For: wpm
Printed on: Tue, Sep 14, 1993 13:50:48
From book: recRefManual
Document: titlePage
Last saved on: Thu, Oct 8, 1992 11:41:07
Document: toc
Last saved on: Thu, Oct 8, 1992 11:41:08
Document: preface
Last saved on: Thu, Oct 8, 1992 11:41:09
Document: intro 1
Last saved on: Thu, Oct 8, 1992 11:41:10
Document: all 2
Last saved on: Thu, Oct 8, 1992 11:41:10
Document: many 3
Last saved on: Thu, Oct 8, 1992 11:41:11
Document: ai 4
Last saved on: Thu, Oct 8, 1992 11:41:13
Document: ao 5
Last saved on: Thu, Oct 8, 1992 11:41:14
Document: bi 6
Last saved on: Thu, Oct 8, 1992 11:41:15
Document: bo 7
Last saved on: Thu, Oct 8, 1992 11:41:16
Document: calc 8
Last saved on: Thu, Oct 8, 1992 11:41:18
(...)

Experimental Physics and Industrial Control System (EPICS)
Input Output Controller (IOC)
Record Reference Manual

Janet B. Anderson
Martin R. Kraimer
October 1992

DRAFT

This software was produced under U.S. Government contracts:
(W–7405–ENG–36) at the Los Alamos National Laboratory,
and (W–31–109–ENG–38) at Argonne National Laboratory.

Initial development by:

The Controls and Automation Group (AT–8)
Ground Test Accelerator
Accelerator Technology Division
Los Alamos National Laboratory

Co–developed with

The Controls and Computing Group
Accelerator Systems Division
Advanced Photon Source
Argonne National Laboratory

PREFACE

This document describes the standard record types supported by the IOC databases.The basic concept of record processing was developed by Bob Dalesio of LANL/GTA. Bob was also the designerer and implementer of the initial record types. This software was developed over a period of several years with feedback from LANL/GTA users. Without their ideas EPICS would not exist.

During 1990 and 1991, ANL/APS undertook a major revision of the IOC software with the primary goal being to provide easily extendible record and device support. Marty Kraimer (ANL/APS) was primarily responsible for designing the data structures needed to support extendible record and device support and for making the changes needed to the IOC resident software. Bob Zieman (ANL/APS) designed and implemented the UNIX tools and IOC modules necessary to support the new facilities. Frank Lenkszus (ANL/APS) made extensive changes to the Database Configuration Tool (DCT) necessary to support the new facilities. Janet Anderson (ANL/APS) developed methods to systematically test various features of the IOC software and is presently involved with developing support for new record types.

The current EPICS software development team consists of the following individuals:

LANL/GTA:	Roger Cole, Bob Dalesio, Betty Gunther, Jeff Hill, Deb Kerstiens, Andy Kozubal, and Cindy Eaton
ANL/APS:	Janet Anderson, Mark Anderson, Ben–chin Cha, Nick Karonis, Jim Kowalkowski, Marty Kraimer, John Winans and Bob Zieman

CHAPTER 1 Introduction

This manual describes all supported record types. The first chapter gives the introduction and describes the field summary table. The second chapter describes the fields in database common, i.e. the fields that are present in every record type. The third chapter describes several input and output field names that are common to multiple record types and have the same usage wherever they are used. Following the third chapter there is a separate chapter for each record type containing a description of all the fields for that record type except those in database common.

Each chapter contains a field summary table of the form:

FIELD SUMMARY

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP

The meaning of each component of the summary table is as follows:

Field	The field name
Type	The database field type, i.e. DBF_<type>
DCT	Is this field definable via the database configuration tool?
Interest	Interest level for the output of the database test routines.

0	Application developer: Field may change during processing
1	Application developer: Not changed during processing
2	System developer: Major interest
3	System developer: Minor interest
4	No interest: pad field

Initial	Initial value when record is created
Access	Is this field accessible via database access?
Modify	Can this field be modified via database access?
Monitor	Does the record processing routine trigger monitors by a call to db_post_event when this field changes value?
PP	Process passive? Will dbPutField call dbProcessPassive when this field is processed?

CHAPTER 2 Fields Common to All Record Types

This chapter contains a description of fields that are common to all records.

2.1 Database Common: Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
NAME	STRING	Yes	0		Yes	No		
DESC	STRING	Yes	0	null	Yes	Yes	No	No
SCAN	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
PINI	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
PHAS	SHORT	Yes	1	0	Yes	Yes	No	No
EVNT	SHORT	Yes	1	0	Yes	Yes	No	No
SDIS	INLINK	Yes	1	0	No			
DISV	SHORT	Yes	0	1	Yes	Yes	No	No
DISA	SHORT	No	0	0	Yes	Yes	No	No
DTYP	DEVCHOICE	Yes	1	0	Yes	No		
DISP	UCHAR	No	0	0	Yes	Yes	Yes	No
PROC	UCHAR	No	3	0	Yes	Yes	No	Yes
MLOK	NOACCESS	No	4					
MLIS	NOACCESS	No	4					
STAT	GBLCHOICE	No	0	udf	Yes	No	Yes	No
SEVR	GBLCHOICE	No	0	invalid	Yes	No	Yes	No
NSTA	GBLCHOICE	No	2	0	Yes	No	No	
NSEV	GBLCHOICE	No	2	0	Yes	No	No	
DISS	GBLCHOICE	Yes	1	0	Yes	Yes	No	
TIME	NOACCESS	No	4		Option			
LSET	SHORT	No	4	compute	Yes	No		
LCNT	UCHAR	No	2	0	Yes	No		
PACT	UCHAR	No	1	0	Yes	No		
SPVT	NOACCESS	No	4					
RSET	NOACCESS	No	4					
DSET	NOACCESS	No	4					
DPVT	NOACCESS	No	4					
TPRO	UCHAR	No	0	0	Yes	Yes	No	No
UDF	UCHAR	No	1	1	Yes	Yes	No	Yes
PRIO	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
FLNK	FWDLINK	Yes	1	0	No			

2.2 Database Common: Field Descriptions

NAME Record Name

An arbitrary 28 character record name supplied by the application devel-

oper. This name is the means of identifying a specific record. It must have a unique value across all IOCs attached to the same local area subnet.

DESC Description

An arbitrary 28 character record description supplied by the application developer.

SCAN Scanning Algorithm

This can be one of the periodic intervals, I/O event, Event, or passive.

PINI Process at initialization

If this field is set to True during database configuration, then the record is processed once at IOC initialization (before the normal scan tasks are started).

PHAS Scan Phase Number

This field orders the records within a specific SCAN group. This is not meaningful for passive records. All records of a specified phase are processed before those with higher phase number. Whenever possible it is better to use linked passive records to enforce the order of processing rather than phase number.

EVNT Event Number

Event number for scan type event. All records with scan type Event and the same EVNT value will be processed when a call to post_event for EVNT is made. The call to post_event is:

post_event(short event_number)

SDIS Scan Disable Input Link

An input link from which to obtain a value for DISA. This field is ignored unless it is a database link or a channel access link. If it is a database or a channel access link, dbProcess calls dbGetLink to obtain a value for DISA before deciding to call the processing routine.

DISV Disable Value

If DISV=DISA, then the record will be disabled, i.e. dbProcess will not process the record.

DISA Scan Disable Input Link Value

This is the value that is compared with DISV to determine if the record is disabled. Its value is obtained via SDIS if SDIS is a database or channel access link. If SDIS is not a database or channel access link, then DISA can be set via dbPutField or dbPutLink.

DTYP Device Type

This field specifies the device type for the record. Each record type has its own set of device support routines which are specified in devSup.ASCII. If a record type does not have any associated device support, DTYP and DSET are meaningless.

DISP Disable putFields

If this field is set to True, then all dbPutFields (normally issued by channel access) directed to this record are ignored except to the field DISP itself.

PROC Process Record

A passive record will be processed whenever a dbPutField is directed to this field. This field is present because often it is not clear which field to write to when the only desire is to force processing.

MLOK Monitor Lock

The lock used by the monitor routines when the monitor list is being used. The list is locked whenever monitors are being scheduled, invoked, or when monitors are being added to or removed from the list. This field is accessed only by the dbEvent routines.

MLIS Monitor List

This is the head of the list of monitors connected to this record. Each record support module is responsible for triggering monitors for any fields that change as a result of record processing. Monitors are present if mlis.count is greater than zero. The call to trigger monitors is:

db_post_event(precord,&data,mask)

mask is some combination of DBE_ALARM, DBE_VALUE, and DBE_LOG.

STAT Current Alarm Status
SEVR Current Alarm Severity

NSTA New Alarm Status
NSEV New Alarm Severity

These four fields are the alarm status and severity fields. STAT and SEVR are the values seen outside database access. NSTA and NSEV are the fields the database access, record support, and device support use to set new alarm status and severity values. Whenever any software component discovers an alarm condition, it uses the following macro function:

recGblSetSevr(precord,new_status,new_severity)

This ensures that the current alarm severity is set equal to the highest outstanding alarm. The file alarm.h defines all allowed alarm status and severity values.

DISS Disable Alarm Severity

When this record is disabled, it will be put into alarm with this severity and a status of DISABLE_ALARM.

TIME Time

The time when this record was last processed, in standard format.

LSET Lock Set

The lock set to which this record belongs. All records linked in any way via input, output, or forward database links belong to the same lock set. The only exception is that non–process passive input links do not force the linked record to be in the same lock set. The lock sets are determined at IOC initialization time.

LCNT Lock Count

The number of times in succession dbProcess finds the record active, i.e. PACT is True. If dbProcess finds the record active MAX_LOCK (currently set to 10) times in succession, it raises a SCAN_ALARM.

PACT Processing Active

See Application Developers Guide for details on usage. PACT is True while the record is being processed. For asynchronous records PACT can be True from the time record processing is started until the asynchronous completion occurs. As long as PACT is True, dbProcess will not call the record processing routine.

SPVT Scan Private.

This field is for private use of the scanning system.

RSET Address of record support entry table. See Application Developers Guide for details on usage.

DSET Address of Device Support Entry Table

This address of the device support entry table for this record. The value of this field is determined at IOC initialization time. Record support routines use this field to locate their device support routines.

DPVT Device Private.

This field is for private use of the device support modules.

TPRO Trace Processing.

If this field is set True, a message is printed each time this record is processed and a message is printed for each record processed as a result of this record being processed

UDF VAL Undefined

UDF is initialized to True at IOC initialization. Record and device support routines which write to the VAL field are responsible for setting UDF to False.

PRIO Priority

Scheduling priority for processing I/O Event scanned records and asynchronous record completion tasks.

FLNK Forward Link

This field is a database link. If FLNK is specified, processing this record will force a processing of the scan passive forward link record.

CHAPTER 3 Fields Common to Many Record Types

This chapter describes input and output fields that are common to multiple record types. These fields have the same meaning whenever they are used.

3.1 Input Records

3.1.1 Common Fields

INP — Input Link

This field is used by the device support routines to obtain input. For soft analog records it can be a constant, a database link, or a channel access link

DTYP — Device Type

DTYP specifies the name of the device support module that will input values. Each record type has its own set of device support routines which are specified in devSup.ASCII. If a record type does not have any associated device support, DTYP is meaningless.

RVAL — Raw Value

Whenever possible this field contains the raw data value exactly as it is obtained from the hardware or from the associated device driver.

VAL — Value

This is the record's final value, after any needed conversions have been performed.

SIMM — Simulation mode

This field has either the value YES or NO. By setting this field to YES, the record can be switched into simulation mode of operation. While in simulation mode, input will be obtained from SIOL instead of INP.

SIML — Simulation mode location

This field can be a constant, a database link, or a channel access link. If SIML is a database or channel access link, then SIMM is read from SIML. If SIML is a constant link then SIMM is initialized with the constant value but can be changed via dbPuts.

SVAL Simulation value

This is the record's input value, in engineering units, when the record is switched into simulation mode, i.e. when SIMM is set to YES.

SIOL Simulation value location

This field can be a constant, a database link, or a channel access link. If SIOL is a database or channel access link, then SVAL is read from SIOL. If SIOL is a constant link then SVAL is initialized with the constant value but can be changed via dbPuts.

SIMS Simulation mode alarm severity

When this record is in simulation mode , it will be put into alarm with this severity and a status of SIMM.

3.1.2 Device input

A device input routine normally returns one of the following values to its associated record support routine:

0 Success and convert. The input value is in RVAL. The record support module is expected to compute VAL from RVAL.

2 Success, but don't convert. The device support module can specify this value if it does not want any conversions. It might do this for two reasons:

- a A hardware error is detected (in this case, it should also raise an alarm condition).
- b The device support routine reads values directly into the VAL field and then sets UDF to False.

3.1.3 Soft input

In almost all cases, two special device support modules are provided: Soft and Raw Soft. Both allow INP to be a constant, a database link, or a channel access link. The Soft support module reads input directly into the VAL field and specifies that no conversion of any type should be performed. Thus Soft support allows the record to hold values corresponding to the C datatype of the VAL field. Note that for soft input, RVAL is not used. The Raw Soft support module reads input into RVAL and asks that normal conversion to VAL be performed.

The device support read routine normally calls recGblGetLinkValue which performs the following steps:

If the INP link type is CONSTANT recGblGetLinkValue does nothing and returns with a status of zero.

If the INP link type is DB_LINK, then dbGetLink is called to obtain a new input value. If dbGetLink returns an error, a LINK_ALARM with a severity of INVALID_ALARM is raised. RecGblGetLinkValue returns the status of dbGetLink.

If the INP link type is CA_LINK, then dbCaGetLink is called to obtain a new input value. If dbCaGetLink returns an error, a LINK alarm with a severity of INVALID is raised. RecGblGetLinkValue retruns the status of dbCaGetLink.

If the return status of recGblGetLinkValue is zero and the INP link type is not CONSTANT, then UDF is set to False. The device support read routine normally returns the status of recGblGetLinkValue.

3.1.4 Simulation mode

A record can be switched into simulation mode of operation by setting the value of SIMM to YES. During simulation, the record will be put into alarm with a severity of SIMS and a status of SIMM_ALARM. While in simulation mode, input values, in engineering units, will be obtained from SIOL instead of INP. Also, while the record is in simulation mode, there will be no raw value conversion and no calls to device support during record processing.

Normally input records contain a private readValue routine which performs the following steps:

If PACT is True, the device support read routine is called, status is set to its return code, and readValue returns.
Call recGblGetLinkValue to get a new value for SIMM if SIML is a DB_LINK or a CA_LINK.
Check value of SIMM.
If SIMM is No, then call the device support read routine, set status to its return code, and return.
If SIMM is Yes, then call recGblGetLinkValue to read the input value from SIOL into SVAL. If success, then set VAL to SVAL and UDF to False and set status to 2 (don't convert) if input record supports conversion. If SIMS is greater than zero, set alarm status to SIMM and severity to SIMS. Set status to the return code from recGblGetLinkValue and return.
IF SIMM is not Yes or No, a SOFT alarm with a severity of INVALID is raised, and return status is set to –1.

3.2 Output Records

3.2.1 Common Fields

OUT Output Link

This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.

DTYP Device Type

DTYP specifies the device support module that will receive values.

VAL Value

This is the desired value before any conversions to raw output have been performed.

OVAL Output Value

OVAL is used to decide when to invoke monitors. Archive and value change monitors are invoked if OVAL is not equal to VAL. If a record type needs to make adjustments, OVAL is used to enforce the maximum rate of change limit before converting the desired value to a raw value.

RVAL Raw Value

Whenever possible this is the actual value sent to the hardware itself or to the associated device driver.

RBV Read Back Value

Whenever possible this is the actual read back value obtained from the hardware itself or from the associated device driver.

DOL Desired Output Location (an Input Link)

DOL can be a constant, a database link, or a channel access link. There is no device support associated with DOL. If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is obtained from DOL.

OMSL Output Mode Select

This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts.

OIF Output Full or Incremental (ao record only)

This field, which is only used when input is obtained from DOL, determines if the value obtained from DOL is an increment to add to the current VAL or is the actual VAL desired.

SIMM Simulation mode

This field has either the value YES or NO. By setting this field to YES, the record can be switched into simulation mode of operation. While in simulation mode, output will be written to SIOL instead of OUT.

SIML Simulation mode location

This field can be a constant, a database link, or a channel access link. If SIML is a database or channel access link, then SIMM is read from SIML. If SIML is a constant link then SIMM is initialized with the constant value but can be changed via dbPuts.

SIOL Simulation value location

This field can be a constant, a database link, or a channel access link. If SIOL is a database or channel access link, then the output value is written to SIOL. If this link is a constant, the result is no output.

SIMS Simulation mode alarm severity

When this record is in simulation mode, it will be put into alarm with this severity and a status of SIMM_ALARM.

IVOA Invalid alarm output action

Whenever the record is put into invalid alarm severity IVOA specifies an action. IVOA can be one of the following actions.

Continue normally
Don't drive outputs
Set output equal to IVOV

IVOV Invalid alarm output value, in engineering units

When new severity has been set to INVALID alarm and IVOA is "Set output equal to IVOV", then, VAL is set to IVOV and converted to RVAL before device support is called .

3.2.2 Soft Output

Normally two soft output device support modules are provided Soft and Raw Soft. Both allow the output link OUT to be a constant, a database link, or a channel access link. It is normally meaningless to use constant output links. The Soft support module writes output from the value associated with OVAL or VAL (if OVAL does not exist). The Raw Soft support module writes the value associated with the RVAL field after conversion has been performed.

The device support write routine normally calls recGblPutLinkValue which performs the following steps:

If the OUT link type is CONSTANT recGblPutLinkValue does nothing and returns with a status of zero.

If the OUT link type is DB_LINK, then dbPutLink is called to write the current value. If dbPutLink returns an error, a LINK_ALARM with a severity of INVALID_ALARM is raised. RecGblPutLinkValue returns the status of dbPutLink.

If the OUT link type is CA_LINK, then dbCaPutLink is called to write the current value. If dbCaPutLink returns an error, a LINK_ALARM with a severity of INVALID_ALARM is raised. RecGblPutLinkValue returns the status of dbCaPutLink.

The device support write routine normally returns the status of recGblPutLinkValue.

3.2.3 Output Mode Select

The fields DOL and OMSL are used to allow the output record to be part of a closed loop control algorithm. OMSL is meaningful only if DOL refers to a database or channel access link. It can have the values SUPERVISORY or CLOSED_LOOP. If the mode is SUPERVISORY, then nothing is done to VAL. If the mode is CLOSED_LOOP and the record type does not contain an OIF field, then each time the record is processed, VAL is set equal to the value obtained from the location referenced by DOL. If the mode is CLOSED_LOOP in record types with an OIF field and OIF is Full, VAL is set equal to the value obtained from the location referenced by DOL; if OIF is Incremental VAL is incremented by the value obtained from DOL.

3.2.4 Simulation Mode

An output record can be switched into simulation mode of operation by setting the value of SIMM to YES. During simulation, the record will be put into alarm with a severity of SIMS and a status of SIMM_ALARM. While in simulation mode, output values, in engineering units, will be written to SIOL instead of OUT. Also, while the record is in simulation mode, there will be no calls to device support during record processing.

Normally output records contain a private writeValue routine which performs the following steps:

If PACT is True, the device support write routine is called, status is set to its return code, and readValue returns.
Call recGblGetLinkValue to get a new value for SIMM if SIML is a DB_LINK or a CA_LINK.
Check value of SIMM.
If SIMM is No, then call the device support write routine, set status to its return code, and return.
If SIMM is Yes, then call recGblPutLinkValue to write the output value from VAL or OVAL to SIOL. Set alarm status to SIMM and severity to SIMS, if SIMS is greater than zero. Set status to the return code from recGblPutLinkValue and return.
If SIMM not one of the above, a SOFT alarm with a severity of INVALID is raised, and return status is set to –1.

3.2.5 Invalid Alarm Output Action

Whenever an output record is put into INVALID alarm severity, IVOA specifies an action to take. The record support process routine for each output record contains code which performs the following steps.

If new severity is less than INVALID, then call writeValue:

Else do the following:

If IVOA is Continue, then call writeValue.
If IVOA is No_output, then do not write output.
If IVOA is Output_ivov, then set VAL to IVOV, call convert if necessary, and then call writeValue.
If IVOA not one of the above, an error message is generated..

CHAPTER 4 Ai – Analog Input

The normal use for this record type is to obtain an analog value converted to engineering units. Most device support modules obtain values from hardware. Soft device modules are provided to obtain input via database or channel access links or via dbPutField or dbPutLink requests. The record supports alarm limits, conversion to engineering units, smoothing, and graphics and control limits.

Two soft device support modules are provided. One reads values directly into VAL. The other reads values into RVAL, which is then converted just like raw values obtained from hardware device support modules. If soft device support with a constant INP link is chosen, then the VAL field can be modified via dbPuts.

