

CMPLDW Support in PowerWorld Simulator



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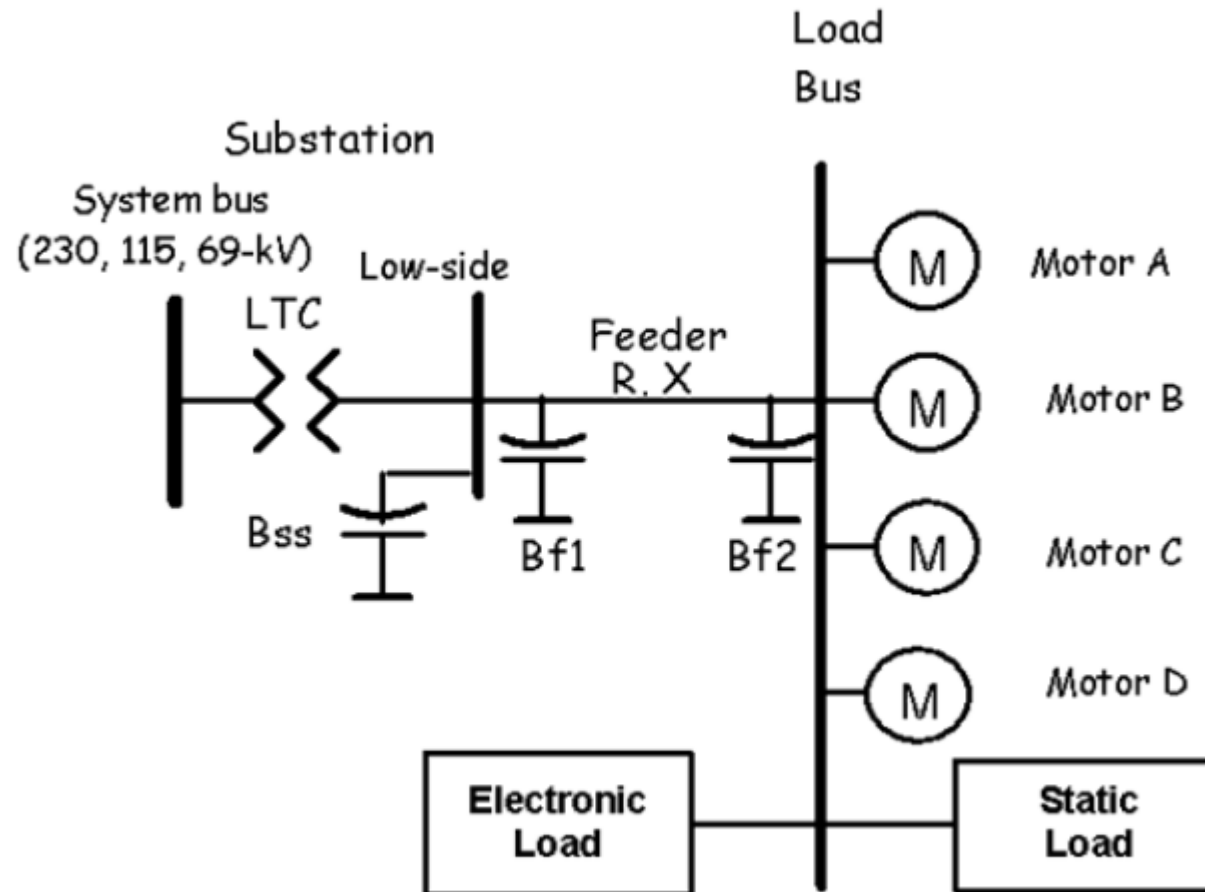


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CMPLDW Model



CMPLDW Model



- Data management issue
 - Up to 130 parameters
 - Number of parameters can differ depending on the type of motor models used
 - Pushing the limits of how much data can be reasonably managed
 - Proposal is to add even more parameters with the addition of a PV model
 - What about pluggable hybrid cars?
 - What about controllable distribution loads?

