

Protocol Implementation eXtra Information for Testing (PIXIT)
for the IEC 61850 Edition 2 with Amendment 1 server interface in SEL-
451-5, SEL-451-A, SEL-487B-1, SEL-487E-3, SEL-487E-4, SEL-421-4,
SEL-421-5, SEL-487V-0 and SEL-487V-1

Version 1
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Based Upon UCAlug Server PIXIT Template version 24

PIXIT for Server

Introduction

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in

SEL-451-5 with firmware R332,
SEL-451-A with firmware R332,
SEL-487B-1 with firmware R321,
SEL-487E-3 with firmware R325,
SEL-487E-4 with firmware R325,
SEL-421-4 with firmware R335,
SEL-421-5 with firmware R335,
SEL-487V-0 with firmware R112 and
SEL-487V-1 with firmware R112.

All variants have the same IEC 61850 library LIB61850ID=4C93F616 and use the same hardware SEL-4XX MB5E.

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10. The PIXIT entries contain information which is not available in the PICS, MICS, TICS documents or SCL file.

Each table specifies the PIXIT for applicable ACSI service model as structured in IEC 61850-10. The "Ed" column indicates if the entry is applicable for IEC 61850 Edition 1 and/or Edition 2. A hyphen ("-") in the Ed column indicates the PIXIT entry is not applicable for any version.

PIXIT for Documentation

ID	Ed	Description	Value / Clarification
Do1	2	How to expose required firmware versions not present in the datamodel	Firmware version is exposed in datamodel: LLN0.NamPlt.swRev Additional methods to expose the firmware version: 1) Perform the following to display firmware version from the front panel:

ID	Ed	Description	Value / Clarification
			- From the initial screen press ENTER. - Repeatedly press the down arrow button until RELAY STATUS is selected then press ENTER. 2) Command-line: ID FID is listed as the first entry in the response.

PIXIT for Configuration

ID	Ed	Description	Value / Clarification
Cf1	2	Can IED tool export ICD file or IID file (SICS I12)	ICD: Y IID: Y

PIXIT for Association model

ID	Ed	Description	Value / Clarification
As1	1	Maximum number of clients that can set-up an association simultaneously	7
As2	1,2	TCP_KEEPALIVE value. The recommended range is 1..20s	1 - 20 s Note: This time is settable through the ETCPKA and KAIDLE settings in the Ethernet Port 5.
As3	1,2	Lost connection detection time	1 - 20 s
As4	-	Authentication is not supported yet	
As5	1,2	What association parameters are necessary for successful association: Called values: Calling values:	Transport selector Y Session selector Y Presentation selector Y AP Title N AE Qualifier N other Transport selector N Session selector N Presentation selector N AP Title N AE Qualifier N Other

ID	Ed	Description	Value / Clarification
As6	1,2	If association parameters are necessary for association, describe the correct Called values: e.g. Calling parameters: e.g.	Transport selector 0001 Session selector 0001 Presentation selector 00000001 AP Title NA AE Qualifier NA other
As7	1,2	What is the maximum and minimum MMS PDU size	Max MMS PDU size 12000 bytes Min MMS PDU size 512 bytes
As8	1,2	What is the maximum start up time after a power supply interrupt	~ 15 s
As9	1,2	Does this device function only as test equipment? (test equipment need not have a non-volatile configuration; but it cannot be part of the substation automation system)	N
As10	2	How does the server behave when the associate request fails	Not Applicable

PIXIT for Server model

ID	Ed	Description	Value / Clarification
Sr1	1,2	Which analogue value (MX) quality bits are supported (can be set by server)	Validity: Y Good, Y Invalid, N Reserved, N Questionable Detail Quality N Overflow N OutofRange N BadReference N Oscillatory Y Failure N OldData N Inconsistent N Inaccurate Miscellaneous: Y Source Y Test N OperatorBlocked
Sr2	1,2	Which status value (ST) quality bits are supported (can be set by server)	Validity: Y Good, Y Invalid, N Reserved, N Questionable Detail Quality N BadReference N Oscillatory Y Failure N OldData N Inconsistent N Inaccurate Miscellaneous: Y Source Y Test N OperatorBlocked
Sr3	-	What is the maximum number of data object references in one GetDataValues request	Deprecated
Sr4	-	What is the maximum number of data object references in one SetDataValues request	Deprecated

