Power Data
ASSOCIATES

ubitricity

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Ubitricity – CMS Approval Test Evidence

This document is part of ubitricity's application to become a BSC approved measure Central Management System (mCMS). This document captures the test evidence from the tests defined in the ELEXON Measured Central Management System Test Specification[1]

29th May 2018

[1] www.elexon.co.uk/reference/technical-operations/unmetered-supplies/central-management-systems/

Contents

Change History

Number	Status	Date of issue	Reason for change
0.1	Draft	06 Mar 2018	First draft – for internal review
0.2	Draft	23 Mar 2018	Second draft – for internal review
1.0	Issue	26 Mar 2018	Issue – for Elexon review
1.1	Draft	14 May 2018	Third draft – for internal review
1.2	Draft	25 May 2018	Fourth draft – for internal review
2.0	Issue	29 May 2018	Second Issue – for Elexon review

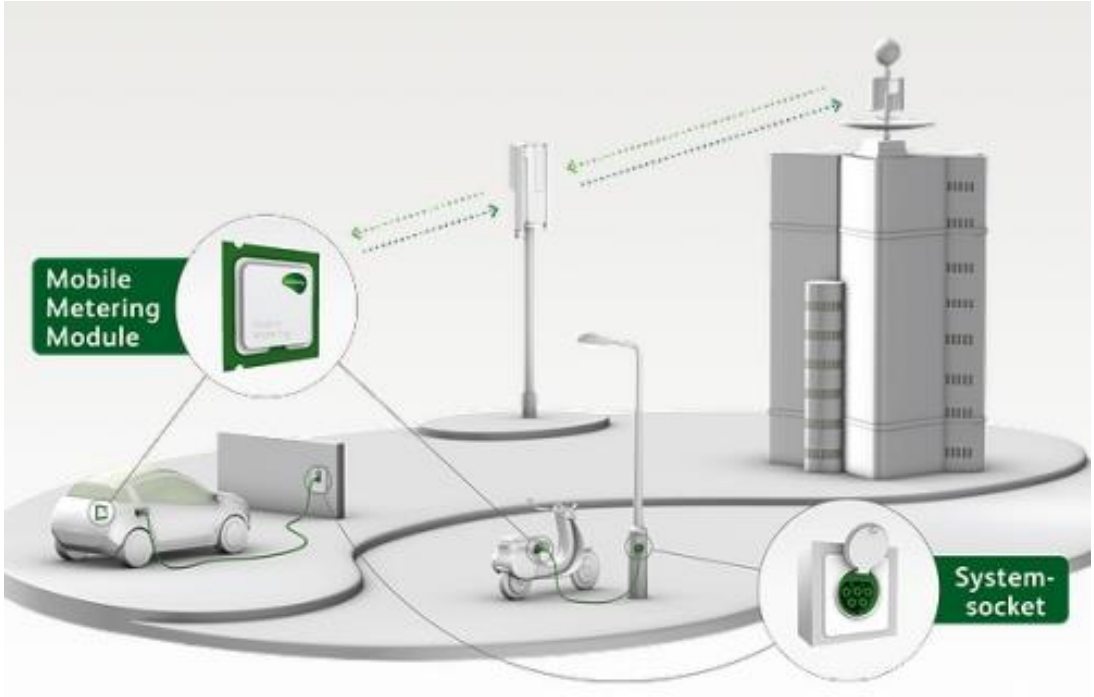
1. Introduction

ubitricity has developed a unique solution for Electric Vehicle (EV) residential charging in urban areas, utilising existing street lighting infrastructure. This has been made possible by it being the very first company to develop the concept of a mobile metering ecosystem, which complies with the central international standards of EV conductive charging infrastructure (IEC 61851, IEC 62196).

1.1. April 2017 approved system

The main components of the system approved in April 2017 are:

- SmartCable: ubitricity developed an intelligent charging cable – the SmartCable – which contains an integrated MID metering and communication technology designed to transfer the metering and billing process, from the charging point to the cable. The SmartCable is the EV driver's mobile device to access all SimpleSockets with secure authorisation. The charged electricity is allocated directly to the driver and not to the Charge Point Provider (CPP).
- SimpleSocket: In turn, this reduces the charging point to a simple switchable power Socket – or SimpleSocket. This significantly reduces the costs per charging point.
- The Connectivity Manager and Back-end Systems: ubitricity's Back-end System supports the management of all processes including customer handling, metering and billing of EV users, thereby reducing operating costs to a minimum. Via the Connectivity Manager (User Interface), EV users can monitor and review all transactions with live updates, view itemised charges to the kWh, and identify charging locations. Moreover, the Back-end system provides flexible access management for sensitive handling of user and charge related data.



1.2. Spring 2018 approval

The Spring 2018 testing is a variant of the previously approved ubitricity solution that includes the metered module within the measured SimpleSocket. The measured SimpleSocket includes cellular communication, so that the EV driver can contact a website site or use a smartphone app to scan the barcode of the socket and initiate payment using the ubitricity backend system.

Once the backend system has authorised a charge a message is sent to the measured SimpleSocket to enable the socket to charge the vehicle using a conventional (unmetered / “dumb”) EV charging cable.

