Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

EVALUATION KIT AVAILABLE

MAX8895V/MAX8895W/ MAX8895X/MAX8895Y

Li-Ion Chargers with Smart Power Selector, Adapter Type Detection, and USB Enumeration

General Description

The MAX8895_ USB-compliant linear battery chargers operate from either a USB port or dedicated charger with automatic detection of adapter type and USB enumeration capability. The MAX8895_ integrate the battery disconnect switch, current-sense circuit, MOSFET pass elements, and thermal regulation circuitry, and eliminate the external reverse-blocking Schottky diode to create the simplest and smallest stand-alone charging solutions.

The MAX8895_ includes an automated detection of charge adapter type, making it possible to distinguish between USB 2.0 device, USB charger, and dedicated charger devices. Furthermore, the MAX8895_ include a USB enumeration function that automatically negotiates with a USB host, making it possible to achieve the highest current available from a USB 2.0 device or USB charger without processor intervention. The adapter type detection is compliant with USB 2.0 specification as well as USB charging Revision 1.1.

The MAX8895_ controls the charging sequence for single-cell Li+ batteries from initial power-OK indication, through prequalification, fast-charge, top-off, and finally charge termination. Charging is controlled using constant current, constant voltage, and constant die-temperature (CCCVCTj) regulation for safe operation under all conditions. The maximum charging current is adaptively controlled by subtracting the system current from the input current limit, ensuring that the charging current is always maximized for any given operating condition.

The MAX8895_ features optimized smart power control to make the best use of limited USB or adapter power. Battery charge current is set independently of the SYS_ input current limit. Power not used by the system charges the battery. Automatic input selection switches the system from battery to external power. This allows the application to operate without a battery, discharged battery, or dead battery.

Other features include undervoltage lockout (UVLO), overvoltage protection (OVP), charge status flag, charge fault flag, power-OK monitor, battery thermistor monitor, charge timer, and a 3.3V output.

The MAX8895_ operates from a +4.0V to +6.6V supply and include overvoltage protection up to +16V. The MAX8895_ is specified over the extended temperature range (-40°C to +85°C) and are available in a compact 2.36mm x 2.36mm, 25-bump WLP package (0.4mm pitch).

Features

- **Enables Charging from a USB Port***
- **Automatic Detection of Adapter Type**
- **Enumeration Capability Without Processor Intervention**
- **USB Low-Speed Operation Without External Crystal (MAX8895V/MAX8895W/MAX8895X)**
- **USB Full-Speed Operation Using an External Crystal (MAX8895Y)**
- **Compliant with USB 2.0 Specification**
- **Compliant with USB Charging Specification (Revision 1.1)**
- **Adaptive Input Current Limit for Dedicated Charger**
- **Input Overvoltage Protection to 16V**
- **Automatic Current Sharing Between Battery Charging and System**
- **Smart Power Selector™ Allows Operation with Discharged or No Battery**
- **NTC Monitoring of Battery Temperature**
- **No External MOSFETs Required**
- **Thermal Regulation Prevents Overheating**
- **2µA Shutdown Current**
- **Tiny 2.36mm x 2.36mm, 25-Bump, 0.4mm Pitch WLP Package**

Applications

Bluetooth® Headsets

Charging Cradles

Portable Devices

***Ordering Information* and *Typical Operating Circuit* appear at end of data sheet.**

Bluetooth is a registered trademark of Bluetooth SIG.

Smart Power Selector is a trademark of Maxim Integrated Products, Inc.
**Protected by US Patent #6,507,172.*

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maximintegrated.com.

19-5205; Rev 4 9/12

ABSOLUTE MAXIMUM RATINGS

BUS_ to AGND .....-0.3V to +16.0V
XIN, XOUT, INT_3V3 to AGND .....-0.3V to +4.0V
$\overline{ENU\_EN}$, SUS_EN, RWU, D+, D-, $\overline{PREQ}$, $\overline{CHG}$, $\overline{UOK}$, $\overline{FLT}$, BAT_, SYS_, $\overline{CEN}$, STDBY, $\overline{DET\_DONE}$, IBUS_DEF, CHG_TYPE to AGND .....-0.3V to +6.0V
KB_TM, ISET, THM, IDN, CT to AGND ..... -0.3V to (V_{INT_3V3} + 0.3V)
DGND to AGND .....-0.3V to + 0.3V
$I_{BUS\_}$, $I_{BAT\_}$, and $I_{SYS\_}$ Continuous Current ..... 1800mA_{RMS}
Continuous Power Dissipation (T_A = +70°C)
25-Bump, 2.36mm x 2.36mm WLP
(derate 19.34mW/°C above +70°C) 1560mW
Operating Temperature ..... -40°C to +85°C
Junction Temperature .....+150°C
Storage Temperature Range ..... -65°C to +150°C
Soldering Temperature (reflow) .....+260°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(THM = $\overline{CEN}$ = SUS_EN = AGND, $V_{BAT\_}$ = 4.2V, $V_{BUS\_}$, CT, $\overline{PREQ}$, $\overline{CHG}$, $\overline{UOK}$, $\overline{FLT}$, $\overline{DET\_DONE}$ are unconnected, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS			MIN	TYP	MAX	UNITS
USB-TO-SYS PREREGULATOR								
USB Operating Range		Initial $V_{BUS\_}$ voltage before enabling charger			4.0		6.6	V
USB Standoff Voltage		$V_{BAT\_}$ = $V_{SYS\_}$ = 0V, $I_{BUS\_}$ < 650µA (max)					14	V
BUS_OK Debounce Timer	t_{USB_DB}	Time from BUS_ within valid range until $\overline{UOK}$ logic-low				500	650	ms
USB Undervoltage Lockout Threshold		$\overline{UOK}$ logic-low, $V_{BUS\_}$ rising, 100mV hysteresis	Before initial detection of external device		3.85	4.0	4.15	V
		$\overline{UOK}$ logic-low, $V_{BUS\_}$ falling	USB 2.0 low-power device		3.75	3.9	4.05	
		$\overline{UOK}$ logic-low, $V_{BUS\_}$ falling	USB 2.0 high-power device		3.95	4.1	4.25	
		$\overline{UOK}$ logic-low, $V_{BUS\_}$ falling	Dedicated charger or USB charger		$V_{SYS\_}$ -100mV	$V_{SYS\_}$ + 50mV	$V_{SYS\_}$ + 200mV	
USB Overvoltage Protection Threshold		$\overline{UOK}$ logic-low, $V_{BUS\_}$ rising, 100mV hysteresis			6.8	6.95	7.1	V
USB Input Supply Current (Note 2)	I_{DETECT}	Charge type detection, $I_{SYS\_}$ = $I_{BAT\_}$ = 0mA, $V_{\overline{CEN}}$ = 0V		MAX8895V/ MAX8895W/ MAX8895X			0.5	mA
				MAX8895Y			2.5	
	$I_{ENUMERATE}$	USB 2.0 enumeration in progress, $I_{SYS\_}$ = $I_{BAT\_}$ = 0mA, $V_{\overline{CEN}}$ = 0V					100	
	$I_{SUSPEND}$	Suspend mode, $I_{SYS\_}$ = $I_{BAT\_}$ = 0mA, V_{STDBY} = 3.3V		MAX8895V/ MAX8895W/ MAX8895X			0.5	
				MAX8895Y			2.5	
	I_{USB_100mA}	USB 2.0 low-power device detected	T_A = 0°C to +85°C				100	
			T_A = -40°C to +85°C				102.5	
	I_{USB_500mA}	USB 2.0 high-power device detected					500	
USB Input Current Limit	I_{SUS}	During suspend				0		mA
	I_{ENU}	During USB enumeration			40	45	55	
	I_{USB_LP}	USB 2.0 low-power device detected			80	90	98	
	I_{USB_HP}	USB 2.0 high-power device detected			460	475	490	

ELECTRICAL CHARACTERISTICS (continued)

(THM = $\overline{CEN}$ = SUS_EN = AGND, $V_{BAT\_}$ = 4.2V, $V_{BUS\_}$, CT, $\overline{PREQ}$, $\overline{CHG}$, $\overline{UOK}$, $\overline{FLT}$, $\overline{DET\_DONE}$ are unconnected, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
$V_{BUS\_}$-to-$V_{SYS\_}$ On-Resistance		$V_{BUS\_}$ = $V_{\overline{CEN}}$ = 5V, $I_{SYS\_}$ = 400mA		200	320	mΩ
$V_{SYS\_}$-to-$V_{BAT\_}$ Reverse Regulation		When SYS is in regulation and charging stops, $V_{SYS\_}$ falling, 50mV hysteresis	$V_{BAT\_}$ - 80mV	$V_{BAT\_}$ - 50mV	$V_{BAT\_}$ - 20mV	V
Input Limiter Soft-Start Time		Input current ramp time		50	100	µs
Thermal-Limit Start Temperature	T_{DIE_LIM}			+110		°C
Thermal-Limit Start Temperature Hysteresis				10		°C
Thermal-Limit Gain		$I_{SYS\_}$ reduction/die temperature (above +110°C)		5		%/°C
$V_{BUS\_}$ Adaptive Current Regulation Threshold		$V_{BUS\_}$ regulation threshold where input current limit is regulated for dedicated charger or USB charger		$V_{SYS\_}$ + 440mV	$V_{SYS\_}$ + 550mV	V
SYS_ Regulation Voltage		$V_{BAT\_}$ > 3.45V, $I_{SYS\_}$ = 1mA to 1.6A, $V_{BUS\_}$ = $V_{\overline{CEN}}$ = 5V		$V_{BAT\_}$ + 140mV	$V_{BAT\_}$ + 210mV	V
Minimum SYS Regulation Voltage		$V_{BUS\_}$ = 6V, $I_{SYS\_}$ = 1mA to 1.6A, $V_{\overline{CEN}}$ = 5V	3.3	3.4	3.55	V
CHARGER						
BAT_-to-SYS_ On-Resistance		$I_{SYS\_}$ = 200mA		55	80	mΩ
BAT_ Undervoltage Lockout	$V_{BAT\_UVLO\_F}$	$V_{BAT\_}$ falling	2.60	2.85	3.1	V
	$V_{BAT\_UVLO\_R}$	$V_{BAT\_}$ rising	2.75	3.00	3.25	
Charger Soft-Start Time		Charge-current ramp time		1		ms
BAT_ Leakage Current		$V_{BUS\_}$ not connected		2	6	µA
		$V_{BUS\_}$ connected, $V_{\overline{CEN}}$ = 5V		2	6	
PRECHARGE MODE						
BAT_ Precharge-Current Set Range	I_{PCHG}	R_{ISET} = 30kΩ to 1.875kΩ, $V_{BAT\_}$ >1.4V (Note 3)		I_{FCHG}/10		A
BAT_ Prequalification Threshold	$V_{BAT\_PCHG\_R}$	$V_{BAT\_}$ rising	2.7	2.8	2.9	V
	$V_{BAT\_PCHG\_F}$	$V_{BAT\_}$ falling	2.6	2.7	2.8	
FAST-CHARGE MODE						
BAT_ Charge-Current Set Range	I_{FCHG}	R_{ISET} = 30kΩ to 1.875kΩ, $V_{BAT\_}$ >1.4V (Note 3)	0.1		1.85	A
		ISET = INT_3V3 (Note 3)		600		mA
BAT_ Charge-Current Accuracy, Charger Loop in Control		$V_{BUS\_}$ = 5.5V (Note 3), R_{ISET} = 1.875kΩ		1850		mA
		$V_{BUS\_}$ = 5.5V (Note 3), R_{ISET} = 5kΩ	540	600	660	
		$V_{BUS\_}$ = 5.5V (Note 3), R_{ISET} = 30kΩ	90	100	110	
BAT_ Fast-Charge Threshold	$V_{BAT\_FCHG\_R}$	$V_{BAT\_}$ rising threshold, where charging current I_{FCHG} is reduced to I_{TCHG}	3.9	4.0	4.1	V
	$V_{BAT\_FCHG\_F}$	$V_{BAT\_}$ falling threshold, where charging current is increased to I_{FCHG}	3.7	3.8	3.9	

ELECTRICAL CHARACTERISTICS (continued)