Better Data Management



- Hundreds or thousands of loads with the same CMPLDW parameters
 - MOTORW too
- Group together models with the same parameters
- Create new objects in Simulator
 - Load Model Groups
 - Load Distribution Equivalent Types

Load Model Use



Model Explorer: Load Model Use

Load Model Summary

Filter: Advanced | Load

	Number of Bus	Name of Bus	ID	Status	MW	Mvar	Load Model Group	Distribution Equivalent Type
1	10005	ALCAZAR	1	Closed	18.13	-0.81	HID4	RES 43
2	10008	ALLISON	1	Closed	9.64	3.17	HID	COM31
3	10013	ANDERSON	1	Closed	8.98	-0.97	HID4	RES 11
4	10015	ARNO_1	1	Closed	3.61	0.04		
5	10017	ARRIBA	1	Closed	3.74	-0.32		
6	10020	ASPEN	1	Closed	19.25	3.91	HID4	RES 55
7	10022	AVILA	1	Closed	8.48	2.43	HID4	RES 90
8	10027	BACA	1	Closed	3.86	-0.64		
9	10029	BALL_PRK	1	Closed	1.72	-0.20		
10	10032	BECKNER	1	Closed	13.11	1.78	HID	COM22
11	10034	BEL_AIR	1	Closed	12.90	-0.23	HID4	RES 43
12	10036	ARNO_2	1	Closed	9.21	-0.77	HID4	RES 11
13	10037	FIRST_ST	1	Closed	12.75	4.63	HID4	RES 62
14	10040	BEV_WOOD	1	Closed	7.15	1.26	HID4	RES 35
15	10041	BISTI	1	Closed	7.50	4.28	HID3	RAG47
16	10043	BLCKRA	1	Closed	18.50	4.32	HID4	RES 35
17	10046	BOSQUE_F	1	Closed	4.81	-0.06		
18	10049	BROADWAY	1	Open	0.00	0.00		
19	10050	BUCKMAN	1	Closed	7.54	-1.78	HID	COM32
20	10051	BURNHAM	1	Closed	1.50	0.50		

Fields

Available Fields

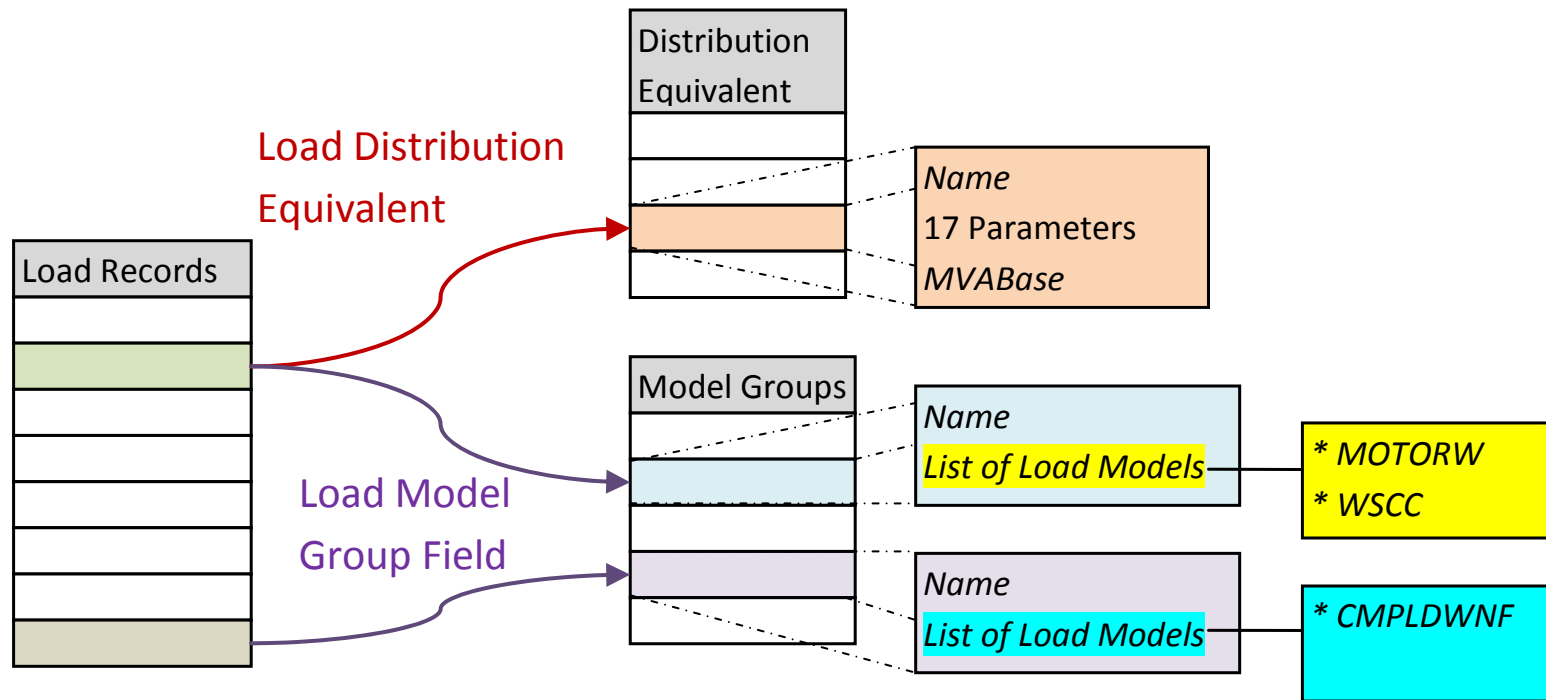
- Sensitivity of Bus
- Substation
- Super Area
- Time Step
- Transient Stability
 - Results
 - Save
 - Load Characteristic Name (Motor)
 - Load Characteristic Name (Static)
 - Load Distribution Equivalent Type
 - Load Model Group
 - Load Relay Name
- Voltage
- Zone
- Key Fields
- Required Fields
- Secondary Key Fields