4.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	DOUBLE	No	0	0	Yes	Yes	Yes	Yes
INP	INLINK	Yes	1	0	No			
PREC	SHORT	Yes	1	0	Yes	Yes	No	No
LINR	CVTCHOICE	Yes	1	0	Yes	Yes	No	Yes
EGUF	FLOAT	Yes	1	0	Yes	Yes	No	Yes
EGUL	FLOAT	Yes	1	0	Yes	Yes	No	Yes
EGU	STRING	Yes	1	null	Yes	Yes	No	No
HOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
LOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
AOFF	FLOAT	Yes	1	0	Yes	Yes	No	Yes
ASLO	FLOAT	Yes	1	1	Yes	Yes	No	Yes
SMOO	FLOAT	Yes	1	0	Yes	Yes	No	No
HIHI	FLOAT	Yes	1	0	Yes	Yes	No	Yes
LOLO	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HIGH	FLOAT	Yes	1	0	Yes	Yes	No	Yes
LOW	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HHSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LLSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HYST	DOUBLE	Yes	1	0	Yes	Yes	No	No
ADEL	DOUBLE	Yes	1	0	Yes	Yes	No	No
MDEL	DOUBLE	Yes	1	0	Yes	Yes	No	No
ROFF	LONG	No	2	0	Yes	Yes	No	Yes
ESLO	DOUBLE	No	2	1	Yes	No	No	
LALM	DOUBLE	No	3	0	Yes	No	No	
ALST	DOUBLE	No	3	0	Yes	No	No	
MLST	DOUBLE	No	3	0	Yes	No	No	
PBRK	NOACCESS	No	4					
INIT	SHORT	No	3	0	Yes	No	No	
LBRK	SHORT	No	3	0	Yes	No	No	
RVAL	LONG	No	0	0	Yes	Yes	Yes	Yes

ORAW	LONG	No	3	0	Yes	No	No	
SIOL	INLINK	Yes	1	0	No			
SVAL	DOUBLE	No	0	0	Yes	Yes	No	No
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No

4.2 Field Descriptions

VAL Value Field

Unless INP is a constant link and the device support module specifies no conversion, this is the value resulting from the record being processed. If INP is a constant, then VAL is initialized to the INP value but can be changed dynamically via dbPutField or dbPutLink.

INP Input Link

This field is used by the device support routines to obtain input. For soft analog records it can be a constant, a database link, or a channel access link.

PREC Display Precision

Precision with which to display VAL and OVAL. This field is not used by record support other than to supply a value when get_precision is called.

LINR Conversion Type

NO_CONVERSION, LINEAR and breakpoint table conversion are supported.

EGUF Engineering Units Full
EGUL Engineering Units Low
ROFF Raw Value Offset
ESLO Slope for Linear Conversions

These fields are used to perform linear conversions. It is the responsibility of the device support routines to use EGUF and EGUL to compute ESLO and ROFF. EGUF and EGUL must be set by the user to the engineering units corresponding to the high and low ADC limits. For example if the ADC has a range of –10 to +10 Volts, then EGUF must be the engineering units value corresponding to 10 volts and EGUL to –10 volts. If a linear conversion is specified, recAi uses ESLO, ROFF, and EGUL to convert

the raw value to engineering units according to the formula:

VAL = (RVAL + ROFF)*ESLO + EGUL

EGU Engineering Units

An ASCII string of up to 16 characters describing the engineering units. This field is not used by record support other than to supply a units description string when get_units is called.

HOPR High Operating Range
LOPR Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double.

AOFF Adjustment Offset
ASLO Adjustment Slope

These fields are adjustment parameters for the raw input values. They are applied to the raw data value returned by the device support routine before any other conversions are performed.

SMOO Smoothing Factor

The converted data value is subjected to the following algorithm:

val = newvalue * (1 – smoo) + oldvalue * smoo

SMOO should have a value between 0 and 1, with 0 meaning no smoothing and 1 meaning ultimate smoothing (in fact, the data value will never change).

HIHI Hihi Alarm Limit
HIGH High Alarm Limit
LOW Low Alarm Limit
LOLO Lolo Alarm Limit
HHSV Hihi Alarm Severity
HSV High Alarm Severity
LSV Low Alarm Severity
LLSV Lolo Alarm Severity

These fields specify the alarm limits and severities.

HYST Alarm Deadband
ADEL Archive Deadband
MDEL Monitor, i.e. value change, Deadband

These parameters specify hysteresis factors for triggering monitors by a call to db_post_event or monitor callbacks, i.e. callbacks specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.

LALM Value when last monitors for alarm were triggered
ALST Value when last monitors for archiver were triggered
MLST Value when last monitors for value changes were triggered

These fields are used to implement the hysteresis factors for monitor callbacks.

INIT Initialize

This field is used by record support to perform initialization for LBRK and for smoothing.

LBRK Last Breakpoint

Index of last breakpoint interval. LBRK is used to perform conversions via breakpoint tables.

PBRK Address of Breakpoint Table

PBRK is used to perform conversions via breakpoint tables.

RVAL Raw Value

RVAL is the raw data value obtained by the device support routine. Unless the device support routine returns value requests that no conversion should be performed, the record support routine converts this value to engineering units.

ORAW Old Raw Value

ORAW is used to decide if monitors should be triggered for RVAL at the same time monitors are triggered for changes in VAL.

4.3 Record Support Routines

init_record This routine initializes SIMM with the value of SIML if SIML type is CONSTANT link or creates a channel access link if SIML type is

PV_LINK. SVAL is likewise initialized if SIOL is CONSTANT or PV_LINK. This routine next checks to see that device support is available and a device support read_ai routine is defined. If either does not exist, an error message is issued and processing is terminated. INIT is then set to TRUE. If device support includes init_record, it is called.

process See next section.

special The only special processing for analog input records is SPC_LINCONV. which is invoked whenever any of the fields LINR, EGUF, EGUL or ROFF is changed. If the device support routine special_linconv exists, it is called. In addition INIT is set True. This causes PBRK, LBRK, and smoothing to be reinitialized.

get_value Fills in the values of the structure valueDes so that they refer to VAL.

get_units Retrieves EGU.

get_precision Retrieves PREC.

get_graphic_double Sets the upper display and lower display limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double Sets the upper control and the lower control limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_alarm_double Sets the following values:

upper_alarm_limit = HIHI
upper_warning_limit = HIGH
lower_warning_limit = LOW
lower_alarm_limit = LOLO

4.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 ReadValue is called. See Simulation Mode described in Fields Common to Many Record Types for details.

3 If PACT has been changed to True, the device support read routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving PACT True.

4 PACT is then set to True, TIME is set to tslocaltime and the return status value of readValue is checked. Convert is called only if status is 0. If status is 2, then convert is not called, but status is reset to 0.

5 convert (if necessary)

The new raw data value is expected to be in field RVAL. The first step is to set val equal to RVAL + ROFF. The next step is to adjust the raw value via the equation:

val = val* ASLO + AOFF

If the conversion algorithm is linear, the raw value is converted via the equation:

val = val * ESLO + EGUL

If the conversion is via a breakpoint table, the new value is obtained.

The next step is to apply the following smoothing algorithm:

if SMOO equal to 0. or INIT is True, VAL = val
else VAL = val * (1 – SMOO) + Previous_value * SMOO

Since VAL is now defined, the last step is to set UDF to False.

6 Check alarms

This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set. It also honors the alarm hysteresis factor (HYST). Thus the value must change by more than HYST before the alarm status and severity is lowered.

7 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if ADEL and MDEL conditions are met. Monitors for RVAL are checked whenever other monitors are invoked. NSEV and NSTA are reset to 0.

8 Scans forward link if necessary, sets PACT and INIT to False, and returns.

4.5 Device Support

4.5.1 Fields of interest to device support

Each analog input record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new raw analog input value whenever read_ai is called. The device support routines are primarily interested in the following fields:

PACT, DPVT, UDF See Chapter titled Fields Common to All Record Types for description.

VAL Value. This field is used by device support only if it obtains a value already converted to engineering units. See RVAL below..

INP Input Link. This field is used by the device support routines to locate its input.

EGUF,EGUL Engineering Units Full and Engineering Units Low. These fields are used to calculate ESLO. Note that these fields correspond to the high and low hardware limits.

ESLO,ROFF Slope and Raw Offset. These fields are used for linear conversions from raw to engineering units. The device support routines must calculate these fields unless they obtain values already in engineering units.

RVAL Raw Value. It is the responsibility of the device support routine to give this field a value. If the device support routine obtains a value already in engineering units, it should place the value in VAL and return a value of 2.

NSEV,NSTA See Chapter titled Fields Common to All Record Types for description.

4.5.2 Device Support routines

Device support consists of the following routines:

report(FILE fp, paddr)

Not currently used.

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

read_ai(precord)

This routine must provide a new input value. Asynchronous device support routines will return with PACT set to True. If PACT is True, the process routine will just return and not continue processing. When the asynchronous routine completes, it can call process which will again call read_ai. Because PACT is still True read_ai knows that this is a request to retrieve the data obtained by the previous call. When finished, read_ai should set PACT to False and return one the following values:

0	Success. A new raw value is placed in RVAL. Convert will be called.
2	Success, but don't call convert. This is useful if read_ai obtains a value already converted to engineering units or in the event a hardware failure is detected.
other	Error.

special_linconv(precord,after)

This routine is called whenever any of the fields LINR, EGUF, EGUL or ROFF is modified.

4.6 Device support for soft records

Two soft device support modules Soft Channel and Raw Soft Channel are provided for for input records not related to actual hardware devices. The INP link type must be either CONSTANT, DB_LINK, or CA_LINK.

Soft Channel

This module places a value directly in VAL. Read_ai always returns a value of 2, which means that no conversion will ever be attempted.

If the INP link type is constant, then the constant value is stored into VAL by init_record, and UDF is set to False. If the INP link type is PV_LINK, then dbCaAddInlink is called by init_record.

Read_ai calls recGblGetLinkValue to read the current value of VAL. See Soft Input in Fields Common to Many Record Types for details.

If the return status of recGblGetLinkValue is zero, then read_ai sets UDF to False. The status of recGblGetLinkValue is returned.

If soft support is chosen, the following fields become meaningless: LINR, EGUF, EGUL, ESLO, ROFF, AOFF, ASLO, and SMOO. The read_ai routine always returns a value of 2 which means don't convert.

Raw Soft Channel

This module is like the previous except that it places its value in RVAL and read_ai returns a value of 0. Thus the record processing routine will convert the raw value in the normal way.

If raw soft support is chosen, the fields EGUF and EGUL become meaningless. ESLO and ROFF always have their default values of 1 and 0.

CHAPTER 5 Ao – Analog Output

The normal use for this record type is to store values to be sent to Digital to Analog Converters. It can also be used to write values to other records via database or channel access links. The OUT field determines how the record is used. The record supports alarm limits, conversion from/to engineering units, and graphics and control limits.

5.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	DOUBLE	No	0	0	Yes	Yes	Yes	Yes
OVAL	DOUBLE	No	0	0	Yes	No	Yes	
OUT	OUTLINK	Yes	1	0	No			
OROC	FLOAT	Yes	1	0	Yes	Yes	No	No
DOL	INLINK	Yes	1	0	No			
OMSL	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
OIF	RECCHOICE	Yes	1	0	Yes	Yes	No	No
PREC	SHORT	Yes	1	0	Yes	Yes	No	No
LINR	CVTCHOICE	Yes	1	0	Yes	Yes	No	Yes
EGUF	FLOAT	Yes	1	0	Yes	Yes	No	Yes
EGUL	FLOAT	Yes	1	0	Yes	Yes	No	Yes
EGU	STRING	Yes	1	null	Yes	Yes	No	No
ESLO	DOUBLE	No	2	1	Yes	No	No	
ROFF	LONG	No	2	0	Yes	Yes	No	Yes
DRVH	FLOAT	Yes	1	0	Yes	Yes	No	Yes
DRVL	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
LOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
HIHI	FLOAT	Yes	1	0	Yes	Yes	No	Yes
LOLO	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HIGH	FLOAT	Yes	1	0	Yes	Yes	No	Yes
LOW	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HHSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LLSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HYST	DOUBLE	Yes	1	0	Yes	Yes	No	No
ADEL	DOUBLE	Yes	1	0	Yes	Yes	No	No
MDEL	DOUBLE	Yes	1	0	Yes	Yes	No	No
RVAL	LONG	No	0	0	Yes	Yes	Yes	Yes
ORAW	LONG	No	3	0	Yes	No	No	
RBV	LONG	No	0	0	Yes	No	Yes	
ORBV	LONG	No	3	0	Yes	No	No	
PVAL	DOUBLE	No	3	0	Yes	No	No	
LALM	DOUBLE	No	3	0	Yes	No	No	
ALST	DOUBLE	No	3	0	Yes	No	No	

MLST	DOUBLE	No	3	0	Yes	No	No	
PBRK	NOACCESS	No	4					
INIT	SHORT	No	3	0	Yes	No	No	
LBRK	SHORT	No	3	0	Yes	No	No	
SIOL	INLINK	Yes	1	0	No			
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
IVOA	GBLCHOICE	Yes	2	0	Yes	Yes	No	No
IVOV	DOUBLE	Yes	2	0	Yes	Yes	No	No

5.2 Field Descriptions

VAL Value

This is the desired output value, in engineering units. If DRVH and DRVL are defined, VAL is forced to be within the drive limits. VAL is either obtained from DOL or set via dbPuts.

OVAL Output Value

This is the desired output value, after adjustments, in engineering units. It is just VAL possibly adjusted by OROC. This is the value used to compute RVAL. OVAL is used to enforce a maximum rate of change limit before converting the desired value to a raw value. If soft device support is selected and OUT is a database or channel access link, this is the value written to the link.

OUT Output Link

This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.

OROC Maximum Output Rate of Change

If this is not zero, it specifies the maximum change in value (engineering units) to be sent to OUT each time the record is processed. It is this field that can cause VAL and OVAL to differ.

DOL Desired Output Location (an Input Link)

If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL. After the check for drive limits, VAL will be set to the value determined by DOL.

OMSL Output Mode Select

This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts.

OIF Out Full or Incremental

This field, which is only used when input is obtained from DOL, determines if the value obtained from DOL is an increment to add to the current VAL or is the actual VAL desired.

PREC Display Precision

Precision with which to display VAL. This field is not used by record support other than to supply a value when get_precision is called.

LINR Conversion type

NO_CONVERSION, LINEAR and breakpoint table conversion are supported.

EGUF Engineering Units Full
EGUL Engineering Units Low
ESLO Slope for linear conversions
ROFF Raw value offset

These fields are used to perform linear conversions. It is the responsibility of the device support routines to use EGUF and EGUL to compute ESLO and ROFF. EGUF and EGUL must be set by the user to the engineering units corresponding to the high and low ADC limits. For example if the DAC has a range of –10 to +10 Volts, then EGUF must be the engineering units value corresponding to 10 volts and EGUL to –10 volts. If a linear conversion is specified ESLO, ROFF, and EGUL are used to convert the value from/to engineering units using the following formula:

$$RVAL = (OVAL - EGUL)/ESLO - ROFF$$

EGU Engineering Units

ASCII string describing Engineering units. This field is not used by record support other than to supply a units description string when get_units is called.

DRVH	Drive High
DRVL	Drive Low

If these values are defined then VAL will forced to be in the range DRVL<=VAL<=DRVH

HOPR	High Operating Range
LOPR	Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double. If these values are defined, they must be in the range DRVL<=LOPR<=HOPR<=DRVH.

HIHI	Hihi Alarm Limit
HIGH	High Alarm Limit
LOW	Low Alarm Limit
LOLO	Lolo Alarm Limit
HHSV	Severity for a Hihi Alarm
HSV	Severity for a High Alarm
LSV	Severity for a Low Alarm
LLSV	Severity for a Lolo Alarm

These fields specify the alarm limits and severities.

HYST	Alarm Deadband
ADEL	Archive Deadband
MDEL	Monitor, i.e. value change, Deadband

These parameters specify hysteresis factors for triggering monitor callbacks, i.e. callbacks specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.

RVAL	Raw Data Value

RVAL is the value actually sent to the device.

ORAW	Old raw data value. ORAW is used to decide if monitors should be triggered for RVAL.

RBV	Read Back Value

This is the actual read back value obtained from the hardware itself or from the associated device driver. It is the responsibility of the device support routine to give this field a value.

ORBV Old read back value. ORBV is used to decide if monitors should be triggered for RBV at the same time monitors are triggered for changes in VAL.

PVAL Previous Data Value.

LALM Value when last monitors for alarm were triggered
ALST Value when last monitors for archiver were triggered
MLST Value when last monitors for value changes were triggered

These fields are used to implement the hysteresis factors for monitors.

INIT Initialize

This field is used by record support to perform initialization for LBRK and for smoothing.

LBRK Last Breakpoint

Index of last breakpoint interval

PBRK Breakpoint Pointer

Address of breakpoint table

5.3 Record Support Routines

init_record This routine initializes SIMM if SIML is a constant or creates a channel access link if SIML is PV_LINK. If SIOL is PV_LINK a channel access link is created . This routine next checks to see that device support is available. If DOL is a constant, then VAL is initialized with its value and UDF is set to False. The routine next checks to see if the device support write routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated. If device support includes init_record, it is called. In addition, INIT is set True. This causes PBRK, LBRK, and smoothing to be reinitialized. If linear conversion is requested, then VAL is computed from RVAL using the algorithm:

VAL=(RVAL+ROFF)/ESLO+EGUL

and UDF is set to False. For breakpoint conversion, a call is made to cvtEngToRawBpt and UDF is then set to False. PVAL is set to VAL.

process — See next section.

special — The only special processing for analog output records is SPC_LINCONV. which is invoked whenever either of the fields LINR, EGUF, EGUL or ROFF is changed. If the device support routine special_linconv exists it is called. In addition INIT is set True. This causes PBRK, LBRK, and smoothing to be reinitialized.

get_value — Fills in the values of struct valueDes so that they refer to VAL.

get_units — Retrieves EGU.

get_precision — Retrieves PREC.

get_graphic_double — Sets the upper display and lower display limits for the field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double — Sets the upper display and lower control limits for the field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_alarm_double — Sets the following values:

upper_alarm_limit = hihi
upper_warning_limit = high
lower_warning_limit = low
lower_alarm_limit = lolo

5.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field set to

True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 check PACT

If PACT is False call fetch_values and convert which perform the following steps:

fetch_values:
if DOL is DB_LINK and OMSL is CLOSED_LOOP get value from DOL
if OIF is INCREMENTAL then set value = value + VAL
else value = VAL

convert:
If Drive limits are defined force value to be within limits
Set VAL equal to value
Set UDF to False.
If OVAL is undefined set it equal to value
If OROC is defined and not 0 make |value–OVAL| <=OROC
set OVAL equal to value
Compute RVAL from OVAL. using linear or break point table conversion. For linear conversions the algorithm is:

RVAL = (OVAL–EGUL)/ESLO –ROFF

For break point table conversion a call is made to cvtEngToRawBpt.

3 Check alarms

This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set. It also honors the alarm hysteresis factor (hyst). Thus the value must change by at least hyst before the alarm status and severity is reduced.

4 Check severity and write the new value. See Invalid Alarm Output Action and Simulation Mode described in Fields Common to Many Record Types for details.

5 If PACT has been changed to True, the device support write output routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving PACT True.

6 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if ADEL and MDEL conditions are met. Monitors for RVAL and for RBV are checked whenever other monitors are invoked. NSEV and NSTA are reset to 0.

7 Scan forward link if necessary, sets PACT and INIT False, and returns.

5.5 Device Support

5.5.1 Fields of interest to device support

Each analog output record must have an associated set of device support routines. The primary responsibility of the device support routines is to output a new value whenever write_ao is called. The device support routines are primarily interested in the following fields:

PACT, DPVT See Chapter titled Fields Common to All Record Types for description.

OUT This field is used by the device support routines to locate its output.

EGUF,EGUL These fields are used to calculate ESLO. Note that these fields correspond to the high and low hardware limits.

ESLO,ROFF Slope and raw value offset for linear conversions from raw to engineering units. The device support routines must calculate this field unless they obtain values already converted to engineering units.

RVAL Raw data value. This is the value to write to OUT.

NSEV,NSTA See Chapter titled Fields Common to All Record Types for description.

5.5.2 Device Support routines

Device support consists of the following routines:

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine. It returns a zero for success or a 2 for success, don't convert.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

write_ao(precord)

This routine must output a new value. It returns one of the following values:

This routine must output a new value. Asynchronous device support routines will return with PACT set to True. If PACT is True, the process routine will just return and not continue processing. When the asynchronous routine completes, it can call process which will again call write_ao. When finished, write_ao should set PACT to False and return one the following values:

0	Success.
other	Error.

special_linconv(precord,after)

This routine is called whenever either of the fields LINR, EGUF, EGUL or ROFF is modified.

5.6 Device support for soft records

Two soft device support modules Soft Channel and Raw Soft Channel are provided for for output records not related to actual hardware devices. The OUT link type must be either a CONSTANT, DB_LINK, or CA_LINK.

Soft Channel

This module writes the current value of OVAL.

If the OUT link type is PV_LINK, then dbCaAddInlink is called by init_record. Init_record always returns a value of 2, which means that no conversion will ever be attempted.

Write_ao calls recGblPutLinkValue to write the current value of VAL. See Soft Output in Fields Common to Many Record Types for details.

Raw Soft Channel

This module is like the previous except that it writes the current value of RVAL.

CHAPTER 6 Bi – Binary Input

The normal use for this record type is to obtain a binary value, i.e. a value that is 0 or 1. Most device support modules obtain values from hardware and place the value in RVAL. For these devices record processing sets VAL = (0,1) if RVAL is (0, not 0). Devices may optionally read a value directly into VAL. Soft device modules are provided to obtain input via database or channel access links or via dbPutField or dbPutLink requests. Two soft device support modules are provided. One allows VAL to be an arbitrary unsigned short integer. The other reads the value into RVAL just like normal hardware modules.

6.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	ENUM	No	0	0	Yes	Yes	Yes	Yes
INP	INLINK	Yes	1	0	No			
ZSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
OSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
COSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
ZNAM	STRING	Yes	1	null	Yes	Yes	No	Yes
ONAM	STRING	Yes	1	null	Yes	Yes	No	Yes
RVAL	ULONG	No	0	0	Yes	Yes	Yes	Yes
ORAW	ULONG	No	3	0	Yes	No	No	No
MASK	ULONG	No	1	compute	Yes	No	No	No
LALM	USHORT	No	3	0	Yes	No	No	No
MLST	USHORT	No	3	0	Yes	No	No	No
SIOL	INLINK	Yes	1	0	No			
SVAL	USHORT	No	0	0	Yes	Yes	No	No
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No

6.2 Field Descriptions

VAL Value Field

This is the value resulting from record processing unless Soft device support with a constant INP is chosen. If the later is chosen, VAL, which is an unsigned short, is given values via dbPuts.