The measured SimpleSocket can also work with the existing SmartCable technology. When a SmartCable is plugged into the measured SimpleSocket it recognises the socket identity, communicates with the ubitricity backend, and subject to suitable authorisation enables the socket to allow a charge in the same way as set out in the April 2017 approval. In this arrangement the consumption data is measured twice, in the SmartCable and the measured SimpleSocket. Only one set of consumption data (events) however is associated with the socket and provided for settlement. An additional test has been included to prove this scenario.

The 15min consumption information captured by the ubitricity system is translated into 30min event data included within the mCMS Event Log.

2. Test group 1 – System Configuration

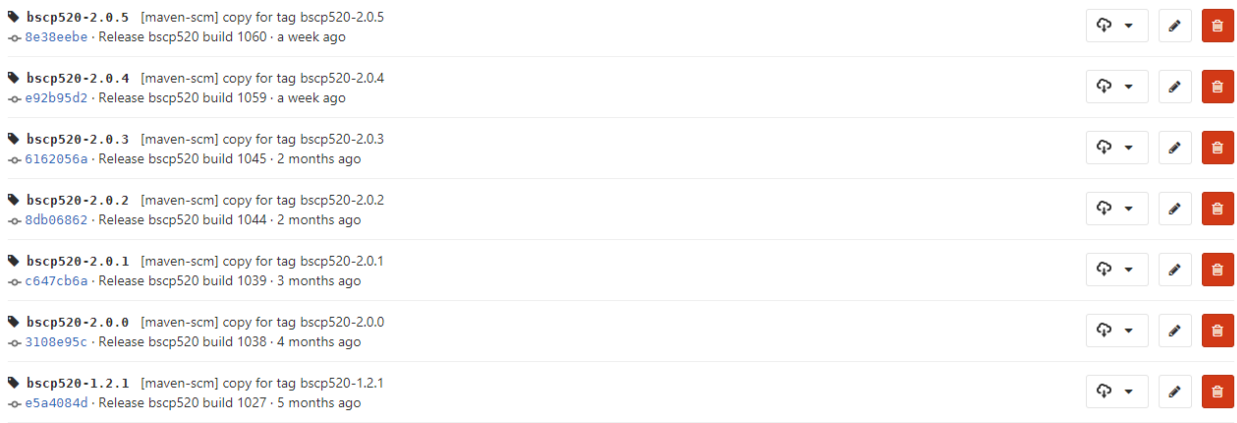
2.1. Test 1.1 CMS software version

The application that provides the unmetered asset event log files is called BSCP-520-Mediator. The current version that approval is sought for is 2.0.5. Ubitricity follows the common industry standard of “major.minor.fix” versioning. The application offers a ReST resource that provides this version number at runtime for verification:

```
$ curl -XGET http://localhost:45001/bscp/services/status
```


```
{"application.version":"2.0.5","build.date":"2018-03-13
17:04","Mode":"Production","spring.profiles.active":"production","Start
time":"2018-03-14T13:00:28.767Z","Current time":"2018-03-22T11:00:02.875Z"}
```


For in-house software development, ubitricity uses the git system for version control of the application code, in combination with the Gitlab user interface. Git uses SHA256 hashes to uniquely identify versions. The tags of the BSCP-520-Mediator version are shown in the Gitlab screenshot below:



Only a major change would result in conversation with ELEXON as to whether this would trigger a requalification of the whole system.

2.2. Test 1.2 CMS operating platform and version

The ubitricity server runs on Ubuntu Linux 16.04.4 LTS with all recent patches installed.

The BSCP-520-Mediator itself is a Java 8 application. It uses the following major frameworks:

- Spring enterprise framework (core, boot, web, orm, data)
- Hibernate, for object-relational mapping
- Apache CXF, for ReSTful web-services
- Apache Camel, for general routing, scheduling, and FTP access
- BeanIO, for writing event log files
- Joda-Time, for proper time and date handling, including time zones and daylight saving
- Log4J, for general application logging

The application itself runs on any Java 8 Virtual Machine.

For persistence, ubitricity uses a MariaDB 10 database management system (DBMS) with master-slave replication and 2-hourly backups from the replicated DBMS.

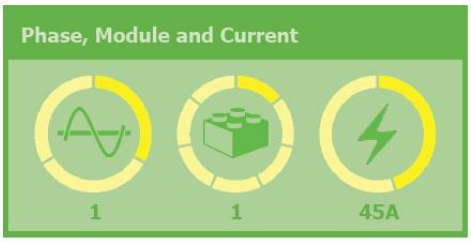
2.3. Measurement Device

Smart PRO1 - Modbus/M-bus

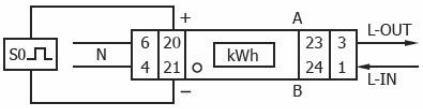
The PRO1 series is a range of 1 module, single phase energy measurement devices consisting of 4 different types, each with their specific characteristics. They have an exceptional combination of a high accuracy class (1) and a broad temperature range of -25°C - +55°C. Another unique feature is the Imax of 45A.