Expand Collapse

Frozen Columns 1

Reset to Factory Defaults

Model Relationship



Load Model Group



- Identified by unique name
- List of Load Characteristic Models assigned to it
 - MOTORW, WSCC, CMPLDWNF, etc.
- Allows flexibility in grouping load characteristic models with the same parameters that area, zone, etc. aggregations do not
- May represent the behavior of a climate group
 - “High Desert”

Load Model Hierarchy



1. Load-specific
2. *NEW - Load Model Group-specific*
3. Bus-specific
4. Owner-specific
5. Zone-specific
6. Area-specific
7. System-specific
8. Default load modeling option with transient stability options

Load Model Group



Load Model Hierarchy

The screenshot displays the 'Model Explorer: Load Characteristics' window. The left-hand 'Explore' pane shows a hierarchical tree structure. A red box highlights the 'Load Model Group' section, which includes 'Load-Specific', 'Bus-Specific', 'Zone-Specific', 'Area-Specific', and 'System-Specific' sub-categories. A red arrow points from the title 'Load Model Hierarchy' to this highlighted area. The main window displays a table of 'Model Group CMPLDWNF' with the following data:

Element Type	ID	Name	Type	Device Status	FmA	FmB	FmC	FmD	Fel	PFel	Vd1	Vd2	frc
1	LoadModelGroup AGR	AGR	CMPLDWNF	Active	1	0	0	0	0	1	0.75	0.6	0
2	LoadModelGroup DSW2	Desert Southwest	CMPLDWNF	Active	0.31	0.122	0.052	0.129	0.157	1	0.7	0.5	0
3	LoadModelGroup DSW2	Desert Southwest	CMPLDWNF	Active	0.169	0.153	0.108	0.284	0.107	1	0.7	0.5	0
4	LoadModelGroup DSW3	Desert Southwest	CMPLDWNF	Active	0.096	0.168	0.027	0.484	0.088	1	0.7	0.5	0
5	LoadModelGroup DSW4	Desert Southwest	CMPLDWNF	Active	0.206	0.141	0.04	0.29	0.141	1	0.7	0.5	0
6	LoadModelGroup HID	High Desert	CMPLDWNF	Active	0.257	0.122	0.049	0.113	0.172	1	0.7	0.5	0
7	LoadModelGroup HID2	High Desert	CMPLDWNF	Active	0.171	0.133	0.041	0.254	0.158	1	0.7	0.5	0
8	LoadModelGroup HID3	High Desert	CMPLDWNF	Active	0.153	0.144	0.11	0.249	0.12	1	0.7	0.5	0
9	LoadModelGroup HID4	High Desert	CMPLDWNF	Active	0.079	0.151	0.032	0.424	0.109	1	0.7	0.5	0
10	LoadModelGroup IND	IND	CMPLDWNF	Active	0.05	0.55	0.25	0	0.12	1	0.75	0.6	0
11	LoadModelGroup IND2	IND	CMPLDWNF	Active	0.1	0.35	0.1	0	0.4	1	0.75	0.6	0
12	LoadModelGroup IND3	IND	CMPLDWNF	Active	0.2	0.35	0.35	0	0.05	1	0.75	0.6	0
