

REV LTR	DESCRIPTION	DATE	APPVD.
-	Orig. Release	1/25/24	MLG

XE643K – R00 SERIES
HC/ACMOS OSCILLATORS
FOR SPACE & HI-REL APPLICATIONS
450 KHz to 125 MHz
(7 x 9 mm, Straight Leads, 1.8V)

(Refer to Page 5 for Reduced QCI Models XE643E, XE643B & XE643P)

REV STATUS OF SHEETS	REV																	
	SHEET NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
APPROVALS	DATE	XSIS ELECTRONICS, INC.																
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Q. A. S. Gupta	1/25/24																	
CUST. ENG.		FSC NO. 57051						DWG. NO. XE643K – R00										
CUST Q A.		SCALE N/A						SHEET 1 OF 11										

1. SCOPE:

XE643K-R00, 1.8V, HC/ACMOS, high reliability hybrid microcircuit crystal oscillators are designed, produced and tested by Xsis Electronics, Inc. as MIL-PRF-38534 (modified), Class K equivalent devices, as described herein, for use in high reliability industrial, military, avionics and space applications. These devices are of hybrid microcircuit technology conforming to MIL-PRF-55310, Type 1, Class 2 oscillators.

1.1 ALTERNATE MODELS: Models XE643E, XE643B and XE643P with reduced QCI and/or reduced screening and shorter lead times are also offered as explained on page 5.

2. APPLICABLE DOCUMENTS:

MIL-PRF-55310F Oscillator, Crystal Controlled, General Specifications for
MIL-PRF-38534K Hybrid Microcircuits, General Specifications for
MIL-STD-883L Test Methods and Procedures for Microelectronics

3. REQUIREMENTS:

3.1 General: The individual item requirements shall be as specified herein.

3.2 Package: Ceramic, 90% Min. AL₂O₃, Weight: 0.6 Gms Max., Thermal Resistance, θ_{JC} : 28 °C / Watt.

3.2.1 Lead Material & finish: Kovar, 50 to 70 micro-inches gold over 100 to 250 micro-inches nickel. Hot Solder tinning with Sn63/Pb37 solder per MIL-PRF-55310 is optional at an additional cost.

3.2.2 Reflow Soldering: Reflow soldering at 260 °C for 10 seconds shall not degrade the performance.

3.3 Hermeticity: Resistance welded, hermetically sealed, leak rate of 1 x (10)⁻⁸ atm-cc/s Max.

3.4 Marking: As a minimum, the parts shall be marked with Xsis P/N, ESD symbol, date code and serial number.

3.5 Absolute Maximum Ratings: Unless otherwise specified, absolute maximum ratings shall be as follows:

Supply Voltage	-0.5 to +5 VDC
Operating Free-Air Temperature Range	-55°C to +125°C
Storage Temperature	-55°C to +125°C

3.6 Electrical Characteristics: See Table I

3.6.1 Total Dose Radiation: Hybrid Microcircuit Crystal Oscillators shall be capable of meeting the electrical characteristics of Para. 3.6 after being exposed to total ionizing dose radiation of 100 krads as per MIL-STD-883, method 1019.

3.7 Hybrid Elements:

3.7.1 Quartz Crystals: A high grade cultured quartz crystal shall be used. As an option, Xsis will use a premium Q swept quartz crystal at an additional charge, refer to part numbering example in paragraph 6 to specify swept quartz crystal. Crystal element evaluation shall be in accordance with MIL-PRF-55310.

3.7.2 Crystal Mounting: The crystal element shall be mounted at 4 points in such a manner as to provide adequate ruggedness and performance under extreme environments specified herein.

3.7.3 Passive Elements: Established Reliability (ER) QPL components, failure level R minimum shall be used or element evaluation shall be as per MIL-PRF-38534, Level K.