The PRO1 series is available as a standard version (with a selectable S0 output) and also as a Modbus, M-bus or 2-tariff version. It can communicate and be programmed via an infra-red input. The different communication modes have over 40 variables like kWh, active and reactive energy, forward and reverse energy as well as Cos phi.

The PRO1 energy measurement device is equipped with a resettable day counter and the total energy usage can be calculated via 5 different modes.



Wiring



Inepro - Metering - New-PRO-Line - **S05**

Technical specifications

- Height with protection cover : 117mm
- Height without protection cover : 90mm
- Width : 17,5mm
- Depth : 63mm
- Mounting : DIN rail
- Active energy : ±1%
- Operating temperature : -25° ~ +55°C
- Nominal Voltage (Un) : 230V AC
- Operational Voltage : 195-253VAC
- AC Voltage withstand for 1 min : 4KV
- Impulse voltage 1.2uS Waveform : 6KV
- Basic current (Ib) : 5A
- Max current (Imax) : 45A
- Operational current range : 0,4%Ib~Imax
- Over current withstand : 30Imax for 0.01s
- Operational frequency range : 50Hz +- 10%
- Calculation of total energy : Forward, Forward+Reverse, Forward-Reverse, Reverse-Forward, Reverse

Different models

Article number	Phase	Mod.	Cur.	Com.	Display	Digits	Con. mode	S0	Back-light	Acc. Class	Tarriffs	SO pulse output
0265 PRO1-S	1	1	45A	x	LCD	4+2	direct	1	Yes	1	x	Selectable[1]
0266 PRO1-2T	1	1	45A	x	LCD	4+2	direct	1	Yes	1	2	Selectable[1]
0267 PRO1-Mb	1	1	45A	M-bus	LCD	4+2	direct	1	Yes	1	2	Selectable[1]
0268 PRO1-Mod	1	1	45A	Mod	LCD	4+2	direct	1	Yes	1	2	Selectable[1]

[1] selectable options: 10.000-2.000-1.000-100-10-1-0.1-0.01

3. Test group 2 – Synchronisation to UTC

3.1. Test 2.1 Synchronisation to UTC

The ubitricity server uses the standard Network Time Protocol (NTP) to keep in sync with UTC, accurate to within a few milliseconds. As time source, the NTP servers of the German Federal Institute of Metrology (Physikalisch-Technische Bundesanstalt – PTB) are used.

The SmartCable and measured SimpleSocket in the field update their local time with the ubitricity server every time they communicate.

4. Test group 3 – Inventory Control Information

4.1. Test 3.1 Inventory data

The BSCP-520-Mediator maintains current and historical inventory in its database, as shown in the screenshot below. All unmetered assets are uniquely identified and given an Unmetered Asset Administration Number (UAAN). In addition, the address and GPS location are recorded.

id	distribution_area_number	uaan	valid_from	valid_from_time_zone	valid_to	valid_to_time_zone	city_name	street_name	location	latitude	longitude
1	ubitr20	12UB00000100	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Wavendon Avenue	98	51,489348	-0,260636
2	ubitr20	12UB00000101	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Wavendon Avenue	89	51,489463	-0,260373
3	ubitr20	12UB00000102	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Wavendon Avenue	90	51,489446	-0,261112
4	ubitr20	12UB00000103	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Foster Road	81	51,489811	-0,261379
5	ubitr20	12UB00000104	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Elmwood Road	34	51,487314	-0,270298
6	ubitr20	12UB00000105	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Wavendon Avenue	64	51,489361	-0,260856
7	ubitr20	12UB00000106	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Wavendon Avenue	71/73	51,489567	-0,261883
8	ubitr20	12UB00000107	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Elmwood Road	23	51,487136	-0,269732
9	ubitr20	12UB00000108	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Elmwood Road	14	51,487102	-0,269216
16	ubitr20	12UB00000109	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Percy Road	54	51,465094	-0,324549
17	ubitr20	12UB0000010A	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Percy Road	47	51,464932	-0,325055
18	ubitr20	12UB0000010B	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Percy Road	35	51,465013	-0,325616
19	ubitr12	12UB0000010C	2016-06-01 00:00:00.000	UTC	2017-01-22 23:59:59.999	UTC	London	Whitehall Park Rd	2	51,487816	-0,275288
20	ubitr12	12UB0000010D	2016-06-01 00:00:00.000	UTC	2017-01-22 23:59:59.999	UTC	London	Whitehall Park Rd	15	51,487241	-0,275288
21	ubitr12	12UB0000010E	2016-11-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	ONSLOW GARDENS	(NULL)	51,491128	-0,177335
22	ubitr12	12UB0000010F	2016-11-01 00:00:00.000	UTC	2016-11-07 23:59:59.999	UTC	London	(NULL)	(NULL)	(NULL)	(NULL)
23	ubitr12	12UB00000110	2016-11-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	ONSLOW GARDENS	(NULL)	51,490706	-0,177210
24	ubitr12	12UB00000111	2016-11-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	ONSLOW GARDENS	(NULL)	51,491621	-0,178055
25	ubitr12	12UB00000112	2016-11-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	ONSLOW GARDENS	(NULL)	51,491395	-0,177770
26	ubitr20	12UB00000113	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Whitehall Park Rd	(NULL)	51,487808	-0,275258
27	ubitr20	12UB00000114	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Whitehall Park Rd	(NULL)	51,487181	-0,275263
28	ubitr20	12UB00000115	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Burnaby Crescent	(NULL)	51,486135	-0,272210
29	ubitr20	12UB00000116	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Burnaby Crescent	(NULL)	51,485972	-0,271880
30	ubitr20	12UB00000117	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Nethravon Rd	27	51,492041	-0,246751
31	ubitr20	12UB00000118	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Nethravon Rd	38	51,491655	-0,246569
32	ubitr20	12UB00000119	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC	London	Nethravon Rd	20	51,492233	-0,246822