13	LoadModelGroup IND4	IND	CMPLDWNF	Active	0.15	0.25	0.4	0	0.15	1	0.75	0.6	0
14	LoadModelGroup IND5	IND	CMPLDWNF	Active	0.25	0.1	0.05	0	0.65	1	0.75	0.6	0
15	LoadModelGroup IND6	IND	CMPLDWNF	Active	0.2	0.25	0.3	0	0.2	1	0.75	0.6	0
16	LoadModelGroup IND7	IND	CMPLDWNF	Active	0.1	0.25	0.4	0	0.2	1	0.75	0.6	0
17	LoadModelGroup NCC	Northern California Coast	CMPLDWNF	Active	0.236	0.115	0.05	0.063	0.208	1	0.7	0.5	0
18	LoadModelGroup NCC2	Northern California Coast	CMPLDWNF	Active	0.151	0.116	0.122	0.144	0.156	1	0.7	0.5	0
19	LoadModelGroup NCC3	Northern California Coast	CMPLDWNF	Active	0.161	0.108	0.05	0.146	0.204	1	0.7	0.5	0
20	LoadModelGroup NCC4	Northern California Coast	CMPLDWNF	Active	0.076	0.103	0.052	0.25	0.166	1	0.7	0.5	0
21	LoadModelGroup NCI	Northern California Inland	CMPLDWNF	Active	0.089	0.135	0.038	0.361	0.133	1	0.7	0.5	0
22	LoadModelGroup NCI2	Northern California Inland	CMPLDWNF	Active	0.163	0.134	0.114	0.206	0.137	1	0.7	0.5	0
23	LoadModelGroup NCI3	Northern California Inland	CMPLDWNF	Active	0.186	0.123	0.041	0.208	0.184	1	0.7	0.5	0
24	LoadModelGroup NCI4	Northern California Inland	CMPLDWNF	Active	0.271	0.118	0.044	0.09	0.199	1	0.7	0.5	0
25	LoadModelGroup NCV	Northern California Valley	CMPLDWNF	Active	0.112	0.15	0.032	0.422	0.109	1	0.7	0.5	0
26	LoadModelGroup NCV2	Northern California Valley	CMPLDWNF	Active	0.184	0.141	0.111	0.242	0.121	1	0.7	0.5	0
27	LoadModelGroup NCV3	Northern California Valley	CMPLDWNF	Active	0.231	0.126	0.04	0.244	0.161	1	0.7	0.5	0
28	LoadModelGroup NCV4	Northern California Valley	CMPLDWNF	Active	0.337	0.111	0.048	0.105	0.176	1	0.7	0.5	0
29	LoadModelGroup NWC	Northwest Coast	CMPLDWNF	Active	0.137	0.094	0.047	0.089	0.206	1	0.7	0.5	0
30	LoadModelGroup NWC2	Northwest Coast	CMPLDWNF	Active	0.139	0.102	0.12	0.088	0.155	1	0.7	0.5	0
31	LoadModelGroup NWC3	Northwest Coast	CMPLDWNF	Active	0.201	0.112	0.046	0.039	0.216	1	0.7	0.5	0

Load Distribution Equivalent



- Supplementary model that defines an equivalent of the distribution system's transformer, capacitors, and feeder
- Created independently of the load characteristic models
- Can be used with any load characteristic model
- Design assumes small number of Load Distribution Equivalent Types with many different loads assigned to each

