Table 1: Device Nameplate Ratings

	Cree CMF20120D	Infineon IPW90R120C3
V_{DS}	1200 V	900 V
I_{D_MAX} @ 25 ºC	33 A	36 A
$R_{DS\_ON(MAX)}$ @ 25 ºC	110 mΩ	120 mΩ

For each of the devices considered, the part number-specific SPICE model provided by the manufacturer was validated against multiple sources of open-source data. Four characteristics were used as the basis for this validation:

1. Forward conduction characteristics
2. Device capacitance curves
3. Transconductance curve
4. Time-domain CIL switching waveforms

Since the ultimate goal of this effort is to analyze the characteristics of the device under switching, the validation process was heavily weighted toward part (4), the time-domain switching waveforms. However, the authors recognize that there exist multiple solutions to the system of differential equations which underlie the time-domain curves produced by the SPICE simulation. The other three criteria (1)-(3) were used to inform this process to ensure that the selected solution can be reasonably explained by the selected physical device parameters. The following sections demonstrate the results of the validation of the manufacturer's SPICE models for each of the exemplar MOSFET's.

4.1 Cree CMF20120D Manufacturer Model Validation

As a first step toward validation of the Cree MOSFET manufacturer model, the forward conduction characteristics, device capacitance curves, and transconductance curve were compared to the plots appearing in the device datasheet. The results of these comparisons are shown in Figure 3 through Figure 5, respectively. Note that the fit of the model to the forward characteristic curves is not ideal. However, it should be noted that the manufacturer datasheet provides only a limited view of the forward characteristics, and this limited view is focused on the behavior of the device in the ohmic (triode) region. For the purpose of the analysis in this paper, the behavior of the device in the ohmic region is of limited importance. Much more critical to the accurate prediction of switching performance is the device intrinsic capacitance. Note that this aspect of the model is in strong agreement with the datasheet curves (Figure 4). The agreement of the transconductance curve is also relatively important to the fidelity of the time-domain waveforms, and this aspect of the model is also in good agreement with the datasheet curves (Figure 5). Note that no tuning was performed on this model in order to achieve the presented agreement with the datasheet curves. These plots represent the behavior of the model as received from the manufacturer.