The actual SimpleSocket hardware is identified by its SSO-ID. Each SSO-ID is linked to a specific UAAN for a given time slice, as shown in the screenshot below. In this way, it is possible to replace a SimpleSocket, say, for repair. The time-sliced attribution ensures that individual assets remain in the database available for inspection even if they are no longer in use. Thus, the entire operational history is kept available.

unmetered_asset_id	sso_id	valid_from	valid_from_time_zone	valid_to	valid_to_time_zone
1	steob100000068	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
2	steob100000078	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
3	steob100000074	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
4	steob100000075	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
5	steob100000069	2016-06-01 00:00:00.000	UTC	2016-07-31 23:59:59.999	UTC
6	steob100000076	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
7	steob100000070	2016-06-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
8	steob100000077	2016-06-01 00:00:00.000	UTC	2016-11-24 23:59:59.999	UTC
9	steob100000065	2016-06-01 00:00:00.000	UTC	2016-07-31 23:59:59.999	UTC
9	steob100000137	2016-08-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
16	steob100000193	2016-08-25 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
17	steob100000194	2016-08-25 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
18	steob100000195	2016-08-25 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
19	steob100000198	2016-08-25 00:00:00.000	UTC	2017-01-22 23:59:59.999	UTC
20	steob100000199	2016-08-25 00:00:00.000	UTC	2017-01-22 23:59:59.999	UTC
5	steob100000065	2016-08-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
21	steob100000342	2016-11-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
22	steob100000343	2016-11-01 00:00:00.000	UTC	2016-11-07 23:59:59.999	UTC
23	steob100000344	2016-11-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
24	steob100000345	2016-11-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
25	steob100000346	2016-11-01 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
8	steob100000192	2016-11-25 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
21	steob100000343	2016-12-14 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
26	steob100000350	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
27	steob100000202	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
28	steob100000432	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
29	steob100000201	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
30	steob100000355	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
31	steob100000351	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC
32	steob100000198	2017-01-23 00:00:00.000	UTC	2030-12-31 23:59:59.999	UTC

New SimpleSockets or updates must be entered by operations staff into the database. This happens as part of the SimpleSocket installation process.

From the data shown above, the BSCP-520-Mediator automatically creates its monthly inventory export, which covers all inventory changes over the past month.

The detailed inventory is automatically produced as a text file. These are the files produced on 23 March 2018 (inventory export run triggered manually to reflect current data as automated export scheduled for the beginning of each month):

2018-02-23_ubitest.csv:

```
road_ref;town_name;road_name;location;unit_energy_type;unit_identity;cmsunitreference;
charge code;number of items;Switch Regime;no_of_controls;control_energy_code;OS ref
east;OS ref north;Exit point
;Silsoe Bedfordshire;Wrest Park;;M;;12UB00000006;8901000000100;1;990;0;;52.008059;-
0.412163;U
;Berlin;EUREF Campus;8;M;;12UB00000007;8901000000100;1;990;0;;52.481318;13.355916;U
;Berlin;EUREF-Campus;;M;;12UB0000000B;8901000000100;1;990;0;;51.485053;-0.174923;U
;Berlin;EUREF Campus;8;M;;12UB00000008;8901000000100;1;990;0;;52.481318;13.355916;U
```

This can be imported into an Excel file as follows:

ubitest

road_ref	town_name	road_name	location	unit_energy_type	unit_identity	cmsunitreference	charge code	number of items	Switch Regime	no_of_controls	control_energy_code	OS ref east	OS ref north	Exit point
	Silsoe Bedfordshire	Wrest Park		M		12UB00000006	8901000000100	1	990	0		52.008059	-0.412163	U
	Berlin	EUREF Campus	8	M		12UB00000007	8901000000100	1	990	0		52.481318	13.355916	U
	Berlin	EUREF-Campus		M		12UB0000000B	8901000000100	1	990	0		51.485053	-0.174923	U
	Berlin	EUREF Campus	8	M		12UB00000008	8901000000100	1	990	0		52.481318	13.355916	U

5. Test group 4 – Equipment Control Information

5.1. Test 4.1 Equipment control information

This is not relevant to this application. The Equipment Control in a CMS lighting scenario is separate physical equipment. In this application there is no separate control equipment.