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- 3.7.4 The Microcircuit die shall be from lots that have passed the element evaluation per MIL-PRF-38534, Level K. In addition, ionizing radiation testing shall be performed at the oscillator level as explained in paragraph 3.7.5 herein.
- 3.7.5 For Output Frequencies up to 16 MHz the microcircuit die shall be from NSC/FC 54ACT family. For higher output frequencies, the microcircuit die shall be from CMOS or BiCMOS Si family from NPC. The Microcircuit die shall be from wafer lots that have been successfully tested in the oscillator for ionizing radiation up to 100 krad. Xsis Electronics has also performed SET & SEL testing on both types of microcircuit die stated above. Both die are SEL immune for LET of up to 95 Mev-cm²/mg. Test reports are available on request.
- 3.7.6 Workmanship, Rework and Process controls shall be in accordance with the requirements of MIL-PRF-55310 and MIL-PRF-38534 as applicable.
- 3.7.7 Lot Traceability: Production lot for these oscillators shall be homogenous. Each element used in the production lot shall be traceable to a single lot. Swept quartz shall be traceable to the quartz bar, and its applicable processing details.
- 3.7.8 Prohibited Materials: The following items shall not be used in these oscillators: Pure Tin (Sn >97%), Cadmium, Zinc, Mercury, Selenium, Silver as under plate. Gold Plating without a nickel barrier.
- 3.7.9 Element Derating: All active and passive elements shall be derated in accordance with the applicable Hybrid microcircuit requirements of MIL-STD-975. Elements shall not operate in excess of derated values.
- 3.7.10 Material Outgassing: All materials shall meet a TML of 1% Max. and a CVCM of 0.1% Max., when tested in accordance with ASTM E595.

4. QUALITY ASSURANCE PROVISIONS: The quality assurance provisions shall be as specified herein.

- 4.1 100% Screening: The 100% screening shall be performed as per Table II. PDA requirements for nondestructive bond pull, burn-in and frequency aging shall be as specified below.
- 4.2 PDA for Nondestruct Bond Pull: Unless otherwise specified, PDA shall be 2% of total number of wires or one wire whichever is greater.
- 4.3 PDA for Burn-in: Unless otherwise specified, PDA for burn-in #2 shall be 2% or 1 oscillator whichever is greater and shall be applicable to +23 °C and/or +25 °C static tests only. In addition Delta Calculation shall be performed after Burn-in and shall count for PDA. All measured values for Delta Calculation shall be recorded. Parts that exceed the specified delta limits shall be rejected and be counted for PDA. Delta Calculation shall be performed at 1.8 VDC for the following parameters:

Input Current	10% change Maximum
Output High Level	10% change Maximum
Output Low Level	0.1V change Maximum

- 4.4 PDA for Frequency Aging: 5% or 1 oscillator whichever is greater. Delta limit for frequency aging shall be as specified in Table I.
- 4.5 Group A inspection shall be performed as per Table III.
- 4.6 Group B inspection shall be performed as per Table IV.
- 4.7 If required by the purchase order, Group C inspection shall be performed as per Table V.

NOTE: Frequency accuracy limit after life test shall be increased by 10 PPM to allow for Accelerated frequency aging at +125°C.

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- 4.8 Group D inspection per Table VI is omitted because it is performed as a part of receiving inspection of packages.
- 4.9 Inspection and Test Data: Unless otherwise specified in the purchase order, the following Inspection and test data documentation shall be supplied with the parts.

(See Page 5 for the description of the Model Numbers XE643E, XE643B & XE643P)

Model XE643K:

Certificate of Conformance
 Summary of Screening Test Results per Table II
 PDA Calculations for Non-Destruct Bond Pull and Burn-in
 Summary of Elements Lot Traceability
 Electrical Tests before and after Burn-in
 Group A Inspection Summary
 Group B Inspection Data
 Group C Inspection Data, if required by the purchase order
 Group D Inspection Data
 Radiographic Inspection Certificate

Model XE643E:

Certificate of Conformance
 Summary of Screening Test Results per Table VII
 Summary of Elements Lot Traceability
 Group A Inspection Summary
 Radiographic Inspection Certificate

Model XE643B:

Certificate of Conformance
 Summary of Screening Test Results per Table VII
 Group A Inspection Summary
 Radiographic Inspection Certificate, if required by the Purchase Order

Model XE643P:

Certificate of Conformance

- 4.10 The following test and inspection options are available at customer request.