INP Input Link

This field is used by the device support routines to obtain input. For soft records, it can be a constant, a database link, or a channel access link.

ZSV Zero Severity

Alarm Severity for state zero.

OSV One Severity

Alarm Severity for state one.

COSV Change of State Severity

Alarm Severity for change of state.

ZNAM Zero Name

ASCII string defining state zero.

ONAM One Name

ASCII string defining state one.

RVAL Raw Value

RVAL is the value obtained by the device support routine.

ORAW Old Raw Value

ORAW is used to decide if monitors should be triggered for RVAL at the same time monitors are triggered for changes in VAL.

MASK Hardware mask.

LALM Last Alarmed Value

Value when last change of state alarm was issued.

MLST Last Monitored Value

Value when last monitor for value changes was triggered

6.3 Record Support Routines

init_record This routine initializes SIMM with the value of SIML if SIML type is CONSTANT link or creates a channel access link if SIML type is PV_LINK. SVAL is likewise initialized if SIOL is CONSTANT or

PV_LINK. This routine next checks to see that device support is available and a device support read routine is defined. If either does not exist, an error message is issued and processing is terminated. If device support includes init_record, it is called.

process See next section.

get_value Fills in the values of struct valueDes so that they refer to VAL.

get_enum_str Retrieves ASCII string corresponding to VAL

get_enum_strs Retrieves ASCII strings for ZNAM and ONAM.

put_enum_str Checks if string matches ZNAM or ONAM, and if it does, sets VAL.

6.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 ReadValue is called. See Simulation Mode described in Fields Common to Many Record Types for details.

3 If PACT has been changed to True, the device support read routine has started but has not completed reading a new input value. In this case, the processing routine merely returns, leaving PACT True.

4 Convert

status=read_bi
PACT = True

TIME = tslocaltime
if status is 0, then set VAL=(0,1) if RVAL is (0, not 0) and UDF = False
if status is 2, set status = 0

5 Check alarms

This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV and NSTA and LALM are set. Note that if VAL is greater than 1, no checking is performed.

6 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if MLST is not equal to VAL. Monitors

for RVAL are checked whenever other monitors are invoked. NSEV and NSTA are reset to 0.

7 Scans forward link, if necessary, sets PACT False, and returns.

6.5 Device Support

6.5.1 Fields of interest to device support

Each input record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new raw input value whenever read_bi is called. The device support routines are primarily interested in the following fields:

PACT, DPVT, UDF See Chapter titled Fields Common to All Record Types for description.

VAL This field is set by a device support routines only if it doesn't want record support to set it.

INP This field is used by the device support routines to locate its input.

RVAL Raw data value. It is the responsibility of the device support routine to give this field a value.

MASK The device support routine must give this field a value it it needs to use it.

NSEV,NSTA See Chapter titled Fields Common to All Record Types for description.

6.5.2 Device Support routines

Device support consists of the following routines:

report(FILE fp, paddr)

Not currently used.

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

read_bi(precord)

This routine must provide a new input value. It returns the following values:

0	Success. A new raw value is placed in RVAL. The record support module forces VAL to be (0,1) if RVAL is (0, not 0).
2	Success, but don't modify VAL.
other	Error.

6.6 Device support for soft records

Two soft device support modules Soft Channel and Raw Soft Channel are provided for for input records not related to actual hardware devices. The INP link type must be either CONSTANT, DB_LINK, or CA_LINK.

Soft Channel

Read_bi always returns a value of 2, which means that no conversion is performed.

If the INP link type is constant, then the constant value is stored into VAL by init_record, and UDF is set to False. VAL can be changed via dbPut requests. If the INP link type is PV_LINK, then dbCaAddInlink is called by init_record.

Read_bi calls recGblGetLinkValue to read the current value of VAL. See Soft Input in Fields Common to Many Record Types for details.

If the return status of recGblGetLinkValue is zero, then read_bi sets UDF to False. The status of recGblGetLinkValue is returned.

Raw Soft Channel

This module is like the previous except that values are read into RVAL. Read_bi returns a value of 0. Thus the record processing routine will force VAL to be 0 or 1.

CHAPTER 7 Bo – Binary Output

The normal use for this record type is to store a binary (0 or 1) value to be sent to a Digital Output module. It can also be used to write binary values into other records via database or channel access links.

7.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	ENUM	No	0	0	Yes	Yes	Yes	Yes
OMSL	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
OUT	OUTLINK	Yes	1	0	No			
DOL	INLINK	Yes	1	0	No			
HIGH	FLOAT	Yes	1	0	Yes	Yes	No	No
ZNAM	STRING	Yes	1	null	Yes	Yes	No	Yes
ONAM	STRING	Yes	1	null	Yes	Yes	No	Yes
RVAL	ULONG	No	0	0	Yes	Yes	Yes	Yes
ORAW	ULONG	No	3	0	Yes	No	No	
MASK	ULONG	No	1	compute	Yes	No	No	
WDPT	NOACCESS	No	4	compute	No			
ZSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
OSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
COSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
RBV	ULONG	No	0	0	Yes	No	Yes	
ORBV	ULONG	No	3	0	Yes	No	No	
MLST	USHORT	No	3	0	Yes	No	No	
LALM	USHORT	No	3	0	Yes	No	No	
SIOL	INLINK	Yes	1	0	No			
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
IVOA	GBLCHOICE	Yes	2	0	Yes	Yes	No	No
IVOV	DOUBLE	Yes	2	0	Yes	Yes	No	No

7.2 Field Descriptions

VAL Value Field

This is the value to be sent to OUT. It is either obtained from DOL or else given a value via dbPuts.

OMSL Output Mode Select

This field has either the value SUPERVISORY or CLOSED_LOOP. DOL

is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts.

DOL Desired Output Location (an Input Link)

If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from from DOL.

OUT Output Link

This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.

HIGH Seconds to Hold High

If this value is greater than zero, then whenever VAL is set equal to 1, it is reset to zero after HIGH seconds.

ZNAM Zero Name

ASCII string defining state zero.

ONAM One Name

ASCII string defining state one.

RVAL Raw Data Value

RVAL is the value written by the device support routine. If MASK is set by the device support routine, RVAL is computed by record support.

ORAW Old Raw Data Value

ORAW is used to decide if monitors should be triggered for RVAL at the same time monitors are triggered for changes in VAL.

MASK Hardware Mask

This value can be set by the device support routine. It is the value sent to the hardware when VAL is not zero.

WDPT Watchdog Pointer

Private field for honoring second to hold HIGH.

ZSV Zero Severity

Alarm Severity for state zero.

OSV One Severity

Alarm Severity for state one.

COSV Change of State Severity

Alarm Severity for change of state.

RBV Read Back Value

This is the actual read back value obtained from the hardware itself or from the associated device driver. It is the responsibility of the device support routine to give this field a value.

ORBV Old Read Back Value

ORBV is used to decide if monitors should be triggered for RBV at the same time monitors are triggered for changes in VAL.

MLST Monitor Last

Value when last monitor for value changes was triggered

LALM Last Alarmed

Value when last change of state alarm was issued.

7.3 Record Support Routines

init_record This routine initializes SIMM if SIML is a constant or creates a channel access link if SIML is PV_LINK. If SIOL is PV_LINK a channel access link is created .

This routine next checks to see that device support is available.The routine next checks to see if the device support write routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated.

If DOL is a constant, then VAL is initialized to 1 if its value is nonzero or initialized to 0 if DOL is zero, and UDF is set to False.

If device support includes init_record, it is called. VAL is set using RVAL, and UDF is set to False.

process — See next section.

get_value — Fills in the values of struct valueDes so that they refer to VAL.

get_enum_str — Retrieves ASCII string corresponding to VAL

get_enum_strs — Retrieves ASCII strings for ZNAM and ONAM.

put_enum_str — Checks if string matches ZNAM or ONAM, and if it does, sets VAL.

7.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 If PACT is False

```
if DOL is DB_LINK and OMSL is CLOSED_LOOP
        get value from DOL
        check for link alarm
        force VAL to be 0 or 1
if mask is defined
        if VAL is 0 set RVAL = 0
        else set RVAL = MASK
```

3 Check alarms

This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set.

4 Check severity and write the new value. See Invalid Alarm Output Action and Simulation Mode described in Fields Common to Many Record Types for details.

5 If PACT has been changed to True, the device support write output routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving PACT True.

6 Check WAIT.

If VAL is 1 and WAIT is greater than 0, process again with a VAL=0 after WAIT seconds.

7 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if MLST is not equal to VAL. Monitors for RVAL and for RBV are checked whenever other monitors are invoked. NSEV and NSTA are reset to 0.

8 Scans forward link if necessary, sets PACT False, and returns.

7.5 Device Support

7.5.1 Fields of interest to device support

Each binary output record must have an associated set of device support routines. The primary responsibility of the device support routines is to write a new value whenever write_bo is called. The device support routines are primarily interested in the following fields:

PACT, DPVT See Chapter titled Fields Common to All Record Types for description.

VAL This field is only of interest to device support routines that do not use MASK and RVAL.

OUT This field is used by the device support routines to locate its output.

RVAL Raw data value. If MASK is defined then record support sets RVAL=(0,MASK) if VAL is (0, not zero).

MASK Hardware mask. The device support module must set this field. Not that if VAL is 1, then record processing sets RVAL = MASK.

RBV Read Back Value. This is the actual read back value obtained from the hardware itself or from the associated device driver. It is the responsibility of the device support routine to give this field a value.

NSEV,NSTA See Chapter titled Fields Common to All Record Types for description.

7.5.2 Device Support routines

Device support consists of the following routines:

report(FILE fp, paddr)

Not currently used.

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine. It should determine MASK if it is needed.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

write_bo(precord)

This routine must output an new value. It returns the following values:

0	Success.
other	Error.

7.6 Device support for soft records

Two soft device support modules Soft Channel and Raw Soft Channel are provided for for output records not related to actual hardware devices. The OUT link type must be either a CONSTANT, DB_LINK, or CA_LINK.

Soft Channel

This module writes the current value of VAL.

If the OUT link type is PV_LINK, then dbCaAddInlink is called by init_record. Init_record always returns a value of 2, which means that no conversion will ever be attempted.

Write_bo calls recGblPutLinkValue to write the current value of VAL. See Soft Output in Fields Common to Many Record Types for details.

Raw Soft Channel

This module is like the previous except that it writes the current value of RVAL.

CHAPTER 8 Calculation

This record calculates an expression.

8.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	DOUBLE	No	0	0	Yes	Yes	Yes	No
CALC	STRING	Yes	0	null	Yes	Yes	Yes	Yes
INPA	INLINK	Yes	1	0	No			
INPB	INLINK	Yes	1	0	No			
INPC	INLINK	Yes	1	0	No			
INPD	INLINK	Yes	1	0	No			
INPE	INLINK	Yes	1	0	No			
INPF	INLINK	Yes	1	0	No			
INPG	INLINK	Yes	1	0	No			
INPH	INLINK	Yes	1	0	No			
INPI	INLINK	Yes	1	0	No			
INPJ	INLINK	Yes	1	0	No			
INPK	INLINK	Yes	1	0	No			
INPL	INLINK	Yes	1	0	No			
A	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
B	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
C	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
D	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
E	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
F	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
G	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
H	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
I	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
J	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
K	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
L	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
LA	DOUBLE	No	3	0	Yes	No	No	
LB	DOUBLE	No	3	0	Yes	No	No	
LC	DOUBLE	No	3	0	Yes	No	No	
LD	DOUBLE	No	3	0	Yes	No	No	
LE	DOUBLE	No	3	0	Yes	No	No	
LF	DOUBLE	No	3	0	Yes	No	No	
LG	DOUBLE	No	3	0	Yes	No	No	
LH	DOUBLE	No	3	0	Yes	No	No	
LI	DOUBLE	No	3	0	Yes	No	No	
LJ	DOUBLE	No	3	0	Yes	No	No	
LK	DOUBLE	No	3	0	Yes	No	No	
LL	DOUBLE	No	3	0	Yes	No	No	
EGU	STRING	Yes	1	null	Yes	Yes	No	No

PREC	SHORT	Yes	1	0	Yes	Yes	No	No
HOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
LOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
HIHI	FLOAT	Yes	1	0	Yes	Yes	No	Yes
LOLO	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HIGH	FLOAT	Yes	1	0	Yes	Yes	No	Yes
LOW	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HHSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LLSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HYST	DOUBLE	Yes	1	0	Yes	Yes	No	No
ADEL	DOUBLE	Yes	1	0	Yes	Yes	No	No
MDEL	DOUBLE	Yes	1	0	Yes	Yes	No	No
LALM	DOUBLE	No	3	0	Yes	No	No	
ALST	DOUBLE	No	3	0	Yes	No	No	
MLST	DOUBLE	No	3	0	Yes	No	No	
RPCL	NOACCESS	No	4					

8.2 Field Descriptions

VAL Value Field

This field is calculated, via the CALC expression, each time the record is processed.

CALC Infix expression

See below for details

INPA,...,INPL Input Links.

Each may be a constant, a database link, or a channel access link. Any link not defined is ignored.

A,...,L Input Values

If the corresponding INP field is a constant, this field is initialized with the constant value but can be changed via dbPuts.

LA,...,LL Previous Input Values

These fields are used to decide when to trigger monitors on A,...,L.

EGU Engineering Units

A 16 character ASCII string describing Engineering units. This field is not used by record support other than to supply a units description string when get_units is called.

PREC Display Precision

Precision with which to display VAL. This field is not used by record support other than to supply a value when get_precision is called.

HOPR High Operating Range
LOPR Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double.

HIHI Hihi Alarm Limit
HIGH High Alarm Limit
LOW Low Alarm Limit
LOLO Lolo Alarm Limit
HHSV Severity for a Hihi Alarm
HSV Severity for a High Alarm
LSV Severity for a Low Alarm
LLSV Severity for a Lolo Alarm

These fields specify the alarm limits and severities.

HYST Alarm Deadband
ADEL Archive Deadband
MDEL Monitor, i.e. value change, Deadband

These parameters specify hysteresis factors for triggering monitor callbacks, i.e. monitors specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.

LALM Last Alarmed Value when last monitors for alarm were triggered
ALST Archive Last Value when last monitors for archiver were triggered
MLST Monitor Last Value when last monitors for value changes were triggered

These fields are used to implement the hysteresis factors for monitors.

RPCL Expression in reverse polish.

8.3 Record Support Routines

init_record For each constant input link, the corresponding value field is initialized with the constant value if the input link is CONSTANT or a channel ac-

cess link is created if the input link is PV_LINK. A routine postfix is called to convert the infix expression in CALC to reverse polish notation. The result is stored in RPCL.

process See next section.

special This is called if CALC is changed. Special calls postfix.

get_value Fills in the values of struct valueDes so that they refer to VAL.

get_units Retrieves EGU.

get_precision Retrieves PREC.

get_graphic_double Sets the upper display and lower display limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double Sets the upper control and the lower control limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_alarm_double Sets the following values:

upper_alarm_limit = hihi
upper_warning_limit = high
lower_warning_limit = low
lower_alarm_limit = lolo

8.4 Record Processing

Routine process implements the following algorithm:

1 Fetches all arguments.

2 Calls routine calcPerform, which calculates VAL from the postfix version of the expression given in CALC. If calcPerform returns success UDF is set to False.

3 Check alarms. This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set. It also honors the alarm hysteresis factor (hyst). Thus the value must change by at least hyst before the alarm status and severity changes.

4 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if ADEL and MDEL conditions are met. Monitors for A–L are checked whenever other monitors are invoked. NSEV and NSTA are reset to 0.

5 Scans forward link if necessary, sets PACT False, and returns.

8.5 Allowed Expressions

The calculation can express algebraic, relational, and logical expressions. The expression is converted to opcode and stored as reverse polish notation in the calculation record. The database fields are as follows:

CALC	infix expression as entered
RPCL	reverse polish expression

The reverse polish calculation is most efficient to evaluate during run–time. The range of expressions supported by the calculation record are separated into operands, algebraic operations, trigonometric, relational operations, logical operations, parenthesis, and the question mark operator.

8.5.1 Operands

A	Use the value specified by input A
B	Use the value specified by input B
C	Use the value specified by input C
D	Use the value specified by input D
E	Use the value specified by input E
F	Use the value specified by input F
G	Use the value specified by input G
H	Use the value specified by input H
I	Use the value specified by input I
J	Use the value specified by input J
K	Use the value specified by input K
L	Use the value specified by input L
RNDM	Random number (unary), random number between 0–1.

8.5.2 Algebraic Operators

ABS	Absolute value (unary)
SQR	Square root (unary)
MIN	Minimum (binary function)
MAX	Maximum (binary function)
CEIL	Ceiling (unary)
FLOOR	Floor (unary)
LOG	Log base 10 (unary)
LOGE	Natural log (unary)
EXP	Exponential function (unary)
^	Exponential (binary)

**	Exponential (binary)
+	Addition (binary)
–	Subtraction (binary)
*	Multiplication (binary)
/	Division (binary)
%	Modulo (binary)
NOT	Negate (unary)

8.5.3 Trigonometric Operators

SIN	Sine
SINH	Hyperbolic sine
ASIN	Arc sine
COS	Cosine
COSH	Hyperbolic cosine
ACOS	Arc cosine
TAN	Tangent
TANH	Hyperbolic tangent
ATAN	Arc tangent

8.5.4 Relational Operators

>=	Greater than or equal to
>	Greater than
<=	Less than or equal to
<	Less than
#	Not equal to
=	Equal to

8.5.5 Logical Operators

&&	And
||	Or
!	Not

8.5.6 Bitwise Operators

|	Bitwise or
&	Bitwise and
OR	Bitwise or
AND	Bitwise and
XOR	Bitwise exclusive or
~	One‘s complement
<<	Left shift
>>	Right shift

8.5.7 Parenthesis and Comma

The open and close parenthesis are supported. Nested parenthesis are supported. The comma is supported when used to separate the arguments of a binary function.

8.5.8 Conditional Expression

The ”C” question mark operator is supported. The format is:

(condition)? True result : False result.

8.6 Example Expressions

Algebraic	A + B	Result is A + B
Relational	(A + B) < (C + D)	Result is 1 if (A+B) < (C+D) Result is 0 if (A+B) >= (C+D)
Question Mark	(A+B)<(C+D)?E:F	Result is E if (A+B) < (C+D) Result is F if (A+B) >= (C+D)
	(A+B)<(C+D)?E	Result is E if (A+B) < (C+D) Result is unchanged if (A+B) >= (C+D)
Logical	A&B	Causes the following to occur: Convert A to integer Convert B to integer Bit–wise and A and B Convert result to floating point

CHAPTER 9 Compress

The VAL field of this record refers to an array of length NSAM. Unless INP is a database link, the compression algorithm is ignored. If, however, INP is a database link, then this record type supports several algorithms: CIRBUF, AVERAGE, NTO1LOW, NTO1HIGH, and NTO1AVE. Each must be discussed separately.

CIRBUF keeps a circular buffer of length NSAM. Each time the record is processed, it gets the data referenced by INP and puts it into the circular buffer referenced by VAL. Note that when INP refers to a scalar, VAL is just a time ordered circular buffer of values obtained from INP.

If AVERAGE is chosen then VAL refers to an array of length NSAM that contains an element by element time average of values taken from the array referenced by INP. N successive samples of INP are averaged in order to compute VAL.

If NTO1LOW, NTO1HIGH, or NTO1AVE are chosen, then VAL is a circular buffer of length NSAM. The actual algorithm depends on whether INP references a scalar or an array. If INP refers to a scalar, then N successive time ordered samples of INP are taken. After the Nth sample is obtained a new value, determined by the algorithm (LOW, HIGH, or AVE), is written to the circular buffer referenced by VAL. If INP refers to an array, then each time the record is processed, the array referenced by INP is obtained, divided into subarrays each of length N, and the algorithm applied to each subarray. The result obtained from each subarray is written to the circular buffer referenced by VAL.

9.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	DOUBLE	No	0	0	Yes	Yes	Yes	Yes
INP	INLINK	Yes	1	0	No			
RES	SHORT	No	3	0	Yes	Yes	No	No
ALG	RECCHOICE	Yes	1	0	Yes	No	No	
NSAM	ULONG	Yes	1	1	Yes	No	No	
N	ULONG	Yes	1	1	Yes	No	No	
ILIL	FLOAT	Yes	1	0	Yes	Yes	No	No
IHIL	FLOAT	Yes	1	0	Yes	Yes	No	No
HOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
LOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
PREC	SHORT	Yes	1	0	Yes	Yes	No	No
EGU	STRING	Yes	1	null	Yes	Yes	No	No
OFF	ULONG	No	0	0	Yes	No	No	
NUSE	ULONG	No	0	0	Yes	No	No	
BPTR	NOACCESS	No	4					
SPTR	NOACCESS	No	4					
WPTR	NOACCESS	No	4					
CVB	DOUBLE	No	3	0	Yes	No	No	
INX	ULONG	No	3	0	Yes	No	No	

9.2 Field Descriptions

VAL — Value Field

This field is determined as a result of record processing. It is a double precision array of length NSAM.

INP — Input Link.

INP can be a constant, a database link, or a channel access link. Unless it is a database link, ALG is meaningless.

RES — Reset

Setting this field causes the algorithm to start over from the beginning.

ALG — Algorithm

CIRBUF, AVERAGE, NTO1LOW, NTO1HIGH, or NTO1AVE.