ID	Ed	Description	Value / Clarification
Sr5	1	Which Mode values are supported 1	On Y [On-]Blocked Y Test Y Test/Blocked Y Off Y

PIXIT for Data set model

ID	Ed	Description	Value / Clarification
Ds1	1	What is the maximum number of data elements in one data set (compare ICD setting)	Not Applicable
Ds2	1	How many persistent data sets can be created by one or more clients (this number includes predefined datasets)	Not Applicable
Ds3	1	How many non-persistent data sets can be created by one or more clients	Not Applicable

PIXIT for Substitution model

ID	Ed	Description	Value / Clarification
Sb1	1	Are substituted values stored in volatile memory	Not Applicable

PIXIT for Setting group control model

ID	Ed	Description	Value / Clarification
Sg1	1	What is the number of supported setting groups for each logical device	6
Sg2	1,2	What is the effect of when and how the non-volatile storage is updated (compare IEC 61850-8-1 §16.2.4)	Non-volatile storage is updated by switching the active setting group or by explicit save/write operations.
Sg3	1	Can multiple clients edit the same setting group	Not Applicable
Sg4	1	What happens if the association is lost while editing a setting group	Not Applicable

1 IEC 61850-6:2009 clause 9.5.6 states that if only a subrange of the enumeration value set is supported, this shall be indicated within an ICD file by an enumeration type, where the unsupported values are missing

ID	Ed	Description	Value / Clarification
Sg5	1	Is EditSG value 0 allowed	Not Applicable
Sg6	2	When ResvTms is not present how long is an edit setting group locked	Not Applicable
Sg7	2	Can the active setting group be changed locally Can a setting in the active setting group be changed locally	Y Y

PIXIT for Reporting model

ID	Ed	Description	Value / Clarification
Rp1	1	The supported trigger conditions are (compare PICS)	integrity Y data change Y quality change Y data update Y general interrogation Y
Rp2	1	The supported optional fields are	sequence-number Y report-time-stamp Y reason-for-inclusion Y data-set-name Y data-reference Y buffer-overflow Y entryID Y conf-rev Y segmentation Y
Rp3	1,2	Can the server send segmented reports (when not supported the device shall refuse an association request with a smaller than minimum PDU size)	Y
Rp4	1,2	Mechanism on second internal data change notification of the same analogue data value within buffer period (Compare IEC 61850-7-2 Ed2 §17.2.2.9)	Send report immediately
Rp5	1	Multi client URCB approach (compare IEC 61850-7-2:2003 §14.2.1)	Each URCB is visible to all clients
Rp6	-	What is the format of EntryID	Deprecated
Rp7	1,2	What is the buffer size for each BRCB or how many reports can be buffered	120k bytes or 200 reports, whichever limit is reached first.
Rp8	-	Pre-configured RCB attributes that are dynamic, compare SCL report settings	Deprecated

ID	Ed	Description	Value / Clarification
Rp9	1	May the reported data set contain: - structured data objects - data attributes	Y Y
Rp10	1,2	What is the scan cycle for binary events Is this fixed, configurable	1/8 cycle (2 ms) when RWBs are configured in SER; otherwise 500 ms. Fixed
Rp11	1	Does the device support to pre-assign a RCB to a specific client in the SCL	N
Rp12	2	After restart of the server is the value of ConfRev restored from the original configuration or retained prior to restart	Restored from original configuration
Rp13	1,2	Does the server accept any client to configure / enable an RCB with BRCB.ResvTms=-1 or URCB.Resv=T? What fields are used to do the identification?	Y IP-address Y AP-Title N AE-Qualifier N <other field> N
Rp14	1,2	When BRCB.ResvTms is exposed, what is the default value for BRCB.ResvTms if client does not write (must be > 0) or When BRCB.ResvTms is not exposed, what is the internal reservation time (must be >= 0) Note: for Amd1 the client shall always write ResvTms and ResvTms is mandatory	60 s N/A
Rp15	2	Is data model db=0 supported	Y