The SimpleSocket uses a small quiescent load. This load is less than 1 watt and therefore extremely difficult to measure. The SimpleSocket and the measured SimpleSocket use a very similar energy consumption to provide a monitoring power supply and the illuminate a status LED. The only difference is the measured SimpleSocket has a communications module which is triggered to wake and communicate every so often.

The measured SimpleSocket was measured using a simple metering device and consumed over a 48 hour period. The consumption did not register on a meter with a granularity of 0.1kWh.

The display shows a kWh reading on Fri & Sun, with zero advance.

A further test evidence will be provided as part of the Charge Code application.

6. Test group 8 – Volume and Performance

6.1. Test 8.1 Volume and Performance

The ubitricity system has been designed to scale to several 100,000s of sockets. However, with the current small population of electric vehicles, the system in production is intentionally scaled down to save operational cost; scaling up follows standard principles for scaling internet-size applications. In particular, the ubitricity applications are designed to be stateless servers, so that multiple instances can be run in parallel behind a load balancer.

Yet, even the system in production right now, with a single instance, will be able to handle several thousand sockets at the same time, as the following analysis will show:

Each charging session starts with an authorisation send to the ubitricity backend to initiate a measured SimpleSocket. Once authorised, the charging process continues without additional communication until the vehicle driver terminates charging, or the pre-determined time expires. At this point, the measured SimpleSocket sends a Charge Detail Record (CDR) to the backend that contains the time series of meter readings for the entire charging process. Hence, there is one CDR per charging session.

Assume that there are two charging sessions conducted on average at each SimpleSocket integrated into a streetlight – one during the day, and one overnight. Furthermore, assume that ubitricity provides 5,000 SimpleSockets in London – which would be much more than all currently existing charging stations combined. This would result in 10,000 charging events per day.

In March 2017 there were 32 SimpleSockets active in the London trials. An event log export run for these 32 SimpleSockets takes about 4.5 seconds, as can be seen from the log files below:

Start event log file export:

```
[2017-01-25 07:30:00,008] [DefaultQuartzScheduler-camel-1_Worker-8] INFO  route3:159 -
Triggered distribution area export cron
```

```
[2017-01-25 07:30:00,008] [DefaultQuartzScheduler-camel-1_Worker-8] INFO  route4:159 -
starting export
```

```
[..]
```

End event log file export:

```
[2017-01-25 07:30:04,652] [DefaultQuartzScheduler-camel-1_Worker-8] [..] INFO
DEBUG:159 - jobRunTime=-1, mergedJobDataMap=org.quartz.JobDataMap@3d5d629e,
nextFireTime=Wed Jan 25 16:30:00 GMT 2017, NUMBER_OF_AREAS=3, PERFORM_EXPORT=false,
previousFireTime=Tue Jan 24 16:30:00 GMT 2017, refireCount=0, result=null,
scheduledFireTime=Wed Jan 25 07:30:00 GMT 2017,
scheduler=org.quartz.impl.StdScheduler@2708e7fa, trigger=Trigger
'Camel.eventLogExport':  triggerClass: 'org.quartz.CronTrigger isVolatile: false
calendar: 'null' misfireInstruction: 0 nextFireTime: Wed Jan 25 16:30:00 GMT 2017,
triggerGroup=Camel, triggerName=eventLogExport}, BodyType: java.util.ArrayList, Body:
]
```

Processing of the event log files currently is purely sequential. Therefore, we can simply scale up the numbers linearly. Exporting event logs for 32 SimpleSockets takes 4.65 seconds; hence exporting event logs for 10,000 SimpleSockets would take 1,425s, approximately 24 minutes. This export would occur once or twice per day so there is considerable excess capacity.

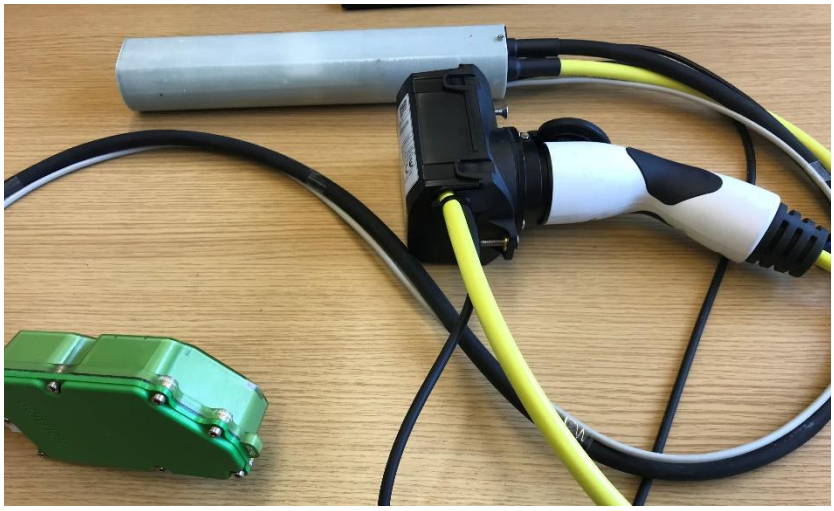
7. Test group 5, 6, 7 & 9 – The Test Scenarios