(THM = $\overline{CEN}$ = SUS_EN = AGND, $V_{BAT\_}$ = 4.2V, $V_{BUS\_}$, CT, $\overline{PREQ}$, $\overline{CHG}$, $\overline{UOK}$, $\overline{FLT}$, $\overline{DET\_DONE}$ are unconnected, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
TOP-OFF CHARGE MODE							
Top-Off Charge Current	I_{TCHG}	R_{ISET} = 30kΩ to 1.875kΩ (Note 3)			0.6 x I_{FCHG}		A
BAT_ Charge Termination Current Range	I_{CHG_DONE}	R_{IDN} = 240kΩ to 15kΩ		10		160	mA
		IDN = INT_3V3			80		
BAT_ Regulation Voltage	V_{BAT_REG}	$I_{BAT\_}$ = 0mA	T_A = +25°C	4.179	4.200	4.221	V
			T_A = 0°C to +85°C	4.158	4.200	4.242	
BAT_ Recharge Threshold	V_{BAT_RECHG}	Recharge threshold in relation to $V_{BAT\_}$ in DONE state going into top-off mode (Figure 20)		-100	-200	-300	mV
CHARGE TIMER							
Maximum Prequalification Time	t_{PCHG}	From $V_{\overline{CEN}}$ falling to end of prequalification charge mode, $V_{BAT\_}$ = 2.5V	C_T = 0.068µF		16		Min
			C_T = AGND		20		
Maximum Fast-Charge Time	t_{FCHG}	From $V_{\overline{CEN}}$ falling to $V_{\overline{FLT}}$ falling	C_T = 0.068µF		100		Min
			C_T = AGND		120		
Maintain-Charge Time	t_{MTCHG}		C_T = 0.068µF		4		Min
			C_T = AGND		5		
Timer Accuracy		C_T = 0.068µF		-30		+30	%
		C_T connected to AGND		-30		+30	
Timer Extend Threshold		Percentage of charge current below which timer clock operates at half speed			50		%
Timer Suspend Threshold		Percentage of charge current below which timer clock pauses			20		%
ADAPTER TYPE DETECTION							
D- Current Sink	I_{DM_SINK}	MAX8895V/MAX8895X/MAX8895Y		50	86	150	µA
		MAX8895W		64	86	102	
D+ Source Voltage	V_{DP_SRC}	I_{DP_SRC} = 0 to 200µA		0.5	0.6	0.7	V
D+ Detection Threshold	V_{DAT_REF}			0.25	0.32	0.40	V
D+ Source On-Time	$t_{DP\_SRC\_ON}$			100			ms
D+ Source to High Current Time	$t_{DP\_SRC\_HC}$			40			ms
D- Pullup Resistor	R_{DM_PU}	MAX8895V/MAX8895W/MAX8895X only, external series resistor = 33Ω		1.425	1.500	1.575	kΩ
D+ Pullup Resistor	R_{DP_PU}	MAX8895Y only, external series resistor = 33Ω		1.425	1.500	1.575	kΩ
D+ Charger Detection Pullup Resistor	$R_{DP\_CD\_PU}$	$R_{DP\_CD\_PU}$ connect to INT_3V3		200	330	600	kΩ
D- Weak Current Sink	$I_{DM\_CD\_PD}$					0.1	µA
D- Logic-High Threshold	V_{DM_IH}			0.8		2.0	V

ELECTRICAL CHARACTERISTICS (continued)

(THM = $\overline{CEN}$ = SUS_EN = AGND, $V_{BAT\_}$ = 4.2V, $V_{BUS\_}$, CT, $\overline{PREQ}$, $\overline{CHG}$, $\overline{UOK}$, $\overline{FLT}$, $\overline{DET\_DONE}$ are unconnected, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Enumeration Time Limit	t_{ENUM}	Time from start of enumeration process until enumeration must be completed; if not completed, the MAX8895_ retries to enumerate			10		s
Reconnect Timer	t_{FAULT}	Time from failed enumeration to adapter type detection reenabled			3		s
Enumeration Fail to Reconnect Timer	t_{ENU_FAULT}	Time from enumeration fail at 500mA until enumeration is retried at 100mA or time from enumeration fail at 100mA until reconnect timer is started			87		ms
Reenumeration Timer	t_{RE_ENUM}	Time from when the MAX8895_ has entered suspend mode until it reenumerates, RWU = AGND			100		ms
Oscillator Frequency Accuracy		MAX8895V/MAX8895X only (internal oscillator), T_A = +25°C		5.91	6.00	6.09	MHz
XIN Input Current		MAX8895Y only, V_{XIN} = V_{STDBY} = 3.3V				10	µA
XIN Logic-High Input Voltage		MAX8895Y only		2/3x V_{INT_3V3}		V_{INT_3V3}	V
XIN Logic-Low Input Voltage		MAX8895Y only				0.4	V
THM							
THM Cold Threshold	T_{AMB_COLD}	When charging is suspended, rising threshold, 2% hysteresis		72	74	76	% of V_{INT_3V3}
THM Hot Threshold	T_{AMB_HOT}	When charging is suspended, falling threshold, 2% hysteresis		26	28	30	% of V_{INT_3V3}
THM Threshold, Disabled		When THM function is disabled, falling threshold, 2% hysteresis			3		% of V_{INT_3V3}
THM Input Leakage		THM = AGND or INT_3V3	T_A = +25°C	-0.1	0.001	+0.2	µA
			T_A = +85°C		0.01		
LOGIC I/O: $\overline{CHG}$, $\overline{FLT}$, $\overline{UOK}$, $\overline{CEN}$, $\overline{PREQ}$, KB_TM, RWU, STDBY, SUS_EN, $\overline{ENU\_EN}$, $\overline{DET\_DONE}$, CHG_TYPE, IBUS_DEF							
Logic-Input Threshold		High level		1.3			V
		Low level				0.4	
		Hysteresis			50		mV
Logic-Input Leakage Current		$V_{BUS\_}$ = 0 to 5.5V	T_A = +25°C		0.001	1	µA
			T_A = +85°C		0.01		
Logic-Low Output Voltage ($\overline{CHG}$, $\overline{FLT}$, $\overline{UOK}$, $\overline{PREQ}$, $\overline{DET\_DONE}$, CHG_TYPE Only)		Sinking 10mA			35	100	mV
Logic-High Output-Leakage Current ($\overline{CHG}$, $\overline{FLT}$, $\overline{UOK}$, $\overline{PREQ}$, $\overline{DET\_DONE}$, CHG_TYPE Only)		$V_{SYS\_}$ = 5.5V	T_A = +25°C		0.001	1	µA
			T_A = +85°C		0.01		

ELECTRICAL CHARACTERISTICS (continued)

(THM = $\overline{CEN}$ = SUS_EN = AGND, $V_{BAT\_}$ = 4.2V, $V_{BUS\_}$, CT, $\overline{PREQ}$, $\overline{CHG}$, $\overline{UOK}$, $\overline{FLT}$, $\overline{DET\_DONE}$ are unconnected, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
USB DATA INTERFACE						
Differential-Receiver Input Sensitivity		$\lvert V_{D+} - V_{D-} \rvert$	0.2			V
Differential-Receiver Common-Mode Voltage			0.8		2.5	V
D+, D- Input Impedance			300			kΩ
D+, D- Output Low Voltage	V_{OL}	R_{LOAD} = 1.5kΩ from V_{D-} to 3.6V			0.3	V
D+, D- Output High Voltage	V_{OH}	R_{LOAD} = 15kΩ from D+ and D- to AGND	2.8		3.6	V
Driver Output Impedance		Excludes external resistor	2	7	11	Ω
BUS_ Idle Time	t_{IDLE}	Only valid when an adapter type is detected as a USB 2.0 device; time BUS_ is inactive until charging current is reduced to $I_{SUSPEND}$		3		ms
USB Host Remote Wake-Up Timer	t_{RWU}	Time delay from when the MAX8895_ is put into suspend mode until they request the host for a remote wake-up		100		ms
D+, D- Rise Time (Note 5)	t_{RISE}	MAX8895V/MAX8895W/MAX8895X only, C_L = 50pF to 600pF, (Figures 5 and 6)	75		250	ns
		MAX8895Y only, C_L = 50pF (Figures 5 and 6)	4		20	
D+, D- Fall Time (Note 5)	t_{FALL}	MAX8895V/MAX8895W/MAX8895X only, C_L = 50pF to 600pF (Figures 5 and 6)	75		250	ns
		MAX8895Y only, C_L = 50pF (Figures 5 and 6)	4		20	
Rise-/Fall-Time Matching (Note 5)		MAX8895V/MAX8895W/MAX8895X only, C_L = 50pF to 600pF (Figures 5 and 6)	80		120	%
		MAX8895Y only, C_L = 50pF (Figures 5 and 6)	90		110	
Output-Signal Crossover Voltage (Note 5)		MAX8895V/MAX8895W/MAX8895X only, C_L = 50pF to 600pF (Figures 5 and 6)	1.3		2.0	V
		MAX8895Y only, C_L = 50pF (Figures 5 and 6)	1.3		2.0	
INT_3V3 REGULATOR						
INT_3V3 Voltage		$V_{BUS\_}$ = 5V, I_{INT_3V3} = 0 to 10mA	3.0	3.3	3.6	V
ESD PROTECTION (D+, D-, $V_{BUS\_}$)						
Human Body Model		$V_{BUS\_}$ bypassed with 1µF to AGND		±8		kV

Note 1: Specifications are 100% production tested at T_A = +25°C. Limits over the operating temperature range are guaranteed by design and characterization.

Note 2: Sum of input current limit and current used for INT_3V3.

Note 3: Maximum charging current is adaptively regulated to I_{IN_LIM} - $I_{SYS\_}$ with a maximum value of $I_{\overline{CHG}}$.

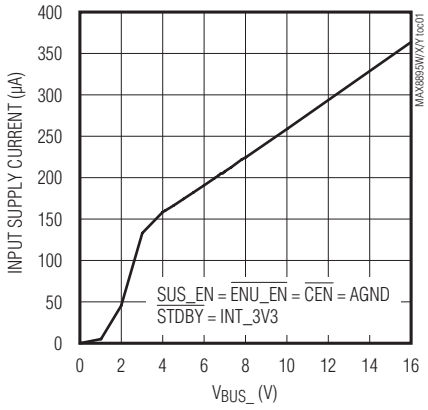
Note 4: All devices are 100% production tested at T_A = +25°C. Limits over the operating temperature range are guaranteed by design.

Note 5: Guaranteed by design, not production tested.

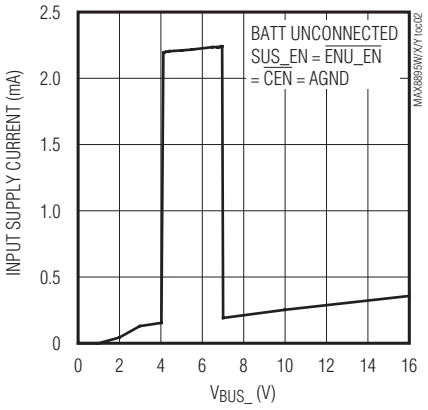
Typical Operating Characteristics

($V_{BAT\_}$ = 4.2V, $V_{BUS\_}$ = 5V, ISET = IDN = CT = SUS_EN = INT_3V3, STDBY = $\overline{ENU\_EN}$ = RWU = $\overline{CEN}$ = KB_TM = AGND, circuits of Figures 4 and 5 (MAX8895V/MAX8895X and MAX8895Y, respectively), T_A = +25°C, unless otherwise noted.)

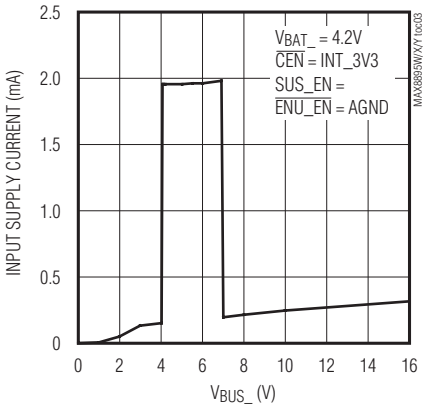
MAX8895V/W/X $V_{BUS\_}$ INPUT SUPPLY CURRENT vs. $V_{BUS\_}$ (SUSPEND MODE)



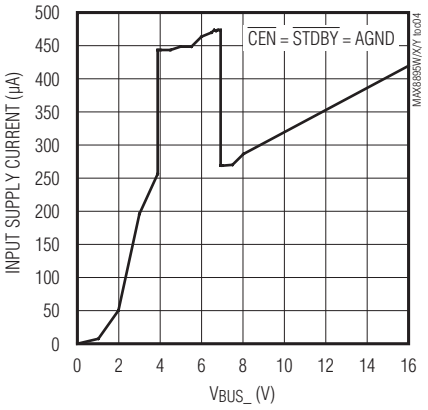
MAX8895V/W/X $V_{BUS\_}$ INPUT SUPPLY CURRENT vs. $V_{BUS\_}$ (CHARGER ENABLED)



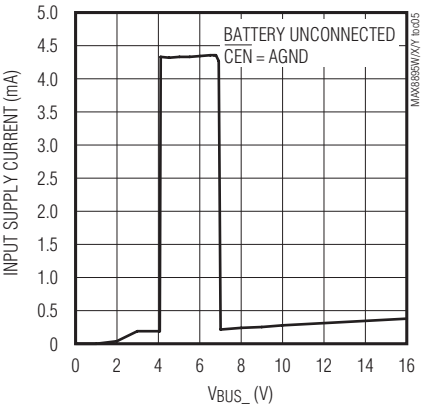
MAX8895V/W/X $V_{BUS\_}$ INPUT SUPPLY CURRENT vs. $V_{BUS\_}$ (CHARGER DISABLED)



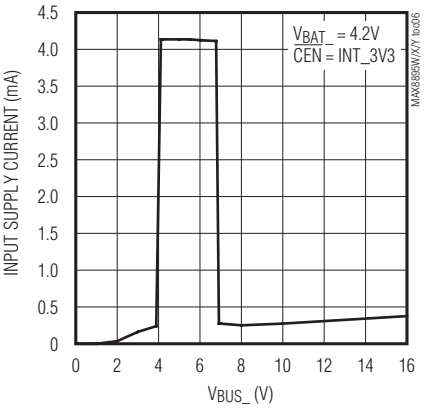
MAX8895Y $V_{BUS\_}$ INPUT SUPPLY CURRENT vs. $V_{BUS\_}$ (SUSPEND MODE)