NSAM — Number in Sample

Number of elements in VAL.

N — Number

Value of N for AVERAGE and NTO1xxx algorithms.

ILIL,IHIL — Initial low and high interest values. Applies to NTO1xxx applied to INP arrays.

HOPR — High Operating Range
LOPR — Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double.

PREC — Display Precision

Precision with which to display VAL. This field is not used by record support other than to supply a value when get_precision is called.

EGU — Engineering Units

ASCII string describing Engineering units. This field is not used by record support other than to supply a units description string when get_units is called.

OFF Current Offset.

NUSE Number Used

Number of elements currently stored.

BPTR Buffer Pointer (holds array referenced by VAL)

SPTR Summing Buffer Pointer for array averages.

WPTR Work Buffer Pointer for dbGetLinks.

CVB Compress Value Buffer

INX Current Index of 1,...,N.

9.3 Record Support Routines

init_record Space for all necessary arrays is allocated. The addresses are stored in the appropriate fields in the record.

process See next section.

special This routine is called when RSET is set. It performs a reset.

get_value Fills in the values of struct valueDes so that they refer to VAL.

cvt_dbaddr This is called by dbNameToAddr. It makes the dbAddr structure refer to the actual buffer holding the result.

get_array_info Obtains values from the circular buffer referenced by VAL.

put_array_info Writes values into the circular buffer referenced by VAL.

get_units Retrieves EGU.

get_precision Retrieves PREC.

get_graphic_double Sets the upper display and lower display limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR

and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double Sets the upper control and the lower control limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

9.4 Record Processing

Routine process implements the following algorithm:

1 If INP is not a database link just check monitors and the forward link and return.

2 Gets the current data referenced by INP

3 Perform the appropriate algorithm:

a AVERAGE

Read N successive instances of INP and perform an element by element average. Until N instances have been obtained it just return without checking monitors or the forward link. When N instances have been obtained complete the algorithm, store the result in the VAL array, check monitors and the forward link, and return.

b CIRBUF

Write the values obtained from INP into the VAL array as a circular buffer, checks monitors and the forward link, and return.

c NTO1xxx and INP refers to a scalar

Obtain N successive values from INP and apply the NTO1xxx algorithm to these values. Until N values are obtained monitors and forward links are not checked. When N successive values have been obtained, complete the algorithm, check monitors and the forward link, and return.

d NTO1xxx and INP refers to an array

The ILIL and IHIL are honored if ILIL<IHIL. The input array is divided into subarrays of length N. The specified NTO1xxx compression algorithm is applied to each subarray and the result stored in the array referenced by VAL. The monitors and forward link are checked.

4 If success, set UDF to False.

5 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. NSEV and NSTA are reset to 0.

6 Scans forward link if necessary, sets PACT False, and returns.

CHAPTER 10 Event

The normal use for this record type is to post an event and/or process a forward link. Device support for this record can provide a hardware interrupt handler routine for I/O Event scanned records.

10.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	SHORT	No	0	0	Yes	Yes	Yes	No
INP	INLINK	Yes	1	0	No			
SIOL	INLINK	Yes	1	0	No			
SVAL	USHORT	No	0	0	Yes	Yes	No	No
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No

10.2 Field Descriptions

VAL Value Field

Event number to post.

INP Input Link

This field is used by the device support routines to obtain input. For soft records, it can be a constant, a database link, or a channel access link.

10.3 Record Support Routines

init_record This routine initializes SIMM with the value of SIML if SIML type is CONSTANT link or creates a channel access link if SIML type is PV_LINK. SVAL is likewise initialized if SIOL is CONSTANT or PV_LINK. If device support includes init_record, it is called.

process See next section.

get_value Fills in the values of struct valueDes so that they refer to VAL.

10.4 Record Processing

Routine process implements the following algorithm:

1 ReadValue is called. See Simulation Mode described in Fields Common to Many Record Types for details.

2 If PACT has been changed to True, the device support read routine has started but has not completed reading a new input value. In this case, the processing routine merely returns, leaving PACT True.

3 If VAL > 0, post event number VAL.

4 Checks to see if monitors should be invoked.

Alarm monitors are invoked if the alarm status or severity has changed NSEV and NSTA are reset to 0.

5 Scans forward link if necessary, sets PACT False, and returns.

10.5 Device Support

10.5.1 Fields of interest to device support

Each record must have an associated set of device support routines. The device support routines are primarily interested in the following fields:

PACT, DPVT, UDF See Chapter titled Fields Common to All Record Types for description.

INP This field is used by the device support routines to locate its input.

NSEV,NSTA See Chapter titled Fields Common to All Record Types for description.

PRIO This value must be used by the device support interrupt handler to set the scheduling priority for processing this record.

10.5.2 Device Support routines

Device support consists of the following routines:

report(FILE fp, interest)

Not currently used.

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

read_event(precord)

This routine returns the following values:

0	Success.
other	Error.

10.6 Device support for soft records

A soft device support module is provided. The INP link type must be either CONSTANT, DB_LINK, or CA_LINK.

If the INP link type is constant, then the constant value is stored into VAL by init_record, and UDF is set to False. If the INP link type is PV_LINK, then dbCaAddInlink is called by init_record.

Read_event calls recGblGetLinkValue to read the current value of VAL. See Soft Input in Fields Common to Many Record Types for details.

If the return status of recGblGetLinkValue is zero, then read_event sets UDF to False. The status of recGblGetLinkValue is returned.

CHAPTER 11 Fanout

This record is used to trigger the processing of up to six other records. It has no associated device support.

11.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	LONG	No	0	0	Yes	Yes	No	Yes
SELM	RECCHOICE	Yes	1	0	Yes	Yes	No	No
SELN	USHORT	No	1	1	Yes	Yes	No	No
SELL	INLINK	Yes	1	0	No			
LNK1	FWDLINK	Yes	1	0	No			
LNK2	FWDLINK	Yes	1	0	No			
LNK3	FWDLINK	Yes	1	0	No			
LNK4	FWDLINK	Yes	1	0	No			
LNK5	FWDLINK	Yes	1	0	No			
LNK6	FWDLINK	Yes	1	0	No			

11.2 Field Descriptions

VAL — Value Field

This field exits only because every record type must have a VAL field so that dNameToAddr succeeds when a field name is not specified.

SELM — Select Mechanism:

SELECT_ALL	Select all links
SELECTED	Use SELN as index (1 to 6)
MASK	Use SELN as a mask to select an arbitrary combination of links.

SELN — Link Selection

If SELM=SELECT_ALL then this field is not used.

If SELM=SELECTED then this is the index (1 to 6) of the link to select.

If SELM=MASK then this is the mask (in decimal) used to determine the selected links. For example, if SELN=1, then LNK1 will be processed. If SELN=3 then LNK1 and LNK2 will be processed. If SELN=63 then all links LNK1, LNK2, ... LNK6 will be processed.

SELL — Link Selection Location

SELN is read from SELL. SELL can be a constant, a database link, or a channel access link.

LNK1,...,LNK6 Link Selection Forward Links

Link selection forward links are always processed in numeric order. That is LNK1 is always processed before LNK2, LNK2 before LNK3, etc.

11.3 Record Support Routines

init_record This routine initializes SELN with the value of SELL if SELL type is CONSTANT link or creates a channel access link if SELL type is PV_LINK.

process See next section.

11.4 Record Processing

Routine process implements the following algorithm:

1 PACT is set to True .

2 The link selection SELN is fetched.

3 Depending on the selection mechanism, the link selection forward links are processed. and UDF is set to False.

4 Checks to see if monitors should be invoked.

Alarm monitors are invoked if the alarm status or severity has changed NSEV and NSTA are reset to 0.

5 Scans forward link if necessary, sets PACT False, and returns.

CHAPTER 12 Histogram

NOTE: This record type is undergoing revision. The field names and functions will change.

This record type is used to store frequency counts of a signal into an array of arbitrary length.

12.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	See BPTR	No	0	udf	Yes	No	No	Yes
NELM	USHORT	Yes	1	1	Yes	No	No	
RES	SHORT	No	1	0	Yes	Yes	No	Yes
ULIM	DOUBLE	Yes	1	0	Yes	Yes	No	Yes
LLIM	DOUBLE	Yes	1	0	Yes	Yes	No	Yes
SGNL	DOUBLE	Yes	1	0	Yes	Yes	Yes	Yes
SVL	INLINK	Yes	1	udf	No			
BPTR	NOACCESS	NO	4					
MCNT	SHORT	No	3	0	No			
MDEL	SHORT	Yes	1	0	Yes	Yes	No	Yes
SIOL	INLINK	Yes	1	0	No			
SVAL	DOUBLE	No	0	0	Yes	Yes	No	No
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No

12.2 Field Descriptions

VAL Value Field.

This field is used to reference the array.

NELM Number of elements in array.

RES Reset Array.

Whenever RES is set to a nonzero value, the array elements counts will be reset to zero. RES is then set to 0.

ULIM Upper Signal Limit.
LLIM Lower Signal Limit.

These fields determine the range of signal values to be used. This range is subdivided into NELM equal intervals. The histogram array elements

contain frequency counts of SGNL values for these intervals. Values of the signal outside these limits are not used by the record support routines. Whenever ULIM or LLIM are changed, the array elements counts will be reset to zero.

SGNL Signal Value.

SVL Signal Value Location, an input link

This field can be a constant, a database link, or a channel access link. If SVL is a database or channel access link, then SGNL is read from SVL. If SVL is a constant link then SGNL is initialized with the constant value but can be changed via dbPuts.

BPTR Buffer Pointer

Address of unsigned long array of frequency values.

MCNT Monitor Counts

Number of counts since last monitor.

MDEL Monitor Delta

Monitor count deadband.

12.3 Record Support Routines

init_record Using NELM, space for the unsigned long array is allocated and the width WDTH of the array is calculated

This routine initializes SIMM with the value of SIML if SIML type is CONSTANT link or creates a channel access link if SIML type is PV_LINK. SVAL is likewise initialized if SIOL is CONSTANT or PV_LINK.

This routine next checks to see that device supportand a device support read routine are available. If device support includes init_record, it is called.

process See next section.

special Special is invoked whenever the fields CMD, SGNL, ULIM, or LLIM are changed. If SGNL is changed, add_count is called. If ULIM or LLIM are changed, WDTH is recalculated and clear_histogram is called. If CMD is

less or equal to 1, clear_histogram is called and CMD is reset to 0. If CMD is 2, CSTA is set to True and CMD is reset to 0. If CMD is 3, CSTA is set to False and CMD is reset to 0. Clear_histogram zeros out the histogram array. Add_count increments the frequency in the histogram array.

get_value Fills in the values of struct valueDes so that they refer to the array.

cvt_dbaddr This is called by dbNameToAddr. It makes the dbAddr structure refer to the actual buffer holding the array.

get_array_info Obtains values from the array referenced by VAL.

put_array_info Writes values into the array referenced by VAL.

12.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 ReadValue is called. See Simulation Mode described in Fields Common to Many Record Types for details.

3 If PACT has been changed to True, the device support read routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving PACT True.

4 Add count to histogram array.

5 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if MDEL conditions are met. NSEV and NSTA are reset to 0.

6 Scans forward link if necessary, sets PACT and INIT to False, and returns.

CHAPTER 13 Long Input

The normal use for this record type is to input an integer value of up to 32 bits. Soft device modules are provided to obtain input via database or channel access links or via dbPutField or dbPutLink requests.

13.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	LONG	No	0	0	Yes	Yes	Yes	Yes
INP	INLINK	Yes	1	0	No			
EGU	STRING	Yes	1	null	Yes	Yes	No	No
HOPR	LONG	Yes	1	0	Yes	Yes	No	No
LOPR	LONG	Yes	1	0	Yes	Yes	No	No
HIHI	LONG	Yes	1	0	Yes	Yes	No	Yes
LOLO	LONG	Yes	1	0	Yes	Yes	No	Yes
HIGH	LONG	Yes	1	0	Yes	Yes	No	Yes
LOW	LONG	Yes	1	0	Yes	Yes	No	Yes
HHSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LLSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HYST	LONG	Yes	1	0	Yes	Yes	No	No
ADEL	LONG	Yes	1	0	Yes	Yes	No	No
MDEL	LONG	Yes	1	0	Yes	Yes	No	No
LALM	LONG	No	3	0	Yes	No	No	
ALST	LONG	No	3	0	Yes	No	No	
MLST	LONG	No	3	0	Yes	No	No	
SIOL	INLINK	Yes	1	0	No			
SVAL	LONG	No	0	0	Yes	Yes	No	No
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No

13.2 Field Descriptions

VAL Value Field

This is the value resulting form record processing. If INP is a constant, then VAL is initialized to the INP value but it can be changed dynamically via dbPutField or dbPutLink.

INP Input Link

This field is used by the device support routines to obtain input. For soft records, it can be a constant, a database link, or a channel access link.

EGU Engineering Units

ASCII string describing Engineering units. This field is not used by record support other than to supply a units description string when get_units is called.

HOPR High Operating Range
LOPR Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double.

HIHI Hihi Alarm Limit
HIGH High Alarm Limit
LOW Low Alarm Limit
LOLO Lolo Alarm Limit
HHSV Severity for a Hihi Alarm
HSV Severity for a High Alarm
LSV Severity for a Low Alarm
LLSV Severity for a Lolo Alarm

These fields specify the alarm limits and severities.

HYST Alarm Deadband
ADEL Archive Deadband
MDEL Monitor, i.e. value change, Deadband

These parameters specify hysteresis factors for triggering monitor callbacks, i.e. callbacks specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.

LALM Last Alarmed Value when last monitors for alarm were triggered
ALST Archive Last Value when last monitors for archiver were triggered
MLST Monitor Last Value when last monitors for value changes were triggered

These fields are used to implement the hysteresis factors for monitor callbacks.

13.3 Record Support Routines

init_record This routine initializes SIMM with the value of SIML if SIML type is CONSTANT link or creates a channel access link if SIML type is

PV_LINK. SVAL is likewise initialized if SIOL is CONSTANT or PV_LINK. This routine next checks to see that device support is available and a device support read routine is defined. If either does not exist, an error message is issued and processing is terminated. If device support includes init_record, it is called.

process See next section.

get_value Fills in the values of struct valueDes so that they refer to VAL.

get_units Retrieves EGU.

get_graphic_double Sets the upper display and lower display limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double Sets the upper control and the lower control limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_alarm_double Sets the following values:

upper_alarm_limit = hihi
upper_warning_limit = high
lower_warning_limit = low
lower_alarm_limit = lolo

13.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 ReadValue is called. See Simulation Mode described in Fields Common to Many Record Types for details.

3 If PACT has been changed to True, the device support read routine has started but has not completed reading a new input value. In this case, the processing routine merely returns, leaving PACT True.

4 Check alarms

This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set. It also honors the alarm hysteresis factor (HYST). Thus the value must change by more than HYST before the alarm status and severity is lowered.

5 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if ADEL and MDEL conditions are met. NSEV and NSTA are reset to 0.

6 Scans forward link, if necessary, sets PACT False, and returns.

13.5 Device Support

13.5.1 Fields of interest to device support

Each long input record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new input value whenever read_longin is called. The device support routines are primarily interested in the following fields:

PACT, DPVT, UDF See Chapter titled Fields Common to All Record Types for description.

VAL This field is set by device support routines.

INP This field is used by the device support routines to locate its input.

NSEV,NSTA See Chapter titled Fields Common to All Record Types for description.

13.5.2 Device Support routines

Device support consists of the following routines:

report(FILE fp, paddr)

Not currently used.

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

read_longin(precord)

This routine must provide a new input value. It returns the following values:

0	Success. A new value is placed in VAL.
other	Error.

13.6 Device support for soft records

This module places a value directly in VAL.

If the INP link type is constant, then the constant value is stored into VAL by init_record, and UDF is set to False. If the INP link type is PV_LINK, then dbCaAddInlink is called by init_record.

Read_longin calls recGblGetLinkValue to read the current value of VAL. See Soft Input in Fields Common to Many Record Types for details.

If the return status of recGblGetLinkValue is zero then read_longin sets UDF to False. Read_longin returns the status of recGblGetLinkValue.

CHAPTER 14 Long Output

The normal use for this record type is to store integer values of up to 31 bits. It can also be used to write values to other records via database or channel access links. The OUT field determines how the record is used. The record supports alarm limits and graphics and control limits.

14.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	LONG	No	0	0	Yes	Yes	Yes	Yes
OUT	OUTLINK	Yes	1	0	No			
DOL	INLINK	Yes	1	0	No			
OMSL	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
EGU	STRING	Yes	1	null	Yes	Yes	No	No
HOPR	LONG	Yes	1	0	Yes	Yes	No	No
LOPR	LONG	Yes	1	0	Yes	Yes	No	No
HIHI	LONG	Yes	1	0	Yes	Yes	No	Yes
LOLO	LONG	Yes	1	0	Yes	Yes	No	Yes
HIGH	LONG	Yes	1	0	Yes	Yes	No	Yes
LOW	LONG	Yes	1	0	Yes	Yes	No	Yes
HHSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LLSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HYST	LONG	Yes	1	0	Yes	Yes	No	No
ADEL	LONG	Yes	1	0	Yes	Yes	No	No
MDEL	LONG	Yes	1	0	Yes	Yes	No	No
LALM	LONG	No	3	0	Yes	No	No	
ALST	LONG	No	3	0	Yes	No	No	
MLST	LONG	No	3	0	Yes	No	No	
SIOL	INLINK	Yes	1	0	No			
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
IVOA	GBLCHOICE	Yes	2	0	Yes	Yes	No	No
IVOV	DOUBLE	Yes	2	0	Yes	Yes	No	No

14.2 Field Descriptions

VAL Value

This is the desired output value, in engineering units. If DRVH and DRVL are defined, VAL is forced to be within the drive limits. VAL is either obtained from DOL or set via dbPuts.

OUT Output Link

This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.

DOL Desired Output Location (an Input Link)

If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL. After the check for drive limits VAL will be set to the value determined by DOL.

OMSL Output Mode Select

This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts.

EGU Engineering Units

ASCII string describing Engineering units. This field is not used by record support other than to supply a units description string when get_units is called.

HOPR High Operating Range
LOPR Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double. If these values are defined, they must be in the range DRVL<=LOPR<=HOPR<=DRVH.

HIHI Hihi Alarm Limit
HIGH High Alarm Limit
LOW Low Alarm Limit
LOLO Lolo Alarm Limit
HHSV Severity for a Hihi Alarm
HSV Severity for a High Alarm
LSV Severity for a Low Alarm
LLSV Severity for a Lolo Alarm

These fields specify the alarm limits and severities.

HYST Alarm Deadband
ADEL Archive Deadband

MDEL Monitor, i.e. value change, Deadband

These parameters specify hysteresis factors for triggering monitor callbacks, i.e. callbacks specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.

LALM Last Alarmed Value when last monitors for alarm were triggered
ALST Archive Last Value when last monitors for archiver were triggered
MLST Monitor Last Value when last monitors for value changes were triggered

These fields are used to implement the hysteresis factors for monitors.

14.3 Record Support Routines

init_record This routine initializes SIMM if SIML is a constant or creates a channel access link if SIML is PV_LINK. If SIOL is PV_LINK a channel access link is created .

This routine next checks to see that device support is available.The routine next checks to see if the device support write routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated.

If DOL is a constant, then VAL is initialized to its value and UDF is set to False. If DOL type is a PV_LINK then dbCaAddInlink is called to create a channel access link.

If device support includes init_record, it is called.

process See next section.

get_value Fills in the values of struct valueDes so that they refer to VAL.

get_units Retrieves EGU.

get_graphic_double Sets the upper display and lower display limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double Sets the upper control and the lower control limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be

used, else the upper and lower maximum values for the field type will be used.

get_alarm_double Sets the following values:

upper_alarm_limit = hihi
upper_warning_limit = high
lower_warning_limit = low
lower_alarm_limit = lolo

14.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 If PACT is False and OMSL is CLOSED_LOOP recGblGetLinkValue is called to read the current value of VAL. See Soft Input in Fields Common to Many Record Types for details. If the return status of recGblGetLinkValue is zero then UDF is set to False.

3 Check alarms

This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set. It also honors the alarm hysteresis factor (HYST). Thus the value must change by more than HYST before the alarm status and severity is lowered.

4 Check severity and write the new value. See Invalid Alarm Output Action and Simulation Mode described in Fields Common to Many Record Types for details.

5 If PACT has been changed to True, the device support write output routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving PACT True.

6 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if ADEL and MDEL contitions are met. NSEV and NSTA are reset to 0.

7 Scans forward link if necessary, sets PACT False, and returns.

14.5 Device Support

14.5.1 Fields of interest to device support

Each long output record must have an associated set of device support routines. The primary responsibility of the device support routines is to output a new value whenever write_longout is called. The device support routines are primarily interested in the following fields:

PACT, DPVT See Chapter titled Fields Common to All Record Types for description.

OUT This field is used by the device support routines to locate its output.

NSEV,NSTA See Chapter titled Fields Common to All Record Types for description.

14.5.2 Device Support routines

Device support consists of the following routines:

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

write_longout(precord)

This routine must output a new value. It returns the following values:

0 Success.

other Error.

14.6 Device support for soft records

This module writes the current value of VAL.

If the OUT link type is PV_LINK, then dbCaAddInlink is called by init_record.

Write_longout calls recGblPutLinkValue to write the current value of VAL. See Soft Output in Fields Common to Many Record Types for details.

CHAPTER 15 Mbbi – MultiBit Binary Input

The normal use for this record type is to obtain a binary value that represents one of up to 16 states. Most device support modules obtain values from hardware and place the value in RVAL. For these devices record processing uses RVAL to determine the current state (VAL is given a value between 0 and 15). Devices may optionally read a value directly into VAL. Soft device modules are provided to obtain input via database or channel access links or via dbPutField or dbPutLink requests. Two soft device support modules are provided. One allows VAL to be an arbitrary unsigned short integer. The other reads the value into RVAL just like normal hardware modules.

