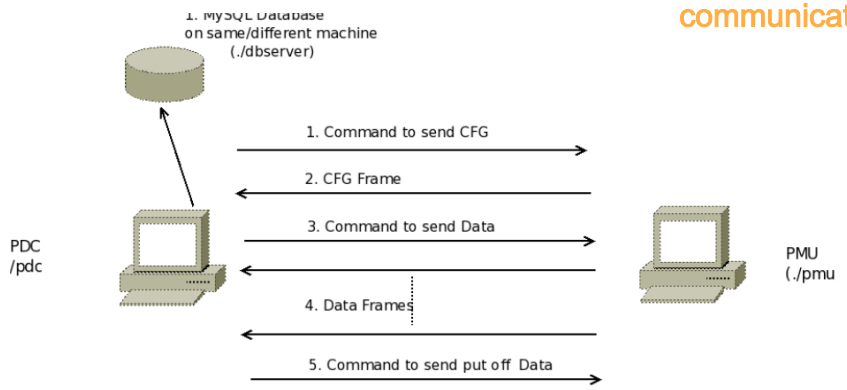
Format of Command Frame from PDC

Command word bits	Definition
Bits 15–0:	
0000 0000 0000 0001	Turn off transmission of data frames.
0000 0000 0000 0010	Turn on transmission of data frames.
0000 0000 0000 0011	Send HDR frame.
0000 0000 0000 0100	Send CFG-1 frame.
0000 0000 0000 0101	Send CFG-2 frame.
0000 0000 0000 0110	Send CFG-3 frame (optional command).
0000 0000 0000 1000	Extended frame.
0000 0000 xxxx xxxx	All undesignated codes reserved.
0000 yyyy xxxx xxxx	All codes where yyyy ≠ 0 available for user designation.
zzzz xxxx xxxx xxxx	All codes where zzzz ≠ 0 reserved.

Table 14—Command frame organization

No	Field	Size (bytes)	Comment
1	SYNC	2	Sync byte followed by frame type and version number (AA41 hex).
2	FRAMESIZE	2	Number of bytes in frame, defined in 6.2.
3	IDCODE	2	PMU/PDC ID data stream number, 16-bit integer, defined in 6.2.
4	SOC	4	SOC time stamp, defined in 6.2.
5	FRACSEC	4	Fraction of Second and Time Quality, defined in 6.2.
6	CMD	2	Command being sent to the PMU/PDC (0).
7	EXTFRAME	0–65518	Extended frame data, 16-bit words, 0 to 65518 bytes as indicated by frame size, data user defined.
8	CHK	2	CRC-CCITT.

PMU to iPDC communication



Format of Data frame from PMU

Table 5—Data frame organization

No.	Field	Size (bytes)	Comment
1	SYNC	2	Sync byte followed by frame type and version number.
2	FRAMESIZE	2	Number of bytes in frame, defined in 6.2.
3	IDCODE	2	Stream source ID number, 16-bit integer, defined in 6.2.
4	SOC	4	SOC time stamp, defined in 6.2, for all measurements in frame.
5	FRACSEC	4	Fraction of Second and Time Quality, defined in 6.2, for all measurements in frame.
6	STAT	2	Bit-mapped flags.
7	PHASORS	4 × PHNMR or 8 × PHNMR	Phasor estimates. May be single phase or 3-phase positive, negative, or zero sequence. Four or 8 bytes each depending on the fixed 16-bit or floating-point format used, as indicated by the FORMAT field in the configuration frame. The number of values is determined by the PHNMR field in configuration 1, 2, and 3 frames.
8	FREQ	2 / 4	Frequency (fixed or floating point).
9	DFREQ	2 / 4	ROCOF (fixed or floating point).
10	ANALOG	2 × ANNMR or 4 × ANNMR	Analog data, 2 or 4 bytes per value depending on fixed or floating-point format used, as indicated by the FORMAT field in configuration 1, 2, and 3 frames. The number of values is determined by the ANNMR field in configuration 1, 2, and 3 frames.
11	DIGITAL	2 × DGNMR	Digital data, usually representing 16 digital status points (channels). The number of values is determined by the DGNMR field in configuration 1, 2, and 3 frames.
	Repeat 6–11		Fields 6–11 are repeated for as many PMUs as in NUM_PMU field in configuration frame.
12+	CHK	2	CRC-CCITT

