in activity SCMU, the positive, negative, and zero sequence branch currents on zero impedance lines are determined and preserved, and are subsequently available to activity SCOP. In the ACCC, as well as activity ASCC and in the linearized network analysis activities, zero impedance line results are calculated and reported as needed.

The remainder of this section contains points to be noted, and restrictions to be observed, in using zero impedance lines.

Branch impedances may not be specified as identically zero; a non-zero reactance must be specified for all branches, and those meeting the criteria above are treated as zero impedance lines.

The zero impedance line threshold tolerance, THRSHZ, may be changed using the category of solution parameter data via activity CHNG or the *[Solution Parameters]* dialog. Setting THRSHZ to zero disables zero impedance line modeling, and all branches are represented with their specified impedances.

A zero impedance line may not have a transformer in parallel with it. Although not required, it is recommended that *no* other in-service lines exist in parallel with a zero impedance line.

A zero impedance line may have non-zero values of line charging and/or line connected shunts. This allows, for example, a low impedance cable to be modeled as a zero impedance line.

When more than two buses are connected together by zero impedance lines in a loop arrangement, there is no unique solution to the flows on the individual zero impedance lines that form the loop. In this case, the reactances specified for these branches is used in determining the zero impedance line flows.

It is important to note that buses connected together by zero impedance lines are treated as a single bus by the power flow solution activities. Hence, equipment controlling the voltages of multiple buses in a zero impedance connected group of buses must have coordinated voltage schedules (i.e., the same voltage setpoint should be specified for each of the voltage controlling devices). Activity CNTB recognizes this condition in scanning for conflicting voltage objectives, and activity REGB may be used to generate a regulated bus report.

Similarly, if multiple voltage controlling devices are present in a group of buses connected together by zero impedance lines, the power flow solution activities handle the boundary condition as if they are all connected to the same bus (refer to Setpoint Voltage Control).

In fault analysis activities, a branch treated as a zero impedance line in the positive sequence is treated in the same manner in the zero sequence, regardless of its zero sequence branch impedance. Zero sequence mutual couplings involving a zero impedance line are ignored in the fault analysis solution activities.

1.12. System Switching Device Data

Breakers and switches can be represented by system switching devices in PSSE. System switching devices are set to represent breakers or switches by setting the STYPE data element described below.

Most activities do not honor the system switching devices. System switching devices are treated as zero impedance lines if they have characteristics of zero impedance lines; otherwise, they are treated as regular non-transformer branches.

System switching devices are recognized in Substation Reliability Assessment (refer to Section 6.16, Calculating Substation Reliability) and activity DFAX. Substation Reliability Assessment simulates operations of breakers to isolate faults in a substation and manual switching to restore the service to supply loads. Distribution Factor File setup activity can process automatic commands to operate and monitor breakers and switches in Contingency Description Data File and Monitored Element Data File respectively.

As mentioned in the section Zero Impedance Lines, PSSE is able to handle a loop arrangement consisting of zero impedance lines so that users can build a fully detailed bus/breaker model for any bus configuration, such as a ring bus configuration. When adding a system switching device into a network model, connectivity nodes where the terminals of a transmission line connect to the terminals of the system switching device must be added as well. This will change a bus branch configuration which is widely used in planning studies to a detailed bus breaker configuration and lead to a tremendous increase in number of buses. In such cases as this, the use of the the use of the extensive substation modeling capabilities introduced in PSSE 34 is recommended.

```
I, J, CKT, X, RATE1...RATE12, STATUS, NSTATUS, METERED, STYPE, 'NAME'
```

RAWX Data Table Format

```
"sysswd":{
    "fields":["ibus", "jbus", "ckt", "xpu",
              "rate1", "rate2", "rate3", "rate4", "rate5", "rate6",
              "rate7", "rate8", "rate9", "rate10", "rate11", "rate12",
              "stat", "nstat", "met", "stype", "name"],
    "data":[
        [151, 201, "*1", 1.0E-4, 1206.0, 1106.0, 1006.0, 0.0, 0.0, 0.0,
         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 1, 1, 2, 3, ""],
        ...

        [153, 3006, "@1", 1.0E-4, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
         0.0, 0.0, 0.0, 0.0, 0.0, 1, 1, 2, 2, ""]
    ]
}
```

Field	RAWX Key	Description
I	ibus	From bus number. No default allowed
J	jbus	To bus number. No default allowed
CKT	ckt	Two-character uppercase non-blank alphanumeric switching device identifier. CKT = '1' by default
X	xpu	Branch reactance; entered in pu, must be less than ZTHRES
RATEn	rate1, rate2, rate3, rate4, rate5, rate6, rate7, rate8, rate9,	nth rating; entered in either MVA or current expressed as MVA, according to the value specified for NXFRAT specified on the first data record (refer to Case Identification Data).

Field	RAWX Key	Description
	rate10, rate11, rate12	Each RATEn = 0.0 (bypass check for this branch; this branch will not be included in any examination of circuit loading) by default. Refer to activity RATE.
STATUS	stat	Switching device status 0 - Open 1 - Closed 2 - Stuck closed STATUS = 1 by default
NSTAT	nstat	Switching device normal status 0 - Open 1 - Closed 2 - Stuck closed NSTAT = 1 by default
METERD	met	Metered end
STYPE	stype	Switching device type 1 - Generic connector 2 - Circuit breaker 3 - Disconnect switch
NAME	name	System switching device name

System Switching Device data input is terminated with a record specifying a from bus number of zero.

1.13. Transformer Data

Each ac transformer to be represented in PSSE is introduced through transformer data record blocks that specify all the data required to model transformers in power flow calculations, with one exception. That exception is an optional set of ancillary data, transformer impedance correction tables, which define the manner in which transformer impedance changes as off-nominal turns ratio or phase shift angle is adjusted. Those data records are described in Transformer Impedance Cor.

Both two-winding and three-winding transformers are specified in transformer data record blocks. Two-winding transformers require a block of four data records. Three-winding transformers require five data records.