easyRadio Advanced
eRA- LoRa Long Range Datasheet

Product image for illustration purposes only

The easyRadio eRA-LoRa (Long Range) RF transceiver module uses Chirped Spread Spectrum (CSS) modulation together with DSP (Digital Signal Processing) to achieve greater range than traditional devices using OOK, FSK or GFSK modulation.

In addition, sensitivity and blocking performance are improved giving high interference immunity whilst still offering low power consumption.

The module is a complete sub-system that combines a high performance low power RF transceiver, a microcontroller and a voltage regulator.

Key operating parameters can be changed and configured by sending simple 'text' (ASCII character) commands to the module.

Features

Chirped Spread Spectrum technology
Pin compatible with easyRadio Advanced (eRA) series RF modules
uFL RF connector for remote antennas
Multipoint communication
Half duplex transparent Serial Data Input and Output
Up to 180 bytes per packet
Familiar easyRadio commands
Built in temperature sensor
'Flash' firmware upgrades. New features and updates can be quickly programmed using LPRS tools

Key Parameters

Frequency Range: 860 - 1000MHz
Frequency Bands: 868/915MHz
Receiver sensitivity: down to -137dBm
Multi-channel operation
RF Power output: up to +20dBm (100mW)
Receive current consumption: 15mA
RSSI dynamic range: 127dB
Line of Sight (LoS) range – Up to 10km+ (Depending on environment)

User Programmable Options:

Spreading factors 6: to 12
Selectable Bandwidth: 125, 250, 500kHz
Over air bit rates of up to 300 kbps offer effective 37.5 kbps data rate
Host Data Rate: 2.4kbps – 115.2kbps

The variable spreading factor in combination with the bandwidth provide a balance between sensitivity (range) and data rate.

Applications

Required range is above 1km or transceiver is in poor RF location
Suburban security alarms - void buildings, caravan or car storage sites, warehouses
Rural security, farm buildings/equipment, livestock monitoring, remote irrigation pumps
Data collection and monitoring over a wide area

FCC Warning Statement:

- This device complies with Part 15 of the FCC Rules.
  Operation is subject to the following two conditions:
  (1) This device may not cause harmful interference, and
  (2) This device must accept any interference received, including interference that may cause undesired operation.
- This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.
- Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Canada Warning Statement:

English:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada.
To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.
This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

French:

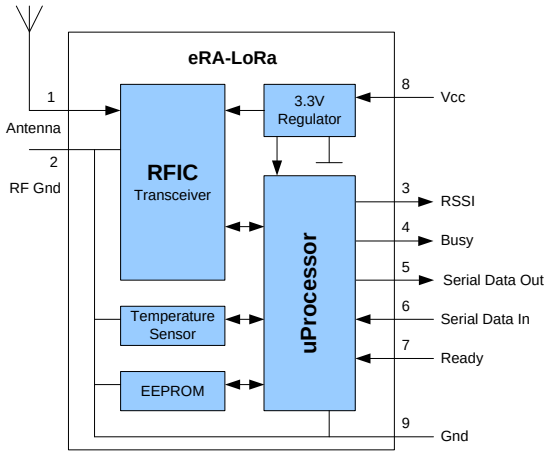
Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada.
Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.
Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

eRA-LoRa Transceiver

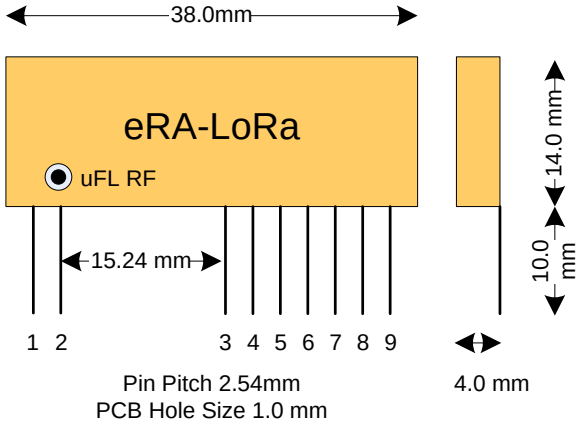
The easyRadio eRA-LoRa RF transceiver module is a complete sub-system that combines a high performance low power RF transceiver, a microcontroller and a voltage regulator.