PIXIT for Logging model

ID	Ed	Description	Value / Clarification
Lg1	1,2	What is the default value of LogEna (Compare IEC 61850-8-1 §17.3.3.2.1, the default value should be FALSE)	Not Applicable
Lg2	-	What is the format of EntryID	Deprecated
Lg3	1,2	Are there multiple Log Control Blocks that specify the Journaling of the same MMS NamedVariable and TrgOps and the Event Condition	Not Applicable

		(Compare IEC 61850-8-1 §17.3.3.3.2)	
Lg4	-	Pre-configured LCB attributes that cannot be changed online	Not Applicable
Lg5	1	Which TrgOps are supported for logging (note Ed2 and up requires support for all TrgOps)	Not Applicable

PIXIT for GOOSE publish model

ID	Ed	Description	Value / Clarification
Gp1	1,2	Can the test (Ed1) / simulation (Ed2) flag in the published GOOSE be set Note: simulation is intended for test equipment	Y Notes: Command-line (CAL level): - PUB SIM GOO (enable simulation) - PUB SIM OFF (disable simulation)
Gp2	1	What is the behaviour when the GOOSE publish configuration is incorrect	DUT rejects the configuration file
Gp3	1,2	Published FCD supported common data classes are	ACD, ACT, APC, ASG, BAC, BCR, BSC, BTS, CMV, CTS, CUG, CURVE, DEL, DPC, DPS, DPL, ENS, ENC, ENG, INC, ING, INS, ISC, LPL, MV, ORG, SAV, SEQ, SPC, SPG, SPS, STS, TSG, UTS, VSD, VSG, VSS and WYE
Gp4	1,2	What is the maximum value of TAL (maxTime) Is it fixed or configurable	60000 ms configured by SCL
Gp5	1,2	What is the minimum MinTime supported (GSE.MinTime) Is MinTime configurable by SCT	4 ms configured by SCL Y
Gp6	-	Can the GOOSE publish be turned on / off by using SetGoCBValues(GoEna)	Deprecated See PICS – SetGoCBValues
Gp7	1,2	What is the initial GOOSE sqNum after restart	sqNum = 0
Gp8	1	May the GOOSE data set contain: - structured data objects (FCD) - data attributes - timestamp data attributes	Y Y Y

ID	Ed	Description	Value / Clarification
Gp9	1,2	Does Server or ICT refuse GOOSE payload dataset length greater than SCSM supports?	Y
Gp10	1,2	What is the minimum MaxTime supported (GSE.MaxTime)	4 ms
Gp11	2	When data set is fixed does the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	GOOSE datasets are configurable

PIXIT for GOOSE subscribe model

ID	Ed	Description	Value / Clarification
Gs1	1,2	What elements of a subscribed GOOSE message are checked to decide the message is valid and the allData values are accepted? If yes, describe the conditions. Notes: the VLAN tag may be removed by an Ethernet switch and shall not be checked the simulation flag shall always be checked (Ed2) the ndsCom shall always be checked	Y destination MAC address as configured in SCL Y APPID* Y gocbRef* N timeAllowedtoLive Y datSet* Y gold* N T N stNum N sqNum Y simulation / test* Y confRev* Y numDatSetEntries Y out-of-order dataset members * Configurable parameters for DUT GOOSE message processing.
Gs2	1,2	When is a subscribed GOOSE marked as lost (TAL = time allowed to live value from the last received GOOSE message)	d) GOOSE messages are not accepted or rejected based on TAL. If no GOOSE message is received within the TAL interval, the DUT sets a subscription error status. This error status can be transmitted via a GOOSE publication.

ID	Ed	Description	Value / Clarification
Gs3	1,2	What is the behaviour when one or more subscribed GOOSE messages is not received or syntactically incorrect (missing GOOSE)	DUT will issue an out-of-sequence error and wait for the next message to update the status. For syntax errors, DUT will issue message-corrupted error and wait for the next message to update the status.
Gs4	1,2	What is the behaviour when a subscribed GOOSE message is out-of-order	DUT will issue an out-of-sequence error and process the received GOOSE message.
Gs5	-	What is the behaviour when a subscribed GOOSE message is duplicated	DUT will issue an out-of-sequence error
Gs6	1	Does the device subscribe to GOOSE messages with/without the VLAN tag	Y, with the VLAN tag Y, without the VLAN tag
Gs7	1	May the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	Y Y
Gs8	1,2	Subscribed FCD supported common data classes are	All CDCs except these: H MV, HWYE, HDEL, and CSD Note: 4XX DUTs only support mapping of Boolean and Analogs
Gs9	1	Are subscribed GOOSE with test=T (Ed1) / simulation=T (Ed2) accepted in test/simulation mode	Y
Gs10	1,2	Max number of dataset members	Count = 200
Gs11	1	Is Fixed-length encoded GOOSE supported	Y
Gs12	Amd1	Is the "processing data as invalid" configurable? When not configurable how does the subscriber "process data as invalid"?	Y Any data point that depends on the incoming GOOSE message remains unchanged.