Load Distribution Equivalent



- First 17 parameters of the CMPLDW load characteristic model along with MVA base

Model Explorer: Load Distribution Equivalent Type

Distribution Equivalent Type

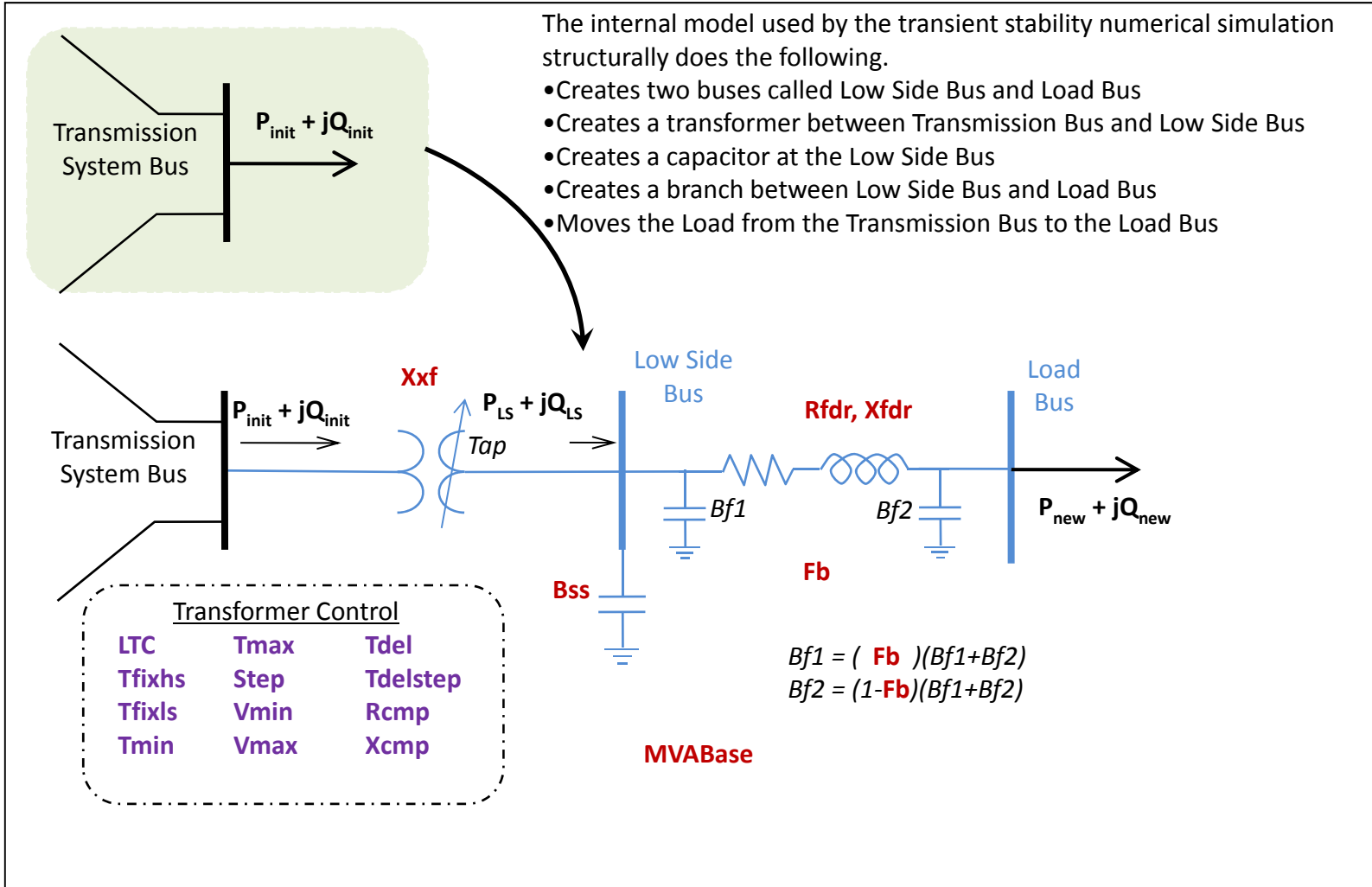
Records Set Columns

Filter Find... Remove Quick Filter...

