or Remote head (client):

- q Frame 'A' (ID A): STATUS Frame (Telemeter Data)
- q Frame 'B' (ID B): DGI (Differential Graphic Information)
- q Frame 'C' (ID C): Acknowledgement of Frame 'X' from TCS (client)

Two (2) frames from the TCS or remote head (client) to the Telemeter Cab unit (server):

- q Frame 'X' (Id X): EVENT Frame
- q Frame 'Y' (ID Y): Acknowledgement of Frame 'A' or 'B' from server.

- ✓ Under normal conditions a Status message (Frame 'A') as well as a Differential Graphic Interface (DGI) message (Frame 'B') must be sent by the EoT CU to the TCS each time it receives an update from the RU, whereupon the TCS must update its display, and acknowledge receipt of each of the update messages. Frame 'A' must be sent first and acknowledged, where-after Frame 'B' must be sent.
- ✓ If the CU does not receive an update from the RU within 65 seconds as per AAR S-5701, after 66 seconds it must update the TCS / client with its current status.
- ✓ Should the TCS not receive an update within 66 seconds, an alarm shall be sounded and a "Data Link" alarm displayed on the screen.

3.4.3.1 Status Frame A (ID A): Server → Client

Frame A is implemented as a comma delimited record (ASCII Frame)

For Example:

* , A, 10123,587, Train OK, Ext Pwr,45,80, 85,2215, Y,-15, 16:45,F,M,X,S 26 07' 36. 8",E027 5' 15.0",S 26 07' 36.8",E027 5' 15.0", 1, 1234,COMMS ALM,5A3C,&, CR, LF.

Field	Abbreviation	Characters	Description	Example
1	STX	1	Start (Asterisk)	*
2	FRM_ID	1	Frame ID (A)	A
3	RU_ID	5	Matched/Paired Rear Unit ID	10123
4	PRESSURE	3 (Signed)	Brake Pipe Pressure (kPa)	587 or -58 or ERR
5	TR_STATUS	16 (Max)(String)	Train Complete Status	e.g. TRAIN OK
6	CU_PWR	16 (Max)(String)	CU Power Status	Ext Pwr
7	RU_PWR	2	RU Bat Remaining (hrs)	45 or --
8	CU_SPEED	3 (max)	CU Speed (km/h)	80 or --
9	RU_SPEED	3 (max)	RU Speed (km/h)	85 or --

10	DSPLM	4 (max)	CU to RU Displacement (m)	2215 or ----
11	DISPL_STATUS	1	See note 'A' below	P
12	DEVIATION	4 (Signed)	Distance Deviation (+/- m)	-15 or +20 or --
13	TIME	5 (String)	Time @ Cab Unit (hh:mm)	16:45
14	HVM	1	HVM Status (ON, OFF or ?)	F,O or blank
15	RU_MOV	1	RU Movement Status	M or S or blank
16	RU_EMV	1	Emergency Valve Status	X or O or blank
17	RU_LAT	16 (Max)(String)	RU Latitude (Deg Min [6 decimals])	S 26° 07,123456' or --
18	RU_LONG	16 (Max)(String)	RU Longitude (Deg Min [6 decimals])	E027° 5,123456' or ---
19	CU_LAT	16 (Max)(String)	CU Latitude (Deg Min [6 decimals])	S 26° 07,123456' or --
20	CU_LONG	16 (Max)(String)	CU Longitude (Deg Min [6 decimals])	E027° 5,123456' or ---
21	SPARE	1	For Future Use	-
22	PKT_CNT	3 (max)	Packet Counter (max 255)	0 to 255
23	SPARE	16 (Max)(String)	Possibly for Logging Data	-
24	CRC	4	CCITT CRC16 (Polynomial)	5A3C
25	ETX	3	End	&, CR, LF

Note A

Field 11 (DISPL_STATUS) character is defined as

'P' (Pop-Up): Must "pop up" the EoT CU display on the TCS screen, and flash the RED LED/Icon once, when an EoT event occurs which requires train driver response (e.g. "ARM NOW?")