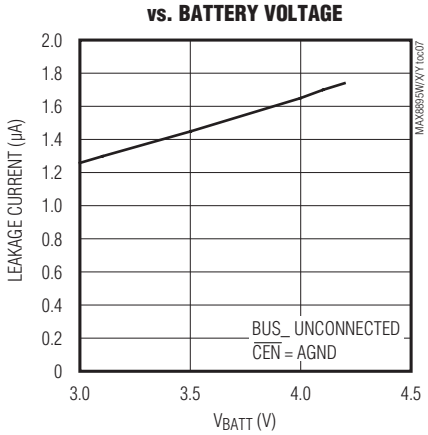
MAX8895Y $V_{BUS\_}$ INPUT SUPPLY CURRENT vs. $V_{BUS\_}$ (CHARGER ENABLED)



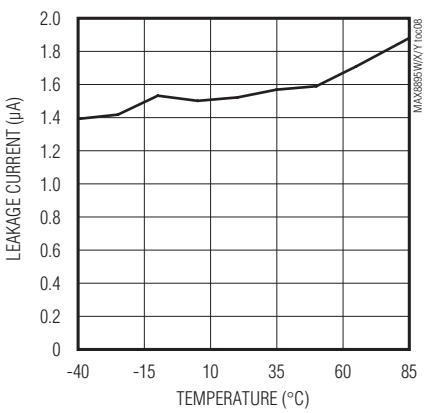
MAX8895Y $V_{BUS\_}$ INPUT SUPPLY CURRENT vs. $V_{BUS\_}$ (CHARGER DISABLED)



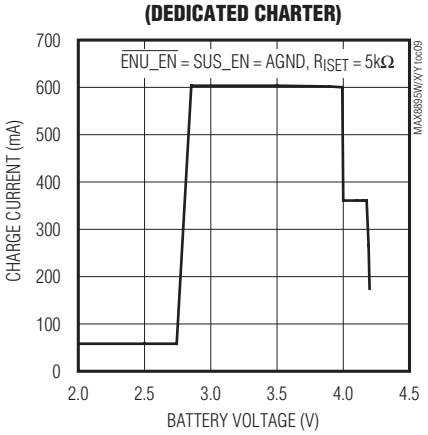
BATTERY LEAKAGE CURRENT vs. BATTERY VOLTAGE



BATTERY LEAKAGE CURRENT vs. TEMPERATURE



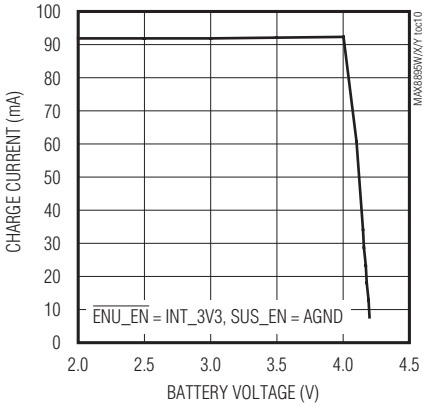
CHARGE CURRENT vs. BATTERY VOLTAGE (DEDICATED CHARTER)



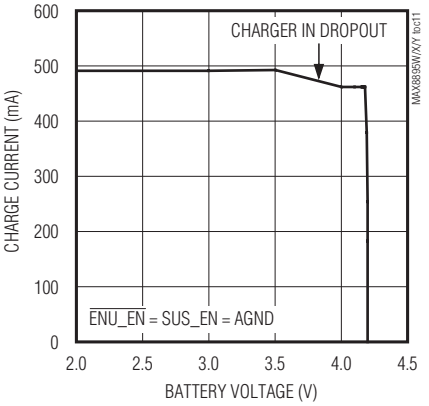
Typical Operating Characteristics (continued)

($V_{BAT\_}$ = 4.2V, $V_{BUS\_}$ = 5V, ISET = IDN = CT = SUS_EN = INT_3V3, STDBY = $\overline{ENU\_EN}$ = RWU = $\overline{CEN}$ = KB_TM = AGND, circuits of Figures 4 and 5 (MAX8895V/MAX8895X and MAX8895Y, respectively), T_A = +25°C, unless otherwise noted.)

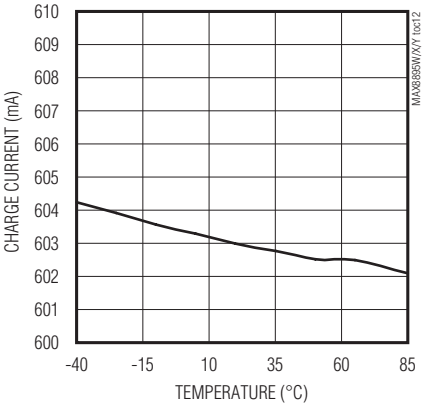
CHARGE CURRENT vs. BATTERY VOLTAGE (LOW-POWER USB)



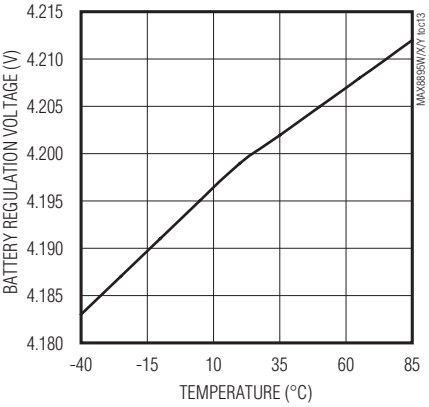
CHARGE CURRENT vs. BATTERY VOLTAGE (HIGH-POWER USB)



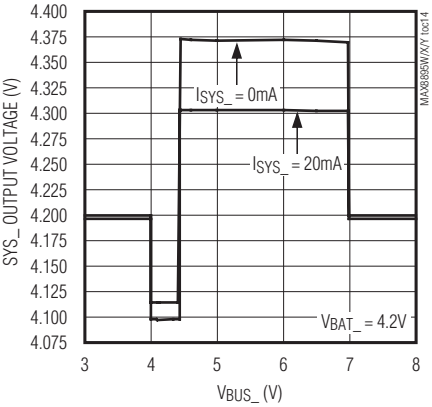
CHARGE CURRENT (DEDICATED CHARGER) vs. AMBIENT TEMPERATURE



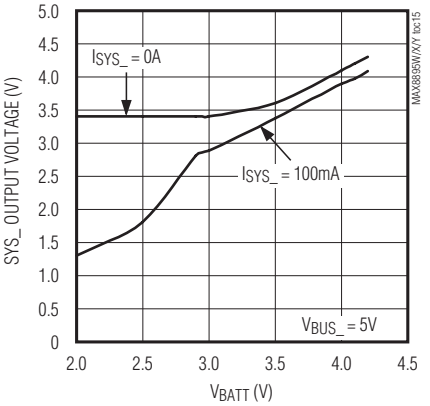
BATTERY REGULATION VOLTAGE vs. AMBIENT TEMPERATURE



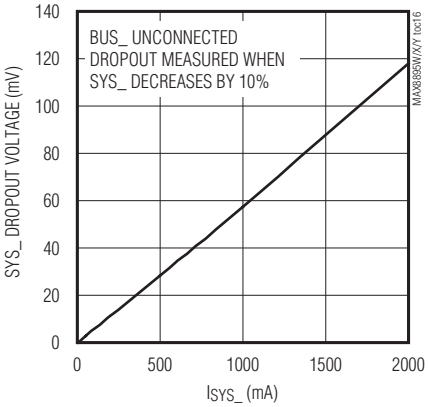
SYS_ OUTPUT VOLTAGE vs. $V_{BUS\_}$



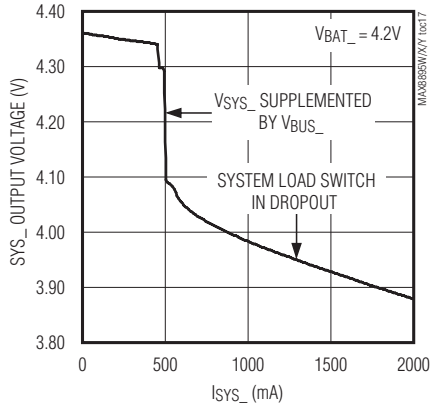
SYS_ OUTPUT VOLTAGE vs. BATTERY VOLTAGE



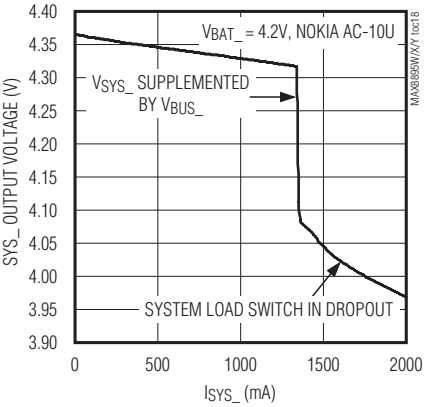
SYS_ DROPOUT VOLTAGE vs. LOAD CURRENT



SYS_ OUTPUT VOLTAGE vs. LOAD CURRENT (HIGH-POWER USB MODE)



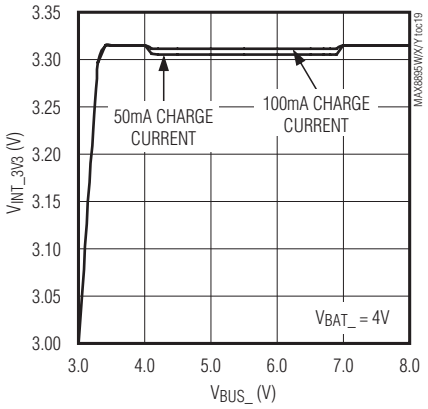
SYS_ OUTPUT VOLTAGE vs. LOAD CURRENT (DEDICATED CHARGER)



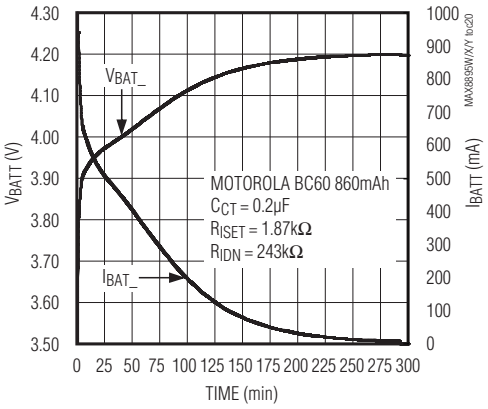
Typical Operating Characteristics (continued)

($V_{BAT\_}$ = 4.2V, $V_{BUS\_}$ = 5V, ISET = IDN = CT = SUS_EN = INT_3V3, STDBY = $\overline{ENU\_EN}$ = RWU = $\overline{CEN}$ = KB_TM = AGND, circuits of Figures 4 and 5 (MAX8895V/MAX8895X and MAX8895Y, respectively), T_A = +25°C, unless otherwise noted.)

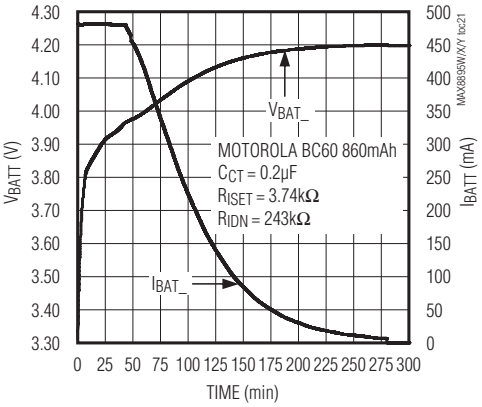
INT_3V3 VOLTAGE vs. BUS_ VOLTAGE



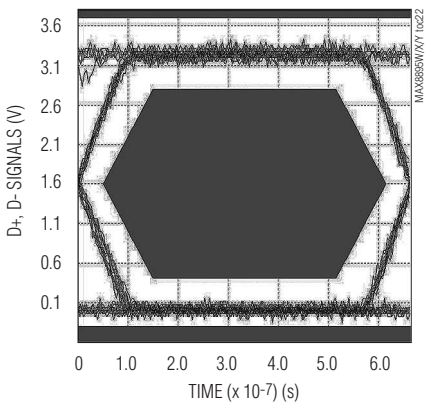
CHARGE PROFILE (NOKIA AC-10 CHARGER)



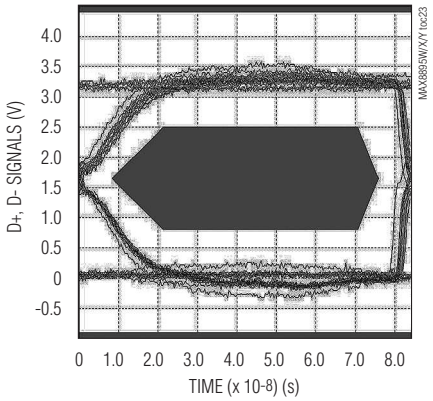
CHARGE PROFILE (USB 2.0 CHARGER)