	Name	Long Name	Mbase	Bss	Rfdr	Xfdr	Fb	Xxf	Tfixhs	Tfixls	LTC	Tmin	Tmax	step	Vmin	Vmax	Tdel	Tdelstep	Rcmp	Xcmp
1	AUX	AUX	0	0	0	0.01	1	0.08	1	1	0	0.9	1.1	0.00625	1.025	1.04	0	0	0	0
2	COM	Commercial	0	0	0.0216	0.027	0.75	0	1	1	0	1	1	0.001	1	1	0	0	0	0
3	COM 2	Commercial	0	0	0.036	0.045	0.78	0.08	1	1	1	0.9	1.1	0.00625	1.025	1.04	30	5	0	0
4	COM 3	Commercial	0	0	0.0328	0.041	0.75	0.08	1	1	0	0.9	1.1	0.00625	1	1.02	30	5	0	0
5	COM 4	Commercial	0	0	0.036	0.045	0.76	0.08	1	1	1	0.9	1.1	0.00625	1.025	1.04	30	5	0	0
6	COM 5	Commercial	0	0	0.0224	0.028	0.76	0	1	1	0	1	1	0.001	1	1	0	0	0	0
7	COM 6	Commercial	0	0	0.0232	0.029	0.74	0	1	1	0	1	1	0.001	1	1	0	0	0	0

Search Search Now Options

Modeling Distribution Equivalent



Distribution Equivalent Initialization



- MVABase determines the *DistEquivMVABase*
 - (MVABase > 0) then *DistEquivMVABase* = MVABase
 - (MVABase < 0) then *DistEquivMVABase* = Pinit/MVABase
 - (MVABase = 0) then *DistEquivMVABase* = Pinit/0.8
- Impedance parameters are on the *DistEquivMVABase* and are converted to system base
- Transformer taps and impedances are converted to the system MVA base on the fixed taps
- Transformer tap ratio set so that Low Side Bus voltage is equal to the average of Vmin and Vmax
- After converting the impedances and taps, Low Side Bus voltage and flow on the Low Side Bus ($P_{LS} + jQ_{LS}$) are calculated exactly
- Iterative process to determine $P_{new} + jQ_{new}$, Bf1, and Bf2 depending on the transient load model

Distribution Equivalent Initialization



- If Load Bus voltage falls below 0.95 per unit, feeder impedances R_{fdr} and X_{fdr} are reduced so that the Load Bus voltage is 0.95 per unit
 - There is no need to modify the input data to prevent the Load Bus voltage from being too small

New Model CMPLDWNF



- Identical to CMPLDW except that parameters for Load Distribution Equivalent have been removed (first 17 parameters and MVABase)