7.1. Test environment

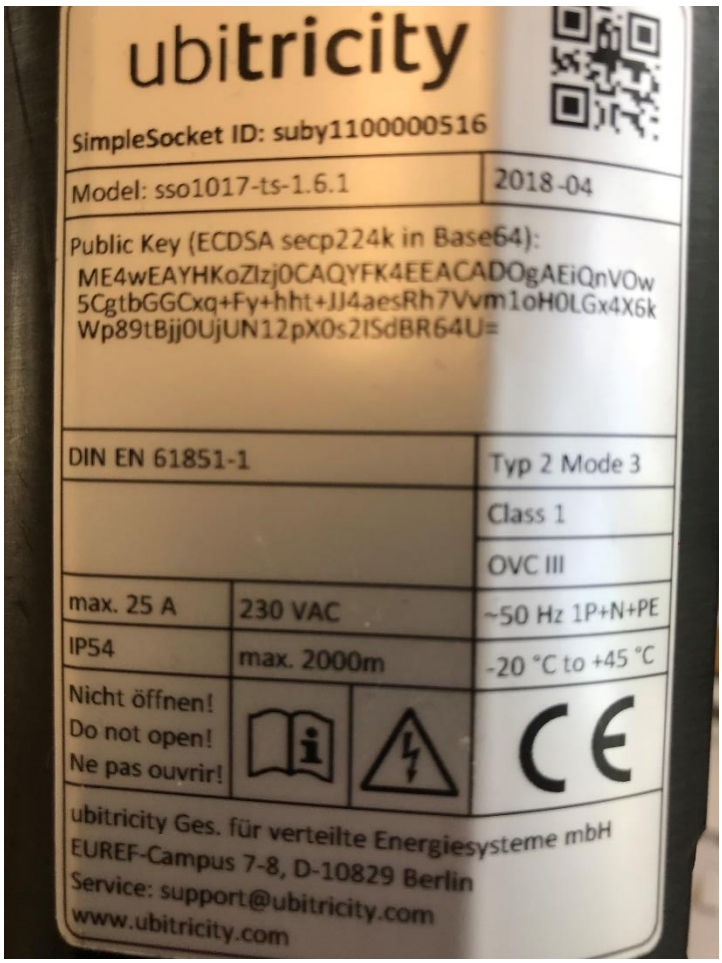
A test arrangement has been created at the Power Data Associates offices at Wrest Park. The equipment shown first is a socket with a control switch to mimic the EV's control. The car is mimicked using a multi-position switch which requests charge using a small resistor. The test load is a fan heater with two power levels.

The load is measured via a separate MID approved meter, unrelated to the equipment.

This picture shows the plastic tube containing the modem and antenna, and the socket.



The following photo is a close up of the rating plate of the socket specification label



Below is the plate of the fan heater, the supply voltage at site is ~230volts. The heater has two output settings, most tests have been done at nominal 2kW.

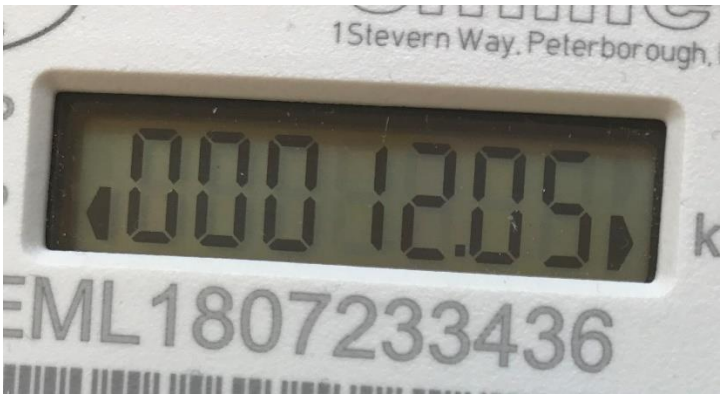
The set up at Wrest Park is connected to the test instance of the ubitricity back office infrastructure.

8. Scenario 1 – On and Off test

8.1. Photo of display at commencement and end of charge

Charge for 1 hour on 23 May 2018. The reading meter display reads 10.29.

This photograph shows the display at the end of the 1 hour charge. The display reads 12.05.



8.2. Copies of the event log(s)

The event log was generated by the ubitricity system and sent automatically to PDA at 06:30 (UTC) on the 24 May.

The file name is ubisse 20180523001. This conforms to the name defined in BSCP520, ubisse being the submeter name assigned to this test submeter, the date and version number.

The file content is:

```
Hubisse 20180523001
12UB0000000A000000000.000
12UB0000000C135033171.550
12UB0000000C140000176.000
12UB0000000C143000175.340
12UB0000000C145031000.000
12UB00000009000000000.000
T0000008
```

The header and trailer records are correctly formatted, and the detail records are also correct.