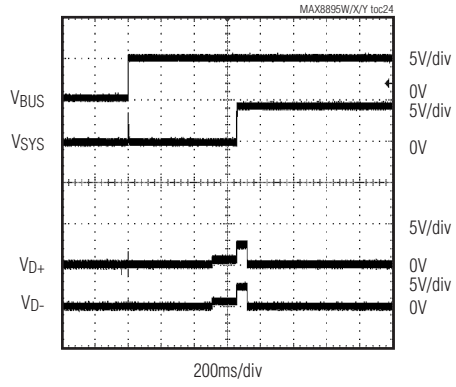
MAX8895V/W/X EYE DIAGRAM



MAX8895Y EYE DIAGRAM



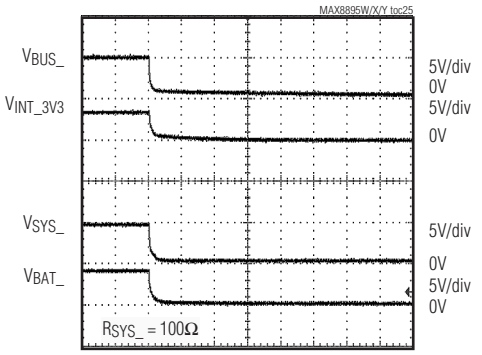
DEDICATED CHARGER CONNECT



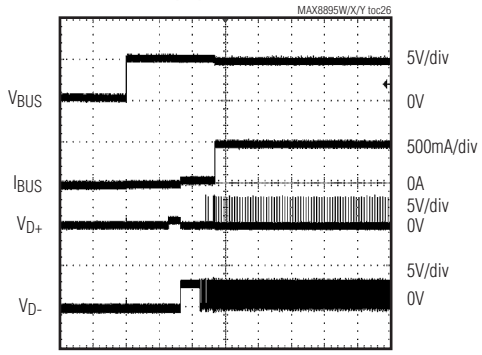
Typical Operating Characteristics (continued)

($V_{BAT\_}$ = 4.2V, $V_{BUS\_}$ = 5V, ISET = IDN = CT = SUS_EN = INT_3V3, STDBY = $\overline{ENU\_EN}$ = RWU = $\overline{CEN}$ = KB_TM = AGND, circuits of Figures 4 and 5 (MAX8895V/MAX8895X and MAX8895Y, respectively), T_A = +25°C, unless otherwise noted.)

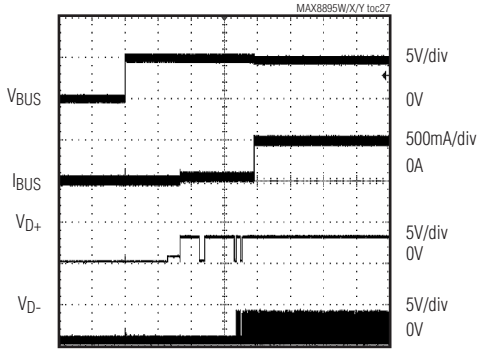
DEDICATED CHARGER DISCONNECT



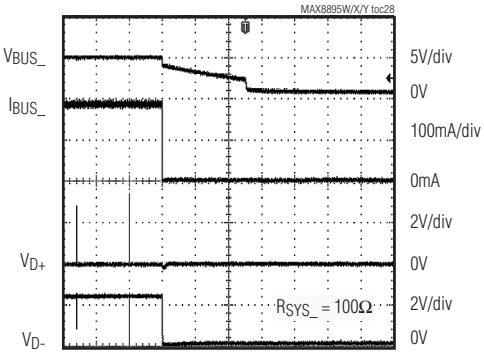
MAX8895V/W/X HIGH-POWER 2.0



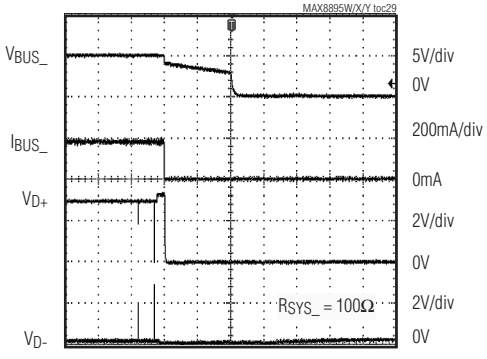
MAX8895Y USB HIGH-POWER 2.0 CONNECT



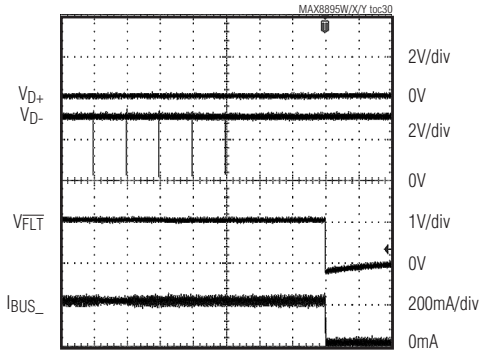
MAX8895V/W/X USB HIGH-POWER 2.0 DISCONNECT



MAX8895Y USB HIGH-POWER 2.0 DISCONNECT



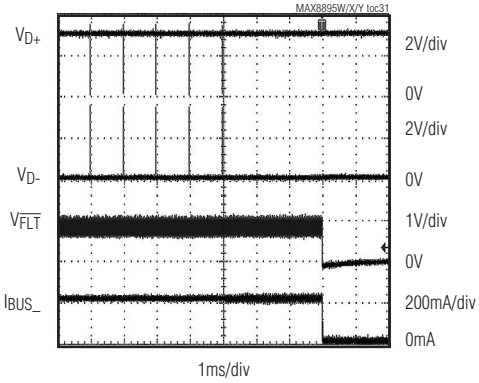
MAX8895V/W/X USB AUTOSUSPEND



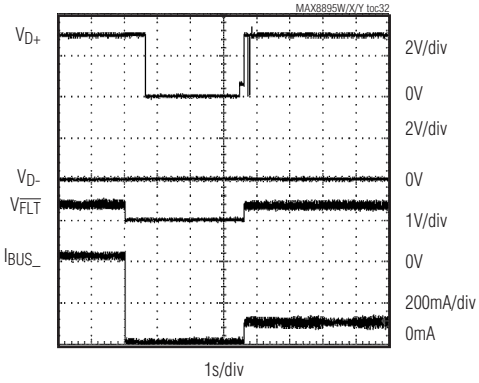
Typical Operating Characteristics (continued)

($V_{BAT\_}$ = 4.2V, $V_{BUS\_}$ = 5V, ISET = IDN = CT = SUS_EN = INT_3V3, STDBY = $\overline{ENU\_EN}$ = RWU = $\overline{CEN}$ = KB_TM = AGND, circuits of Figures 4 and 5 (MAX8895V/MAX8895X and MAX8895Y, respectively), T_A = +25°C, unless otherwise noted.)

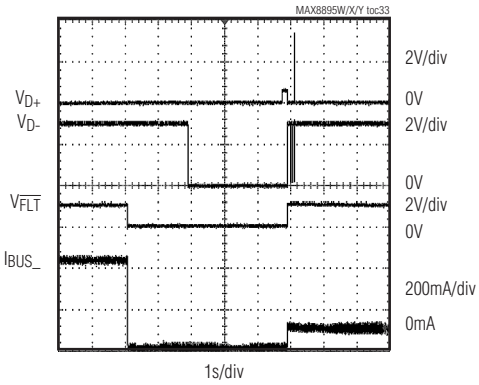
MAX8895Y USB AUTOSUSPEND



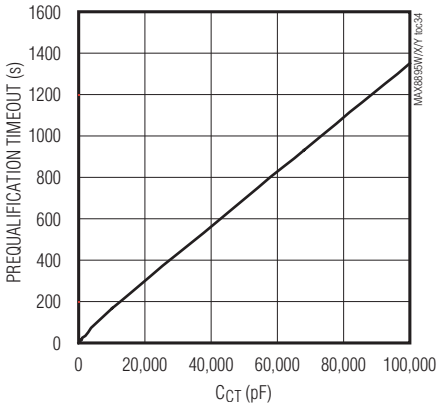
MAX8895V/W/X USB RESUME



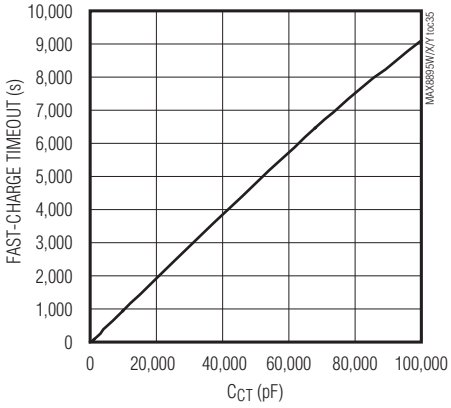
MAX8895Y USB RESUME



PREQUALIFICATION TIMEOUT vs. CT CAPACITANCE



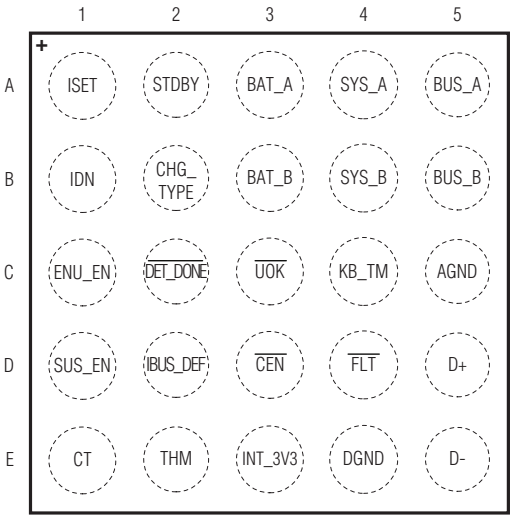
FAST-CHARGE TIMEOUT vs. CT CAPACITANCE



Pin Configurations

TOP VIEW
(BUMP SIDE DOWN)

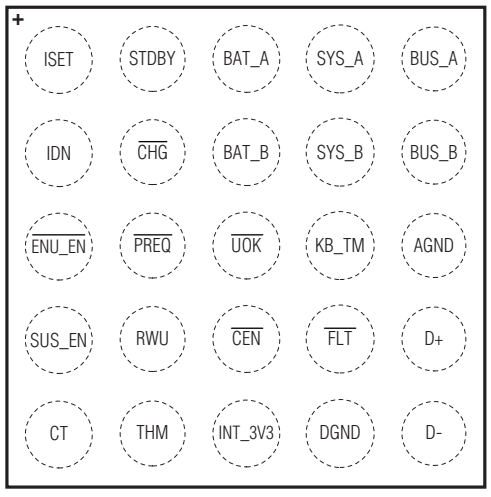
MAX8895W



WLP

TOP VIEW
(BUMP SIDE DOWN)

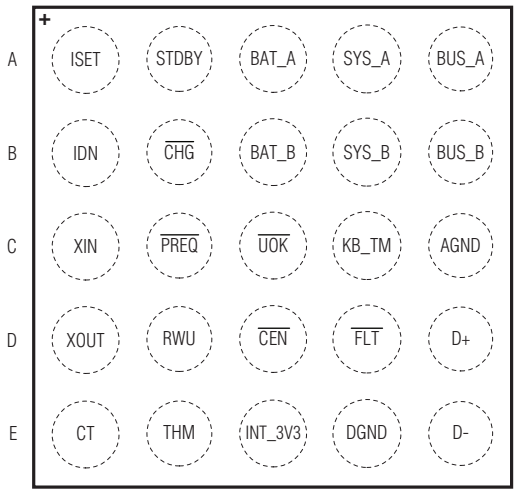
MAX8895V
MAX8895X



WLP

TOP VIEW
(BUMP SIDE DOWN)

MAX8895Y



WLP

Pin Description

PIN	NAME			FUNCTION
	MAX8895W	MAX8895V/ MAX8895X	MAX8895Y	
A1	ISET	ISET	ISET	Maximum Fast-Charge Current Selection. Connect a resistor from ISET to AGND to set the fast-charge current from 0.1A to 1.85A. $I_{FCHG} = 3000/R_{ISET}$ If ISET is connected to INT_3V3 the default I_{FCHG} is set as maximum charge current. ISET can also be used to monitor the actual current charging the battery. See the *Monitoring Charge Current* section for details.
A2	STDBY	STDBY	STDBY	Standby Mode Enable. Connect STDBY to AGND to enter automatic detect mode. In automatic detect mode, the MAX8895V/MAX8895W/MAX8895X determine when to enter suspend mode depending on the status of the SUS_EN logic input. When using the MAX8895Y, the IC always starts in automatic suspend mode. Connect STDBY to INT_3V3 or drive logic-high to force the MAX8895_ into suspend mode regardless of external conditions.
A3	BAT_A	BAT_A	BAT_A	Li+ Battery Connection ($V_{BAT\_}$). Connect a single-cell Li+ battery from $V_{BAT\_}$ to DGND. The battery charges from $V_{SYS\_}$ when a valid source is present at $V_{BUS\_}$. $V_{BAT\_}$ powers $V_{SYS\_}$ when $V_{BUS\_}$ power is not present, or when the $V_{SYS\_}$ load exceeds the input current limit. Bypass $V_{BAT\_}$ to DGND with a 10µF X5R or X7R ceramic capacitor. Both BAT_A and BAT_B must be connected together externally.
B3	BAT_B	BAT_B	BAT_B	
A4	SYS_A	SYS_A	SYS_A	System Supply Output ($V_{SYS\_}$). $V_{SYS\_}$ is connected to $V_{BAT\_}$ through an internal 55mΩ system load switch when $V_{BUS\_}$ is invalid, or when the $V_{SYS\_}$ load is greater than the input current limit. When a valid voltage is present at $V_{BUS\_}$, $V_{SYS\_}$ is limited to 4.35V when using the MAX8895V/MAX8895X/ MAX8895Y, and 4.53V when using the MAX8895W. When the system load current ($I_{SYS\_}$) exceeds the $V_{BUS\_}$ current limit $V_{BAT\_}$ also powers $V_{SYS\_}$ to maintain the load current. Bypass $V_{SYS\_}$ to DGND with a 10µF X5R or X7R ceramic capacitor. Both SYS_A and SYS_B must be connected together externally.
B4	SYS_B	SYS_B	SYS_B	
A5	BUS_A	BUS_A	BUS_A	USB Power Input ($V_{BUS\_}$). During initial connection of an external device, the MAX8895_ identifies the type of connection established and set the input current limit accordingly. Bypass $V_{BUS\_}$ to DGND with a 10µF X5R or X7R ceramic capacitor. Both BUS_A and BUS_B must be connected together externally.
B5	BUS_B	BUS_B	BUS_B	
B1	IDN	IDN	IDN	Charge Termination Current Threshold. Connect a resistor from IDN to AGND to set the termination current threshold from 10mA to 160mA. $I_{TERM} = 2400/R_{IDN}$ If IDN is connected to INT_3V3, the termination current is set to the default I_{CHG_DONE} threshold.