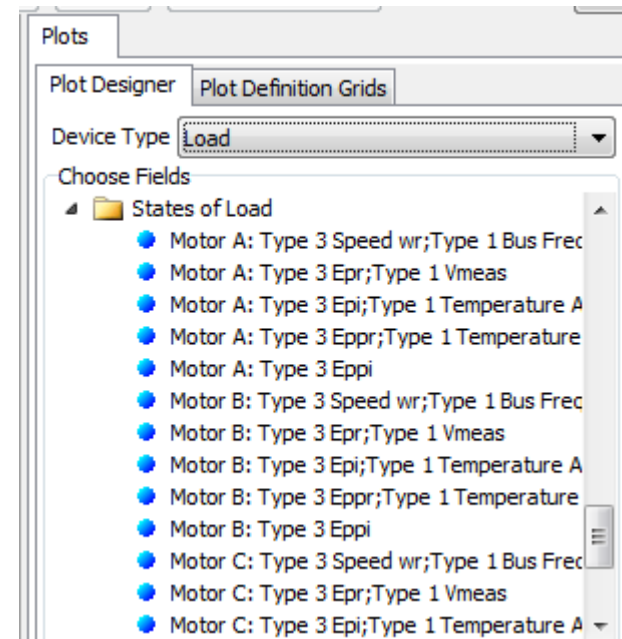
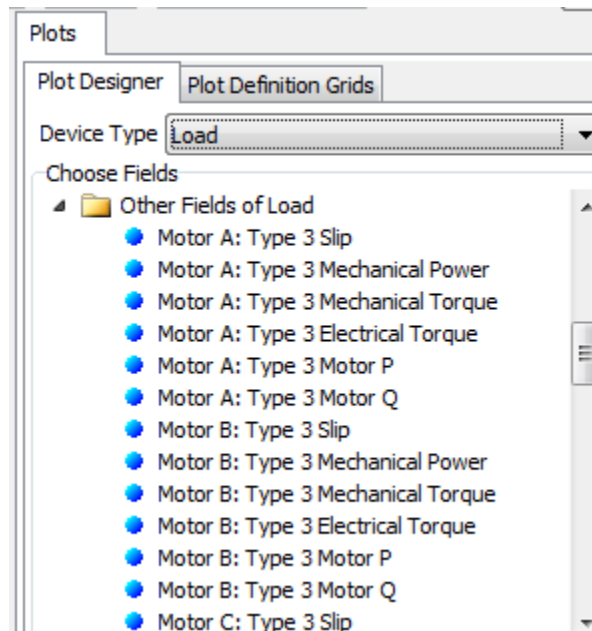
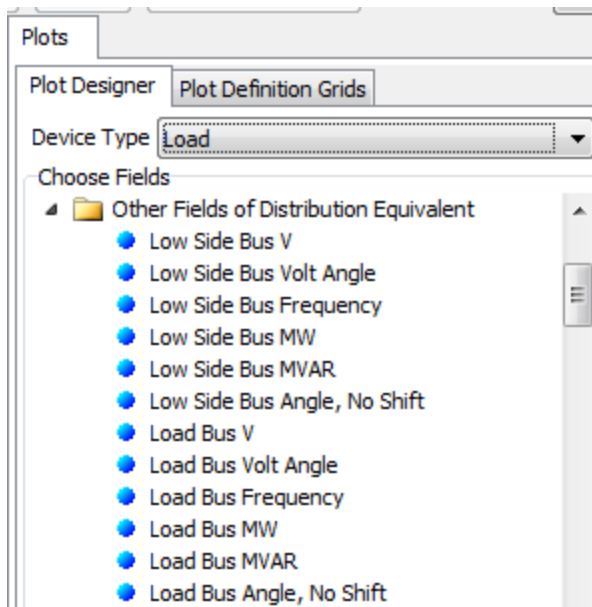
The screenshot shows the 'Load Characteristic Information' dialog box. The 'LoadModelGroup' is set to 'DSW'. The 'Type' is set to 'Active - CMPLDWNF'. The 'Active' checkbox is checked. The parameters are listed in a table below.

Parameter	Value	Parameter	Value	Parameter	Value
FmA	0.0960	P2e	1.0000	LFma	0.7500
FmB	0.1680	P2c	0.4526	Rsa_CompPFa	0.0400
FmC	0.0270	Pfrq	0.0000	Lsa_Vstalla	1.8000
FmD	0.4840	Q1e	2.0000	Lpa_Rstalla	0.1200
Fel	0.0880	Q1c	-0.5000	Lppa_Xstalla	0.1040
PFel	1.0000	Q2e	1.0000	Tpoa_Tstalla	0.0950
Vd1	0.7000	Q2c	1.5000	Tppoa_Frsta	0.0021
Vd2	0.5000	Qfrq	-1.0000	Ha_Vrsta	0.0500
frcl	0.7000	Mtypa	3.0000	Etrqa_Trsta	0.0000
PFs	-0.9973	Mtypb	3.0000	Ftr1a_Fuvra	0.7000
P1e	2.0000	Mtypc	3.0000	Vtr1a	0.0200
P1c	0.5474	Mtypd	1.0000	Ttr1a	0.2000

Load Fields and States



- Distribution equivalent related fields and CMPLDW fields and states are accessible through the load