'A' (Alarm): Must "pop up" the CU display on the TCS, Flash (~1Hz) the RED

LED/Icon and flash RED the background on Default display, as well as sounding the audible alarm/buzzer for 3 seconds.

'O' (OK) (no Alarm): Must flash RED LED/Icon *once* on TCS display, "refresh" default and pop-up display (if active), and cancel any existing alarm/flashing.

3.4.3.2 DGI (Differential Graphic Information)**Frame B (ID B)(Binary Frame): Server → Client**

In this Frame 'B' the data is packaged in multiples of rows (i.e. horizontally).

Field	Abbreviation	Bytes	Description	Example
1	STX	1 byte	Start (Asterisk)	*, 0x2A, d:042
2	FRM_ID	1 byte	Frame ID : B	B, 0x42, d:066
3	Packet Length	2 bytes	Packet Length Typical : (Block width * (Block Height/8)) + 9	Variable Min 13, Max 1933
4	Output Status	1 byte	Bit 0 : ALARM LED On/Off Bit 1 : Led 2 On/Off Bit 2 : BUZZER On/Off Bit 3 : Flash Led 1 On/Off Bit 4 : Flash Led 2 On/Off Bit 5 : Spare Bit 6 : Spare Bit 7: LCD backlight Intensity Bits 0 to 2: 1 = ON and 0 = OFF	LSB : Bit 0 For bit 7, if '1' then display backlight is at max. brightness, & if '0' then display backlight is at standard intensity.
5	Packet Counter PKT_CNT	1 byte	Packet counter Increment from 0 to 255 and overflow to 0 on each packet sent by the EoT CU	0x00 to 0xFF
6	Start X Position	1 byte	In LCD screen pixels Left = 1, max = 240	Top LHS = 1,1
7	Start Y Position	1 byte	In LCD screen pixels Top = 1, max = 64	Bott. RHS = 240,64
8	Block width	1 byte	In Pixels, max = 240	
9	Block height	1 byte	In Pixels, max = 64	
10	DGI Information	0 to 1920 bytes	Each byte represents 8 pixels on the LCD screen. LSB of byte is Top (or Left) of LCD and MSB is below (or to right of) it. One byte represents 8 columns of data, 1 bit in height. See examples below	
11	CRC	2 bytes	CCITT CRC16 (Polynomial) Standard TFR CRC	Calculated from Field 1 (STX) up to field 10 (DGI information) (inclusive)
12	ETX	3	End	&, CR, LF

Packet length: Minimum 15 bytes if zero DGI is included. (Including *, CR, LF)

The TCS or CU remote display will always acknowledge this frame 'B' received from the EoT CU with the Acknowledge frame 'Y'.

Sample implementation for DGI data for Horizontal data in frame 'B':

Each bit represents 1 pixel on the Telemeter CU LCD screen, or screen buffer.

To display or update the text 'DGI' with an empty space at both sides roughly in the middle of the screen (based on a 240 x 64 bit LCD), the data will appear as follows:

		Column 1 X=120	Column 2 X=121	Column 3 X=122	Column 4 X=123	Column 5 X=124	Column 6 X=125	Column 7 X=126	Column 8 X=127	Column 1 X=128	Column 2 X=129	Column 3 X=130	Column 4 X=131	Column 5 X=132	Column 6 X=133	Column 7 X=134	Column 8 X=135		Data	Data
Y=32	Row 1																	0x00	0x00	
Y=33	Row 2																	0x1E	0x73	
Y=34	Row 3																	0xA4	0x24	
Y=35	Row 4																	0xA4	0x20	
Y=36	Row 5																	0xA4	0x26	
Y=37	Row 6																	0xA4	0x24	
Y=38	Row 7																	0x1E	0x73	
Y=39	Row 8																	0x00	0x00	
		8 bits wide				8 bits wide														
		LSB		MSB	LSB		MSB													
Start X		120																		
Start Y		32																		
Block Width		16																		
Block height		8																		
Data in frame		0x00, 0x00, 0x1E, 0x73, 0xA4, 0x24, 0xA4, 0x20, 0xA4, 0x26, 0xA4, 0x24, 0x1E, 0x73, 0x00, 0x00																		

Note that the block width will always be multiples of 8 bits.