Pin Description (continued)

PIN	NAME			FUNCTION
	MAX8895W	MAX8895V/ MAX8895X	MAX8895Y	
B2	—	$\overline{CHG}$	$\overline{CHG}$	Active-Low, Charging Indicator. $\overline{CHG}$ is an open-drain output that is pulled low when the battery is in prequalification mode, fast-charge mode, or top-off states. Otherwise, $\overline{CHG}$ is high impedance.
	CHG_TYPE	—	—	CHG_TYPE is used to indicate capacity of input current. IF CHG_TYPE is high, the input current can be greater than or equal to 500mA. If CHG_TYPE is low, the input current is 100mA from the USB 2.0 host.
C1	—	—	XIN	Crystal Oscillator Input. Connect XIN to one side of a parallel resonant 12MHz ±0.25% crystal and a capacitor to AGND. XIN can also be driven by an external clock referenced to INT_3V3.
	—	$\overline{ENU\_EN}$	—	Automatic Enumeration Enable. Connect $\overline{ENU\_EN}$ to AGND to allow the MAX8895V/MAX8895X to automatically perform enumeration. Connect to INT_3V3 or drive logic-high to force the input current limit to 100mA without performing an adapter type detection.
	$\overline{ENU\_EN}$	—	—	Automatic Enumeration Enable. Connect $\overline{ENU\_EN}$ to AGND to allow the MAX8895W to automatically perform enumeration. By connecting $\overline{ENU\_EN}$ to INT_3V3 or drive logic-high, disables automatic enumeration and sets the input current limit to level determined by the IBUS_DEF if a USB 2.0 device is detected.
C2	—	$\overline{PREQ}$	$\overline{PREQ}$	Active-Low, Prequalification Charging Output. $\overline{PREQ}$ is an open-drain output that is pulled low when the charger enters the prequalification state.
	$\overline{DET\_DONE}$	—	—	Active-Low Adapter-Type Detection Done Output. $\overline{DET\_DONE}$ is an open-drain output that is pulled low when adapter detection is completed. $\overline{DET\_DONE}$ is high impedance in suspend mode.
C3	$\overline{UOK}$	$\overline{UOK}$	$\overline{UOK}$	Active-Low, $V_{BUS\_}$ Power-OK Output. $\overline{UOK}$ is an open-drain output that is pulled low when a valid input is detected at $V_{BUS\_}$.
C4	KB_TM	KB_TM	KB_TM	Keyboard Test Mode. In normal operation, connect KB_TM to AGND. This input is only used during USB certification.
C5	AGND	AGND	AGND	Analog Ground. Both AGND and DGND should be connected together at the negative terminal of the battery.
D1	—	—	XOUT	Crystal Oscillator Output. Connect XOUT to one side of a parallel resonant 12MHz ±0.25% crystal and a capacitor to AGND. Leave XOUT unconnected if XIN is driven by an external clock.
	SUS_EN	SUS_EN	—	Automatic Suspend Mode Detection Enable. Connect SUS_EN to AGND to disable the automatic suspend mode detection. Connect SUS_EN to INT_3V3 or drive logic-high to enable the automatic detection of suspend mode.
D2	—	RWU	RWU	Remote Wake-up. Connect RWU to AGND or logic-low for remote wake-ups whenever the device is put into suspend mode and the supervisor determines that more current is needed.
	IBUS_DEF	—	—	Sets USB Input Current if Adapter is Detected as a USB 2.0 Device and $\overline{ENU\_EN}$ is Logic-High. If IBUS_DEF is connected high, the input current limit is set to 500mA. If IBUS_DEF is connected low or to ground, the input current limit is set to 100mA.

Pin Description (continued)

PIN	NAME			FUNCTION
	MAX8895W	MAX8895V/ MAX8895X	MAX8895Y	
D3	$\overline{CEN}$	$\overline{CEN}$	$\overline{CEN}$	Charger Enable Input. Connect $\overline{CEN}$ to AGND to enable battery charging when a valid source is connected at $V_{BUS\_}$. Connect $\overline{CEN}$ to INT_3V3 or drive logic-high to disable battery charging. In this condition the USB state machine is still active, and $V_{SYS\_}$ is powered from $V_{BUS\_}$ under normal conditions and supplemented from $V_{BAT\_}$ if sufficient current is not available from $V_{BUS\_}$ input.
D4	$\overline{FLT}$	$\overline{FLT}$	$\overline{FLT}$	Active-Low Fault Output. $\overline{FLT}$ is an open-drain output that is pulled low when the battery charger timer expires before prequalification or fast-charge completes. $\overline{FLT}$ is also pulled low during adapter type detection or if USB enumeration fails.
D5	D+	D+	D+	USB D+ signal. Connect D+ to a USB “B” connector through a 33Ω series resistor. The 1.5kΩ D+ pullup resistor is internal to the device (for MAX8895Y only).
E1	CT	CT	CT	Timer Set Capacitor. Connect a capacitor from CT to AGND to set the fault timers for prequalification and fast-charge. $t_{PREQUAL}$ = 16min x (C_{CT}/0.068µF) t_{FCHG} = 100min x (C_{CT}/0.068µF) t_{MTCHG} = 4min x (C_{CT}/0.068µF) If CT is connected directly to AGND, the default timers are used.
E2	THM	THM	THM	Thermistor Input. Connect a negative temperature coefficient (NTC) thermistor that has good thermal contact with the battery from THM to AGND. Connect a resistor equal to the thermistor at T_A = +25°C resistance from THM to INT_3V3. Charging is suspended when the thermistor is outside the hot and cold limits. Connect THM to AGND to disable the thermistor temperature sensor.
E3	INT_3V3	INT_3V3	INT_3V3	LDO Output. INT_3V3 is the output of an LDO that powers the internal circuitry. INT_3V3 is powered from the $V_{BUS\_}$ input. Connect a 0.1µF capacitor from INT_3V3 to AGND.
E4	DGND	DGND	DGND	Digital Ground. Both AGND and DGND should be connected together at the negative terminal of the battery.
E5	D-	D-	D-	USB D- Signal. Connect D- to a USB “B” connector through a 33Ω series resistor. The 1.5kΩ D- pullup resistor is internal to the device (for MAX8895V/ MAX8895W/MAX8895X only).