Table 6—Word definitions unique to data frames

Field	Size (bytes)	Comments
SYNC	2	First byte: AA hex Second byte: 01 hex (frame is version 1, IEEE Std C37.118-2005 [B6])
STAT	2	Bit mapped flags. Bit 15–14: Data error: 00 = good measurement data, no errors 01 = PMU error. No information about data 10 = PMU in test mode (do not use values) or *absent data tags* have been inserted (do not use values) 11 = PMU error (do not use values) Bit 13: PMU sync, 0 when in sync with a UTC traceable time source Bit 12: Data sorting, 0 by time stamp, 1 by arrival Bit 11: PMU trigger detected, 0 when no trigger Bit 10: Configuration change, set to 1 for 1 min to advise configuration will change, and clear to 0 when change effected. Bit 09: Data modified, 1 if data modified by post processing, 0 otherwise Bits 08–06: PMU Time Quality. Refer to codes in Table 7. Bits 05–04: Unlocked time: 00 = sync locked or unlocked < 10 s (best quality) \01 = 10 s ≤ unlocked time < 100 s 10 = 100 s < unlock time ≤ 1000 s 11 = unlocked time > 1000 s Bits 03–00: Trigger reason: 1111–1000: Available for user definition 0111: Digital — 0110: Reserved 0101: df/dt High — 0100: Frequency high or low 0011: Phase angle diff — 0010: Magnitude high 0001: Magnitude low — 0000: Manual
PHASORS	4 / 8	Data type indicated by the FORMAT field in configuration 1, 2, and 3 frames **16-bit integer values:** *Rectangular format:* —real and imaginary, real value first —16-bit signed integers, range –32 767 to +32 767 *Polar format:* —magnitude and angle, magnitude first —magnitude 16-bit unsigned integer range 0 to 65535 —angle 16-bit signed integer, in radians × 10^4, range –31 416 to +31 416 **32-bit values in IEEE floating-point format:** *Rectangular format:* —real and imaginary, in engineering units, real value first *Polar format:* —magnitude and angle, magnitude first and in engineering units —angle in radians, range $-\pi$ to $+\pi$
FREQ	2 / 4	Frequency deviation from nominal, in mHz Range–nominal (50 Hz or 60 Hz) –32.767 to +32.767 Hz 16-bit integer or 32-bit floating point 16-bit integer: 16-bit signed integers, range –32 767 to +32 767 32-bit floating point: actual frequency value in IEEE floating-point format. Data type indicated by the FORMAT field in configuration 1, 2, and 3 frames
DFREQ	2 / 4	ROCOF, in hertz per second times 100 Range –327.67 to +327.67 Hz per second Can be 16-bit integer or IEEE floating point, same as FREQ above. Data type indicated by the FORMAT field in configuration 1, 2, and 3 frames
ANALOG	2 / 4	Analog word. 16-bit integer. It could be sampled data such as control signal or transducer value. Values and ranges defined by user. Can be 16-bit integer or IEEE floating point. Data type indicated by the FORMAT field in configuration 1, 2, and 3 frames
DIGITAL	2	Digital status word. It could be bit mapped status or flag. Values and ranges defined by user.