The Serial Data Input (SDI) and Serial Data Output (SDO) by default operate at the standard 19,200 Baud and two handshake lines provide optional flow control to and from the host. The easyRadio Transceiver can accept and transmit up to 180 bytes of data, which it buffers internally before transmitting in an efficient over-air code format.

Any other eRA-Lora transceiver, within range and on the same settings, that 'hears' the transmission will decode the message and place the recovered data within a receive buffer that can then be downloaded to the receiving host for processing and interpretation. Radio transmission and reception is bi-directional (half duplex) i.e. transmit OR receive but not simultaneously. Extra internal buffers however, allow the user to upload data while a download is in progress giving the appearance of fully duplex data flow.



Block Diagram



Physical Dimensions

Pin Description

Pin No	Name	Description	Notes
1	Antenna	50Ω RF input/output. Connect to suitable antenna.	
2	RF Ground	RF ground. Connect to antenna ground (coaxial cable screen braid) and local ground plane. Internally connected to other Ground pins.	
3	Programmable IO	Provisional - TBA	
4	Busy	Digital output indicates that transceiver is ready to receive serial data from host	CTS function
5	Serial Data Out	Digital output for received serial data to host	
6	Serial Data In	Digital input for serial data to be transmitted	
7	Ready	Digital Input to indicate that Host is Ready to receive serial data from transceiver	RTS function
8	Vcc	Positive supply pin. +2.5 to +6.0 Volts. This should be a 'clean' noise free supply with less than 25mV of ripple.	
9	Ground	Connect to supply 0 Volt and ground plane	

Notes

The module operates internally from the output of an on-board 3.3 Volt low drop regulator. This regulator will still provide an (un-regulated) output below its drop out voltage, down to the minimum operating voltage (1.8V) of the RF IC which at 2.4V allows up to +20dBm RF output. The internal Vreg is not brought out to a specific pin.

The logic levels of the input/output pins are therefore between 0 Volt and the actual output voltage of the internal regulator. Outputs will drive external logic operating at 3.3 Volts. Resistors (10k typical) should be fitted in series with input data lines when interfacing to external 5V logic outputs to prevent driving excess current into inputs and thus damaging them.

The serial inputs and outputs are intended for connection to a UART or similar low voltage logic device. Do not connect any of the inputs or outputs directly to an RS232 port. The transceiver module may be permanently damaged by the voltages (+/- 12V) present on RS232 signal lines.

When handshaking is enabled the 'Host Ready Input' should be held at 0 Volt (Ground) in the idle state.

On power up the transceiver is, by default configured to receive data.

Absolute Maximum Ratings

Operating Temperature Range	-40° C to +85° C
Storage Temperature Range	-40° C to +85° C
Vcc	- 0.3 to + 6.0 Volts
All Other Pins (N.B.)	- 0.3 to +3.3 Volts
Antenna	+10dBm - Should be protected to prevent damage from ESD