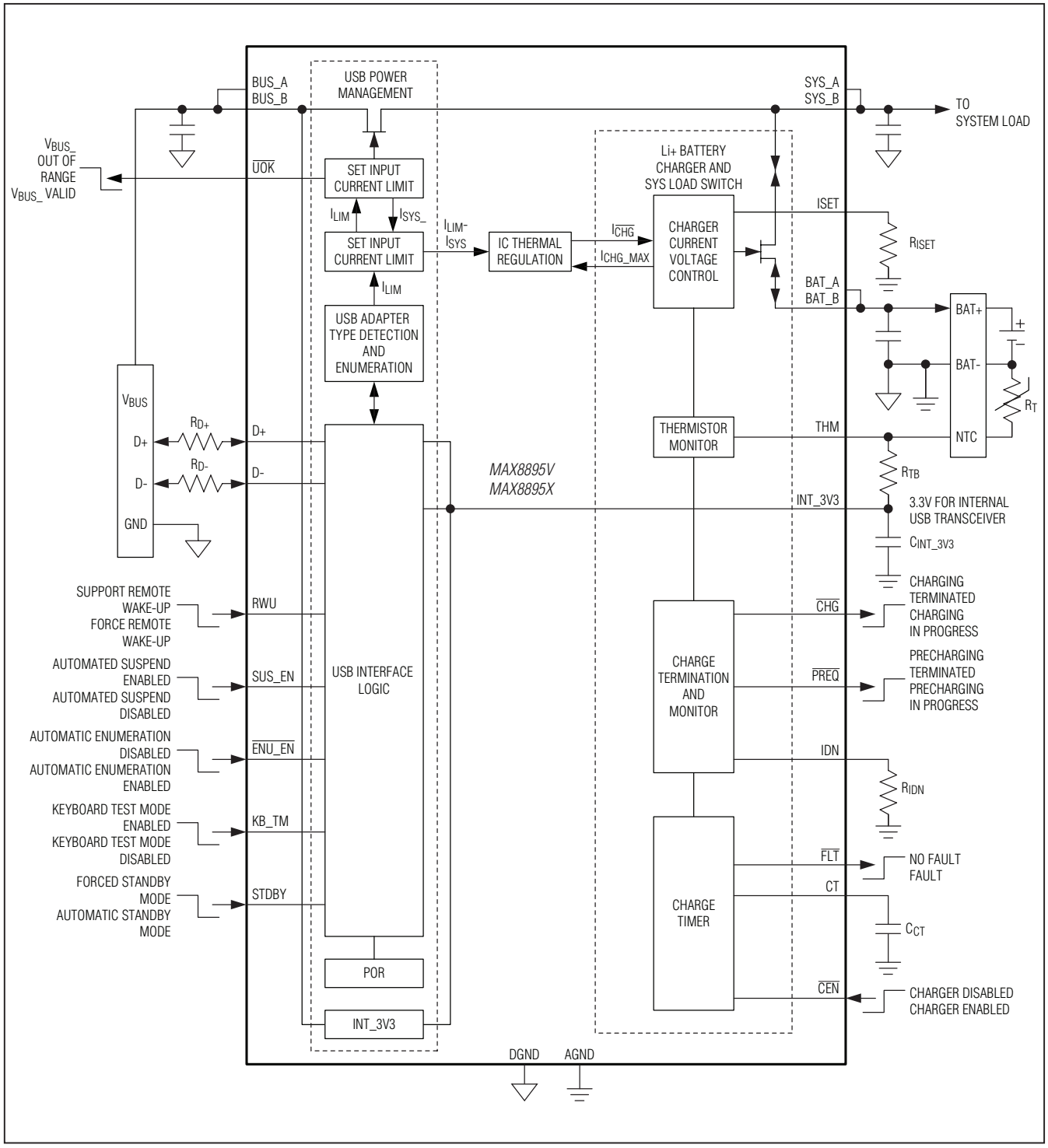


Figure 1. MAX8895V/MAX8895X Block Diagram

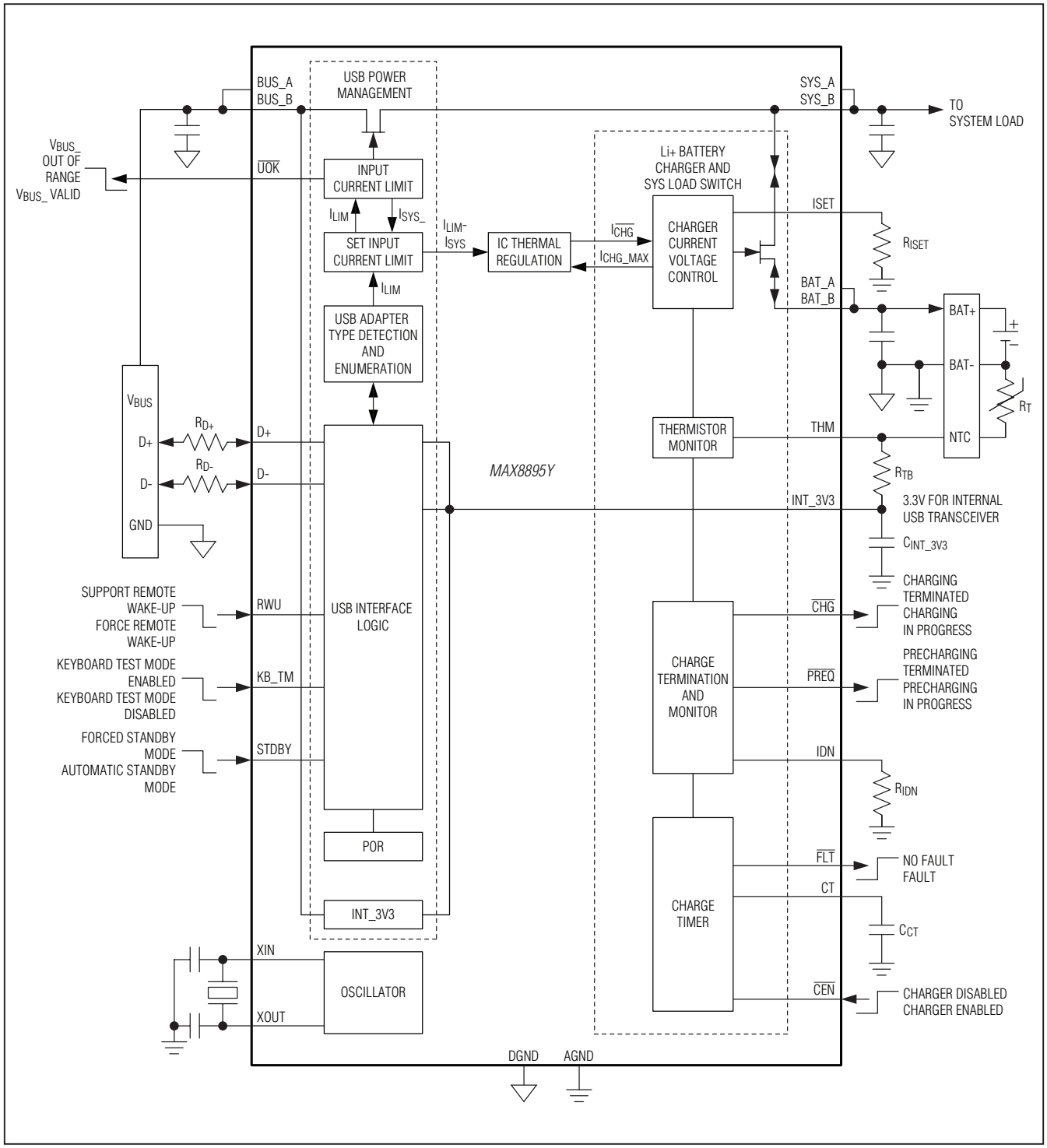


Figure 2. Differential Input Configuration

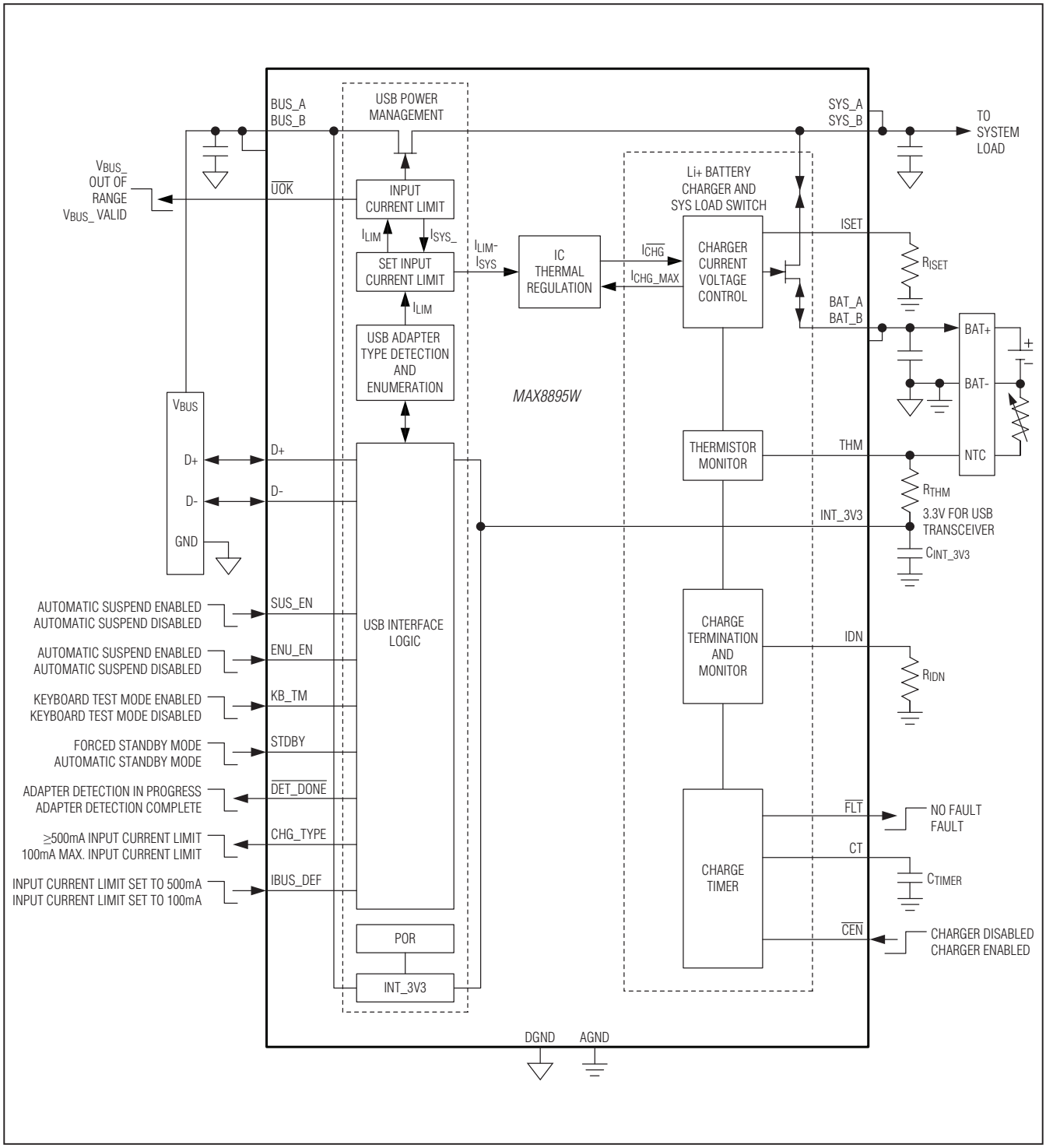


Figure 3. MAX8895W Block Diagram

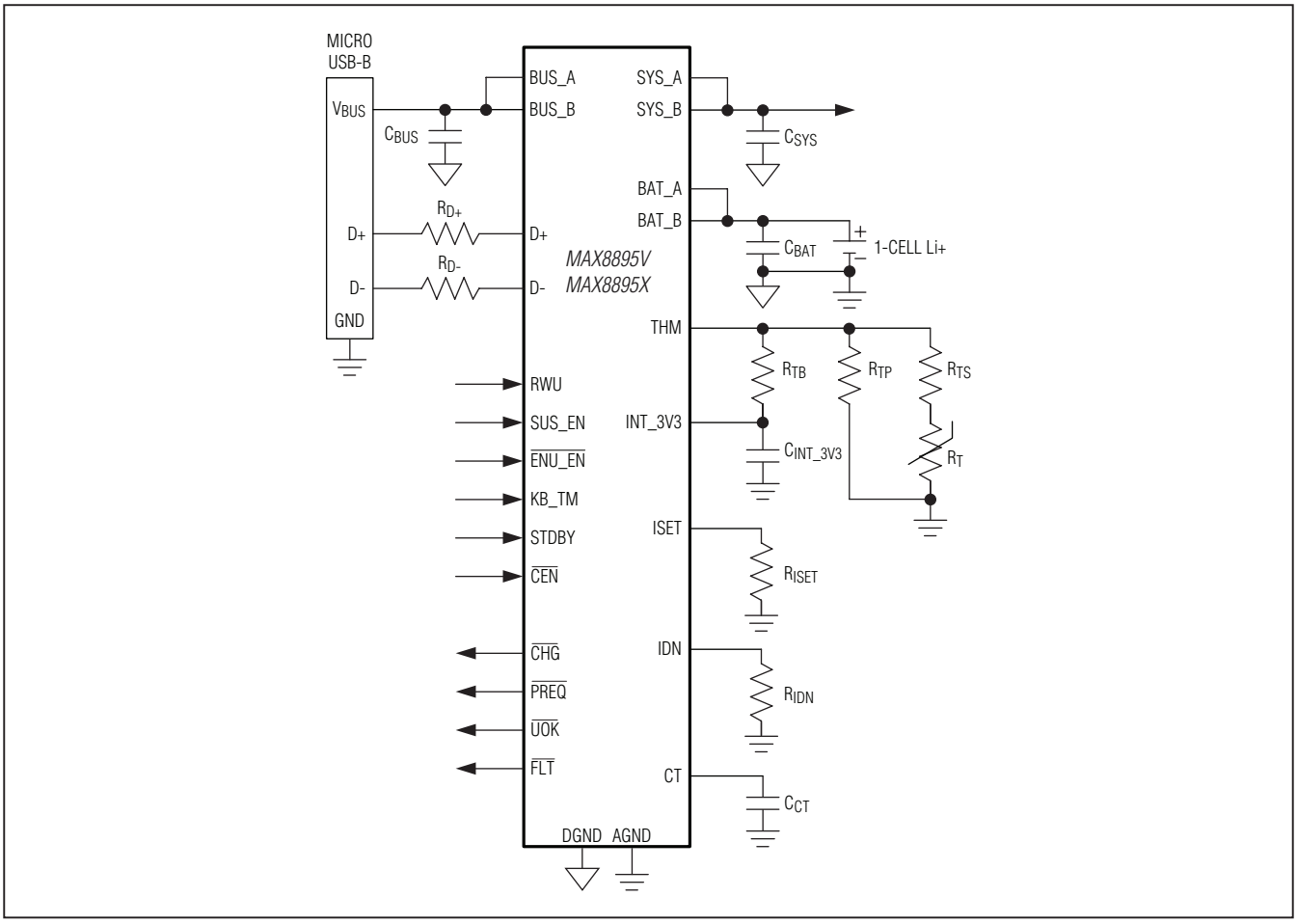


Figure 4. MAX8895V/MAX8895X Typical Application Circuit

NAME	VALUE	FUNCTION
C_{BUS}	10µF, 16V	Decoupling of input supply.
C_{SYS}	10µF, 6.3V	Decoupling of system rail.
C_{BAT}	10µF, 6.3V	Decoupling of battery rail.
R_T	User dependent	Thermistor for thermal sensing. See the *Thermistor Input (THM)* section for details.
R_{TB}, R_{TP}, R_{TS}	User dependent	Bias resistors for thermal sensing. See the *Thermistor Input (THM)* section for details.
C_{INT_3V3}	0.1µF, 6.3V	Decoupling of internal 3.3V rail.
C_{CT}	1000pF to 0.2µF	Capacitor to set charge timer, optional. See the *Fault Output ($\overline{FLT}$) and Charge Timer (CT)* section for details.
R_{ISET}	1.875kΩ to 30kΩ	Resistor to set maximum charging current, optional.
R_{IDN}	15kΩ to 240kΩ	Resistor to set termination current for charger, optional.
R_{D+}, R_{D-}	33Ω	D+/D- serial impedance.