3.4.3.3 Acknowledge Frame C (ID C): Server → Client.

Field	Abbreviation	Bytes	Description	Example
1	STX	1 byte	Start (Asterisk)	*, 0x2A, d:042
2	FRM_ID	1 byte	Frame ID : C	C, 0x43, d:067
3	Packet Length	2 bytes	Number of Bytes to follow	This packet has a fixed length to follow of 5 bytes 0x05 (excluding CR, LF)

4	ACKNW	1 byte	0x58: 'X' = Event frame from TCS/Remote head. or Any other future message from TCS/remote head to TCS	
5	Packet Counter PKT_CNT	1 byte	Increment from 0 to 255 and overflow to 0 on each packet sent by the HOT or TCS to the EoT CU	0x00 to 0xFF
6	CRC	2 bytes	CCITT CRC16 (Polynomial) Standard TFR CRC	CRC is calculated from field 1 (STX) up to field 5 (PKT_CNT)
7	ETX	3 bytes	End of Packet.	&, CR, LF

Total Packet length: Always 11 bytes (Including *, CR, LF)

3.4.3.4 EVENT Frame (ID X): Client → Server

Field	Abbreviation	Bytes	Description	Example
1	STX	1 byte	Start (Asterisk)	*, 0x2A, d:042
2	FRM_ID	1 byte	Frame ID : X	X, 0x58, d:088
3	Packet Length	2 bytes	Number of Bytes to follow	This packet has a fixed length to follow of 5 bytes 0x05 (excluding CR, LF)
4	Button Status BT_ST	1 byte	Bit 0 – Up button pressed Bit 1 – Enter/Select button pressed Bit 2 : Down button pressed Bit 3 : Emergency function Bit 4 : Update Request / Query Bit 5 : Spare bit Bit 6 : Spare bit Bit 7 : spare bit Where 1=pressed, 0=not pressed.	0x00 to 0x08
5	Packet Counter PKT_CNT	1 byte	Increment from 0 to 255 & overflow to 0 on each packet sent by the TCS or R/H to the EoT CU.	0x00 to 0xFF
6	CRC	2 bytes	CCITT CRC16 (Polynomial) Standard TFR CRC	CRC is calculated from field 1 (STX) up to field 5 (PKT_CNT) (inclusive)
7	ETX	3 bytes	End of Packet.	&, CR, LF

Total Packet length: Always 11 bytes (Including *, CR, LF)

3.4.3.5 Acknowledge Frame (ID Y): Client → Server

Field	Abbreviation	Bytes	Description	Example
1	STX	1 byte	Start (Asterisk)	*, 0x2A, d:042
2	FRM_ID	1 byte	Frame ID : Y	Y, 0x59, d:089
3	Packet Length	2 bytes	Number of Bytes to follow	This packet has a fixed length to follow of 5 bytes 0x05 (excluding CR, LF)
4	ACKNW	1 byte	0x41 : 'A' = Status frame from CU or 0x42 : 'B' – DGI frame from CU or Any other future message from CU to TCS	
5	Packet Counter PKT_CNT	1 byte	Increment from 0 to 255 and overflow to 0 on each packet sent by the HOT or TCS to the EoT CU	0x00 to 0xFF
6	CRC	2 bytes	CCITT CRC16 (Polynomial) Standard TFR CRC	CRC is calculated from field 1 (STX) up to field 5 (PKT_CNT) (inclusive)
7	ETX	3 bytes	End of Packet.	&, CR, LF

Total Packet length: Always 11 bytes (Including *, CR, LF)

3.4.3.6 Illustrative Frame Flows

Action	TCS/Remote head (Client)	Data Direction	CU Telemeter (Server)	Note
TCS Starts Up	Connect to CU (server) IP 192.168.0.20:9760	--à		
	Send Event Frame X Field 4.4 Update Request / Query	--à		TCS requests updated screen and status info.
		<---	Send Event ACKNW Frame C, Field 4='X'	CU Acknowledges Event frame X
			Delay....	