15.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	ENUM	No	0	0	Yes	Yes	Yes	Yes
NOBT	SHORT	Yes	1	0	Yes	No		
INP	INLINK	Yes	1	0	No			
ZRVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
ONVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
TWVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
THVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
FRVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
FVVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
SXVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
SVVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
EIVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
NIVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
TEVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
ELVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
TVVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
TTVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
FTVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
FFVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
ZRST	STRING	Yes	1	null	Yes	Yes	No	Yes
ONST	STRING	Yes	1	null	Yes	Yes	No	Yes
TWST	STRING	Yes	1	null	Yes	Yes	No	Yes
THST	STRING	Yes	1	null	Yes	Yes	No	Yes
FRST	STRING	Yes	1	null	Yes	Yes	No	Yes
FVST	STRING	Yes	1	null	Yes	Yes	No	Yes
SXST	STRING	Yes	1	null	Yes	Yes	No	Yes
SVST	STRING	Yes	1	null	Yes	Yes	No	Yes
EIST	STRING	Yes	1	null	Yes	Yes	No	Yes
NIST	STRING	Yes	1	null	Yes	Yes	No	Yes
TEST	STRING	Yes	1	null	Yes	Yes	No	Yes
ELST	STRING	Yes	1	null	Yes	Yes	No	Yes
TVST	STRING	Yes	1	null	Yes	Yes	No	Yes
TTST	STRING	Yes	1	null	Yes	Yes	No	Yes

FTST	STRING	Yes	1	null	Yes	Yes	No	Yes
FFST	STRING	Yes	1	null	Yes	Yes	No	Yes
ZRSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
ONSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
TWSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
THSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
FRSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
FVSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
SXSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
SVSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
EISV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
NISV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
TESV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
ELSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
TVSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
TTSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
FTSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
FFSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
UNSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
COSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
RVAL	ULONG	No	0	0	Yes	Yes	Yes	Yes
ORAW	ULONG	No	3	0	Yes	No	No	No
MASK	ULONG	No	1	0	Yes	No	No	No
MLST	USHORT	No	3	0	Yes	No	No	No
LALM	USHORT	No	3	0	Yes	No	No	No
SDEF	SHORT	No	3	0	Yes	No	No	No
SHFT	USHORT	No	1	0	Yes	No	No	No
SIOL	INLINK	Yes	1	0	No			
SVAL	USHORT	No	0	0	Yes	Yes	No	No
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No

15.2 Field Descriptions

VAL Value Field

Unless INP is a constant link, this is the value resulting from the record being processed. If INP is a constant, then VAL is initialized to the INP value but can be changed dynamically via dbPutField or dbPutLink. It normally is the index (0 to 15) of the current state.

NOBT Number of Bits

Number of bits set in hardware mask.

INP Input Link

This field is used by the device support routines to obtain input. For soft records, it can be a constant, a database link, or a channel access link.

ZRVL,...,FFVL Zero Value, One Value ...

Masks for hardware value associated with each state.

ZRST,...,FFST Zero String, One String ...

Strings associated with each state.

ZRSV,...,COSV Zero Severity, One Severity,...

Alarm severity associated with each state.

RVAL Raw Data Value

RVAL is the value obtained by the device support routine. Unless the device support routine specifies no conversion, VAL is determined as follows: A temporary variable rval is set equal to RVAL. It is then shifted right SHFT bits. After shifting, the result should match one of the values ZRVL,...,FFVL.

ORAW Old Raw Data Value

ORAW is used to decide if monitors should be triggered for RVAL at the same time monitors are triggered for changes in VAL.

MASK Mask

Mask used by device support routine to read hardware register. Record support sets low order NOBT bits. Device support can shift this value.

SHFT Shift

Number of bits to shift values obtained from RVAL.

LALM Last Alarmed

Value when last change of state alarm was issued.

MLST Monitor Last

Value when last monitor for value changes was triggered

SDEF States Defined?

Record support uses this field to save time if no states are defined

15.3 Record Support Routines

init_record This routine initializes SIMM with the value of SIML if SIML type is CONSTANT link or creates a channel access link if SIML type is PV_LINK. SVAL is likewise initialized if SIOL is CONSTANT or PV_LINK. This routine next checks to see that device support is available and a device support read routine is defined. If either does not exist, an error message is issued and processing is terminated. Clears MASK and then sets the NOBT low order bits. If device support includes init_record, it is called. Init_common is then called. to determine if any states are defined.. If states are defined, SDEF is set to True.

process See next section.

special Calls init_common to compute SDEF when any of the fields ZRVL, ... FFVL change value.

get_value Fills in the values of struct valueDes so that they refer to VAL.

get_enum_str Retrieves ASCII string corresponding to VAL

get_enum_strs Retrieves ASCII strings for ZRST,...FFST..

put_enum_str Checks if string matches ZRST,...FFST and if it does, sets VAL.

15.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 ReadValue is called. See Simulation Mode described in Fields Common to Many Record Types for details.

3 If PACT has been changed to True, the device support read routine has started but has not completed reading a new input value. In this case, the processing routine merely returns, leaving PACT True.

4 Convert.

status=read_mbbi

```
PACT = True
TIME = tsLocalTime
if status is 0, then determine VAL
        set rval = RVAL
        Shift rval right SHFT bits
        if at least one state value is defined
                        set UDF to True
                        if rval is ZRVL,...,FFVL then set
                                        VAL equals index of state
                                        UDF set to False
                        else set VAL = undefined
        else             set VAL = rval
                         set UDF to False
if status is 1, return(0)
if status is 2, set status = 0
```

5 Check alarms

This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set.

6 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if MLST is not equal to VAL. Monitors for RVAL are checked whenever other monitors are invoked. NSEV and NSTA are reset to 0.

7 Scans forward link if necessary, sets PACT False, and returns.

15.5 Device Support

15.5.1 Fields of interest to device support

Each input record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new raw input value whenever read_mbbi is called. The device support routines are primarily interested in the following fields:

PACT, DPVT, UDF See Chapter titled Fields Common to All Record Types for description.

NOBT Number of hardware bits accessed. They must be consecutive.

VAL This field is set by the device support routines if they don't want record support to set it.

INP This field is used by the device support routines to locate its input.

RVAL	Raw data value. It is the responsibility of the device support routine to give this field a value.
NSEV,NSTA	See Chapter titled Fields Common to All Record Types for description.
MASK	This is a mask used to read the hardware. Record support sets the low order NOBT bits. The device support routine can shift the bits. The device support routine should perform the shift in in init_record.
SHFT	This can be set by the device support module at init_record time.

15.5.2 Device Support routines

Device support consists of the following routines:

report(FILE fp, paddr)

Not currently used.

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine. If it uses MASK, it should shift it as necessary and also give SHFT a value.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

read_mbbi(precord)

This routine must provide a new input value. It returns the following values:

0	Success. A new raw value is placed in RVAL. The record support module determines VAL from RVAL, SHFT, and ZEVL ... FFVL.
2	Success, but don't modify VAL.
other	Error.

15.6 Device support for soft records

Two soft device support modules Soft Channel and Raw Soft Channel are provided for multi-bit binary input records not related to actual hardware devices. The INP link type must be either CONSTANT, DB_LINK, or CA_LINK.

Soft Channel

Read_mbbi always returns a value of 2, which means that no conversion is performed.

If the INP link type is constant, then the constant value is stored into VAL by init_record, and UDF is set to False. VAL can be changed via dbPut requests. If the INP link type is PV_LINK, then dbCaAddInlink is called by init_record.

Read_mbbi calls recGblGetLinkValue to read the current value of VAL. See Soft Input in Fields Common to Many Record Types for details.

If the return status of recGblGetLinkValue is zero, then read_mbbi sets UDF to False. The status of recGblGetLinkValue is returned.

Raw Soft Channel

This module is like the previous except that values are read into RVAL, VAL is computed from RVAL, and read_mbbi returns a value of 0. Thus the record processing routine will determine VAL in the normal way.

CHAPTER 16 Mbbo – MultiBit Binary Output

The normal use for this record type is to send a binary value (representing one of up to 16 states) to a Digital Output module. It can also be used to write to other records via database or channel access links.

16.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	ENUM	No	0	0	Yes	Yes	Yes	Yes
DOL	INLINK	Yes	1	0	No			
OMSL	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
NOBT	SHORT	Yes	1	0	Yes	No		
OUT	OUTLINK	Yes	1	0	No			
ZRVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
ONVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
TWVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
THVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
FRVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
FVVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
SXVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
SVVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
EIVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
NIVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
TEVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
ELVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
TVVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
TTVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
FTVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
FFVL	ULONG	Yes	1	0	Yes	Yes	No	Yes
ZRST	STRING	Yes	1	null	Yes	Yes	No	Yes
ONST	STRING	Yes	1	null	Yes	Yes	No	Yes
TWST	STRING	Yes	1	null	Yes	Yes	No	Yes
THST	STRING	Yes	1	null	Yes	Yes	No	Yes
FRST	STRING	Yes	1	null	Yes	Yes	No	Yes
FVST	STRING	Yes	1	null	Yes	Yes	No	Yes
SXST	STRING	Yes	1	null	Yes	Yes	No	Yes
SVST	STRING	Yes	1	null	Yes	Yes	No	Yes
EIST	STRING	Yes	1	null	Yes	Yes	No	Yes
NIST	STRING	Yes	1	null	Yes	Yes	No	Yes
TEST	STRING	Yes	1	null	Yes	Yes	No	Yes
ELST	STRING	Yes	1	null	Yes	Yes	No	Yes
TVST	STRING	Yes	1	null	Yes	Yes	No	Yes
TTST	STRING	Yes	1	null	Yes	Yes	No	Yes
FTST	STRING	Yes	1	null	Yes	Yes	No	Yes
FFST	STRING	Yes	1	null	Yes	Yes	No	Yes

ZRSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
ONSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
TWSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
THSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
FRSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
FVSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
SXSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
SVSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
EISV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
NISV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
TESV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
ELSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
TVSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
TTSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
FTSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
FFSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
UNSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
COSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
RVAL	ULONG	No	0	0	Yes	Yes	Yes	Yes
ORAW	ULONG	No	3	0	Yes	No	No	No
RBV	ULONG	No	0	0	Yes	No	Yes	No
ORBV	ULONG	No	3	0	Yes	No	No	No
MASK	ULONG	No	1	0	Yes	No	No	No
MLST	USHORT	No	3	0	Yes	No	No	No
LALM	USHORT	No	3	0	Yes	No	No	No
SDEF	SHORT	No	3	0	Yes	No	No	No
SHFT	USHORT	No	1	0	Yes	No	No	No
SIOL	INLINK	Yes	1	0	No			
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
IVOA	GBLCHOICE	Yes	2	0	Yes	Yes	No	No
IVOV	DOUBLE	Yes	2	0	Yes	Yes	No	No

16.2 Field Descriptions

VAL Value Field

This is the index of the state value to be sent to OUT.

DOL Desired Output Location (an Input Link)

If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL.

OMSL Output Mode Select

This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field, the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts.

NOBT Number of Bits

Number of bits in hardware mask.

OUT Output Link

This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.

ZRVL,...,FFVL Zero Value, One Value, ...

Masks for hardware value associated with each state.

ZRST,...,FFST Zero State, One State, ...

Strings associated with each state.

ZRSV,...,COSV Zero Severity, One Severity, ...

Alarm severity associated with each state.

RVAL Raw Data Value

RVAL is the value to be written to the hardware device. It is determined by the record support module using VAL as the index of the values stored in ZRVL,...FFVL. The value is also shifted left SHFT bits.

ORAW Old Raw Data Value

ORAW is used to decide if monitors should be triggered for RVAL at the same time monitors are generated for changes in VAL.

RBV Read Back Value

This is the actual read back value obtained from the hardware itself or from the associated device driver. It is the responsibility of the device support routine to give this field a value

ORAW Old Read Back Value

ORBV is used to decide if monitors should be triggered for RBV at the same time monitors are triggered for changes in VAL.

MASK Mask

Mask used by device support routine to read hardware register. Record support sets low order NOBT bits. Device support can shift this value.

MLST Monitor Last

Value when last monitor for value changes was triggered

LALM Last Alarmed

Value when last change of state alarm was issued.

SDEF States Defined?

Record support uses this field to save time if no states are defined

SHFT Shift

Number of bits to shift values obtained from ZRVL,...,FFVL.

16.3 Record Support Routines

init_record This routine initializes SIMM if SIML is a constant or creates a channel access link if SIML is PV_LINK. If SIOL is PV_LINK a channel access link is created .

This routine next checks to see that device support is available.The routine next checks to see if the device support write routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated.

If DOL is a constant, then VAL is initialized to its value and UDF is set to False.

MASK is cleared and then the NOBT low order bits are set.

If device support includes init_record, it is called.

Init_common is then called. to determine if any states are defined.. If states are defined, SDEF is set to True.

If device support returns success, VAL is then set from RVAL and UDF is set to False.

process See next section.

special Computes SDEF when any of the fields ZRVL,...FFVL change value.

get_value Fills in the values of struct valueDes so that they refer to VAL.

get_enum_str Retrieves ASCII string corresponding to VAL

get_enum_strs Retrieves ASCII strings for ZRST,...FFST..

put_enum_str Checks if string matches ZRST,...FFST and if it does, sets VAL.

16.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 If PACT is False

```
if DOL is DB_LINK and OMSL is CLOSED_LOOP
        get value from DOL
        set UDF to False
        check for link alarm
if any state values are defined
        if VAL > 15, then raise alarm and go to 4
        else using VAL as index set RVAL = one of ZRVL,...FFVL
else set RVAL = VAL
Shift RVAL left SHFT bits
```

3 Convert

```
        if PACT is False, compute RVAL
                if VAL is 0,...,15, set RVAL from ZRVL,...,FFVL
                if VAL out of range, set RVAL = undefined
        status=write_mbbo
```

4 Check alarms

This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set.

5 Check severity and write the new value. See Invalid Alarm Output Action and Simulation Mode described in Fields Common to Many Record Types for details.

6 If PACT has been changed to True, the device support write output routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving PACT True.

7 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if MLST is not equal to VAL. Monitors for RVAL and RBV are checked whenever other monitors are invoked. NSEV and NSTA are reset to 0.

8 Scans forward link if necessary, sets PACT False, and returns.

16.5 Device Support

16.5.1 Fields of interest to device support

Each mbbo input record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new raw mbbo input value whenever write_mbbo is called. The device support routines are primarily interested in the following fields:

PACT, DPVT, UDF See Chapter titled Fields Common to All Record Types for description.

NOBT Number of hardware bits accessed. They must be consecutive.

OUT This field is used by the device support routines to locate its output.

RVAL Raw data value. This is the value to be written to OUT.

RBV Read Back Value It is the responsibility of the device support modules to set this field.

NSEV,NSTA See Chapter titled Fields Common to All Record Types for description.

MASK This is a mask used to read the hardware. Record support sets the low order NOBT bits. The device support routine can shift the bits. The device support routine should perform the shift in in init_record.

SHFT This can be set by the device support module at init_record time.

16.5.2 Device Support routines

Device support consists of the following routines:

report(FILE fp, paddr)

Not currently used.

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine. If MASK is used, it should be shifted if necessary and SHFT given a value.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

write_mbbo(precord)

This routine must output a new value. It returns the following values:

0	Success.
other	Error.

16.6 Device support for soft records

This module writes the current value of VAL.

If the OUT link type is PV_LINK, then dbCaAddInlink is called by init_record.

Write_mbbo calls recGblPutLinkValue to write the current value of VAL. See Soft Output in Fields Common to Many Record Types for details.

CHAPTER 17 Permissive

This record is for communication between a server and a client. An example is a sequence program client and an operator interface server. Two fields are used VAL and WFLG. The method of use is as follows:

1 Initially both VAL and WFLG are 0, which means OFF.

2 When the server is ready to accept a request, it sets WFLG equal to 1, which means ON.

3 The client monitors WFLG. Until it turns ON, the client must not change VAL.

4 When the client wants to notify the server it turns VAL ON.

5 The server notices that VAL is ON. He sets both WFLG and VAL OFF. Performs whatever action is associated with this permissive (a private matter server and client), and when ready to accept a new request sets WFLG ON.

By using multiple permissive records a sequence program can communicate its current state to a client.

17.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
LABL	STRING	Yes	1	null	Yes	Yes	No	Yes
VAL	USHORT	No	0	0	Yes	Yes	Yes	Yes
OVAL	USHORT	No	3	0	Yes	No		
WFLG	USHORT	No	0	0	Yes	Yes	Yes	Yes
OFLG	USHORT	No	3	0	Yes	No		

17.2 Field Descriptions

LABL Label

A descriptive string.

VAL Value

Client sets this field when it wants service from server. Only the client should set this field. The server clears it.

OVAL Old Value

Used to decide if monitors should be triggered. Value change monitors are invoked if OVAL is not equal to VAL.

WFLG Watchdog Flag

Server sets this field when it is ready to accept a request. Only the server should modify this field.

OFLG Old Flag Value

Used to decide if monitors should be triggered.

17.3 Record Support Routines

Two record support routines are provided: process, and get_value. Process sets UDF to False, triggers monitors on VAL and WFLG when they change, and scans the forward link if necessary. Get_value fills in struct valueDes so that it refers to VAL.

CHAPTER 18 Pid Control

This record type provides a Proportional, Integral, and Derivative (PID) control algorithm. A discrete form of the PID algorithm is:

$$M(n) = KP*(E(n) + KI*SUMi(E(i)*dT(i)) + KD*(E(n) – E(n–1))/dT(n) + Mr$$

where:

M(n)	Value of manipulated variable at nth sampliing instant
KP,KI,KD	Proportional, Integral, and Derivative gains
E(n)	Error at nth sampling instant
SUMi	Sum from i=0 to i=n
dT(n)	Time difference between n–1 and n
Mr	Midrange adjustment

Taking the first difference yields:

$$delM(n) = KP*((E(n)–E(n–1)) + E(n)*dT(n)*KI + KD*((E(n) –E(n–1))/dT(n) – (E(n–1)–E(n–2))/dT(n–1)))$$

For this record:

DM	This is delM(n)
VAL	This is the setpoint
CVAL	This is current value
ERR	E(n) = VAL – CVAL

18.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	FLOAT	No	0	0	Yes	Yes	Yes	Yes
CVL	INLINK	Yes	1	0	No			
STPL	INLINK	Yes	1	0	No			
SMSL	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
PREC	SHORT	Yes	1	0	Yes	Yes	No	No
MDT	FLOAT	Yes	1	0	Yes	Yes	No	No
KP	FLOAT	Yes	1	0	Yes	Yes	No	No
KI	FLOAT	Yes	1	0	Yes	Yes	No	No
KD	FLOAT	Yes	1	0	Yes	Yes	No	No
EGU	STRING	Yes	1	null	Yes	Yes	No	No
HOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
LOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
HIHI	FLOAT	Yes	1	0	Yes	Yes	No	No
LOLO	FLOAT	Yes	1	0	Yes	Yes	No	No
HIGH	FLOAT	Yes	1	0	Yes	Yes	No	No

LOW	FLOAT	Yes	1	0	Yes	Yes	No	No
HHSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
LLSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
HSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
LSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
HYST	FLOAT	Yes	1	0	Yes	Yes	No	No
ADEL	FLOAT	Yes	1	0	Yes	Yes	No	No
MDEL	FLOAT	Yes	1	0	Yes	Yes	No	No
ODEL	FLOAT	Yes	1	0	Yes	Yes	No	No
CVAL	FLOAT	No	0	0	Yes	Yes	No	No
DM	FLOAT	No	0	0	Yes	No	Yes	No
ODM	FLOAT	No	3	0	Yes	No	Yes	No
P	FLOAT	No	2	0	Yes	No	Yes	No
I	FLOAT	No	2	0	Yes	No	Yes	No
D	FLOAT	No	2	0	Yes	No	Yes	No
CT	ULONG	No	4	0	Yes	No	Yes	No
DT	FLOAT	No	2	0	Yes	No	Yes	No
ERR	FLOAT	No	2	0	Yes	No	Yes	No
DERR	FLOAT	No	2	0	Yes	No	Yes	No
LALM	FLOAT	No	3	0	Yes	No	No	No
ALST	FLOAT	No	3	0	Yes	No	No	No
MLST	FLOAT	No	3	0	Yes	No	No	No

18.2 Field Descriptions

VAL Setpoint Value, in engineering units.

This is the value that the control algorithm attempts to achieve.

CVL Controlled Value Location (an input link)

This is a link specifying the location of the controlled variable. This must be a database link. Each time the record is processed the current value referenced by CVL is read into CVAL.

STPL Setpoint Location (an input link)

If STPL is a database or channel access link and SMSL is CLOSED_LOOP, then VAL is read from STPL. STPL and SMSL act just like DOL and OMSL.

SMSL Setpoint Mode Select.

This is SUPERVISORY or CLOSED_LOOP. VAL is obtained from STPL only when this is CLOSED_LOOP. By setting this field, the record can be switched between supervisory and closed loop. Note that closed loop is useful for cascaded control records.

PREC Display Precision

Precision with which to display VAL. This field is not used by record support other than to supply a value when get_precision is called.

MDT Minimum Delta Time, in seconds.

Minimum time difference between processing in seconds. If this is zero, the minimum time is one clock tick.

KP Proportional Gain

KI Integral Gain, in repeats per minute.

The number of times per minute that the integral contribution repeats the proportional contribution.

KD Derivative Gain, in minutes per repeat.