8.3. Commentary of the numeric calculation and sequence of events

Scenario Test 1				
event time	Interval time	Percentage power	Manual	meter register
13:50:33	00:09:27	171.55%	0.27	10.29
14:00:00	00:30:00	176.00%	0.88	
14:30:00	00:20:31	175.34%	0.60	
14:50:31	00:09:29	0.00%	0.00	12.05
15:00:00		0.00%	0.00	
		total	1.75	1.76

For each time period the consumption has been recorded by the ubitricity meter. This has been converted into a 'percentage power' against the 1000W charge code which together with the times has been included in the event log.

The test has been performed on the basis that the MID meter records energy consumption accurately. The evidence of the MID display is the legal meteorological display which is displayed above in this test.

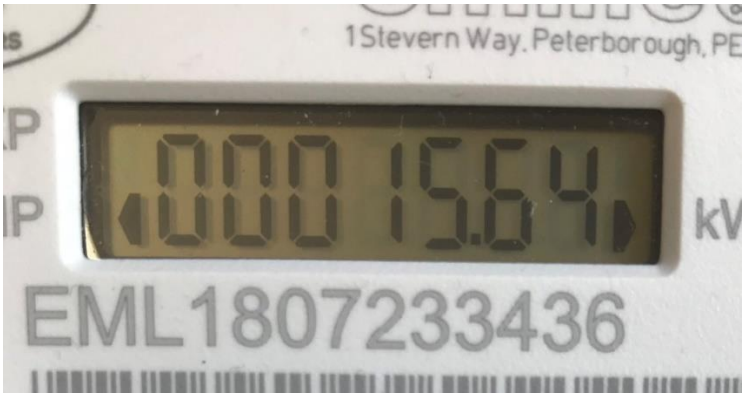
In conclusion, the test has passed.

9. Scenario 2 – Two events with disconnection in between

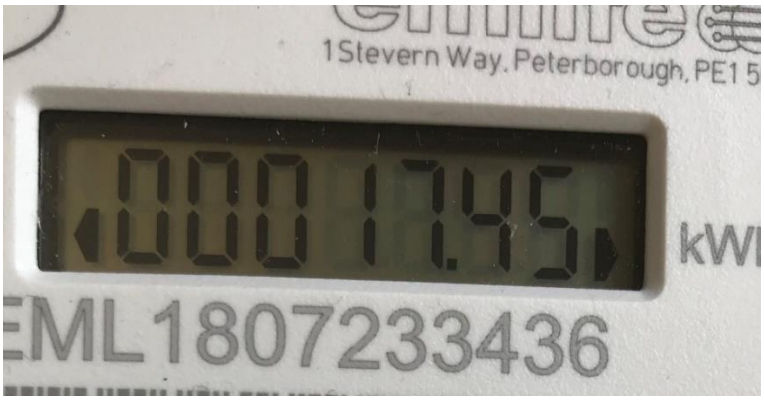
9.1. Photo of display at commencement and end of charge

9.1.1. First charge

The following picture shows the meter display at the beginning of the first 1 hour charge, on Friday 25 May at 10.11am. The reading is 15.64



The following picture shows the end of the first 1 hour charge, illustrating the meter display, reading showing 17.45.



9.1.2. Second charge

This image shows the meter display at the start of the second charge, the picture is taken at the commencement on Friday 25 May at 12.15pm. The display reads 17.45.

The second image shows the end of this 1 hour charge, the display reads 19.28.

9.2. Copy of the event log(s)

```
Hubitest20180525001
12UB000001FB091136179.450
12UB000001FB093000180.000
12UB000001FB100000181.000
12UB000001FB101136000.000
12UB000001FB111509181.930
12UB000001FB113000182.000
12UB000001FB120000181.970
12UB000001FB121510000.000
T0000010
```

9.3. Commentary of the sequence of events

As demonstrated above the sequence of activities occurred as expected. The first and second charges occurred and were communicated correctly.

In conclusion, the test has passed.

10. Scenario 3 – No connection, No consumption

10.1. Photo of display at commencement and end of charge

There are no photos of the meter display – as the charging cable was not connected for this test.

10.2. Copies of the event log(s)

On Friday 25 May a version 1 event log was received for Thursday 24 May, which contains a single zero power event.

ubitest20180524001 - Notepad

File Edit Format View Help

```
Hubitest20180524001
12UB000001FB000000000.000
T0000003
```

10.3. Commentary of the sequence of events

As demonstrated above the sequence of activities occurred as expected.

In conclusion, the test has passed.

11. Scenario 4 – Connection, No consumption

11.1. Photo of display at commencement and end of charge

This test has been performed slightly differently to the recorded definition. It has not been possible to test for a whole day, the reason for this is that for charging to commence, authorisation needs to be given via the website/app from the user. There is a restriction on the length of time consumption can be purchased by the user, limited to 8 hours in 1 hour blocks. Without authorisation for consumption being given on the Website/App (generated by the user entering a Pin Code, or payment details), charging will not commence. Ubitricity have confirmed that "*If there is no connection in the beginning we cannot start charging.*"
For this test, authorisation was given for charging, but no load was connected. 0.01kWh was consumed is down to the light on the switch of the power supply, which allows the heater to plug to the device which mimics the car control, as well as a light on the socket.