Performance Data: eRA-LoRa. Supply +5.0 Volt ± 5%, Temperature 20° C

DC Parameters	Pin	Min	Typical	Max	Units	Notes
Supply Voltage (Vcc)	8	2.5	3.3-5.0	6.0	Volts	
Transmit supply current	8	18	90	125	mA	90mA at +17dBm 125mA at +20dBm
Receive supply current	8	15.2	16	17.4	mA	*2
Sleep Mode current	8		15		µA	
Interface Levels						
Data Output Logic 1		2.2	3.1	3.1	Volts	10k load to +Vcc supply
Data Output Logic 0			0.1		Volts	10k load to +Vcc supply
Logic Output Current				25	mA	
Data Input Logic 1		2.0		3.6	Volts	*1
Data Input Logic 0				0.2	Volts	
Input Pull-ups			100		KΩ	*1
RF Parameters						
Antenna Impedance	1		50		Ohms	
Frequency Range		860		1000	MHz	Please refer to local ISM licence free radio regulations. See ER Frequency commands
Frequency Regional	EU	868	869.85	870	MHz	See ER Configuration commands
	USA	902	903	928	MHz	
Transmitter						
RF Power Output	1		+7	+20	dBm	868MHz - 50Ω load *4
	1		+17	+20	dBm	915MHz - 50Ω load *4
Frequency accuracy			±10		ppm	Overall
Harmonics/Spurious Emissions			-47	< -36	dBm	Meets EN 300 220-3
Over Air Bit Rate				300	Kbps	(Not the effective Data Rate)
Receiver		**SF6**		**SF12**		
		-122		-137	dBm	At 125kHz bandwidth (SF 6 - 12)
		-119		-134	dBm	At 250kHz bandwidth
		-116		-131	dBm	At 500kHz bandwidth
Serial Data Rate		2.4	19.2	115.2	Kbps	Host interface
Logic Timing						
Initial Power Up Time			1		mS	*2,3
Mechanical						
Size			38 x 14 x 4		mm	
Pin Pitch			2.54		mm	(Standard 0.1 Inches)
Weight			3.5		grams	

Notes *:

1. The 'Host Ready Input' and the 'Serial Data Input' have 'weak' internal pull-ups enabled.
2. The transceiver will then be ready to receive (default) or transmit. It would normally be left in this powered state ready to receive data. Bandwidth 125 kHz = 15.2mA, 250 kHz = 16mA, 500 kHz = 17.4mA
3. During power-up the 'Busy' Output line initially goes high and then goes low when ready for use.
4. Typical values show restricted with 'Worldwide settings' applied.

easyRadio eRA Configuration Command Set

Key operating parameters of most easyRadio modules can be changed and configured by sending the 'text' (ASCII character) commands detailed below. These commands can also be executed using the free 'easyRadio Companion' software available for download on the LPRS website, any 'Terminal' software like Realterm/Tera Term that operates on a PC or from the host microcontroller.

The commands should be sent exactly as shown: i.e. case sensitive with no spaces between characters.
Commands are not executed until the Acknowledgement sequence (ACK) is sent to and processed by the module.

To send the commands follow this procedure:

Send Command from host: e.g. ER_CMD#U5 (Set UART BAUD to 38400)
Wait for the completion of the echo of the Command from the module. e.g. ER_CMD#U5
Send the ACK command as the three upper case ASCII characters 'A' 'C' 'K' in sequence with no spaces
If enabled from firmware version 4.1.16 the module can reply with 'OK' to indicate correct modification of parameters.
Commands ending with '?' or 9-character length do not require an ACK follow up. Some special commands (noted below) do require an ACK

Host Serial Communication Settings			
Command	**UART Data Rate**	✓	Tick Indicates Factory Default setting
ER_CMD#U1	2400		
ER_CMD#U2	4800		
ER_CMD#U3	9600		
ER_CMD#U4	19200	✓	
ER_CMD#U5	38400		
ER_CMD#U6	31250		MIDI - Musical Instrument Digital Interface (Not supported by PC UARTS)
ER_CMD#U7	76800		(Not supported by PC UARTS)
ER_CMD#U8	115200		
ER_CMD#U?	Get UART Value		The module replies with the current UART data rate value E.g: ER_CMD#U2 - No 'ACK' is required
ER_CMD#A70	No Parity	✓	Data = 1 Start, 8 Data, No Parity, 1 Stop
ER_CMD#A71	Even Parity		Data = 1 Start, 8 Data, 1 Parity, 1 Stop
ER_CMD#A72	Odd Parity		Data = 1 Start, 8 Data, 1 Parity, 1 Stop
ER_CMD#A40	Disable FAST ACK	✓	
ER_CMD#A41	Enable FAST ACK		**"FAST ACK"** In this mode the procedure to update settings is made much faster. In response to an ER_CMD#x string the TRS/RS module will reply with a single HEX 6 (0x06) which is the ASCII ACK value. The host will then issue the same single byte 0x06 in replacement of the Txt version of "ACK".