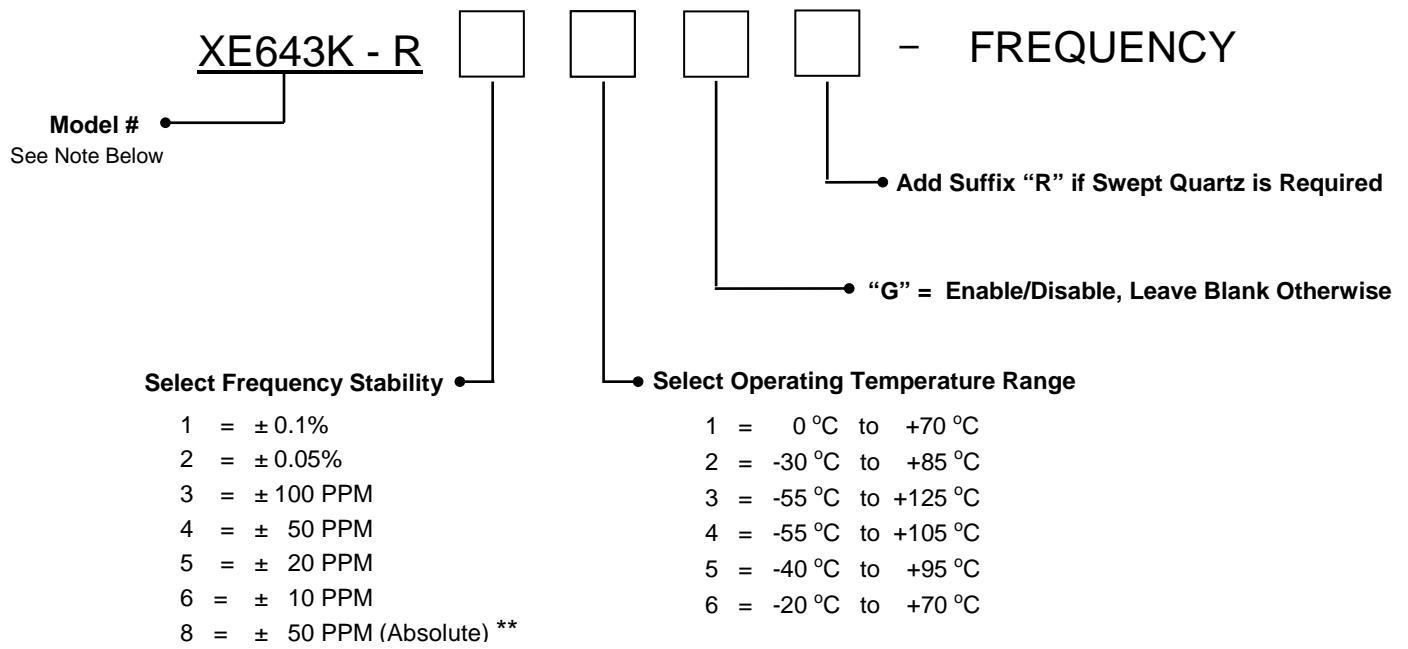
Customer Source Inspection for Pre-Cap and Final
 DPA (Destructive Physical Analysis)
 Group C testing per Table V

5. PRESERVATION, PACKAGING AND PACKING:

The oscillators shall be clean, dry and packaged in a manner to provide adequate protection against electrostatic discharge, corrosion, deterioration and physical damage during shipment.

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6. PART NUMBERING EXAMPLE:



** Option 8 provides ± 50 PPM frequency-temperature stability referenced to the specified nominal frequency including load & supply voltage variations of ± 10%.

(Frequency Stability Options 5 & 6 are not available for all Temperature Range Options)

P/N Example: XE643K - R43 - 24.000 MHz = 24.000 MHz, 1.8V Oscillator, ± 50 PPM Frequency Stability over an operating temperature range of -55 °C to +125 °C.