The number of minutes until the derivative contribtuion repeats the proportional contribution.

EGU Engineering Units

ASCII string describing Engineering units. This field is not used by record support other than to supply a units description string when get_units is called.

HOPR High Operating Range
LOPR Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double.

HIHI Hihi Alarm Limit
HIGH High Alarm Limit
LOW Low Alarm Limit
LOLO Lolo Alarm Limit
HHSV Severity for a Hihi Alarm
HSV Severity for a High Alarm
LSV Severity for a Low Alarm
LLSV Severity for a Lolo Alarm

These fields specify the alarm limits and severities.

HYST Alarm Deadband
ADEL Archive Deadband
MDEL Monitor, i.e. value change, Deadband

These parameters specify hysteresis factors for triggering monitor callbacks, i.e. monitors specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.

ODEL Output Delta

This parameter specifies a hysteresis factor for triggering monitor callbacks for DM, P, I, D, CT, DT, ERR, and DERR. It refers to the change in DM. Whenever monitors are triggered for DM, monitors for the other fields are also triggered.

CVAL Value of Controlled Variable, in engineering units.

This value is obtained from CVL each time the record is processed.

DM This is the value computed by the pid algorithm. It is an increment to be added to the controller output. Note that in most cases this will be read via the DOL field of an analog output record. The analog output record will be configured with OIF set to incremental.

ODM Old DM. ODM is used to decide if monitors should be triggered for DM.

P Proportional contribution to DM, in engineering units.

I Integral contribution to DM, in repeats per minute.

The number of times per minute that the integral contribution repeats the proportional contribution.

D Derivative contribution to DM, in minutes.

The number of minutes until the derivative contribtuion repeats the proportional contribution.

CT Clocks Ticks Clock ticks when previous process occurred.

DT Time difference in seconds between processing steps.

ERR Error. Current error (VAL – CVAL).

DERR Delta Error. Change in error since last time step.

LALM Value when last monitors for alarm were triggered
ALST Value when last monitors for archiver were triggered
MLST Value when last monitors for value changes were triggered.

These fields are used to implement the hysteresis factors for monitors.

18.3 Record Support Routines

init_record This routine initializes VAL with the value of STPL and sets UDF to False if STPL type is CONSTANT link or creates a channel access link if STPL type is PV_LINK.

process See next section.

get_value Fills in the values of struct valueDes so that they refer to VAL.

get_units Retrieves EGU.

get_precision Retrieves PREC.

get_graphic_double Sets the upper display and lower display limits for a field. If the field is P, I, D, CVAL, VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double Sets the upper control and the lower control limits for a field. If the field is P, I, D, CVAL, VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_alarm_double Sets the following values:

upper_alarm_limit = hihi
upper_warning_limit = high
lower_warning_limit = low
lower_alarm_limit = lolo

18.4 Record Processing

Routine process implements the following algorithm:

1 If CVL is not a database link, a major alarm is declared and the algorithm completes.

2 The current value of CVAL is obtained from CVL.

3 If STPL is a database or channel access link and SMSL is CLOSED_LOOP, then VAL is obtained from STPL and UDF is set to False.

4 The time difference since the last time step is calculated. If it is less than MDT or if no ticks have occurred since the last time the algorithm was executed, process just completes without raising any alarms, checking monitors, or scanning the forward link.

5 The new values of P, I, D, OUT, CT, DT, ERR, and DERR are computed.

6 Check alarms

This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set. It also honors the alarm hysteresis factor (HYST). Thus the value must change by more than HYST before the alarm status and severity is lowered.

7 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if ADEL and MDEL conditions are met. Value change monitors on DM are invoked if ODEL conditions are met. If monitors are triggered from DM, they are also triggered for P, I, D, CT, DT, ERR, and DERR. NSEV and NSTA are reset to 0.

8 Scans forward link if necessary, sets PACT False, and returns.

CHAPTER 19 Pulse Counter

The normal use for this record type is to record counts.

19.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	ULONG	No	0	0	Yes	Yes	Yes	No
OUT	OUTLINK	Yes	1	0	No			
GTYP	RECCHOICE	Yes	1	0	Yes	Yes	No	No
HGV	SHORT	Yes	0	0	Yes	Yes	No	No
SGL	INLINK	Yes	1	0	No			
SGV	RECCHOICE	Yes	0	0	Yes	Yes	No	No
OSGV	SHORT	No	3	0	Yes	No		
CSIZ	SHORT	Yes	1	0	Yes	No		
CNTE	RECCHOICE	Yes	1	0	Yes	Yes	No	No
CNTS	SHORT	Yes	1	0	Yes	Yes	No	No
HOPR	FLOAT	Yes	1	4.3e+9	Yes	Yes	No	No
LOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
CMD	RECCHOICE	No	1	0	Yes	Yes	Yes	Yes
SCMD	SHORT	No	3	0	Yes	No		

19.2 Field Descriptions

VAL Counter Value

The read command places the current value of the counter into the VAL field.

OUT Output Link

This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.

GTYP Gate Type

This can be Hardware or software. If GTYP is hardware, then HGV determines gating control. If GTYP is software, the SGV determines gating control.

HGV Hardware Gate Value

If GTYP is hardware, then this field is device dependent.

SGL Soft Gate Location (an Input Link)

If SGL is a database link and GTYP is software, then SGV will be set to the value read from SGL.

SGV Soft Gate Value

This can be inactive or active. This will enable and disable counting if GTYP is software.

OSGV Old Soft Gate Value

This is the previous value of SGV.

CSIZ Counter size. 16 bit or 32 bit counter.

CNTE Count Edge

This can be Rising Edge or Falling Edge. This field forces counting on rising or falling edge of source signal.

CNTS Count Source

HOPR High Operating Range
LOPR Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double.

CMD Command

Read	Read the current value of the counter.
Clear	Clear the counter. Note theat the counter is also stopped. The Start command must be issued to restart the counter.
Start	Start counting.
Stop	Stop counting.
Setup	Setup the counter. Counting will not begin until the Start command is issued.

SCMD Save Command

This is the saved value of CMD.

19.3 Record Support Routines

init_record This routine next checks to see that device support is available. If it does not exist, an error message is issued and processing is terminated. If SGL is a constant and GTYP is software, then SGV is initialized with its value. If SGL type is PV_LINK a channel access link is created. Device support is then checked to see if cmd_pc is defined. If device support includes init_record, it is called.

process See next section.

get_value Fills in the values of struct valueDes so that they refer to VAL.

get_graphic_double Sets the upper display and lower display limits for a field. If the field is VAL the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double Sets the upper control and the lower control limits for a field. If the field is VAL the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

19.4 Record Processing

The routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 If SGL is DB_LINK and GTYP is Software, get SGV from SGL. If SGV has changed, save the CMD value, call the command routine with START if SGV =0 or with STOP if SGV is 1 , reset the command to the saved value, and set alarms if return status not zero. If the device is not done (PACT TRUE), then issue a callback request for this record to process and return

3 If CMD is not READ, call command routine and set CMD to READ. If the device is not done (PACT TRUE), then issue a callback request for this record to process again and return.

4 Call command routine. If device support set PACT to TRUE, then return.

5 Checks to see if monitors should be invoked.

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors on CMD are invoked if values have changed. NSEV and NSTA are reset to 0.

6 Scans forward link if necessary, sets PACT False, and returns.

19.5 Device Support

19.5.1 Fields of interest to device support

Each record must have an associated set of device support routines. The primary responsibility of the device support routines is to issue commands to the output device. The device support routines are primarily interested in the following fields:

CSIZ	This will determine to a 16 bit or 32 bit count is to be used. With 32 bit, two counter are used.
CMD	The device support routine is responsible for processing the commands READ, CLEAR, START, STOP, and SETUP.
GTYP,IGV	If GTYP is internal, device support is responsible for using IGV to determine gating control.
CNTE	This field is used by the device support routines to force counting on leading or falling edge of signal.
CNTS	Device support must use CNTS to set count source during setup.

19.5.2 Device Support routines

Device support consists of the following routines:

report()

This routine is optional. If provided, it prints a report of all device modules..

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. *cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

cmd_pc(precord)

This routine issues commands to the output device. It returns the following values:

0	Success.
other	Error.

CHAPTER 20 Pulse Delay

The normal use for this record type is to generate output pulses.

20.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
OUT	OUTLINK	Yes	1	0	No			
UNIT	RECCHOICE	Yes	1	0	Yes	Yes	No	No
DLY	DOUBLE	Yes	1	0	Yes	Yes	Yes	Yes
WIDE	DOUBLE	Yes	1	0	Yes	Yes	Yes	No
ODLY	DOUBLE	No	3	0	Yes	No		
OWID	DOUBLE	No	3	0	Yes	No		
CTYP	RECCHOICE	Yes	1	0	Yes	Yes	No	No
CEDG	RECCHOICE	Yes	1	0	Yes	Yes	No	No
ECS	SHORT	Yes	1	0	Yes	Yes	No	No
ECR	DOUBLE	Yes	1	0	Yes	Yes	No	No
VAL	SHORT	No	0	0	Yes	Yes	Yes	Yes
PFLD	SHORT	No	3	0	Yes	No		
LLOW	RECCHOICE	Yes	1	0	Yes	Yes	No	No
TTYP	RECCHOICE	Yes	1	0	Yes	Yes	No	No
HTS	SHORT	Yes	1	0	Yes	Yes	No	Yes
STL	INLINK	Yes	1	0	Yes	No		
STV	RECCHOICE	Yes	0	0	Yes	Yes	No	Yes
HOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
LOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
PREC	SHORT	Yes	1	0	Yes	Yes	No	No
GATE	SHORT	Yes	1	0	Yes	Yes	No	Yes
GLNK	INLINK	Yes	1	0	Yes	No		

20.2 Field Descriptions

OUT — Output Link

This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.

UNIT — Time units of delay and width. (Seconds,Milliseconds, Microseconds, Nanoseconds, Picoseconds).

DLY — Pulse Delay, in UNITS of time.

Delay after trigger edge until beginning of pulse.

WIDE Pulse Width, in UNITS of time.

Width of pulse generated.

ODLY Old Delay

Value when last monitors for delay were triggered.

OWID Old Width

Value when last monitors for width were triggered.

CTYP Clock Type.

Hardware/Software. If software selected, then clock automatically determined by software. If hardware selected, then clock determined by ECS and ECR.

CEDG Clock Signal Edge

This can be Rising Edge or Falling Edge. This field forces clock timing on rising or falling edge of source signal.

ECS External Clock Source

If CTYP is internal, this field is ignored. If CTYP is external, then this field is device dependent.

ECR External Clock Rate, in Hz

Clock rate for external clock source.

VAL Value

This field is will contain value 1 if a trigger was detected since the last time the record was processed and a 0 otherwise.

PFLD Processing Field. This field is set to indicate if which of the following fields changed since last processed: DLY, WIDE, STV, GATE, or HTS.

LLOW Low Logic Level

0	Logic Low=0
1	Logic Low=1

TTYP Trigger Type. (Hardware/Software)

This field indicates where the pulse trigger will come from. Hardware indicates HTS will be used, software will use STL, STV.

HTS Hardware Trigger source. The source of the delayed pulse trigger.

STL Soft Trigger Location (Input link).

This value for STV will be read from here if this is set.

STV Soft Trigger Value.

This can be enabled or disable. This will trigger a delayed pulse if TTYP set to software and device allows it.

HOPR High Operating Range
LOPR Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double.

PREC Display Precision

Precision with which to display DLY. This field is not used by record support other than to supply a value when get_precision is called.

GATE Gate for enable/disable of pulse generation.

This field can be used to enable and disable the pulses.

GLNK Gate Location.

This field is used to determine where to get the value for GATE.

20.3 Record Support Routines

init_record This routine first checks that device support is available. Device support is then checked to see if write_pd is defined. Next this routine initializes STV with the value of STL if STL type is CONSTANT link or creates a channel access link if STL type is PV_LINK. GATE is likewise initialized if GLNK is CONSTANT or PV_LINK. If device support includes init_record, it is called.

process See next section.

special Sets the PFLD field to indicate if write to DLY, STV, GATE or HTS field caused processing of the record.

get_value Fills in the values of struct valueDes so that they refer to VAL.

get_precision Retrieves PREC.

get_graphic_double Sets the upper display and lower display limits for a field. If the field is VAL, DLY, ODLY, WIDE or OWID the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double Sets the upper control and the lower control limits for a field. If the field is VAL, DLY, ODLY, WIDE or OWID the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

20.4 Record Processing

Routine process implements the following algorithm:

1 Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 The values for STV and GATE are then fetched.

3 Call write_pd routine.

4 PFLD is reset to zero.

5 If device support set PACT to True, then return.

6 Set UDF to False.

7 Check to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors on DLY and WIDE are invoked if values have changed. NSEV and NSTA are reset to 0.

8 Scans forward link if necessary, sets PACT False, and returns.

20.5 Device Support

20.5.1 Fields of interest to device support

Each record must have an associated set of device support routines. The primary responsibility of the device support routines is to issue commands to the output device. The device support routines are primarily interested in the following fields:

OUT	This field is used by the device support routines to locate its output.
WIDE	Device support must use WIDE for pulse width
DLY	Device support must use DLY for the delay after trigger edge until beginning of pulse.
LLOW	Device support must use to determine logic low level.
UNIT	All values that refer to time measure will be in this time unit.
VAL	This field will contain a 1 if a trigger occured since the last time the record was processed if the device supports it.
PFLD	This field is used by some devices to indicate if the record was scanned to adjust certain fields such as delay or trigger source. If the device has a destructive read, then changes to these types of fields will only could writes to the device instead of a read and a write.
TTYP	This field is used by the device support routines to force triggering on leading or falling edge of signal if the specified device supports it.
HTS	This field wil be used to set the hardware trigger source if the device supports it.
STV	This field will be used for software to trigger an output delayed pulse if the device supports it.
CEDG	This field is used by the device support routines to force clock timing on leading or falling edge of signal.
CTYP,ECS ECR	If CTYP is external, device support is responsible for using ECR for the clock rate and if CTYP is internal, ECS is the clock source.

20.5.2 Device Support routines

Device support consists of the following routines:

report()

This routine is optional. If provided, it prints a report of all device modules..

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. *cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

write_pd(precord)

This routine issues commands to the output device.

CHAPTER 21 Pulse Train

The normal use for this record type is to generate an output pulse train.

21.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
OUT	OUTLINK	Yes	1	0	No			
UNIT	RECCHOICE	Yes	1	0	Yes	Yes	No	No
PER	DOUBLE	Yes	1	0	Yes	Yes	Yes	No
DCY	DOUBLE	Yes	1	0	Yes	Yes	Yes	No
OPER	DOUBLE	No	3	0	Yes	No		
ODCY	DOUBLE	No	3	0	Yes	No		
GTYP	RECCHOICE	Yes	1	0	Yes	Yes	No	No
HGV	SHORT	Yes	0	0	Yes	Yes	No	No
SGL	INLINK	Yes	1	0	Yes	No		
SGV	RECCHOICE	Yes	0	0	Yes	Yes	No	No
OSGV	SHORT	No	0	0	Yes	No		
VAL	SHORT	No	0	0	Yes	Yes	Yes	Yes
CTYP	RECCHOICE	Yes	1	0	Yes	Yes	No	No
CEDG	RECCHOICE	Yes	1	0	Yes	Yes	No	No
ECS	SHORT	Yes	1	0	Yes	Yes	No	No
ECR	DOUBLE	Yes	1	0	Yes	Yes	No	No
HOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
LOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
PREC	SHORT	Yes	1	0	Yes	Yes	No	No
LLOW	RECCHOICE	Yes	1	0	Yes	Yes	No	No

21.2 Field Descriptions

OUT — Output Link

This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.

UNIT — Units of time (Seconds, milliseconds, microseconds, nanoseconds, pico-seconds).

PER — Period, in UNITs

Pulse train period..

DCY — Duty Cycle, percent

Percent of time that signal is high.

OPER Old Period, in UNITS

Value when last monitors for period were triggered.

ODCY Old Duty Cycle, percent

Value when last monitors for duty cycle were triggered.

GTYP Gate Type

This can be hardware or software. If GTYP is hardware, then HGV determines gating control. If GTYP is software, the SGV determines gating control.

HGV Hardware Gate Value

This field is device dependant.

SGL Soft Gate Location (an Input Link)

If SGL is a database link and GTYP is software, then SGV will be set to the value read from SGL.

SGV Soft Gate Value

This can be inactive (no gating) or active.

OSGV Old Soft Gate Value

This is the previous value of SGV.

VAL Value

This field is not used..

CTYP Clock Type.

This can be internal or external.

CEDG Clock Signal Edge

This can be Rising Edge or Falling Edge. This field forces counting on rising or falling edge of source signal.

ECS External Clock Source

If CTYP is internal, this field is ignored. If CTYP is external, then this field is device dependent.

ECR External Clock Rate, in Hz

Clock rate for external clock source.

HOPR High Operating Range
LOPR Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double.

PREC Display Precision

Precision with which to display DLY. This field is not used by record support other than to supply a value when get_precision is called.

LLOW Low Logic Level

Logic Low=0
Logic Low=1

21.3 Record Support Routines

init_record This routine first checks that device support is available. If SGL is a constant then HGV is initialized with its value or a channel access link is created if SGL type is PV_LINK. Device support is then checked to see if write_pt is defined. If device support includes init_record, it is called.

process See next section.

get_value Fills in the values of struct valueDes so that they refer to VAL.

get_precision Retrieves PREC.

get_graphic_double Sets the upper display and lower display limits for a field. If the field is VAL, PER, or OPER the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double Sets the upper control and the lower control limits for a field. If the field is VAL, or PER the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

21.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 If SGL is DB_LINK and GTYP is Software, get SGV from SGL. If SGV has changed, save the duty cycle DCY value, call the write_pt routine with duty cycle =0, reset the duty cycle to the saved value, and set alarms if return status not zero. Then set the old soft gate value OSGV to SGV.

3 Call write_pt routine. If device support set PACT to TRUE, then return.

4 Sets UDF to False.

5 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors on PER and DCY are invoked if values have changed. NSEV and NSTA are reset to 0.

6 Scans forward link if necessary, sets PACT False, and returns.

21.5 Device Support

21.5.1 Fields of interest to device support

Each record must have an associated set of device support routines. The primary responsibility of the device support routines is to issue commands to the output device. The device support routines are primarily interested in the following fields:

UNIT This field will be used to identify the time units used for time fields.

OUT This field is used by the device support routines to locate its output.

PER Device support must use PER for pulse period.

DCY Device support must use DCY for the percent of time the signal is high.

LLOW Device support must use to determine logic low level.

CEDG This field is used by the device support routines to force counting on leading or falling edge of signal.

GTYP,IGV
SGV — Device support is responsible for using IGV to determine gating control if GTYP is internal, or SGV if GTYP is external.

CTYP,ECS
ECR — If CTYP is external, device support is responsible for using ECR for the clock rate and if CTYP is internal, ECS is the clock source.

21.5.2 Device Support routines

Device support consists of the following routines:

report()

This routine is optional. If provided, it prints a report of all device modules..

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. *cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

write_pt(precord)

This routine issues commands to the output device. It returns the following values:

0 — Success.

other — Error.

CHAPTER 22 Select

This record computes a value based on input obtained from up to 12 inputs. The selection algorithm can be one of the following: Specified, Highest, Lowest, Median. Each input can be a constant, a database link, or a channel access link.

22.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	DOUBLE	No	0	0	Yes	No	Yes	
SELM	RECCHOICE	Yes	1	0	Yes	Yes	No	No
SELN	USHORT	No	1	0	Yes	Yes	No	No
PREC	SHORT	Yes	1	0	Yes	Yes	No	No
NVL	INLINK	Yes	1	0	No			
INPA	INLINK	Yes	1	0	No			
INPB	INLINK	Yes	1	0	No			
INPC	INLINK	Yes	1	0	No			
INPD	INLINK	Yes	1	0	No			
INPE	INLINK	Yes	1	0	No			
INPF	INLINK	Yes	1	0	No			
INPG	INLINK	Yes	1	0	No			
INPH	INLINK	Yes	1	0	No			
INPI	INLINK	Yes	1	0	No			
INPJ	INLINK	Yes	1	0	No			
INPK	INLINK	Yes	1	0	No			
INPL	INLINK	Yes	1	0	No			
A	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
B	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
C	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
D	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
E	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
F	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
G	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
H	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
I	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
J	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
K	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
L	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
LA	DOUBLE	No	3	0	Yes	No	No	
LB	DOUBLE	No	3	0	Yes	No	No	
LC	DOUBLE	No	3	0	Yes	No	No	
LD	DOUBLE	No	3	0	Yes	No	No	
LE	DOUBLE	No	3	0	Yes	No	No	
LF	DOUBLE	No	3	0	Yes	No	No	
LG	DOUBLE	No	3	0	Yes	No	No	
LH	DOUBLE	No	3	0	Yes	No	No	

LI	DOUBLE	No	3	0	Yes	No	No	
LJ	DOUBLE	No	3	0	Yes	No	No	
LK	DOUBLE	No	3	0	Yes	No	No	
LL	DOUBLE	No	3	0	Yes	No	No	
EGU	STRING	Yes	1	null	Yes	Yes	No	No
HOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
LOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
HIHI	FLOAT	Yes	1	0	Yes	Yes	No	Yes
LOLO	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HIGH	FLOAT	Yes	1	0	Yes	Yes	No	Yes
LOW	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HHSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LLSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HYST	DOUBLE	Yes	1	0	Yes	Yes	No	No
ADEL	DOUBLE	Yes	1	0	Yes	Yes	No	No
MDEL	DOUBLE	Yes	1	0	Yes	Yes	No	No
LALM	DOUBLE	No	3	0	Yes	No	No	No
ALST	DOUBLE	No	3	0	Yes	No	No	No
MLST	DOUBLE	No	3	0	Yes	No	No	No

22.2 Field Descriptions

VAL Value Field

This field is the computed value, determined as a result of record processing.