Transmit RF Power Output Settings					
				eRA-LoRa	**Units**
				868 or 902-928	MHz
ER_CMD#P0			All frequencies from firmware version 4.1.16 and above, use a single table. Maximum limits for the band can be capped using the new W (World Regulations) Command. The default W setting is unrestricted and the user is responsible to comply with local laws.	-1	dBm
ER_CMD#P1				1	dBm
ER_CMD#P2				3	dBm
ER_CMD#P3				5	dBm
ER_CMD#P4				7	dBm
ER_CMD#P5				9	dBm
ER_CMD#P6				11	dBm
ER_CMD#P7				13	dBm
ER_CMD#P8				15	dBm
ER_CMD#P9		✓		17	dBm
			N.B. RF Power Output conforms with and is restricted by EU & US regulations +17dBm selectable firmware/frequency dependent		
ER_CMD#P?	Get Power Value		The module replies with the current power value. e.g: ER_CMD#P9 - No ACK is required.		

RF Channel Settings							
ER_CMD#Cx	Where x = Channel Number in decimal		E.g. For Channel 1: ER_CMD#C1 or ER_CMD#C01 (leading zero) Value saved in non-volatile EEPROM				
ER_CMD#C?	Get Channel Value		The module replies with the current channel setting E.g: ER_CMD#C9 - No ACK is required.				
Signal Bandwidth							
			Bandwidth		**Data Rate @ S/F = 10**		After sending these commands the Channel number will be reset to Channel 0
ER_CMD#B0	Set Signal Bandwidth		125	kHz	977	bps	
ER_CMD#B1	Default 4.1.16+	✓	250	kHz	1953	bps	
ER_CMD#B2			500	kHz	3906	bps	
ER_CMD#B?	Get Signal Bandwidth						
Band Plan							
ER_CMD#b0	EU	✓	869.850			MHz	Band base/start frequency Europe/ USA b6 user configurable using absolute frequency settings.
ER_CMD#b1	USA		903.000			MHz	
ER_CMD#b6	Custom Setting		903.000			MHz	
ER_CMD#b?	Get current Band Plan						
Frequency Settings							
ER_CMD#F	Set Absolute Frequency		Sets the absolute frequency to xxxxxxxx in Hex E.g. ER_CMD#F33D8DB90 sets the radio frequency to 869850000Hz. This will automatically set Band Plan to b6				Set Frequency of Channel 0
ER_CMD#F?	Get current Frequency value		Returns the current frequency value as 8 bytes of Hex E.g. ER_CMD#F? Returns 33D8DB90 which is 869850000MHz				Get Frequency of Channel 0
Spreading Factor							
	S/F	**Chips**		**Bandwidth kHz** B0	B1	B2	**Data Rate**
				125	**250 ✓**	**500**	
ER_CMD#s0	6	64		9375	18750	37500	bps
ER_CMD#s1	7	128		5469	10938	21875	bps
ER_CMD#s2	8	256		3125	6250	12500	bps
ER_CMD#s3	9	512		1758	3516	7031	bps
ER_CMD#s4	10	1024	✓	977	**1953**	3906	bps
ER_CMD#s5	11	2048		537	1074	2148	bps
ER_CMD#s6	12	4096		N/A	586	1171	bps
ER_CMD#s?	Get Spreading Factor						S/F 12 at 125kHz not supported at this time
Miscellaneous							
ER_CMD#R0	Reset Module (POR)		Reset module and retrieve all Power On Reset values				
ER_CMD#R1	Reset to Defaults		Restores all factory default settings (Applies to V4.1.16 and above)				
ER_CMD#A10	Encryption Off	✓	LPRS Proprietary Encryption for P2P				
ER_CMD#A11	Encryption On						
ER_CMD#A50	Handshaking Off	✓	Currently not available. If handshaking is required, please contact LPRS directly.				
ER_CMD#A51	Handshaking On						
ER_CMD#a00	RSSI Off	✓	Received Signal Strength Indicator				
ER_CMD#a01	RSSI On		Each received packet delivered is preceded by the 8 bit RSSI value of the received packet				
ER_CMD#a40	'OK' Confirmation Disabled	✓	When enabled, the transceiver will reply 'OK' following the confirmation 'ACK' from the host.				
ER_CMD#a41	'OK' Confirmation Enabled						
ER_CMD#a50	Disable Sleep mode	✓	When enabled Pin3 must be held low for normal operation. Setting the pin high puts the transceiver and MCU into sleep mode consuming only 15uA.				
ER_CMD#a51	Enable Sleep mode						
ER_CMD#S0	Sleep Command		Prior to sending this command, set pin 7 High. Following the ACK the current will drop to < 20uA. Pull pin 5 Low to wake from Sleep. (This is unrelated to Pin3 Sleep Pin Function) It takes approximately 200uS to enter Sleep and approximately 6mS to wake from Sleep.				