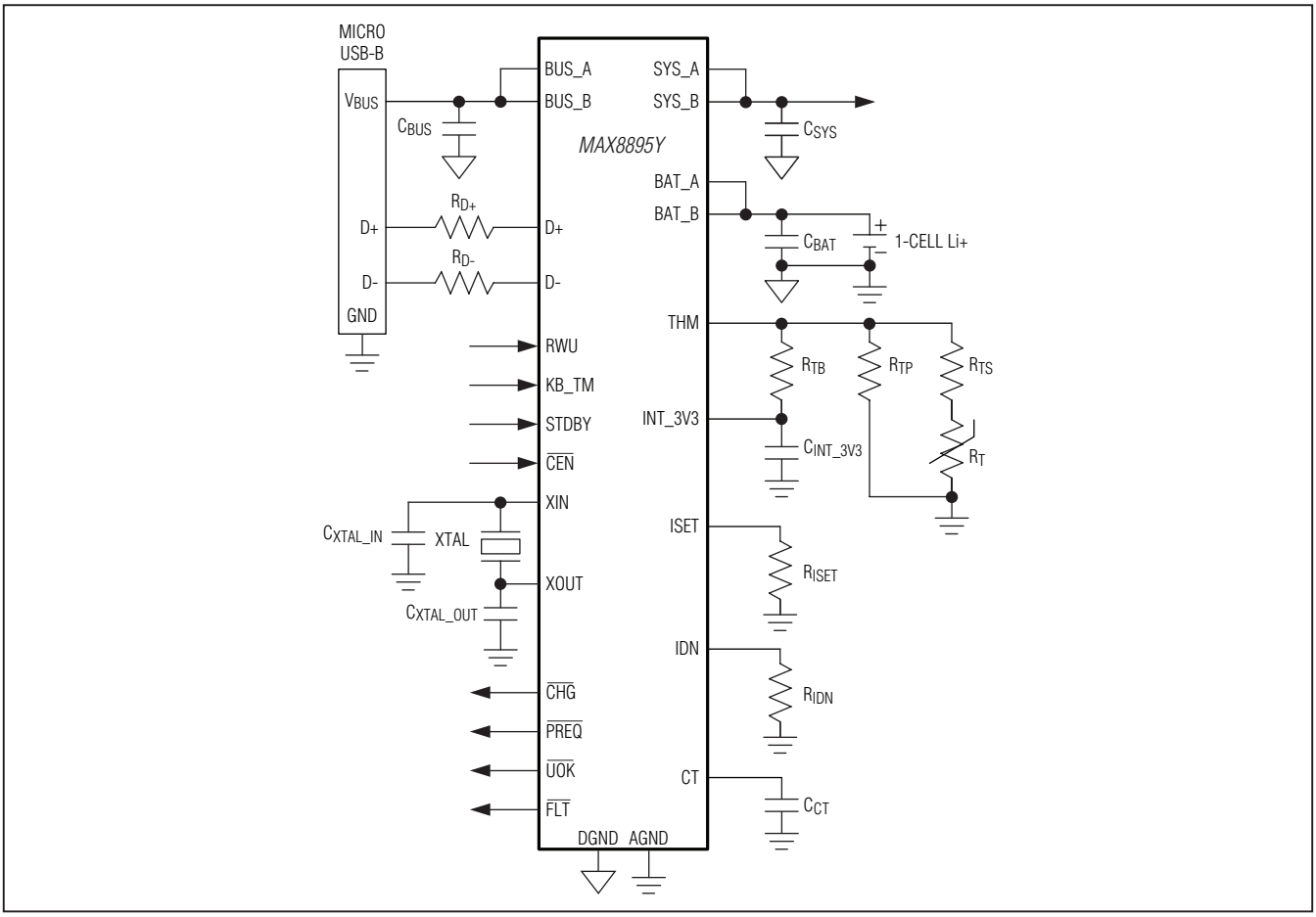


Figure 5. MAX8895Y Typical Application Circuit

NAME	VALUE	FUNCTION
C_{BUS}	10µF, 16V	Decoupling of input supply.
C_{SYS}	10µF, 6.3V	Decoupling of system rail.
C_{BAT}	10µF, 6.3V	Decoupling of battery rail.
R_T	User dependent	Thermistor for thermal sensing. See the *Thermistor Input (THM)* section for details.
R_{TB}, R_{TP}, R_{TS}	User dependent	Bias resistors for thermal sensing. See the *Thermistor Input (THM)* section for details.
C_{INT_3V3}	0.1µF, 6.3V	Decoupling of internal 3.3V rail.
XTAL	12MHz 2500ppm	MAX8895Y only, clock source for full-speed mode, requires a 2500ppm or better accuracy.
C_{XTAL_IN}	User dependent	MAX8895Y only, crystal load capacitor, only required for full-speed operation. See the *External Crystal/Ceramic Resonator* section for details.
C_{XTAL_OUT}	User dependent	MAX8895Y only, crystal load capacitor, only required for full-speed operation.
C_{CT}	1000pF to 0.2µF	Capacitor to set charge timer, optional. See the *Fault Output ($\overline{FLT}$) and Charge Timer (CT)* section for details.
R_{ISET}	1.875kΩ to 30kΩ	Resistor to set maximum charging current, optional.
R_{IDN}	15kΩ to 240kΩ	Resistor to set termination current for charger, optional.
R_{D+}, R_{D-}	33Ω	D+/D- serial impedance.

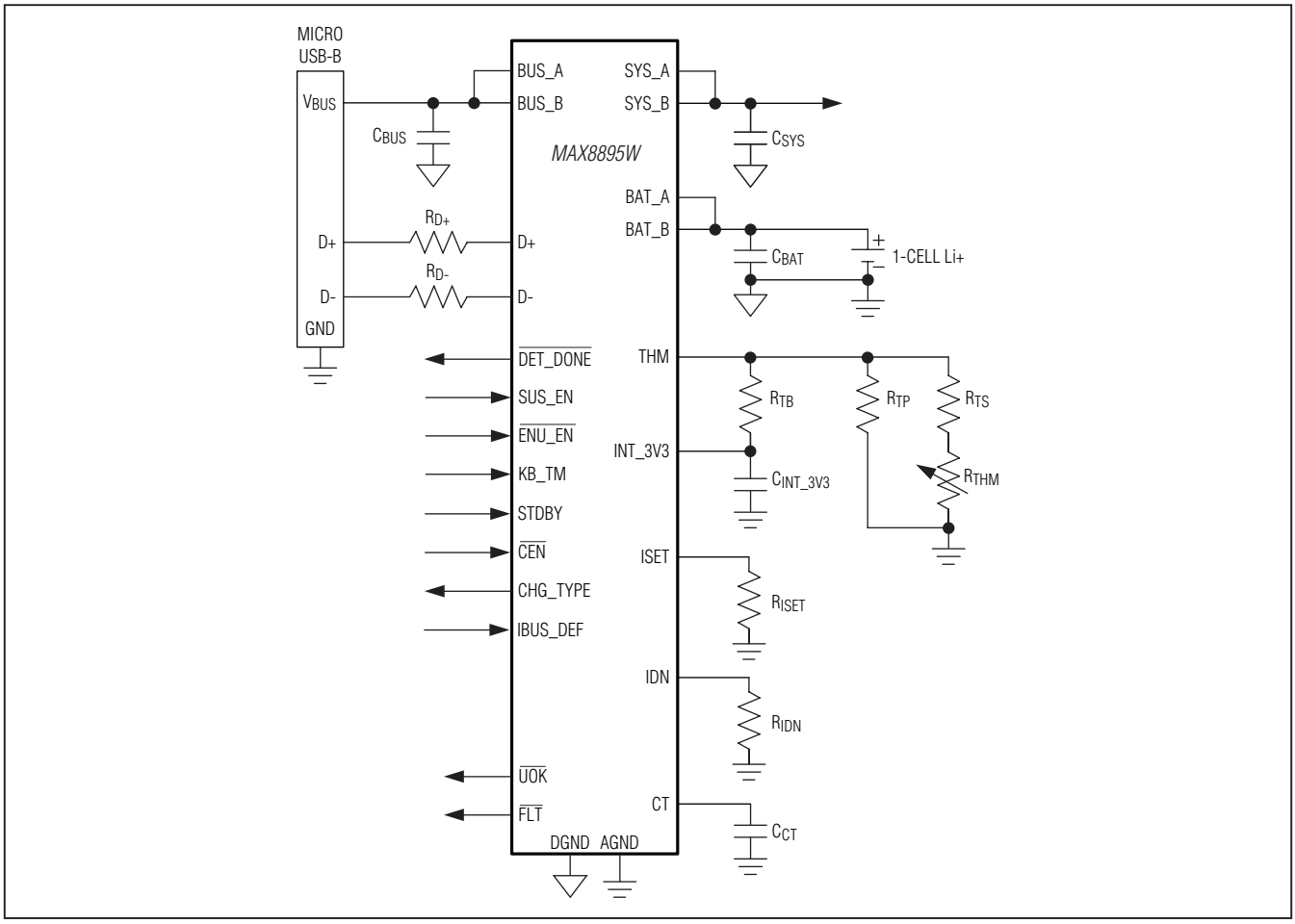


Figure 6. MAX8895W Typical Application Circuit

NAME	VALUE	FUNCTION
C_{BUS}	10µF, 16V	Decoupling of input supply.
C_{SYS}	10µF, 6.3V	Decoupling of system rail.
C_{BAT}	10µF, 6.3V	Decoupling of battery rail.
R_{THM}	User dependent	Thermistor for thermal sensing. See the *Thermistor Input (THM)* section for details.
R_{TB}, R_{TP}, R_{TS}	User dependent	Bias resistors for thermal sensing. See the *Thermistor Input (THM)* section for details.
C_{INT_3V3}	0.1µF, 6.3V	Decoupling of internal 3.3V rail.
C_{CT}	1000pF to 0.2µF	Capacitor to set charge timer, optional. See the *Fault Output ($\overline{FLT}$) and Charge Timer (CT)* section for details.
R_{ISET}	1.875kΩ to 30kΩ	Resistor to set maximum charging current, optional.
R_{IDN}	15kΩ to 240kΩ	Resistor to set termination current for charger, optional.
R_{D+}, R_{D-}	33Ω	D+/D- serial impedance.

Detailed Description

The MAX8895_ is an integrated 1-cell Li+ charger with USB enumeration capability. All power switches for charging and switching the load between battery and external power are internal. No external MOSFETS are required.

The MAX8895_ makes it possible to negotiate more than 100mA of charging current from a USB host or hub without processor intervention. The MAX8895_ also automatically detects a dedicated charger or USB charger and set the input current limit accordingly. The battery charge current can be set up to 1.85A. Input power not used by the system charges the battery.

USB Interface

An integrated USB peripheral controller provides auto-enumeration for full-speed (MAX8895Y) and low-speed (MAX8895V/MAX8895W/MAX8895X) modes.

The USB controller executes the adapter detection sequence, which consists of detecting the type of adapter that is externally connected and setting the input current limit accordingly.

If attached to a USB charger (host or hub) or a USB 2.0 (host or hub), it enumerates as an HID device and negotiates the maximum charging current level (from $V_{BUS\_}$).

The MAX8895V/MAX8895W/MAX8895X operate in low-speed mode, using an internal 6MHz oscillator, and does not require an external crystal to be USB compliant. The MAX8895Y operates in full-speed mode and requires an external 12MHz crystal.

According to the USB 2.0 specification, a low-speed device is not allowed to use a standard USB “B” connector. This is why MAX8895_ is available in both a low- and full-speed version. This makes it possible to use a custom or captive cable for low-speed mode using the MAX8895V/MAX8895W/MAX8895X and still be USB compliant. Operating in full-speed mode, using the MAX8895Y allows use of a standard USB “B” connector.

USB Timing

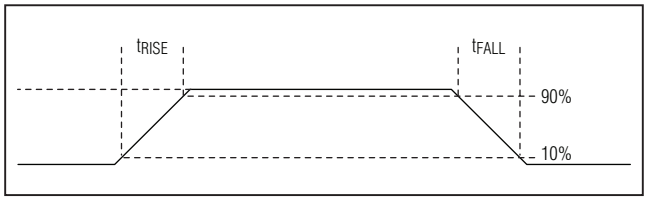


Figure 7. USB Rise and Fall Timing

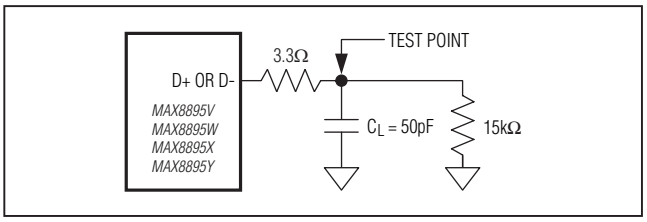


Figure 8. Load for D+/D- AC Measurements

D+ and D-

The internal USB full speed (MAX8895Y)/low-speed (MAX8895V/MAX8895W/MAX8895X) transceiver is brought out to the bidirectional data pins D+ and D-. These pins are ESD protected up to ±8kV (HBM). Connect these pins to a USB “B” custom connector through external 33Ω series resistors. The MAX8895V/MAX8895X provide an automatic switchable 1.5kΩ pullup resistor for D-, while the MAX8895Y provides an automatic switchable 1.5kΩ pullup resistor for D+.

Adapter Detection

When an adapter is present on $V_{BUS\_}$, the MAX8895_ examines the external device to identify the type of adapter connected.

The possible adapter types are:

- Dedicated charger
- USB charger (host or hub)
- USB 2.0 (host or hub) low power
- USB 2.0 (host or hub) high power

Each of these different devices has different current capability as shown in Table 1.

Table 1. Adapter Types

ADAPTER TYPE	OUTPUT VOLTAGE	OUTPUT CURRENT
Dedicated charger	4.75V to 5.25V at I_{LOAD} < 500mA 2.0V to 5.25V for I_{LOAD} ≥500mA	500mA to 1.85A
USB charger	4.75V to 5.25V at I_{LOAD} < 500mA 0 to 5.25V for I_{LOAD} ≥ 500mA	500mA to 900mA for low speed, full speed 500mA to 1.5A for low speed and full speed
USB 2.0 low power	4.25V to 5.25V	100mA (max)
USB 2.0 high power	4.75V to 5.25V	500mA (max)

When an adapter is connected to the MAX8895_, a series of tests is performed to identify the type of device connected. The sequence is done according to the flow charts in Figures 7 and 8. Figures 9, 10, and 11 show the adapter-type detection timing.