NOTE: Besides model XE643K, the following additional models are available for applications that can accommodate reduced level of screening and quality conformance inspection:

XE643E: Model XE643E uses the same design and elements as Model XE643K except as follows:

- 100% screening is as per Table III herein
- PDA for Burn-in is 10% or 1 unit whichever is greater
- Delta measurements of paragraph 4.3 are not applicable
- Group A inspection is as per MIL-PRF-55310, Class B
- Group B inspection (30 day aging) per MIL-PRF-55310 is not applicable

XE643B: Model XE643B is same as Model XE643E except as follows:

- Active and Passive Elements are as per MIL-PRF-55310, Class B. The Microcircuit die is the same as in Model XE643K but is not from a radiation tested wafer lot.
- Radiographic Inspection is not applicable, unless required by the Purchase Order at additional cost.

XE643P: Model XE643P is a form, fit and function equivalent prototype of Model XE643K.

- Prototypes may use commercial grade elements and are not screened.
- Quality Conformance inspection is not applicable

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7. PACKAGE OUTLINE:

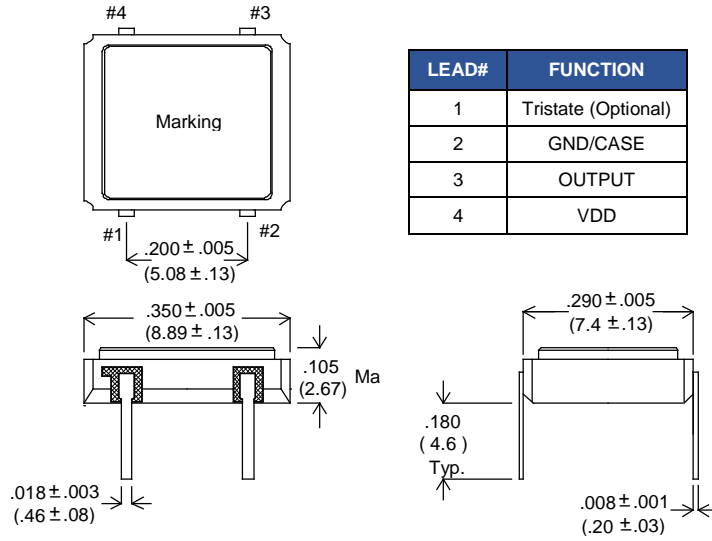


Figure 1 - Package Configuration & Pin Connections

Table I - Electrical Characteristics

Parameter	Spec. Limits
Frequency Range	450 KHz to 125 MHz
Input Voltage	+ 1.8 VDC \pm 10%
Absolute Max. Applied Voltage	+ 5.0 VDC
Frequency Accuracy at 23°C	\pm 15 PPM Max.
Frequency Stability vs. Temperature	See Options in Paragraph 6.0
Operating Temperature Range	See Options in Paragraph 6.0
Input Current at 1.8V (no load)	
450 KHz - 5 MHz	2.0 mA Max.
5 MHz - 10 MHz	2.5 mA Max.
10 MHz - 16 MHz	3.0 mA Max.
16 MHz - 30 MHz	6.0 mA Max.
30 MHz - 55 MHz	10.0 mA Max.
55 MHz - 70 MHz	20.0 mA Max.
70 MHz - 125 MHz	30.0 mA Max.
Output Waveform	Square Wave, HC/ACMOS
Output Duty Cycle (at 50% Output Levels)	55/45% Max
Output Load	10K 15 pF
High Output Level	0.9 VDD Min.
Low Output Level	0.1 VDD Max.
Tristate (Option G)	\geq 0.7 Vdd or Open:Normal Output, \leq 0.3 Vdd:High Impedance
Rise & Fall Times (at 10 to 90% Output Levels)	
450.00 KHz to 16.00 MHz	10 nS Max.
16.01 MHz to 55.00 MHz	5 nS Max.
55.01 MHz to 125.00 MHz	3 nS Max.
Start-up Time	10 mS Max.
Phase Jitter	0.5 pS rms typ, (10 KHz to 20 MHz Integrated)
Frequency Stability Vs. Voltage	\pm 4 PPM Max for \pm 10% change in Supply Voltage
Frequency Aging @ 70°C	\pm 1.5 PPM Max. / 30 days, \pm 5 PPM Max. First Year, \pm 2.5 PPM Max. / Year thereafter

Contact Xsis Engineering for any other special requirements.