Test Modes			
ER_CMD#T3	Get Firmware Revision		Returns module firmware revision string E.g. ERIC-LORA V4.1.16
ER_CMD#T4	RAW Data Out		Output received data on the CTS pin
ER_CMD#T7	Read on chip temperature Sensor		Example reply: -15 or 23 (This decimal value is in Celsius)
ER_CMD#T7xx	Calibrate on-chip temperature sensor		xx = Actual Temp (only calibrate when above 0 degrees)
ER_CMD#T8	Last Packet RSSI		Returns the Hex value of the RSSI (Received Signal Strength Indicator) register measured on the last valid packet
Other Special Commands			
ER_CMD#L8?	Get Serial Number		Returns the unique four byte module serial number in Hex. E.g. 40 00 00 56 'ACK' required
Worldwide Regulations (Firmware Versions 4.1.16+)			
ER_CMD#W0		✓	Default – No RF Power output restrictions
ER_CMD#W1			EU Regulation Band Restrictions
ER_CMD#W2			USA FCC Restrictions
ER_CMD#W?			Read the current setting
Group ID Setting			
ER_CMD#N0xxxx	Enable Group ID		E.g. ER_CMD#N04578 sets the group ID as 0x4578 See Notes on Group ID number assignment below
ER_CMD#N00000	Disable Group ID		
ER_CMD#N0?	Get Group ID		Returns the 4 byte Group ID number in Hex. Requires ACK
Encryption Key			
ER_CMD#N1xxxx	Set Encryption Key		e.g. ER_CMD#N121F5 = set Encryption Key to 0x21F5
			There is no method to read the Encryption Key for security purposes.

Reserved LoRa Group ID number assignments.

12xx Reserved for standard LoRa communications
34xx Reserved for LoRaWAN communications
00xx and FFxx will default to 12xx

When Group ID's are different to the above reserved values, data is automatically encrypted using LPRS proprietary encryption using the encryption key stored in memory (Default 0000).
Group ID's can also be modified to increase security to the Key as it is used in the calculation creating a 32-bit seed.

Channel Frequencies

Each channel frequency is calculated relative to the Start Frequency of the channel, the Channel Number and the Channel Spacing/Band width.

Three commands control the values of each of these parameters:

ER_CMD#bn	Where n is the Start Frequency in MHz of the Band Plan being used	b
ER_CMD#Cn	Where n is the integer Channel Number	c
ER_CMD#Bn	Where n is the Channel Spacing/Bandwidth in kHz	s

The centre frequency of each channel is calculated using the formula:

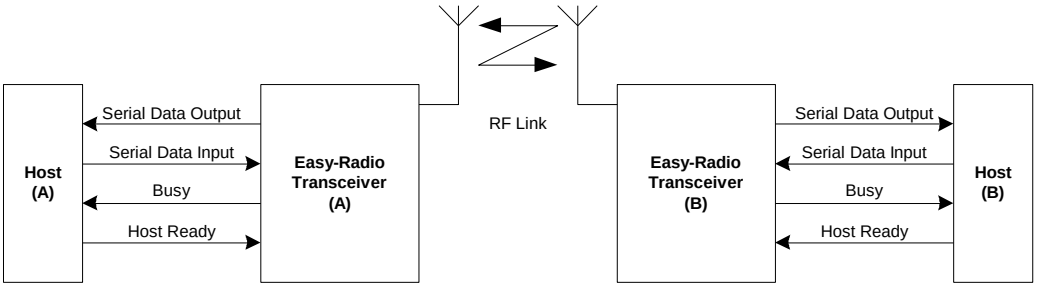
Centre Frequency $(f) = b + cs + \frac{s}{2}$

Where	**Example**
Band plan Start Frequency	b = 0
Channel Number	c = 1
Channel Spacing/Bandwidth	s = 500kHz

f = 903.000MHz + 1 x 500kHz + 500kHz/2 = **903.750MHz**

Application & Operation of eRA-LoRa Transceiver

The diagram below shows a typical system block diagram comprising hosts (user's application) connected to easyRadio transceivers. The hosts (A & B) will be monitoring (collecting data) and/or controlling (sending data) to some real world application.



Typical System Block Diagram

The hosts provide serial data input and output lines and two 'handshaking' lines that control the flow of data to and from the easyRadio Transceivers. The 'Busy' output line, when active, indicates that the transceiver is undertaking an internal task and is not ready to receive serial data. The 'Host Ready' input is used to indicate that the host is ready to receive the data held in the buffer of the easyRadio Transceiver.

The host should check before sending data that the 'Busy' line is not high, as this would indicate that the transceiver is unable to reliably receive further data. It should also pull the 'Host Ready' line low and check that no data appears on the Serial Data Output line.

The Busy output is active all the time regardless of handshaking setting. The host Ready is enabled by the handshaking setting command.

Timing Specifications		Units	Notes
Host Serial Input/Output	2400, 4800, 9600, 19200, 38400, 31250 (MIDI), 76800 & 115200	baud	1
Host Character Format	1 Start, 8 Data, No Parity, 1 Stop	Bits	2
End of Data Delay	2 x BAUD Byte Duration	mS	3
RF Transmit duration	Depends on Bandwidth and data rate setting	mS	4
Buffer Size	180	Bytes	5

Notes

1. Data is inverted i.e. Start Bit is logic low. The inputs are intended for direct connection to a microcontroller UART or to RS232 inputs and outputs via an RS232 Level translator such as a Maxim MAX232, which invert the logic of the RS232 signals. This allows direct connection to, for example a microcontroller UART. The data rate is user programmable (Default 19200 baud) and may differ between individual units within a system.
2. 1 start, 8 data, 1 stop = 10 bits @ 104uS/bit = 0.52mS/character at 19200 Baud. (Default)
3. The 'End of Data' delay is fixed at twice the character time.
4. A fixed package overhead of xx is added to all packets.
5. The buffer size is limited to 180 bytes. Sending more than 180 bytes will cause loss of data.
6. CTS pin will go high 2 bytes before the buffer is full. This allows characters already sent to be accepted by the ER module.

Product Order Codes

Name	Description	Order Code
eRA-LoRa	CE/FCC/IC Certified Radio Module	ERA-LORA

Please contact the sales office for availability of variants of the standard product. The software interface can be customised to specific requirements for high volume applications.

easyRadio Advanced Firmware Versions

Version	Date	Revision	Known Issues
3.6.2XXX	January 2016	Initial Release	
4.1.16	March 2018		Temperature bug.

Document History

Issue	Date	Revision
1.0	February 2016	Provisional datasheet
1.1	August 2016	Amendments for Approvals
1.2	December 2016	Minor additions
1.22	February 2017	New easyRadio Companion commands added
1.23	November 2017	Clarification of Frequency Range
1.3	January 2018	Corrections and clarifications
1.4	May 2018	Corrections, amendments, additional features V4.1.16

Changes to this Document This data sheet has been updated to reflect changes throughout the range of LPRS modules. Specific changes are recorded in the documentation history above.

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