More details about Data frames: Data is in binary

Format of Config frame from PMU

Table 9—Word definitions unique to configuration frames 1 and 2

Field	Size (bytes)	Description
SYNC	2	First byte: AA hex Second byte: 21 hex for configuration 1 31 hex for configuration 2 Both frames are version 1 (IEEE Std C37.118-2005 [B6])
TIME_BASE	4	Resolution of the fractional second time stamp (FRACSEC) in all frames. Bits 31–24: Reserved for flags (high 8 bits). Bits 23–0: 24-bit unsigned integer, which is the subdivision of the second that the FRACSEC is based on. The actual "fractional second of the data frame" = FRACSEC / TIME_BASE.
NUM_PMU	2	The number of PMUs included in the data frame. No limit specified. The actual limit will be determined by the limit of 65 535 bytes in one frame ("FRAMESIZE" field).
STN	16	Station Name—16 bytes in ASCII format.
IDCODE	2	Data stream ID number, 16-bit integer, defined in 6.2. It identifies the data stream in field 3 and the data source in fields 9 and higher. Field 3 identifies the stream that is being received. The IDCODEs in field 9 (and higher if more than one PMU data is present) identify the original source of the data and will usually be associated with a particular PMU. The IDCODEs in a data stream received directly from a PMU will usually be the same.
FORMAT	2	Data format in data frames, 16-bit flag. Bits 15–4: Unused Bit 3: 0 = FREQ/DFREQ 16-bit integer, 1 = floating point Bit 2: 0 = analogs 16-bit integer, 1 = floating point Bit 1: 0 = phasors 16-bit integer, 1 = floating point Bit 0: 0 = phasor real and imaginary (rectangular), 1 = magnitude and angle (polar)
PHNMR	2	Number of phasors—2-byte integer.
ANNMR	2	Number of analog values—2-byte integer.
DGNMR	2	Number of digital status words—2-byte integer. Digital status words are normally 16-bit Boolean numbers with each bit representing a digital status channel measured by a PMU. A digital status word may be used in other user-designated ways.
CHNAM	16	Phasor and channel names—16 bytes for each phasor, analog and digital status word in ASCII format in the same order as they are transmitted.
PHUNIT	4	Conversion factor for phasor channels. Four bytes for each phasor. Most significant byte: 0—voltage; 1—current. Least significant bytes: An unsigned 24-bit word in 10^{-5} V or amperes per bit to scale 16-bit integer data (if transmitted data is in floating-point format, this 24-bit value shall be ignored).
ANUNIT	4	Conversion factor for analog channels. Four bytes for each analog value. Most significant byte: 0—single point-on-wave, 1—rms of analog input, 2—peak of analog input, 5–64—reserved for future definition; 65–255—user definable. Least significant bytes: A signed 24-bit word, user defined scaling.
DIGUNIT	4	Mask words for digital status words. Two 16-bit words are provided for each digital word. The first will be used to indicate the normal status of the digital inputs by returning a 0 when exclusive ORed (XOR) with the status word. The second will indicate the current valid inputs to the PMU by having a bit set in the binary position corresponding to the digital input and all other bits set to 0. See NOTE.
FNOM	2	Nominal line frequency code (16 bit unsigned integer) Bits 15–1:Reserved Bit 0: 1—Fundamental frequency = 50 Hz 0—Fundamental frequency = 60 Hz
DATA_RATE	2	Rate of phasor data transmissions—2-byte integer word (–32 767 to +32 767) If DATA_RATE > 0, rate is number of frames per second. If DATA_RATE < 0, rate is negative of seconds per frame. E.g., DATA_RATE = 15 is 15 frames per second; DATA_RATE = –5 is 1 frame per 5 s.
CFGCNT	2	Configuration change count is incremented each time a change is made in the PMU configuration. 0 is the factory default and the initial value. This count identifies the number of changes in the configuration of this message stream. The count will be the same in all configuration messages (CFG-1, CFG-2, and CFG-3) for the same message revision.
NOTE—If digital status words are used for something other than Boolean status indications, the use of masks is left to the user, such as min or max settings.		

Some Example of Data frame

Table D.1—Data message example

Field	Short description	Example entry	Size (bytes)	Hexadecimal value
SYNC	Synchronization and Frame Format Field.	Data Frame, Version 1	2	AA 01
FRAMESIZE	Total number of bytes in this frame.	52 bytes in this frame	2	00 34
IDCODE	PMU/PDC data stream ID number, 16-bit integer, 1–65534.	7734	2	1E 36
SOC	Second count. (UNIX time, starting midnight 01-Jan-1970 neglecting leap seconds).	9:00 AM on 6/6/2006 = 1 149 580 800	4	44 85 36 00
FRACSEC	Time of phasor measurement in microseconds with Time Quality.	Not a leap second, none pending; time locked. 16817 μs after the second mark	4	00 00 41 B1
STAT	Bit mapped flags: Data valid?, PMU OK?, PMU sync?, Data align by time?, PMU Trigger?, Reserved, Time Error, Trigger Cause	Data valid, no PMU error, PMU sync, data sorted by time stamp, no PMU trigger, best time quality	2	00 00
PHASORS	Phasor data, 16-bit integer, rectangular format. The first two bytes contain the real part of the phasor and the second two contain the imaginary part.	VA = 14 635 ∠ 0° (= 134.0 kV ∠ 0°)	4	39 2B 00 00
		VB = 14 635 ∠ -120° (= 134.0 kV ∠ –120°)	4	E3 6A CE 7C
		VC = 14 635 ∠ 120° (= 134.0 kV ∠ 120°)	4	E3 6A 31 83
		I1 = 1092 ∠ 0° (= 500 A ∠ 0°)	4	04 44 00 00
FREQ	16-bit signed integer. Frequency deviation from nominal in mHz.	+2500 mHz (nominal 60 Hz with measured 62.5 Hz)	2	09 C4
DFREQ	ROCOF.		2	00 00
ANALOG	32-bit floating point.	ANALOG1 = 100	4	42 C8 00 00
		ANALOG2 = 1000	4	44 7A 00 00
		ANALOG3 = 10000	4	46 1C 40 00
DIGITAL	Digital data, 16-bit bit fields.	0011 1100 0001 0010	2	3C 12
CHK	CRC-CCITT.	—	2	D4 3F