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Table II - Model XE643K, Modified MIL-PRF-38534, Class K Screening (100%)

Test - Inspection	Test Method – Condition
Nondestructive Bond Pull	MIL-STD-883, Method 2023
Internal Visual	MIL-STD-883, Method 2017, Level S
Stabilization Bake (Prior to Seal) <u>1/</u>	MIL-STD-883, Method 1008, Condition C (+150 °C), 48 hours minimum
Temperature Cycling	MIL-STD-883, Method 1010, Condition C
Constant Acceleration	MIL-STD-883, Method 2001, Condition A Y ₁ axis only (5000 G)
Seal (Fine and Gross Leak)	MIL-PRF-55310, Para. 4.8.2.2.2
Particle Impact Noise Detection (PIND)	MIL-STD-883, Method 2020, Condition A
Radiographic Inspection	MIL-STD-883, Method 2012, Class S
Pre Burn-in Electrical Tests: Record as applicable	Refer to Table II-a below
Burn-in #1	+125 °C, Nominal Supply Voltage and Burn-in load, 160 Hours Minimum
Interim Electrical Tests: Record as applicable	Refer to Table II-a below
Burn-in #2	+125 °C, Nominal Supply Voltage and Burn-in load, 160 Hours Minimum
Post Burn-in Electrical Tests: Record as applicable	Refer to Table II-a below
Frequency Aging 30 days	Per MIL-PRF-55310
Seal (Fine and Gross Leak)	MIL-PRF-55310, Para. 4.8.2.2.3
External Visual	MIL-STD-883, Method 2009

1/ Vacuum bake and maintain oscillators in dry nitrogen per MIL-PRF-55310.

Table II-a – Pre, Interim & Post Burn-in Electrical Tests

Test Parameter	MIL-PRF-55310 Method	Pre BI 24 ± 1 °C	Interim BI 24 ± 1 °C	Post BI 24 ± 1 °C	Post BI Low Temp	Post BI High Temp
Input Current	4.8.5	✓	✓	✓	✓	✓
Output Frequency	4.8.6	✓	✓	✓	✓	✓
Frequency Vs. Temperature Stability	4.8.10.1	✓	✓	✓	✓	✓
Frequency Vs. Supply Voltage	4.8.14	✓	✓	✓	✓	✓
Output Voltage Levels	4.8.21.3	✓	✓	✓	✓	✓
Output Rise & Fall Times	4.8.22	✓	✓	✓	✓	✓
Output Duty Cycle	4.8.23	✓	✓	✓	✓	✓
Start-up time	4.8.29	✓	✓	✓	✓	✓
Enable/Disable, if applicable	4.8.28	✓	✓	✓	✓	✓

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Table III - Model XE643K, Group A Inspection 1/

Test - Inspection	Test Method – Condition
Input Current Frequency Accuracy Frequency Vs. Supply Voltage Tolerance Output Waveform Output Voltage Levels Output Rise & Fall Times Output Duty Cycle Start-up time Output Enable/Disable Function if Applicable	24 ± 1 °C, Applicable Method of MIL-PRF-55310
Frequency Vs. Temperature Stability	Measure output frequency at ten equispaced points of the operating temperature range.

1/ Any electrical tests performed as part of final electrical tests in 100% screening need not be repeated.

Table IV - Model XE643K, Group B Inspection 1/

Subgroup	Test - Inspection	MIL-STD-883		Quantity (Accept No.)
		Method	Condition	
1	Physical Dimensions	2016	-	2(0)
2	PIND <u>2/</u>	2020	A	15(0)
3	Resistance to Solvents <u>3/</u>	2015	-	3(0)
4	Internal Visual & Mechanical <u>4/</u>	2014	-	1(0)
5	Bond Strength <u>5/</u>	2011	C or D	2(0)
6	Die Shear Strength <u>6/</u>	2019	-	2(0)
7	Solderability	2003	Solder Temp. 245 ± 5 °C	1(0)
8	Seal (Fine & Gross) <u>7/</u>	1014	A1 or B1 & B3	15(0)

1/ Non-catastrophic screening rejects may be used for Group B testing.

2/ This test is performed during 100% screening

3/ This test is performed on each lot of marking ink

4/ Internal Visual inspection is performed at pre-seal on each unit.

5/ This test is performed prior to seal in accordance with Group B bond strength requirements of MIL-PRF-38534.