SELM Select Mechanism:

SELECTED	Use SELN as index (0 to 15)
SELECT_HIGH	Select highest
SELECT_LOW	Select lowest
SELECT_MEDIAN	Select median value.

SELN Select Number

Index of selected input If SELM=SELECTED, then this is the index (0 to 15) of the input to select.

PREC Display Precision

Precision with which to display VAL. This field is not used by record support other than to supply a value when get_precision is called.

NVL Index Value Location, an input link.

IF NVL is a constant, SELN is set to the constant value. If NVL is a database or channel access link then SELN is read from NVL.

INPA,...,INPL Input A, INput B, ...

The input links. Each may be a constant, a database link, or a channel access link. Any link not defined is ignored.

A,...,L A, B, ...

The input values If the corresponding INP field is a constant, this field is initialized with the constant value but can be changed via dbPuts.

LA,...,LL Last A, Last B, ...

Previous input values These fields are used to decide when to trigger monitors on A,...,L.

EGU Engineering Units

ASCII string describing Engineering units. This field is not used by record support other than to supply a units description string when get_units is called.

HOPR High Operating Range
LOPR Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double.

HIHI Hihi Alarm Limit
HIGH High Alarm Limit
LOW Low Alarm Limit
LOLO Lolo Alarm Limit
HHSV Severity for a Hihi Alarm
HSV Severity for a High Alarm
LSV Severity for a Low Alarm
LLSV Severity for a Lolo Alarm

These fields specify the alarm limits and severities.

HYST Alarm Deadband
ADEL Archive Deadband

MDEL Monitor, i.e. value change, Deadband

These parameters specify hysteresis factors for triggering monitor callbacks, i.e. monitors specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.

LALM Last Alarmed. Value when last monitors for alarm were triggered
ALST Archive Last. Value when last monitors for archiver were triggered
MLST Monitor Last. Value when last monitors for value changes were triggered

These fields are used to implement the hysteresis factors for monitors.

22.3 Record Support Routines

init_record IF NVL is a constant, SELN is set to its value. If NVL is a PV_LINK a channel access link is created. For each constant input link, the corresponding value field is initialized with the constant value. For each input link that is of type PV_LINK, a channel access link is created.

process See next section.

get_value Fills in the values of struct valueDes so that they refer to VAL.

get_units Retrieves EGU.

get_precision Retrieves PREC.

get_graphic_double Sets the upper display and lower display limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double Sets the upper control and the lower control limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_alarm_double Sets the following values:

upper_alarm_limit = hihi
upper_warning_limit = high

lower_warning_limit = low
lower_alarm_limit = lolo

22.4 Record Processing

Routine process implements the following algorithm:

1 If NVL is a database or channel access link, SELN is obtained from NVL. Fetch all values if database or channel access links. If SELM is SELECTED, then only the selected link is fetched.

2 Implements the appropriate selection algorithm. For SELECT_HIGH, SELECT_LOW, and SELECT_MEDIAN, input fields are ignored if they are undefined. If success, UDF is set to False.

3 Check alarms

This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set. It also honors the alarm hysteresis factor (HYST). Thus the value must change by more than HYST before the alarm status and severity is lowered.

4 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if ADEL and MDEL conditions are met. Monitors for A–L are checked whenever other monitors are invoked. NSEV and NSTA are reset to 0.

5 Scans forward link if necessary, sets PACT False, and returns.

CHAPTER 23 Sequence

This record is used to trigger the processing of up to ten other records. It has no associated device support. It is similar to the fanout record except it will fetch an input value and write an output value instead of simply processing a collection of forward links.

23.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	LONG	No	0	0	Yes	Yes	No	Yes
SELM	RECCHOICE	Yes	1	0	Yes	Yes	No	No
SELN	USHORT	No	1	1	Yes	Yes	No	No
SELL	INLINK	Yes	1	0	No			
PREC	SHORT	Yes	1	0	Yes	Yes	No	No
DLY1	DOUBLE	Yes	1	0	Yes	Yes	No	No
DOL1	INLINK	Yes	1	0	No			
DO1	DOUBLE	Yes	1	0	Yes	Yes	No	No
LNK1	OUTLINK	Yes	1	0	No			
DLY2	DOUBLE	Yes	1	0	Yes	Yes	No	No
DOL2	INLINK	Yes	1	0	No			
DO2	DOUBLE	Yes	1	0	Yes	Yes	No	No
LNK2	OUTLINK	Yes	1	0	No			
DLY3	DOUBLE	Yes	1	0	Yes	Yes	No	No
DOL3	INLINK	Yes	1	0	No			
DO3	DOUBLE	Yes	1	0	Yes	Yes	No	No
LNK3	OUTLINK	Yes	1	0	No			
DLY4	DOUBLE	Yes	1	0	Yes	Yes	No	No
DOL4	INLINK	Yes	1	0	No			
DO4	DOUBLE	Yes	1	0	Yes	Yes	No	No
LNK4	OUTLINK	Yes	1	0	No			
DLY5	DOUBLE	Yes	1	0	Yes	Yes	No	No
DOL5	INLINK	Yes	1	0	No			
DO5	DOUBLE	Yes	1	0	Yes	Yes	No	No
LNK5	OUTLINK	Yes	1	0	No			
DLY6	DOUBLE	Yes	1	0	Yes	Yes	No	No
DOL6	INLINK	Yes	1	0	No			
DO6	DOUBLE	Yes	1	0	Yes	Yes	No	No
LNK6	OUTLINK	Yes	1	0	No			
DLY7	DOUBLE	Yes	1	0	Yes	Yes	No	No
DOL7	INLINK	Yes	1	0	No			
DO7	DOUBLE	Yes	1	0	Yes	Yes	No	No
LNK7	OUTLINK	Yes	1	0	No			
DLY8	DOUBLE	Yes	1	0	Yes	Yes	No	No
DOL8	INLINK	Yes	1	0	No			
DO8	DOUBLE	Yes	1	0	Yes	Yes	No	No
LNK8	OUTLINK	Yes	1	0	No			

DLY9	DOUBLE	Yes	1	0	Yes	Yes	No	No
DOL9	INLINK	Yes	1	0	No			
DO9	DOUBLE	Yes	1	0	Yes	Yes	No	No
LNK9	OUTLINK	Yes	1	0	No			
DLYA	DOUBLE	Yes	1	0	Yes	Yes	No	No
DOLA	INLINK	Yes	1	0	No			
DOA	DOUBLE	Yes	1	0	Yes	Yes	No	No
LNKA	OUTLINK	Yes	1	0	No			

23.2 Field Descriptions

VAL Value Field

This field exits only because every record type must have a VAL field so that dNameToAddr succeeds when a field name is not specified.

SELM Select Mechanism:

SELECT_ALL	Select all links
SELECTED	Use SELN as index (1 to 6)
MASK	Use SELN as a mask to select an arbitrary combination of links.

SELN Link Selection

If SELM=SELECT_ALL then this field is not used.

If SELM=SELECTED then this is the index (1 to 6) of the link to select.

If SELM=MASK then this is the mask (in decimal) used to determine the selected links. For example, if SELN=1, then LNK1 will be processed. If SELN=3 then LNK1 and LNK2 will be processed. If SELN=63 then links LNK1, LNK2, ... LNK6 will be processed.

SELL Link Selection Location

SELN is read from SELL. SELL can be a constant, a database link, or a channel access link.

PREC Display Precision

Precision with which to display DLY1–DLYA and DO1–DOA fields. This field is not used by record support other than to supply a value when get_precision is called.

DLY1–DLYA Delay time

This represents the delay time (in seconds) to wait before processing the input and output link pair (ie. DOLn and LNKn.)

DOL1–DOLA Input link selection

DO is read from DOL. DOL can be a constant, database link or channel access link. If it is a constant, it is only copied to the DO field once at initialization time. Otherwise, it is re–fetched each time the record is processed.

DO1–DOA Desired output value

This field holds the desired output value that will be placed in the output location indicated by the LNK field.

LNK1–LNKA Output link field

DO is written to LNK. LNK can be a database link or a channel access link.

23.3 Record Support Routines

The only record support routine is process. First, PACT is set to True, and the link selection if fetched. Depending on the selection mechanism, the link selection output links are processed in order from LNK1 to LNKA. When LNKn is processed, the corresponding DLYn value is used to generate a delay via watchdog timer. After DLYn seconds have expired, the input value is fetched from DOn (if DOLn is constant) or DOLn (if DOLn is a database link or channel access link) and written to LNKn. When all links are completed, an asynchronous completion call back to dbProcess is made (see the Application Developer's Guide for more information on asynchronous processing.) Then UDF is set to False. Monitors are checked, the forward link is scanned, PACT is set False, and the process routine returns.

For the delay mechanism to operate properly, the record is processed asynchronously. The only time the record will not be processed asynchronously is when there are no non–NULL output links selected (ie. when it has nothing to do.) The processing of the links is done via callback tasks at the priority set in the PRIO field in dbCommon (see the Application Developer's Guide for more information on callback tasks.)

CHAPTER 24 State

This record is used to store an arbitrary ASCII string.

24.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	STRING	Yes	0	null	Yes	Yes	Yes	Yes
OVAL	STRING	No	3	null	Yes	No		

24.2 Field Descriptions

VAL Value Field

An arbitrary string value

OVAL Old Value

Used to decide when to invoke monitors.

24.3 Record Support Routines

Two record support routines are provided: process, and get_value. Process triggers monitors on VAL when it changes and scans the forward link if necessary. Get_value fills in struct valueDes so that it refers to VAL.

CHAPTER 25 Stepper Motor

This record type is used to control stepper motors. This record may undergo revision.

25.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	FLOAT	No	0	0	Yes	Yes	Yes	Yes
OUT	OUTLINK	Yes	1	0	No			
RDBL	INLINK	Yes	1	0	No			
DOL	INLINK	Yes	1	0	No			
OMSL	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
ACCL	FLOAT	Yes	1	0	Yes	Yes	No	No
VELO	FLOAT	Yes	1	0	Yes	Yes	No	No
DIST	FLOAT	Yes	1	0	Yes	Yes	No	No
IVAL	FLOAT	Yes	1	0	Yes	Yes	No	No
MODE	RECCHOICE	Yes	1	0	Yes	Yes	No	No
CMOD	RECCHOICE	Yes	1	0	Yes	Yes	No	No
IALG	RECCHOICE	Yes	1	0	Yes	Yes	No	No
MRES	USHORT	Yes	1	0	Yes	Yes	No	No
ERES	USHORT	Yes	1	0	Yes	Yes	No	No
PREC	SHORT	Yes	1	0	Yes	Yes	No	No
EGU	STRING	Yes	1	null	Yes	Yes	No	No
DRVH	FLOAT	Yes	1	0	Yes	Yes	No	Yes
DRVL	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
LOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
HIHI	FLOAT	Yes	1	0	Yes	Yes	No	Yes
LOLO	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HIGH	FLOAT	Yes	1	0	Yes	Yes	No	Yes
LOW	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HHSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LLSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HLSV	GBLCHOICE	Yes	2	0	Yes	Yes	No	Yes
ADEL	FLOAT	Yes	1	0	Yes	Yes	No	No
MDEL	FLOAT	Yes	1	0	Yes	Yes	No	No
RDBD	FLOAT	Yes	1	0	Yes	Yes	No	No
RTRY	SHORT	Yes	1	0	Yes	Yes	No	No
STHM	SHORT	No	2	0	Yes	Yes	No	Yes
STOP	SHORT	No	2	0	Yes	Yes	No	Yes
DMOV	SHORT	No	2	0	Yes	Yes	No	No
RVAL	LONG	No	0	0	Yes	Yes	Yes	Yes
RBV	FLOAT	No	1	0	Yes	No	Yes	No
RRBV	LONG	No	1	0	Yes	No	Yes	No

ALST	FLOAT	No	3	0	Yes	No	No	
MLST	FLOAT	No	3	0	Yes	No	No	
INIT	SHORT	No	2	0	Yes	Yes	No	Yes
MCW	SHORT	No	2	0	Yes	Yes	No	Yes
MCCW	SHORT	No	2	0	Yes	Yes	No	Yes
CW	SHORT	No	2	0	Yes	Yes	No	Yes
CCW	SHORT	No	2	0	Yes	Yes	No	Yes
DIR	SHORT	No	2	0	Yes	Yes	No	Yes
MOVN	SHORT	No	2	0	Yes	Yes	No	No
CVEL	SHORT	No	2	0	Yes	Yes	No	No
RCNT	SHORT	No	2	0	Yes	Yes	No	No
POSM	SHORT	No	2	0	Yes	Yes	No	
LVAL	FLOAT	No	2	0	Yes	Yes	No	
EPOS	FLOAT	No	3	0	Yes	Yes	No	
MPOS	FLOAT	No	2	0	Yes	Yes	No	
MISS	FLOAT	No	2	0	Yes	Yes	No	
LVEL	FLOAT	No	2	0	Yes	Yes	No	
LACC	FLOAT	No	2	0	Yes	Yes	No	

25.2 Field Descriptions

VAL Value

This is the desired output value, in engineering units. If DRVH and DRVL are defined, VAL is forced to be within the drive limits. VAL is either obtained from DOL or set via dbPuts.

OUT Output Link

This field is used by the device support routines to locate the stepper motor.

RDBL Read Back Location (Input link)

This link is used to obtain the read back value when a physical read back is attached to the device being driven from the stepper motor.

DOL Desired Output Location (an Input Link)

If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL. After the check for drive limits, VAL will be set to the value determined by DOL.

OMSL Output Mode Select

This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field, the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts.

ACCL Acceleration.

Number of seconds to reach VELO velocity.

VELO Velocity.

Rotations per second.

DIST Distance

Distance moved by each pulse of the stepper motor.

IVAL Initial Value

MODE Mode

Velocity or Position.

CMOD Current Mode

Velocity or Position.

IALG Initialization Algorithm:

None, Move to positive limit, Move to negative limit.

MRES Motor Pulses per Revolution.

ERES Encoder Pulses per Revolution

PREC Display Precision

Precision with which to display. This field is not used by record support other than to supply a value when get_precision is called.

EGU Engineering Units

ASCII string describing Engineering units. This field is not used by re-

cord support other than to supply a units description string when get_units is called.

DRVH Drive High
DRVL Drive Low

If these values are defined, then VAL will forced to be in the range DRVL<=VAL<=DRVH

HOPR High Operating Range
LOPR Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double.

HIHI Hihi Alarm Limit
HIGH High Alarm Limit
LOW Low Alarm Limit
LOLO Lolo Alarm Limit
HHSV Severity for a Hihi Alarm
HSV Severity for a High Alarm
LSV Severity for a Low Alarm
LLSV Severity for a Lolo Alarm
HLSV Severity for a hardware limit violation

These fields specify the alarm limits and severities.

ADEL Archive Deadband
MDEL Monitor, i.e. value change, Deadband

These parameters specify hysteresis factors for triggering monitor callbacks, i.e. monitors specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.

RDBD Retry Deadband.

RTRY Number of retries before failure.

STHM Set Home

Setting this field to 1 via a dbPut is a command to set home to the current position of the stepper motor. This field will automatically be reset to 0 after the command is accepted.

STOP Stop

Setting this field to 1 will cause the motor to stop if it is moving. This field will automatically be reset to 0 after the command is accepted.

DMOV Done Moving to Value

RVAL Raw Data Value

RVAL is the value actually sent to the device.

RBV Read Back Value

This is the actual read back value obtained from the hardware itself or from the associated device driver. It is the responsibility of the device support routine to give this field a value.

RRBV Raw Read Back Value.

Raw read back value obtained from the encoder.

ALST Archive Last. Value when last monitors for archiver were triggered
MLST Monitor Last. Value when last monitors for value changes were triggered

These fields are used to implement the hysteresis factors for monitors.

INIT Initialize.

MCW Motor clockwise limit switch value.

MCCW Motor counter clockwise limit switch value.

CW Is motor clockwise limit switch True?

CCW Is motor counter clockwise limit switch True?

DIR Current direction.

MOVN Is motor moving?

CVEL Has Constant velocity been attained?

RCNT Current retry count.

LVAL	Last value.
POSM	Positive motion.
EPOS	Encoder read back position
MPOS	Motor position
MISS	First attempt error
LVEL	Last velocity set
LACC	Last acceleration set
DPVT	Device private

25.3 Record Support Routines

init_record	This routine checks to see that device support is available. The routine next checks to see if the device support sm_command routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated. If device support includes init_record, it is called. If DOL is a constant, then VAL is initialized with its value and UDF is set to False. If DOL is a PV_LINK then a channel access link is created. Init_sm is then called.
init_record	Not written yet.
process	See next section.
get_value	Fills in the values of struct valueDes so that they refer to VAL.
get_units	Retrieves EGU.
get_precision	Retrieves PREC.
get_graphic_double	Sets the upper display and lower display limits for a field. If the field is VAL, LVAL, MPOS, RBV, EPOS, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.
get_control_double	Sets the upper control and the lower control limits for a field. If the field is VAL, LVAL, MPOS, RBV, EPOS, HIHI, HIGH, LOW, or LOLO,

the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_alarm_double Sets the following values:

upper_alarm_limit = hihi
upper_warning_limit = high
lower_warning_limit = low
lower_alarm_limit = lolo

25.4 Record Processing

Not yet written

25.5 Device Support

At the present time, device support is intimately connected to record support. The compumotor 1830 and the OMS 6 axis controllers are supported.

CHAPTER 26 Stringin – String Input

This record is used to input an arbitrary ASCII string.

26.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	STRING	Yes	0	null	Yes	Yes	Yes	Yes
OVAL	STRING	No	3	null	Yes	No		
INP	INLINK	Yes	1	0	No			
SIOL	INLINK	Yes	1	0	No			
SVAL	STRING	No	0	0	Yes	Yes	No	No
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No

26.2 Field Descriptions

VAL Value.

An arbitrary ASCII string of 40 characters. It is either obtained from INP or else given a value via dbPuts.

OVAL Output Value

Old ASCII string. Used to decide when to invoke monitors. If VAL differs from OVAL, monitors will be invoked.

INP Input Link.

This field is used by the device support routines to obtain input. For soft records, it can be a constant, a database link, or a channel access link.

26.3 Record Support Routines

Three record support routines are provided: init_record, process, and get_value.

init_record This routine initializes SIMM with the value of SIML if SIML type is CONSTANT link or creates a channel access link if SIML type is PV_LINK. SVAL is likewise initialized if SIOL is CONSTANT or PV_LINK. This routine next checks to see that device support is available and a record support read routine is defined. If either does not exist, an error message is issued and processing is terminated. If device support includes init_record, it is called.

process See next section.

get_value Fills in the values of struct valueDes so that they refer to VAL.

26.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 ReadValue is called. See Simulation Mode described in Fields Common to Many Record Types for details.

3 If PACT has been changed to True, the device support read routine has started but has not completed reading a new input value. In this case, the processing routine merely returns, leaving PACT True.

4 TIME is set to tslocaltime

5 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if OVAL is not equal to VAL. NSEV and NSTA are reset to 0.

6 Scans forward link if necessary, sets PACT False, and returns.

26.5 Device Support

26.5.1 Fields of interest to device support

Each stringin input record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new ASCII string value whenever read_stringin is called. The device support routines are primarily interested in the following fields:

PACT, DPVT, UDF See Chapter titled Fields Common to All Record Types for description.

VAL This field is set by the device support routines.

INP This field is used by the device support routines to locate its input.

26.5.2 Device Support routines

Device support consists of the following routines:

report(FILE fp, paddr)

Not currently used.

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

read_stringin(precord)

This routine must provide a new input value. It returns the following values:

0	Success. A new ASCII string is stored into VAL.
other	Error.

26.6 Device support for soft records

This module places a value directly in VAL.

If the INP link type is constant, the double constant, if nonzero, is converted to a string and stored into VAL by init_record, and UDF is set to False. If the INP link type is PV_LINK, then dbCaAddInlink is called by init_record.

Read_stringin calls recGblGetLinkValue to read the current value of VAL. See Soft Input in Fields Common to Many Record Types for details.

If the return status of recGblGetLinkValue is zero, then read_stringin sets UDF to False. The status of recGblGetLinkValue is returned.

CHAPTER 27 Stringout – String Output

This record is used to output an arbitrary ASCII string.

27.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	STRING	Yes	0	null	Yes	Yes	Yes	Yes
OVAL	STRING	No	3	null	Yes	No		
DOL	INLINK	Yes	1	0	No			
OMSL	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
OUT	OUTLINK	Yes	1	0	No			
SIOL	INLINK	Yes	1	0	No			
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No
IVOA	GBLCHOICE	Yes	2	0	Yes	Yes	No	No
IVOV	DOUBLE	Yes	2	0	Yes	Yes	No	No

27.2 Field Descriptions

VAL Value

An arbitrary ASCII string of 40 characters. This is the field to be sent to OUT. It is either obtained from DOL or else given a value via dbPuts.

OVAL Old Value

Used to decide when to invoke monitors. If VAL differs from OVAL, then monitors will be invoked.

DOL Desired Output Location (an Input Link)

If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL.

OMSL Output Mode Select

This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field, the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts.

OUT Output Link
This field is used by the device support routines to decide where to send

output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.

27.3 Record Support Routines

Three record support routines are provided: init_record, process, and get_value.

init_record — This routine initializes SIMM if SIML is a constant or creates a channel access link if SIML is PV_LINK. If SIOL is PV_LINK a channel access link is created .

This routine next checks to see that device support is available. The routine next checks to see if the device support write routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated.