PIXIT for GOOSE performance

ID	Ed	Description	Value / Clarification
Gf1	1,2	Performance class	P1 = 3 ms
Gf2	1,2	GOOSE ping-pong processing method	Scan cycle based

ID	Ed	Description	Value / Clarification	
Gf3	1,2	Application logic scan cycle (ms)	Max.	4ms at 60Hz 5ms at 50Hz
			Min.	2ms at 60Hz 5ms at 50Hz
Gf4	1	Maximum number of data attributes in GOOSE dataset (value and quality has to be counted as separate attributes)	Count = 200 Note: it is constrained by the GOOSE Ethernet frame limit	

PIXIT for IEC 61869-9 publisher

ID	Description	Value / Clarification
Svp1	Supported application class (compare table 901)	Not Applicable
Svp2	Support behaviour = test Support behaviour = off	Not Applicable
Svp3	Support simulation mode Backwards rates Preferred rates When supported how to enable simulation mode Note: simulation mode is intended for test equipment	Not Applicable
Svp4	Are neutral sampled values calculated	Not Applicable
Svp5	How are the CT/VT ratios configured (only applicable for MU connected to conventional CT/VT)	Not Applicable
Svp6	Support time synchronization method	Not Applicable
Svp7	What is the maximum time required to achieve synchronization after restoring the time synch	Not Applicable
Svp8	What is the maximum time required to achieve synchronization after power up	Not Applicable
Svp9	In which conditions is the quality field Validity set to Invalid	Not Applicable
Svp10	What is the maximum time to start-up the device	Not Applicable

Svp11	How can the date of manufacture be derived from PhyNam.serNum?	Not Applicable
Svp12 (deprecated)	Calculated IN = (Ia + Ib + Ic) = -(Ia + Ib + Ic)	Not Applicable
Svp13	Is detail quality "out-of-range" supported? How to force out-of-range?	Not Applicable
Svp14	Maximum number of channels by rate (0=rate not supported)	Not Applicable

PIXIT for IEC 61869-9 subscriber

ID	Description	Value / Clarification
Svs1a	How does the subscriber process subscribed sampled values (one is mandatory) Telco 21jul: how to observe that ...	Not Applicable
Svs1b	How does the subscriber supervise subscribed sampled values (optional)	Not Applicable
Svs2a	Which backwards compatible variants can be subscribed to (at least one shall be supported)	Not Applicable
Svs2b	Which preferred variants can be subscribed to (at least one shall be supported)	Not Applicable
Svs3	<deprecated>	Not Applicable
Svs4	Which element of the SV header are verified (when Y the SV packets are ignored)	Not Applicable
Svs5	What will happen in case an extra element pair is added to the data set What will happen in case an element pair of the data set is missing	Not Applicable
Svs6	How does the subscriber behave in case a broken path is detected	Not Applicable

Svs7	How does the subscriber behave in case packets are missing 1 packet 3 consecutive packets 5 consecutive packets 10 consecutive packets Packet with smpCnt = 0	Not Applicable
Svs8	How does the subscriber behave in case smpSynch = 0 smpSynch = 1 smpSynch = 3..255	Not Applicable
Svs9	How does the subscriber behave in case one sample value continuously has quality invalid all sample values continuously have quality invalid	Not Applicable
Svs10	Declare smallest value of publisher maximum processing delay time that the subscriber requires (per Table 901).	Not Applicable
Svs11	What is the total delay that can be tolerated (Svs10 processing time + maximum network delay)	Not Applicable
Svs12	Which function can be used to verify the polarity of subscribed samples IN?	Not Applicable