Sequence AB		β--	Send Status Frame 'A'	Send Status information
	Send Acknw Frame 'Y' with Field 4='A'	--à		TCS Ackn's Status Frame 'A'
		β--	Send DGI Frame 'B'	Send DGI information
	Send Acknw Frame 'Y' with Field 4='B'	--à		TCS Ackn's DGI Frame 'B'
Normal operation, All communications OK, Telemeter RU Updates CU twice a minute. With a CU update from RU, the CU updates the Status and DGI frames.				
		β--	Send Status Frame 'A'	Send Status information
	Send Acknw Frame 'Y' with Field 4='A'	--à		TCS Ackn's Status Frame 'A'
		β--	Send DGI Frame 'B'	Send DGI information
	Send Acknw Frame 'Y' with Field 4='B'	--à		TCS Ackn's DGI frame 'B'
Driver presses any Telemeter button on TCS screen. (e.g. Enter/Select button)				
	Send Event Frame X Field 4, bit 1 = 1 (Enter/Select button pressed)	-à		
		<--	Send Event Acknw Frame C, Field4='X'	CU Ackn's Event frame 'X'
If CU display changes OR the Enter button causes a change in data value, sequence AB follows. Else no DGI or Status is sent.				
Driver presses a Telemeter button on TCS screen. (e.g. Enter/Select button) AND there is a communication delay or problem on the data link between the TCS and CU				
	Send Event Frame X Field 4, bit 1 = 1 (Enter/Select button pressed)	-à		
No Acknw is sent: Triton Hub problem.				
Wait 1 Second for Acknw, if not received, send again 2 nd time.				
	Send Event Frame X Field 4, bit 1 = 1 (Enter/Select button pressed)			
Wait 1 Second for Acknw, if not received, Send again 3 rd time.				
TCS / Remote Head receives no frames from Telemeter CU for 66 seconds.				
	TCS must display 'Data Link Error.'			

3.4.4 Alarm Messages, Indications & Sounds (As per BBB 1776)

- ✓ When an alarm occurs on the EOT system, the CU must immediately send an alarm message to the client via an updated Status Frame (ID **A**) and DGI Frame (ID **B**).
The TCS / client must then immediately “pop-up” the telemeter screen (per 3.1.3) on its display.
- ✓ The Red (LED) indicator must flash and an audible alarm must sound when
 - Ø the brake pipe pressure drops below 400 kPa (or less than –51 kPa for a vacuum train) OR
 - Ø a Train Status alarm occurs (“Caution” or “Train Error”)
 - Ø a Comms Alarm is received from the CU
 - Ø the cab- or rear unit battery life drops below 25% or 10 hours of normal operation.
- ✓ In the case of a “Train Error” alarm, the audible alarm must latch ON until acknowledged by the train driver.
- ✓ Each time a status update is received, the red indicator must flash once, and a short audible beep must be sounded.

3.4.5 Emergency Rear-End Brake Operation

In order to minimize the possibility of accidental / unintended operation, this function shall preferably not be a single button operation. The required operation shall be

1: Press the Emergency button on the TCS

A message “*Emergency Brake?!?*” must then be displayed

2: ENTER within 5 seconds.

3.4.6 Error Checking

- ✓ CRC Error checking is required between the EoT CU and the TCS / remote display, to ensure that trustworthy information is displayed to the train driver.

4 Corrections of Errors by EoT / TCS Suppliers

4.1 Suppliers are welcome to point out any possible errors or omissions in this specification, and clearly propose how these could be corrected, in order to clarify any possible misunderstandings.

5 Acknowledgements

Acknowledgements to both Messrs EMS Industries and Inteletack for their proposals and constructive inputs into this document.