If DOL is a constant, then the type double constant, if nonzero, is converted to a string and stored into VAL and UDF is set to False. If DOL type is a PV_LINK then dbCaAddInlink is called to create a channel access link.

If device support includes init_record, it is called.

process — See next section.

get_value — Fills in the values of struct valueDes so that they refer to VAL.

27.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 If PACT is False and OMSL is CLOSED_LOOP recGblGetLinkValue is called to read the current value of VAL. See Soft Input in Fields Common to Many Record Types for details. If the return status of recGblGetLinkValue is zero then UDF is set to False.

3 Check severity and write the new value. See Invalid Alarm Output Action and Simulation Mode described in Fields Common to Many Record Types for details.

4 If PACT has been changed to True, the device support write output routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving PACT True.

5 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if OVAL is not equal to VAL. NSEV and NSTA are reset to 0.

6 Scans forward link if necessary, sets PACT False, and returns.

27.5 Device Support

27.5.1 Fields of interest to device support

Each stringout output record must have an associated set of device support routines. The primary responsibility of the device support routines is to write a new value whenever write_stringout is called. The device support routines are primarily interested in the following fields:

PACT, DPVT See Chapter titled Fields Common to All Record Types for description.

VAL This is the field written by the device support routines.

OUT This field is used by the device support routines to locate its output.

NSEV,NSTA See Chapter titled Fields Common to All Record Types for description.

27.5.2 Device Support routines

Device support consists of the following routines:

report(FILE fp, paddr)

Not currently used.

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

write_stringout(precord)

This routine must output a new value. It returns the following values:

0 Success.

other Error.

27.6 Device support for soft records

This module writes the current value of VAL.

If the OUT link type is PV_LINK, then dbCaAddInlink is called by init_record.

Write_so calls recGblPutLinkValue to write the current value of VAL. See Soft Output in Fields Common to Many Record Types for details.

CHAPTER 28 Subroutine

This record provides a subroutine escape mechanism.

28.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	DOUBLE	No	0	0	Yes	Yes	Yes	Yes
INAM	STRING	Yes	1	null	Yes	No		
SNAM	STRING	Yes	1	null	Yes	No		
SADR	NOACCESS	NO	4					
STYP	SHORT	No	3	0	Yes	No	No	
INPA	INLINK	Yes	1	0	No			
INPB	INLINK	Yes	1	0	No			
INPC	INLINK	Yes	1	0	No			
INPD	INLINK	Yes	1	0	No			
INPE	INLINK	Yes	1	0	No			
INPF	INLINK	Yes	1	0	No			
INPG	INLINK	Yes	1	0	No			
INPH	INLINK	Yes	1	0	No			
INPI	INLINK	Yes	1	0	No			
INPJ	INLINK	Yes	1	0	No			
INPK	INLINK	Yes	1	0	No			
INPL	INLINK	Yes	1	0	No			
A	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
B	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
C	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
D	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
E	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
F	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
G	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
H	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
I	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
J	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
K	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
L	DOUBLE	No	0	0	Yes	Yes/No	Yes	Yes
LA	DOUBLE	No	3	0	Yes	No	No	
LB	DOUBLE	No	3	0	Yes	No	No	
LC	DOUBLE	No	3	0	Yes	No	No	
LD	DOUBLE	No	3	0	Yes	No	No	
LE	DOUBLE	No	3	0	Yes	No	No	
LF	DOUBLE	No	3	0	Yes	No	No	
LG	DOUBLE	No	3	0	Yes	No	No	
LH	DOUBLE	No	3	0	Yes	No	No	
LI	DOUBLE	No	3	0	Yes	No	No	
LJ	DOUBLE	No	3	0	Yes	No	No	

LK	DOUBLE	No	3	0	Yes	No	No	
LL	DOUBLE	No	3	0	Yes	No	No	
PREC	SHORT	Yes	1	0	Yes	Yes	No	No
EGU	STRING	Yes	1	null	Yes	Yes	No	No
HOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
LOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
HIHI	FLOAT	Yes	1	0	Yes	Yes	No	Yes
LOLO	FLOAT	Yes	1	0	Yes	Yes	No	Yes
HIGH	FLOAT	Yes	1	0	Yes	Yes	No	Yes
LOW	FLOAT	Yes	1	0	Yes	Yes	No	Yes
BRSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HHSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LLSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
LSV	GBLCHOICE	Yes	1	0	Yes	Yes	No	Yes
HYST	DOUBLE	Yes	1	0	Yes	Yes	No	No
ADEL	DOUBLE	Yes	1	0	Yes	Yes	No	No
MDEL	DOUBLE	Yes	1	0	Yes	Yes	No	No
LALM	DOUBLE	No	3	0	Yes	No	No	No
ALST	DOUBLE	No	3	0	Yes	No	No	No
MLST	DOUBLE	No	3	0	Yes	No	No	No

28.2 Field Descriptions

VAL Value Field

This field is determined by the subroutine as a result of record processing.

INAM Initialization Name

This is the name of the initialization entry. It is called once at record initialization time.

SNAM Subroutine Name

This the the name of the processing routine. It is called by the the record processing routine.

SADR Subroutine Address. Filled in by record processing.

STYP Subroutine Symbol Type. Filled in by record processing.

INPA,...,INPL Input Link A, Input Link B, ..

The input links. Each may be a constant, a database link, or a channel access link. Any link not defined is ignored.

A,...,L A, B, ...

The input values If the corresponding INP field is a constant, this field is initialized with the constant value but can be changed via dbPuts.

LA,...,LL Last A, Last B, ...

Previous input values These fields are used to decide when to trigger monitors on A,...,L.

PREC Display Precision

Precision with which to display VAL. This field is not used by record support other than to supply a value when get_precision is called.

EGU Engineering Units

ASCII string describing Engineering units. This field is not used by record support other than to supply a units description string when get_units is called.

HOPR High Operating Range
LOPR Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double.

HIHI Hihi Alarm Limit
HIGH High Alarm Limit
LOW Low Alarm Limit
LOLO Lolo Alarm Limit
BRSV Severity for a subroutine return value less than 0.
HHSV Severity for a Hihi Alarm
HSV Severity for a High Alarm
LSV Severity for a Low Alarm
LLSV Severity for a Lolo Alarm

These fields specify the alarm limits and severities.

HYST Alarm Deadband
ADEL Archive Deadband

MDEL Monitor, i.e. value change, Deadband

These parameters specify hysteresis factors for triggering monitor callbacks, i.e. monitors specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.

LALM Value when last monitors for alarm were triggered
ALST Value when last monitors for archiver were triggered
MLST Value when last monitors for value changes were triggered

These fields are used to implement the hysteresis factors for monitors.

28.3 Record Support Routines

init_record For each constant input link, the corresponding value field is initialized with the constant value. For each input link that is of type PV_LINK, a channel access link is created. If an initialization subroutine is defined, it is located and called. The processing subroutine is located and its address and type stored in SADR and STYP.

process See next section.

get_value Fills in the values of struct valueDes so that they refer to VAL.

get_units Retrieves EGU.

get_precision Retrieves PREC.

get_graphic_double Sets the upper display and lower display limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double Sets the upper control and the lower control limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_alarm_double Sets the following values:

upper_alarm_limit = hihi
upper_warning_limit = high
lower_warning_limit = low
lower_alarm_limit = lolo

28.4 Record Processing

Routine process implements the following algorithm:

1 If PACT is False then fetch all arguments.

2 Call the subroutine and check return value.

Call subroutine
Set PACT True
If return value is 1, return

3 Check alarms

This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set. It also honors the alarm hysteresis factor (HYST). Thus the value must change by more than HYST before the alarm status and severity is lowered.

4 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if ADEL and MDEL conditions are met. Monitors for A–L are are invoked if value has changed. NSEV and NSTA are reset to 0.

5 Scans forward link if necessary, sets PACT False, and returns.

28.5 Example Synchronous Subroutine

This is an example that merely increments VAL each time process is called.

```
#include        <vxWorks.h>
#include        <types.h>
#include        <stdioLib.h>

#include        <dbDefs.h>
#include        <subRecord.h>
#include        <dbCommon.h>
#include        <recSup.h>


long subInit(psub)
    struct subRecord     *psub;
{
    printf("subInit was called\n");
    return(0);
}

long subProcess(psub)
    struct subRecord     *psub;
{

    psub->val++;
```

```
    return(0);
}
```

28.6 Example Asynchronous Subroutine

This example shows an asynchronous subroutine. It uses (actually misuses) fields a and b. Field a is taken as the number of seconds until asynchronous completion. Field b is a flag to decide if messages should be printed. Lets assume a>0 and b=1. The following sequence of actions will occur:

1 subProcess is called with PACT False. It performs the following steps.

   a Computes, from a, the number of ticks until asynchronous completion should occur.

   b Prints a message stating that it is requesting an asynchronous callback.

   c Calls the vxWorks watchdog start routine. The routine callbackRequest is described in Part 1 of this manual.

   d Returns a value of 1. This tells record support to complete without checking alarms, monitors, or the forward link.

2 When the time expires, the system wide callback task calls myCallback. myCallback locks the record, calls process, and unlocks the record.

3 Process again calls subProcess, but now PACT is True. Thus the following is done:

   a VAL is incremented.

   b A completion message is printed.

   c subProcess returns 0. The record processing routine will complete record processing.

```
#include       <vxWorks.h>
#include       <types.h>
#include       <stdioLib.h>
#include       <wdLib.h>

#include       <callback.h>
#include       <dbDefs.h>
#include       <dbAccess.h>
#include       <subRecord.h>

/* control block for callback*/
struct callback {
        CALLBACK       callback;
        struct dbCommon *precord;
        WDOG_ID wd_id;
};

void myCallback(pcallback)
    struct callback *pcallback;
{
    struct dbCommon *precord=pcallback->precord;
    struct rset     *prset=(struct rset *)(precord->rset);

    dbScanLock(precord);
    (*prset->process)(precord);
```

```
    dbScanUnlock(precord);
}

long subInit(psub)
    struct subRecord  *psub;
{
    struct callback *pcallback;

    pcallback = (struct callback *)(calloc(1,sizeof(struct callback)));
    psub->dpvt = (void *)pcallback;
    callbackSetCallback(myCallback,pcallback);
    pcallback->precord = (struct dbCommon *)psub;
    pcallback->wd_id = wdCreate();
    printf("subInit was called\n");
    return(0);
}

long subProcess(psub)
    struct subRecord  *psub;
{
    struct callback *pcallback=(struct callback *)(psub->dpvt);
    int        wait_time;

    /* sub.inp must be a CONSTANT*/
       if(psub->pact) {
               psub->val++;
               if(psub->b)
                       printf("%s subProcess Completed\n",psub->name);
                       return(0);
       } else {
               wait_time = (long)(psub->a * vxTicksPerSecond);
               if(wait_time<=0){
                       if (psub->b)
                               printf("%s subProcess synchronous proces-
sing\n",psub->name);
                               return(0);
               }
               if (psub->b){
                       callbackSetPriority(psub->prio,pcallback);
                       printf("%s Starting asynchronous processing\n",psub->name);
                       wdStart(pcallback->wd_id,wait_time,callbackRequest,(int)pcallback);
                       return(1);
               }
       }
    return(0);
}
```

CHAPTER 29 Timer

The functions of this record have been replaced by the pulseCounter, pulseDelay, pulseTrain, and Event records. The Timer record type is included for upward compatibility.

This record type interacts with timer modules.

29.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
TORG	INLINK	Yes	1	0	No			
OUT	OUTLINK	Yes	1	0	No			
VAL	SHORT	No	0	0	Yes	Yes	Yes	Yes
TSRC	RECCHOICE	Yes	1	0	Yes	Yes	No	No
PTST	RECCHOICE	Yes	1	0	Yes	Yes	No	No
TEVT	SHORT	Yes	1	0	Yes	Yes	No	Yes
PREC	SHORT	Yes	1	0	Yes	Yes	No	No
TIMU	RECCHOICE	Yes	1	0	Yes	Yes	No	No
MAIN	GBLCHOICE	Yes	1	1	Yes	Yes	No	Yes
RDT1	FLOAT	No	1	0	Yes	Yes	No	No
RDW1	FLOAT	No	1	0	Yes	Yes	No	No
PDLY	FLOAT	Yes	1	0	Yes	Yes	No	No
DUT1	FLOAT	Yes	1	0	Yes	Yes	No	Yes
OPW1	FLOAT	Yes	1	0	Yes	Yes	No	Yes
DUT2	FLOAT	Yes	1	0	Yes	Yes	No	Yes
OPW2	FLOAT	Yes	1	0	Yes	Yes	No	Yes
DUT3	FLOAT	Yes	1	0	Yes	Yes	No	Yes
OPW3	FLOAT	Yes	1	0	Yes	Yes	No	Yes
DUT4	FLOAT	Yes	1	0	Yes	Yes	No	Yes
OPW4	FLOAT	Yes	1	0	Yes	Yes	No	Yes
DUT5	FLOAT	Yes	1	0	Yes	Yes	No	Yes
OPW5	FLOAT	Yes	1	0	Yes	Yes	No	Yes
T1DL	DOUBLE	No	2	0	Yes	Yes	No	No
T1WD	DOUBLE	No	2	0	Yes	Yes	Yes	No
T2DL	DOUBLE	No	2	0	Yes	Yes	No	No
T2WD	DOUBLE	No	2	0	Yes	Yes	No	No
T3DL	DOUBLE	No	2	0	Yes	Yes	No	No
T3WD	DOUBLE	No	2	0	Yes	Yes	No	No
T4DL	DOUBLE	No	2	0	Yes	Yes	No	No
T4WD	DOUBLE	No	2	0	Yes	Yes	No	No
T5DL	DOUBLE	No	2	0	Yes	Yes	No	No
T5WD	DOUBLE	No	2	0	Yes	Yes	No	No
T1TD	FLOAT	No	2	0	Yes	Yes	Yes	No
T1LD	FLOAT	No	2	0	Yes	Yes	Yes	No
T2TD	FLOAT	No	2	0	Yes	Yes	No	No
T2LD	FLOAT	No	2	0	Yes	Yes	No	No
T3TD	FLOAT	No	2	0	Yes	Yes	No	No

T3LD	FLOAT	No	2	0	Yes	Yes	No	No
T4TD	FLOAT	No	2	0	Yes	Yes	No	No
T4LD	FLOAT	No	2	0	Yes	Yes	No	No
T5TD	FLOAT	No	2	0	Yes	Yes	No	No
T5LD	FLOAT	No	2	0	Yes	Yes	No	No
TRDL	FLOAT	No	2	0	Yes	Yes	No	No
TDIS	SHORT	No	2	0	Yes	Yes	No	Yes

29.2 Field Descriptions

TORG — Trigger Delay Origin, an input link.

This is a link specifying the location of the trigger delay value. This must be a constant, a database link, or a channel access link. If TORG is a database link, then TRDL is read from TORG.

OUT — Output Link

This field is used by the device support routines to decide where to send output.

VAL — Value Field. This field is used only to force record processing

TSRC — Clock source: external or internal

PTST — Pre trigger state: low or high

TEVT — Event number to be posted on trigger

PREC — Display Precision

TIMU — Timer units: milli, micro, nano. pico seconds

RDW1 — Reboot width of 1.

DUTi — Delay width for trigger i, in timer units.

OPWi — Output pulse width for trigger i, in timer units.

TiDL — Delay width for trigger i, in seconds.

TiWD — Pulse width of trigger i, in seconds.

TiTD	Trailing delay of trigger i. (TiLD+OPWi)
TiLD	Leading delay of trigger i. (DUTi+TRDL)
TRDL	Trigger delay, obtained from trigger delay origin TORG.
TDIS	Timing pulse disable

29.3 Record Support Routines

init_record	
process	See next section.
get_value	Fills in the values of struct valueDes so that they refer to the array.

29.4 Record Processing

This section not yet written.

29.5 Device Support

Currently device support is intimately combined with record support.

CHAPTER 30 Waveform

This record type stores arrays is data. The array can contain any of the supported data types.

30.1 Field Summary

Field	Type	DCT	Interest	Initial	Access	Modify	Monitor	PP
VAL	See FTVL	No	0	0	Yes	Yes	Yes	Yes
RARM	SHORT	Yes	1	0	Yes	Yes	No	Yes
PREC	SHORT	Yes	1	0	Yes	Yes	No	No
INP	INLINK	Yes	1	0	No			
EGU	STRING	Yes	1	null	Yes	Yes	No	No
HOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
LOPR	FLOAT	Yes	1	0	Yes	Yes	No	No
NELM	ULONG	Yes	1	1	Yes	No	No	
FTVL	GBLCHOICE	Yes	1	0	Yes	No	No	
BPTR	NOACCESS	No	4					
NORD	ULONG	No	0	0	Yes	No	No	
BUSY	SHORT	No	0	0	Yes	No	No	
SIOL	INLINK	Yes	1	0	No			
SIML	INLINK	Yes	1	0	No			
SIMM	GBLCHOICE	No	1	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	1	0	Yes	Yes	No	No

30.2 Field Descriptions

VAL Value Field

This is used to reference the array.

RARM Rearm.

When set to 1, the device will be rearmed.

PREC Display Precision

Precision with which to display VAL. This field is not used by record support other than to supply a value when get_precision is called.

INP Input Link

This field is used by the device support routines to obtain input.

EGU Engineering Units

ASCII string describing Engineering units. This field is not used by record support other than to supply a units description string when get_units is called.

HOPR High Operating Range
LOPR Low Operating Range

These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are not used by the record support routines themselves other than to honor calls to get_graphic_double or get_control_double.

NELM Number of Elements, in array.

FTVL Field Type of Value. This is DBF_STRING, ... , DBF_ENUM.

BPTR Buffer Pointer. Holds address of array.

NORD Number of Elements Read.

BUSY Busy. Is device busy?

30.3 Record Support Routines

init_record Using NELM and FTVL space for the array is allocated. The array address is stored in the record. This routine initializes SIMM with the value of SIML if SIML type is CONSTANT link or creates a channel access link if SIML type is PV_LINK. VAL is likewise initialized if SIOL is CONSTANT or PV_LINK. This routine next checks to see that device support is available and a device support read routine is defined. If either does not exist, an error message is issued and processing is terminated. If device support includes init_record, it is called.

process See next section.

get_value Fills in the values of struct valueDes so that they refer to the array.

cvt_dbaddr This is called by dbNameToAddr. It makes the dbAddr structure refer to the actual buffer holding the result.

get_array_info Obtains values from the array referenced by VAL.

put_array_info Writes values into the array referenced by VAL.

get_units Retrieves EGU.

get_prec Retrieves PREC.

get_graphic_double Sets the upper display and lower display limits for a field. If the field is VAL the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_control_double Sets the upper control and the lower control limits for a field. If the field is VAL the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

get_graphic_double Sets the following values:

upper_disp_limit = hopr
lower_disp_limit = lopr

get_control_double Sets the following values

upper_ctrl_limit = hopr
lower_ctrl_limit = lopr

30.4 Record Processing

Routine process implements the following algorithm:

1 Checks to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to True. This ensures that another process will no longer be called for this record. Thus error storms will not occur.

2 Call device support read routine.

3 If PACT has been changed to True, the device support read routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving PACT True.

4 Checks to see if monitors should be invoked

Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are always invoked. NSEV and NSTA are reset to 0.

5 Scans forward link if necessary, sets PACT False, and returns.

30.5 Device Support

30.5.1 Fields of interest to device support

Each waveform record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new array value whenever read_wf is called. The device support routines are primarily interested in the following fields:

PACT, DPVT	See Chapter titled Fields Common to All Record Types for description.
INP	This field is used by the device support routines to locate its input.
NSEV,NSTA	See Chapter titled Fields Common to All Record Types for description.
RATE	Sampling rate. Some device support modules may find this useful.
PTSS	Pretrigger samples. Some device support modules may find this useful.
NELM	Number of elements in array.
FTVL	Field type of value. This is DBF_STRING, ... , DBF_ENUM. The device support routine should check that this is correctly defined.
RARM	Rearm. When set to 1, the device will be rearmed. The device support routine should reset it to 0 when done.
BPTR	Holds address of array.
NORD	Number of elements read. Device support must set this value when it completes.
BUSY	Is device busy?

30.5.2 Device Support routines

Device support consists of the following routines:

report(FILE fp, paddr)

Not currently used.

init()

This routine is called once during IOC initialization.

init_record(precord)

This routine is optional. If provided, it is called by the record support init_record routine.

get_ioint_info(int cmd,struct dbCommon *precord,IOSCANPVT *ppvt)

This routine is called by the ioEventScan system each time the record is added or deleted form an I/O event scan list. cmd has the value (0,1) if the record is being (added to , deleted from) an I/O event list. It must be provided for any device type that can use the ioEvent scanner.

read_wf(precord)

This routine must provide a new input value. It returns the following values:

0	Success.
other	Error.

30.6 Device support for soft records

If INP is a constant link, then read_wf does nothing. In this case, the record can be used to hold arrays written via dbPuts. If INP is a database or channel access link, the new array value is read from the link. NORD is set.

30.7 Device support for soft records

This module places a value directly in VAL.

If the INP link type is constant, then NORD is set to zero. If the INP link type is PV_LINK, then dbCaAddInlink is called by init_record.

Read_wf calls recGblGetLinkValue which performs the following steps:

If the INP link type is CONSTANT recGblGetLinkValue does nothing.

If the INP link type is DB_LINK, then dbGetLink is called to obtain a new input value. If dbGetLink returns an error, a LINK_ALARM with a severity of INVALID_ALARM is raised.

If the INP link type is CA_LINK, then dbCaGetLink is called to obtain a new input value. If dbCaGetLink returns an error, a LINK_ALARM with a severity of INVALID_ALARM is raised.

NORD is set to the number of values returned and read_wf returns.