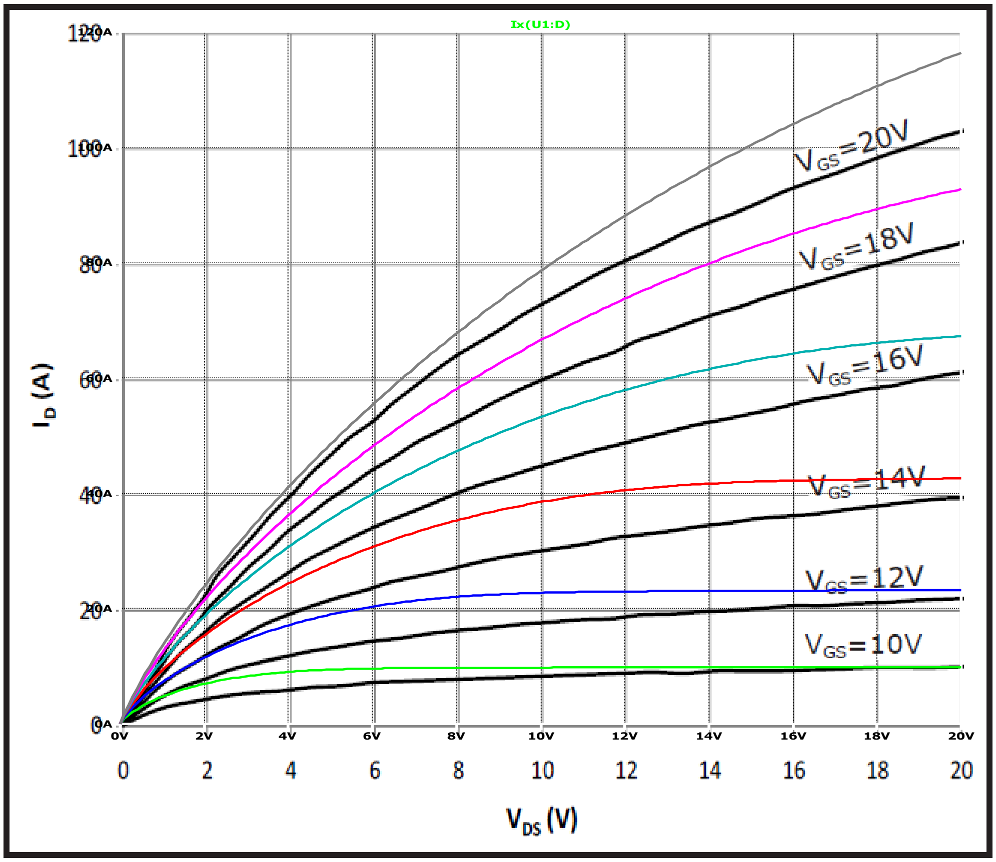

Figure 3: Cree CMF20120D Static Characterization

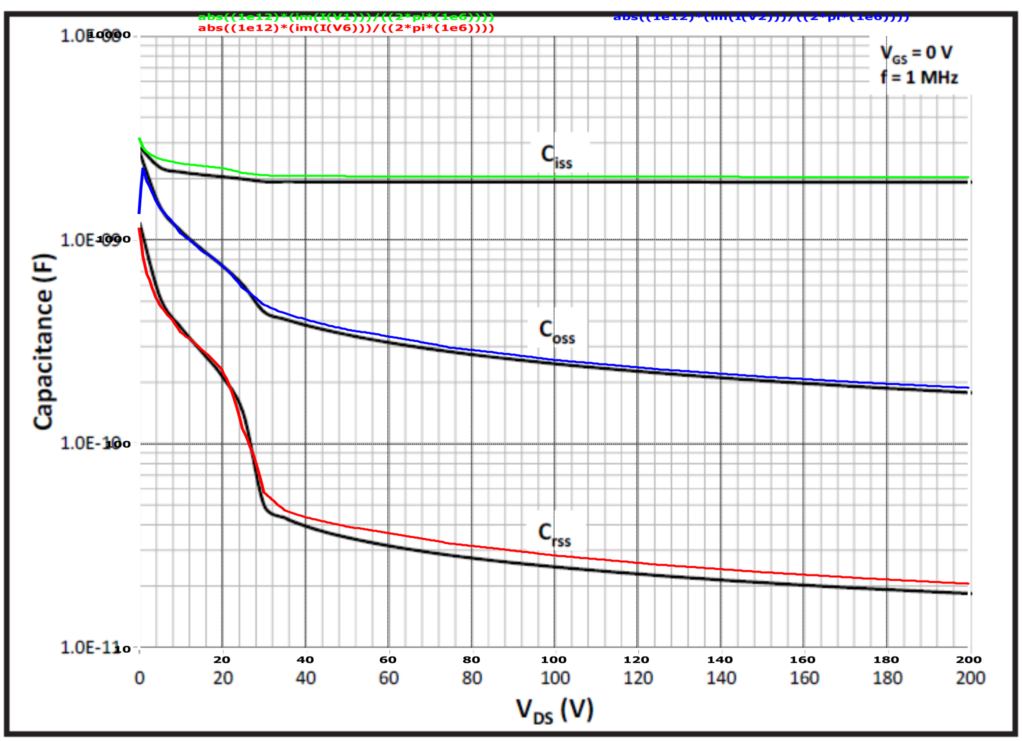

Figure 4: Cree CMF20120D Capacitance Characterization

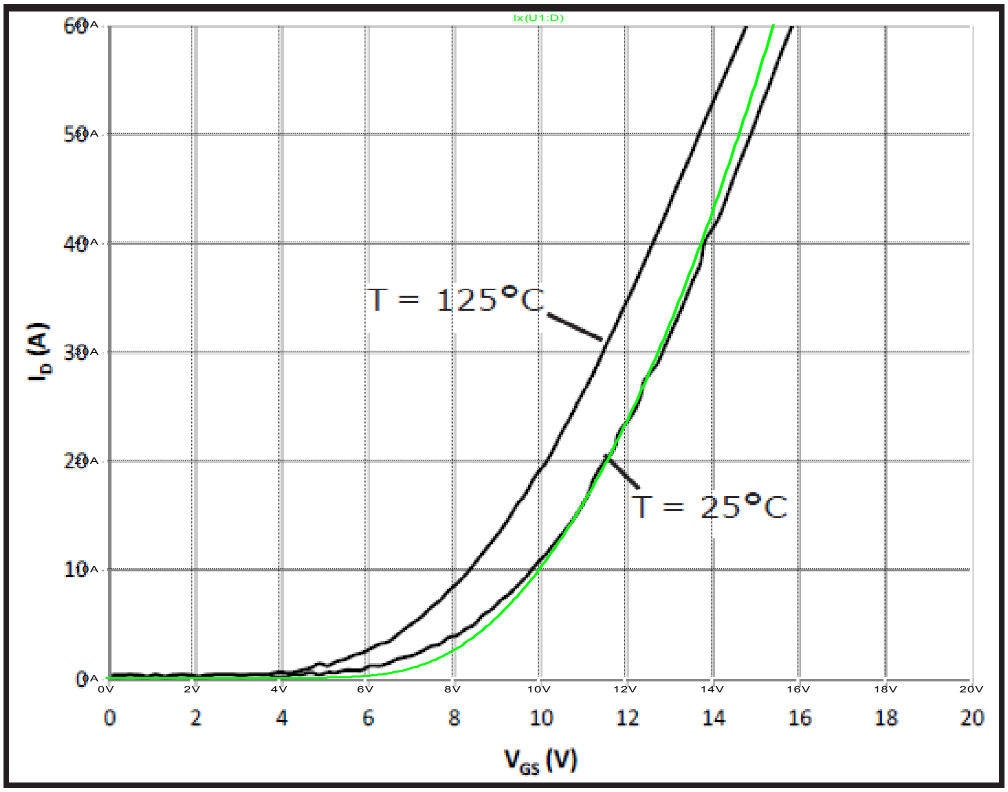

Figure 5: Cree CMF20120D Transconductance Characterization

Once the previous characteristics of the model were deemed to reasonably agree with the manufacturer's published data, the model was inserted into a CIL test circuit in order to extract time-domain waveforms. The resulting waveforms were compared with a set of CMD20120D CIL waveforms found in [6], which were chosen as a reference. The test circuit described in this reference was followed as closely as possible. This circuit is essentially that shown in Figure 1 with a unipolar gate drive. The operating conditions and critical circuit values employed in this reference are presented in Table 2. A comparison of the transient behavior of the model and the reference is shown in Figure 6 and Figure 7 for turn-off and turn-on, respectively. Note that the agreement between the model behavior and the reference data is reasonably close. The only parameter tuned in the test circuit to yield this agreement was the gate resistor, R_G. It was found that a value of 22 Ω for R_G provided good agreement, and can likely be justified as representative of the effective output impedance of the gate drive employed in this paper.

Table 2: Test Circuit Parameters from [6]

Parameter	**Value**
V_{DS}	600 V
I_D	20 A
Gate Drive V_{DD}	15 V
Gate Drive V_{SS}	0 V
R_G (specified)	10 Ω
R_G (tuned)	22 Ω