Table D.2—Configuration message example

Field	Short description	Example	Size (bytes)	Hexadecimal value
SYNC	Synchronization byte and version number.	Configuration Frame 2 Version 1	2	AA 31
FRAMESIZE	Number of bytes in frame.	This frame contains 454 bytes	2	01 C6
IDCODE	PMU/PDC data stream ID number, 16-bit integer, 1–65534.	7734	2	1E 36
SOC	SOC time stamp (UNIX time, starting midnight 01-Jan-1970).	8:00 AM on 6/6/2006 = 1 149 577 200	4	44 85 27 F0
FRACSEC	Fraction of second with Time Quality.	Leap second pending, to be deleted, clock unlocked but within 100 µs. Fractional time is 0.463 s.	4	56 07 10 98
TIME_BASE	Flag and divisor for time stamping the data.	1 000 000 µs	4	00 0F 42 40
NUM_PMU	The number of PMUs included in the data frame.	Data from 1 PMU	2	00 01
STN	Station Name—16 bytes in ASCII format.	The station name for this example is: "Station A "	16	53 74 61 74 69 6F 6E 20 41 20 20 20 20 20 20 20
IDCODE	PMU/PDC data source ID number, 16-bit integer, 1–65534.	7734	2	1E 36
FORMAT	Data format within the data frame.	Phasors are represented using rectangular coordinates and 16-bit integers. Analogs are 32-bit floating-point numbers.	2	00 04
PHNMR	Number of phasors—2 byte integer (0 to 32 767).	This example contains 4 phasors.	2	00 04
ANNMR	Number of analog values—2 byte integer.	This example contains 3 analog values.	2	00 03
DGNMR	Number of digital status words—2 byte integer.	This example contains 1 set of binary data.	2	00 01

Table D.2—Configuration message example *(continued)*

Field	Short description	Example	Size (bytes)	Hexadecimal value
CHNAM	Phasor and channel names—16 bytes for each phasor, analog, and digital channel in ASCII format in the same order as they are transmitted.	The first phasor name is: "VA "	16	56 41 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
		The second phasor name is: "VB "	16	56 42 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
		The third phasor name is: "VC "	16	56 43 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
		The fourth phasor name is: "I1 "	16	49 31 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
		The first analog name is: "ANALOG1 "	16	41 4E 41 4C 4F 47 31 20 20 20 20 20 20 20 20 20
		The second analog name is: "ANALOG2 "	16	41 4E 41 4C 4F 47 32 20 20 20 20 20 20 20 20 20
		The third analog name is: "ANALOG3 "	16	41 4E 41 4C 4F 47 33 20 20 20 20 20 20 20 20 20
		Digital channel 1 label is: "BREAKER 1 STATUS"	16	42 52 45 41 4B 45 52 20 31 20 53 54 41 54 55 53
		Digital channel 2 label is: "BREAKER 2 STATUS"	16	42 52 45 41 4B 45 52 20 32 20 53 54 41 54 55 53
		Digital channel 3 label is: "BREAKER 3 STATUS"	16	42 52 45 41 4B 45 52 20 33 20 53 54 41 54 55 53
		Digital channel 4 label is: "BREAKER 4 STATUS"	16	42 52 45 41 4B 45 52 20 34 20 53 54 41 54 55 53
		Digital channel 5 label is: "BREAKER 5 STATUS"	16	42 52 45 41 4B 45 52 20 35 20 53 54 41 54 55 53
PHUNIT	Conversion factor for phasor channels. PhasorMAG = PHUNIT X× 0.00001 Voltage PHUNIT = (300 000/32768) × 10E+5 Current PHUNIT = (15 000/32768) × 10E+5	Factor = 915527	4	00 0D F8 47
		Factor = 915527	4	00 0D F8 47
		Factor = 915527	4	00 0D F8 47
		Factor = 45776	4	01 00 B2 D0
ANUNIT	Conversion factor for analog channels. Because the analogs are represented by floating-point conversion factor is unity (or simply not used).	This analog is an "instantaneous" sample of a point on the input waveform	4	00 00 00 01
		This analog is an rms calculation	4	01 00 00 01
		This analog is a peak calculation	4	02 00 00 01
DIGUNIT	Mask words for digital status words.	First mask: Normal state is 0 for all bits Second mask: All 16 bits are valid	4	00 00 FF FF
FNOM	Nominal line frequency code and flags.	Nominal 60 Hz	2	00 00
CFGCNT	Configuration change count.	22 changes	2	00 16
DATA_RATE	Rate of phasor data transmissions.	30 messages per second	2	00 1E
CHK	CRC-CCITT.	—	2	D5 D1

Examples of Configuration Frame