6/ This test is performed prior to seal in accordance with Group B die shear strength requirements of MIL-PRF-38534.

7/ Fine and Gross tests are being performed during 100% screening.

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Table V - Model XE643K, Group C Inspection

Subgroup	Test - Inspection	MIL-STD-883		Quantity (Accept No.)
		Method	Condition	
1	External Visual	2009	-	5(0) <u>1/</u>
	PIND	2020	A	
	Temperature Cycling	1010	C, 20 cycles	
	Constant Acceleration	2001	5000G, Y ₁ Axis	
	Seal (Fine Leak)	1014	A1 or B1	
	Seal (Gross Leak)	1014	B3	
	Visual Examination	1010	-	
	End Point Electricals	-	-	
2	End Point Electricals Steady State Life End Point Electricals <u>4/</u>	1005	1000 Hours at 125°C	5(0) <u>2/</u>
3	Internal Gas Analysis	1018	-	3(0) <u>3/</u>

1/ Five units are used for Group C inspection in accordance with limited usage requirements of MIL-PRF-38534

2/ Subgroup 1 test samples are not recommended to be used for Subgroup 2 testing

3/ Subgroup 1 test samples shall be used for Subgroup 3 testing.

4/ Frequency accuracy limit shall be increased by 10 PPM to allow for accelerated frequency aging during life test.

Table VI - Model XE643K, Group D Inspection

Subgroup	Test - Inspection	MIL-STD-883		Quantity (Accept No.)
		Method	Condition	
1	Thermal Shock	1011	C	5(0)
	Stabilization Bake	1008	1 hour at 150 °C	5(0)
	Lead Integrity	2004	B2 (lead fatigue)	1(0)
	Seal (Fine & Gross)	1014	A1 or B1 & C	5(0)

Group D inspection is not required when package evaluation has been performed as a part of receiving inspection.

Table VII - Models XE643E & XE643B, Screening (100%)

Test - Inspection	Test Method – Condition
Nondestructive Bond Pull	MIL-STD-883, Method 2023
Internal Visual	MIL-STD-883, Method 2017, Level B
Stabilization Bake (Prior to Seal) <u>1/</u>	MIL-STD-883, Method 1008, Condition C (+150 °C), 24 hours minimum
Temperature Cycling	MIL-STD-883, Method 1010, Condition B
Constant Acceleration	MIL-STD-883, Method 2001, Condition A Y ₁ axis only (5000 G)
Seal (Fine & Gross)	MIL-PRF-55310, Para. 4.8.2.2.2
Particle Impact Noise Detection (PIND)	MIL-STD-883, Method 2020, Condition A
Radiographic Inspection (Model XE643E only) <u>2/</u>	MIL-STD-883, Method 2012, Class S
Pre Burn-in Electrical Tests: Verify Measurements	Refer to Table VII-a below
Burn-in	+125 °C, Nominal Supply Voltage and Burn-in load, 160 Hours Minimum
Post Burn-in Electrical Tests: Verify Measurements	Refer to Table VII-a below
External Visual	MIL-STD-883, Method 2009

1/ Vacuum bake and maintain oscillators in dry nitrogen per MIL-PRF-55310.

2/ Radiographic Inspection is applicable to **Model XE643E** only.

Table VII-a - Pre & Post Burn-in Electrical Tests

Test Parameter	MIL-PRF-55310 Method	Pre BI 24 ± 1 °C	Post BI 24 ± 1 °C	Post BI Low Temp	Post BI High Temp
Input Current	4.8.5	✓	✓	✓	✓
Output Frequency at 23 to 25 °C	4.8.6	✓	✓	✓	✓
Frequency Vs. Temperature Stability	4.8.10.1	✓	✓	✓	✓
Frequency Vs. Supply Voltage	4.8.14	✓	✓	✓	✓
Output Voltage Levels	4.8.21.3	✓	✓	✓	✓
Output Rise & Fall Times	4.8.22	✓	✓	✓	✓
Output Duty Cycle	4.8.23	✓	✓	✓	✓
Start-up time	4.8.29	✓	✓	✓	✓
Enable/Disable, if applicable	4.8.28	✓	✓	✓	✓

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