11.2. Copies of the event log(s)

On Friday 17 March a version 1 event log for Thursday 16 March shows 2% consumption was received.

Hubitest20180316001
12UB0000000B000000000.000
12UB00000006000000000.000
12UB00000008142815000.000
12UB00000008143000002.000
12UB00000008150000000.000
12UB00000008152813000.000
12UB00000007000000000.000
T0000009

11.3. Commentary of the sequence of events

As demonstrated above the sequence of activities and consumption occurred as expected.

In conclusion, the test has passed.

12. Scenario 5 – Consumption over midnight

12.1. Photo of display at commencement and end of charge

The charge was commenced at 22:27 on Saturday 10 March 2018 for 2 hours, concluding at 00:27 on Sunday 11 March.

12.2. Copies of the event log(s)

12.2.1. Event logs 10 March

The version 1 event log for Saturday 10 March received at 06:30 on Sunday 11 March shows the charge event (items greyed out were not relevant to this test).

Hubitest20180310001
12UB0000000B000000000.000
12UB00000006000000000.000
12UB000000082227350 24.920
12UB000000082230000 39.800
12UB000000082300000 42.200
12UB000000082330000 40.000
12UB00000007000000000.000
T0000009

12.2.2. Event logs 11 March

The event log for Sunday 11 March received at 06:30 on Monday 12 March includes the events relevant to this test which occurred after midnight (items greyed out were not relevant to this test). No other charge events occurred on 12 March.

Hubitest20180311001
12UB0000000B000000000.000
12UB00000006000000000.000
12UB000000080000000 41.350
12UB000000080027330 00.000
12UB00000007000000000.000
T0000007

12.3. Commentary of the sequence of events

As demonstrated above the sequence of activities occurred as expected. The charge operated through midnight and the event log for both Saturday 10 March and Sunday 11 March show the continuing charging information as it progressed over midnight.

In conclusion, the test has passed.

13. Scenario 6 – Communications failure

13.1. Photo of display at commencement, change and end of charge

The initial charge was commenced on Wednesday 21 March 11:12, concluding at 12:12.

A second charge commenced at 16:09 and concluded at 16:52 when we interrupted the signal before ending the charge, which was ended by switching the connection off on the vehicle emulator. The following are the meter display readings for the 2nd charge.

13.1.1. Initial event log (version1)

Items in grey are not relevant to this test.

Hubitest20180321001
12UB0000000B000000000.000
12UB00000006000000000.000
12UB00000008111240180.040
12UB00000008113000180.000
12UB00000008120000179.370
12UB00000008121242000.000
12UB00000007000000000.000
T0000009

13.1.2. Second event log (version 2)

Hubitest20180321002
12UB00000008111240180.040
12UB00000008113000180.000
12UB00000008120000179.370
12UB00000008121242000.000
12UB00000008161026181.020
12UB00000008163000181.450
12UB00000008165308000.000
T0000009

13.1.3. Comment on event logs

The Copy of the event log(s) show that we received the results for the initial charge in the version 1 file for 21 March, received 22 March at 6:30. The version 2 event log was received on 22 March at 15:30.

13.2. Commentary of the sequence of events

The Copy of the event log(s) show that we received the results for the initial charge in the version 1 file for 21 March, received 22 March at 6:30. The consumption between 11:12 and 12:12 are shown in periods 23 to 25. This didn't include the results for the 2nd charge, these appeared in a version 2 event log which was received on 22 March at 15:30. Reviewing the version 2 file, the initial charge remains identical in periods 23-25 in hHums, but the 2nd charge now also appears in period 33-34.

In conclusion, the test has passed.

14. Scenario 7 (additional test) – using a SmartCable

14.1. Photo of display at commencement, change and end of charge

We wanted to understand the activity when a SmartCable is used with a SmartSocket. In this scenario authorisation is not given via the website/App, instead the charging is authorised by the SmartCable.

The SmartCable was plugged into a load at 14:12 on Thursday 15 March 2018. This enabled a charge to occur, the charge ended at 15:19. This charge was for 1 hour and 7 minutes.

The photo below shows the display on the SmartMeter (0.08) at this time.

The following photos show the display when charging was ended at 15.19pm (after 1hr and 7 minutes) with the SmartCable display showing 2.08.

14.2. Copy of the event log(s)

14.2.1. Initial event log (version1)

The event log for Thursday 15 March 2018, version 1, was generated and sent on the morning of Friday 16 March 2018 (items not relevant to this test are in grey).

Hubitest20180315001
12UB0000000B000000000.000
12UB00000006000000000.000
12UB00000008140903177.700
12UB00000008143000178.000
12UB00000008150000180.110
12UB00000008152119000.000
12UB00000007000000000.000
T0000009

14.2.2. Comment on event logs

The event logs show the charge commencing at 14:09 and finishing at 15:21 (the slight difference in timing owing to photos being taken prior to the charge stopping as a result of needing the display showing on the SmartCable).

14.3. Commentary of the sequence of events

The sequence of activities occurring shows us that regardless of it charging is authorised via the Website, or SmartCable, we still receive event logs as expected.

In conclusion, the test has passed.