PIXIT for Control model

ID	Ed	Description	Value / Clarification
Ct1	1	What control models are supported (compare ICD file for Ed2)	DOns: Y SBOs: N DOes: Y SBOes: Y
Ct2	1,2	Is the control model fixed, configurable and/or dynamic	Configurable
Ct3	-	Is TimeActivatedOperate supported (compare PICS or SCL)	Deprecated
Ct4	-	Is "operate-many" supported (compare sboClass)	Deprecated, see sboClass in datamodel (ICD)

ID	Ed	Description	Value / Clarification
Ct5	1	Will the DUT activate the control output when the test attribute is set in the SelectWithValue and/or Operate request (when N test procedure Ctl2 is applicable)	Not Applicable
Ct6	-	What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request	Deprecated
Ct7	-	Is pulse configuration supported (compare pulseConfig)	Deprecated
Ct8	1,2	What is the behaviour of the DUT when the check conditions are not set	DUT refuses to bypass the check with "Not supported" or "Blocked-by-interlocking"
		This behaviour is:	Fixed

Ct9	1,2	Which additional cause diagnosis are supported	N Unknown Y Not-supported Y Blocked-by-switching-hierarchy Y Select-failed Y Invalid-position Y Position-reached Y Step-limit * Y Blocked-by-Mode N Blocked-by-process Y Blocked-by-interlocking N Blocked-by-synchrocheck Y Command-already-in-execution N Blocked-by-health N 1-of-n-control N Abortion-by-cancel N Time-limit-over N Abortion-by-trip Y Object-not-selected Edition 1 specific values: N Parameter-change-in-execution (Ed1 semantics) Edition 2 specific values: Y Object-already-selected Y No-access-authority N Ended-with-overshoot N Abortion-due-to-deviation N Abortion-by-communication-loss N Blocked-by-command N None Y Inconsistent-parameters Y Locked-by-other-client N Parameter-change-in-execution (Ed2 semantics) Note: AddCause "Step-limit" is only used for stepSize/min/max validation per IEC 61850-7-2 (BSC/BAC). It is not used to signal
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ID	Ed	Description	Value / Clarification
			end position reached (e.g. tap changer limits).
Ct10	1,2	How to force a “test-not-ok” respond with SelectWithValue request	Send the SelectWithValue request with an orCat value greater than 8.
Ct11	1,2	How to force a “test-not-ok” respond with Select request	The control service Select is not supported.
Ct12	1,2	How to force a “test-not-ok” respond with Operate request	DOns: SBOs: Not supported DOes: SBOes: Send the Operate request with an orCat value greater than 8.
Ct13	1,2	Which origin categories are accepted in control direction	Y bay-control (1) Y station-control (2) Y remote-control (3) Y automatic-bay (4) Y automatic-station (5) Y automatic-remote (6) Y maintenance (7)
Ct14	1,2	What happens if the orCat value is not supported or invalid	DOns: SBOs: Not Supported DOes: SBOes: DUT issues “test-not-ok” response with AddCause value “Not-supported”.
Ct15	1,2	Does the IED accept a SelectWithValue / Operate with the same control value as the current status value Is this behaviour configurable	DOns: Y SBOs: NA DOes: N SBOes: N Configurable N
Ct16	1	Does the IED accept a select/operate on the same control object from 2 different clients at the same time	DOns: N SBOs: NA DOes: N SBOes: N