Reading CMPLDW Records from DYD Files



- CMPLDW models are automatically split into separate Load Distribution Equivalent Type and CMPLDWNF models when reading a DYD file
 - Individual loads are assigned to a Load Model Group containing the CMPLDWNF model

Reading CMPLDW Records from DYD Files



- Long ID field in the EPC file determine the names of the Load Model Groups and Load Distribution Equivalent Types
 - Three characters for climate zone separated by an underscore followed by three characters for the feeder type
 - First three characters used to name Load Model Group
 - Last three characters used to name the Load Distribution Equivalent Type
 - “HID_RES” for High Desert climate zone with Residential feeder type

Reading CMPLDW Records from DYD Files



- Unique Load Distribution Equivalent Types
 - First 17 CMPLDW parameters
 - MVABase for the CMPLDW record
 - Last three characters (feeder type) of GE Long ID determine the Name
 - Name appended with numeric identifiers to ensure uniqueness

Reading CMPLDW Records from DYD Files



- Unique Load Model Group
 - Parameters 18 through 129 of CMPLDW record
 - First three characters (climate zone) of GE Long ID determine the Name
 - Name appended with numeric identifiers to ensure uniqueness

Reading CMPLDW Records from DYD Files



Model Explorer: Loads

Fields

Explore Fields

Find Field... Add ->

Available Fields <- Remove

- Custom
- Difference Flows
- EPC File
 - EPC Modification Status
 - Flagged for Delete in EPC
 - GE In Service Date
 - GE Long ID**
 - GE Normal Status
 - GE Project ID
 - GE Retirement Date
- Transient Stability
 - Results
 - Save
 - Load Characteristic Name (Motor)
 - Load Characteristic Name (Static)
 - Load Distribution Equivalent Type**
 - Load Model Group
 - Load Relay Name

Expand Collapse

Frozen Columns 1

Reset to Factory Defaults

Load Records Load Model Group Load Distribution Equivalent

Filter Advanced Load

	Number of Bus	Name of Bus	GE Long ID	Load Model Group	Distribution Equivalent Type
1	10005	ALCAZAR	HID_RES	HID4	RES 43
2	10008	ALLISON	HID_COM	HID	COM31
3	10013	ANDERSON	HID_RES	HID4	RES 11
4	10015	ARNO_1	HID_RES		
5	10017	ARRIBA	HID_RES		
6	10020	ASPEN	HID_RES	HID4	RES 55
7	10022	AVILA	HID_RES	HID4	RES 90
8	10027	BACA	HID_MIX		
9	10029	BALL_PRK	HID_RES		
10	10032	BECKNER	HID_COM	HID	COM22
11	10034	BEL_MIR	HID_RES	HID4	RES 43
12	10036	ARNO_2	HID_RES	HID4	RES 11
13	10037	FIRST_ST	HID_RES	HID4	RES 62
14	10040	BEV_WOOD	HID_RES	HID4	RES 35
15	10041	BISTI	HID_RAG	HID3	RAG47
16	10043	BLCKRA	HID_RES	HID4	RES 35
17	10046	BOSQUE_F	HID_RES		
	10049	BROADWAY			
19	10050	BUCKMAN	HID_COM	HID	COM32
20	10052	BURNHAM	HID_RAG		
21	10053	CAMEL_TR	HID_COM		
22	10056	CANYON	HID_RES		
23	10058	CAPITOL	HID_COM		
24	10061	CENTRALP	HID_RES	HID4	RES 90
25	10064	CHURCH_R	HID_RES		
26	10067	CLAREMNT	HID_COM	HID	COM53

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Writing CMPLDW Records to DYD Files



- CMPLDWNF records combined with Load Distribution Equivalent Type to write out appropriate CMPLDW model with each load

Reading and Writing MOTORW Records from DYD Files



- When reading a DYD file, MOTORW models are grouped together by identical parameters and MVABase
- Load Model Group with MOTORW model is created for each unique grouping
 - Load Model Group named “MOTORW”, “MOTORW 1”, “MOTORW 2”, etc.
- Loads are assigned to the appropriate Load Model Group
- When writing out to DYD, MOTORW models will be written as if they are assigned to the specific load record