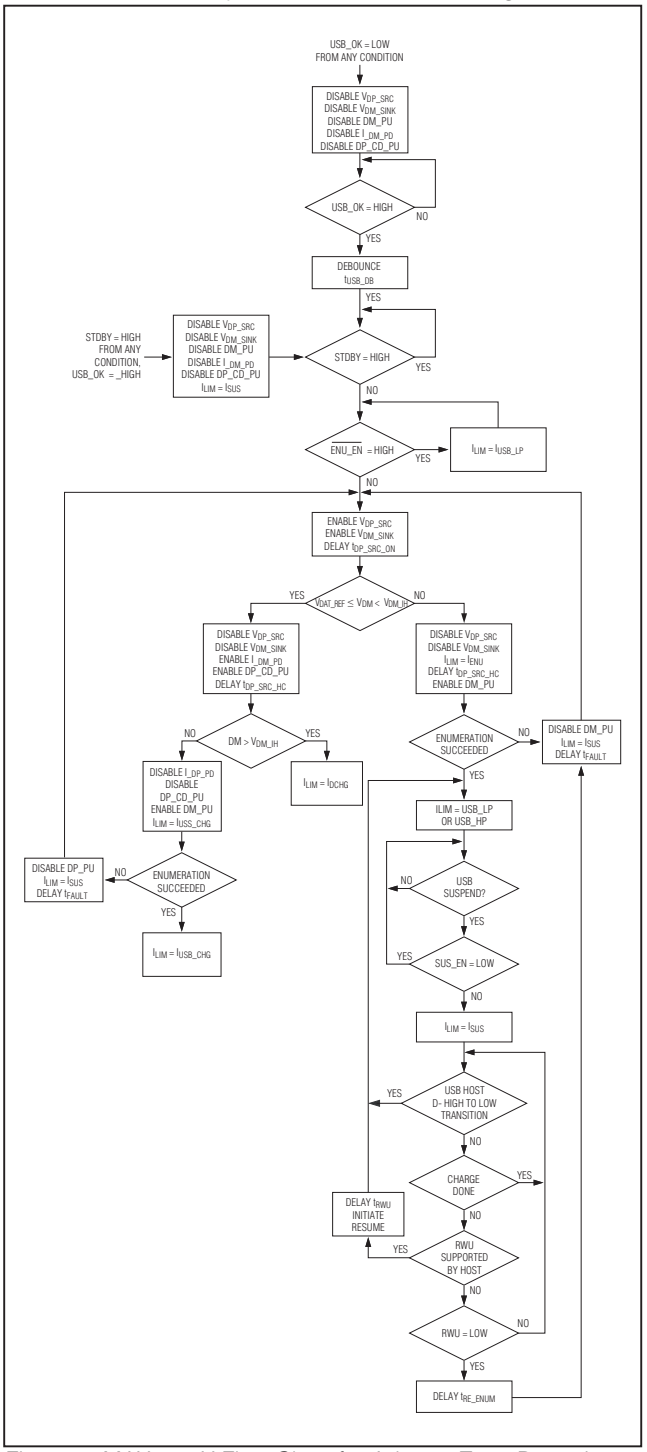


Figure 9. MAX8895X Flow Chart for Adapter Type Detection

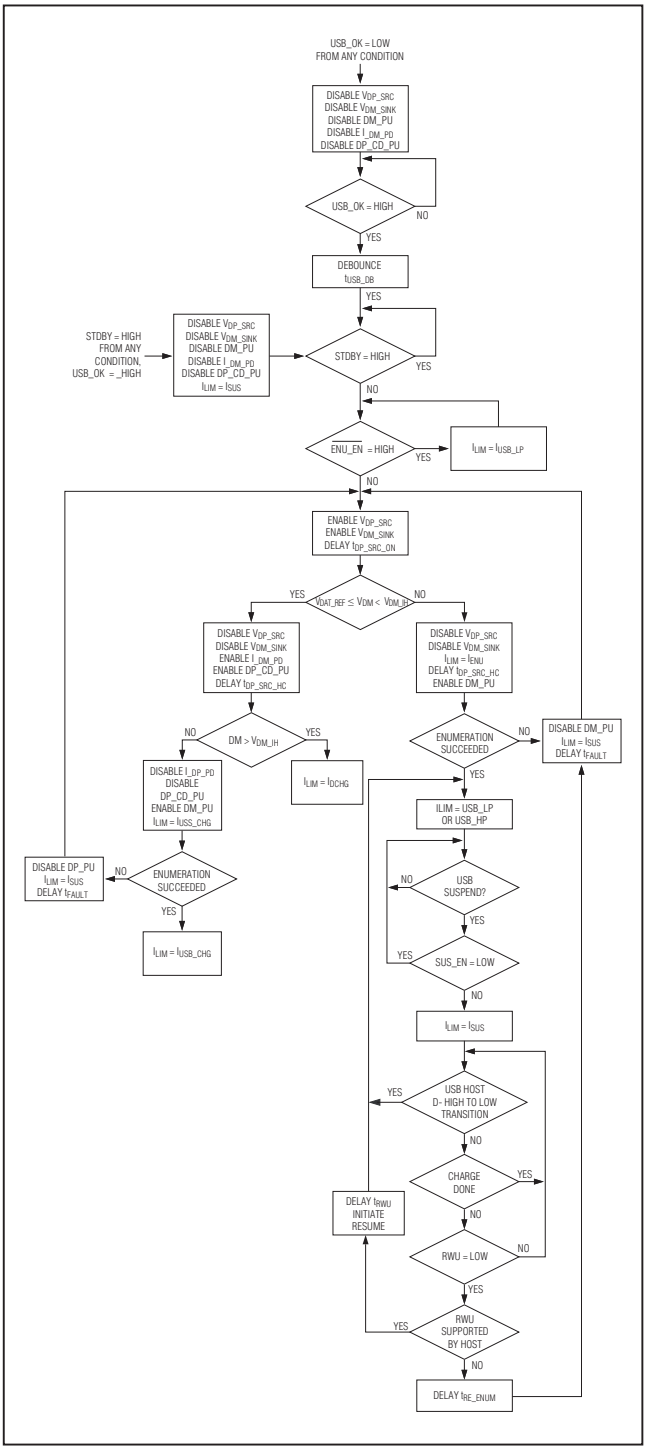


Figure 10. MAX8895V Flow Chart for Adapter Type Detection

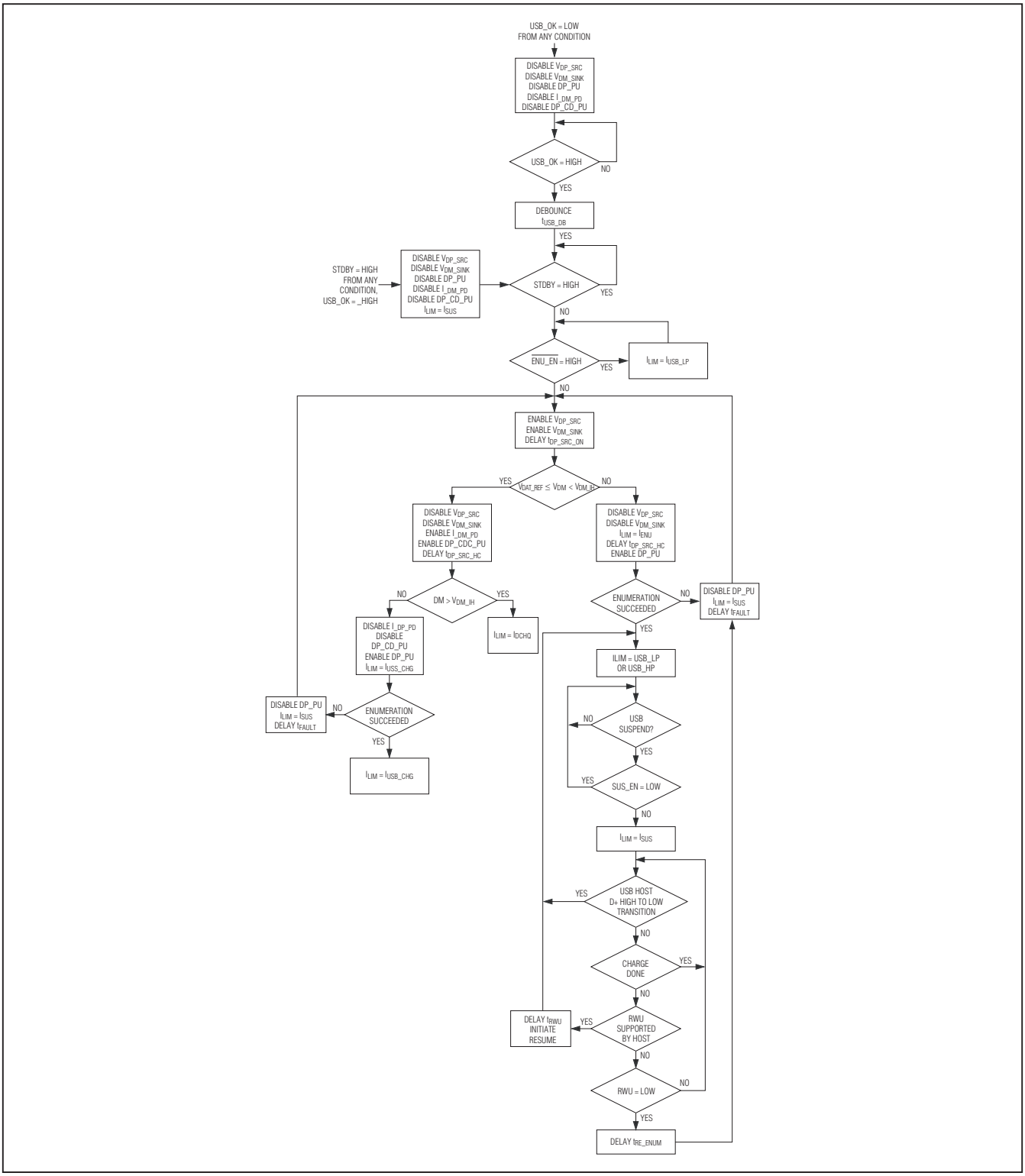


Figure 11. MAX8895Y Flow Chart for Adapter Type Detection

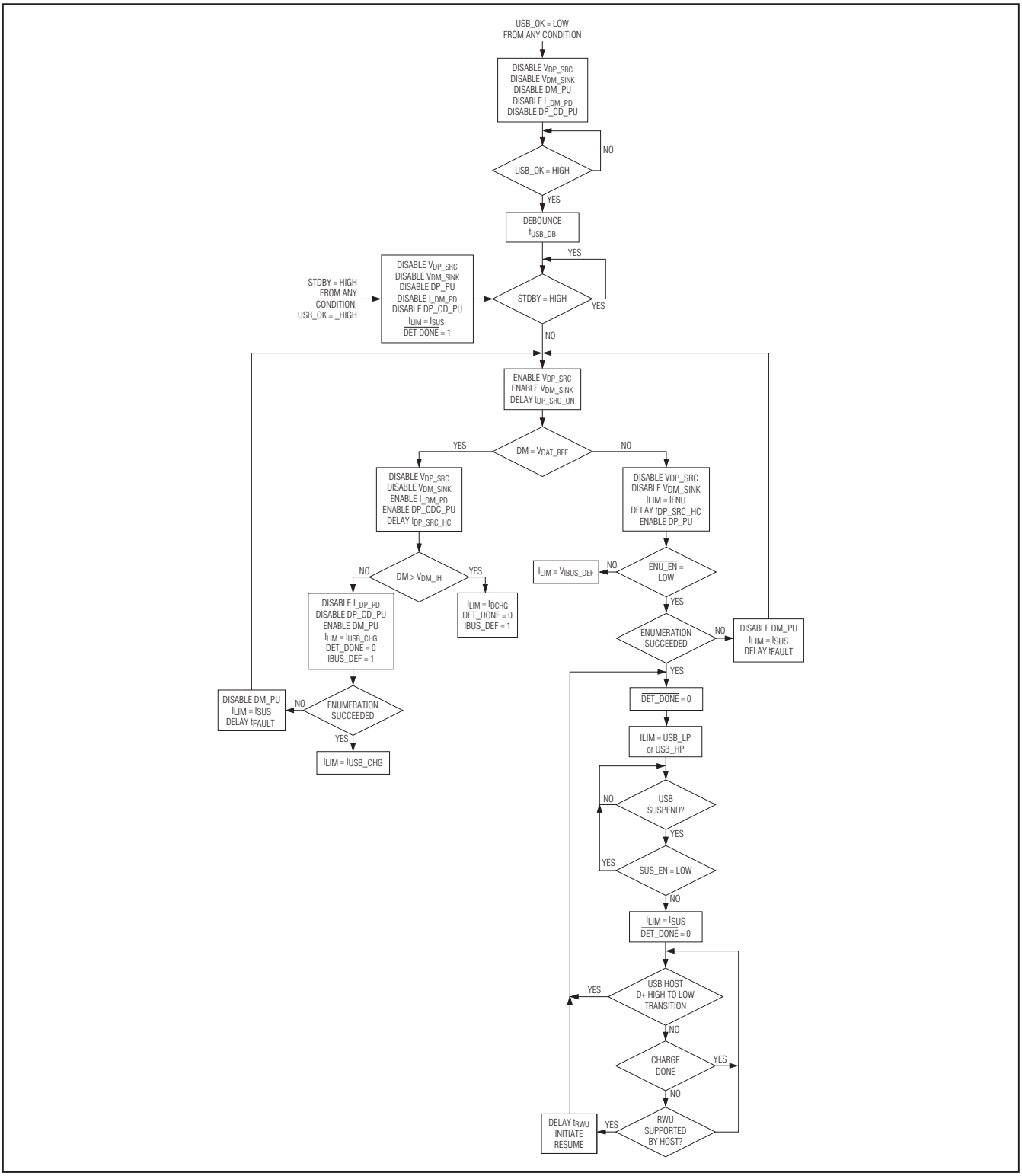


Figure 12. MAX8895W Flow Chart for Adapter Type Detection