ID	Ed	Description	Value / Clarification
Ct17	1	Does the IED accept a Select/SelectWithValue from the same client when the control object is already selected (Tissue #334)	SBOns: NA SBOes: N
Ct18	1	Deprecated	
Ct19	-	Can a control operation be blocked by Mod=Off or [On-]Blocked (Compare PIXIT-Sr5)	Deprecated
Ct20	1,2	Does the IED support local / remote operation	Y
Ct21	1,2	Does the IED send an InformationReport with LastApplError as part of the Operate response- for control with normal security	SBOns: NA DOes: Y
Ct22	2	How to force a "parameter-change-in-execution"	SBOns: Not Applicable SBOes: Not Applicable
Ct23	1,2	How many SBOns/SBOes control objects can be selected at the same time?	SBOns:N/A SBOes: multiple=10
Ct24	1,2	Can a controllable object be forced to keep its old state e.g. local data objects may not be accessible to keep the old state, whereas a switch like Circuit Breaker outside the DUT can?	Y
Ct25	1,2	When CDC=DPC is supported, is it possible to have DPC (Controllable Double Point) go to the intermediate state? (00)	Y
Ct26	1,2	Name an enhanced security control point (if any) with a finite operate timeout Specify the operate timeout (in milliseconds)	SEL_4XXPRO/DC1CSW11, DOes: Configurable in the CID file SBOes: Configurable in the CID file. Default: 10 s
Ct27	2	Does the IED support control objects with external signals?	DOes: Y SBOns: Not Applicable DOes: Y SBOes: Y

ID	Ed	Description	Value / Clarification
Ct28		Deprecated, kept as placeholder	
Ct29	Amd1	Does the IED support XCBR/XSWI.Loc=False and LLN0/CSWI.Loc=True Does the IED accept the control with orCat=1 or 4 Local	DOns: Y, orCat 1-4: Y SBOs: N, orCat 1-4: N DOes: Y, orCat 1-4: Y SBOes: Y, orCat 1-4: Y
Ct30	2	What is the Operate timeout?	operTimeout in datamodel

PIXIT for Time synchronisation model

ID	Ed	Description	Value / Clarification
Tm1	1	What time quality bits are supported (may be set by the IED) Note: Ability to set ClockNotSynchronized and LeapSecondKnown is mandatory in Ed2	Y LeapSecondsKnown Y ClockFailure Y ClockNotSynchronized
Tm2	1,2	Describe the behaviour when all time server(s) cease to respond What is the time server lost detection time	Assert ClockNotSynchronized after lost detection time 5-20 s depending on DUT Ethernet port 5 settings. Default is 5 s
Tm3	1,2	How long does it take to take over the new time from time server	15 - 3600 s depending on relay settings. Default is 60 s
Tm4	1,2	When is the time quality bit "ClockFailure" set	The IED sets ClockFailure when it is in "Disabled" state
Tm5	1	When is the time quality bit "Clock not Synchronized" set	When connection to all time servers is lost (see PIXIT-Tm2)
Tm6	-	Is the timestamp of a binary event adjusted to the configured scan cycle	Deprecated
Tm7	1	Does the device support time zone and daylight saving	Y
Tm8	1,2	Which attributes of the SNTP response packet are validated	Y Leap indicator not equal to 3 Y Mode is equal to SERVER Y OriginateTimestamp is equal to value sent by the SNTP client as Transmit Timestamp N RX/TX timestamp fields are checked for reasonableness Y SNTP version 3 and/or 4

ID	Ed	Description	Value / Clarification
			N other (describe)
Tm9	1,2	When COMTRADE files are supported do these have local time or UTC time and is this configurable	Supported Y Local for COMTRADE C37.111 - 1999 files UTC for COMTRADE C37.111 - 2013 files N Configurable

PIXIT for File transfer model

ID	Ed	Description	Value / Clarification
Ft1	1	What is the structure of files and directories Where are the COMTRADE files stored Are COMTRADE files zipped and what files are included in each zip file	File system with folders /COMTRADE/ Not zipped
Ft2	1,2	Directory names are separated from the file name by	"/"
Ft3	1	The maximum file name size including path (recommended 64 chars)	255 chars
Ft4	1,2	Are directory/file name case sensitive	Not Case sensitive
Ft5	1,2	Maximum file size for SetFile	Not limited. It depends on available memory
Ft6	1	Is the requested file path included in the MMS fileDirectory respond file name	Y
Ft7	1	Is the wild card supported in the MMS fileDirectory request	Yes, wild card = *
Ft8	1,2	Is it allowed that 2 clients get a file at the same time	N same file N different files
Ft9	1,2	Which files can be deleted	Not Applicable

PIXIT for Service tracking model

ID	Ed	Description	Value / Clarification
Tr1	2	Which ACSI services are tracked by LTRK.GenTrk	SpcTrk DpcTrk EncTrk1

ID	Ed	Description	Value / Clarification
			BrcbTrk UrcbTrk SgcbTrk